TITLE

A COMPARATIVE STUDY OF CERTAIN SOIL-BORNE CEREAL PATHOGENS WITH REFERENCE TO CARBOHYDRATE UTILISATION AND POLYSACCHARIDE HYDROLYSIS.

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DEDICATION

The author wishes to dedicate this thesis to his parents Mr. & Mrs. A. A. Magreola, who at an earlier age instilled in him the quest for Knowledge.

ABSTRACT

A Comparative study of certain soil-borne cereal pathogens with reference to carbohydrate utilisation and polysaccharide hydrolysis.

N. O. Magreola

Cochliobolus sativus, *Fusarium culmorum* and *Gaeumannomyces graminis* var *tritici* isolates produced pectin degrading enzymes, xylanase and carboxymethylcellulase when grown in a salts medium with an appropriate carbon source. There was little difference in the amounts of enzymes produced by the organisms except for the greatly enhanced endo-poly-methylgalacturonase activity when *F. culmorum* was grown with citrus pectin as the carbon source. When grown on powdered wheat straw xylanase and carboxymethylcellulase activities were not present until the late stages of incubation whereas pectin degrading enzyme activity appeared at an early stage. Absence of phosphate from culture meduim did not prevent the production of pectin degrading enzymes by *F. culmorum* and *C. sativus* although its presence influenced early enzyme production. Low nitrate concentrations did not preclude cell wall polysaccharide degrading emzymes production. Multiple forms of pectin degrading enzymes were produced by *F.culmorum* and *C. sativus* when grown on citrus pectin and and sodium polypectate.

Uptake of glucose from the culture medium by *F culmorum* was fastest, *C. sativus* was slowest and *G. graminis* var *tritici* was intermediate irrespective of nitrate concentrations. Low levels of nitrate in culture medium drastically reduced the uptake of glucose by *C. sativus*: slightly reduced that of *G. graminis* var *tritici* isolates but increased rate of uptake by *F. culmorum*.

It is suggested that degradation of pectin and xylan and the utilisation of the degradation product may be as important as cellulolysis in the saprophytic survival of these organisms.

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INTRODUCTION

Plant pathogens are living organisms that attack plants and cause diseases (Tarr,1972). It was first suggested by de Barry (1886) that extracellular fungal enzymes are involved in the maceration of plant tissues in soft rot diseases. Following this suggestion, it has been shown that polysaccharide degrading enzymes produced by pathogenic fungi are involved in pathogenesis in some diseases (Gilligan & Reese, 1954; Venkata Ram,1959; Bateman,1963; Wood,1978; Verhoeff,1978; Martinez-Molina & Olivares,1982). These enzymes have also been shown to be important in plant cell wall degradation by pathogens (Sui & Reese, 1953; Garrett,1962; Spalding,1963; Baker & Millar,1966; Eriksson & Petterson,1971; Millar & Mcmillan,1971; Baker,et.al.,1977; Barthe, et. al.,1981; Wick & Schroeder,1982; Chanda & Prabhu,1983; Lal & Prasad, 1983; Rose & Knosel,1983; Haruyoshi,et. al.,1983). Enzyme activity has been found in infected tissues (Bateman & Beer,1965; Cole,1970; Knee & Friend,1970; Mullen & Bateman,1975; Haruyoshi,1983; Arinze & Smith,1983), and eletron microscopic examination indicates that there is a limited degradation of host cell wall material (Sargent,1973).

In some cases, the properties of enzyme(s) isolated from infected tissues are different from those produced by the pathogen in culture (Bateman,1963). It is also noteworthy that multiple forms of the same enzyme may be found in infected tissues or culture filtrates. This multiplicity of form of polysaccharide degrading enzymes was reported by Endo (1963) with Coniothyrium diplodiella, and improved techniques for enzyme separation have subsequently shown its widespread occurrence (Mullen & Bateman,1975; Hirayama, et. al.,1979; Byrde,1982; Marcus & Schejter,1983). The existence and consequences of multiplicity have been recognised in many forms of life and with many enzymes

(Johnson,1973; Markert,1975; Eriksen & Goksøyr,1977; Eriksen,1978; Wood & McCrae,1978; Tong et. al.,1980). Each form may be adapted to a particular environmental situation, thus having ecological significance (Byrde,1982). The special consequences of multiple forms of pectin degrading enzymes in pathogens have been stressed by Hancock,(1976) and Byrde,(1978), to confer versatility to the organism.

THE PLANT CELL WALL AND ITS CONSTITUENTS

Until recently the plant cell wall was regarded as a relatively simple structure containing relatively simple chemical substances. However, it is now known to be more complex than was earlier believed. The plant cell wall is currently considered to be a complex yet ordered structure composed primarily of polysaccharides (cellulose, hemicellulose, and pectin) with cellulose as the important component (Roelofsen,1959 & Wood,1967),structural glycoprotein and in some tissues lignin (Preston, 1952,1959 & 1974; Northcote,1958 & 1972; Honeyman,1959; Aspinall,1959 & 1973; Newcomb,1963; Cowling,1963; Lamport,1970; Keegstra et. al.,1973; Darvill et. al., 1980). It may be viewed as a two phase system: a dispersed phase consisting of cellulose fibrils and a continuous matrix made up of other polysaccharides and a hydroxy-proline glycoprotein.

Functionally, the cell wall may be divided into three regions: middle lamella, primary cell wall and secondary cell wall. The middle lamella serves as an "intracellular cement" that binds cells together in tissue systems (Bateman,1976). The primary cell wall is considered to be the most dynamic region and functions to support the protoplast in young growing cells. It is the first formed wall of the plant. The secondary wall is deposited after the completion of cell elongation. It adds structural strength to the cell wall and functions as a major element in supporting the plant body. In certain species and/or tissues cell walls are lignified after the deposition of the secondary wall region. Lignification is usually associated with cessation of metabolic activity and death of the cells whose walls are lignified. Lignin is deposited throughout the cell wall and may be covalently linked to other wall polymers (Fergus et. al., 1969; Cowling,1975). The polysaccharides in lignified cell walls are believed to be masked and rendered resistant to enzymatic hydrolysis by most plant pathogens (Bateman,1978).

Plant cell wall polysaccharides have historically been grouped into pectic substances, hemicelluloses and cellulose (Northcote,1963). This classification is based upon solubilities of the wall polysaccharides in various extractants, (cold and hot water, solutions of chelating agents and alkali) rather than their chemical compositions. This means of cell wall fractionation give rise to mixtures of polysaccharide components.

The pectic component was previously thought to be consisted of a linear polymer of 1,4-α-linked galacturonic acid units (Joslyn,1962). However, it is now realised that the majority of pectic polysaccharides contain significant amounts of neutral sugar residues and that pure galacturonans are of infrequent occurrence (Aspinall,1973). For exmple, L-rhamnose occurs in the interior of galacturonan chains forming rhamno-galacturonans whereas the other neutral sugars, the most important of which are galactose and arabinose, occur as arabinan and galactan side chains (Aspinall,1973). These neutral polymers are believed to be covalently linked to the rhamnogalacturonide component (Northcote,1969 & 1972). A major component of the pectic fraction is a high molecular weight polymer of α-1,4-linked α-galacturonopyranose interspersed with 1,2-linked rhamnose (Aspinall,1970a; Keegstra et. al.,1973; Talmadge et. al.,1973). The uronic acid carboxyls may be methylated and in some plants the uronide residues may be acetylated at carbons 2 and/or 3 (Kertesz & Lavin,1954; Deuel & Stutz,1958).

The hemicellulose components of the plant cell wall comprises several polymers which contain mainly xylose and mannose often combined with smaller amounts of glucose and galactose. An important hemicellulose in the primary wall region is xyloglucan. This polymer is made up of a β-1,4-linked glucopyranose chain with terminal branches of 1,6-linked D-xylopyranose with the relative amount of the latter varying from one plant source to another (Bauer et. al.,1973). The xylans represent a widely distributed and important group of hemicelluloses in higher plants. Xylans commonly have side branches of 1,3-linked arabinofuranose and α-1,2-linked D-glucuronopyranose (or its 4-methylester) (Aspinall,1970b). Other hemicelluloses include glucomannan, a heteropolymer consisting of a D-glucopyranose backbone with D-mannopyranose side chains (Northcote,1972). The mannans and galactomannans are β-1,4-linked D-mannopyranose chains with the latter having 1,6-linked D-galactopyranose side chains. These last two polymers occur in higher plants but their significance as structural elements does not appear to be resolved. Xyloglucans, xylans and possibly other hemicelluloses have the capacity to hydrogen bond to cellulose (Bauer et. al.,1973).

Cellulose an important component of plant cell walls, is a polymeric insoluble substance in which the extent of interaction of chains varies widely. It has been shown to consist of long chains of β-1, 4-linked D-glucopyranose residues containing as many as 8000-12000 residues. It occurs as microfibrils which constitute primary structural elements. Cellulose fibrils contain both crystallineand amorphous cellulose. Crystalline cellulose is postulated to form as a result of antiparallel deposition of cellulose chains which can result in inter- and intramolecular hydrogen bonding (Muhlethaler,1967; Frey-Wyssling,1969; Preston, 1971; Northcote,1972), but the exact structure of cellulose fibrils is a matter for dispute (Sarko & Muggli,1974). Native cellulose is highly crystalline although amorphous regions occur in the structure (Roelofsen, 1959; Wardrop,1962; Preston,1974). This is a considerable limitation to enzyme attack and to experimental work.

The existence of a structural protein in plant cell walls has been a subject of considerable controversy (Steward et. al.,1967; Sadava &Chrispeels,1969; Colvin & Leppard,1971). It appears that most researchers now agree that a glycoprotein, rich in hydroxyproline, does reside in the primary cell wall region (Lamport,1970; Northcote,1972; Keegstra et. al., 1973; Sadava et. al.,1973). The carbohydrate moities are arabinose and galactose; the former is glycosidically linked to the hydroxyproline residues and galactose is believed to be covalently linked to serine residues (Lamport,1970; Lamport et. al.,1973).

CELL WALL POLYSACCHARIDE DEGRADING ENZYMES

Microorganisms are able to produce several enzymes which are capable of bringing about the degradation of plant cell wall polysaccharides (Endo,1964a; Yoshihara et. al.,1977; Holden & Ashby,1978; Rombouts et. al.,1978; Nakanishi & Yasui,1980; Yoshika et. al.,1981; Rose & Knosel, 1983; Shoemaker et.al.,1983; Rao et. al.,1983; Nadan& Bisaria,1983). The enzymes that degrade the pectic fraction of the middle lamella are generally called 'pectinases'. These include Pectinesterases, Polygalacturonases, and Lyases; those that degrade the cellulose fraction are Cellulases (and are now known to be a complex of several enzymes); while those that degrade the hemicellulose component are known as Hemicellulases prominent amongst which are Xylanases which degrade the xylan fraction.

Pectic Enzymes:

Pectic enzymes are classified into two main groups, namely deesterifying enzymes (Pectinesterases) and the chain-splitting enzymes (depolymerases). Pectinesterase (pectimethylesterase) is classified as a carboxyl ester hydrolase, its systematic name being pectin pectyl-hydrolase, EC 3.1.1.11; it deesterifies pectin, producing methanol and pectic acid. The depolymerases (Endo- and exopolygalacturonases, endo- and exopectate lyases and Endopectin lyase), split the glycosidic bonds of their preffered substrates either by hydrolysis (hydrolases) or by B-elimination (lyases) (Rombouts & Pilnik,1980). The pectic enzymes degrade the rhamnogalacturonide portion of the plant cell wall (Jones et. al.,1972; Mullen & Bateman,1975; Basham & Bateman,1975; Cooper & Wood,1975; Bateman,1978; Friend & Threfall,1978).

Pectinesterases have been purified and characterized from a number of sources (Lee & Macmillan,1968; Miller & Macmillan,1971; Olutiola & Akintunde,1979; Markovic et.al., 1980; Brady et.al.,1982), and may be assayed by different methods (Kertsz,1951; Benkova & Markovic,1976; Brady, 1982; Marcus & Schejter,1983). Fungal pectinesterases have a high specificity towards the methylester of pectic acid. The reduction of some of the methylgalacturonate residues in a pectin chain to galactose residues causes a marked inhibition of enzyme activity (Solms & Deuel,1955). On very highly methylated pectin, about half of the pectinesterase activity may be initiated at the reducing end of the molecules (Lee & Mcmillan,1970; Miller & Mcmillan,1971). The pectinesterase of Clostridium multifermentans, which is complexed with exopectate lyase, attacks its substrate from the reducing end only (Sheiman et.al.,1976).

Endopolygalacturonases are produced by numerous plant-pathogenic and saprophytic fungi, bacteria and by some yeasts (Rombouts & Pilnik, 1980).Recently a number of fungal endopolygalacturonases have been purified and characterized (Ulrich,1975; Cooke et. al.,1976; Heinrichova & Rexova-Benkova,1977; Takehana et. al.,1977; Cervone et. al., 1977 & 1978; Barthe et. al.,1981; Wick & Schroeder,1982; Rose & Knosel,1983; Marcus & Schejter,1983). They show preference for polygalacturonate; the rate and degree of hydrolysis of pectins decrease rapidly with increasing degree of esterification and the same is true for glycyl esters of pectate (Pilnik et. al.,1973).

Exopolygalacturonases are found in plants (Pressey & Avants, 1975a; Riov,1975; Pressey & Avants,1977; Bartley,1978), in the intestinal tracts of a number of insects (Courtois et. al.,1968; Foghetti et. al., 1971), in fungi (Nagel & Hasegawa,1967a; Bateman et. al.,1970; Wagner & Hollman,1976; Haruyoshi et.al.,1983; Lal & Prasad,1983) and in some bacteria (Hatanaka &Ozawa,1971b; Hatanaka & Imamura,1974).

Endopectate lyases are produced by some bacteria and plant pathogenic fungi (Sato & Kaji,1975; Hancock,1976; Kamimiya et. al.,1977; Atallah & Nagel,1977; Cheeson & Codner,1978; Rombouts et. al.,1978; Olutiola & Akintunde,1979). All of these enzymes have very high optimum pH values and an absolute requirement of calcium ions for their activity.

Exopectate lyase is produced by many microorganisms including the fungi (Okamoto et. al.,1964a,b; Macmillan et. al.,1964; Miller & Mcmillan,1971; Castelein & Pilnik,1976; Urbanek et.al.,1976; Sheiman et. al.,1976; Sato & Kaji 1977a,b). It is the only pectic depolymerase produced by certain bacteria (Macmillan & Vaughn,1964; Macmillan et. al., 1964; Hatanaka & Ozawa,1972 & 1973; Castelein & Pilnik,1976; Sato & Kaji, 1977a,b). These enzymes prefer pectate over pectins, and polymethylgalacturonate-methylglycoside is not attacked at all. They are reported to have high optimal pH values (8.0 - 9.5) and an absolute requirement for calcium ions exists for some of the enzymes, while the activities of some are relativelly indifferent towards calcium ions (Hatanaka & Ozawa,1972). In one case, a strong activity is reported with sodium ions (Hatanaka & Ozawa,1973).

Endopectin lyases are produced almost exclusively by fungi, the expections known so far being a soft - rot pseudomonad (Ohuchi & TOminaga, 1974), a strain of Erwinia carotovora (Almengor-Hecht & Bull,1978) and one of Erwinia aroideae (Kamimiya et. al.,1972 & 1974). Some of these have been purified and characterized (Edstrom & Phaff,1964a,b; Amado, 1970; Ishii & Yokotisuka,1972b; Knobel & Neukom,1974; Kamimiya et. al., 1974; Van Hondenhoven,1975; Hasuii et. al.,1976).

In addition to the enzymes described above microorganisms are known to produce another array of enzymes which further degrade the end-products of pectin and pectate hydrolysis (Schlegel,1972; Kosaric & Zajic, 1974). These enzymes are generally called oligogalacturonases. Little is known about fungal production of these enzymes while in the last two decades a lot of research has been done on these enzymes produced by bacteria (Hasegawa & Nagel,1968; Hatanaka & Ozawa, 1969a, b, 1970, 1971a; Schlegel, 1972; Kosaric & Zajic, 1974). These cell - bound enzymes convert oligogalacturonates or unsaturated oligogalacturonates into monomeric units (Rombouts & Pilnik, 1980). The essential difference between these cell-bound enzymes and exo-polygalacturonase and exo-pectate lyase is that they preferentially attack short-chain substrates. Both hydrolases and lyases of these enzymes have been described. The hydrolases attack their substrates from the non-reducing end, whereas the lyases operate from the reducing end (Preiss & Ashwell, 1963a; Mull, 1966a, b; Hasegawa & Nagel, 1968; Hatnaka & Ozawa, 1969a,b). By transelimination, these enzymes remove unsaturated monomers from the reducing end of their substrates, thus converting unsaturated oligogalacturonates into only unsaturated monomers. The products of oligogalacturonate metobolism are unsaturated monomers, and a single D-galacturonate monomer from each oligomer (Rombouts & Pilnik, 1980).

Hemicellulases: The enzymes which hydrolyse the hemicellulosic portion of the plant cell wall are generally termed hemicellulases. This includes xylanases, xylobiases and certain glucanases. The hemicellulosic xyloglucan chain can be fragmented by endo-β-1,4-glucanase (Cellulase, C_x type), but enzymes that remove the 1,6-linked xylopyranose residues apparently have not been properly examined (Bauer et. al., 1963). Endo-β-1,4 xylanases and xylobiases have been described that convert β-1,4-xylan to xylose (Strobel, 1963; Walker, 1967; Van Etten & Batrman, 1969; Hashimoto et. al., 1971; Mullen & Bateman, 1975b; Nakanishi & Yasui,1980; Yoshioka et. al., 1981).

Similarly, endo- and exo-enzymes which hydrolyse β-1,4-linked mannan have been prepared from a number of fungi (Lyr, 1963; Reese & Shibata, 1965; Van Etten & Bateman, 1969). Terminal branch sugar residues of xylans in the cell wall polymer are hydrolysed by specific glycosidases. For example, 1,3-linked arabinose residues of xylans are released by α-L-arabinofuranosidase (Kaji & Yoshihara, 1976), and α-1,6-linked galactose in galactomannan is released by α-galactosidase (Van Etten & Bateman,1969). Pathogenic organisms such as Colletotrichium lindemuthianium and Sclerotium rolfsii are good sources of a variety of glycosidases (English et. al., 1971; Jones & Bateman, 1972).

Cellulolytic Enzymes:

Since the first observations of the action of cellulolytic enzymes invitro (probably Seilliere, 1906), an extensive research has been carried out on cellulolytic enzymes from a variety of microorganisms, with reviews of earlier works given by Sui, (1951); Gascoigne & Gascoigne, (1960); Reese, (1963); Norkrans, (1963 & 1967); Whitaker, (1971); and Emert et. al., (1974).

A major advance in the understanding of cellulase activity was made by introduction of the C_1 - C_x concept by Reese et. al., (1950). This concept was based on the observation that culture filtrates of some cellulolytic microorganisms hydrolyse native cellulose, whereas those from other strains were able to hydrolyse only soluble cellulose derivatives such as carboxymethylcellulose. They suggested that C_1 was a component capable of forming shorter, linear cellulose chains from native cellulose. These chains are then hydrolysed by C_x, which also hydrolysed soluble cellulose derivatives, and which was the cellulase proper. C_1 was therefore considered a 'prehydrolytic factor' not necessarily enzymic (Goksøyr & Eriksen, 1980), and a protein corresponding to this factor was first isolated by Selby & Maitland, (1967). Selby, (1968), suggested that C_1 could be a 'hydrogen bondase' acting by removing hydrogen bonds between adjacent cellulose chains, thereby making them available for attack by C_x enzyme. This idea was supported by King & Vessal. (1969), on the basis of the very low activation energies for C_1 action on native cellulose (Rantela & King, 1968). However, as pointed out by Eriksen & Goksøyr(1977) this argument is not valid in a kinetically complex system like the cellulase system. Eriksson & Pettersson, (1972) isolated a 'C_1-type' protein from Sporotrichium pulverulentum, and showed this to be an enzyme catalysing the splitting of cellobiose and glucose units from the ends of cellulose chains. Similar exo-glucanases were later isolated from a number of fungi (Halliwell & Griffin, 1973; Berghem & Pettersson, 1973 & 1974; Berghem et. al., 1975 & 1976; Gum & Brown, 1976; Eriksen & Goksøyr,1977). The finding that cellobiose is an important end-product of cellulolytic activity also gives a rational explanation of the fact that cellobiase activity is needed to obtain maximal enzyme hydrolysis of native cellulose.

The nature of cellulase complexes have been found to be different for different groups of microorganisms so that it is difficult to make generalisations valid for all types of microorganisms. The gliding bacteria and the brown rot fungi exhibit only endoglucanase activity (Osmundsvag & Goksøyr, 1975; Yamane et. al., 1971; Eidsa, 1972; Suzuki, 1975; Highley, 1975), while the fungal group - ascomycetes and Deuteromycetes, with a few exceptions exhibit both exo- and endo-glucanase activity (Halliwell, 1966; Berghem & Pettersson, 1974; Almin et. al., 1975; Wood & McCrae, 1972, 1975 & 1978; Berghem et. al., 1975 & 1967; Gum & Brown, 1976; Eriksen & Goksøyr, 1976 & 1977; Eriksson, 1978; Tong et. al., 1980; Shoemaker et. al., 1983).

The enzymes making up the cellulase complex have been shown to act in a synergistic or cooperative manner on native cellulose (Selby, 1968; Wood, 1975; Wood & McCrae, 1977b, 1978 & 1979; Mchale & Coughlan, 1980). A study by Wood (1975), revealed that there is a stoicheiometric relationship between the amount of endo- and exo-glucanase which gives the highest cellulolytic activity. The synergism observed in cellulase complex activity is however, found not to be species specific (Wood, 1968; Wood & McCrae, 1977b). Also the discovery that C_1 acts synergistically only with certain C_x components suggests that the proposed mechanism is an over-simplification (Wood & McCrae, 1978).

ROLE OF ENZYMES IN PLANT DISEASES

The rate of production of cell wall degrading enzymes is of significance to the development of pathogens in their hosts (Wood, 1978; Verhoeff, 1978). This is an important factor in determining whether or not the pathogen becomes quickly established and multiplies in host tissues, or how severe the disease will be. Studies with soft-rot bacteria parasitic on potato tubers suggest that significantly large quantities of macerating enzymes are secreted before active growth starts (Murrant & Wood, 1957). This may also happen with spores and germ tubes of fungi.

Recent studies on isolated cell walls have emphasized that degradation of the rhamnogalacturonan moeity of the pectic fraction is important in the first stage of cell wall degradation (Basham & Bateman, 1975; Mullen & Bateman, 1975). Karr & Albersheim (1970), found that treatment with a " wall-modifying enzyme", which appeared to have polygalacturonate hydrolase activity was necessary before many cell wall polysaccharide hydrolases could catalyse hydrolytic reactions on cell walls isolated from Phaseolus vulgaris. Thus it seems that endolyases and endo-hydrolyases are of great importance in the initial stages of cell wall degradation. The necessity for at least partial degradation of the rhamnogalacturonan fraction of the wall before enzymes which hydrolyse other polysaccharides can act on wall fragments is further established by several reports on the sequence of production of cell wall polysaccharide degrading enzymes by pathogens. In all the cases so far reported, in which pathogens have been cultured on isolated plant cell walls, the first enzymes produced are those that degrade the rhamnogalacturonan polymers followed by enzymes which hydrolyse the hemicellulose; cellulase is the last enzyme to be produced (English et. al., 1971; Jones et. al., 1972; Mullen & Bateman, 1975; Cooper & Wood, 1975; Friend & Threlfall, 1978). These findings emphasize the key role of the rhamnogalacturonan chain in the attack on plant cell walls; this is particularly consistent with the model structure proposed for the wall of sycamore cells grown in suspension culture (Keegstra et. al., 1973; Talmadge, 1973; Albersheim, 1975; Friend & Threlfall, 1978). In the model, it is proposed that the pectic and hemicellulose components are covalently linked to each other and that the cellular microfibrils are hydrogen-bonded to the xyloglucan hemicellulose. The model also contains glycoprotein which is now generally accepted as a structural component of cell walls (Lamport, 1970; Preston, 1974).

Although, the involvement of pectic enzymes in plant pathogenesis has been reviewed regularly (Bateman & Millar, 1966; Starr & Chatterjee, 1972; Hall & Wood, 1973; Mussell & Strand, 1977), these are not the only enzymes involved. Once the other polysaccharides in the plant cell wall become exposed by degradation of pectic substances, the pathogen may be induced to produce high levels of other enzymes, including glycosidases, hemicellulases and cellulases. This may lead to a sequence of enzyme induction. In such systems, exo-enzymes and glycosidases may play an important role. They may provide the monomeric or oligomeric compounds necessary for specific induction of certain exo-enzymes (Wood & Cooper, 1975). In addition to these enzymes, other enzymic factors, for which substrates are as yet unknown, may be involved in tissue maceration and plant pathogenesis. Such a factor was purified from A. japonicus (Ishii & Kiho, 1976; Ishii, 1977). This factor stimulates tissue maceration by endo-pectin lyase and endo-polygalacturonase, although it does not macerate by itself or stimulate the enzymes in their activity on pectin and pectate.

The interpretation of the role of wall degrading enzymes in pathogenesis is compounded by the fact that some non-pathogenic fungi e.g. Trichoderma viride and higher plants also produce polysaccharide degrading enzymes (Delincee, 1976; Gong et. al., 1979; Machova & Markovic, 1981; McAlpine et. al., 1982; Puri et.al., 1982).

It is however, clear that the ability to attack plant cell walls is a widespread attribute of plant pathogenic fungi (Wood, 1967). However, despite intensive work over many years which has led to an extensive literature, there remain many unsolved problems.

COMPETITIVE SAPROPHYTIC ABILITY OF SOIL BORNE CEREAL PATHOGENS

Garrett and his co-workers made a comparative study of several soil-borne cereal pathogens. They compared the competitive saprophytic colonisation of substrates and saprophytic survival in dead host tissues. It is apparent from these experiments that the pathogens studied have varied and distinct physiological differences. Some have a high degree of competitive saprophytic ability for colonisation of wheat straws whilst others are intermediate in behaviour, or have a low degree of competitive saprophytic ability (Butler, 1953; Burgess & Griffin, 1967; Garrett, 1966, 1967 &1970). When extra nitrate was provided it was found that those pathogens with a high degree of competitive saprophytic ability have a prolonged survival, while those with low degree of competitive saprophytic ability had a shortened survival (Butler, 1953 & 1959; Garrett, 1966 & 1970). These physiological characteristics have a bearing on survival during the winter period. When the degradation of cellulose filter paper by culture of these organisms was studied it was found that those organisms with a strong negative response to nitrate in saprophytic survival have a high cellulolysis rate. However, cellulolysis rate by itself could not be correlated at all clearly with the nitrate effects. The "Cellulolysis Adequacy Index"(CAI) concept was therefore invoked to explain the results. The concept showed that a high value of CAI is associated with a strongly positive response to nitrate in longevity of survival and a low value of the index with a strongly negative response (Garrett, 1966 & 1970). An inverse relationship between competitive saprophytic ability and pathogenicity was also found (Garrett, 1970 & 1976). Organisms with strong competitive ability are weak pathogens while those with a weak competitive saprophytic ability are strong pathogens. The hypothesis finally concluded that the primary factor determining the survival of a fungus to nitrate is its own behaviour in rapidly utilising the cellulose, and that other fungi or soil microbes play a subsidiary role in the decomposition and eventual exhaustion of the substrate.

The probability of successful saprophytic colonization of a standard substrate by a fungus under uniform environmental conditions is determined by the intrinsic saprophytic ability of the particular fungus and its inoculum potential (Garrett, 1958, 1960a & 1970). Competitive saprophytic ability is defined as the summation of physiological characteristics that make for success in competitive colonization of dead organic substrates (Garrett, 1956). Saprophytic ability is thus an innate or genetic characteristic of the organism, like pathogenicity in a parasite, though such phenomena as loss of pathogenecity in prolonged artificial culture indicate that physiological races of specialised parasites differ in pathogenicity. There are four characteristics that contribute to high saprophytic ability; (1), high growth rate and rapid germination of spores, (2), ability to produce a range of enzymes, (3), production of antibiotic toxins and (4), tolerance of antibiotics produced by other microorganisms (Garrett, 1970). In more specialised parasites, however, a high fungal rate is likely to be more of a disadvantage than an asset, tending to prevent evolution towards a harmonious host-parasite relationship. Similarly, other aggressive behaviour on the part of the parasite, such as copious production of tissue-destroying enzymes and excretion of antibiotic toxins might induce the production of substances from the host which might be unfavourable to the prolonged existence of the parasite.

The present investigation has been concerned with the production of cell wall polysaccharide degrading enzymes in relation to saprophytic ability of three well known and important soil-borne cereal pathogens (Fusarium culmorum, Cochliobolus sativus and Gaeumannomyces graminis var tritici). These belong to a class of fungi which are classified as soil - inhabiting saprophytes by early researchers. This characteristic was demonstrated by showing the fungi as colonizers of dead organic material buried in (unsterilised) soil. The saprophytic colonization of dead organic material was suggested by frequent isolation of the fungus under investigation from dead plant tissues - roots, stems or leaves (Leach, 1937; Sadasivan, 1939 & 1952; Blair, 1943; Subramanian, 1946; Zacchariah, 1949). However, it is important to realise that mere isolation of a fungus from dead plant tissues does not in itself constitute proof that the fungus is a soil - inhabiting saprophyte, because the tissues may have been invaded while still alive.

FUSARIUM CULMORUM

Fusarium culmorum is well described in Wollenweber & Reinking (1935), " Die Fusarien", the CMI Descriptions Set, 3, sheet 26, 1964, and in Booth, (1977), Fusarium, Laboratory guide to the identification of the Major Species. The macroscopic features are described by Colhoun & Park, 1959 - Fusarium diseases of cereals. The perfect state of the fungus is unknown.The fungus produces abundant chlamydospores; a charateristic which probably enhances its isolation from washed soil particles in greater quantities than other species of Fusarium.

The fungus is implicated in the aetiology of the common root-rot of cereals. This disease is least serious in seasons of good summer rainfall (Sallans, 1948; Garrett, 1956). The fungus causes seedling blight of cereals in association with other species of Fusarium. It reduces seed germination of wild oats in low soil humidity, the effect diminishing with increasing temperatures. It is also a widespread wound parasite of many plants, and a common secondary parasite following Ophiobolus graminis (Syn. Gaeummanomyces graminis) in wheat roots (Sadsivan, 1939; White, 1945); because of this characteristic it is somewhat difficult to estimate the role of the fungus as a pathogen. Sadasivan, (1939) showed that F. culmorum is an important colonizer of wheat straw buried in the soil, and this observation was confirmed by Walker, (1941) and Butler, (1953a). The fungus is one of the predominant invaders of senescent wheat roots in Canada (Simmonds, 1928; Broadfoot, 1934; Johnston & Greaney, 1942), England (Bennett, 1928; Samuel & Greaney, 1937), and Australia (White, 1945). In England, F. culmorum also causes brown foot-rot of older cereal plants, but this disease is rarely noticeable except, in hot, dry summers and even then is usually of minor importance. There is evidence that the disease is aggravated by adverse soil conditions, and its occurrence is associated with soils that are too wet or too dry, too heavy in texture, too acid or too saline (Garrett, 1970).

F. culmorum has a wide range of host plants but is known primarily as a pathogen of cereal roots and ears. It's geographical distribution ranges from the north of Scotland to the Congo and India (Garrett, 1956). It is rarely present in forest or nursery soils but very frequent in grassland and arable soils especially in permanent wheat fields. It occurs mainly in the uppermost layers of soil and apparently prefers neutral or faintly alkaline soils. It is a soil-inhabiting saprophyte and forms part of the normal microbiological environment of the roots of plants. It has an optimum growth on agar between 20° and 25°C at pH values of between 4.8 and 8.0 and a relative humidity of at least 91%. It is osmotically tolerant, autotrophic for growth substances and grows in an atmosphere with 3-7% carbondioxide quite normally (Garrett, 1956). Good development is also possible under anaerobic conditions.

F. culmorum is a vigorous saprophytic colonizer of wheat straw (Butler, 1953a) and has a high competitive saprophytic ability (Garrett, 1956, 1966b & 1970). Excess nitrogen increases longevity of saprophytic survival of the fungus (Butler, 1953c & 1959; Garrett, 1967). It has a high tolerance of fungistatic growth products produced by soil microorganisms and a high rate of straw penetration in the soil (Butler, 1953a & b; Garrett, 1970).

COCHLIOBOLUS SATIVUS

Cochliobolus sativus (Ito & Kurib. ex Kurib) Drechs ex Dast is a genus of pyrenomycetes that has conidial states in the genus

Helminthosporium Link. The conidial state is Helminthosporium sorokinianum Sacc. ex Sorokin although a latter synonymn, Helminthosporium sativum Pamm, King & Bakke has been more widely used for this fungus (Luttrell, 1955). The conidial states of Cochliobolus are widely distributed and are destructive pathogens of grasses; but the perfect states are uncommon in nature and difficult to bring to maturity in the laboratory. Consequently ascocarp morphology has not been used much to resolve taxonomic problems of Cochliobolus conidial states. Genetic studies with some species of Helminthosporium syn. Cochliobolus have likewise been impeded. Tinline, (1971) established culture methods to induce ascocarps to form and demonstrated that this fungus is heterothallic.

Cochliobolus sativus is implicated in the aetiology of the common root-rot of cereals (Weste, 1975). It also causes leaf blight of corn and has been implicated in the brown-rot disease of rice. The fungus is regarded as a specialised root - inhabiting fungus of low saprophytic ability. However, there is evidence to suggest that the fungus (like F. culmorum) might be a saprophytic colonizer of dead wheat roots and straw (Garrett, 1970). Because of its low competitive saprophytic ability Cochliobolus sativus is very slow in colonising a substrate in the soil. Fungistatic effect have been noted to affect the germination of spores of the fungus (Simmonds et. al., 1950). Butler, (1953c & 1959) and Garrett, (1966b) discovered that excess of soil nitrogen actually reduced longevity of C. sativus. They suggested that the low competitive saprophytic ability and effect of nitrogen on longevity might be connected with low tolerance of fungistatic growth - products excreted by competing soil microorganisms. This suggestion was agreed to by Wastie, (1961).

The frequent presence of Helminthosporium sativum syn. Cochliobolus sativus is ascribed to its entry of senescent tissues as a weak parasite, rather than as a saprophyte, for which its low saprophytic ability makes it unsuitable. In its parasitic phase, the fungus seems to be limited to infection of seedling tissues, tissues of plants damaged by frost injury or other agents and senescent tissues (Butler, 1948). Cochliobolus sativus thus occupies a somewhat different 'ecological niche' from that of other fungi assigned to the class of specialised root inhabitants, none of which appears to be restricted in the same way as this fungus by host resitance. Optimum temperature for the disease caused by the fungus in wheat seedlings was found by Mckinney, (1923) to be about 28°C, while optimum temperature for growth on agar is 25°C. Mckinney and Davies, (1925) pointed out that the high temperature optimum for disease caused by the fungus was readily explicable as being most favourable for its activity and least favourable for the development of the wheat plant.

GAEUMANNOMYCES GRAMINIS

Gaeumannomyces graminis var tritici (take-all fungus of wheat) has been fully described by Walker, (1972, 1973, 1975 & 1980). The fungus has a wide range of hosts and under the name 'Ophiobolus graminis' has been the subject of intensive study for over a hundred years (bibliographies given by Butler, 1961; Nilsson, 1969; Walker, 1975; Asher & Shipton, 1980). Walker, (1972) has recognised three varieties - var graminis, var tritici Walker and var avenae (E.M. TURNER) Dennis. Gaeumannomyces graminis var tritici is distinguished by the size of its ascospores and by producing simple hyphopodia only.

The fungus has long been recognised as a cosmopolitan and serious pathogen on wheat. It is thought to be second only in importance to stem rust (Puccinia graminis), as the cause of world losses of wheat (Garrett, 1970). There are two symptoms of the disease and both denote different phases of attack. Take-all refers to the killing outright of young plants and Whiteheads relates to a latter or less severe attack which results in empty, bleached ears, although this symptom may also be due to other root parasites. It is a very specialised parasite which grows over the roots of grasses and cereals as demonstrated by experiments of Padwick, (1935); Adam & Colquhoun, 1936; Fellows & Ficke, 1939; and Holden, 1976. Its penetration of cell walls in cereal roots have been shown to be achieved by enzymic degradation rather than mechanical pressure (Holland & Fulcher, 1971).

The fungus is geographically widely distributed and the disease caused is well documented in Australia, N.America and certain European countries including Britain, especially where the crop is grown on the same land for several years in succession (Garrett, 1944a, b, 1948 & 1950; Butler, 1961; Slope & Etheridge, 1971; Holden, 1976; Pearson, 1974; Wildermuth, 1980; Jackson, 1979 & 1982; Holden & Ashby, 1982; Dernoeden & O'Neill, 1983). The destructiveness of the take-all disease of wheat appears to be increased in infertile soil or in those with unbalanced nutrients. The disease is also prevalent on well aerated soils of light texture, especially if it is also alkaline. Adverse soil conditions e.g. low temperatures, high acid content, dryness and poor aeration have a restrictive effect on the spread of the fungus over the roots of its hosts. However, a high population level of the pathogen can nulify this restrictive effect of adverse soil conditions (Garrett, 1936). The fungus persists in the soil on the stubble of the previous cereal crop and on the roots of certain grasses e.g. Agropyron repens. Intensity of attack in the next cereal crop depends partly on the spread of decomposition of this plant material by general microbiological activity in the soil (Garrett, 1970).

Gaeumannomyces graminis var tritici was found to have an intermediate competitive saprophytic ability in relation to F. culmorum and C.sativus (Butler, 1953c; Garrett, 1966, 1967 & 1971). It is susceptible to antagonism by microorganisms present in most natural soils (Sandford & Broadfoot, 1931; Vojinovic, 1973; Baker & Cook, 1974; Shipton, 1975; Wildermuth, 1980), and it competes poorly with the general microflora for the colonization of buried substrates (Garrett, 1970; Deacon, 1973a). The low saprophytic ability of the fungus under the experimental conditions was attributed to both its low tolerance of fungistatic effect and low straw penetration rate. High levels of nitrogen has been found to increase the longevity of saprophytic ability of the fungus (Garrett, 1938, 1940, 1944, 1967 & 1976; Butler, 1953c & 1959; Macer, 1961b; Chambers & Flentje, 1969), and hence severity of take-all disease unless phosphorus is present in adequate amounts to promote the development of new roots to compensate for those injured by disease (Stakman & Harrar, 1957).

The control of take-all disease of wheat has been a subject of intensive study. There is evidence for a widespread natural biological control which depends on crop rotation, nature of the soil and use of non-pathogenic organisms (Glynne, 1965; Baker & Cook, 1974; Prew, 1974; Zogg & Jaggi, 1974; Shipton, 1975; Wong, 1975; Zogg, 1975; Cook & Rovira, 1976; Wildermuth & Rovira, 1977; Wildermuth, 1980); and the judicious use of nitrogenous fertilizers (Garrett, 1948; Huber et. al., 1968; Smiley & Cook, 1973). Gerlagh, (1968) and Cook & Rovira, (1976) concluded from results of experiments that biological control of the take-all caused by G. graminis var tritici may be due to general suppression which occurs after a number of consecutive wheat crops with severe take-all. The sensitivity of G. graminis var tritici to activities of the general micrflora is important to its activity (Henry, 1932), and also as a background against which specific control agents must operate.

MATERIALS & METHODS

MATERIALS & METHODS

(1) ORGANISMS: FUNGAL STRAINS

Five fungal strains were used in this research project. The strains of *Fusarium culmorum* (CMI 180420) and *Cochliobolus sativus* (CMI 160149) used were obtained from the Commonwealth Mycological Institute, Kew, Surrey. The strains of *Gaeumannomyces graminis* var *tritici* (GGT. og12, 43 and WPBS1), *Phialophora radicicola* var *radicicola* (PRR rB) and *Phialophora radicicola* var *graminicola* (PRG. gc) were obtained from Miss. M. Holden of the Rothamsted Exrerimental Station. Cultures were maintained on PDA. or Oat agar plates.

(2a) GROWTH MEDIUM:

The liquid growth medium used was a salts' solution containing the following dissolved in one litre of distilled water: (Garrett, 1966)

Sodium nitrate	5g.
Di-potassium hydrogen phosphate	1g.
Magnesium sulphate pentahydrate	0.5g.
Thiamine	0.1mg.
Biotin	0.1mg.
Ferric ammonium citrate	1mg.

Appropriate carbohydrates (1g/100ml) were added to this liquid culture medium as sole carbon sources according to the requirement for each of the experiments. The liquid medium was sterilised by autoclaving for 15minutes at 10lbs. and 110 C. The carbon sources were sterilised by either subjecting the solid to ultra - violet light for at least 24hrs. or by filtration of a solution through a sterile Millipore filter. All glassware used in the experiments was sterilised by autoclaving at 15lbs. and 120 C for 15minutes.

2b. GROWTH OF FUNGI:

(i) CULTURING OF FUNGI IN LIQUID MEDIUM

The organisms were grown at 25°C in still cultures (unless otherwise stated) in 250cm^3 conical flasks containing 100ml. liquid medium which was inoculated with spore suspension or with an agar disc taken from the edge of a growing colony with a No.1 cork borer. Determination of reducing sugars was carried out daily (unless otherwise stated) on filtrates taken from the growth experiments using Somogyi's method as adapted by Nelson, (1944) for colorimetry (see section 4).

The following carbon sources (1g/100ml) were used: GLUCOSE, ARABINOSE, CELLOBIOSE, XYLOSE, LARCHWOOD XYLAN, CITRUS PECTIN, α-CELLULOSE CELLULOSE FILTER PAPER, MALT EXTRACT, SODIUM CARBOXYMETHYLCELLULOSE, POWDERED WHEAT STRAW. Three replicate flasks were used for each carbon source in growth experiments.

(ii) GROWTH DETERMINATION

Growth of each organism was estimated by determinig the dry weight of mycelia produced. The mycelia were collected by filtration using a Buchner funnel (unless otherwise stated) and dried to constant weight at 50°C in a drying oven.

(3) PREPARATION OF SOMOGYI REAGENTS

The colometric determination of carbohydrate using the Somogyi method as adapted by Nelson, (1944) required three salt solutions designated A, B & C. Each reagent was prepared as follows: (Plummer,1978)

REAGENT A: This reagent was a salts' solution containing 25g of sodium potassium tartrate (Rochelle salt); 25g of anhydrous sodium carbonate; 20g of sodium bicarbonate; and 200g of anhydrous sodium sulphate in a litre of distilled water. Sodium sulphate was dissolved by adding the solid salt, in small portions, with stirring to distilled water because addition of water to the solid impedes its solubility.

REAGENT B: This reagent was a salt solution, containing 30g of cupric sulphate pentahydrate and four drops of concentrated sulphuric acid. The solid cupric salt was first dissolved in 200cm^3 of distilled water before the addition of the acid.

REAGENT C: This reagent was prepared in two separate portions before being added together. 25g of ammonium molybdate was dissolved in 450cm^3 of distilled water containing 21cm^3 of concentrated sulphuric acid. To 3g of sodium arsenite septahydrate solid in a 100cm^3 beaker was added slowly with stirring 25cm^3 of distilled water. The resultant solution was then added to the solution of ammonium molybdate in the dark and made up to 500cm^3 with distilled water in a volumetric flask. The mixture was then transferred into a dark reagent bottle and incubated overnight at 37^{o}C in dark conditions.

(4). DETERMINATION OF GLUCOSE: STANDARD CURVE

Glucose was determined using Somogyi's method adapted for colorimetry by Nelson, (1944). From a stock glucose solution (concentration 1mgcm^{-3}), diluted solutions containing 0.02 - 0.2mgcm^{-3} were prepared. To 1cm^3 of each glucose solution, 1cm^3 of Somogyi reagents A & B (25:1) was added and heated in a boiling water bath for twenty minutes in closed boiling tubes. After cooling, 1cm^3 of Somogyi reagent C was added to each and shaken until effervescence ceased. 7cm^3 of distilled water was added to make the solutions up to 10cm^3 and their absorbance read at 520nm on a Cecil C272 Linear Readout Ultraviolet Spectrophotometer using a mixture of water and Somogyi reagents as a blank. A graph of absorbance against glucose concentrations was then plotted and used to estimate concentration of reducing sugars of unknown solutions.

(5). DETERMINATION OF PROTEIN

Protein was estimated by the Folin - Lowry method (Lowry et. al., 1951).

REAGENTS: 1. Alkaline sodium carbonate solution (20g/l sodium carbonate in 0.1ml/l of sodium hydroxide).

2. Copper sulphate - sodium potassium tartrate solution, prepared freshly by mixing stock solutions (5g/l $CuSO_4.5H_2O$ in 10g/l $COOK.CHOH.CHOH.COONA.4H_2O$).

3. 'Alkaline solution prepared freshly (50ml of (1) and 1ml of (2)).

4. Folin - Ciocaltreau reagent (commercial reagent was diluted with an equal volume of distilled water on day of use). This is a solution of sodium tungstate and sodium molybdate in phosphoric and hydrochloric acid.

5. Albumen solution (standard protein) 0.2mg ml^{-1}.

PROCEDURE: The 'alkaline solution' (5ml) was added to 1ml of test solution with thorough mixing. The mixture was allowed to stand at room temperature for 15minutes. 0.5ml of Folin - Ciocaltreau reagent was rapidly added and immediately mixed. The extinction of the resulting solution was read after 30minutes against a blank (distilled water) at 750nm.

STANDARD CURVE: A standard curve was prepared using the procedure above and standard albumen solutions (0 - 0.2mg ml^{-1}). A graph of absorbance against concentration was plotted and used to estimate the protein concentration of unknown solutions.

(6). ENZYME ACTIVITY ASSAYS

The enzyme activities in culture filtrates were estimated by measuring reducing sugar liberation in reaction mixtures (Nelson, 1944) and by a viscometric procedure (Holden & Ashby, 1978) based on that of Goodenough & Maw, (1974). Lyase activity was assayed spectrophotometrically at 235nm, a wavelength at which unsaturated uronide products of pectin degradation absorb best (Sherwood, 1966; Olutiola & Akintunde, 1979) and by the thiobarbituric acid (TBA) procedure of Neukom (1960) as modified by Olutiola & Akintunde, (1979). Pectinesterase activity was determined by the method of Kertesz, (1951) as modified by Olutiola & Akintunde, (1979).

PROCEDURES:

(a) ENZYME ACTIVITY BY MEASURING LIBERATION OF REDUCING SUGARS (NELSON, 1944)

Culture filtrate (2ml) was incubated at 30°C for 30minutes with 2ml of substrate in 0.075M sodium acetate buffer pH 5.5 (citrus pectin, sodium carboxymethylcellulose, sodium-polypectate and larchwood xylan, 10mg ml^{-1}). The amount of reducing groups released during the incubation period were then estimated by the Somogyi method as adapted for colorimetry by Nelson, (1944), (see section 4), using 1ml of the enzyme/substrate mixture and with reference to a glucose standard curve. Boiled filtrate and substrate mixtures were used as blank unless otherwise stated. In the calculations of enzyme activity data allowance was made for any reducing activity in the enzyme preparation and substrates. One unit of enzyme liberates one nano-mole of reducing group in one minute.

(b). ENZYME ACTIVITY BY VISCOMETRY (Goodenough & Maw, 1974; Holden & Ashby, 1978)

For the enzyme activity assay, a total volume of 8mls. in a U-tube Ostwald viscometer, size C, contained the substrate (citrus pectin 1%, sodium polypectate 3.5%, sodium carboxymethylcellulose 1%, larchwood xylan 2.5% heated at 50°C for 15minutes), the buffer, 0.075M sodium acetate, pH 5.5, and the enzyme solution and/or water in the following volumes - 3ml : 3ml : 1ml : 1ml (to determine activity); or 3ml : 3ml : 2ml : (to determine the flow rate of substrate). The substrate concentrations gave a flow rate of between 80 - 85secs. while the flow rate for water was 25secs. The assay mixture in the viscometer was incubated at 26°C and viscosity readings were taken 10minutes after mixing enzyme and substrate. One unit of activity was defined as the amount of enzyme which decreased the viscosity by 50% in 10minutes under the experimental conditions used. Because there is not a straight line relationship between percentage reduction in viscosity and the amount of enzyme, a calibration curve was constructed from which the units in a sample could be calculated.

The calibration curve was carried out according to Goodenough & Maw, (1974). A highly active polygalacturonase preparation was made into a series of diluted solutions. Each solution was then assayed as described above and a graph of Units of activity against % viscosity plotted. (See Appendix page A210).

(c) LYASE ACTIVITY

Lyase activity was determined by two methods, (1), Sherwood (1966) as modified by Olutiola & Akintunde, (1979) and (2), Neukom,(1960) also as modified by Olutiola & Akintunde, (1979).

METHOD 1: SHERWOOD (1966); OLUTIOLA & AKINTUNDE (1979).

The reaction mixture contained 3ml of 0.1% citrus pectin or sodium polypectate in 0.05M Tris-HCL buffer (pH 8.0) and 0.2ml of culture filtrate. The mixture was incubated at 30°C for 3hrs. To 3ml of 0.01N-HCL was added 1ml of the reaction mixture, mixed thoroughly and absorbance measured at 235nm in 1cm fused silica cells with a Cecil CE 202) Spectrophotometer. In all assays, boiled enzyme and substrate mixtures were employed as controls. One unit of lyase activity was defined as that amount which effected an increase in absorbance of 0.01 in 30mins.

METHOD 2: Thiobarbituric acid (TBA) procedure (Neukom, 1960; Olutiola & Akintunde, 1979)

The reaction mixture contained 3ml of 1.2% citrus pectin or sodium polypectate in 0.05M Tris-HCL buffer, (pH 8.0) and 2ml of culture filtrate. The mixture was incubated at 30°C for 3hrs. After incubation, 1.5ml of 1N-HCL and 3ml of 0.04M thiobarbituric acid (SIGMA) were added to the mixture and maintained at 100°C for 20minutes. When the mixture had cooled, the optical density of the reaction mixture was measured at 550nm. One unit of lyase activity was defined as that amount of enzyme which caused an increase of 0.01 in absorbance in 30minutes.

(d) PECTINESTERASE ACTIVITY (KERTESZ, 1951; OLUTIOLA & AKINTUNDE, 1979)

The reaction mixture contained 5ml of 1.2% citrus pectin or sodium polypectate in 0.05M Tris-HCL buffer, pH 8.0, containing 5mM-NaN_3 and 2ml of culture filtrate in sterile 10ml beaker. The pH of the mixture was readjusted to pH 8.0 with 0.02N-NaOH. The beakers were then covered with parafilm (Gallenkamp) and placed in a water bath at 30°C. At specific time intervals, reaction mixtures were readjusted to pH 8.0 by titration with 0.02N-sodium hydroxide (Talboys & Bush, 1970). One unit of pectinesterase activity was defined as the amount of enzyme that under assay conditions required the addition of 1 microequivalent of sodium-hydroxide in 1hour to maintain the reaction at pH 8.0.

RESULTS

1. Carbohydrate Utilisation in Liquid Culture

Initially it was necessary to determine the ability of the organisms to utilize a range of carbohydrate substrates known to be constituents of plant cell wall polysaccharides. It was found that all the organisms grew on arabinose, cellobiose, glucose or xylose when each was used as the sole carbon source in liquid culture. This was shown by the extensive mycelial growth produced by all the organisms. The ability of the organisms to utilize the carbohydrates was also shown by the decrease in amounts of reducing sugars in the culture medium (Tables 1-5). However, the rate of uptake of each carbohydrate by the organisms was found to be different.

In general, *Fusarium culmorum* exhibited a faster rate of uptake of carbohydrates in liquid culture than *Cochliobolus sativus*, *G. graminis* var *tritici* and *Phialophora* isolates with the exception of xylose uptake. *C. sativus* (Table 4) exhibited slightly faster rate of xylose uptake than *F. culmorum*. *P. radicicola* var *graminis* exhibited in general the slowest uptake of carbohydrates from liquid culture (Table 1-4). *G. graminis* var *tritici* isolates exhibited a very gradual uptake of all the carbohydrates used as carbon sources in culture experiments.

TABLE 1

UTILISATION OF ARABINOSE IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og.12	GGT. 43	GGT.WPBS1	PRR rB	PRG. gc
0	11.95±0.0	11.95 ± 0	11.4 ± 0	11.4 ± 0	11.4 ± 0	11.4 ± 0	11.4 ± 0
1	10.56 ± 0.51	9.83 ± 0.24	12.01 ± 0.03	11.7 ± 0.07	11.48 ± 0.05	11.7 ± 0.21	11.2 ± 0.082
2	10.85 ± 0.08	12.4 ± 0.03	11.25 ± 0.19	11.4 ± 0.07	10.85 ± 0.08	11.1 ± 0.12	10.85 ± 0
3	10.3 ± 0.24	11.22 ± 0.13	11.7 ± 0.35	12.2 ± 0	11.7 ± 0.21	11.4 ± 0.08	12.2 ± 0.19
4	10.8 ± 0.1	11.41 ± 0.01	11.95 ± 0.18	11.95± 0.04	11.4 ± 0	11.95± 0.11	11.4 ± 0.14
5	11.2 ± 0	11.39 ± 0.01	11.78 ± 0.06	11.68± 0.07	11.25 ± 0.12	11.68± 0.05	11.2 ± 0.14
6	12.4 ± 0.14	11.3 ± 0.07	---	---	---	---	---
7	10.66 ± 0.29	10.3 ± 0.11	11.55 ± 0.18	11.4 ± 0.14	11.1 ± 0.11	10.85± 0.04	11.1 ± 0
8	8.78 ± 0.36	9.3 ± 0.26	11.1 ± 0	10.98± 0.1	10.85 ± 0.08	9.5 ± 0.11	10.85 ± 0.07
9	8.96 ± 0.04	9.86 ± 0.08	10.85 ± 0.1	10.75± 0.11	10.68 ± 0.03	10.3 ± 0.14	10.7 ± 0.08
10	8.24 ± 0.08	8.63 ± 0.1	10.3 ± 0.25	10.1 ± 0	10.3 ± 0	10.1 ± 0.28	10.6 ± 0
11	7.61 ± 0.2	7.51 ± 0.07	9.95 ± 0.07	10.2 ± 0	9.5 ± 0.15	9.1 ± 0.35	9.65 ± 0.09
12	8.88 ± 0.07	7.85 ± 0.2	9.98 ± 0.13	10.1 ± 0	9.85 ± 0.07	8.76± 0.26	9.98 ± 0.04
13	8.5 ± 0	8.66 ± 0.17	---	---	---	---	---
14	7.91 ± 0.21	7.75 ± 0.18	10.1 ± 0.11	10.1 ± 0.26	10.1 ± 0.11	8.4 ± 0.04	10.1 ± 0.07
15	7.15 ± 0.14	6.65 ± 0.19	9.95 ± 0.19	9.8 ± 0.11	9.25 ± 0.07	8.4 ± 0.08	9.25 ± 0.07
16	6.54 ± 0.17	6.14 ± 0	9.68 ± 0.16	9.8 ± 0.08	9.08 ± 0.14	7.92± 0.03	9.12 ± 0.04
18	6.33 ± 0.27	5.08 ± 0.07	9.5 ± 0	9.8 ± 0	8.95 ± 0.11	7.6 ± 0.16	9.5 ± 0.18
19	5.85 ± 0.08	4.3 ± 0.18	9.25 ± 0	9.5 ± 0.07	8.4 ± 0.14	7.35± 0.12	8.7 ± 0.15
20	5.63 ± 0.1	4.4 ± 0	8.95 ± 0.04	9.25± 0.08	7.6 ± 0.24	7.05± 0.07	7.9 ± 0.15

TABLE 1 (Contd.)

Cocentration of Reducing of Sugars (mg cm^{-3}) Mean ± S.D.

DAYS	FC	CS	GGT.og.12	GGT. 43	GGT. WPBS1	PRR. rB	PRG. gc
21	5.4 ± 0.15	4.66 ± 0.1	8.7 ± 0.12	9.25 ± 0.07	7.6 ± 0	7.05 ± 0.07	7.9 ± 0.08
22	4.5 ± 0	3.43 ± 0.05	8.7 ± 0	8.95 ± 0.11	6.8 ± 0.32	6.8 ± 0.14	7.9 ± 0
23	4.14± 0.07	3.08 ± 0.03	8.1 ± 0.15	8.1 ± 0.14	6.0 ± 0.16	6.8 ± 0.07	7.6 ± 0.14
25	3.45± 0.07	2.95 ± 0.02	8.1 ± 0.04	8.1 ± 0.16	6.0 ± 0	6.6 ± 0.08	7.6 ± 0.08
26	3.2 ± 0.11	2.61 ± 0.21	7.95± 0.1	7.98 ± 0.16	5.9 ± 0	6.6 ± 0	7.4 ± 0
27	3.11± 0.12	2.53 ± 0.1	7.86± 0.09	7.8 ± 0.07	5.86± 0.07	6.53 ± 0.1	7.38 ± 0.07
28	2.8 ± 0	2.02 ± 0.02	7.75± 0.07	7.6 ± 0.08	5.7 ± 0.07	6.5 ± 0.04	7.35 ± 0.04
29	1.9 ± 0.21	1.56 ± 0.06	7.2 ± 0	7.35 ± 0.15	5.4 ± 0	6.0 ± 0	7.05 ± 0.07
30	0.98± 0.05	0.72 ± 0.02	7.05± 0.07	7.35 ± 0.07	5.25± 0.11	5.85 ± 0.12	6.5 ± 0

All readings are an average of three determinations.
All the microoganisms produced extensive growth although dry weight of mycelium produced was not determined.

FC = *Fusarium culmorum*
CS = *Cochliobolus sativus*
GGT. og.12 = *Gaeumannomyces graminis var tritici* isolate og.12
GGT. 43 = *Gaeumannomyces graminis* var *tritici* isolate 43
GGT. WPBS1 = *Gaeumannomyces graminis* var *tritici* isolate WPBS1
PRR. rB = *Phialophora radicicola* var *radicicola* isolate rB
PRG. gc. = *Phialophora radicicola* var *graminis* isolate gc.

(See Appendix page A2 - A9 for raw data)

TABLE 2

UTILISATION OF CELLOBIOSE IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og.12	GGT. 43	GGT.WPBS1	PRR. rB	PRG. gc.
0	5.7 ± 0	7.48 ± 0	6.75 ± 0	6.75 ± 0	6.75 ± 0	6.75 ± 0	6.75 ± 0
1	5.7 ± 0	6.2 ± 0.14	6.95 ± 0.03	6.08 ± 0.06	6.42 ± 0.13	6.5 ± 0.07	6.8 ± 0.11
2	5.18 ± 0.15	6.85 ± 0.04	6.95 ± 0.07	6.1 ± 0	6.57 ± 0.09	6.15 ± 0.11	6.52 ± 0.13
3	4.84 ± 0.2	6.79 ± 0.03	6.98 ± 0.09	6.16 ± 0.08	6.7 ± 0	5.9 ± 0.15	6.43 ± 0.14
4	4.0 ± 0.15	6.62 ± 0.06	6.75 ± 0.14	6.5 ± 0.07	6.58 ± 0.06	6.2 ± 0.09	6.6 ± 0.08
5	3.65 ± 0.11	6.32 ± 0.06	6.5 ± 0.14	6.5 ± 0	6.75 ± 0.07	6.25 ± 0.08	6.48 ± 0.09
6	2.94 ± 0.15	5.6 ± 0.16	---	---	---	---	---
7	1.52 ± 0.05	5.26 ± 0.1	6.25 ± 0.04	6.0 ± 0.12	6.25 ± 0.09	5.8 ± 0.1	6.13 ± 0.14
8	1.55 ± 0.07	4.81 ± 0.15	6.25 ± 0	6.25 ± 0.11	6.08 ± 0.05	5.4 ± 0.16	5.7 ± 0.08
9	0.86 ± 0.07	5.08 ± 0.06	6.06 ± 0.07	6.25 ± 0.09	6.25 ± 0.07	5.8 ± 0.08	5.6 ± 0
10	0.53 ± 0.02	4.97 ± 0.08	5.6 ± 0	6.5 ± 0.09	6.17 ± 0.06	5.5 ± 0.07	5.5 ± 0
11	0.94 ± 0.01	4.89 ± 0.04	6.25 ± 0.11	6.75 ± 0.09	6.42 ± 0.09	4.9 ± 0	5.06 ± 0.07
12	0.62 ± 0.01	5.32 ± 0.06	6.16 ± 0.09	6.48 ± 0.06	6.15 ± 0.08	5.15 ± 0.16	4.92 ± 0.06
13	0.38 ± 0.03	4.86 ± 0.08	---	---	---	---	---
14	0.1 ± 0.04	4.21 ± 0.07	5.8 ± 0.11	6.03 ± 0.09	5.9 ± 0.08	5.33 ± 0.1	4.76 ± 0.03
15	0.06 ± 0.02	4.34 ± 0.02	6.0 ± 0	6.08 ± 0.07	6.25 ± 0	4.75 ± 0.15	4.36 ± 0.12
16	0.07 ± 0.01	4.11 ± 0.08	5.85 ± 0.08	5.9 ± 0	6.1 ± 0.16	4.65 ± 0.12	4.18 ± 0.06
18	0.09 ± 0	4.08 ± 0.07	5.78 ± 0.03	5.98 ± 0.09	5.97 ± 0.15	4.51 ± 0.13	4.05 ± 0.08
19	0.04 ± 0.01	3.97 ± 0.06	6.42 ± 0.11	6.5 ± 0.07	6.88 ± 0.06	4.53 ± 0.15	3.83 ± 0.09
20	0.02 ± 0	4.12 ± 0.12	5.98 ± 0.12	6.0 ± 0.11	6.52 ± 0.06	3.8 ± 0.09	3.61 ± 0.17

TABLE 2 (Contd.): CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og.12	GGT. 43	GGT.WPBS1	PRR.rB	PRG.gc.
21	0 ± 0	4.14 ± 0.09	5.68 ± 0.1	5.8 ± 0.08	6.23 ± 0.17	3.65 ± 0.07	3.34 ± 0.15
22	0	3.42 ± 0.07	5.57 ± 0.05	5.8 ± 0	5.97 ± 0.1	3.38 ± 0.12	3.03 ± 0.11
23	0	3.53 ± 0.08	5.51 ± 0.01	6.03 ± 0.09	5.77 ± 0.1	3.25 ± 0.07	3.0 ± 0
25	0	3.59 ± 0.02	5.95 ± 0.22	6.08 ± 0.09	6.72 ± 0.08	3.04 ± 0.1	2.68 ± 0.03
26	—	4.76 ± 0.03	5.95 ± 0.17	6.15 ± 0.07	6.45 ± 0.16	2.96 ± 0.07	2.42 ± 0.11
27	—	6.47 ± 0.09	5.95 ± 0.11	6.5 ± 0	6.35 ± 0.07	2.6 ± 0.14	2.08 ± 0.13
28	—	6.53 ± 0.06	5.98 ± 0.09	6.42 ± 0.28	6.33 ± 0.1	2.2 ± 0.15	1.96 ± 0.14
29	—	6.58 ± 0.02	6.05 ± 0.07	6.33 ± 0.07	5.78 ± 0.03	2.05 ± 0.12	2.0 ± 0.06
30	—	6.03 ± 0.07	5.72 ± 0.08	6.25 ± 0.08	5.42 ± 0.06	1.89 ± 0.05	1.64 ± 0.08

All readings are an average of three determinations.
All the microorganisms produced extensive growth although dry weight of mycelium produced was not determined.
The experiment with C. sativus was continued for a longer period as the organism was found to utilise cellobiose very slowly. Reducing sugars were still evident in culture filtrates up to day 69 (1.95mg/ml).
FC = Fusarium culmorum

CS = Cochliobolus sativus

GGT. og12, 43, WPBS1 = Gaeumannomyces graminis var tritici isolates

PRR. rB. = Phialophora radicicola var radicicola isolate.

PRG. gc. = Phialophora radicicola var graminis isolate

(See Appendix page A10 - A16 for raw data)

TABLE 3

UTILISATION OF GLUCOSE IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT. og12	GGT. 43	GGT.WPBS1	PRR. rB	PRG. gc
0	12.28 ± 0	14.33 ± 0	12.2 ± 0	12.2 ± 0	12.2 ± 0	12.2 ± 0	12.2 ± 0
1	12.16 ± 0.11	12.95 ± 0.14	11.86 ± 0.07	12.2 ± 0.14	12.38 ± 0.09	12.8 ± 0.12	12.63 ± 0.21
2	12.1 ± 0	12.16 ± 0.09	12.73 ± 0.13	11.95 ± 0.08	12.31 ± 0.03	13.01 ± 0.14	12.52 ± 0.16
3	12.02 ± 0.2	12.3 ± 0.11	11.95 ± 0.14	11.78 ± 0.09	11.78 ± 0.11	13.4 ± 0.22	12.4 ± 0.08
4	8.97 ± 0.4	12.52 ± 0.06	11.4 ± 0.21	11.92 ± 0.04	11.68 ± 0.07	12.95 ± 0.16	13.01 ± 0.07
5	7.82 ± 0.4	12.82 ± 0.1	11.95 ± 0.19	11.89 ± 0.02	11.95 ± 0.07	12.65 ± 0.15	12.78 ± 0.07
6	7.6 ± 0.21	10.58 ± 0.28	—	—	—	—	—
7	6.85 ± 0.19	10.33 ± 0.2	12.06 ± 0.06	11.86 ± 0.06	12.13 ± 0.11	12.13 ± 0.09	12.11 ± 0.11
8	4.8 ± 0.29	10.3 ± 0.08	11.6 ± 0.24	11.42 ± 0.09	11.96 ± 0.07	11.56 ± 0.09	11.25 ± 0.04
9	3.97 ± 0.39	10.28 ± 0.06	11.72 ± 0.09	10.86 ± 0.09	12.10 ± 0.07	11.75 ± 0.07	11.08 ± 0.07
10	2.72 ± 0.32	9.87 ± 0.14	11.5 ± 0.14	10.4 ± 0.22	12.13 ± 0.07	11.65 ± 0.06	10.95 ± 0.14
11	2.14 ± 0.09	9.63 ± 0.21	11.26 ± 0.09	9.68 ± 0.09	10.85 ± 0.08	11.5 ± 0	11.32 ± 0.06
12	2.01 ± 0.12	8.85 ± 0.21	10.85 ± 0.06	10.21 ± 0.09	10.68 ± 0.14	11.32 ± 0.12	11.18 ± 0.17
13	1.82 ± 0.18	8.78 ± 0.13	—	—	—	—	—
14	0.92 ± 0.02	7.93 ± 0.13	9.69 ± 0.09	9.95 ± 0.07	10.3 ± 0.16	11.21 ± 0.13	10.93 ± 0.11
15	0.34 ± 0.04	7.8 ± 0.14	9.33 ± 0.14	9.23 ± 0.13	10.68 ± 0.11	10.93 ± 0.09	10.76 ± 0.15
16	0.34 ± 0.02	7.26 ± 0.17	9.05 ± 0.1	9.29 ± 0.04	10.35 ± 0.18	10.68 ± 0.06	10.48 ± 0.07
18	0.34 ± 0	7.06 ± 0.09	8.96 ± 0.03	9.33 ± 0.05	9.92 ± 0.24	10.4 ± 0	10.2 ± 0.14
19	0.3 ± 0	6.52 ± 0.06	8.6 ± 0	9.02 ± 0.1	9.5 ± 0.21	10.01 ± 0.12	9.95 ± 0.14
20	0.29 ± 0.01	6.17 ± 0.04	8.6 ± 0.08	8.7 ± 0.16	9.1 ± 0.22	8.96 ± 0.1	9.23 ± 0.09

TABLE 3 (Contd.):

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1	PPR.rB	PRG.gc
21	0.27 ± 0.014	6.07 ± 0.06	8.25 ± 0.12	7.48 ± 0.06	8.15 ± 0.12	8.7 ± 0.14	8.93 ± 0.15
22	0.26 ± 0.01	5.84 ± 0.06	7.91 ± 0.05	7.2 ± 0.22	7.35 ± 0.12	8.31 ± 0.17	8.5 ± 0.08
23	0.24 ± 0.014	5.72 ± 0.11	8.03 ± 0.09	7.2 ± 0.11	6.91 ± 0.16	7.96 ± 0.15	8.2 ± 0.16
25	0.21 ± 0.021	5.65 ± 0.07	7.42 ± 0.1	7.11 ± 0.05	6.31 ± 0.17	7.65 ± 0.29	7.9 ± 0.14
26	0.09 ± 0.022	5.5 ± 0	6.51 ± 0.23	7.05 ± 0	6.15 ± 0.071	7.46 ± 0.06	7.75 ± 0.14
27	0	4.97 ± 0.06	5.75 ± 0.04	6.75 ± 0.18	5.98 ± 0.09	7.18 ± 0.19	7.6 ± 0.18
28	0	5.05 ± 0	5.45 ± 0.09	6.08 ± 0.07	5.93 ± 0.07	7.05 ± 0.04	7.33 ± 0.12
29	0	4.85 ± 0.06	5.3 ± 0	5.3 ± 0.15	5.33 ± 0.17	6.5 ± 0	7.05 ± 0.07
30	0	5.15 ± 0.04	4.65 ± 0.07	4.83 ± 0.08	4.92 ± 0.096	6.5 ± 0.14	6.8 ± 0.08

All readings are an average of three determinations.
All the microorganisms produced extensive mycelial growth although dry weight of mycelium produced was not determined.
FC = *Fusarium culmorum*

CS = *Cochliobolus sativus*

GGT. og.12, 43, WPBS1 = *Gaeumannomyces graminis* var *tritici* isolates.

PRR rB = *Phialophora radicicola* var *radicicola* isolate.
PRG gc. = *Phialophora radicicola* var *graminis* isolate

(See Appendix page A17 - A23 for raw data)

TABLE 4

UTILISATION OF XYLOSE IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1	PRR.rB	PRG. gc.
0	11.1 ± 0	11.1 ± 0	12.5 ± 0	12.5 ± 0	12.5 ± 0	12.5 ± 0	12.5 ± 0
1	12.73 ± 0.11	12.67 ± 0.17	11.4 ± 0.28	10.05 ± 0.11	11.4 ± 0.22	12.2 ± 0.08	11.7 ± 0.12
2	13.5 ± 0.18	12.68 ± 0.07	11.15 ± 0.11	10.3 ± 0.11	10.85 ± 0.11	11.55 ± 0.15	11.0 ± 0.12
3	13.1 ± 0.16	11.4 ± 0.07	10.6 ± 0.29	11.4 ± 0.14	11.55 ± 0.12	10.85 ± 0.13	11.7 ± 0.19
4	12.97 ± 0.14	11.8 ± 0.11	11.7 ± 0.08	12.5 ± 0.19	12.2 ± 0.18	11.95 ± 0.11	12.2 ± 0.21
5	12.75 ± 0.19	12.02 ± 0.15	11.5 ± 0	12.2 ± 0.16	12.08 ± 0.14	11.65 ± 0.15	12.08 ± 0.08
6	12.55 ± 0.07	12.2 ± 0.23	—	—	—	—	—
7	10.85 ± 0.19	10.21 ± 0.1	11.15 ± 0.07	11.95 ± 0.14	11.95 ± 0.11	11.4 ± 0.16	11.95 ± 0.08
8	10.21 ± 0.23	7.62 ± 0.11	10.85 ± 0.11	11.7 ± 0.19	10.85 ± 0.08	10.05 ± 0.18	11.95 ± 0
9	8.43 ± 0.17	7.23 ± 0.15	10.98 ± 0.09	11.85 ± 0.07	10.65 ± 0.2	9.95 ± 0.15	11.8 ± 0.08
10	6.83 ± 0.09	6.85 ± 0.08	11.4 ± 0.14	11.95 ± 0.11	10.05 ± 0.07	9.8 ± 0.08	11.7 ± 0
11	5.78 ± 0.09	5.23 ± 0.12	10.6 ± 0.16	11.4 ± 0.15	9.8 ± 0.16	8.4 ± 0.19	11.4 ± 0.19
12	6.06 ± 0.11	4.78 ± 0.07	10.6 ± 0.08	10.98 ± 0.07	9.8 ± 0.08	8.4 ± 0.11	10.95 ± 0.11
13	5.98 ± 0.03	4.88 ± 0.02	—	—	—	—	—
14	5.15 ± 0.11	4.24 ± 0.07	10.6 ± 0	10.6 ± 0.19	9.8 ± 0	8.4 ± 0.08	10.85 ± 0.07
15	4.18 ± 0.11	3.35 ± 0.07	10.3 ± 0.16	10.3 ± 0.16	9.8 ± 0.14	7.6 ± 0.19	10.3 ± 0.16
16	3.64 ± 0.11	2.8 ± 0.11	9.95 ± 0.19	10.15 ± 0.12	9.65 ± 0.19	7.42 ± 0.08	9.67 ± 0.27
18	2.9 ± 0.14	2.4 ± 0.22	9.8 ± 0.12	10.05 ± 0.04	9.5 ± 0.16	7.35 ± 0.07	9.25 ± 0.23
19	2.65 ± 0.23	1.72 ± 0.12	8.98 ± 0.13	9.8 ± 0.15	9.5 ± 0.14	6.8 ± 0.22	8.7 ± 0.19
20	2.43 ± 0.17	1.54 ± 0.07	7.6 ± 0.22	8.4 ± 0.2	8.0 ± 0.15	6.5 ± 0.15	8.25 ± 0.13

TABLE 4 (Contd.):

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1	PRR rB.	PRG gc.
21	2.31 ± 0.13	1.45 ± 0	6.58 ± 0.06	7.75 ± 0.15	7.35 ± 0.12	6.25 ± 0.11	7.9 ± 0.17
22	1.89 ± 0.11	0.43 ± 0.07	6.25 ± 0.15	7.35 ± 0.11	7.05 ± 0.11	6.25 ± 0.08	7.6 ± 0.19
23	1.62 ± 0.08	0.29 ± 0.05	6.0 ± 0.11	6.8 ± 0.15	6.5 ± 0.37	6.13 ± 0.09	7.05 ± 0.13
25	1.12 ± 0.08	0.13 ± 0.04	5.4 ± 0.22	6.38 ± 0.12	6.0 ± 0.12	5.7 ± 0.11	6.8 ± 0.17
26	1.09 ± 0.05	0.04 ± 0.01	4.9 ± 0.19	5.85 ± 0.11	5.3 ± 0.22	5.4 ± 0.25	6.25 ± 0.19
27	1.07 ± 0.06	0	4.6 ± 0.22	5.7 ± 0.16	5.1 ± 0.09	5.4 ± 0.11	6.25 ± 0.12
28	0.86 ± 0.07	0	4.6 ± 0.16	5.4 ± 0.22	5.1 ± 0.08	5.1 ± 0.09	6.0 ± 0.15
29	0.54 ± 0.07	0	4.35 ± 0.15	4.9 ± 0.23	4.6 ± 0.18	5.1 ± 0	6.0 ± 0.11
30	0.28 ± 0.02	0	4.0 ± 0.15	4.35 ± 0.12	4.18 ± 0.18	4.6 ± 0.08	6.0 ± 0

All readings are an average of three determinations.
All the microorganisms produced extensive mycelial growth although dry weight of mycelium produced was not determined.

FC = *Fusarium culmorum*

CS = *Cochliobolus sativus*

GGT. og12, 43, WPBS1 = *Gaeumannomyces graminis* var *tritici* isolates

PRR rB = *Phialophora radicicola* var *radicicola* isolate

PRG gc = *Phialophora radicicola* var *graminis* isolate

(See Appendix page A24 - A30 for raw data)

2. Degradation and Utilisation of Polysaccharides in liquid culture

Intially it was necessary to determine the ability of the organisms to degrade and utilise products of hydrolysis of polysaccharides known yo be present in the plant cell wall in culture.

All organisms used in these experiments were able to utilise citrus pectin, sodium carboxymethylcellulose or larchwood xylan in liquid culture. Each organism produced significant mycelial growth although these were not determined. Growth was probably achieved by the degradation and subsequent utilisation of the degradation products of the polysaccharides used as substrates. Appearance of reducing groups in culture filtrates (TABLE 6 & 7) and change in consistency of the culture medium indicated that degradation of citrus pectin and sodium carboxymethylcellulose was occurring. The culture medium changed from a cloudy and sticky solution to a colourless or slightly coloured and watery solution. The disappearance of xylan granules and continuous increase in amount of reducing groups in culture filtrates (TABLE 8) indicated that degradation of this polysaccharide occured. The disappearance of xylan granules from culture medium was gradual in experiments with G. graminis var tritici isolates og.12, 43, & WPBS1, while it was rapid in those of F. culmorum (13days) and C. sativus (15days).

Extensive mycelial growth occured when each of the organisms was grown on powdered wheat staw. The presence of the solid particles in the medium throughout the experimental period in all the cultures made quantitative determination of mycelial growth impossible. Production of reducing groups indicated that degradation of the substrate was occuring (TABLE 9). Only traces of reducing groups were detected in growth experiments with F. culmorum and C. sativus (TABLE 9), but extensive mycelial growth by these organisms suggested that the substrate was a suitable carbon source and products of hydrolysis were rapidly removed.

F. culmorum and *C. sativus* grew sparsely when incubated with α-cellulose or cellulose filter paper. No reducing groups were detected in culture filtrates when *C. sativus* was incubated with cellulose filter paper and only traces were detected with *F. culmorum* (TABLE 10). Quantitative determination of mycelial growth was not carried out because it was impossible to separate the mycelium produced by the organisms from the substrates.

TABLE 6

DEGRADATION AND UTILISATION OF CITRUS PECTIN IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
0	0.24 ± 0	0.24 ± 0	0.5 ± 0	0.5 ± 0	0.5 ± 0
1	0.58 ± 0.07	0.48 ± 0.04	0.42 ± 0.08	0.8 ± 0	0.65 ± 0.15
2	0.78 ± 0.07	0.6 ± 0.04	0.8 ± 0	0.63 ± 0.13	1.0 ± 0.17
3	0.95 ± 0.1	0.63 ± 0.03	1.11 ± 0.04	1.18 ± 0.1	1.13 ± 0.06
4	0.5 ± 0.13	0.66 ± 0.04	1.17 ± 0.12	1.52 ± 0.14	1.05 ± 0.23
5	0.8 ± 0.05	0.69 ± 0.07	1.33 ± 0.06	1.52 ± 0.14	1.2 ± 0.09
6	1.24 ± 0.09	0.79 ± 0.06	1.67 ± 0.12	1.6 ± 0	1.35 ± 0
7	1.77 ± 0.08	0.8 ± 0.04	1.22 ± 0.15	0.97 ± 0.14	1.3 ± 0.15
8	2.27 ± 0.1	0.79 ± 0.03	1.17 ± 0.08	1.39 ± 0.05	1.15 ± 0.05
9	2.68 ± 0.04	0.83 ± 0.04	0.8 ± 0	1.1 ± 0	1.1 ± 0
10	2.77 ± 0.08	0.84 ± 0.03	1.35 ± 0	1.23 ± 0.13	1.35 ± 0
11	3.22 ± 0.08	0.85 ± 0.04	1.21 ± 0.07	1.05 ± 0.23	1.28 ± 0.16
12	3.29 ± 0.05	0.86 ± 0.03	1.05 ± 0.23	1.27 ± 0.08	1.5 ± 0
13	3.38 ± 0.08	0.88 ± 0.03	1.35 ± 0	1.38 ± 0.06	1.41 ± 0.24
14	3.42 ± 0.07	0.9 ± 0.04	1.15 ± 0.05	1.12 ± 0.03	1.09 ± 0.03
15	4.24 ± 0.05	0.92 ± 0.02	1.23 ± 0.15	1.3 ± 0.1	1.12 ± 0.05
16	4.45 ± 0.09	0.84 ± 0.01	1.6 ± 0	1.75 ± 0.15	1.33 ± 0.33
18	4.66 ± 0.08	0.81 ± 0.04	0.8 ± 0	1.35 ± 0	0.83 ± 0.06

Table 6 (Contd.):

Concentration of Reducing Sugars (mg cm^{-3}) Mean ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
19	4.73 ± 0.04	0.8 ± 0	0.62 ± 0.06	1.03±± 0.21	0.43 ± 0.15
20	4.84 ± 0.07	0.92 ± 0.02	0.83 ± 0.06	0.8 ± 0	1.1 ± 0
21	4.6 ± 0.11	0.98 ± 0.05	1.1 ± 0.05	1.15 ± 0.05	1.1 ± 0
22	4.56 ± 0.07	1.1 ± 0.04	1.42 ± 0.08	1.32 ± 0.06	1.43 ± 0.08
23	4.48 ± 0.05	1.15 ± 0.07	1.18 ± 0.08	1.2 ± 0.15	1.32 ± 0.08
25	2.48 ± 0.08	1.19 ± 0.03	0.8 ± 0	0.8 ± 0	0.8 ± 0
26	2.36 ± 0.08	1.23 ± 0.05	1.28 ± 0.2	1.18 ± 0.19	1.32 ± 0.07
27	2.02 ± 0.1	1.57 ± 0.04	1.53 ± 0.06	1.47 ± 0.15	1.63 ± 0.15
28	1.79 ± 0.04	1.63 ± 0.12	1.75 ± 0.15	1.75 ± 0.15	1.75 ± 0.15
31	1.32 ± 0.12	1.49 ± 0.05	1.6 ± 0	1.9 ± 0.06	1.9 ± 0
32	0.92 ± 0.12	1.52 ± 0.04	1.37 ± 0.12	1.75 ± 0.15	1.83 ± 0.14

All readings are an average of three determinations.
All the microorganisms produced extensive mycelial growth although dry weight of mycelium produced was not determined. The best growth was observed when this polysaccharide i.e. citrus pectin was the sole carbon source in culture medium.
(See Appendix page A31 - A35 for raw data)

TABLE 7

DEGRADATION AND UTILISATION OF SODIUM CARBOXYMETHYLCELLULOSE IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
0	0.12 ± 0	0.12 ± 0	0.5 ± 0	0.5 ± 0	0.5 ± 0
1	0.14 ± 0.01	0.05 ± 0.01	0	0.25 ± 0	0.25 ± 0
2	0.13 ± 0	0	0.27 ± 0.03	0.25 ± 0	0.26 ± 0.02
3	0.12 ± 0.01	0.03 ± 0.01	0.38 ± 0.13	0.42 ± 0.07	0.38 ± 0.13
4	0.08 ± 0.01	0.06 ± 0.01	0.5 ± 0	0.53 ± 0.06	0.5 ± 0
5	0.1 ± 0.01	0.08 ± 0.01	0.55 ± 0.09	0.58 ± 0.08	0.53 ± 0.06
6	0.14 ± 0.02	0.07 ± 0	0.65 ± 0.15	0.8 ± 0.06	0.77 ± 0.06
7	0.17 ± 0.01	0.12 ± 0.01	0.8 ± 0	0.83 ± 0.06	0.83 ± 0.06
8	0.08 ± 0	0.08 ± 0.01	0.65 ± 0.15	0.8 ± 0	0.8 ± 0

Table 7 (Contd.):

Concentration of Reducing Sugars (mg cm^{-3}) Mean ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
9	0.08 ± 0.01	0.11 ± 0.02	0.53 ± 0.06	0.5 ± 0	0.53 ± 0.06
10	0.08 ± 0	0.12 ± 0.01	0.83 ± 0.06	0.93 ± 0.15	0.73 ± 0.06
11	0.11 ± 0.02	0.13 ± 0.02	0.9 ± 0.17	0.78 ± 0.13	0.63 ± 0.15
12	0.08 ± 0.02	0.14 ± 0.01	1.0 ± 0.17	0.9 ± 0.17	0.73 ± 0.12
13	0.06 ± 0.01	0.12 ± 0.02	0.83 ± 0.06	1.1 ± 0	0.8 ± 0
14	0.05 ± 0.01	0.12 ± 0.01	0.53 ± 0.06	0.5 ± 0	0.5 ± 0
15	0.12 ± 0.02	0.15 ± 0.01	0.25 ± 0	0.25 ± 0	0.28 ± 0.06
16	0.15 ± 0.02	0.14 ± 0	1.27 ± 0.14	1.22 ± 0.1	1.35 ± 0
18	0.17 ± 0.01	0.09 ± 0.02	0.87 ± 0.06	0.53 ± 0.06	0.63 ± 0.15
19	0.18 ± 0.01	0.04 ± 0.01	1.15 ± 0.09	0.9 ± 0.17	0.53 ± 0.06
20	0.16 ± 0	0.13 ± 0.01	1.1 ± 0	1.15 ± 0.09	0.87 ± 0.06
21	0.16 ± 0	0.14 ± 0	0.8 ± 0	0.83 ± 0.06	0.6 ± 0.1
22	0.16 ± 0.01	0.16 ± 0.01	0.8 ± 0	0.87 ± 0.06	0.5 ± 0
23	0.16 ± 0.02	0.09 ± 0.02	0.37 ± 0.12	0.47 ± 0.15	0.37 ± 0.06
25	0.18 ± 0.01	0.13 ± 0.01	0.5 ± 0	0.47 ± 0.06	0.5 ± 0
26	0.16 ± 0.01	0.17 ± 0.01	1.0 ± 0.17	0.63 ± 0.15	0.63 ± 0.15
27	0.14 ± 0.02	0.2 ± 0.01	1.2 ± 0.09	0.85 ± 0.22	1.05 ± 0.23
28	0.14 ± 0	0.16 ± 0.02	1.38 ± 0.06	1.1 ± 0	1.23 ± 0.13
31	—	—	1.4 ± 0.05	1.35 ± 0	1.1 ± 0
32	—	—	1.37 ± 0.03	1.6 ±	0.8 ± 0

All readings are an average of three determinations.

All the organisms produced some growth when this polysaccharide was used as sole carbon source in culture experiments.

Mycelial growth produced (dry weight) were not determined.

Low accumulation of reducing sugars were obtained as shown in the table above.

FC = *Fusarium culmorum*

CS = *Cochliobolus sativus*

GGT. og.12, 43, WPBS1 = *G. graminis* var *tritici* isolates

(See Appendix page A36 - A40 for raw data)

TABLE 8

DEGRADATION AND UTILISATION OF COMMERCIAL LARCHWOOD XYLAN IN LIQUID CULTURE

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
0	0.02 ± 0	0.02 ± 0	0	0	0
1	0.06 ± 0.01	0	0	0	0
2	0.08 ± 0.01	0.39 ± 0.37	0.25 ± 0	0.25 ± 0	0.25 ± 0
3	0.1 ± 0.01	0.68 ± 0.07	0.38 ± 0.13	0.25 ± 0	0.32 ± 0.06
4	0.13 ± 0.02	0.94 ± 0.1	0.95 ± 0.15	0.95 ± 0.15	0.8 ± 0
5	0.19 ± 0.03	1.24 ± 0.11	0.8 ± 0	0.8 ± 0	0.8 ± 0
6	0.24 ± 0.03	1.89 ± 0.05	0.8 ± 0	1.1 ± 0	0.95 ± 0.15
7	0.3 ± 0.07	1.57 ± 0.08	0.43 ± 0.15	0.68 ± 0.16	0.73 ± 0.11
8	0.46 ± 0.09	1.65 ± 0.06	0.6 ± 0	0.93 ± 0.15	0.8 ± 0
9	0.41 ± 0.03	2.13 ± 0.15	0.8 ± 0	1.1 ± 0	0.95 ± 0.15
10	0.38 ± 0.04	1.96 ± 0.15	0.5 ± 0	0.5 ± 0	0.5 ± 0
11	0.32 ± 0.04	1.81 ± 0.04	1.08 ± 0.28	1.23 ± 0.13	1.1 ± 0
12	0.69 ± 0.05	1.18 ± 0.07	1.0 ± 0.17	1.15 ± 0.09	1.22 ± 0.12
13	0.73 ± 0.06	1.4 ± 0.1	1.1 ± 0	1.35 ± 0	1.35 ± 0
14	0.48 ± 0.05	0.98 ± 0.12	0.8 ± 0	0.8 ± 0	1.1 ± 0
15	0.52 ± 0.02	0.36 ± 0.09	0.8 ± 0	0.8 ± 0	0.8 ± 0
16	0.38 ± 0.04	0.18 ± 0.03	1.9 ± 0	1.35 ± 0	1.67 ± 0.11
18	0.25 ± 0.07	0.1 ± 0.01	1.1 ± 0	0.5 ± 0	0.67 ± 0.15
19	0.32 ± 0.02	0.08 ± 0.01	1.03 ± 0.2	0.47 ± 0.06	0.45 ± 0.67
20	0.18 ± 0.04	0.02 ± 0	1.35 ± 0	0.5 ± 0	0.66 ± 0.24
21	0.19 ± 0.02	0	1.6 ± 0	0.8 ± 0	0.53 ± 0.05
22	0.11 ± 0.02	0	1.75 ± 0.15	0.8 ± 0	0.77 ± 0.06
23	0.13 ± 0.02	0	1.6 ± 0	0.43 ± 0.06	0.6 ± 0.2
25	0.14 ± 0.01	0	1.9 ± 0	0.25 ± 0	0.38 ± 0.12
26	0.11 ± 0.02	0	2.03 ± 0.15	0.55 ± 0.09	0.58 ± 0.14
27	0.06 ± 0.02	0	2.16 ± 0.28	0.72 ± 0.08	1.37 ± 0.23
28	0	0	2.7 ± 0	1.1 ± 0	1.6 ± 0
31	0	0	1.9 ± 0	1.32 ± 0.06	1.6 ± 0
32	0	0	0.8 ± 0	1.32 ± 0.03	1.48 ± 0.13

All readings are an average of three determinations. All the microorganisms produced extensive mycelial growth, although this was not quantitatively determined.

(See Appendix page A41 - A45 for raw data)

TABLE 9

DEGRADATION AND UTILISATION OF POWDERED WHEAT STRAW IN CULTURE.

CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.

DAYS	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0.36 ± 0.005	0.01 ± 0.005	0
3	0	0	0.07 ± 0.01	0.04 ± 0.015	0.17 ± 0.03
4	0	0	0.03 ± 0.01	0.06 ± 0.015	1.19 ± 0.09
5	0	0	0.8 ± 0	1.15 ± 0.09	2.08 ± 0.38
6	0	0	0.9 ± 0.17	0.89 ± 0.71	2.4 ± 0.53
7	0	0	1.03 ± 0.35	1.62 ± 0.34	2.67 ± 0.76
8	0	0	0.98 ± 0.32	0.95 ± 0.26	2.0 ± 0.5
9	0	0	1.62 ± 0.16	0.13 ± 0.03	1.87 ± 0.3
10	0	0	1.15 ± 0.09	0.27 ± 0.03	1.58 ± 0.45
11	0	0	1.35 ± 0	0.29 ± 0.14	1.13 ± 0.35
12	0	0	1.55 ± 0.09	0.15 ± 0.04	0.6 ± 0.17
13	0	0	1.68 ± 0.26	0.11 ± 0.03	0.23 ± 0.06
14	0	0	2.25 ± 0.43	0.01 ± 0.01	0.023± 0.02
15	0.01 ± 0	0.01 ± 0.01	2.76 ± 0.25	0.85 ± 0.09	0.53 ± 0.25
16	0.01 ± 0.01	0	3.13 ± 0.56	1.37 ± 0.13	1.08 ± 0.18
18	0.01 ± 0	0.01 ± 0	3.2 ± 0.11	1.95 ± 0.48	1.78 ± 0.45
19	0.04 ± 0.01	0.01 ± 0	4.32 ± 0.02	2.43 ± 0.6	2.5 ± 0.5
20	0.01 ± 0	0	5.06 ± 0.1	3.48 ± 0.88	3.01 ± 0.65
21	0.04 ± 0	0.01 ± 0	5.67 ± 0.07	4.0 ± 0.86	4.5 ± 0.87
22	0.02 ± 0	0	4.93 ± 0.03	2.83 ± 0.58	4.13 ± 0.81
23	0.01 ± 0.01	0	3.77 ± 0.08	2.17 ± 0.35	3.25 ± 0.66
25	0.03 ± 0.01	0.02 ± 0	2.93 ± 0.51	1.78 ± 0.38	2.98 ± 0.69
26	0.03 ± 0.01	0.01 ± 0	2.36 ± 0.37	1.52 ± 0.37	2.45 ± 0.43
27	0.03 ± 0	0	2.26 ± 0.33	2.02 ± 0.42	2.83 ± 0.29
28	0.03 ± 0.01	0	2.08 ± 0.38	2.17 ± 0.29	2.83 ± 0.63
31	0.03 ± 0.01	0	2.08 ± 0.38	2.33 ± 0.58	3.17 ± 1.04
32	0	0	1.27 ± 0.28	1.5 ± 0	1.85 ± 0.13

All readings are an average of three determinations. All the microorganisms produced mycelial growth although this was not determined. Very low accumulation of reducing sugars were obtained for F. culmorum and C. sativus as compared to G. graminis isolates.

(See Appendix page A46 - A50 for raw data)

TABLE 10

DEGRADATION AND UTILISATION OF CELLULOSE FILTER PAPER AND α-CELLULOSE IN LIQUID CULTURE

	CONCENTRATION OF REDUCING SUGARS (mg cm^{-3}) MEAN ± S.D.			
	α-CELLULOSE		CELLULOSE FILTER PAPER	
DAYS	FC	CS	FC	CS
0	0	0	0	0
1	0	0	0	0
2	0.01 ± 0	0.01 ± 0	0	0
3	0	0	0	0
4	0.01 ± 0	0	0.01 ± 0	0
5	0.03 ± 0.007	0.01 ± 0	0.02 ± 0.008	0
6	0.08 ± 0.011	0	0.03 ± 0.008	0
7	0.01 ± 0	0.01 ± 0	0	0
8	0.06 ± 0.008	0.02 ± 0.007	0	0
9	0.04 ± 0.014	0.01 ± 0.008	0	0
10	0.02 ± 0.008	0.02 ± 0.004	0.01 ± 0	0
11	0	0.02 ± 0.008	0	0
12	0.02 ± 0.008	0	0	0
13	0.01 ± 0.008	0	0	0
14	0	0	0	0
15	0.02 ± 0	0	0.02 ± 0	0
16	0.02 ± 0.008	0.01 ± 0	0	0
18	0.02 ± 0.008	0.01 ± 0	0.06 ± 0.016	0
19	0.03 ± 0.014	0	0.01 ± 0	0
20	0.01 ± 0	0.03 ± 0	0	0
21	0.03 ± 0.008	0.01 ± 0.008	0	0
22	0.01 ± 0.008	0	0.06 ± 0.11	0
23	0.02 ± 0.008	0	0.01 ± 0	0
25	0.03 ± 0.008	0	0	0
26	0.03 ± 0.008	0.01 ± 0	0	0
27	0.02 ± 0.008	0.01 ± 0.008	0.01 ± 0	0
28	0.01 ± 0.008	0	0	0
31	0.02 ± 0.008	0	0.03 ± 0	0
32	0	0	0	0

All readings are an average of three determinations.

FC = *Fusarium culmorum* CS = *Cochliobolus sativus*

(See Appendix page A51 - A54 for raw data)

3. Effect of Glucose on Cellulose Filter Paper Degradation and Utilisation in liquid culture

Because of the sparse mycelial growth when *F. culmorum* and *C. sativus* were incubated with cellulose filter paper in the previous growth experiment (see section 2), it was thought that addition of glucose to the culture medium might allow mycelial growth and subsequent degradation of filter paper. To examine this possibility 0.1g of glucose was included with cellulose fiter paper as growth substrates in liquid culture.

Sparse mycelial growth occured and reducing groups were not detected in culture filtrates after the complete uptake of the added glucose (TABLE 11). These observations apply to both organisms. Addition of glucose did not bring about degradation of cellulose filter paper.

TABLE 11

EFFECT OF GLUCOSE ON CELLULOSE FILTER PAPER DEGRADATION AND UTILISATION IN LIQUID CULTURE

	Concentration of Reducing sugars in culture medium (mg cm^{-3}) Mean± S.D.	
DAYS	*F. culmorum*	*C. sativus*
0	1.1 ± 0	1.08 ± 0
1	0.92 ± 0.022	1.05 ± 0.022
2	0.78 ± 0.16	0.81 ± 0.016
3	0.5 ± 0.24	0.73 ± 0.022
4	0.29 ± 0.021	0.57 ± 0.022
5	0.1 ± 0	0.25 ± 0.016
6	0.08 ± 0.014	0.13 ± 0.014
7	0	0.08 ± 0
8	0	0.05 ± 0.014
9	0	0.03 ± 0
11	0	0.02 ± 0.008

Table 11 (Contd.):

DAYS	Concentration of Reducing sugars in culture medium (mg cm^{-3}) Mean ± S.D. F. culmorum	C. sativus
12	0	0.01 ± 0
13	0	0.01 ± 0
14	0	0
15	0	0
16	0	0
17	0.01 ± 0	0
19	0.01 ± 0.008	0
20	0.04 ± 0.008	0
21	0.02 ± 0.008	0
22	0	0
23	0	0
24	0	0.02 ± 0
26	0	0.02 ± 0.008
27	0	0.01 ± 0.008
28	0	0.01 ± 0.008
29	0	0
30	0	0

All readings are an average of three determinations.
Sparse mycelial growth by both microorganisms was observed in all culture experiments.
The Cellulose filter paper retained its tensile strength throughout the experimental period of nine months, although measurements of reducing groups were discontinued after three months.
(See Appendix page A55 - A56 for raw data)

4. FRACTIONATION AND CHARACTERIZATION OF COMMERCIAL LARCHWOOD XYLAN

This experiment was performed to find out the chemical components, that is, the monosaccharides making up the molecule of commercial larchwood xylan; and also to find out if there is any difference in the constituent monosaccharides making up the molecule of hot water soluble and hot water insoluble components of larchwood xylan.

0.25g of commercial larchwood xylan was suspended in 25cm^3 of distilled water and heated at 50^{o}C for 15minutes in a Gallenkamp water bath. It was then cooled and filtered through Whatman No.1 filter paper. The solid was collected and dried at room temperature. The filtrate was poured into 5 volumes of absolute alcohol and the precipitate obtained collected by centrifugation. The first solid collected is the hot water insoluble component of larchwood xylan while the second precipitate is the hot water soluble component of larchwood xylan. Both components were then subjected to acid and enzyme hydrolysis.

In the acid hydrolysis experiment, 1cm^3 of 1N-sulphuric acid was added to a micro-spatula fullof each component in boiling tubes fitted with condensers and heated at 100^{o}C for 6hrs. The mixtures were then allowed to cool and the acid neutralised with barium carbonate. They were then filtered and the filtrates collected and stored.

In the enzyme hydrolysis experiment, 0.1g of each component were suspended in 1cm^3 of hot distilled water. The suspensions after cooling, were then incubated with 1cm^3 of filtrates from culture experiments in which F. culmorum and C. sativus were being grown on sodium carboxymethylcellulose for 3hrs. at 30^{o}C. The reaction mixtures were then cooled to room temperature and stored in sample bottles at 4^{o}C for further use.

Hydrolysates obtained from both acid and enzyme hydrolysis experiments were characterized chromatographically according to Wilson, (1959), and modified by Boothby, (1980). Each hydrolysate was evaporated to about 1cm^3 using a Buchi rotary evaporator maintained at 50^{o}C. Samples (5µ - 30µ) were applied to the origin on Whatman No1 chromatography paper and separated in a solvent mixture butanol/pyridine/ water (6: 4: 3). After 24hrs. sugars were located by the use of aniline-hydrogen-phthalate reagent. A spot containing a mixture of arabinose, galacturonic acid, xylose and glucose was used as a marker.

The hot water soluble component was found to consist of glucose, arabinose, galacturonic acid and xylose. The hot water insoluble component consisted of glucose, arabinose and xylose. In both chromatograms xylose was the major component. The hot water soluble component of commercial larchwood xylan differs from the hot water insoluble component by containing as one of its chemical constituents galacturonic acid units. The molecule of commercial larchwood xylan was found to be made up of xylose, galacturonic acid, arabinose, and glucose.

Enzyme hydrolysis was unsuccessful.

5. Preliminary survey of cell wall Polysaccharide Degrading Enzymes produced in culture.

All organisms were able to produce extracellular cell wall polysaccharide degrading enzymes when grown on an appropriate carbon source (TABLE 12-15). Extracellular pectin degrading enzyme was produced by each of the organisms when grown on several carbohydrates (TABLE 12). However, when grown on citrus pectin, there was a significant increment of enzyme activity which was much greater in culture filtrates of F. culmorum. Because this enzyme liberated reducing groups from citrus pectin it is an exo-enzyme and probably exo-polymethylgalacturonase.

Extracellular polygalacturonase production was influenced by carbon source to a greater extent than was the production of exo-polymethylgalacturonase. The former liberated smallamounts of reducing groups from sodium polypectate irrespective of carbon source, with F. culmorum showing the greater activity (TABLE 13). It is therefore an exo-polygalacturonase. No exo-polygalacturonase activity was detected in culture filtrates when each of the organisms were cultured on filter paper and sodium carboxymethylcellulose.

Extracellular carboxymethylcellulase was produced by F. culmorum when cultured on a variety of carbohydrate substrates (TABLE 14). C. sativus produced the same enzyme only when cultured on sodium carboxymethylcellulose, filter paper and larchwood xylan. G. graminis var tritici isolates did not produce extracellular carboxymethylcellulase irrespective of carbon source in culture experiment (TABLE 14).

Although there were differences in the extent of enzyme activity, depending on carbon source in culture medium, each of the organisms produced extracellular xylanase on a variety of substrates

(TABLE 15). However, F. culmorum was the only organism that produced xylanase when grown on glucose. F. culmorum and C. sativus exhibited the capability to produce extracellular xylanase when cultured on larchwood xylan or a substituted cellulose, in this case, sodium carboxymethylcellulose (TABLE 14 & 15).

Exo-polymethylgalacturonase activity was much greater than that of exo-pogalacturonase, carboxymethycellulase and xylanase irrespective of carbon source in culture medium. This observation applies to all the organisms used in culture experiments.

TABLE 12

Preliminary investigation of culture filtrates of F. culmorum C. sativus and G. graminis var tritici isolates for cell wall polysaccharide degrading enzymes

Enzyme activity by measuring amounts of reducing sugars liberated (µg ml^{-1}) Mean ± S.D.

ENZYME SUBSTRATE : CITRUS PECTIN

GROWTH SUBSTRATES	FC	CS	GGT.og12	GGT. 43	GGT.WPBS1
GLUCOSE	195.6 ± 0.75	150.04 ± 0.49	156.13 ± 0.79	148.24 ± 0.25	141.53 ± 0.54
CITRUS PECTIN	227.58 ± 0.66	187.69 ± 1.05	173.88 ± 0.33	168.23 ± 0.33	158.8 ± 0.51
CELLOBIOSE	115.15 ± 0.32	185.0 ± 0.41	—	—	—
CMC	52.99 ± 0.37	52.75 ± 0.35	37.25 ± 0.48	43.79 ± 0.25	42.89 ± 0.26
FP + G.	3.75 ± 0.71	3.48 ± 0.34	—	—	—
FILTER PAPER	0	0	—	—	—
XYLAN	148.65 ± 0.71	83.3 ± 0.29	27.4 ± 0.32	25.8 ± 0.37	33.33 ± 0.37

CMC = Sodium carboxymethylcellulose FP + G. = Filter paper and 0.1% Glucose.
FC = Fusarium culmorum. CS = Cochliobolus sativus
GGT. og12, 43,WPBS1 = G. graminis var tritici isolates

Enzyme substrates used in the assay has a concentration of 10mg cm^{-3} and were dissolved in acetate buffer (pH 5.5). The assays were carried out for 15minutes. Culture filtrates were filtered to remove mycelial fragments. Dry weight of mycelium produed were not determined. Culture filtrates were taken from 14days old culture experiments with the exception of filter and glucose culture experiments which were 28days old.

(See Appendix page A57 - A63 for raw data)

TABLE 13

Preliminary investigation of culture filtrates of F. culmorum C. sativus and G. graminis var tritici isolates for cell wall polysaccharide degrading enzymes

Enzyme activity by measuring amounts of reducing sugars liberated (µg ml^{-1}) Mean ± S.D.

ENZYME SUBSTRATE : SODIUM POLYPECTATE

GROWTH SUBSTRATES	FC	CS	GGT.ogl2	GGT. 43	GGT.WPBS1
GLUCOSE	18.42 ± 0.48	0	0	0	0
CITRUS PECTIN	11.03 ± 0.16	20.13 ± 0.47	21.43 ± 0.64	12.93 ± 0.17	19.93 ± 0.7
CELLOBIOSE	25.08 ± 0.37	12.7 ± 0.29	—	—	—
CMC	0	0	0	0	0
FP.& GLUCOSE	0	0	—	—	—
FILTER PAPER	0	0	—	—	—
XYLAN	8.07 ± 0.19	18.78 ± 0.3	0	0	0

CMC = Sodium carboxymethylcellulose   FP = Filter paper
FC = Fusarium culmorum   CS = C. sativus   GGT. ogl2, 43, WPBS1 = G. graminis isolates.

Enzyme substrate had a concentration of 10mg cm^{-3} and was dissolved in acetate buffer pH 5.5. Enzyme activity in culture filtrates were assayed at 30°C for 15mins. Culture filtrates were obtained from 14day old culture experiments with the exception of that in which organisms were cultured on filter paper (28 days), and were filtered to remove mycelial fragments. Dry weight of mycelium produced was not determined.

(See Appendix page A57 - A63 for raw data)

TABLE 14

Preliminary investigation of culture filtrates of F. culmorum C. sativus and G. graminis var tritici isolates for cell wall polysaccharide degrading enzymes

Enzyme activity by measuring amounts of reducing sugars liberated (μg ml^{-1}) Mean ± S.D.

ENZYME SUBSTRATE : SODIUM CARBOXYMETHYLCELLULOSE

GROWTH SUBSTRATES	FC	CS	GGT. og12	GGT. 43	GGT. WPBS1
GLUCOSE	58.6 ± 1.28	0	0	0	0
CITRUS PECTIN	20.95 ± 0.98	0	0	0	0
CELLOBIOSE	50.93 ± 0.94	0	—	—	—
CMC	12.23 ± 0.22	11.87 ± 0.25	0	0	0
FP & GLUCOSE	0	0	—	—	—
FILTER PAPER	10.01 ± 0.15	10.54 ± 0.38	—	—	—
XYLAN	19.76 ± 0.35	16.59 ± 0.21	0	0	0

CMC = Sodium carboxymethylcellulose FP = Filter paper
FC = F. culmorum CS = C. sativus GGT. og12, 43, WPBS1 = G. graminis var tritici

Enzyme substrate had a concentration of 10mg cm^{-3} and was dissolved in acetate buffer pH 5.5. Enzyme activity in culture filtrates was assayed at 30°C for 15mins. Culture filtrates were obtained from 14 day old culture experiments with the exception of that in which organisms were cultured on filter paper (28 days), and were filtered to remove mycelial fragments. Dry weight of mycelium produced was not determined.

(See Appendix page A57 - A63 for raw data)

TABLE 15

Preliminary investigation of culture filtrates of F. culmorum C. sativus and G. graminis var tritici isolates for cell wall polysaccharide degrading enzymes

Enzyme activity by measuring amounts of reducings groups liberated (µg ml^{-1}) Mean ± S.D.

ENZYME SUBSTRATE : LARCHWOOD XYLAN

GROWTH SUBSTRATES	FC	CS	GGT. ogl2	GGT. 43	GGT. WPBS1
GLUCOSE	8.12 ± 0.25	0	0	0	0
CITRUS PECTIN	0	0	0	0	0
CELLOBIOSE	0	0	—	—	—
CMC	8.49 ± 0.16	20.23 ± 0.19	15.18 ± 0.15	0.09 ± 0.018	0.056 ± 0.01
FP & GLUCOSE	0	0	—	—	—
FILTER PAPER	0	0	—	—	—
XYLAN	28.4 ± 0.36	24.72 ± 0.33	10.63 ± 0.18	10.04 ± 0.14	0.053 ± 0.011

CMC = Sodium carboxymethylcellulose FP =Filter paper
FC = F. culmorum CS = C. sativus GGT. ogl2, 43, WPBS1 = G. graminis var tritici isolates

Enzyme substrate had a concentration of 10mg cm^{-3} and was dissolved in acetate buffer pH 5.5. Enzyme activity in culture filtrates was assayed at 30^{o}C for 15mins.
Culture filtrates were obtained from 14 day old culture experiments with the expection of that in which organisms were cultured on filter paper (28 days), and were filtered to remove mycelia fragments. Dry weight of mycelia produced were not determined.

(See Appendix page A57 - A63 for raw data)

6. Further survey of cell wall polysaccharide degrading enzyme production in liquid culture.

These enzyme experiments were carried out to test the postulate of Eriksson & Pettersson, (1971), that extracellular xylanase and carboxymethylcellulase are produced when organisms are cultured on larchwood xylan or a substituted cellulose. They were also designed to test the effect of culture age on xylanase production.

Enzyme solutions used were obtained from culture experiments in which F. culmorum and C. sativus were grown on larchwood xylan. The enzyme solutions liberated reducing groups from a variety of polysaccharides used as enzyme substrates, that of F. culmorum liberating the largest amounts irrespective of enzyme substrate (TABLE 16). Pectin degrading enzyme and carboxymethylcellulase activities were also detected. Pectin degrading enzyme activity by F. culmorum was much higher than xylanase and carboxymethylcellulase while the converse was obtained with C. sativus.

Lyophilisation of enzyme solutions resulted in the exclusion of pectin degrading enzyme, an increase in xylanase activity and a slight decrease in carboxymethylcellulase activity. Culture age did not preclude the production of extracellular xylanase but decreased its activity (Compare TABLE 14, 15 & 16). These observations apply to both organisms.

The results obtained from these experiments were in agreement with the postulate of Eriksson & Pettersson, (1971).

TABLE 16

Further investigation of enzyme activity in culture filtrates of *F. culmorum* and *C. sativus*

Enzyme activity by measuring reducing groups liberated (µg ml^{-1}) Mean ± S.D.

ENZYME SUBSTRATES	CULTURE FITRATES FROM GROWTH EXPTS. WITH XYLAN AS SUBSTRATES		LYOPHILIZED CULTURE FILTRATES FROM GROWTH EXPTS. WITH XYLAN AS SUBSTRATES	
	F.culmorum	C. sativus	F. culmorum	C. sativus
CITRUS PECTIN	148.93 ± 0.29	9.01 ± 0.14	0	0
CMC	16.22 ± 0.21	8.55 ± 0.23	9.57 ± 0.29	8.48 ± 0.23
XYLAN	20.83 ± 0.29	12.08 ± 0.1	28.17 ± 0.29	20.77 ± 0.45
H.W.I.C.X.	47.13 ± 0.25	8.9 ± 0.24	—	—
H.W.S.C.X.	80.43 ± 0.62	24.93 ± 0.29	—	—

CMC = Sodium carboxymethylcellulose
H.W.I.C.X. = Hot water insoluble component of larchwood xylan
H.W.S.C.X. = Hot water soluble component of larchwood xylan

Enzyme substrates (1% solutions) were dissolvedin sodium acetate buffer pH 5.5. Enzyme activity assays were carried out at 30°C for 15mins. Culture filtrates were obtained from 28day old culture experiments, and filtered to remove mycelial fragments. Dry weight of mycelium produced was not determined, although good growth was achieved. Lyophilization was carried out using a freeze-drying machine.

(See Appendix page A64 for raw data)

7. Effect of nitrate concentration on growth and utilisation of carbohydrates in liquid culture

There were marked differences in the response of organisms to nitrate concentration in the culture medium when glucose was used as carbon source. Uptake of glucose by F. culmorum was faster than that of the the other organisms irrespective of nitrate concentrations in culture medium (TABLE 17-24) and was completed by day 18 (TABLE 17). In full strength nitrate (5g/1), there was a gradual uptake of glucose by C. sativus and G. graminis var tritici isolates (TABLE 18 & 19). Low nitrate concentration (0.5g/1) in the culture medium increased uptake of glucose by F. culmorum while it decreased that of the other organisms. However, the decrease in uptake by G. graminis var tritici was less than that of C. sativus.

There were no marked differences in the effect of nitrate when citrus pectin and larchwood xylan were used as carbon sources (TABLE 20 & 21). Both organisms were able to degrade and utilize the products of degradation of the polysaccharide substrates. Degradation of polysaccharides was indicated by an initial increase in reducing groups and utilisation was indicated by later gradual decrease of reducing groups as well as mycelial growth.

Although all isolates were able to grow under all the conditions used there were marked differences (TABLE 22A - 24). F. culmorum produced the greatest mycelial dry weight irrespective of nitrate concentration when glucose was used as carbon source while C. sativus produced the smallest (TABLE 22A & B). Low nitrate concentration in culture medium decreased mycelial dry weight produced by C. sativus more than it did G. graminis var tritici isolates. Initially low nitrate concentrations increased mycelial dry weight produced by F. culmorum but later growth was either decreased or maintained at almost the same weight in full strength nitrate (5g/1) (TABLE 22A & B). Mycelial dry weight produced by F. culmorum showed an increase after complete uptake of glucose from culture medium irrespective of nitrate concentrations (TABLE 17 & 22A).

The effects of nitrate concentrations on growth of F. culmorum and C. sativus differed when cultured on citrus pectin and larchwood xylan. There was an initial increase in dry weight of mycelium produced irrespective of nitrate concentrations. This was followed by a period of decreasing mycelial dry weight (TABLE 23). These observations applied to both F. culmorum and C. sativus.

Both organisms produced more mycelial growth when grown on larchwood xylan than when grown on citrus pectin with F. culmorum showing the best growth in full strength of nitrate (TABLE 23 & 24). C. sativus showed a marked decrease in mycelial dry weight in very low nitrate concentrations (0.5g/1) when cultured on citrus pectin than F. culmorum.

TABLE 17

Effect of nitrate concentration in culture medium on glucose uptake by F. culmorum

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	100% NITRATE (5g/1) (1)	100% NITRATE (5g/1) (2)	50% NITRATE (2.5g/1) (1)	50% NITRATE (2.5g/1) (2)	10% NITRATE (0.5g/1) (1)	10% NITRATE (0.5g/1) (2)
0	11.27 ± 0.38	13.46 ± 0.93	11.08 ± 0.29	13.14 ± 0.74	10.77 ± 0.26	13.02 ± 0.56
1	11.98 ± 0.42	13.48 ± 0.5	12.55 ± 0.29	13.4 ± 0.59	11.59 ± 0.59	12.98 ± 0.41
2	11.11 ± 0.27	12.62 ± 0.21	10.86 ± 0.34	13.4 ± 0.75	11.14 ± 0.56	12.69 ± 0.37
3	10.21 ± 0.61	11.45 ± 0.19	10.2 ± 0.12	11.53 ± 0.2	10.14 ± 0.24	11.46 ± 0.32
4	9.5 ± 0.27	9.9 ± 0.41	9.85 ± 0.24	10.46 ± 0.57	10.01 ± 0.26	10.19 ± 0.41
6	8.26 ± 0.7	6.95 ± 0.25	8.86 ± 0.49	8.26 ± 0.53	6.79 ± 0.86	6.18 ± 0.21
7	7.35 ± 0.74	5.95 ± 0.62	7.79 ± 0.42	6.93 ± 0.78	4.72 ± 0.67	2.83 ± 0.45
8	6.5 ± 0.41	4.8 ± 0.62	7.4 ± 0.52	5.28 ± 0.79	3.41 ± 0.71	1.2 ± 0.1
9	5.96 ± 0.26	3.1 ± 0.68	7.11 ± 0.17	3.88 ± 0.56	2.71 ± 0.57	0.25 ± 0.07
10	4.93 ± 0.3	0.98 ± 0.16	6.31 ± 0.62	3.03 ± 0.24	1.43 ± 0.41	0.04 ± 0.01
11	3.51 ± 0.37	0.7 ± 0.07	4.2 ± 0.55	1.13 ± 0.24	0.89 ± 0.12	0.02 ± 0.01
13	1.59 ± 0.3	0.41 ± 0.06	2.88 ± 0.63	1.24 ± 0.13	0	0
14	0.99 ± 0.21	0.01 ± 0	2.18 ± 0.49	1.82 ± 0.07	0	0
15	0.39 ± 0.07		1.41 ± 0.1		0	
16	0.07 ± 0.02		0.61 ± 0.07		0	
17	0		0.12 ± 0.02		0	
18	0		0.08 ± 0.02		0	
20	0		0.01 ± 0		0	
21	0		0		0	

TABLE 17 (Contd.):

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	100% NITRATE (5g/1)		50% NITRATE (2.5g/1)		10% NITRATE (0.5g/1)	
	(1)	(2)	(1)	(2)	(1)	(2)
22	0		0		0	
23	0		0		0	
24	0		0		0	

(1) = Culture experiment terminated after five weeks, although measurement of reducing sugars was discontinued after 24days.

(2) = Culture experiment terminated on the 14th day. This second experiment was carried out to determine behaviour of the fungus while glucose was still present in culture medium.

All datas are an average of six determinations

Nitrate concentrations are with reference to Garrett's culture medium. (Garrett, 1966).

(See Appendix page A65 - A69 for raw data)

TABLE 18

Effect of nitrate concentrations in culture medium on Glucose uptake by Cochliobolus sativus

DAYS	100% NITRATE (5g/1)	50% NITRATE (2.5g/1)	10% NITRATE (0.5g/1)
0	12.58 ± 0.3	11.86 ± 0.12	11.73 ± 0.31
1	11.75 ± 0.11	11.41 ± 0.3	11.4 ± 0.28
2	10.85 ± 0.17	10.84 ± 0.18	10.85 ± 0.34
3	11.26 ± 0.38	10.54 ± 0.26	10.92 ± 0.25
4	9.74 ± 0.39	10.27 ± 0.49	10.95 ± 0.23
6	9.68 ± 0.07	9.86 ± 0.12	9.95 ± 0.17
7	9.47 ± 1.46	9.17 ± 0.96	9.72 ± 0.27
8	8.87 ± 0.05	8.97 ± 0.24	8.98 ± 0.31
9	8.31 ± 0.53	8.58 ± 0.21	7.89 ± 0.13
10	8.14 ± 0.2	8.56 ± 0.07	8.48 ± 0.04
11	7.86 ± 0.41	8.52 ± 0.13	8.65 ± 0.23
13	7.84 ± 0.05	8.61 ± 0.05	8.73 ± 0.13
14	7.79 ± 0.09	8.68 ± 0.05	8.8 ± 0.07
15	7.73 ± 0.06	8.72 ± 0.02	8.89 ± 0.03
16	7.69 ± 0.03	8.8 ± 0.1	9.0 ± 0.17
17	7.66 ± 0.53	8.9 ± 0.26	9.02 ± 0.19
18	7.42 ± 0.51	8.68 ± 0.4	8.71 ± 0.2
20	6.84 ± 0.22	8.24 ± 0.33	8.58 ± 0.08
21	5.93 ± 0.42	7.07 ± 0.18	7.64 ± 0.3
22	6.08 ± 0.18	7.37 ± 0.17	5.39 ± 0.17
23	6.73 ± 0.37	7.76 ± 0.14	8.4 ± 0.17
24	6.53 ± 0.34	7.61 ± 0.19	8.4 ± 0.13
25	5.75 ± 0.37	7.27 ± 0.19	7.83 ± 0.12
26	5.79 ± 0.4	7.25 ± 0.1	7.83 ± 0.09
28	5.34 ± 0.47	7.38 ± 0.19	8.15 ± 0.16
29	5.11 ± 0.48	6.75 ± 0.62	7.43 ± 0.11
30	5.15 ± 0.33	7.0 ± 0.36	7.52 ± 0.1
31	5.03 ± 0.19	6.93 ± 0.3	7.68 ± 0.21
36	3.84 ± 0.51	6.38 ± 0.49	6.93 ± 0.58
38	3.2 ± 0.25	6.23 ± 0.53	6.8 ± 0.36
39	3.08 ± 0.13	4.6 ± 0	7.35 ± 0.16
42	2.8 ± 0.39	4.75 ± 0.12	6.93 ± 0.31

TABLE 18 (Contd.): Cochliobolus sativus (Glucose uptake)

DAYS	100% NITRATE (5g/1)	50% NITRATE (2.5g/1)	10% NITRATE (0.5g/1)
43	2.5 ± 0.16	4.2 ± 0.3	7.6 ± 0.25
44	2.25 ± 0.05	3.53 ± 0.13	7.48 ± 0.14

All datas are an average of six determinations. Nitrate concentrations are with reference to Garratt's medium. (Garrett, 1966).

(See Appendix page A70 - A73 for raw data)

TABLE 19

Effect of nitrate concentrations in culture medium on Glucose uptake by G. graminis var trtici isolates.

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

100% NITRATE CONCENTRATION (5g/1)

DAYS	GGT. og12	GGT. 43	GGT. WPBS1
0	12.2 ± 0	12.2 ± 0	12.2 ± 0
1	11.83 ± 0.13	11.83 ± 0.13	12.48 ± 0.15
2	12.15 ± 0.09	11.87 ± 0.12	12.9 ± 0.14
4	12.78 ± 0.23	11.87 ± 0.12	13.2 ± 0.14
5	12.38 ± 0.2	12.12 ± 0.12	13.15 ± 0.15
7	12.8 ± 0.14	12.6 ± 0.1	12.57 ± 0.09
8	12.6 ± 0.1	12.35 ± 0.15	12.5 ± 0
9	12.35 ± 0.15	12.03 ± 0.12	12.4 ± 0.14
11	11.6 ± 0.14	11.3 ± 0.14	11.78 ± 0.2
12	11.2 ± 0.12	10.98 ± 0.13	10.2 ± 0.22
13	10.6 ± 0	10.4 ± 0.22	9.2 ± 0.11
14	10.4 ± 0.12	9.79 ± 0.17	9.54 ± 0.17
15	10.2 ± 0.14	9.43 ± 0.09	9.83 ± 0.12
18	9.88 ± 0.13	8.74 ± 0.09	8.5 ± 0.22
19	9.63 ± 0.19	8.25 ± 0.15	7.39 ± 0.22
20	8.88 ± 0.2	7.78 ± 0.2	6.75 ± 0.11
21	8.03 ± 0.09	7.35 ± 0.25	5.98 ± 0.22
22	6.91 ± 0.22	7.35 ± 0.14	5.89 ± 0.21

TABLE 19 (Contd.): G. graminis var tritici isolates (Glucose uptake)

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

100% NITRATE CONCENTRATION (5g/1)

DAYS	GGT. og12	GGT. 43	GGT. WPBS1
25	6.5 ± 0	7.6 ± 0	5.8 ± 0.14
26	5.85 ± 0.13	6.38 ± 0.13	6.0 ± 0
27	5.7 ± 0	6.5 ± 0	5.7 ± 0
28	5.03 ± 0.13	6.33 ± 0.12	6.17 ± 0.12
29	4.28 ± 0.21	6.08 ± 0.12	5.8 ± 0.14
32	3.4 ± 0.14	6.17 ± 0.12	5.07 ± 0.12
33	2.1 ± 0.14	6.08 ± 0.12	4.52 ± 0.12
34	1.9 ± 0	5.8 ± 0.14	5.23 ± 0.12
35	2.08 ± 0.2	5.28 ± 0.14	5.8 ± 0.22
36	1.23 ± 0.13	5.9 ± 0.15	4.53 ± 0.2
39	0.5 ± 0	5.7 ± 0	1.9 ± 0
40	0.38 ± 0.13	4.23 ± 0.17	1.43 ± 0.12
41	0.29 ± 0.09	3.6 ± 0.12	0.9 ± 0.14
42	0.17 ± 0.12	2.83 ± 0.23	0.21 ± 0.17

50% NITRATE CONCENTRATION (2.5g/1)

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	GGT. og12	GGT. 43	GGT. WPBS1
0	12.2 ± 0	12.2 ± 0	12.2 ± 0
1	11.64 ± 0.19	12.57 ± 0.09	12.7 ± 0
2	12.35 ± 0.15	12.3 ± 0.14	12.63 ± 0.09
4	12.9 ± 0.14	11.83 ± 0.13	12.12 ± 0.12
5	12.7 ± 0	12.4 ± 0.14	12.12 ± 0.12
7	12.9 ± 0.14	11.78 ± 0.12	12.63 ± 0.09
8	12.57 ± 0.09	11.87 ± 0.12	12.57 ± 0.09
9	12.08 ± 0.13	11.95 ± 0	12.03 ± 0.12
11	11.35 ± 0.27	12.31 ± 0.21	11.25 ± 0.15
12	10.77 ± 0.19	11.12 ± 0.22	10.68 ± 0.2
13	10.02 ± 0.22	9.85 ± 0.36	10.02 ± 0.22
14	9.67 ± 0.12	10.06 ± 0.19	9.5 ± 0.29

TABLE 19 (Contd.): G. graminis var tritici isolates (Glucose uptake)

50% NITRATE CONCENTRATION (2.5g/1)(Contd.)

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	GGT. og12	GGT. 43	GGT. WPBS1
15	9.32 ± 0.26	10.5 ± 0.15	8.63 ± 0.3
18	8.45 ± 0.21	9.28 ± 0.19	7.83 ± 0.18
19	7.75 ± 0.15	8.83 ± 0.13	6.8 ± 0.3
20	7.23 ± 0.13	8.5 ± 0.14	6.48 ± 0.25
21	6.6 ± 0.14	8.2 ± 0.14	6.29 ± 0.22
22	6.13 ± 0.13	7.97 ± 0.09	6.38 ± 0.13
25	5.52 ± 0.31	7.7 ± 0.14	6.5 ± 0
26	5.8 ± 0.14	7.6 ± 0	5.85 ± 0.15
27	4.72 ± 0.26	7.0 ± 0.14	5.23 ± 0.12
28	5.36 ± 0.2	6.65 ± 0.15	5.32 ± 0.12
29	6.17 ± 0.1	5.37 ± 0.19	5.03 ± 0.13
32	6.0 ± 0	4.57 ± 0.19	4.98 ± 0.12
33	5.8 ± 0.14	4.03 ± 0.16	3.87 ± 0.09
34	5.8 ± 0.14	4.08 ± 0.28	4.62 ± 0.22
35	6.16 ± 0.29	3.4 ± 0.14	3.83 ± 0.08
36	4.84 ± 0.19	2.6 ± 0.17	3.07 ± 0.09
39	4.6 ± 0	2.95 ± 0.16	1.7 ± 0.14
40	3.93 ± 0.09	2.04 ± 0.15	1.43 ± 0.1
41	3.7 ± 0.14	2.85 ± 0.21	1.23 ± 0.13
42	3.55 ± 0.27	2.56 ± 0.18	1.04 ± 0.19

10% NITRATE CONCENTRATION (0.5g/1)

Concentration of reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	GGT. og12	GGT. 43	GGT. WPBS1
0	12.2 ± 0	12.2 ± 0	12.2 ± 0
1	11.87 ± 0.19	11.6 ± 0.2	12.03 ± 0.12
2	12.3 ± 0.14	11.83 ± 0.13	11.99 ± 0.09
4	13.0 ± 0.24	12.55 ± 0.18	12.4 ± 0.14
5	12.43 ± 0.18	12.85 ± 0.15	12.78 ± 0.23
7	12.3 ± 0.14	12.9 ± 0.14	11.82 ± 0.25
8	12.12 ± 0.12	12.08 ± 0.13	10.98 ± 0.25

TABLE 19 (Contd.): *G. graminis* var *tritici* isolates (Glucose uptake)

Concentration of reducing sugars in
culture filtrates (mg cm^{-3}) Mean ± S.D.
10% NITRATE CONCENTRATION (0.5g/1)(Contd.)

DAYS	GGT. og12	GGT. 43	GGT. WPBS1
9	11.78 ± 0.12	11.87 ± 0.19	9.93 ± 0.36
11	10.72 ± 0.25	10.85 ± 0.2	9.42 ± 0.19
12	9.75 ± 0.2	9.45 ± 0.28	8.08 ± 0.17
13	8.1 ± 0	7.9 ± 0	7.04 ± 0.19
14	7.7 ± 0.14	7.13 ± 0.19	7.23 ± 0.13
15	7.48 ± 0.13	6.42 ± 0.12	7.43 ± 0.19
18	7.6 ± 0	6.08 ± 0.12	7.6 ± 0
19	7.43 ± 0.12	6.0 ± 0	7.6 ± 0
20	6.95 ± 0.15	5.6 ± 0.14	6.95 ± 0.15
21	6.5 ± 0	5.07 ± 0.12	6.42 ± 0.12
22	6.46 ± 0.09	5.42 ± 0.22	6.51 ± 0.16
25	6.25 ± 0	5.85 ± 0.15	6.95 ± 0.15
26	5.9 ± 0.14	5.7 ± 0	7.1 ± 0
27	5.7 ± 0	5.18 ± 0.07	6.33 ± 0.12
28	5.07 ± 0.12	4.98 ± 0.1	5.8 ± 0.18
29	4.9 ± 0	4.48 ± 0.2	5.5 ± 0.19
32	4.94 ± 0.09	3.73 ± 0.16	5.4 ± 0
33	4.98 ± 0.12	3.55 ± 0.08	5.07 ± 0.12
34	4.72 ± 0.26	3.9 ± 0.09	5.7 ± 0.24
35	4.08 ± 0.2	3.18 ± 0.15	5.03 ± 0.13
36	4.4 ± 0.21	3.7 ± 0.14	5.85 ± 0.15
39	4.97 ± 0.2	4.23 ± 0.16	5.15 ± 0.25
40	4.65 ± 0.11	3.7 ± 0.14	4.98 ± 0.12
41	4.48 ± 0.17	3.4 ± 0.22	4.61 ± 0.16
42	4.11 ± 0.22	3.13 ± 0.09	4.38 ± 0.2

All datas are an average of six determinations.
Nitrate concentrations are with reference to
Garrett's culture medium. (Garrett, 1966).
(See Appendix page A74 - A83 for raw data)

TABLE 20

Effect of Nitrate Concentrations in culture medium on Degradation and Utilisation of Citrus pectin by Fusarium culmorum & Cochliobolus sativus

Concentrations of Reducing Sugars in culture filtrates (mg cm^{-3}) MEAN ± S.D.

DAYS	100% NITRATE (5g/1)		50% NITRATE (2.5g/1)		10% NITRATE (0.5g/1)	
	FC	CS	FC	CS	FC	CS
0	0.6 ± 0	0.6 ± 0	0.6 ± 0	0.6 ± 0	0.6 ± 0	0.6 ± 0
1	0.95 ± 0.051	0.68 ± 0.015	0.92 ± 0.12	0.66 ± 0.026	1.09 ± 0.088	0.71 ± 0.038
2	1.26 ± 0.064	1.31 ± 0.03	1.21 ± 0.07	1.31 ± 0.041	1.25 ± 0.054	1.33 ± 0.064
5	2.31 ± 0.37	1.68 ± 0.22	1.98 ± 0.25	2.55 ± 0.28	1.77 ± 0.42	1.36 ± 0.35
6	4.24 ± 0.64	3.0 ± 0.35	3.39 ± 0.39	2.96 ± 0.31	3.21 ± 0.3	2.62 ± 0.26
7	4.23 ± 0.28	3.1 ± 0.18	4.16 ± 0.34	1.89 ± 0.27	3.15 ± 0.38	2.41 ± 0.11
8	5.56 ± 0.72	3.76 ± 0.059	4.78 ± 0.28	3.38 ± 0.1	3.97 ± 0.27	2.82 ± 0.2
9	5.43 ± 0.41	3.18 ± 0.25	4.32 ± 0.45	3.5 ± 0.42	4.22 ± 0.49	2.76 ± 0.11
12	6.09 ± 0.41	4.37 ± 0.39	5.66 ± 0.36	4.23 ± 0.23	5.38 ± 0.24	3.65 ± 0.18
13	5.78 ± 0.39	4.44 ± 0.24	6.32 ± 0.35	3.82 ± 0.29	5.61 ± 0.17	4.13 ± 0.33
14	8.68 ± 0.44	6.79 ± 0.27	7.31 ± 0.46	5.87 ± 0.33	7.37 ± 0.33	5.87 ± 0.19
15	7.38 ± 0.26	5.78 ± 0.4	6.45 ± 0.2	5.71 ± 0.23	6.17 ± 0.16	6.83 ± 0.086
16	7.41 ± 0.17	5.81 ± 0.24	7.04 ± 0.11	6.22 ± 0.12	7.05 ± 0.1	7.83 ± 0.062
19	6.82 ± 0.056	6.24 ± 0.2	6.14 ± 0.2	5.85 ± 0.087	6.03 ± 0.34	7.28 ± 0.14
20	5.68 ± 0.44	6.22 ± 0.16	5.73 ± 0.23	6.29 ± 0.19	5.7 ± 0.19	7.65 ± 0.21
21	5.58 ± 0.44	5.78 ± 0.11	5.86 ± 0.43	5.75 ± 0.33	5.6 ± 0.23	7.86 ± 0.058
22	4.96 ± 0.21	4.9 ± 0	4.96 ± 0.24	5.48 ± 0.36	5.08 ± 0.15	6.93 ± 0.2
23	4.7 ± 0.1	4.25 ± 0.13	5.3 ± 0.076	5.2 ± 0.17	5.28 ± 0.37	5.94 ± 0.2

TABLE 20 (Contd.): Concentrations of Reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	100% NITRATE (5.g/1)		50% NITRATE (2.5g/1)		10% NITRATE (0.5g/1)	
	FC	CS	FC	CS	FC	CS
26	4.55 ± 0.17	3.75 ± 0.21	4.28 ± 0.46	4.95 ± 0.14	4.9 ± 0	5.7 ± 0.1
27	4.36 ± 0.084	3.49 ± 0.23	3.92 ± 0.13	4.31 ± 0.21	5.3 ± 0.21	5.77 ± 0.09
28	4.4 ± 0.071	3.16 ± 0.088	3.71 ± 0.15	3.43 ± 0.35	5.05 ± 0.17	4.3 ± 0.26
29	3.45 ± 0.2	3.19 ± 0.049	3.52 ± 0.088	3.25 ± 0.19	4.53 ± 0.077	4.45 ± 0.041
30	3.86 ± 0.062	3.0 ± 0	3.65 ± 0	3.0 ± 0	4.3 ± 0	4.3 ± 0
33	2.48 ± 0.097	1.29 ± 0.068	2.63 ± 0.16	2.18 ± 0.082	4.05 ± 0.17	5.15 ± 0.16
34	1.5 ± 0.058	0.25 ± 0.029	1.75 ± 0.3	1.6 ± 0	3.93 ± 0.23	4.38 ± 0.12
35	1.5 ± 0.058	0.25 ± 0.14	1.63 ± 0.2	0.65 ± 0.13	3.5 ± 0.24	3.65 ± 0.4
36	1.4 ± 0	1.1 ± 0.2	1.9 ± 0	0.5 ± 0	3.13 ± 0.21	3.25 ± 0.36
37	1.48 ± 0.022	0.5 ± 0	1.35 ± 0.16	0.25 ± 0.029	2.4 ± 0.24	3.8 ± 0
40	0.25 ± 0.1	0.95 ± 0.074	0.5 ± 0.12	0.25 ± 0.071	1.6 ± 0	2.15 ± 0.23
41	0	1.48 ± 0.11	0.65 ± 0.14	0.25 ± 0.065	2.05 ± 0.15	2.05 ± 0.13
42	0	1.25 ± 0.11	0.65 ± 0.11	0	1.6 ± 0.14	2.85 ± 0.13

FC = Fusarium culmorum

CS = Cochliobolus sativus

All datas are an average of six determinations.

Nitrate concentrations are with reference to Garrett's medium (Garrett, 1966).

(See Appendix page A84 - A89 for raw data)

TABLE 21

Effect of Nitrate Concentrations in culture medium on Degradation and Utilisation of Larchwood xylan by Fusarium culmorum & Cochliobolus sativus

Concentrations of Reducing Sugars in culture filtrates (mg cm^{-3}) MEAN ± S.D.

DAYS	100% NITRATE (5g/1)		50% NITRATE (2.5g/1)		10% NITRATE (0.5g/1)	
	FC	CS	FC	CS	FC	CS
0	0	0	0	0	0	0
1	0	0	0	0.25 ± 0	0.13 ± 0	0.13 ± 0
3	0.25 ± 0.072	0.087 ± 0.061	0.16 ± 0.086	0.13 ± 0.072	0.13 ± 0.072	0.1 ± 0.068
4	0.13 ± 0	0.33 ± 0.058	0.32 ± 0.052	0.31 ± 0.038	0.29 ± 0.044	0.26 ± 0.092
7	0.54 ± 0.059	0.23 ± 0.045	0.42 ± 0.057	0	0.37 ± 0.045	0
8	0.25 ± 0	0.25 ± 0	0.13 ± 0	0.38 ± 0	0.5 ± 0	0.38 ± 0
10	0.62 ± 0.043	0.8 ± 0.087	0.68 ± 0.073	0.56 ± 0.079	0.94 ± 0.14	0.48 ± 0.044
11	0.65 ± 0	0.59 ± 0.062	0.75 ± 0.071	0.38 ± 0.072	0.98 ± 0.13	0.33 ± 0.058
14	0.8 ± 0	0.74 ± 0.068	0.78 ± 0.056	0.86 ± 0.067	1.1 ± 0	1.2 ± 0.11
15	0.8 ± 0	1.26 ± 0.043	0.8 ± 0	1.03 ± 0.089	1.6 ± 0	0.8 ± 0
17	0.5 ± 0	0.84 ± 0.069	0.68 ± 0.071	0.5 ± 0.087	0.88 ± 0.11	0.73 ± 0.062
18	1.03 ± 0.14	1.27 ± 0.086	0.69 ± 0.11	1.2 ± 0.072	0.8 ± 0	1.33 ± 0.048
21	0.5 ± 0.058	0.5 ± 0	0.45 ± 0.054	0.5 ± 0.029	0.69 ± 0.081	0.8 ± 0
22	0.6 ± 0.071	0.65 ± 0.14	0.65 ± 0.12	0.65 ± 0.1	0.85 ± 0.05	1.1 ± 0.16
24	0.8 ± 0	0.8 ± 0.076	0.65 ± 0	0.6 ± 0.12	0.8 ± 0	0.8 ± 0.1
25	0.65 ± 0	0.8 ± 0.029	0.65 ± 0	0.5 ± 0	0.65 ± 0	0.5 ± 0
28	0.25 ± 0	0.25 ± 0	0.28 ± 0.055	0.38 ± 0.047	0.25 ± 0	0.5 ± 0
29	0.38 ± 0.11	0.5 ± 0.05	0.27 ± 0.047	0.73 ± 0.067	0.5 ± 0.065	0.8 ± 0.058

TABLE 21 (Contd.): Concentrations of Reducing sugars in culture filtrates (mg cm^{-3}) Mean ± S.D.

DAYS	100% NITRATE (5g/1) FC	100% NITRATE (5g/1) CS	50% NITRATE (2.5g/1) FC	50% NITRATE (2.5g/1) CS	10% NITRATE (0.5g/1) FC	10% NITRATE (0.5g/1) CS
31	0.5 ± 0.076	0.25 ± 0.041	0.57 ± 0.052	0.22 ± 0.031	0.8 ± 0.065	0.58 ± 0.059
32	0.5 ± 0.082	0.25 ± 0.029	0.5 ± 0	0.25 ± 0	0.8 ± 0.05	0.5 ± 0.058
35	0.25 ± 0.041	0.13 ± 0.016	0.16 ± 0.11	0	1.1 ± 0.087	0.25 ± 0.029
36	0.5 ± 0.065	0.25 ± 0.05	0.25 ± 0	0.25 ± 0.058	0.8 ± 0.13	0.5 ± 0.065
38	0.25 ± 0.029	0.25 ± 0.058	0.53 ± 0.047	0.25 ± 0.029	1.1 ± 0.1	0.5 ± 0
39	0.38 ± 0.017	0	0.3 ± 0.058	0.25 ± 0	0.8 ± 0.065	0.5 ± 0
42	0.25 ± 0.041	0	0.23 ± 0.038	0	0.5 ± 0.058	0.25 ± 0

FC = Fusarium culmorum

CS = Cochliobolus sativus

All datas are an average of six determinations.

Nitrate concentrations are with reference to Garrett's culture medium. (Garrett, 1966).

Disappearance of suspended xylan granules from culture medium is an indication of complete hydrolysis of larchwood xylan by both F. culmorum and C. sativus.

(See Appendix page A90 - A95 for raw data)

TABLE 22A

Effect of Nitrate Concentrations on fungal growth.

GROWTH SUBSTRATE : GLUCOSE

Dry weight of mycelium produced (mg) Mean ± S.D.

100% NITRATE CONCENTRATION (5g/1)

DAYS	FC	CS	GGT. og12	GGT. 43	GGT. WPBS1
7	25.85 ± 1.05	23.9 ± 0.5	21.95 ± 0.15	21.8 ± 0.2	18.9 ± 0.3
14	88.15 ± 0.95	47.65 ± 0.45	42.0 ± 0.3	38.2 ± 0.3	29.1 ± 0.2
21	98.1 ± 0.3	48.75 ± 0.15	61.5 ± 0.6	53.4 ± 1.2	52.55 ± 0.65
28	165.5 ± 0.7	66.5 ± 0.7	81.55 ± 0.35	63.5 ± 0.6	63.65 ± 0.95
35	187.2 ± 0.3	95.6 ± 1.1	118.05± 0.55	86.6 ± 0.7	86.15 ± 0.25
42	—	79.1 ± 0.2	186.4 ± 0.8	118.9 ± 0.3	114.35± 0.45

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	FC	CS	GGT. og12	GGT. 43	GGT. WPBS1
7	23.95 ± 0.35	32.85 ± 0.75	17.75 ± 0.15	16.0 ± 0.2	16.85 ± 0.35
14	84.3 ± 0.6	47.85 ± 1.05	28.95 ± 0.35	29.0 ± 0.4	22.35 ± 0.55
21	108.7 ± 1.6	53.95 ± 1.15	51.25 ± 0.45	41.05 ± 0.45	42.25 ± 0.55
28	137.05± 0.55	65.6 ± 1.7	72.2 ± 0.6	51.2 ± 0.6	51.05 ± 0.45
35	163.7 ± 0.8	39.05 ± 0.15	83.65 ± 0.75	66.8 ± 0.5	70.35 ± 0.55
42	—	42.85 ± 0.75	93.5 ± 0.6	86.45 ± 0.65	90.7 ± 0.4

TABLE 22A (Contd.): Dry weight of mycelium produced (mg) Mean ± S.D.

Growth Substrate : Glucose

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	FC	CS	GGT. og12	GGT. 43	GGT. WPBS1
7	63.85 ± 0.95	23.5 ± 0.6	18.6 ± 0.3	18.75 ± 0.15	18.8 ± 0.4
14	104.9 ± 0.3	53.1 ± 0.3	52.35 ± 0.75	45.35 ± 0.85	46.65 ± 0.75
21	108.6 ± 0.3	47.05 ± 0.15	72.7 ± 0.5	58.95 ± 0.25	54.1 ± 0.5
28	163.75 ± 1.05	48.0 ± 0.4	102.15 ± 0.35	93.25 ± 0.35	83.4 ± 0.7
35	176.0 ± 0.8	28.6 ± 0.3	86.1 ± 0.2	81.25 ± 0.65	64.0 ± 1.4
42		22.2 ± 0.6	68.35 ± 0.45	67.85 ± 0.55	45.35 ± 0.45

(See Appendix page A113 & A115 for raw data)

TABLE 22B

Effect of Nitrate Concentrations in culture medium on growth of Fusarium culmorum*

GROWTH SUBSTRATE : GLUCOSE

DAYS	100% NITRATE(5g/1)	50% NITRATE(2.5g/1)	10% NITRATE(0.5g/1)
2	24.4 ± 0.8	16.8 ± 0.4	18.0 ± 0.4
4	64.15 ± 0.35	66.35 ± 0.75	59.0 ± 0.6
7	84.3 ± 1.9	68.8 ± 0.6	88.5 ± 0.9
9	94.5 ± 0.9	76.85 ± 0.55	117.0 ± 0.8
11	117.8 ± 0.6	104.3 ± 1.9	124.2 ± 0.6
14	109.95 ± 0.35	89.1 ± 0.5	87.35 ± 0.55

FC = F. culmorum   CS = C. sativus   GGT. og12, 43 & WPBS1 = G.graminis isolates
F. culmorum* = Second set of experiments with the fungus.
(See Appendix page A114 for raw data)

TABLE 23

Effect of Nitrate Concentrations in culture medium on Growth of Fusarium culmorum & Cochliobolus sativus

GROWTH SUBSTRATE : LARCHWOOD XYLAN

Dry weight of mycelium produced (mg) Mean ± S.D.

DAYS	100% NITRATE CONCENTRATION (5g/1)		50% NITRATE CONCENTRATION (2.5g/1)		10% NITRATE CONCENTRATION (0.5g/1)	
	FC	CS	FC	CS	FC	CS
7	44.35 ± 0.45	73.9 ± 0.7	38.5 ± 0.45	47.6 ± 0.6	26.9 ± 0.3	21.8 ± 1.1
14	102.85 ± 0.25	105.5 ± 0.6	89.15 ± 0.65	76.35 ± 0.45	63.45 ± 0.75	62.45 ± 0.85
21	424.4 ± 0.8	364.3 ± 0.6	386.95 ± 0.65	334.95 ± 1.05	268.6 ± 0.7	144.7 ± 1.27
28	409.6 ± 0.6	331.8 ± 0.6	328.05 ± 1.75	326.6 ± 0.9	144.25 ± 1.35	192.35 ± 0.65
35	315.45 ± 0.75	297.55 ± 0.65	257.4 ± 1.0	284.0 ± 0.9	95.0 ± 0.6	170.95 ± 0.25
42	274.85 ± 0.75	221.65 ± 0.45	124.45 ± 1.85	150.5 ± 0.9	85.6 ± 0.7	142.8 ± 1.4

FC = Fusarium culmorum   CS = Cochliobolus sativus

All datas are an average of two determinations.

Nitrate concentrations are with reference to Garrett's medium (Garrett, 1966).

(See Appendix page A117 for raw data)

TABLE 24

Effect of Nitrate Concentrations in culture medium on Growth of Fusarium culmorum & Cochliobolus sativus

GROWTH SUBSTRATE : CITRUS PECTIN

Dry weight of mycelium produced (mg) Mean ± S.D.

	100% NITRATE CONCENTRATION (5g/1)		50% NITRATE CONCENTRATION (2.5g/1)		10% NITRATE CONCENTRATION (0.5g/1)	
DAYS	FC	CS	FC	CS	FC	CS
7	35.95 ± 0.65	32.65 ± 0.75	22.7 ± 1.4	42.3 ± 1.3	23.2 ± 0.4	31.95 ± 0.65
14	35.3 ± 0.4	53.45 ± 0.75	45.0 ± 1.4	46.5 ± 1.0	33.55 ± 0.85	46.15 ± 1.05
21	61.15 ± 0.95	84.1 ± 0.5	85.6 ± 1.7	66.9 ± 1.1	67.4 ± 0.4	55.1 ± 1.2
28	101.95 ± 1.65	191.75 ± 0.95	125.25 ± 0.85	209.85 ± 0.75	98.35 ± 0.85	85.75 ± 1.45
35	147.3 ± 0.9	186.8 ± 0.3	142.65 ± 1.25	198.3 ± 1.0	108.2 ± 0.7	95.05 ± 0.45
42	189.3 ± 0.9	161.4 ± 1.1	162.4 ± 0.7	218.65 ± 0.65	165.3 ± 0.8	127.85 ± 0.45

FC = Fusarium culmorum CS = Cochliobolus sativus

All datas are an average of two determinations.

Nitrate concentrations are with reference to Garrett's medium (Garrett, 1966).

(See Appendix page A116 for raw data)

8. Pectin Degrading Enzyme production by organisms when cultured on citrus pectin

Each organism produced extracellular pectin degrading enzymes when grown on citrus pectin as carbon source. The enzymes liberated reducing groups and reduced the viscosity of citrus pectin and sodium polypectate solutions (TABLE 25 & 26). The enzyme which liberated reducing groups was therefore an exo-enzyme while that which reduced the viscosity of the substrates was an endo-enzyme. There was a continuous increase in endo-enzyme activity during incubation with both citrus pectin and sodium polypectate as enzyme substrates. This is possibly because enzymic de-esterification of citrus pectin in the growth medium had occured thereby inducing production of an endo-polygalacturonase and an endo-polymethylgalacturonase. These observations apply to both organisms, but the increase in activity shown by F. culmorum was much greater than that shown by C. sativus (TABLE 25 & 26).

F. culmorum endo-enzyme activity was much greater than its exo-enzyme activity while the reverse is true of C. sativus. Exo-enzyme production by both fungi decreased with growth although there was an observed increase on day 23 by F. culmorum and on days 23, 25, 30 and 37 by C. sativus with citrus pectin as enzyme substrate.

TABLE 25

Pectin Degrading Enzyme Production by *F. culmorum* when grown on Citrus pectin as carbon source.

Reducing sugar assay :

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates Citrus pectin	 Sodium polypectate
3	19.75 ± 0.35	255.96 ± 4.38	34.83 ± 0.78
6	27.0 ± 0.3	201.47 ± 2.24	37.69 ± 0.42
9	39.6 ± 0.2	149.42 ± 0.83	25.54 ± 0.13
11	50.5 ± 0.3	120.59 ± 0.53	20.03 ± 0.12
13	62.6 ± 0.5	97.73 ± 0.78	16.31 ± 0.12
16	74.35 ± 0.25	68.8 ± 0.27	11.74 ± 0.09
18	89.65 ± 0.55	53.76 ± 0.23	3.75 ± 0.01
20	76.8 ± 0.3	63.88 ± 0.13	8.35 ± 0.03
23	50.25 ± 0.35	114.51 ± 0.68	12.7 ± 0.03
25	62.95 ± 0.35	86.65 ± 0.43	17.59 ± 0.15
27	189.9 ± 0.3	25.62 ± 0.07	8.76 ± 0.04
30	237.05 ± 0.25	21.44 ± 0.005	2.98 ± 0.02
32	249.7 ± 0.4	20.36 ± 0.02	2.57 ± 0.005
34	218.0 ± 0.1	23.67 ± 0.005	5.73 ± 0.01
37	240.65 ± 0.75	21.52 ± 0.06	6.14 ± 0.005
39	207.45 ± 0.35	22.85 ± 0.03	3.46 ± 0.01
41	180.3 ± 0.4	28.38 ± 0.05	6.5 ± 0.02
44	170.95 ± 0.25	32.65 ± 0.06	7.6 ± 0.005
46	201.15 ± 0.25	34.97 ± 0.06	7.65 ± 0.005

Viscometric assay :

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates Citrus pectin	 Sodium polypectate
3	19.75 ± 0.35	30.39 ± 0.54	30.79 ± 0.72
6	27.0 ± 0.3	304.98 ±	163.91 ± 1.52
9	39.6 ± 0.2	395.01 ± 1.79	172.35 ± 0.24
11	50.5 ± 0.3	258.43 ± 1.21	155.29 ± 1.09
13	62.6 ± 0.5	275.18 ± 2.33	134.31 ± 0.96
16	74.35 ± 0.25	344.88 ± 1.27	172.61 ± 0.58
18	89.65 ± 0.55	286.31 ± 1.39	143.44 ± 0.42

TABLE 25 (Contd.) :

Viscometric assay :

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates	
		Citrus pectin	Sodium polypectate
20	76.8 ± 0.3	341.8 ± 1.12	268.56 ± 1.16
23	50.25 ± 0.35	531.54 ± 3.54	418.26 ± 1.92
25	62.95 ± 0.35	438.85 ± 2.04	397.69 ± 2.48
27	189.9 ± 0.3	146.53 ± 0.28	135.03 ± 0.35
30	237.05 ± 0.25	35.61 ± 0	33.26 ± 0.18
32	249.7 ± 0.4	33.71 ± 0.02	19.39 ± 0
34	218.0 ± 0.1	19.27 ± 0.09	2.75 ± 0
37	240.65 ± 0.75	1.87 ± 0.01	0.97 ± 0.07
39	207.45 ± 0.35	2.96 ± 0.02	1.12 ± 0.005
41	180.3 ± 0.4	4.21 ± 0	0
44	170.95 ± 0.25	4.26 ± 0.06	0
46	201.15 ± 0.25	2.09 ± 0.02	0

Enzyme activity datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.
(See Appendix page A139 - A A144 for raw data)

TABLE 26

Pectin Degrading Enzyme Production by C. sativus when grown on Citrus pectin as carbon source

Reducing sugar assay :

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates	
		Citrus pectin	Sodium polpectate
3	10.45 ± 0.25	475.62 ± 11.68	102.15 ± 2.45
6	20.35 ± 0.25	235.34 ± 2.74	31.82 ± 0.09
9	26.9 ± 0.4	168.65 ± 2.17	12.77 ± 0.26
11	59.8 ± 0.3	75.69 ± 0.38	9.65 ± 0.11
13	56.05 ± 0.25	80.6 ± 0.2	10.13 ± 0.16
16	78.4 ± 0.4	49.24 ± 0.25	0
18	89.55 ± 0.65	44.32 ± 0.43	0

TABLE 26 (Contd.) : Cochliobolus sativus

Reducing sugar assay :

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates	
		Citrus pectin	Sodium polypectate
20	96.8 ± 0.3	46.8 ± 0.12	8.92 ± 0.03
23	52.6 ± 0.3	92.92 ± 0.59	12.2 ± 0.19
25	49.65 ± 0.45	107.51 ± 1.04	12.86 ± 0.06
27	137.0 ± 0.1	42.47 ± 0.01	12.81 ± 0.02
30	44.95 ± 0.35	127.05 ± 0.99	34.85 ± 0.14
32	92.8 ± 0.4	67.55 ± 0.26	26.05 ± 0.25
34	87.15 ± 0.25	62.52 ± 0.22	23.07 ± 0.21
37	36.45 ± 0.35	143.9 ± 1.13	5.24 ± 0.12
39	47.6 ± 0.3	97.37 ± 0.81	4.15 ± 0.11
41	48.85 ± 0.35	97.02 ± 0.63	1.96 ± 0.08
44	47.5 ± 0.3	99.71 ± 0.5	4.22 ± 0.04
46	47.05 ± 0.25	100.93 ± 0.54	4.06 ± 0.11

Viscometric assay:

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates	
		Citrus pectin	Sodium polypectate
3	10.45 ± 0.25	78.12 ± 1.32	0
6	20.35 ± 0.25	10.64 ± 0.69	0
9	26.9 ± 0.4	8.37 ± 0.19	0
11	59.8 ± 0.3	7.25 ± 0.04	10.45 ± 0.09
13	56.05 ± 0.25	13.98 ± 0.07	12.54 ± 0.5
16	78.4 ± 0.4	15.63 ± 0.03	2.55 ± 0.01
18	89.55 ± 0.65	8.28 ± 0.03	2.62 ± 0.15
20	96.8 ± 0.3	7.67 ± 0.24	6.46 ± 0.07
23	52.6 ± 0.3	7.93 ± 0.05	23.61 ± 0.03
25	49.65 ± 0.45	8.72 ± 0.59	16.29 ± 0.32
27	137.0 ± 0.1	22.08 ± 0.04	26.52 ± 0.02
30	44.95 ± 0.35	40.98 ± 0.14	31.7 ± 0.31
32	92.8 ± 0.4	15.54 ± 0.16	15.63 ± 0.12
34	87.15 ± 0.25	16.55 ± 0.15	7.08 ± 0.14
37	36.45 ± 0.35	19.76 ± 0.005	17.74 ± 0.08
39	47.6 ± 0.3	15.23 ± 0.08	17.16 ± 0.11
41	48.85 ± 0.35	15.22 ± 0.03	16.55 ± 0.29

TABLE 26 (Contd.): Cochliobolus sativus

Viscometric assay:

DAYS	Dry weight of mycelium prod.(mg)	Enzyme substrates: Citrus pectin	Enzyme substrates: Sodium polypectate
44	47.5 ± 0.3	15.26 ± 0.08	4.39 ± 0.15
46	47.05 ± 0.25	15.63 ± 0.1	4.92 ± 0.01

Enzyme activity datas are expressed as enzyme units in culture medium per mg. of mycelial dry weight.

(See Appendix page A139 - A144 for raw data)

9. Influence of Carbon source in the growth medium on Enzyme production by Fusarium culmorum & Cochliobolus sativus

Irrespective of the carbon source in the growth medium each of the organisms produced an enzyme which liberated reducing groups from citrus pectin (TABLE 27 & 28) and whose activity was enhanced by growth on the polysaccharide substrates used (citrus pectin, larchwood xylan and sodium carboxymethylcellulose). The low activity in viscometric assay (TABLE 27 & 28) suggests that an exo-enzyme is responsible. When citrus pectin was the carbon source in the growth medium there was a marked increase in the activity of an enzyme which reduced the viscosity of citrus pectin and was therefore an endo-enzyme (TABLE 27 & 28). There was a small increase by day 7 in endo-enzyme activity with sodium polypectate as enzyme substrate, and by day 14 a further increase in activity had occurred. This is possibly because enzymic de-esterification of citrus pectin in the growth medium had occurred thereby inducing production of an endo-polygalacturonase. These observations apply to both organisms, but the increase in activity shown by F. culmorum grown on citrus pectin was much greater than that shown by C. sativus. This data suggests that an exo-polymethylgalacturonase is produced possibly constitutively and that growth on citrus pectin induces the formation of an endo-polymethylgalacturonase. The endo-enzyme activity shown by F. culmorum when grown on larchwood xylan is possibly because of the presence of pectin in the sample of xylan.

Polygalacturonase, xylanase, and carboxymethylcellulase activities assayed by reducing group liberation displayed much less activity than the exo-polymethylgalacturose. Their activity was somewhat enhanced by growth on a polysaccharide carbon source, but there was no marked differences between the two fungi.

TABLE 27

INFLUENCE OF CARBON SOURCE IN CULTURE MEDIUM ON ENZYME PRODUCTION BY *Fusarium culmorum*

Reducing sugar assay.

DAYS	Carbon source in growth medium	Dry weight of mycelium (mg.)	ENZYME SUBSTRATES Citrus pectin	SPP.	Xylan	CMC
7	GLUCOSE	68.0 ± 0.6	62.97 ± 0.66	0	0	0
	CELLOBIOSE	35.95 ± 0.55	130.68 ± 2.04	0	0	20.61 ± 0.47
	CITRUS PECTIN	23.75 ± 0.15	294.56 ± 1.91	32.67 ± 0.42	27.19 ± 0.2	0
	XYLAN	84.1 ± 1.6	73.31 ± 1.41	11.3 ± 0.33	16.58 ± 0.38	5.38 ± 0.02
	CMC	13.55 ± 0.1	429.15 ± 3.4	53.58 ± 0.72	54.56 ± 0.93	20.8 ± 0.08
14	GLUCOSE	97.5 ± 0.7	68.99 ± 0.6	4.59 ± 0.08	9.41 ± 0.08	2.82 ± 0.03
	CELLOBIOSE	107.5 ± 0.7	51.15 ± 0.3	5.41 ± 0.03	9.51 ± 0.08	2.53 ± 0
	CITRUS PECTIN	68.15 ± 0.35	134.42 ± 0.57	8.8 ± 0.18	8.75 ± 0.08	0
	XYLAN	185.75 ± 1.55	36.21 ± 0.32	4.97 ± 0.03	7.14 ± 0.1	2.37 ± 0.04
	CMC	38.7 ± 0.7	140.45 ± 2.37	25.46 ± 0.45	8.75 ± 0.08	12.08 ± 0.25

Viscometric assay

DAYS	Carbon source in growth medium	Dry weight of mycelium (mg.)	ENZYME SUBSTRATES CITRUS PECTIN	SODIUM POLYPECTATE
7	GLUCOSE	68.0 ± 0.6	8.83 ± 0.57	24.27 ± 0.04
	CELLOBIOSE	35.95 ± 0.55	0	8.33 ± 0.8
	CITRUS PECTIN	23.75 ± 0.15	1011.28 ± 8.49	153.67 ± 1.13
	XYLAN	84.1 ± 1.6	153.05 ± 2.52	7.14 ± 0.14

TABLE 27 (Contd.): *Fusarium culmorum*

Viscometric assay

DAYS	Carbon source in growth medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES	
			CITRUS PECTIN	SODIUM POLYPECTATE
7	CMC	13.55 ± 0.1	44.3 ± 2.79	0
14	GLUCOSE	97.5 ± 0.7	16.93 ± 0.98	2.9 ± 0.15
	CELLOBIOSE	107.5 ± 0.7	11.63 ± 0.08	37.57 ± 1.04
	CITRUS PECTIN	68.15 ± 0.35	383.48 ± 2.46	176.09 ± 1.88
	XYLAN	185.75 ± 1.55	12.75 ± 0.29	7.0 ± 0.12
	CMC	38.7 ± 0.7	20.23 ± 0.93	28.86 ± 0.1

SPP = Sodium polypectate

CMC = Sodium carboxymethylcellulose

Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.

(See Appendix page A147 - A152 for raw data)

TABLE 28

Influence of Carbon source in growth medium on Enzyme Production by C. sativus

Reducing sugar assay:

DAYS	Carbon source in growthmedium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	XYLAN	CMC
7	GLUCOSE	37.4 ± 0.6	85.33 ± 1.37	0	0	0
	CELLOBIOSE	43.5 ± 1.2	97.77 ± 2.83	0	8.46 ± 0.32	0
	CITRUS PECTIN	27.6 ± 0.1	187.55 ± 0.72	18.7 ± 0.07	32.6 ± 0.23	4.74 ± 0.06
	XYLAN	78.55 ± 1.15	70.47 ± 1.08	11.87 ± 0.16	17.76 ± 0.3	2.57 ± 0.02
	CMC	42.6 ± 1.2	115.47 ± 3.32	23.46 ± 0.88	32.47 ± 0.97	6.51 ± 0.09
14	GLUCOSE	96.9 ± 0.4	49.2 ± 0.18	0	0	0
	CELLOBIOSE	124.2 ± 1.3	43.78 ± 0.5	2.21 ± 0	5.98 ± 0.04	0
	CITRUS PECTIN	35.05 ± 0.05	173.62 ± 0.5	10.02 ± 0.14	20.54 ± 0.18	0
	XYLAN	98.65 ± 0.45	57.78 ± 0.27	10.92 ± 0.08	15.25 ± 0.03	3.74 ± 0.01
	CMC	73.3 ± 0.6	66.67 ± 0.51	13.91 ± 0.14	19.11 ± 0.22	6.25 ± 0.07

SPP = Sodium polypectate

CMC = Carboxymethylcellulose

Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.

(See Appendix page A147 - A152 for raw data)

TABLE 28 (Contd.): Cochliobolus sativus

Viscometric assay:

DAYS	Carbon source in growth medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES	
			Citrus pectin	Sodium polypectate
7	GLUCOSE	37.4 ± 0.6	31.22 ± 1.4	16.04 ± 0.64
	CELLOBIOSE	43.5 ± 1.2	23.03 ± 1.4	6.9 ± 0.19
	CITRUS PECTIN	27.6 ± 0.1	164.25 ± 0.61	42.87 ± 0.45
	XYLAN	78.55 ± 1.15	7.63 ± 0.74	7.64 ± 0.11
	CARBOXYMETHYLCELLULOSE	42.6 ± 1.2	7.43 ± 0.18	18.78 ± 0.26
14	GLUCOSE	96.9 ± 0.4	6.37 ± 0.2	6.02 ± 0.2
	CELLOBIOSE	124.2 ± 1.3	11.14 ± 0.25	6.58 ± 0.07
	CITRUS PECTIN	35.05 ± 0.05	164.05 ± 0.71	51.36 ± 0.88
	XYLAN	98.65 ± 0.45	6.42 ± 0.37	8.12 ± 0.38
	CARBOXYMETHYLCELLULOSE	73.3 ± 0.6	15.47 ± 0.59	10.92 ± 0.09

Enzyme activity datas are expressed as enzyme units in culture medium per mg. of mycelial dry weight.
(See Appendix page A147 - A152 for raw data)

10. Influence of Nitrate concentrations on Enzyme Production when the organisms were grown on glucose or citrus pectin.

Irrespective of nitrate concentration in the growth medium each of the organisms produced an enzyme which liberated reducing groups from citrus pectin (TABLE 29-35) and whose activity was enhanced by growth on citrus pectin (TABLE 34 & 35). The liberation of reducing groups in relation to viscosity change suggests that an exo-enzyme is responsible. When citrus pectin was the carbon source in growth medium, there was a marked increase in the activity of an enzyme which reduced the viscosity of both citrus pectin and sodium polypectate and was therefore an endo-enzyme (TABLE 34 & 35). During culture there was an increase in endo-enzyme activity with sodium polypectate as enzyme substrate (TABLE 30 - 35), with marked differences between the organisms, depending on nitrate concentration in culture medium. The increase in activity applies to all the organisms, but that shown by C. sativus grown on glucose was much greater than that shown by F. culmorum and G. graminis var tritici isolates ogl2, 43 & WPBS1, while that shown by F. culmorum grown on citrus pectin was much greater than that shown by C. sativus. These data suggest that an exo-polymethylgalacturonase is produced possibly constitutively.

When grown on glucose, exo-polygalacturonase activity was not detected in culture filtrates of G. graminis var tritici isolates (TABLE 31 - 33), irrespective of nitrate concentrations in culture medium. On the same substrate, the enzyme was produced by C. sativus by day 28 (TABLE 30). When grown on citrus pectin exo-polygalacturonase activity was shown by culture filtrates of both C. sativus and F. culmorum, although there were marked differences in activity. Low nitrate concentrations reduced the activity of F. culmorum exo-polygalacturonase while it tends to slightly increase that of C. sativus (TABLE 34 & 35). However, the production of this enzyme was enhanced when both organisms were grown on citrus pectin. Endo-polygalacturonase activity was not detected in culture filtrates of G. graminis var tritici isolates in low nitrate concentrations after day 7, when glucose was used as sole carbon source (TABLE 32 & 33). When grown on glucose, C. sativus showed more exo-polygalacturonase activity than F. culmorum (TABLE 29 & 30), while the reverse was obtained when both fungi were cultured on citrus pectin (TABLE 34 & 35). Citrus pectin considerably increased the production and activity of F. culmorum endo-polygalacturonase irrespective of nitrate concentrations (TABLE 29 & 34). When grown on citrus pectin low nitrate concentrations decreased the activity of F. culmorum, endo-polygalacturonase while it increased that of C. sativus.

Carboxymethylcellulase activity assayed by reducing group liberation was not detected in culture filtrates of G. graminis var tritici isolates when grown on glucose irrespective of nitrate concentrations in culture medium (TABLE 31 - 33). In C. sativus activity was detected only on day 28, and in F. culmorum with low nitrate concentration (50%) on day 8 (TABLE 29). When grown on citrus pectin, the enzyme was produced by F. culmorum in low nitrate concentrations only on day 21 (TABLE 34). The activity of carboxymethylcellulase was however less than that of exo-polymethylgalacturonase and exo- and endo-polygalacturonases irrespective of nitrate concentrations and growth substrate in culture medium. These observations apply to all the organisms.

The difference in enzyme activities shown by the organisms is however moderated by the weight of mycelium produced. When this parameter is excluded from enzyme activity determinations a different pattern emerged. When grown on glucose, C. sativus exo-polymethylgalacturonase activity showed a continuous increase irrespective of nitrate concentrations in culture medium while that of F. culmorum showed a continuous increase in activity in 50% nitrate concentration and a continuous decrease in 10% nitrate concentration. G. graminis var tritici isolates exo-polymethylgalacturonase activity, in general showed an earlier increase which is then followed by a decrease (Appendix page A99 - A108).

When grown on citrus pectin C. sativus exo-polymethylgalacturonase activity showed a continuous decrease irrespective of nitrate concentrations in culture medium while that of F. culmorum fluctuated throughout the experimental period irrespective of nitrate concentrations (Appendix page A108 - A112).

TABLE 29

Influence of Nitrate concentrations on Enzyme production by F. culmorum

Growth Substrate : GLUCOSE

Reducing sugar assay:

DAYS	NITRATE CONCN. IN MEDIUM	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	CMC
4	100%	57.2 ± 0.1	107.08 ± 0.11	0	0
	50%	55.2 ± 0.1	92.5 ± 0.17	0	0
	10%	55.0 ± 0.4	95.93 ± 0.42	0	0
8	100%	73.6 ± 0.2	73.86 ± 0.24	5.11 ± 0.18	0
	50%	57.55 ± 0.65	92.99 ± 0.86	11.41 ± 0.14	1.93 ± 0.02
	10%	80.65 ± 0.45	62.23 ± 0.03	0	0
12	100%	124.65± 0.85	46.36 ± 0.22	4.5 ± 0.03	0
	50%	99.25 ± 0.95	57.45 ± 0.58	4.56 ± 0.03	0
	10%	140.0 ± 1.1	95.93 ± 0.42	32.6 ± 0.43	0

SPP = Sodium polypectate   CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium
per mg. of mycelial dry weight.

(See Appendix page A99 - A100 & A120 for raw data)

TABLE 29 (Contd.): Fusarium culmorum

Viscometric assay:

DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	ENZYME SUBSTRATES Sodium polypectate
4	100%	57.2 ± 0.1	46.19 ± 0.23	9.52 ± 0.03
	50%	55.2 ± 0.1	18.12 ± 0.04	0
	10%	55.0 ± 0.4	48.94 ± 0.41	26.82 ± 0.26
8	100%	73.6 ± 0.2	22.94 ± 0.22	11.67 ± 0.15
	50%	57.55 ± 0.65	29.63 ± 0.16	0
	10%	80.65 ± 0.45	21.87 ± 0.7	2.92 ± 0.16
12	100%	124.65 ± 0.85	8.5 ± 0.13	6.62 ± 0.16
	50%	99.25 ± 0.95	25.14 ± 0.15	0
	10%	140.0 ± 1.1	18.64 ± 0.21	2.86 ± 0.03

Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.

Nitrate concentrations are with reference to Garrett's medium.

(See Appendix page A99 - A100 & A120 for raw data)

TABLE 30

Influence of Nitrate concentrations on Enzyme production by C. sativus

Growth Substrate : Glucose

Reducing sugar assay:

DAYS	NITRATE CONCN. IN MEDIUM	Dry weight of mycelium (mg)	ENZYME SUBSTRATES		
			Citrus pectin	SPP	CMC
	100%	17.95 ± 0.45	306.26 ± 6.66	14.95 ± 0.2	0
7	50%	27.55 ± 0.95	206.84 ± 7.84	0	0
	10%	14.9 ± 0.3	361.45 ± 6.87	0	0
14	100%	43.65 ± 0.35	148.72 ± 1.67	0	0
	50%	40.75 ±0.25	131.66 ± 0.81	0	0
	10%	27.45 ± 0.85	180.44 ± 6.65	0	0
21	100%	65.6 ± 1.3	117.84 ± 2.43	0	0
	50%	51.7 ± 0.7	143.87 ± 0.41	0	0
	10%	36.45 ± 0.65	190.72 ± 2.56	0	0
28	100%	73.45 ± 0.85	131.29 ± 1.73	7.56 ±	6.26 ± 0.04
	50%	56.3 ± 0.2	157.07 ± 0.78	11.64 ± 0.01	3.29 ± 0.02
	10%	28.45 ± 0.85	329.66 ± 9.96	29.71 ± 0.46	17.25 ± 0.41

SPP = Sodium polypectate   CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium
per mg. of mycelial dry weight.

TABLE 30 (Contd.): Cochliobolus sativus

Viscometric assay:

DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	 Sodium polypectate
7	100%	17.95 ± 0.45	216.96 ± 5.91	68.47 ± 1.44
	50%	27.55 ± 0.95	65 73 ± 2.57	62.55 ± 0.02
	10%	14.9 ± 0.3	121.93 ± 0.22	56.48 ± 0.54
14	100%	43.65 ± 0.95	33.46 ± 1.57	42.21 ± 1.68
	50%	40.75 ± 0.25	14.72 ± 0.09	34.36 ± 0.21
	10%	27.45 ± 0.85	16.37 ± 0.71	44.31 ± 0.45
21	100%	65.6 ± 1.3	107.38 ± 2.0	30.74 ± 0.15
	50%	51.7 ± 0.7	107.36 ± 0.81	36.11 ± 0.49
	10%	36.45 ± 0.65	233.47 ± 2.56	56.46 ± 0.59
28	100%	73.45 ± 0.85	33.71 ± 0.74	22.47 ± 0.2
	50%	56.3 ± 0.2	61.87 ± 0.67	31.98 ± 0.12
	10%	28.45 ± 0.85	56.29 ± 1.68	58.46 ± 0.13

Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

(See Appendix page A96 - A98 & A120 for raw data)

TABLE 31

Influence of Nitrate concentrations on Enzyme production by G. graminis var tririci isolate ogl2

Growth Substrate : GLUCOSE

Reducing sugar assay:

DAYS	NITRATE CONCN. IN MEDIUM	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	 SPP	 CMC
7	100%	20.97 ± 0.46	297.84 ± 5.42	0	0
	50%	18.2 ± 0.29	333.35 ± 4.74	0	0
	10%	19.63 ± 0.99	347.27 ± 16.42	0	0
14	100%	41.33 ± 0.5	152.57 ± 2.02	0	0
	50%	30.4 ± 0.75	213.11 ± 4.8	0	0
	10%	52.6 ± 0.57	108.36 ± 1.38	0	0
21	100%	61.67 ± 0.65	119.67 ± 1.61	0	0
	50%	51.47 ± 0.76	140.16 ± 2.19	0	0
	10%	71.63 ± 0.9	93.81 ± 1.28	0	0
28	100%	80.87 ± 0.77	81.87 ± 0.7	0	0
	50%	71.73 ± 0.58	89.33 ± 0.8	0	0
	10%	102.47 ± 0.61	61.66 ± 0.34	0	0

SPP = Sodium polypectate   CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium
per mg. of mycelial dry weight.
Nitrate concentrations are with reference to Garrett' medium.

TABLE 31 (Contd.): *G. graminis* var *tritici* isolate ogl2.

Viscometric assay:

DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	 Sodium polypectate
7	100%	20.97 ± 0.46	0	0
	50%	18.2 ± 0.29	8.86 ± 0.66	0
	10%	19.63 ± 0.99	21.48 ± 1.43	19.09 ± 1.14
14	100%	41.33 ± 0.5	270.19 ± 2.94	23.79 ± 0.44
	50%	30.4 ± 0.75	359.3 ± 8.05	0
	10%	52.6 ± 0.57	198.69 ± 1.99	0
21	100%	61.67 ± 0.65	246.53 ± 2.11	11.56 ± 0.61
	50%	51.47 ± 0.76	256.85 ± 3.59	7.23 ± 0.42
	10%	71.63 ± 0.9	175.57 ± 2.1	0
28	100%	80.87 ± 0.77	20.82 ± 0.57	12.87 ± 0.47
	50%	71.73 ± 0.58	18.94 ± 0.23	7.67 ± 0.51
	10%	102.47 ± 0.61	6.43 ± 0.26	0

Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

(See Appendix page A101 - A103 & A121 for raw data)

TABLE 32

Influence of Nitrate concentrations on Enzyme production by G. graminis var tritici isolate 43

Growth Substrate : GLUCOSE

Reducing sugar assay:

DAYS	NITRATE CONCN. IN MEDIUM	Dry weight of mycelium (mg)	ENZYME SUBSTRATES: Citrus pectin	SPP	CMC
7	100%	21.07 ± 0.66	280.28 ± 9.3	0	0
	50%	16.13 ± 0.25	310.64 ± 4.79	0	0
	10%	19.03 ± 0.48	357.57 ± 8.34	0	0
14	100%	38.47 ± 0.33	149.9 ± 1.39	0	0
	50%	29.77 ± 1.05	160.01 ± 5.19	0	0
	10%	45.33 ± 1.64	126.03 ± 4.61	0	0
21	100%	52.73 ± 0.7	131.7 ± 2.06	0	0
	50%	41.47 ± 0.45	175.8 ± 1.81	0	0
	10%	59.07 ± 1.61	113.84 ± 2.98	0	0
28	100%	62.67 ± 0.54	82.56 ± 0.3	0	0
	50%	51.07 ± 1.01	106.61 ± 1.98	3.50 ± 0.15	0
	10%	92.83 ± 1.55	68.07 ± 1.22	0	0

SPP = Sodium polypectate   CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium
per mg. of mycelial dry weight.
Nitrate concentrations are withreference to Garrett's medium.

TABLE 32 (Contd.): *G. graminis* var *tritici* isolate 43

Viscometric assay:

DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	 Sodium polypectate
7	100%	21.07 ± 0.66	0	0
	50%	16.13 ± 0.25	10.15 ±	0
	10%	19.03 ± 0.48	21.88 ± 0.69	21.29 ± 1.19
14	100%	38.47 ± 0.33	290.97 ± 2.47	25.78 ± 0.19
	50%	29.77 ± 1.05	404.21 ± 14.4	0
	10%	45.33 ± 1.64	231.89 ± 7.59	0
21	100%	52.73 ± 0.7	279.6 ± 3.8	8.07 ± 0.49
	50%	41.47 ± 0.45	341.69 ± 4.21	0
	10%	59.07 ± 1.61	221.34 ± 4.87	0
28	100%	62.67 ± 0.54	18.57 ± 0.85	17.6 ± 0.67
	50%	51.07 ± 1.01	2.03 ± 0.68	0
	10%	92.83 ± 1.55	0	0

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

(See Appendix page A103 - A106 & A121 for raw data)

TABLE 33

Influence of Nitrate concentrations on Enzyme production by G. graminis var tritici isolate WPBS1

Growth Substrate : GLUCOSE

Reducing sugar assay:

	NITRATE CONCN.	Dry weight of	ENZYME	SUBSTRATES	
DAYS	IN MEDIUM	mycelium (mg)	Citrus pectin	SPP	CMC
7	100%	18.77 ± 0.39	305.37 ± 5.16	0	0
	50%	16.87 ± 0.45	313.16 ± 8.6	0	0
	10%	19.17 ± 0.33	302.95 ± 5.78	0	0
14	100%	29.2 ± 0.43	171.63 ± 2.84	0	0
	50%	22.9 ± 1.43	252.78 ± 15.61	0	0
	10%	45.37 ± 1.84	120.92 ± 5.08	0	0
21	100%	53.97 ± 1.36	124.06 ± 3.11	0	0
	50%	41.77 ± 0.66	153.15 ± 2.58	0	0
	10%	56.13 ± 1.11	106.25 ± 2.27	0	0
28	100%	62.97 ± 1.06	88.9 ± 1.51	0	0
	50%	51.57 ± 0.84	125.01 ± 2.53	0	0
	10%	85.2 ± 2.28	72.6 ± 1.91	0	0

SPP = Sodium polypectate CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium
per mg. of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

TABLE 33 (Contd.): G. graminis var trtici isolate WPBS1

Viscometric assay:

DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	 Sodium polypectate
7	100%	18.77 ± 0.39	0	0
	50%	16.87 ± 0.45	10.7 ± 1.16	12.36 ± 2.78
	10%	19.17 ± 0.33	15.66 ± 0.27	11.12 ± 0.73
14	100%	29.2 ± 0.43	409.89 ± 5.06	16.73 ± 1.03
	50%	22.9 ± 1.43	0	0
	10%	45.37 ± 1.84	279.65 ± 10.88	0
21	100%	53.97 ± 1.36	270.24 ± 6.73	10.97 ± 0.46
	50%	41.77 ± 0.66	384.48 ± 5.79	0
	10%	56.13 ± 1.11	250.85 ± 5.46	0
28	100%	62.97 ± 1.06	10.45 ± 0.09	13.9 ± 0.58
	50%	51.57 ± 0.84	11.64 ± 0.18	0
	10%	85.2 ± 2.28	0	0

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

(See Appendix page A106 - A108 & A121 for raw data)

TABLE 34

Influence of Nitrate concentrations on Enzyme production by F. culmorum when cultured on citrus pectin.

Reducing sugar assay:

DAYS	NITRATE CONCN. IN MEDIUM	Dry weight of mycelium (mg)	ENZYME SUBSTRATES		
			Citrus pectin	SPP	CMC
7	100%	23.7 ± 0.4	257.8 ± 4.22	42.57 ± 1.37	0
	50%	24.95 ± 0.15	251.5 ± 1.64	33.49 ± 0.08	0
	10%	30.4 ± 0.5	198.85 ± 3.47	31.91 ± 0.18	0
14	100%	76.55 ± 0.65	88.71 ± 0.78	10.84 ± 0.14	0
	50%	94.5 ± 0.7	73.65 ± 0.52	9.14 ± 0.005	0
	10%	140.7 ± 1.3	49.16 ± 0.43	3.2 ± 0.01	0
21	100%	136.4 ± 0.6	40.69 ± 0.18	7.35 ± 0.13	0
	50%	241.85 ± 0.65	25.37 ± 0.07	5.33 ± 0.04	0.78 ± 0.02
	10%	229.7 ± 0.9	24.96 ± 0.06	4.81 ± 0.04	0.32 ± 0
28	100%	197.35 ± 0.15	39.74 ± 0.05	10.88 ± 0.03	0
	50%	216.45 ± 0.85	33.32 ± 0.12	4.79 ± 0.01	0
	10%	253.6 ± 1.8	25.94 ± 0.23	4.23 ± 0.03	0

SPP = Sodium polypectate CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

TABLE 34 (Contd.): Fusarium culmorum

Viscometric assay:

DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	 Sodium polypectate
7	100%	23.7 ± 0.4	610.25 ± 11.36	375.99 ± 6.7
	50%	24.95 ± 0.15	566.47 ± 0.07	200.63 ± 3.68
	10%	30.4 ± 0.5	437.61 ± 6.65	173.2 ± 3.51
14	100%	76.55 ± 0.65	236.47 ± 2.66	191.28 ± 1.08
	50%	94.5 ± 0.7	193.05 ± 1.35	144.01 ± 0.8
	10%	140.7 ± 1.3	116.87 ± 1.26	81.27 ± 0.75
21	100%	136.4 ± 0.6	141.78 ± 0.34	100.63 ± 0.51
	50%	241.85 ± 0.65	62.13 ± 0.27	34.17 ± 0.03
	10%	229.7 ± 0.9	58.67 ± 0.27	24.87 ± 0.22
28	100%	197.35 ± 0.15	99.64 ± 0.06	95.73 ± 0.12
	50%	216.45 ± 0.85	9.44 ± 0.08	55.87 ± 0.26
	10%	253.6 ± 1.8	4.77 ± 0.07	27.38 ± 0.23

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.
(See Appendix page A110 - A112 & A124 for raw data)

TABLE 35

Influence of Nitrate concentrations on Enzyme production by Cochliobolus sativus when cultured on citrus pectin

Reducing sugar assay:

DAYS	NITRATE CONCN. IN MEDIUM	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	CMC
7	100%	38.15 ± 0.35	160.16 ± 2.03	10.19 ± 0.26	0
	50%	43.95 ± 0.35	150.84 ± 0.92	8.44 ± 0.05	0
	10%	32.55 ± 0.45	201.8 ± 2.22	10.99 ± 0.42	0
14	100%	67.85 ± 0.25	124.4 ± 0.32	0	0
	50%	50.25 ± 0.45	166.21 ± 2.82	0	0
	10%	44.9 ± 0.2	173.13 ± 1.12	0	0
21	100%	90.15 ± 0.45	62.94 ± 0.25	9.3 ± 0.32	0
	50%	65.15 ± 0.25	82.02 ± 0.46	9.7 ± 0.18	0
	10%	51.65 ± 0.45	100.89 ± 0.76	10.15 ± 0.15	0
28	100%	144.6 ± 1.0	27.57 ± 0.04	0	0
	50%	88.6 ± 0.7	44.86 ± 0.25	0	0
	10%	64.9 ± 0.4	59.72 ± 0.51	0	0

SPP = Sodium polypectate   CMC = Sodium carboxymethylcellulose
Datas are expressed as enzyme units in the culture medium per mg. of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.

TABLE 35 (Contd.): Cochliobolus sativus

Viscometric assay:

			ENZYME	SUBSTRATES
DAYS	Nitrate Concn. in culture medium	Dry weight of mycelium (mg)	Citrus pectin	Sodium polypectate
7	100%	38.15 ± 0.35	70.12 ± 0.01	50.91 ± 1.13
	50%	43.95 ± 0.35	69.59 ± 0.37	23.32 ± 0.38
	10%	32.55 ± 0.45	145.2 ± 2.27	28.68 ± 0.4
14	100%	67.85 ± 0.25	42.12 ± 0.95	36.6 ± 0.6
	50%	50.25 ± 0.45	77.79 ± 1.2	25.71 ± 0.07
	10%	44.9 ± 0.2	133.82 ± 0.41	46.4 ± 0.91
21	100%	90.15 ± 0.45	66.38 ± 0.89	42.99 ± 0.31
	50%	65.15 ± 0.25	107.71 ± 1.19	58.97 ± 0.1
	10%	51.65 ± 0.45	232.83 ± 1.22	91.32 ± 0.15
28	100%	144.6 ± 1.0	46.11 ± 0.09	14.35 ± 0.16
	50%	88.6 ± 0.7	89.27 ± 0.8	23.52 ± 0.005
	10%	64.9 ± 0.4	154.82 ± 1.68	32.23 ± 0.33

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.
Nitrate concentrations are with reference to Garrett's medium.
(See Appendix page A108 - A110 & A124 for raw data)

11. Influence of Phosphate on Pectin Degrading Enzyme Production by Fusarium culmorum & Cochliobolus sativus

Pectin degrading enzymes were produced by each of the organisms irrespective of carbon source and phosphate in the culture medium (TABLE 36 - 40). Whilst the presence of phosphate in culture medium influenced the early production of pectin degrading enzymes in some of the growth experiments (TABLE 36 & 38), its absence did not preclude enzyme production.

When malt extract was the sole carbon source in culture medium, the activity of the endo-enzymes with citrus pectin as enzyme substrate decreased with time with KH_2PO_4 as phosphate, while the reverse occurred with K_2HPO_4 as phosphate (TABLE 37 & 38). These observations apply to both organisms although there were no marked differences between the two organisms.

When citrus pectin was added to malt extract as carbon source, there was a marked increase in the activities of an enzyme which reduced the viscosity of citrus pectin (TABLE 39 & 40). This enzyme is probably endo-polygalacturonase. The endo-enzyme activity first increased before a continuous decrease occurred whether phosphate was present or absent in culture medium. The increase in activity when citrus pectin was added to culture medium as carbon source was therefore due to the growth substrate and not the phosphate.

The presence of phosphate in culture medium significantly increased mycelial dry weight produced by each of the organisms but did not appreciably increase enzyme production.

TABLE 36

Influence of Phosphate on Pectin Degrading Enzyme production by F. culmorum
Cochliobolus sativus when cultured on Malt Extract

Viscometric assay

Fusarium culmorum:

	Growth medium without phosphate			Growth medium with KH_2PO_4 as phosphate		
		ENZYME	SUBSTRATES		ENZYME	SUBSTRATES
DAYS	Dry weight of mycelium (mg)	Citrus pectin	SPP	Dry weight of mycelium (mg)	Citrus pectin	Sodium polypectate
7	122.87 ± 0.25	0	0	262.8 ± 0.33	4.5 ± 0.05	2.38 ± 0.14
14	231.17 ± 0.29	5.25 ± 0.19	0	382.57 ± 0.53	6.47 ± 0.05	4.88 ± 0.06
21	208.2 ± 0.24	7.55 ± 0.07	2.31 ± 0.04	525.3 ± 0.37	4.73 ± 0.09	8.85 ± 0.04
28	198.37 ± 0.34	14.53 ± 0.08	8.15 ± 0.23	526.87 ± 0.25	4.11 ± 0.03	2.23 ± 0.07

Cochliobolus sativus:

		ENZYME	SUBSTRATES		ENZYME	SUBSTRATES
DAYS	Dry weight of mycelium (mg)	Citrus pectin	SPP	Dry weight of mycelium (mg)	Citrus pectin	Sodium polypectate
7	13.27 ± o.29	0	0	194.07 ± 0.39	3.43 ± 0.16	1.46 ± 0.06
14	38.23 ± 0.29	4.8 ± 0.34	3.92 ± 0.04	202.73 ± 0.49	5.88 ± 0.13	6.74 ± 0.04
21	45.43 ± 0.46	3.67 ± 0.27	13.95 ± 0.4	275.9 ± 0.33	5.29 ± 0.15	9.63 ± 0.03
28	63.57 ± 0.56	2.36 ± 0.02	18.96 ± 0.39	281.27 ± 0.5	10.81 ± 0.1	4.79 ± 0.06

SPP = Sodium polypectate
Datas are expressed as enzyme units in the culture medium
per mg of mycelial dry weight.

(See Appendix page A125 - A127 for raw data)

TABLE 37

Influence of Phosphate on Pectin Degrading Enzyme production by Fusarium culmorum when cultured on Malt extract.

Viscometric assay:

Growth medium without phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME Citrus pectin	SUBSTRATES Sodium polypectate
7	66.97 ± 0.25	0	0
14	103.07 ± 0.33	9.38 ± 0.09	1.19 ± 0.09
21	135.83 ± 0.41	5.89 ± 0.17	4.66 ± 0.23
28	165.9 ± 0.24	3.62 ± 0.005	5.02 ± 0.08

Growth medium with KH_2PO_4 as phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME Citrus pectin	SUBSTRATES Sodium polypectate
7	219.13 ± 0.21	0	0
14	313.2 ± 0.33	9.79 ± 0.16	1.6 ± 0.005
21	350.8 ± 0.45	3.54 ± 0.08	9.74 ± 0.02
28	640.43 ± 0.61	2.81 ± 0	2.9 ± 0.02

Growth medium with K_2HPO_4 as phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME Citrus pectin	SUBSTRATES Sodium polypectate
7	57.63 ± 0.34	0	10.54 ± 0.48
14	302.47 ± 0.34	4.02 ± 0.04	3.61 ± 0.04
21	324.37 ± 0.37	6.19 ± 0.04	11.82 ± 0.1

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.

(See Appendix page A128 - A130 for raw data)

TABLE 38

Influence of Phosphate on Pectin Degrading Enzyme production by Cochliobolus sativus when cultured on Malt extract.

Viscometric assay:

Growth medium without phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	Sodium polypectate
7	60.8 ± 0.45	0	0
14	85.67 ± 0.37	1.34 ± 0.08	0
21	92.77 ± 0.42	6.38 ± 0.23	6.38 ± 0.15
28	196.4 ± 0.29	6.02 ± 0.06	4.08 ± 0.11

Growth medium with KH_2PO_4 as phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	Sodium polypectate
7	107.07 ± 0.21	0	1.4 ± 0
14	197.93 ± 0.37	15.29 ± 0.28	7.07 ± 0.01
21	354.3 ± 0.33	10.87 ± 0.1	7.64 ± 0.22
28	285.53 ± 0.25	9.81 ± 0.07	7.71 ± 0.12

Growth medium with K_2HPO_4 as phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	Sodium polypectate
7	262.43 ± 0.29	0.45 ± 0.05	3.11 ± 0.04
14	332.73 ± 0.29	5.49 ± 0.05	2.43 ± 0.04
21	232.77 ± 0.37	7.77 ± 0.09	9.38 ± 0.05
28	274.13 ± 0.21	10.31 ± 0.08	4.35 ± 0.05

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.

(See Appendix page A130 - A132 for raw data)

TABLE 39

Influence of Phosphate on Pectin Degrading Enzyme production by Fusarium culmorum when cultured on a mixture of Malt extract and Citrus pectin

Viscometric assay

Growth medium without phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	Sodium polypectate
7	134.37 ± 0.57	13.52 ± 0.05	1.68 ± 0.14
14	149.83 ± 0.33	38.83 ± 0.15	27.55 ± 0.31
21	162.83 ± 0.25	37.18 ± 0.18	53.84 ± 0.24
28	384.1 ± 0.79	6.88 ± 0.14	14.61 ± 0.02

Growth medium with KH_2PO_4 as phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	Sodium polypectate
7	287.5 ± 0.54	20.96 ± 0.09	6.17 ± 0.08
14	418.93 ± 0.26	62.36 ± 0.12	16.28 ± 0.07
21	604.1 ± 0.37	45.71 ± 0.07	20.78 ± 0.004
28	629.5 ± 0.29	29.83 ± 0.03	11.46 ± 0.05

Growth medium with K_2HPO_4 as phosphate:

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	Sodium polypectate
7	185.63 ± 0.45	13.99 ± 0.04	4.27 ± 0.05
14	195.53 ± 0.57	74.8 ± 0.3	26.68 ± 0.28
21	368.23 ± 0.45	49.38 ± 0.04	29.42 ± 0.11
28	651.73 ± 0.33	20.57 ± 0.07	8.96 ± 0.08

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.

(See Appendix page A133 - A135 for raw data)

TABLE 40

Influence of Phosphate on Pectin Degrading Enzyme production by Cochliobolus sativus when cultured on a mixture of Citrus pectin and Malt extract

Viscometric assay

Growth medium without phosphate:

		ENZYME SUBSTRATES	
DAYS	Dry weight of mycelium (mg)	Citrus pectin	Sodium polypectate
7	107.6 ± 0.49	1.84 ± 0.03	0
14	121.2 ± 0.29	33.61 ± 0.06	45.72 ± 0.32
21	256.2 ± 0.41	20.54 ± 0.08	32.15 ± 0.08
28	236.67 ± 0.61	8.29 ± 0.1	17.74 ± 0.04

Growth medium with KH_2PO_4 as phosphate:

		ENZYME SUBSTRATES	
DAYS	Dry weight of mycelium (mg)	Citrus pectin	Sodium polypectate
7	165.43 ± 0.46	16.83 ± 0.1	4.84 ± 0.14
14	311.27 ± 0.37	83.9 ± 0.14	46.96 ± 0.07
21	477.53 ± 0.74	56.83 ± 0.02	38.97 ± 0.09
28	381.17 ± 0.37	47.08 ± 0.12	28.33 ± 0.04

Growth medium with K_2HPO_4 as phosphate:

		ENZYME SUBSTRATES	
DAYS	Dry weight of mycelium (mg)	Citrus pectin	Sodium polypectate
7	173.57 ± 0.71	10.52 ± 0.16	3.46 ± 0.02
14	245.37 ± 0.56	40.33 ± 0.16	29.45 ± 0.06
21	254.73 ± 0.41	63.89 ± 0.31	37.52 ± 0.31
28	388.63 ± 0.76	22.01 ± 0.06	14.48 ± 0.08

Datas are expressed as enzyme units in the culture medium per mg of mycelial dry weight.

(See Appendix page A135 - A138 for raw data)

12. Enzyme production when Organisms were grown on Powdered wheat straw and on Extracts of Powdered wheat straw.

In previous experiments it had been shown that the organisms produced cell wall polysaccharide degrading enzymes when cultured on a variety of polysaccharides as growth substrates. The experiment was therefore extended to powdered wheat straw which had been shown to enhance survival of the organisms in the soil by Garrett and his co-workers (Garrett, 1956, 1966).

All the organisms produced cell wall polysaccharide degrading enzymes when grown on powdered wheat straw as carbon source. Enzyme activities in the culture medium are given in TABLE 41. Endo-enzymes active on citrus pectin and sodium polypectate were present throughout the incubation period, although showing much reduced activity compared with the previous experiments (See Section 4). Exo-enzyme activity was shown initially with citrus pectin as enzyme substrate and subsequently declined whereas activity on sodium polypectate appeared later in the experiment. Xylanase and carboxymethylcellulase activity was not apparent on day 7 but had appeared by day 14 and increased sustantially by day 56. These observations applied to all the organisms used in the growth experiments.

Because of the low enzyme activity in the culture filtrates compared with the previous experiments and the delay in the appearance of xylanase and carboxymethylcellulase activities despite significant mycelial growth it was thought that other soluble materials in wheat straw might be supporting growth of the fungi. To examine this possibility inoculation was made into extracts of powdered wheat straw prepared by autoclaving 1g samples for 15mins. with 100ml of the salts medium or distilled water. Growth in the water extract was sparse and enzyme activity was not detectable (Appendix page A171-A180). The results of experiments with the salts extract are presented in TABLE 42A - E, which also gives data for the control using glucose as carbon source when the fungi are grown on extract of straw. Pectin degrading enzyme activity was present initially and later declined, whereas xylanase and carboxymethylcellulase activity appeared in the culture medium later in the experiment. Significant mycelial growth occured during this experiment indicating that there was a suitable growth substrate present in the straw extract.

TABLE 41

Enzyme activities in the culture media of organisms when grown with Powdered wheat straw as carbon source. Data is given as enzyme units in the culture medium per mg of mycelial dry weight.

Cochliobolus sativus

		ENZYME SUBSTRATES			
DAYS	Dry weight of mycelium (mg)	Citrus pectin	SPP	XYLAN	CMC
		Viscometric assay			
7	38.6 ± 0.7	13.8 ± 0.03	14.9 ± 0.3	0	0
14	86.3 ± 0.2	8.4 ± 0.08	5.9 ± 0.02	3.8 ± 0.5	4.6 ± 0.2
28	297.5 ± 0.8	2.5 ± 0.1	0.8 ± 0.1	2.3 ± 0.1	1.7 ± 0.1
56	301.0 ± 1.2	1.8 ± 0.1	1.3 ± 0.1	12.3 ± 0.1	24.8 ± 0.2
		Reducing sugar assay			
7	38.6 ± 0.7	8.6 ± 0.3	0	0	0.8 ± 0.05
14	86.3 ± 0.2	2.9 ± 0.02	0	2.0 ± 0.01	0
28	297.5 ± 0.8	0.3 ± 0.1	0.2 ± 0.01	1.1 ± 0.01	0.3 ± 0.08
56	301.0 ± 1.2	0	0.5 ± 0.01	3.9 ± 0.04	1.6 ± 0.03

TABLE 41 (Contd.): Fusarium culmorum

DAYS	Dry weight of mycelium (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	43.0 ± 0.1	16.2 ± 1.1	8.8 ± 0.1	0	0
14	83.8 ± 0.3	12.1 ± 0.6	9.2 ± 0.4	6.6 ± 0.6	5.6 ± 0.2
28	340.6 ± 0.8	2.4 ± 0.4	0.9 ± 0.02	2.2 ± 0.2	2.6 ± 0.1
56	388.8 ± 0.9	1.5 ± 0.01	1.6 ± 0.01	10.9 ± 0.1	30.9 ± 0.2
		Reducing sugar assay			
7	43.0 ± 0.1	10.0 ± 1.7	0	0	0
14	83.8 ± 0.3	3.7 ± 0.3	0	1.8 ± 0.28	1.2 ± 0.4
28	340.6 ± 0.8	0.4 ± 0.2	0.2 ± 0.1	0.9 ± 0.03	0.2 ± 0.03
56	388.8 ± 0.9	0	0.5 ± 0.03	2.9 ± 0.05	1.8 ± 0.01
		G. graminis var tritici isolate ogl2.			
		Viscometric assay			
7	30.0 ± 0.2	19.17 ± 0.71	19.45 ± 0.13	0	0
14	78.75 ± 0.35	9.53 ± 0.68	7.62 ± 0.25	5.19 ± 0.09	8.47 ± 0.46
28	491.0 ± 0.2	1.22 ± 0	0.85 ± 0.04	1.75 ± 0.02	1.48 ± 0.02
56	490.15 ± 0.55	0	0	7.14 ± 0.08	7.41 ± 0.06

TABLE 41 (Contd.): G. graminis var tritici isolate og12

		ENZYME	SUBSTRATES		
DAYS	Dry weight of mycelium (mg)	Citrus pectin	SPP	Xylan	CMC
		Reducing sugar assay			
7	30.0 ± 0.2	15.21 ± 0.1	0	6.99 ± 0.78	1.65 ± 0.02
14	78.75 ± 0.35	3.53 ± 0.07	0	1.72 ± 0.3	1.25 ± 0.31
28	491.0 ± 0.2	0	0	0.36 ± 0	0.36 ± 0.03
56	490.15 ± 0.55	1.27 ± 0.01	0.36 ± 0.03	0.52 ± 0.02	0.1 ± 0.05
		G. graminis var tritici isolate 43			
		Viscometric assay			
7	38.9 ± 0.2	11.79 ± 0.28	12.64 ± 0.28	0	0
14	79.5 ± 0.2	9.12 ± 0.34	6.29 ± 0.23	4.82 ± 0.01	4.61 ± 1.06
28	492.1 ± 0.2	0.8 ± 0.05	0.53 ± 0.02	1.15 ± 0.03	1.14 ± 0.02
56	478.25 ± 0.35	0	0	5.89 ± 0.04	6.63 ± 0.07
		Reducing sugar assay			
7	38.9 ± 0.2	8.56 ± 0.36	0	6.03 ± 0.04	0
14	79.5 ± 0.2	2.95 ± 0.16	0	0	0
28	492.1 ± 0.2	0	0	0.17 ± 0.01	0.33 ± 0
56	478.25 ± 0.35	0	0.52 ± 0	0.67 ± 0	0.34 ± 0

TABLE 41 (Contd.): G. graminis var tritici isolate WPBS1

		ENZYME SUBSTRATES			
DAYS	Dry weight of mycelium (mg)	Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	29.6 ± 0.2	24.22 ± 1.85	12.39 ± 0.65	0	0
14	83.85 ± 0.25	10.34 ± 0.17	3.68 ± 0.11	4.57 ± 0.41	4.38 ± 0.19
28	439.85 ± 0.35	0.83 ± 0	0.4 ± 0.02	1.44 ± 0.04	1.55 ± 0.19
56	438.35 ± 0.85	0	0	7.11 ± 0.02	5.86 ± 0.07
		Reducing sugar assay			
7	29.6 ± 0.2	11.25 ± 0.34	0	5.24 ± 0.21	0
14	83.85 ± 0.25	3.17 ± 0.07	0	1.03 ± 0	0
28	439.85 ± 0.35	0	0	0.2 ± 0.03	0.39 ± 0.03
56	438.35 ± 0.85	0	1.53 ± 0.01	0.57 ± 0.06	0.17 ± 0

SPP = Sodium polypectate

CMC = Sodium carboxymethlcellulose

(See Appendix page A153 - A159, A182 & A183 for raw data)

TABLE 42A

Enzyme activities in the culture media of organisms when grown with a salts extract of powdered wheat straw or glucose (control) as carbon source. Data is given as units of enzyme in culture medium per mg of mycelial dry weight.

Cochliobolus sativus

Powdered wheat straw extract as carbon source:

		ENZYME SUBSTRATES			
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
7	13.5 ± 0.1	24.1 ± 0.8	49.3 ± 0.4	0	0
14	23.1 ± 0.3	30.7 ± 0.7	4.1 ± 0.1	56.1 ± 1.9	28.8 ± 1.2
28	42.2 ± 0.3	3.9 ± 0.4	0	43.4 ± 0.7	17.5 ± 0.7
56	64.4 ± 0.4	0	0	3.2 ± 0.2	0.9 ± 0.4
		Reducing sugar assay			
7	13.5 ± 0.1	56.5 ± 0.4	4.8 ± 0.1	7.6 ± 0.2	0
14	23.1 ± 0.3	5.3 ± 0.07	3.8 ± 0.1	8.1 ± 0.3	3.9 ± 0.09
28	42.2 ± 0.3	0	0	5.7 ± 0.01	1.6 ± 0.3
56	64.4 ± 0.4	0	0	2.4 ± 0.04	0.9 ± 0.02

TABLE 42A (Contd.): Cochliobolus sativus

Glucose as carbon source:

		ENZYME SUBSTRATES			
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	31.4 ± 1.8	110.9 ± 4.9	29.7 ± 0.8	0	0
14	56.2 ± 0.3	73.9 ± 0.4	15.4 ± 0.2	0	0
28	86.9 ± 0.3	4.1 ± 0.1	45.5 ± 0.5	0	11.6 ± 0.04
56	139.6 ± 0.3	1.4 ± 0.3	17.0 ± 0.3	0	0.6 ± 0.3
		Reducing sugar assay			
7	31.4 ± 1.8	173.8 ± 4.7	6.9 ± 0.4	0	0
14	56.2 ± 0.3	114.9 ± 5.9	0	0	0.8 ± 0.4
28	86.9 ± 0.3	72.9 ± 1.8	6.6 ± 0.2	0	1.7 ± 0.4
56	139.6 ± 0.3	17.7 ± 0.1	1.9 ± 0.8	0	0.8 ± 0.01

SPP = Sodium polypectate

CMC = Sodium carboxymethylcellulose
(See Appendix page A159 - A170, A182 & A183 for raw data)

TABLE 42B

Fusarium culmorum

Powdered wheat straw extract as carbon source:

DAYS	Mycelial dry weight (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	8.3 ± 0.2	62.7 ± 0.7	162.3 ± 6.4	0	0
14	33.7 ± 0.2	36.1 ± 2.1	5.5 ± 0.1	55.5 ± 0.7	29.3 ± 0.4
28	78.8 ± 0.5	2.8 ± 0.2	2.2 ± 0.5	23.9 ± 0.3	12.9 ± 0.6
56	90.1 ± 0.2	0	0	3.2 ± 0.6	2.1 ± 0.2
		Reducing sugar assay			
7	8.3 ± 0.2	132.9 ± 4.6	15.2 ± 0.8	12.8 ± 0.7	0
14	33.7 ± 0.2	2.6 ± 0.03	2.4 ± 0.4	3.4 ± 0.03	5.8 ± 0.06
28	78.8 ± 0.5	0	0	4.0 ± 0.1	1.1 ± 0.06
56	90.1 ± 0.2	0	0	2.3 ± 0.01	0.8 ± 0.003

TABLE 42B (Contd.): Fusarium culmorum

Glucose as carbon source:

			ENZYME	SUBSTRATES	
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
7	35.6 ± 0.4	52.7 ± 1.8	15.5 ± 0.1	0	0
14	96.4 ± 0.8	62.5 ± 0.2	10.3 ± 0.6	0	0
28	180.1 ± 0.5	3.4 ± 0.1	24.0 ± 1.4	0	4.1 ± 0.1
56	163.9 ± 0.2	2.5 ± 0.3	7.5 ± 0.1	0	1.3 ± 0.1
		Reducing sugar assay			
7	35.6 ± 0.4	198.3 ± 0.4	0	0	0
14	96.4 ± 0.8	54.0 ± 0.7	7.8 ± 0.1	0	0
28	180.1 ± 0.5	33.5 ± 0.3	4.5 ± 0.1	0	0.4 ± 0.01
56	163.9 ± 0.2	13.3 ± 0.3	2.3 ± 0.01	0	1.3 ± 0.2

SPP = Sodium polypectate

CMC = Sodium carboxymethylcellulose

(See Appendix page A159 - A170, A182 - A183 for raw data)

TABLE 42C

G. graminis var tritici isolate ogl2.

Powdered wheat straw extract as carbon source:

			ENZYME	SUBSTRATES	
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	12.45 ± 0.15	33.44 ± 2.27	56.1 ± 0.82	0	0
14	34.9 ± 0.3	15.76 ± 0.35	5.49 ± 0.19	36.06 ± 0.55	42.98 ± 0.37
28	77.25 ± 0.35	5.07 ± 0.09	0	24.06 ± 0.43	22.55 ± 0.21
56	83.85 ± 0.25	0	0	2.28 ± 0.49	4.57 ± 0.41
		Reducing sugar assay			
7	12.45 ± 0.15	54.51 ± 2.64	12.14 ± 0.39	8.17 ± 0.65	0
14	34.9 ± 0.3	2.03 ± 0.07	0	8.13 ± 0.07	5.13 ± 0.22
28	77.25 ± 0.35	0	0	4.23 ± 0.06	1.76 ± 0.32
56	83.85 ± 0.25	0	0	1.33 ± 0.005	1.11 ± 0.08

TABLE 42C (Contd.): *G. graminis* var *tritici* isolate ogl2.

Glucose as carbon source:

DAYS	Mycelial dry weight (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	22.15 ± 0.35	54.1 ± 5.17	13.53 ± 0.23	0	0
14	45.9 ± 0.3	78.89 ± 0.52	25.43 ± 0.9	0	0
28	73.3 ± 0.4	127.28 ± 9.31	150.75 ± 0.77	0	10.24 ± 1.19
56	83.0 ± 0.1	29.93 ± 6.26	66.67 ± 0.09	0	1.41 ± 0.61
		Reducing sugar assay			
7	22.15 ± 0.35	277.36 ± 4.38	0	0	0
14	45.9 ± 0.3	137.31 ± 0.63	0	0	0
28	73.3 ± 0.4	85.31 ± 0.13	1.31 ± 0.04	0	0
56	83.0 ± 0.1	31.06 ± 0.49	1.12 ± 0.08	0	3.68 ± 0.12

SPP = Sodium polypectate

CMC = Sodium carboxymethylcellulose

(See Appendix page A159 - A170, A182 & A183 for raw data)

TABLE 42D

G. graminis var *tritici* isolate 43

Powdered wheat straw extract as carbon source:

DAYS	Mycelial dry weight (mg)	ENZYME SUBSTRATES Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	11.75 ± 0.15	25.52 ± 1.09	67.42 ± 2.99	0	0
14	45.2 ± 0.1	23.24 ± 1.9	4.43 ± 0.005	26.92 ± 0.43	26.55 ± 0.06
28	79.1 ± 0.2	6.22 ± 0.31	0	15.38 ± 0.25	19.5 ± 0.37
56	89.0 ± 0.3	0	0	2.01 ± 0.52	4.12 ± 0.36
		Reducing sugar assay			
7	11.75 ± 0.15	66.66 ± 0.33	15.75 ± 0.2	6.3 ± 0.45	0
14	45.2 ± 0.1	6.96 ± 0.21	3.21 ± 0.34	1.84 ± 0.2	1.5 ± 0.14
28	79.1 ± 0.2	0	0	2.5 ± 0.005	1.37 ± 0.05
56	89.0 ± 0.3	0	0	1.0 ± 0.1	0.7 ± 0.005

TABLE 42D (Contd.): *G. graminis* var *tritici* isolate 43

Glucose as carbon source:

		ENZYME	SUBSTRATES		
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	26.05 ± 0.45	41.48 ± 6.32	8.64 ± 0.18	0	0
14	42.1 ± 0.3	85.82 ± 0.3	25.34 ± 0.18	0	0
28	64.95 ± 0.25	85.97 ± 0.59	89.81 ± 1.2	0	14.63 ± 0.83
56	72.05 ± 0.25	14.34 ± 1.34	38.17 ± 0.36	0	2.08 ± 1.38
		Reducing sugar assay			
7	26.05 ± 0.45	225.45 ± 4.85	0	0	0
14	42.1 ± 0.3	130.81 ± 0.79	0	0	0
28	64.95 ± 0.25	84.98 ± 0.61	0.81 ± 0.15	0	0
56	72.05 ± 0.25	24.82 ± 0.09	0.6 ± 0	0	0.47 ± 0.13

SPP = Sodium polypectate

CMC = Sodium carboxymethylcellulose

(See Appendix page A159 - A170, A182 & A183 for raw data)

TABLE 42E

G. graminis var tritici isolate WPBS1

Powdered wheat straw extract as carbon source:

		ENZYME SUBSTRATES			
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	11.95 ± 0.15	78.16 ± 3.76	7.18 ± 2.72	0	0
14	40.05 ± 0.15	33.71 ± 1.96	3.75 ± 0.02	21.64 ± 0.5	32.46 ± 0.3
28	59.1 ± 0.2	6.49 ± 0.26	0	25.24 ± 0.9	26.79 ± 0.19
56	70.3 ± 0.1	0	0	3.56 ± 0.005	4.39 ± 0.83
		Reducing sugar assay			
7	11.95 ± 0.15	154.31 ± 1.42	8.01 ± 0.88	6.2 ± 0.59	0
14	40.05 ± 0.15	6.47 ± 0.03	4.16 ± 0.17	4.01 ± 0.02	4.08 ± 0.06
28	59.1 ± 0.2	0	0	4.91 ± 0.51	2.66 ± 0.04
56	70.3 ± 0.1	0	0	1.27 ± 0.13	1.36 ± 0.04

TABLE 42E (Contd.): G. graminis var tritici isolate WPBS1

Glucose as carbon source:

		ENZYME	SUBSTRATES		
DAYS	Mycelial dry weight (mg)	Citrus pectin	SPP	Xylan	CMC
		Viscometric assay			
7	27.95 ± 0.15	32.82 ± 3.16	6.56 ± 0.56	0	0
14	35.6 ± 0.3	88.95 ± 0.19	28.57 ± 0.71	0	0
28	69.2 ± 0.3	70.83 ± 2.72	76.1 ± 1.6	0	9.64 ± 0.05
56	68.35 ± 0.45	13.66 ± 0.09	27.06 ± 1.04	0	1.82 ± 0.84
		Reducing sugar assay			
7	27.95 ± 0.15	200.12 ± 1.29	0	0	0
14	35.6 ± 0.3	144.48 ± 1.22	0	0	0
28	69.2 ± 0.3	80.03 ± 0.53	0.49 ± 0.14	0	0
56	68.35 ± 0.45	25.18 ± 0.08	0.95 ± 0.04	0	4.65 ± 0.02

SPP = Sodium polypectate
CMC = Sodium carboxymethylcellulose

(See Appendix page A159 - A170, A182 - A183 for raw data)

13. Column Chromatography of Pectin Degrading Enzymes produced in liquid culture by Fusarium culmorum & Cochliobolus sativus.

Preparation of culture filtrates for Sephadex G-75 column chromatography.

Fusarium culmorum and Cochliobolus sativus were grown on citrus pectin, glucose or sodium polypectate for 16 days, which in earlier experiments was found to coincide with maximum enzyme activity. The contents of each flask were filtered through glass fiber paper (Whatman, GF/A), using a Buchner funnel. The culture fluids from replicate flasks were combined; a portion was used for protein determination, reducing sugar content, and enzyme activity determination. The remainder was used for enzyme fractionation. The mycelia collected were dried to constant weight at 50°C.

The filtrates were centrifuged at 15,000g for 20minutes at 4°C and the protein precipitated with ammonium sulphate (analytical grade) according to Dixon & Webb (1971). In preliminary experiments, addition of ammonium sulphate to culture filtrates did not precipitate any proteins at 25% saturation and only scanty precipitates at 40% and 50% saturations were formed. Precipitates collected below 60% and above 80% saturation did not possess pectin degrading enzyme activity and were therefore rejected. The precipitates from 60% - 80% ammonium sulphate saturation which were found to exhibit pectin degrading enzyme activities were redissolved in 20ml of 5mM Tris - HCL buffer (pH 7.5). The solutions were then dialysed against the Tris - HCL for 24hr. at 4°C, in Visking dialysis tubing. The dialysed solutions were concentrated to 5ml. under vacuum at room temperature. Enzyme and protein determinations were carried out on the supernatant remaining after precipitation with 80% ammonium sulphate.

Enzyme Separation on Sephadex G-75 Column

40g of dry Sephadex G-75 were dissolved in 350ml of distilled water and deaerated under vaccum. A glass column (1.5cm x 45cm) was then packed with the resulting suspension making sure there were no air bubbles in the Sephadex bed as it settled. A constant rate of flow of solution (2.5ml/min.), through the column was achieved by use of a peristaltic pump. The column was then equilibrated with 0.05M Tris - HCL buffer (pH 7.5) containing 0.1M - KCL and 5mM NaN_3 and calibrated with the following proteins - Calf catalase, Aldolase, Bovine serum albumin, Chymotrypsinogen A, and Cytochrome C. A 2ml. sample of the dialysed concentrated preparation was applied to the column and eluted with 50mM Tris - HCL buffer (pH 7.5). 5ml fractions were collected and the protein content of each fraction determined at 280nm. Fractions under each protein peak obtained by plotting a graph of absorbance against fraction number were pooled, reduced to 20ml at room temperature under vaccum and enzyme activity determined.

Enzyme activities and properties of protein peaks

The amounts of endo-polymethylgalacturonase activity in the culture media when C. sativus and F. culmorum were grown on citrus pectin as carbon source confirm the earlier observation that enhancement of endo-polygalacturonase activity is significantly greater in Fusarium culmorum.

Mycelial dry weight, the protein content and enzyme activities in the culture medium at harvest after 16 days growth on glucose, citrus pectin or sodium polypectate as the carbon source are given in TABLE 43, and the activities of the precipitates obtained on 80% saturation of culture filtrates with ammonium sulphate are given in TABLE 44.

The elution profiles obtained when the 80% ammonium sulphate precipitates were passed through the Sephadex column are depicted in Fig.5. With glucose as the carbon source only peak number 1, was present. This peak was found in all culture media used except that of F. culmorum when grown with citrus pectin as the carbon source. When sodium polypectate was the carbon source, a second peak appeared in the culture medium of each organism. This peak was also present with citrus pectin as the carbon source, when a third peak appeared. In F. culmorum this was accompanied by a disappearance of peak 1, whereas all three peaks were present in Cochliobolus sativus.

The enzyme activities shown by these peaks are given in TABLE 45 & 46. The peak 1 components showed greater liberation of reducing sugar from citrus pectin than from sodium polypectate but greater endo-enzyme activity with sodium polypectate. An exception to this was that when Cochliobolus sativus was grown with citrus pectin as the carbon source; there was a greater increase in endo-polymethylgalacturonase activity. This data indicates the presence in peak 1 of an exo-polymethylgalacturonase and an endopolygalacturonase, and that when C. sativus is grown on citrus pectin an endo-polymethylgalacturonase appears. This last observation cannot be attributed to combined de-esterification and endopolygalacturonase activities because the latter would not be adequate to account for the changes observed. Trans-eliminase activity was not detectable in this peak, which is consistent with its absence from the culture medium with glucose as the carbon source.

Peak 2 was present in the culture medium of each organism when citrus pectin or sodium polypectate was the carbon source. When grown on sodium polypectate endo-polygalacturonase activity was present, and when F. culmorum was grown on citrus, there was a considerable enhancement of endo-polymethylgalacturonase activity.

Peak 3 present only when grown on citrus pectin, showed endo-polygalacturonase activity with each organism. Trans-eliminase activity was present in both peak 2 & 3. The C. sativus enzymes did not show trans-eliminase activity with sodium polypectate as substrate and this was the case with F. culmorum when grown on sodium polypectate. Both organisms produced enzymes that were active when citrus pectin was the carbon source in liquid culture.

Multiplicity of form of pectin degrading enzymes was found in the culture filtrates when both organisms were grown on citrus pectin or sodium polypectate. The organisms produced multiple forms of not just one enzyme but many enzymes. C. sativus culture filtrate, when grown on citrus pectin showed more multiple forms of pectin degrading enzymes than that of F. culmorum. With citrus pectin as growth substrate C. sativus produced multiple forms of endo-polymethylgalacturonase, exo- and endo-polygalacturonase and pectic lyase, while F. culmorum produced multiple forms of endo-polymethylgalacturonase, endo-polygalacturonase and pectate lyase. When grown on sodium polypectate, C. sativus produced multiple forms of exo-polymethylgalacturonase, endo-polygalacturonase and pectate lyase while F. culmorum produced multiple forms of exo- and endo-polygalacturonases and pectate lyase.

TABLE 43

Mycelial dry weight, protein content and enzyme activities in culture filtrates when C. sativus & F. culmorum were grown in liquid culture on glucose, citrus pectin or sodium polypectate.

	Cochliobolus sativus			Fusarium culmorum		
Carbon source	Glucose	Citrus pectin	NaPP	Glucose	Citrus pectin	NaPP
Mycelial dry wt.	110.1 ± 2.8	141.0 ± 4.7	102.7 ± 10.5	133.9 ± 4.9	150.3 ± 6.4	106.9 ± 2.9
Protein content	309.3 ± 7.5	243.2 ± 10.0	293.83± 3.4	200.8 ± 16.7	270.2 ± 7.2	349.0 ± 1.4
Enzyme assay by measuring reducing sugar liberation(units ml^{-1})						
CP substrate	21.14 ± 1.1	40.7 ± 0.2	22.4 ± 1.9	29.6 ± 3.1	52.6 ± 2.1	26.6 ± 1.6
NaPP substrate	11.3 ± 1.1	29.5 ± 2.3	4.7 ± 0.7	15.6 ± 1.6	22.6 ± 2.0	4.1 ± 1.6
Enzyme assay by viscosity (units ml^{-1})						
CP sustrate	0	9.33 ± 1.3	3.33 ± 1.0	4.33 ± 1.03	37.3 ± 3.7	7.3 ± 2.2
NaPP substrate	4.6 ± 1.03	32.0 ± 2.5	30.0 ± 1.6	10.33 ± 2.3	11.33 ± 2.1	33.0 ± 1.1

CP = Citrus pectin NaPP = Sodium polypectate
Mycelial dry weight are expressed as mg.
Protein content are expressed as µg/ml.

(See Appendix page A202 - A208 for raw data)

TABLE 44

Protein content and enzyme activity after precipitation at 80% saturation with Ammonium sulphate

	Cochliobolus sativus			*Fusarium culmorum*		
Carbon source	Glucose	Citrus pectin	NaPP	Glucose	Citrus pectin	NaPP
Protein content ($\mu g\ ml^{-1}$)	198.3 ± 11.7	170.8 ± 13.2	223.8 ± 11.1	145.5 ± 11.3	179.1 ± 10.9	243.16 ± 12.2
Enzyme assay by reducing sugar liberation (units ml^{-1})						
ENZYME SUBSTRATES						
Citrus pectin	23.9 ± 1.2	44.6 ± 0.5	29.1 ± 1.5	24.2 ± 1.5	49.0 ± 0.9	32.6 ± 1.8
NaPP substrate	8.5 ± 0.8	35.0 ± 1.9	4.3 ± 0.9	13.2 ± 1.2	32.7 ± 1.2	4.1 ± 0.7
Enzyme assay by measuring viscosity (units ml^{-1})						
ENZYME SUBSTRATES						
Citrus pectin	3.6 ± 1.0	27.6 ± 2.1	3.0 ± 1.1	2.3 ± 0.5	52.5 ± 2.3	7.0 ± 2.5
NaPP	25.8 ± 2.0	23.5 ± 1.6	43.2 ± 2.1	18.5 ± 0.8	30.3 ± 2.6	45.0 ± 1.9

NaPP = Sodium polypectate

(See Appendix page A202 - A208 for raw data)

TABLE 45 (See Appendix page A203,205 - A208 for raw data)

Enzyme activities of the peaks separated by gel filtration Chromatography on Sephadex G-75 column

		Cochliobolus sativus			Fusarium culmorum		
Carbon source :		GLUCOSE	CITRUS PECTIN	NaPP	GLUCOSE	CITRUS PECTIN	NaPP
Enzyme assay by reducing sugar liberation (units ml^{-1})							
ENZYME SUBSTRATES							
CP	Peak 1	13.8 ± 0.9	16.2 ± 1.4	17.7 ± 1.3	15.4 ± 0.7		20.7 ± 1.1
NaPP		2.4 ± 0.7	3.7 ± 0.1	3.9 ± 0.4	2.8 ± 0.9		8.14 ± 0.1
CP	Peak 2		7.8 ± 0.5	8.1 ± 0.1		25.9 ± 0.1	7.2 ± 0.1
NaPP			10.3 ± 0.9	5.3 ± 0.1		2.2 ± 0.9	8.2 ± 1.1
CP	Peak 3		4.2 ± 0.9			7.5 ± 1.0	
NaPP			24.6 ± 0.9			20.3 ± 1.1	
Enzyme assay by viscosity (units ml^{-1})							
ENZYME SUBSTRATES							
CP	Peak 1	1.3 ± 1.0	35.0 ± 0.1	2.66 ± 1.2	4.6 ± 1.0		4.0 ± 0.1
NaPP		20.5 ± 1.8	10.66± 1.2	11.33 ± 1.2	12.0 ± 1.3		14.3 ± 2.1
CP	Peak 2		17.0 ± 1.7	5.33 ± 1.2		123.67± 10.7	5.3 ± 1.2
NaPP			10.6 ± 4.2	80.33 ± 1.5		14.0 ± 0.1	89.67± 2.1
CP	Peak 3		10.0 ± 0.1			25.67± 1.2	
NaPP			20.33± 1.5			73.0 ± 9.0	

TABLE 46

Lyase activity assays (units ml^{-1}) Mean ± S.D. (Methods 1 & 2)

		Cochliobolus sativus			*Fusarium culmorum*		
Carbon source :		Glucose	Citrus pectin	NaPP	Glucose	Citrus pectin	NaPP
CULTURE FILTRATE							
ENZYME SUBSTRATES							
CP	(Method 1)	0	13.0 ± 1.1	5.5 ± 1.2	0	29.0 ± 0.6	7.5 ± 1.2
NaPP		0	8.2 ± 1.3	5.2 ± 0.9	0	25.6 ± 1.5	0
CP	(Method 2)	0	8.2 ± 1.3	5.2 ± 0.9	0	9.5 ± 1.2	6.3 ± 0.5
NaPP		0	1.2 ± 0.4	0	0	6.8 ± 0.7	0
AMMONIUM SULPHATE PRECIPITATE							
ENZYME SUBSTRATES							
CP	(Method 1)	0	13.0 ± 1.1	8.8 ± 0.6	0	10.3 ± 1.3	10.8 ± 1.3
NaPP		0	0	0	0	10.0 ± 0.6	0
CP	(Method 2)	0	7.0 ± 0.6	7.7 ± 0.5	0	7.6 ± 0.5	8.6 ± 0.8
NaPP		0	0	0	0	4.8 ± 0.7	0

CP = Citrus pectin
NaPP = Sodium polypectate

TABLE 46 (Contd.):

Carbon source :		*Cochliobolus sativus*			*Fusarium culmorum*		
SEPHADEX FRACTIONS		Glucose	Citrus pectin	NaPP	Glucose	Citrus pectin	NaPP
ENZYME SUBSTRATES							
CP	Peak 1 (M.1)	0	7.3 ± 0.6	4.3 ± 0.6	0		5.7 ± 0.6
NaPP		0	0	0	0		0
CP	Peak 1 (M.2)	0	2.7 ± 0.6	3.3 ± 0.6	0		4.0 ± 0.1
NaPP		0	0	0	0		0
CP	Peak 2 (M.1)		8.3 ± 0.6	4.0 ± 0.1		0	4.7 ± 1.2
NaPP			0	0		5.33 ± 1.15	0
CP	Peak 2 (M.2)		11.3 ± 0.6	3.0 ± 0.1		0	3.6 ± 0.6
NaPP			0	0		2.33 ± 0.6	0
CP	Peak 3 (M.1)		8.0 ± 0			4.0 ± 0	
NaPP			0			7.7 ± 0.6	
CP	Peak 3 (M.2)		4.0 ± 0.1			2.33 ± 0.6	
NaPP			0			4.33 ± 0.6	

CP = Citrus pectin NaPP = Sodium polypectate

(M.1) = Method 1 (M.2) = Method 2

(See Appendix page A209 - A213 for raw data)

TABLE 47

Calibration of Sephadex G-75 column with proteins of known molecular weights.

Fraction No.	Absorbance at 280nm Mean ± S.D.
1	0
2	0
3	0
4	0.03 ± 0.004
5	0.08 ± 0.008
6	0.1 ± 0.01
7	0.18 ± 0.008
8	0.28 ± 0.01
9	0.35 ± 0.008
10	0.27 ± 0.01
11	0.19 ± 0.01
12	0.15 ± 0.008
13	0.11 ± 0
14	0.05 ± 0.007
15	0.05 ± 0
16	0.05 ± 0.008
17	0.08 ± 0
18	0.12 ± 0.008
19	0.175 ± 0.007
20	0.22 ± 0.02
21	0.165 ± 0.04
22	0.1 ± 0.008
23	0.08 ± 0.008
24	0.04 ± 0
25	0.02 ± 0
26	0.02 ± 0
27	0.06 ± 0.008
28	0.12 ± 0.008
29	0.19 ± 0.01
30	0.27 ± 0.02
31	0.21 ± 0.008
32	0.18 ± 0
33	0.12 ± 0.008

TABLE 47 (Contd.):

Fraction No.	Absorbance at 280nm Mean ± S.D.
34	0.12 ± 0.008
35	0.11 ± 0
36	0.08 ± 0
37	0.03 ± 0.008
38	0.03 ± 0
39	0.06 ± 0.008
40	0.12 ± 0
41	0.15 ± 0.008
42	0.11 ± 0.008
43	0.1 ± 0
44	0.09 ± 0
45	0.07 ± 0.008
46	0.06 ± 0.005
47	0.04 ± 0
48	0.03 ± 0
49	0.07 ± 0.008
50	0.09 ± 0
51	0.1 ± 0
52	0.11 ± 0
53	0.09 ± 0.008
54	0.07 ± 0.02
55	0.05 ± 0
56	0.02 ± 0
57	0.01 ± 0
58	0.01 ± 0
59	0.01 ± 0
60	0.01 ± 0
61	0
62	0
63	0
64	0
65	0
66	0
67	0
68	0

TABLE 47 (Contd.):

Fraction No.	Absorbance at 280nm Mean ± S.D.
69	0
70	0
71	0
72	0
73	0
74	0
75	0
76	0
77	0
78	0
79	0
80	0

All datas are an average of three determinations.

(See Appendix page A192 - A194 for raw data)

TABLE 48

Enzyme Separation on Sephadex G-75 Column

GROWTH SUBSTRATE : GLUCOSE

Fraction No.	Absorbance at 280nm Mean ± S.D.	
	F. culmorum	*C. sativus*
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0.005 ± 0
8	0	0.006 ± 0.002
9	0	0.008 ± 0.002
10	0.006 ± 0.002	0.008 ± 0.002
11	0.008 ± 0.002	0.01 ± 0
12	0.01 ± 0	0.01 ± 0
13	0.013 ± 0.005	0.015 ± 0.004
14	0.036 ± 0.005	0.046 ± 0.009
15	0.05 ± 0.008	0.106 ± 0.005
16	0.08 ± 0	0.13 ± 0
17	0.15 ± 0.02	0.173 ± 0.009
18	0.116 ± 0.005	0.24 ± 0.008
19	0.086 ± 0.005	0.193 ± 0.01
20	0.043 ± 0.005	0.156 ± 0.005
21	0.02 ± 0	0.12 ± 0
22	0.01 ± 0	0.09 ± 0.008
23	0.01 ± 0	0.05 ± 0
24	0.005 ± 0	0.036 ± 0
25	0	0.033 ± 0.009
26	0	0.023 ± 0.005
27	0	0.016 ± 0.005
28	0	0.013 ± 0.005
29	0	0.008 ± 0.002
30	0	0.006 ± 0.002
31	0	0.005 ± 0

TABLE 48 (Contd.):

Fraction No.	Absorbance at 280nm Mean ± S.D.	
	F. culmorum	*C. sativus*
32	0	0.005 ± 0
33	0	0
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	0	0
40	0	0
41	0	0
42	0	0
43	0	0
44	0	0
45	0	0
46	0	0
47	0	0
48	0	0
49	0	0
50	0	0
51	0	0
52	0	0
53	0	0
54	0	0
55	0	0
56	0	0
57	0	0
58	0	0
59	0	0
60	0	0
61	0	0
62	0	0
63	0	0
64	0	0
65	0	0

TABLE 48 (Contd.):

Fraction No.	Absorbance at 280nm Mean ± S.D.	
	F. culmorum	*C. sativus*
66	0	0
67	0	0
68	0	0
69	0	0
70	0	0
71	0	0
72	0	0
73	0	0
74	0	0
75	0	0
76	0	0
77	0	0
78	0	0
79	0	0
80	0	0

All readings were an average of three determinations

(See Appendix page A194 - A196 for raw data)

TABLE 49

Enzyme Separation on Sephadex G-75 Column

GROWTH SUBSTRATES : Citrus pectin and Sôdium polypectate

Fract.	Absorbance at 280nm Mean ± S.D.			
	Citrus pectin		Sodium polypectate	
No.	FC	CS	FC	CS
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0.0083 ± 0.002
7	0	0	0	0.01 ± 0
8	0	0	0	0.033 ± 0.005
9	0	0	0.01 ± 0	0.083 ± 0.01
10	0	0.008 ± 0.002	0.056 ± 0.009	0.106 ± 0.009
11	0	0.023 ± 0.005	0.116 ± 0.01	0.146 ± 0.005
12	0	0.063 ± 0.01	0.17 ± 0.02	0.193 ± 0.009
13	0	0.08 ± 0	0.206 ±	0.25 ± 0
14	0	0.1 ± 0	0.333 ± 0.009	0.256 ± 0.009
15	0	0.103 ± 0.005	0.423 ± 0.02	0.29 ± 0.008
16	0	0.123 ± 0.005	0.376 ± 0.02	0.243 ± 0.005
17	0	0.1 ± 0	0.32 ± 0.02	0.2 ± 0
18	0.003 ± 0.002	0.073 ± 0.009	0.26 ± 0.008	0.173 ± 0.009
19	0.005 ± 0	0.046 ± 0.005	0.203 ± 0.005	0.15 ± 0
20	0.013 ± 0.005	0.02 ± 0	0.186 ± 0.005	0.116 ± 0.005
21	0.043 ± 0.01	0.01 ± 0	0.156 ± 0.005	0.096 ± 0.005
22	0.096 ± 0.01	0.008 ± 0.002	0.15 ± 0	0.086 ± 0.005
23	0.133 ± 0.005	0.01 ± 0	0.113 ± 0.009	0.053 ± 0.005
24	0.136 ± 0.005	0.033 ± 0.005	0.1 ± 0	0.033 ± 0.005
25	0.16 ± 0	0.056 ± 0.005	0.073 ± 0.009	0.02 ± 0
26	0.16 ± 0	0.08 ± 0	0.046 ± 0.005	0.04 ± 0
27	0.18 ± 0	0.09 ± 0.008	0.02 ± 0	0.08 ± 0.008
28	0.2 ± 0	0.123 ± 0.005	0.02 ± 0	0.13 ± 0.008
29	0.203 ± 0.005	0.13 ± 0	0.056 ± 0.005	0.16 ± 0
30	0.21 ± 0	0.143 ± 0.009	0.106 ± 0.009	0.16 ± 0
31	0.21 ± 0	0.156 ± 0.009	0.156 ± 0.09	0.173 ± 0.01

TABLE 49 (Contd.):

Absorbance at 280nm Mean ± S.D.

Fract.	Citrus pectin		Sodium polypectate	
No.	FC	CS	FC	CS
32	0.226 ± 0.01	0.173 ± 0.005	0.19 ± 0.008	0.186 ± 0.009
33	0.203 ± 0.005	0.206 ± 0.01	0.21 ± 0.008	0.2 ± 0.02
34	0.176 ± 0.005	0.173 ± 0.009	0.233 ± 0.01	0.176 ± 0.02
35	0.15 ± 0.008	0.16 ± 0	0.256 ± 0.009	0.13 ± 0
36	0.113 ± 0.009	0.123 ± 0.005	0.226 ± 0.009	0.103 ± 0.005
37	0.096 ± 0.005	0.103 ± 0.005	0.2 ± 0	0.073 ± 0.005
38	0.06 ± 0.008	0.076 ± 0.005	0.163 ± 0.005	0.05 ± 0.008
39	0.03 ± 0.008	0.056 ± 0.005	0.15 ± 0	0.02 ± 0
40	0.05 ± 0.008	0.02 ± 0	0.113 ± 0.005	0.02 ± 0
41	0.09 ± 0.008	0.046 ± 0.005	0.1 ± 0	0.02 ± 0
42	0.116 ± 0.005	0.083 ± 0.02	0.066 ± 0.009	0.0116 ± 0.002
43	0.133 ± 0.005	0.113 ± 0.005	0.036 ± 0.005	0.0116 ± 0.002
44	0.14 ± 0	0.126 ± 0.005	0.03 ± 0	0.01 ± 0
45	0.166 ± 0.009	0.15 ± 0	0.02 ± 0	0.01 ± 0
46	0.126 ± 0.005	0.13 ± 0	0.01 ± 0	0.005 ± 0
47	0.09 ± 0	0.103 ± 0.005	0.01 ± 0	0.005 ± 0
48	0.053 ± 0	0.063 ± 0.005	0.01 ± 0	0
49	0.026 ± 0.009	0.036 ± 0.005	0.01 ± 0	0
50	0.01 ± 0	0.02 ± 0	0.0083± 0.002	0
51	0.01 ± 0	0.02 ± 0	0.0066± 0.002	0
52	0.0083± 0.002	0.01 ± 0	0.005 ± 0	0
53	0.005 ± 0	0.008 ± 0.002	0.005 ± 0	0
54	0.005 ± 0	0.008 ± 0.002	0	0
55	0	0.005 ± 0	0	0
56	0	0.005 ± 0	0	0
57	0	0.005 ± 0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0

TABLE 49 (Contd.):

Fract. No.	Absorbance at 280nm Mean ± S.D. Citrus pectin FC	 CS	 Sodium polypectate FC	 CS
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0

FC = Fusarium culmorum

CS = Cochliobolus sativus

Datas are an average of three determinations.

(See Appendix page A196 - A201 for raw data)

DISCUSSION

Garrett (1966 & 1976) postulated an important role for cellulolysis in the competitive saprophytic ability and saprophytic survival of certain pathogens of cereal roots. When extra nitrate was provided it was found that those pathogens with a high degree of competitive saprophytic ability survived in the soil longer than those with low degree of competitive saprophytic ability. When the degradation of cellulose filter paper by cultures of these organisms was studied, it was found that organisms with a strong negative response to nitrate in saprophytic survival e.g. Cochliobolus sativus have a high cellulolysis rate. However, it was not possible to correlate cellulolysis rate by itself clearly with the nitrate effects; but with both cellulolysis rate and the general metabolic rate of the fungus. The " Cellulolysis Adequacy Index " concept was therefore invoked to explain the results. CAI was obtained by dividing cellulolysis rate by the linear growth rate (as a parameter of the general metabolic rate) each expressed in suitable units. General metabolic rate determines the rate at which carbohydrates are consumed by the process of respiration and growth; cellulolysis rate determines the rate at which soluble carbohydrates are made available for the metabolism of the fungus. Therefore to survive in wheat straw adequate cellulolysis rate is needed to maintain metabolic rate. The concept showed that a high value of CAI is associated with a strongly positive response to nitrate in longevity of survival and a low value of the index with a strongly negative response. An inverse relationship between competitive saprophytic ability and pathogenicity was also found. Organisms with strong competitive saprophytic ability were found to be weak pathogens while those with a weak competitive saprophytic ability were strong pathogens. The hypothesis finally concluded that the primary factors determining survival of a fungus in response to nitrate is its own ability to rapidly utilize the cellulose substrate, and that other fungi or soil microbes play a subsidiary role in the decomposition and eventual exhaustion of the substrate.

However, cellulose is relatively unreactive both chemically and enzymically (Rowland, 1975) and furthermore it constitutes only about 30% of wheat straw (Theander & Aman, 1978). Other readilly accessible substrates are also present and may be more suitable for sustaining growth (Peitersen, 1975; Wilkie, 1979; Aman & Nordkvist,1983). The present work has shown that *C. sativus* (strong pathogen according to Garrett, 1966), *F. culmorum* (weak pathogen, Garrett, 1966) and *G. graminis* var *tritici* (intermediate pathogen, Garrett, 1966) are able to grow readily in liquid culture using glucose, cellobiose, carboxymethyl-cellulose, citrus pectin or larchwood xylan as carbon source, as well as with powdered wheat straw or an extract of straw. It is therefore possible that enzymes such as pectinases and xylanases may play an equally important role with cellulases in saprophytic survival.

It is well known that microorganisms produce enzymes in response to the presence of particular metabolites in the growth medium and it is therefore not surprising that the form of carbon source influences enzyme production. No marked differences were detected between the organisms except when cultured on citrus pectin. With this substrate as carbon source, there was an appreciable increase in the activity of the pectin degrading enzyme produced by *F. culmorum* than that produced by *C. sativus*. The data suggests that an exo-polymethylgalacturonase is produced possibly constitutively when grown on glucose and that growth on citrus pectin induces the formation of an endo-polymethylgalacturonase.

Comparison of enzyme production by all the organisms suggests that, although differences in their saprophytic ability might be accounted for in part by differential ability to produce polysaccharide degrading enzymes, these differences are generally small and are to some extent moderated when mycelial growth is taken into account. The most marked difference in activity involves endo-polymethylgalacturonase.

It is particularly significant that with powdered wheat straw as the carbon source, xylanase and carboxymethylcellulase activities were not initially detectable. Substantial growth of the organisms had already occurred before these enzymes were detected. Extracts of wheat straw also supported subtantial growth with greatly reduced enzyme activity in the culture medium. The fungal growth occuring in wheat straw (Butler, 1953b; Garrett, 1966) is therefore probably due to the utilisation of the readily available nutrients in the straw.

The results of the present work suggest that the explanation for saprophytic survival proposed by Garrett may need to be extended to include degradation of other polysaccharides in addition to cellulose.

When fungi are grown with isolated cell walls as carbon source polysaccharide degrading enzymes are produced sequentially in correspondence with the layers of polysaccharide in the plant cell wall (English, et. al., 1971; Jones, et.al., 1972; Cooper & Wood, 1975; Mullen & Bateman, 1975; Friend & Threlfall, 1978). It would therefore be expected that readily, accessible wall material and other cellular debris would be utilised first when straw is invaded by mycelium. The chemical nature of the soluble utilisable growth substrate in wheat straw is not clear at this stage.

Extension of these results to a consideration of the processes taking place in wheat straw during fungal colonisation and survival require caution at present because of the involvement of a number of unknown factors. For example readily available substrates might be completely utilised before any degradation of wall polysaccharides commences, in which case polysaccharide degrading enzymes will be of little significance at least at the initial stages. Alternatively, all the stages involved in straw degradation may be operating simultaneously in each colonised straw, when polysaccharide degrading enzymes would be of major significance. Additional factors about which information is lacking concerns the immobilisation of the polysaccharide degrading enzymes on the insoluble polysaccharide matrix, mobility of the degradation products, and the availability of utilisable substrates to the mycelium.

The substrates used for the culture of fungi and the determination of cellulase activities have been chosen for their convenience rather than for their similarity to the structure of cellulose in wall polymers of the host plant. For example, much of the work done on cellulases has involved the use of soluble cellulose derivatives e.g. sodium carboxymethylcellulose as substrates (Gascoigne & Gascoigne, 1960; Reese, 1963; Garrett, 1970; Wood & McCrae, 1972 & 1978). In his experiments on saprophytic survival, Garrett,(1966), used loss in weight of filter paper as a measure of cellulase activity. These substrates have little or no resemblance to native cellulose encountered by the pathogens in intact plants. However, in the absence of better substrates, the results obtained from these experiments, with all their limitations, provide us with a lot of useful information which if properly interpreted of immense value to an understanding of cellulases.

Fungal mycelium can only survive provided its slow growth and extension within the substrate tissue or on the substrate in culture is not limited by lack of an important nutrient e.g. nitrogen. Rate of decomposition of plant tissue is limited by the supply of mineral nutrients essential for fungal growth (Garrett, 1970). The availability of nitrate has been shown to affect the survival of fungi as saprophytes. In the soil the primary source of nitrogen is the nitrate which is found in abundance. In culture experiments, nitrogen is supplied in a variety of organic or inorganic forms e.g. NO_3, ammonium or sodium salts, urea etc.

There were significant differences in the responses of the organisms to nitrate levels in culture medium especially when glucose was used as carbon source. *F. culmorum* exhibited a faster rate of glucose uptake than *C. sativus* and *G. graminis* var *tritici*. The rate of glucose uptake by *F. culmorum* was found to be increased at low levels of nitrate while that of *C. sativus* was substantially decreased. There was a significant difference in the mode of growth of the organisms. *F. culmorum* continued to increase in mycelial dry weight after glucose had been completely removed from the culture medium irrespective of nitrate concentrations. *C. sativus* and *G. graminis* var *tritici* isolates in low levels of nitrate initially showed an increase in mycelial dry weight which later declined. The decline in mycelial dry weight by *C. sativus* was more than that exhibited by *G. graminis* var *tritici*.

The continued growth of *F. culmorum* in the absence of substrate suggests that the organism has the ability to store excess nutrients which are later utilized for growth. The increase in mycelial dry weight shown by the fungus, after complete uptake of glucose is probably due to uptake of the nitrate in growth medium which is then used for protein synthesis and the fixation of carbon dioxide produced during respiration. The results suggest an efficient and economic utilisation of glucose by the fungus, which may contribute to longevity of survival as a saprophyte and might also enhance its competitive saprophytic ability when in competition with other microbes in the soil.

Low nitrate concentrations in culture medium decreased mycelial dry weight produced by C. sativus while it increased that of F. culmorum with G. graminis var tritici occupying the intermediate position between the two extremes. F. culmorum was found to have a strongly positive response to nitrate while C. sativus had a strongly negative response; this is in agreement with the findings of Garrett and his co-workers. To survive and compete with other saprophytes in the soil, adequate nitrate is therefore important for C. sativus and may be crucial for its pathogenic activities. There was no clear indication that nitrate influenced the rate of growth although the organisms differ in their nitrate economy. This may involve differences in efficient use of nitrate, nitrogen storage or turnover. However, nitrogen metabolism by the organisms was not pursued. These results further extend that obtained by Garrett, (1966 & 1967) and Butler, (1953b) in experiments involving high levels of nitrogen. It is noteworthy that glucose, which is the end-product of cellulose hydrolysis might play an important role in saprophytic survival. Continued hydrolysis of cellulose will increase the amount of available glucose for fungal metabolism. If the rate of increase of available glucose is more than the rate of its use by the fungus, a catabolite repression of cellulase synthesis is likely to result. This will decrease the cellulolysis rate necessary to maintain adequate general metabolic rate. Garrett's postulation might need to be modified to accomodate this glucose effect since cellulolysis rate and general metabolic rate were involved in the CAI concept; the concept used to correlate cellulolysis rate with nitrate effects (Garrett, 1970).

Differences in enzyme production were apparent in the response of the ogranisms to levels of nitrate concentrations. The activity of enzymes produced by F. culmorum varied slightly with levels of nitrate while that of C. sativus increased with incubation period irrespective of nitrate concentrations. In view of the importance placed on cellulases by Garrett it is significant that cellulase activity was not detected until very late in the growth experiments. Low levels of nitrate, however did not preclude enzyme activity or production. In fact, at low levels of nitrate there was a considerable increase in pectin degrading enzyme production by C. sativus towards the end of the experimental period. These differences were however masked when growth by the fungi was taken into consideration. G. graminis var tritici once again exhibited an intermediate response between F. culmorum and C. sativus. These observations further strengthened the idea that cell wall polysaccharide degrading enzymes might play an important role in saprophytic survival. It also agrees with the sequential production of cell wall polysaccharide degrading enzymes postulated by English, et. al., 1971; Jones, et. al., 1972; Cooper & Wood, 1975; and Mullen & Bateman, 1975, when fungi are cultured on isolated cell walls. Because low levels of nitrate in culture did not preclude enzyme production or effect a considerable decrease of its activity, it is possible that the organisms probably store the available nitrate which is then turned over in the process of enzyme synthesis when required.

Fusarium culmorum and Cochliobolus sativus produced several pectin degrading enzymes when grown on citrus pectin, glucose or sodium polypectate, with marked differences depending on the carbon source in culture experiments. With glucose as substrate only one protein peak was present when the culture filtrates were passed through a Sephadex column. When sodium polypectate was the carbon source two protein peaks were obtained for both fungi. The second peak was also present with citrus pectin as carbon source, when a third protein peak was obtained.

This peak was however, accompanied by the disappearance of the first peak in F. culmorum while all three peaks were present in C. sativus.

The enzyme activities present in the peaks varied according to the form of carbon source in growth medium. The peak 1 components showed greater liberation of reducing groups from citrus pectin than from sodium polypectate and greater endo-enzyme activity with sodium polypectate than with citrus pectin. This suggests that two enzymes were present, exo-polymethylgalacturonase and endo-polygalacturonase. An exception to the pattern of the peak 1 component activity was obtained when Cochliobolus sativus was grown on citrus pectin as the carbon source In this case, endo-polymethylgalacturonase activity which was present was greater than that obtained for exo-polymethylgalacturonase in the same experiment. This data therefore indicate the presence of in the peak 1 components, an exo-polymethylgalacturonase and an endo-polygalacturonase and that when C. sativus is grown on citrus pectin an endo-polymethylgalacturonase appears. This last observation cannot be attributed to combined de-esterification and endo-polygalacturonase activities because the latter will not be adequate to account for the changes observed. Transeliminative activity was not detectable in this peak, which is consistent with its absence from culture medium with glucose as the carbon source.

Peak 2 components of C. sativus exhibited very low exo-polymethylgalcturonase and high endo-polymethylgalacturonase activities when cultured on citrus pectin as carbon source. There was little difference between the exo- and endo-polygalacturonase activities exhibited by this peak. With F. culmorum, there was high exo- and endo-polymethylgalacturonase, and endo polygalacturonase when this organism was cultured on citrus pectin. There was a considerable enhancement of endo-polymethylgalacturonase activity when F. culmorum was grown on citrus pectin. With sodium polypectate as growth substrate there was very little difference in exo-enzyme activity with both citrus pectin and sodium polypectate as enzyme substrates. However, there was high endo-polygalacturonase activity with both fungi. There was little difference in exo- and endo-polymethylgalacturonase activity with *F. culmorum*, while exo-polygalacturonase activity was slightly higher than that of exo-polymethylgalacturonase.

Endo-polymethylgalacturonase and endo-polygalacturonase activities were present in peak 3 components. The activities of these enzymes in *F. culmorum* were greater than in *C. sativus*. Both fungi showed very small exo-enzyme activity. Below is a summary table of the range of pectin degrading enzymes produced by both fungi.

Summary of Pectin Degrading Enzymes produced in culture by F. culmorum and C. sativus.

GROWTH SUBSTRATES	ACTIVITY DETECTED IN CULTURE FLITRATES	
	F. culmorum	*C. sativus*
GLUCOSE	Exo-PMGase	Exo-PMGase
	Endo-PGase	Endo-PGase
CITRUS PECTIN	Exo-PMGase	Exo-PMGase
	Endo-PMGase(2)	Endo-PMGase (3)
	Endo-PGase (2)	Exo-PGase (3)
	Pectic lyase	Endo-PGase (3)
	Pectate lyase(2)	Pectic lyase (3)
	Pectinesterase	Pectinesterase
SODIUM POLYPECTATE	Exo-PMGase	Exo-PMGase (2)
	Exo-PGase (2)	Endo-PGase (2)
	Endo-PGase (2)	Pectate lyase (2)
	Pectate lyase (2)	

PMGase = Polymethylgalacturonase PGase = Polygalacturonase

(2) & (3) = Number of the multiple forms of the enzyme present in culture filtrates.

From the summary, it can be seen that both fungi not only produce a wide range of pectin degrading enzymes capable of hydrolysing a variety of types of pectin but also multiple forms of each enzyme were produced depending on the carbon source in the culture medium. These enzymes are the ones required by the organisms for the breaking-down of the rhamno-galacturonan fraction of the plant cell wall during pathogenesis. C. sativus exhibited the ability to produce more multiple forms of pectin degrading enzymes than F. culmorum when cultured on citrus pectin. This is to be expected because three separate peaks were obtained when the culture filtrates of the former fungus with this growth substrate were passed through the sephadex column while only two peaks were obtained with the filtrates of the latter fungus. The differences in the enzymes produced however, need further investigations.

Pectinesterase activity was only detected when both fungi were cultured on citrus pectin as carbon source. This is to be expected because glucose and sodium polypectate do not contain any methylesters as structural components. This enzyme is known to have a high specificity towards the methylester of pectic acid and its activity is usually assayed by continuous recorded titration of the free carboxyl groups (Kertesz, 1951; Marcus & Schejter, 1983).

Endo-polygalacturonases vary in their effects on viscosity of substrates during enzyme action. Under carefully standardized assay conditions variations in effects on viscosity of endo-polygalacturonases have been reported (Rombouts & Pilnik, 1972; Endo, 1964b,c,d; Pressey & Avants, 1973). It is possible that these reflect differences in action patterns of the enzymes comparable to those reported for α- amylases (Robyt & French, 1967). Two patterns of enzyme action are possible; a random hydrolysis of one bond in a single enzyme - substrate encounter, followed by complete dissociation of enzyme and products (multichain attack) or a single - chain multiple attack in which a single random hydrolytic scission is followed by a number of non - random attacks on one of the products, resulting in the liberation of oligogalacturonates (Phaff, 1966; English, et. al., 1972). The attack on oligogalacturonates is known to be determined by the nature of the active site of the enzymes, but more specifically by the size of the substrate - binding site and the position of the catalytic groups (Rexova-Benkova, 1973; Koller & Neukom, 1969; Rexova-Benkova & Markovic, 1976).

The multiplicity of forms of the pectin degrading enzymes produced by both F. culmorum and C. sativus will undoubtedly confer added versatility to the organisms which may be of value in saprophytic growth and survival as well as in infecting host plants. These enzymes are known to be essential in the initial stages of cell wall degradation. The enzymes will enable both fungi to adjust to many ecological situations because each form of the enzyme may be adapted to a particular environmental situation thus having ecological significance. This is because multiplicity of form of cell wall polysaccharide degrading enzymes especially " pectinases " have been shown by Hancock, 1976 and Byrde, 1978 to confer versatility on plant pathogens enabling them to adjust to many agricultural environments. The ability to produce multiple forms of enzymes may also account for the number of susceptible hosts of Fusarium culmorum and Cochliobolus sativus and their importance as serious pathogens of cereals.

However, F. culmorum will be more competitive as a saprophyte than C. sativus since it is less susceptible to fungistatic effect (Butler, 1953b; Wastie, 1961 & Garrett, 1970) and possesses all the characteristics that make for a strong competitive saprophyte, i.e. high growth rate, copious production of cell wall polysaccharide degrading enzymes, and production of antibiotic toxins (Garrett, 1976).

In order to demonstrate that these cell wall polysaccharide degrading enzymes are involved in the invasion and colonisation of the host tissue by the pathogens, it is important that they are shown to occur in infected tissues. There are however, many technical difficulties e.g. slow growth of many pathogenic organisms and low yield of experimental material, so that most of the published information on cell wall polysaccharide degrading enzymes have been obtained from pathogenic organisms grown in pure culture.

Though the essentiality of these enzymes for the pathogenicity of a given microorganism has been questioned (Hancock, 1964), their relation to disease severity could be significant when they are produced in vivo. Biochemical processes that increase severity may in many cases be independent of those that are essential for pathogenicity; therefore the role of degradative hydrolytic enzymes in disease must be evaluated with this distinction in mind. Since cellulolytic, pectic and hemicellulosic substances constitute a large proportion of cell wall encrusting materials, a determination of the extent of the decomposition of these compounds during pathogenesis by soft - rot pathogens is needed to evaluate further the plant - pathological significance of the degradative enzymes which mediate these processes. This is because the concentrations of enzymes in tissues, as determined by routine methods do not directly reflect their activity in vivo. However, careful interpretation of the results obtained with in vitro experiments will point in the right direction in fully understanding the role of cell wall polysaccharide degrading enzymes in pathogenesis.

When fungi are grown on isolated cell walls, the results obtained have emphasized the importance of the enzymes which degrade the rhamnogalacturonan moeity of the pectic fraction. Basham & Bateman, (1975), and Mullen & Bateman, (1975) concluded from their experiments that this fraction of the pectic substances is important in the first stage of cell wall degradation. This evidence was further strengthened by the earlier observation of Karr & Albersheim, (1970), who found that treatment with a " wall - modifying enzyme " which appeared to have polygalacturonate hydrolase activity was necessary before many cell wall polysaccharide hydrolases could catalyse hydrolytic reactions on cell walls isolated from *Phaseolus vulgaris*. Sequence of polysaccharide degrading enzyme production by fungi also point to the importance of pectin degrading enzymes since they are usually the first enzymes to be produced when organisms are cultured on isolated cell walls. Because of this importance attributed to " pectinases " in cell wall degradation a study of the " pectinases " produced by *F. culmorum* and *C. sativus* under various cultural conditions was carried out.

Although the saprophytic ability of these fungi is not in question evidence gathered in this study suggests an extension of Garrett's postulation of the importance of cellulolysis to saprophytic survival of *F. culmorum*, *C. sativus* and *G. graminis* var *tritici*. This is because this study has shown that other factors such as ability to utilise various carbohydrates, copious production of other enzymes such as pectinases and xylanases may also be important in saprophytic survival.

The results obtained in this study stress the importance attributed to pectin degrading enzymes in pathogenesis and complement the results obtained by other workers. For example, the fungi used in this study show the ability to produce pectinases under various cultural conditions as reported for other plant pathogens. Wick, et. al., (1982) used citrus pectin as carbon source in an experiment with *F. trincinctum*

TABLE II

Nomenclature of Pectic Depolymerases

Preferred substrate	Action pattern	Name	Modified[a] EC systematic name[a]	EC No.
Hydrolases				
D-Galacturonan	random	endo-D-galacturonanase	poly-(1 → 4)-α-D-galactosiduronate glycanohydrolase	3.2.1.15
D-Galacturonan	terminal	exo-D-galacturonanase	poly-(1 → 4)-α-D-galactosiduronate glycanohydrolase	3.2.1.67
D-Galacturonan	penultimate bonds	D-galacturonandigalacturono hydrolase	poly-(1 → 4)-α-D-galactosiduronate digalacturonohydrolase	3.2.1.82
Oligo-D-galactosiduronate	terminal	oligo-D-galactosiduronate hydrolase		
Lyases				
D-Galacturonan	random	endopectate lyase	poly-(1 → 4)-α-D-galactosiduronate lyase	4.2.2.2
D-Galacturonan	penultimate bonds	exopectate lyase	poly-(1 → 4)-α-D-galactosiduronate exolyase	4.2.2.9
Oligo-D-galactosiduronate	terminal	oligo-D-galactosiduronate lyase	oligo-D-galactosiduronate lyase	4.2.2.6
Poly(methyl D-galactosiduronate)	random	pectin lyase	poly(methyl D-galactosiduronate) lyase	4.2.2.10

[a] Modified to conform with accepted carbohydrate nomenclature.

Table of PECTOLYTIC ENZYMES after

Rexova-Benkova, L. & Markovic, O. (1976).

while Hara, et. al., (1982) used the following as substrates - glucose, galactose, fructose, xylose, mannose, lactose, sucrose and mandarin orange peel (1%) - in experiments with *Aspergillus niger*. They sometimes however, supplemented these growth substrates with pectin. In all these experiments pectin degrading enzymes were detected in culture filtrates.

Many plant pathogens have also been reported to produce multiple forms of pectin degrading enzymes as found in this work for *Fusarium culmorum* and *Cochliobolus sativus*. Marcus & Schejter, (1983) reported the isolation of two endo-polygalacturonases in culture filtrates of *Botrytis cinerea* while Barthe, et. al., (1981) isolated two polygalacturonases in culture filtrates of *Collectotrichum lindemuthianum*. Rose & Knosel, (1983) isolated endo-polygalacturonase and endopolymethyl-galacturonase from the culture filtrates of *Penicillium digitatum* Sacc., *Trichoderma viride* Penz., *Phomopsis citri* (Faw) cf. *Diaporthe citri* (Faw) Wolf, and *Collectotrichum gloeosporiodes* Penz. Both enzymes were found to be active in acid conditions. *Collectotrichum gloeosporioides* Penz produced in addition to the two enzymes above a pectic acid - trans-eliminase which was only active under alkaline conditions.

Catabolite repression of the synthesis of pectin degrading enzymes was not evident in this study with *F. culmorum* and *C. sativus*. This is in contrast to the findings of Giltrap & Lewis (1982) in experiments with *Suillus luteus* (L. EX FR.) S.F. GRAY and *Hebeloma ocalatum* Bruchet in which glucose was found to repress pectin degrading enzyme synthesis.

The sequence of the production of cell wall degrading enzymes as postulated by English, et. al., (1971); Jones, et. al., (1972); Mullen & Bateman, (1975) and Cooper & Wood, (1975) is strongly supported by the results obtained in this present study. This is because pectin degrading enzymes are produced first in all growth experiments, while cellulases are always the last enzymes to be found in culture filtrates irrespective of carbon source .

Byrde, (1982) in his presidental address to the British Mycological Society left those gathered at the meeting in no doubt about the importance of pectin degrading enzymes in plant diseases. He stressed the number of reports in which these enzymes have been shown to be involved in pathogenesis and traced the course of the enzymes from the endoplastic reticulum where they are known to be synthesized, to the cell wall of the host plant where they finally reach their substrates. He concluded by asking questions which will probably point the way to future research on pectin degrading enzymes e.g. the reasons why many pectinases are glycoproteins; the exciting associations between 'pectinases' and the plant's defence system; the possible status of 'pectinases' in biotrophic pathogens recognised by Brown, (1955); the role of natural inhibitors that have been described (Byrde & Archer, (1977); Johansen & Solheim, (1980); Fielding, (1981), and the possible exploitation of these inhibitors in protecting plants.

The central position of pectinases and to some extent xylanases in fungal pathogenesis, and their important role in saprophytic colonisation, will undoubtedly ensure that the study of these fascinating enzymes will continue for many years and increase our knowledge the role of fungal enzymes in pathogenesis.

The investigations carried out in this study strongly suggest that the important role suggested for cellulases in fungal saprophytic survival in wheat straw needs to be modified. This is because other factors may be more important than cellulases.

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PREPARATION OF STANDARD CURVE

Concentration of glucose solutions (mg cm^{-3})	Absorbance at 520nm.			
	1	2	3	MEAN ± S.D.
0.02	0.075	0.075	0.06	0.07 ± 0.0071
0.04	0.115	0.125	0.12	0.12 ± 0.0041
0.06	0.26	0.23	0.26	0.25 ± 0.14
0.08	0.32	0.33	0.34	0.33 ± 0.0082
0.10	0.41	0.38	0.38	0.39 ± 0.14
0.12	0.42	0.42	0.42	0.42 ± 0
0.14	0.55	0.55	0.52	0.54 ± 0.14
0.16	0.65	0.66	0.64	0.65 ± 0.0082
0.18	0.69	0.72	0.72	0.71 ± 0.14
0.20	0.81	0.81	0.81	0.81 ± 0

APPENDIX A.

RAW DATA FOR TABLES 1 - 49.

Utilisation of Arabinose in liquid culture by Fusarium culmorum

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	11.95	11.95	11.95	11.95 ± 0
1	9.85	10.78	11.05	10.56 ± 0.51
2	10.75	10.85	10.95	10.85 ± 0.081
3	10.45	9.95	10.5	10.3 ± 0.24
4	10.87	10.66	10.87	10.8 ± 0.098
5	11.2	11.2	11.2	11.2 ± 0
6	12.25	12.58	12.37	12.4 ± 0.14
7	10.58	11.05	10.35	10.66 ± 0.29
8	8.52	8.52	9.3	8.78 ± 0.36
9	8.9	8.98	9.0	8.96 ± 0.043
10	8.22	8.15	8.35	8.24 ± 0.082
11	7.36	7.61	7.86	7.61 ± 0.2
12	8.79	8.9	8.95	8.88 ± 0.066
13	8.5	8.5	8.5	8.5 ± 0
14	7.95	7.63	8.15	7.91 ± 0.21
15	7.32	7.15	6.98	7.15 ± 0.14
16	6.77	6.35	6.5	6.54 ± 0.17
18	6.52	6.52	5.95	6.33 ± 0.27
19	5.95	5.85	5.75	5.85 ± 0.081
20	5.75	5.64	5.5	5.63 ± 0.1
21	5.6	5.35	5.25	5.4 ± 0.15
22	4.5	4.5	4.5	4.5 ± 0
23	4.1	4.24	4.08	4.14 ± 0.071
25	3.5	3.5	3.35	3.45 ± 0.070
26	3.3	3.25	3.05	3.20 ± 0.11
27	3.23	3.15	2.95	3.11 ± 0.12
28	2.8	2.8	2.8	2.8 ± 0
29	1.75	2.2	1.75	1.9 ± 0.21
30	1.04	0.92	0.98	0.98 ± 0.05

Utilisation of Arabinose in liquid culture by Cochliobolus sativus

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	11.95	11.95	11.95	11.95 ± 0
1	10.04	9.95	9.5	9.83 ± 0.24
2	12.5	12.75	11.95	12.4 ± 0.33
3	11.16	11.4	11.1	11.22 ± 0.13
4	11.43	11.4	11.4	11.41 ± 0.014
5	11.41	11.38	11.38	11.39 ± 0.014
6	11.35	11.2	11.35	11.3 ± 0.07
7	10.4	10.15	10.35	10.3 ± 0.11
8	9.25	9.0	9.65	9.3 ± 0.26
9	9.95	9.87	9.76	9.86 ± 0.08
10	8.76	8.6	8.53	8.63 ± 0.096
11	7.61	7.46	7.46	7.51 ± 0.071
12	7.82	7.62	8.11	7.85 ± 0.2
13	8.66	8.45	8.87	8.66 ± 0.17
14	7.78	7.52	7.95	7.75 ± 0.18
15	6.68	6.4	6.87	6.65 ± 0.19
16	6.14	6.14	6.14	6.14 ± 0
18	5.16	4.98	5.1	5.08 ± 0.074
19	4.45	4.05	4.4	4.3 ± 0.18
20	4.4	4.4	4.4	4.4 ± 0
21	4.73	4.52	4.73	4.66 ± 0.098
22	3.5	3.39	3.4	3.43 ±0.049
23	3.07	3.05	3.12	3.08 ± 0.029
25	2.92	2.95	2.98	2.95 ± 0.024
26	2.86	2.35	2.62	2.61 ± 0.21
27	2.6	2.46	2.53	2.53 ± 0.096
28	2.0	2.01	2.05	2.02 ± 0.022
29	1.48	1.6	1.6	1.56 ± 0.056
30	0.75	0.72	0.69	0.72 ± 0.024

Utilisation of Arabinose in liquid culture by *G. graminis* var *tritici* isolate og.12.

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	11.4	11.4	11.4	11.4 ± 0
1	12.03	11.95	12.05	12.01 ± 0.034
2	11.41	10.98	11.36	11.25 ± 0.19
3	11.95	11.2	11.95	11.7 ± 0.35
4	12.2	11.84	11.81	11.95 ± 0.18
5	11.85	11.78	11.71	11.78 ± 0.06
7	11.65	11.7	11.3	11.55 ± 0.18
8	11.1	11.1	11.1	11.1 ± 0
9	10.84	10.98	10.73	10.85 ± 0.1
10	10.45	10.5	9.95	10.3 ± 0.25
11	9.95	10.04	9.86	9.95 ± 0.073
12	10.09	10.05	9.8	9.98 ± 0.13
14	10.21	10.16	9.95	10.1 ± 0.11
15	10.15	10.0	9.7	9.95 ± 0.19
16	9.89	9.65	9.5	9.68 ± 0.16
18	9.5	9.5	9.5	9.5 ± 0
19	9.25	9.25	9.25	9.25 ± 0
20	8.98	8.98	8.89	8.95 ± 0.042
21	8.7	8.85	8.55	8.7 ± 0.12
22	8.7	8.7	8.7	8.7 ± 0
23	8.05	7.95	8.3	8.1 ± 0.15
25	8.15	8.05	8.1	8.1 ± 0.041
26	7.6	7.5	7.35	7.95 ± 0.1
27	7.73	7.95	7.9	7.86 ± 0.094
28	7.65	7.8	7.8	7.75 ± 0.071
29	7.2	7.2	7.2	7.2 ± 0
30	7.02	6.98	7.15	7.05 ± 0.072

Utilisation of Arabinose in liquid culture by <u>G. graminis</u> var <u>tritici.</u> isolate 43

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	11.4	11.4	11.4	11.4 ± 0
1	11.65	11.65	11.8	11.7 ± 0.071
2	11.35	11.35	11.5	11.4 ± 0.071
3	12.2	12.2	12.2	12.2 ± 0
4	11.9	11.95	12.0	11.95 ± 0.041
5	11.68	11.6	11.76	11.68 ± 0.07
7	11.5	11.2	11.5	11.4 ± 0.14
8	10.98	10.86	11.1	10.98 ± 0.097
9	10.7	10.65	10.9	10.75 ± 0.11
10	10.1	10.1	10.1	10.1 ± 0
11	10.2	10.2	10.2	10.2 ± 0
12	10.1	10.1	10.1	10.1 ± 0
14	10.46	9.86	9.98	10.1 ± 0.26
15	9.95	9.7	9.75	9.8 ± 0.11
16	9.9	9.8	9.7	9.8 ± 0.082
18	9.8	9.8	9.8	9.8 ± 0
19	9.45	9.6	9.45	9.5 ± 0.071
20	9.25	9.15	9.35	9.25 ± 0.082
21	9.3	9.3	9.15	9.25 ± 0.072
22	8.9	9.1	8.85	8.95 ± 0.11
23	8.0	8.3	8.0	8.1 ± 0.14
25	8.1	8.3	7.9	8.1 ± 0.16
26	7.9	8.2	7.84	7.98 ± 0.16
27	7.75	7.9	7.75	7.8 ± 0.071
28	7.7	7.6	7.5	7.6 ± 0.082
29	7.5	7.4	7.15	7.35 ± 0.15
30	7.4	7.4	7.25	7.35 ± 0.071

Utilisation of Arabinose in liquid culture by G. graminis var tritici isolate WPBS1.

DAYS	Concentration of reducing sugars in culture medium (mg cm-3) 1	2	3	Mean ± S.D.
0	11.4	11.4	11.4	11.4 ± 0
1	11.55	11.42	11.47	11.48 ± 0.054
2	10.95	10.85	10.75	10.85 ± 0.082
3	11.85	11.4	11.85	11.7 ± 0.21
4	11.4	11.4	11.4	11.4 ± 0
5	11.4	11.1	11.25	11.25 ± 0.12
7	11.2	10.95	11.15	11.1 ± 0.11
8	10.95	10.76	10.84	10.85 ± 0.077
9	10.7	10.65	10.69	10.68 ± 0.026
10	10.3	10.3	10.3	10.3 ± 0
11	9.3	9.65	9.55	9.5 ± 0.15
12	9.8	9.95	9.8	9.85 ± 0.071
14	10.2	9.95	10.15	10.1 ± 0.11
15	9.3	9.15	9.3	9.25 ± 0.071
16	9.25	8.9	9.09	9.08 ± 0.143
18	9.1	8.85	8.9	8.95 ± 0.11
19	8.6	8.3	8.3	8.4 ± 0.14
20	7.9	7.6	7.3	7.6 ± 0.24
21	7.6	7.6	7.6	7.6 ± 0
22	6.5	6.65	7.25	6.8 ± 0.32
23	5.8	6.o	6.2	6.0 ± 0.16
25	6.0	6.0	6.0	6.0 ± 0
26	5.9	5.9	5.9	5.9 ± 0
27	5.84	5.79	5.95	5.86 ± 0.066
28	5.65	5.65	5.8	5.7 ± 0.071
29	5.4	5.4	5.4	5.4 ± 0
30	5.2	5.15	5.4	5.25 ± 0.11

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Utilisation of Arabinose in liquid culture by Phialophora radicicola var radicicola isolate rB.

DAYS	Concentration of reducing sugars in culture medium (mg cm-3)			
	1	2	3	Mean ± S.D.
0	11.4	11.4	11.4	11.4 ± 0
1	11.85	11.4	11.85	11.7 ± 0.21
2	11.25	10.95	11.1	11.1 ± 0.21
3	11.3	11.5	11.4	11.4 ± 0.082
4	11.85	12.1	11.9	11.95 ± 0.11
5	11.64	11.65	11.75	11.68 ± 0.049
7	10.8	10.85	10.9	10.85 ± 0.041
8	9.35	9.6	9.55	9.5 ± 0.11
9	10.1	10.4	10.4	10.3 ± 0.14
10	9.8	10.15	10.35	10.1 ± 0.28
11	8.6	9.35	9.35	9.1 ± 0.35
12	8.4	8.98	8.9	8.76 ± 0.26
14	8.4	8.45	8.35	8.4 ± 0.041
15	8.4	8.5	8.3	8.4 ± 0.082
16	7.9	7.96	7.9	7.92 ± 0.028
18	7.6	7.8	7.4	7.6 ± 0.16
19	7.2	7.5	7.35	7.35 ± 0.12
20	6.98	7.15	7.02	7.05 ± 0.072
21	6.95	7.1	7.1	7.05 ± 0.071
22	6.6	6.9	6.9	6.8 ± 0.14
23	6.75	6.75	6.9	6.8 ± 0.071
25	6.5	6.6	6.7	6.6 ± 0.082
26	6.6	6.6	6.6	6.6 ± 0
27	6.63	6.39	6.58	6.53 ± 0.1
28	6.5	6.45	6.55	6.5 ± 0.041
29	6.0	6.0	6.0	6.0 ± 0
30	6.0	5.7	5.85	5.85 ± 0.12

Utilisation of Arabinose in liquid culture by Phialophora radicicola var graminis isolate gc.

DAYS	Concentration of reducing sugars in culture medium (mg cm-3)			
	1	2	3	Mean ± S.D.
0	11.4	11.4	11.4	11.4 ± 0
1	11.3	11.1	11.2	11.2 ± 0.082
2	10.85	10.85	10.85	10.85 ± 0
3	12.4	11.95	12.25	12.2 ± 0.19
4	11.6	11.3	11.3	11.4 ± 0.14
5	11.4	11.1	11.1	11.2 ± 0.14
7	11.1	11.1	11.1	11.1 ± 0
8	10.8	10.95	10.8	10.85 ± 0.071
9	10.6	10.8	10.7	10.7 ± 0.082
10	10.6	10.6	10.6	10.6 ± 0
11	9.65	9.76	9.54	9.65 ± 0.09
12	9.95	9.95	10.04	9.98 ± 0.042
14	10.15	10.15	10.0	10.1 ± 0.071
15	9.35	9.2	9.2	9.25 ± 0.071
16	9.2	9.1	9.16	9.12 ± 0.041
18	9.4	9.5	9.6	9.5 ± 0.18
19	8.55	8.65	8.9	8.7 ± 0.15
20	7.75	7.85	8.1	7.9 ± 0.15
21	7.8	7.9	8.0	7.9 ± 0.082
22	7.9	7.9	7.9	7.9 ± 0
23	7.5	7.5	7.8	7.6 ± 0.14
25	7.5	7.6	7.7	7.6 ± 0.082
26	7.4	7.4	7.4	7.4 ± 0
27	7.29	7.45	7.4	7.38 ± 0.067
28	7.3	7.4	7.35	7.35 ± 0.041
29	6.95	7.1	7.1	7.05 ± 0.071
30	6.5	6.5	6.5	6.5 ± 0

Utilisation of Cellobiose in liquid culture by Fusarium culmorum

DAYS	Concentration of reducing sugars in culture medium (mg cm-3)			
	1	2	3	Mean ± S.D.
0	5.7	5.7	5.7	5.7 ± 0
1	5.7	5.7	5.7	5.7 ± 0
2	5.2	5.35	4.99	5.18 ± 0.15
3	4.82	5.1	4.6	4.84 ± 0.2
4	4.05	4.15	3.8	4.0 ± 0.15
5	3.6	3.8	3.55	3.65 ± 0.11
6	2.95	3.12	2.75	2.94 ± 0.15
7	1.47	1.5	1.59	1.52 ± 0.051
8	1.5	1.65	1.5	1.55 ± 0.071
9	0.8	0.95	0.83	0.86 ± 0.065
10	0.51	0.55	0.53	0.53 ± 0.016
11	0.93	0.95	0.94	0.94 ± 0.0082
12	0.61	0.64	0.61	0.62 ± 0.014
13	0.37	0.42	0.35	0.38 ± 0.029
14	0.08	0.15	0.07	0.1 ± 0.035
15	0.05	0.09	0.04	0.06 ± 0.022
16	0.07	0.08	0.06	0.07 ± 0.0082
18	0.09	0.09	0.09	0.09 ± 0
19	0.04	0.05	0.03	0.04 ± 0.0082
20	0.02	0.02	0.02	0.02 ± 0
21	0	0	0	0 ± 0
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
25	0	0	0	0 ± 0

Utilisation of Cellobiose in liquid culture by Cochliobolus sativus

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	7.48	7.48	7.48	7.48 ± 0
1	6.1	6.4	6.1	6.2 ± 0.14
2	6.85	6.9	6.8	6.85 ± 0.041
3	6.75	6.82	6.8	6.79 ± 0.029
4	6.58	6.7	6.58	6.62 ± 0.056
5	6.26	6.4	6.3	6.32 ± 0.059
6	5.4	5.8	5.6	5.6 ± 0.16
7	5.19	5.4	5.19	5.26 ± 0.099
8	4.8	5.0	4.63	4.81 ± 0.15
9	5.12	5.0	5.12	5.08 ± 0.056
10	5.05	5.0	4.86	4.97 ± 0.08
11	4.95	4.86	4.86	4.89 ± 0.042
12	5.4	5.3	5.26	5.32 ± 0.059
13	4.95	4.88	4.75	4.86 ± 0.083
14	4.3	4.31	4.36	4.34 ± 0.065
15	4.35	4.31	4.36	4.34 ± 0.022
16	4.13	4.0	4.2	4.11 ± 0.083
18	4.11	3.98	4.15	4.08 ± 0.072
19	3.96	3.9	4.05	3.97 ± 0.062
20	4.16	3.95	4.25	4.12 ± 0.12
21	4.2	4.02	4.2	4.14 ± 0.085
22	3.5	3.34	3.42	3.42 ± 0.065
23	3.62	3.42	3.55	3.53 ± 0.083
25	3.62	3.56	3.59	3.59 ± 0.024
26	4.8	4.74	4.74	4.76 ± 0.028
27	6.6	6.38	6.43	6.47 ± 0.094
28	6.6	6.45	6.54	6.53 ± 0.062
29	6.58	6.6	6.56	6.58 ± 0.016
30	6.02	6.12	5.95	6.03 ± 0.07

Utilisation of Cellobiose in liquid culture by G. graminis var tritici isolate og.12.

DAYS	Concentration of reducing sugars in culture medium (mg cm-3)			
	1	2	3	Mean ± S.D.
0	6.75	6.75	6.75	6.75 ± 0
1	6.96	6.98	6.91	6.95 ± 0.029
2	7.0	7.0	6.85	6.95 ± 0.071
3	6.89	7.1	6.95	6.98 ± 0.088
4	6.65	6.95	6.65	6.75 ± 0.14
5	6.6	6.6	6.3	6.5 ± 0.14
7	6.25	6.3	6.2	6.25 ± 0.041
8	6.25	6.25	6.25	6.25 ± 0
9	6.05	6.15	5.98	6.06 ± 0.07
10	5.6	5.6	5.6	5.6 ± 0
11	6.35	6.1	6.3	6.25 ± 0.11
12	6.15	6.05	6.28	6.16 ± 0.094
14	5.75	5.7	5.95	5.8 ± 0.11
15	6.0	6.0	6.0	6.0 ± 0
16	5.85	5.75	5.95	5.85 ± 0.082
18	5.76	5.76	5.82	5.78 ± 0.028
19	6.27	6.45	6.54	6.42 ± 0.11
20	5.89	6.15	5.9	5.98 ± 0.12
21	5.61	5.82	5.61	5.68 ± 0.099
22	5.61	5.6	5.5	5.57 ± 0.05
23	5.53	5.5	5.5	5.51 ± 0.014
25	5.95	6.3	5.78	5.95 ± 0.22
26	5.9	6.25	5.88	5.95 ± 0.17
27	5.92	6.1	5.83	5.95 ± 0.11
28	5.89	6.1	5.93	5.98 ± 0.091
29	5.95	6.1	6.1	6.05 ± 0.071
30	5.64	5.7	5.82	5.72 ± 0.075

Utilisation of Cellobiose in liquid culture by G. graminis var tritici isolate 43

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	6.75	6.75	6.75	6.75 ± 0
1	5.98	6.1	6.1	6.08 ± 0.056
2	6.1	6.1	6.1	6.1 ± 0
3	6.25	6.16	6.05	6.16 ± 0.082
4	6.45	6.45	6.6	6.5 ± 0.071
5	6.5	6.5	6.5	6.5 ± 0
7	5.85	6.0	6.15	6.0 ± 0.12
8	6.1	6.3	6.35	6.25 ± 0.11
9	6.2	6.25	6.4	6.25 ± 0.085
10	6.4	6.4	6.6	6.5 ± 0.094
11	6.82	6.63	6.8	6.75 ± 0.085
12	6.54	6.4	6.5	6.48 ± 0.059
14	6.16	5.98	5.95	6.03 ± 0.093
15	6.11	5.98	6.15	6.08 ± 0.072
16	5.9	5.9	5.9	5.9 ± 0
18	5.92	6.1	5.92	5.98 ± 0.085
19	6.45	6.6	6.45	6.5 ± 0.071
20	5.95	6.15	5.9	6.0 ± 0.11
21	5.7	5.9	5.8	5.8 ± 0.082
22	5.8	5.8	5.8	5.8 ± 0
23	6.15	5.98	5.96	6.03 ± 0.085
25	6.17	5.95	6.12	6.08 ± 0.094
26	6.2	6.05	6.2	6.15 ± 0.071
27	6.5	6.5	6.5	6.5 ± 0
28	5.86	6.48	5.9	6.42 ± 0.28
29	6.24	6.4	6.35	6.33 ± 0.067
30	6.15	6.35	6.25	6.25 ± 0.082

Utilisation of Cellobiose in liquid culture by <u>G. graminis</u> var <u>tritici</u> isolate WPBS1

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	6.75	6.75	6.75	6.75 ± 0
1	6.56	6.45	6.25	6.42 ± 0.13
2	6.68	6.58	6.45	6.57 ± 0.094
3	6.7	6.7	6.7	6.7 ± 0
4	6.65	6.58	6.51	6.58 ± 0.057
5	6.8	6.65	6.8	6.75 ± 0.071
7	6.4	6.2	6.25	6.25 ± 0.085
8	6.15	6.05	6.04	6.08 ± 0.05
9	6.3	6.15	6.15	6.25 ± 0.071
10	6.25	6.13	6.13	6.17 ± 0.056
11	6.5	6.46	6.3	6.42 ± 0.086
12	6.25	6.05	6.15	6.15 ± 0.082
14	5.8	5.9	6.0	5.9 ± 0.082
15	6.25	6.25	6.25	6.25 ± 0
16	6.1	5.9	6.3	6.1 ± 0.16
18	6.15	5.9	6.25	5.97 ± 0.15
19	6.89	6.8	6.95	6.88 ± 0.062
20	6.48	6.48	6.6	6.52 ± 0.056
21	5.99	6.4	6.3	6.23 ± 0.17
22	5.86	6.1	5.95	5.97 ± 0.099
23	5.63	5.85	5.83	5.77 ± 0.099
25	6.61	6.8	6.75	6.72 ± 0.08
26	6.23	6.6	6.52	6.45 ± 0.16
27	6.25	6.42	6.38	6.35 ± 0.072
28	6.19	6.4	6.4	6.33 ± 0.099
29	5.75	5.78	5.83	5.78 ± 0.033
30	5.38	5.38	5.5	5.42 ± 0.056

Utilisation of Cellobiose in liquid culture by *Philophora radicicola radicicola* isolate rB

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	6.75	6.75	6.75	6.75 ± 0
1	6.45	6.6	6.45	6.5 ± 0.071
2	6.05	6.3	6.1	6.15 ± 0.11
3	5.85	6.1	5.75	5.9 ± 0.15
4	6.1	6.3	6.1	6.2 ± 0.094
5	6.25	6.35	6.15	6.25 ± 0.082
7	5.79	5.93	5.68	5.8 ± 0.1
8	5.2	5.4	5.6	5.4 ± 0.16
9	5.78	5.9	5.72	5.8 ± 0.075
10	5.45	5.6	5.45	5.5 ± 0.071
11	4.9	4.9	4.9	4.9 ± 0
12	4.95	5.35	5.15	5.15 ± 0.16
14	5.19	5.42	5.38	5.33 ± 0.1
15	4.7	4.95	4.6	4.75 ± 0.15
16	4.5	4.8	4.65	4.65 ± 0.12
18	4.39	4.69	4.45	4.51 ± 0.13
19	4.52	4.72	4.35	4.53 ± 0.15
20	3.68	3.9	3.82	3.8 ± 0.099
21	3.6	3.75	3.6	3.65 ± 0.071
22	3.5	3.43	3.21	3.38 ± 0.12
23	3.35	3.2	3.2	3.25 ± 0.071
25	3.18	2.95	2.99	3.04 ± 0.1
26	3.05	2.88	2.95	2.96 ± 0.07
27	2.78	2.57	2.45	2.6 ± 0.14
28	2.4	2.05	2.15	2.2 ± 0.15
29	2.2	2.05	1.9	2.05 ± 0.12
30	1.92	1.93	1.82	1.89 ± 0.05

Utilisation of Cellobiose in liquid culture by Phialophora radicicola var graminis isolate gc.

	Concentration of reducing sugars in culture medium (mg cm-3)			
DAYS	1	2	3	Mean ± S.D.
0	6.75	6.75	6.75	6.75 ± 0
1	6.7	6.95	6.75	6.8 ± 0.11
2	6.43	6.7	6.43	6.52 ± 0.13
3	6.43	6.6	6.26	6.43 ± 0.14
4	6.7	6.8	6.6	6.6 ± 0.082
5	6.5	6.58	6.36	6.48 ± 0.091
7	6.15	6.29	5.95	6.13 ± 0.14
8	5.8	5.9	5.7	5.7 ± 0.082
9	5.6	5.6	5.6	5.6 ± 0
10	5.5	5.5	5.5	5.5 ± 0
11	4.98	5.15	5.05	5.06 ± 0.07
12	4.85	5.0	4.91	4.92 ± 0.062
14	4.74	4.8	4.74	4.76 ± 0.028
15	4.38	4.5	4.2	4.36 ± 0.12
16	4.19	4.25	4.1	4.18 ± 0.062
18	4.05	4.15	3.95	4.05 ± 0.082
19	3.75	3.95	3.79	3.83 ± 0.086
20	3.64	3.8	3.39	3.61 ± 0.17
21	3.3	3.5	3.14	3.34 ± 0.15
22	2.95	3.18	2.96	3.03 ± 0.11
23	3.0	3.0	3.0	3.0 ± 0
25	2.66	2.72	2.66	2.68 ± 0.028
26	2.3	2.56	2.4	2.42 ± 0.11
27	1.94	2.25	2.05	2.08 ± 0.13
28	1.8	2.15	1.93	1.96 ± 0.14
29	1.95	2.05	1.9	2.0 ± 0.062
30	1.62	1.75	1.55	1.64 ± 0.083

Utilisation of Glucose in liquid culture by Fusarium culmorum

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	12.28	12.28	12.28	12.28 ± 0
1	12.03	12.3	12.15	12.16 ± 0.11
2	12.1	12.1	12.1	12.1 ± 0
3	11.88	12.3	11.88	12.02 ± 0.2
4	8.78	9.5	8.63	8.97 ± 0.4
5	7.49	8.32	7.65	7.82 ± 0.4
6	7.45	7.9	7.45	7.6 ± 0.21
7	6.65	7.1	6.8	6.85 ± 0.19
8	4.45	5.15	4.8	4.8 ± 0.29
9	3.56	4.5	3.85	3.97 ± 0.39
10	2.31	3.1	2.75	2.72 ± 0.32
11	2.02	2.25	2.15	2.14 ± 0.094
12	1.9	2.18	1.95	2.01 ± 0.12
13	1.6	2.05	1.81	1.82 ± 0.18
14	0.92	0.95	0.89	0.92 ± 0.024
15	0.32	0.4	0.3	0.34 ± 0.043
16	0.32	0.36	0.34	0.34 ± 0.016
18	0.34	0.34	0.34	0.34 ± 0
19	0.3	0.3	0.3	0.3 ± 0
20	0.28	0.3	0.29	0.29 ± 0.0082
21	0.26	0.29	0.26	0.27 ± 0.014
22	0.25	0.27	0.27	0.26 ± 0.0094
23	0.22	0.25	0.25	0.24 ± 0.014
25	0.19	0.21	0.24	0.21 ± 0.021
26	0.07	0.12	0.08	0.09 ± 0.022
27	0.02	0.04	0.02	0.026 ± 0.0094
28	0	0	0	0 ± 0
29	0	0	0	0 ± 0
30	0	0	0	0 ± 0

Utilisation of Glucose in liquid culture by Cochliobolus sativus

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	14.33	14.33	14.33	14.33 ± 0
1	13.15	12.85	12.85	12.95 ± 0.14
2	12.28	12.05	12.15	12.16 ± 0.094
3	12.4	12.15	12.35	12.3 ± 0.11
4	12.6	12.5	12.46	12.52 ± 0.059
5	12.95	12.7	12.81	12.82 ± 0.1
6	10.95	10.26	10.53	10.58 ± 0.28
7	10.58	10.1	10.31	10.33 ± 0.2
8	10.4	10.3	10.2	10.3 ± 0.082
9	10.36	10.24	10.24	10.28 ± 0.057
10	10.05	9.86	9.7	9.87 ± 0.14
11	9.8	9.75	9.34	9.63 ± 0.21
12	9.15	8.7	8.7	8.85 ± 0.21
13	8.95	8.65	8.74	8.78 ± 0.13
14	8.05	7.87	7.87	7.93 ± 0.13
15	7.96	7.82	7.62	7.8 ± 0.14
16	7.5	7.14	7.14	7.26 ± 0.17
18	7.18	6.98	7.02	7.06 ± 0.086
19	6.6	6.46	6.5	6.52 ± 0.059
20	6.23	6.14	6.14	6.17 ± 0.042
21	6.15	6.05	6.01	6.07 ± 0.059
22	5.92	5.8	5.8	5.84 ± 0.057
23	5.86	5.6	5.7	5.72 ± 0.11
25	5.75	5.6	5.6	5.65 ± 0.071
26	5.5	5.5	5.5	5.5 ± 0
27	4.9	5.05	4.96	4.97 ± 0.062
28	5.05	5.05	5.05	5.05 ± 0
29	4.77	4.92	4.86	4.85 ± 0.062
30	5.15	5.2	5.1	5.15 ± 0.041

Utilisation of Glucose in liquid culture by *G. graminis var tritici* isolate og.12.

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	12.2	12.2	12.2	12.2 ± 0
1	11.78	11.95	11.85	11.86 ± 0.07
2	12.55	12.86	12.78	12.73 ± 0.13
3	11.85	12.15	11.85	11.95 ± 0.14
4	11.25	11.7	11.25	11.4 ± 0.21
5	11.9	12.2	11.75	11.95 ± 0.19
7	12.1	12.1	11.98	12.06 ± 0.057
8	11.6	11.9	11.3	11.6 ± 0.24
9	11.63	11.85	11.68	11.72 ± 0.094
10	11.6	11.6	11.3	11.5 ± 0.14
11	11.25	11.38	11.15	11.26 ± 0.094
12	10.81	10.93	10.81	10.85 ± 0.057
14	9.6	9.82	9.65	9.69 ± 0.094
15	9.15	9.5	9.34	9.33 ± 0.14
16	9.04	9.18	8.93	9.05 ± 0.1
18	8.95	9.0	8.93	8.96 ± 0.029
19	8.6	8.6	8.6	8.6 ± 0
20	8.5	8.7	8.6	8.6 ± 0.082
21	8.36	8.31	8.08	8.25 ± 0.12
22	7.86	7.98	7.89	7.91 ± 0.051
23	7.97	8.15	7.97	8.03 ± 0.085
25	7.29	7.52	7.45	7.42 ± 0.096
26	6.23	6.8	6.5	6.51 ± 0.23
27	5.72	5.81	5.72	5.75 ± 0.042
28	5.5	5.5	5.35	5.45 ± 0.085
29	5.3	5.3	5.3	5.3 ± 0
30	4.65	4.8	4.5	4.65 ± 0.071

Utilisation of Glucose in liquid culture by *G. graminis* var *tritici* isolate 43

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	12.2	12.2	12.2	12.2 ± 0
1	12.1	12.4	12.1	12.2 ± 0.14
2	12.05	11.95	11.85	11.95 ± 0.082
3	11.63	11.85	11.74	11.78 ± 0.09
4	11.89	11.98	11.89	11.92 ± 0.042
5	11.91	11.9	11.86	11.89 ± 0.022
7	11.78	11.91	11.89	11.86 ± 0.057
8	11.42	11.53	11.31	11.42 ± 0.09
9	10.74	10.95	10.89	10.86 ± 0.088
10	10.2	10.7	10.3	10.4 ± 0.22
11	9.62	9.8	9.62	9.68 ± 0.085
12	10.08	10.3	10.25	10.21 ± 0.094
14	10.0	10.0	9.85	9.95 ± 0.071
15	9.07	9.38	9.24	9.23 ± 0.13
16	9.26	9.35	9.26	9.29 ± 0.042
18	9.3	9.4	9.29	9.33 ± 0.05
19	9.01	9.15	8.9	9.02 ± 0.1
20	8.7	8.9	8.5	8.7 ± 0.16
21	7.44	7.56	7.44	7.48 ± 0.057
22	6.9	7.3	7.4	7.2 ± 0.22
23	7.05	7.3	7.25	7.2 ± 0.11
25	7.05	7.18	7.1	7.11 ± 0.054
26	7.05	7.05	7.05	7.05 ± 0
27	6.5	6.9	6.85	6.75 ± 0.18
28	6.1	5.99	6.15	6.08 ± 0.067
29	5.5	5.15	5.25	5.3 ± 0.15
30	4.92	4.72	4.85	4.83 ± 0.083

Utilisation of Glucose in liquid culture by *G. graminis* var *tritici* isolate WPBS1

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	12.2	12.2	12.2	12.2 ± 0
1	12.26	12.4	12.48	12.38 ± 0.091
2	12.28	12.3	12.35	12.31 ± 0.029
3	11.63	11.9	11.81	11.78 ± 0.11
4	11.59	11.75	11.7	11.68 ± 0.067
5	11.9	12.05	11.9	11.95 ± 0.071
7	11.99	12.25	12.15	12.13 ± 0.11
8	11.95	12.05	11.88	11.96 ± 0.07
9	12.05	12.2	12.05	12.1 ± 0.071
10	12.04	12.2	12.15	12.13 ± 0.067
11	10.75	10.95	10.85	10.85 ± 0.082
12	10.48	10.76	10.8	10.68 ± 0.14
14	10.1	10.3	10.5	10.3 ± 0.16
15	10.5	10.76	10.68	10.68 ± 0.11
16	10.25	10.65	10.6	10.35 ± 0.18
18	9.61	10.2	9.95	9.92 ± 0.24
19	9.35	9.8	9.35	9.5 ± 0.21
20	8.9	8.3	8.15	8.15 ± 0.12
21	8.0	8.3	8.15	8.15 ± 0.12
22	7.2	7.5	7.35	7.35 ± 0.12
23	6.72	7.1	6.91	6.91 ± 0.16
25	6.08	6.5	6.35	6.31 ± 0.17
26	6.1	6.25	6.1	6.15 ± 0.071
27	5.92	6.1	5.92	5.98 ± 0.085
28	5.84	6.0	5.95	5.93 ± 0.067
29	5.38	5.51	5.1	5.33 ± 0.17
30	4.82	5.05	4.89	4.92 ± 0.096

Utilisation of Glucose in liquid culture by *Phialophora radicicola* var *radicicola* isolate rB

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	12.2	12.2	12.2	12.2 ± 0
1	12.95	12.8	12.65	12.8 ± 0.12
2	12.95	13.2	12.88	13.01 ± 0.14
3	13.5	13.6	13.1	13.4 ± 0.22
4	12.95	13.15	12.75	12.95 ± 0.16
5	12.7	12.8	12.45	12.65 ± 0.15
7	12.09	12.25	12.05	12.13 ± 0.086
8	11.5	11.68	11.5	11.56 ± 0.085
9	11.67	11.83	11.75	11.75 ± 0.065
10	11.57	11.7	11.68	11.65 ± 0.057
11	11.5	11.5	11.5	11.5 ± 0
12	11.35	11.45	11.16	11.32 ± 0.12
14	11.03	11.35	11.25	11.21 ± 0.13
15	10.89	11.05	10.85	10.93 ± 0.086
16	10.6	10.75	10.69	10.68 ± 0.062
18	10.4	10.4	10.4	10.4 ± 0
19	10.03	10.15	9.85	10.01 ± 0.12
20	8.93	9.1	8.85	8.96 ± 0.1
21	8.6	8.9	8.6	8.7 ± 0.14
22	8.08	8.5	8.35	8.31 ± 0.17
23	7.9	8.16	7.82	7.96 ± 0.15
25	7.45	7.8	7.7	7.65 ± 0.29
26	7.38	7.5	7.5	7.46 ± 0.057
27	7.1	7.26	7.18	7.18 ± 0.19
28	7.0	7.1	7.05	7.05 ± 0.041
29	6.5	6.5	6.5	6.5 ± 0
30	6.4	6.7	6.4	6.5 ± 0.14

Utilisation of Glucose in liquid culture by *Phialophora radicicola* var *graminis* isolate gc.

DAYS	Concentration of reducing sugars in culture medium (mg cm-3) 1	2	3	Mean ± S.D.
0	12.2	12.2	12.2	12.2 ± 0
1	12.33	12.8	12.76	12.63 ± 0.21
2	12.29	12.65	12.62	12.52 ± 0.16
3	12.3	12.5	12.4	12.4 ± 0.082
4	12.95	13.1	12.98	13.01 ± 0.065
5	12.69	12.85	12.8	12.78 ± 0.067
7	11.98	12.25	12.1	12.11 ± 0.11
8	11.2	11.3	11.25	11.25 ± 0.041
9	10.99	11.15	11.1	11.08 ± 0.067
10	10.85	11.15	10.85	10.95 ± 0.14
11	11.28	11.4	11.28	11.32 ± 0.057
12	10.94	11.25	11.35	11.18 ± 0.17
14	10.95	10.79	11.05	10.93 ± 0.11
15	10.75	10.58	10.95	10.76 ± 0.15
16	10.39	10.5	10.55	10.48 ± 0.067
18	10.1	10.1	10.4	10.2 ± 0.14
19	9.85	9.85	10.15	9.95 ± 0.14
20	9.13	9.21	9.35	9.23 ± 0.091
21	8.74	8.95	9.1	8.93 ± 0.15
22	8.5	8.6	8.7	8.5 ± 0.082
23	8.0	8.2	8.4	8.2 ± 0.16
25	7.8	7.8	8.1	7.9 ± 0.14
26	7.65	7.65	7.95	7.75 ± 0.14
27	7.35	7.7	7.75	7.6 ± 0.18
28	7.16	7.38	7.45	7.33 ± 0.12
29	7.0	7.0	7.15	7.05 ± 0.071
30	6.9	6.8	7.0	6.8 ± 0.082

Utilisation of Xylose in liquid culture by Fusarium culmorum

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	11.1	11.1	11.1	11.1 ± 0
1	12.75	12.59	12.85	12.73 ± 0.11
2	13.6	13.25	13.65	13.5 ± 0.18
3	13.1	12.9	13.16	12.97 ± 0.14
4	12.85	12.9	13.16	12.97 ± 0.14
5	12.5	12.8	12.95	12.75 ± 0.19
6	12.5	12.5	12.65	12.55 ± 0.071
7	10.9	10.6	11.05	10.85 ± 0.19
8	10.18	9.95	10.5	10.21 ± 0.23
9	8.52	8.19	8.58	8.43 ± 0.17
10	6.78	6.76	6.95	6.83 ± 0.085
11	5.8	5.65	5.86	5.78 ± 0.088
12	6.17	5.91	6.1	6.06 ± 0.11
13	6.0	5.94	6.0	5.98 ± 0.028
14	5.25	5.0	5.2	5.15 ± 0.11
15	4.3	4.04	4.2	4.18 ± 0.11
16	3.78	3.5	3.62	3.64 ± 0.11
18	3.1	2.8	2.8	2.9 ± 0.14
19	2.9	2.7	2.35	2.65 ± 0.23
20	2.65	2.39	2.25	2.43 ± 0.17
21	2.4	2.4	2.13	2.31 ± 0.13
22	1.95	1.75	2.0	1.89 ± 0.11
23	1.7	1.51	1.65	1.62 ± 0.08
25	1.2	1.05	1.15	1.13 ± 0.076
26	1.1	1.02	1.15	1.13 ± 0.076
27	1.1	1.02	1.15	1.09 ± 0.054
28	0.85	0.78	0.95	0.86 ± 0.07
29	0.55	0.45	0.62	0.54 ± 0.07
30	0.29	0.25	0.3	0.28 ± 0.022

Utilisation of Xylose in liquid culture by Cochliobolus sativus

DAYS	Concentration of reducing sugars in culture medium (mg cm-3) 1	2	3	Mean ± S.D.
0	11.1	11.1	11.1	11.1 ± 0
1	12.83	12.75	12.43	12.67 ± 0.17
2	12.75	12.7	12.59	12.68 ± 0.067
3	11.5	11.35	11.35	11.4 ± 0.071
4	11.95	11.75	11.7	11.8 ± 0.11
5	12.15	12.1	11.81	12.02 ± 0.15
6	12.5	12.15	11.95	12.2 ± 0.23
7	10.3	10.25	10.08	10.21 ± 0.094
8	7.75	7.62	7.49	7.62 ± 0.11
9	7.45	7.15	7.1	7.23 ± 0.15
10	6.95	6.85	6.75	6.85 ± 0.082
11	5.36	5.08	5.25	5.23 ± 0.12
12	4.87	4.76	4.71	4.78 ± 0.067
13	4.89	4.85	4.9	4.88 ± 0.022
14	4.25	4.15	4.32	4.24 ± 0.07
15	3.4	3.25	3.4	3.35 ± 0.071
16	2.85	2.65	2.9	2.8 ± 0.11
18	2.5	2.1	2.6	2.4 ± 0.22
19	1.68	1.6	1.88	1.72 ± 0.12
20	1.58	1.44	1.6	1.54 ± 0.071
21	1.45	1.45	1.45	1.45 ± 0
22	0.37	0.52	0.4	0.43 ± 0.065
23	0.24	0.35	0.28	0.29 ± 0.045
25	0.1	0.18	0.11	0.13 ± 0.04
26	0.03	0.05	0.04	0.04 ± 0.0082
27	0	0	0	0 ± 0
28	0	0	0	0 ± 0
29	0	0	0	0 ± 0
30	0	0	0	0 ± 0

Utilisation of Xylose in liquid culture by <u>G. graminis</u> var <u>tritici</u> isolate og.12.

	Concentration of reducing sugars in culture medium (mg cm-3)			
DAYS	1	2	3	Mean ± S.D.
0	12.5	12.5	12.5	12.5 ± 0
1	11.0	11.6	11.6	11.4 ± 0.28
2	11.0	11.2	11.25	11.15 ± 0.11
3	10.2	10.5	10.9	10.6 ± 0.26
4	11.7	11.8	11.6	11.7 ± 0.082
5	11.5	11.5	11.5	11.5 ± 0
7	11.05	11.2	11.2	11.15 ± 0.071
8	10.7	10.9	10.95	10.85 ± 0.11
9	10.86	11.03	11.05	10.98 ± 0.085
10	11.3	11.3	11.6	11.4 ± 0.14
11	10.6	10.4	10.8	10.6 ± 0.16
12	10.6	10.5	10.7	10.6 ± 0.082
14	10.6	10.6	10.6	10.6 ± 0
15	10.1	10.3	10.5	10.3 ± 0.16
16	10.0	9.7	10.15	9.95 ± 0.19
18	9.8	9.65	9.95	9.8 ± 0.12
19	8.95	8.84	9.15	8.98 ± 0.13
20	7.5	7.4	7.9	7.6 ± 0.22
21	6.59	6.5	6.65	6.58 ± 0.062
22	6.2	6.1	6.45	6.25 ± 0.15
23	5.95	5.9	6.15	6.0 ± 0.11
25	5.5	5.1	5.6	5.4 ± 0.22
26	4.85	4.7	5.15	4.9 ± 0.19
27	4.5	4.4	4.9	4.6 ± 0.22
28	4.6	4.4	4.8	4.6 ± 0.16
29	4.4	4.15	4.5	4.35 ± 0.15
30	3.95	3.85	4.2	4.0 ± 0.15

Utilisation of Xylose in liquid culture by <u>G. graminis</u> var <u>tritici</u> isolate 43

DAYS	Concentration of reducing sugars in culture medium (mg cm-3)			
	1	2	3	Mean ± S.D.
0	12.5	12.5	12.5	12.5 ± 0
1	9.95	10.2	10.0	10.05 ± 0.11
2	10.15	10.4	10.35	10.3 ± 0.11
3	11.3	11.6	11.3	11.4 ± 0.14
4	12.55	12.7	12.25	12.5 ± 0.19
5	12.2	12.4	12.0	12.2 ± 0.16
7	11.85	12.15	11.85	11.95 ± 0.14
8	11.75	11.9	11.45	11.7 ± 0.19
9	11.8	11.95	11.8	11.85 ± 0.071
10	11.8	12.05	12.0	11.95 ± 0.11
11	11.25	11.6	11.35	11.4 ± 0.15
12	10.89	11.05	11.0	10.98 ± 0.067
14	10.35	10.8	10.65	10.6 ± 0.19
15	10.1	10.5	10.3	10.3 ± 0.16
16	10.0	10.3	10.15	10.15 ± 0.12
18	10.0	10.1	10.05	10.05 ± 0.041
19	9.65	10.0	9.75	9.8 ± 0.15
20	8.17	8.65	8.38	8.4 ± 0.2
21	7.6	7.95	7.7	7.75 ± 0.15
22	7.25	7.5	7.3	7.35 ± 0.11
23	6.65	7.0	6.75	6.8 ± 0.15
25	6.22	6.5	6.42	6.38 ± 0.12
26	5.7	5.95	5.9	5.85 ± 0.11
27	5.5	5.9	5.7	5.7 ± 0.16
28	5.1	5.6	5.5	5.4 ± 0.22
29	4.62	5.18	4.9	4.9 ± 0.23
30	4.2	4.5	4.35	4.35 ± 0.12

Utilisation of Xylose in liquid culture by G. graminis var tritici isolate WPBS1

DAYS	Concentration of reducing sudars in culture medium (mg cm-3) 1	2	3	Mean ± S.D.
0	12.5	12.5	12.5	12.5 ± 0
1	11.2	11.3	11.7	11.4 ± 0.22
2	10.7	10.9	10.95	10.85 ± 0.11
3	11.4	11.55	11.7	11.55 ± 0.12
4	12.05	12.45	12.1	12.2 ± 0.18
5	11.98	12.28	11.98	12.08 ± 0.14
7	11.85	12.1	11.9	11.95 ± 0.11
8	10.75	10.95	10.85	10.85 ± 0.082
9	10.4	10.9	10.65	10.65 ± 0.2
10	10.0	10.15	10.0	10.05 ± 0.071
11	9.6	10.0	9.8	9.8 ± 0.16
12	9.7	9.9	9.8	9.8 ± 0.082
14	9.8	9.8	9.8	9.8 ± 0
15	9.9	9.9	9.6	9.8 ± 0.14
16	9.7	9.85	9.4	9.65 ± 0.19
18	9.5	9.7	9.3	9.5 ± 0.16
19	9.6	9.6	9.3	9.5 ± 0.14
20	7.95	8.2	7.85	8.0 ± 0.15
21	7.35	7.5	7.2	7.35 ± 0.12
22	7.0	7.2	6.95	7.05 ± 0.11
23	6.75	6.78	5.97	6.5 ± 0.37
25	6.0	6.15	5.85	6.0 ± 0.12
26	5.2	5.6	5.1	5.3 ± 0.22
27	5.2	5.0	5.2	5.1 ± 0.094
28	5.2	5.0	5.1	5.1 ± 0.082
29	4.85	4.45	4.5	4.6 ± 0.18
30	4.36	3.93	4.25	4.18 ± 0.18

Utilisation of Xylose in liquid culture by Phialophora radicicola var radicicola isolate rB

DAYS	Concentration of reducing sugars in culture medium (mg cm-3) 1	2	3	Mean ± S.D.
0	12.5	12.5	12.5	12.5 ± 0
1	12.3	12.2	12.1	12.2 ± 0.082
2	11.7	11.6	11.35	11.55 ± 0.15
3	10.98	10.9	10.67	10.85 ± 0.13
4	12.1	11.9	11.85	11.95 ± 0.11
5	11.8	11.7	11.45	11.65 ± 0.15
7	11.4	11.6	11.2	11.4 ± 0.16
8	10.2	10.15	9.8	10.05 ± 0.18
9	10.1	10.0	9.75	9.95 ± 0.15
10	9.9	9.8	9.7	9.8 ± 0.082
11	8.65	8.35	8.2	8.4 ± 0.19
12	8.55	8.35	8.3	8.4 ± 0.11
14	8.5	8.4	8.3	8.4 ± 0.082
15	7.8	7.65	7.35	7.6 ± 0.19
16	7.5	7.45	7.31	7.42 ± 0.08
18	7.4	7.4	7.25	7.35 ± 0.071
19	7.0	6.9	6.5	6.8 ± 0.22
20	6.65	6.56	6.29	6.5 ± 0.15
21	6.35	6.3	6.1	6.25 ± 0.11
22	6.35	6.25	6.15	6.25 ± 0.082
23	6.2	6.18	6.01	6.13 ± 0.085
26	5.6	5.55	5.05	5.4 ± 0.25
27	5.5	5.45	5.25	5.4 ± 0.11
28	5.3	5.1	5.1	5.1 ± 0.094
29	5.1	5.1	5.1	5.1 ± 0
30	4.7	4.6	4.5	4.6 ± 0.082

Utilisation of Xylose in liquid culture by Phialophora radicicola var. graminis isolate gc.

DAYS	Concentration of reducing sugars in culture medium (mg cm-3)			
	1	2	3	Mean ± S.D.
0	12.5	12.5	12.5	12.5 ± 0
1	11.85	11.68	11.57	11.7 ± 0.12
2	11.15	11.0	10.85	11.0 ± 0.12
3	11.9	11.75	11.45	11.7 ± 0.19
4	12.48	12.15	11.97	12.2 ± 0.21
5	12.1	11.98	12.16	12.08 ± 0.075
7	12.05	11.85	11.95	11.95 ± 0.082
8	11.95	11.95	11.95	11.95 ± 0
9	11.8	11.7	11.9	11.8 ± 0.082
10	11.7	11.7	11.7	11.7 ± 0
11	11.6	11.45	11.15	11.4 ± 0.19
12	11.1	10.9	10.85	10.95 ± 0.11
14	10.95	10.8	10.8	10.85 ± 0.071
15	10.5	10.3	10.1	10.3 ± 0.16
16	9.95	9.76	9.3	9.67 ± 0.27
18	9.5	9.3	8.95	9.25 ± 0.23
19	8.9	8.75	8.45	8.7 ± 0.19
20	8.38	8.29	8.08	8.25 ± 0.13
21	8.1	7.92	7.68	7.9 ± 0.17
22	7.8	7.65	7.35	7.6 ± 0.19
23	7.18	7.1	6.87	7.05 ± 0.13
25	6.98	6.85	6.57	6.8 ± 0.17
26	6.5	6.2	6.05	6.25 ± 0.19
27	6.4	6.25	6.1	6.25 ± 0.12
28	6.2	5.85	5.95	6.0 ± 0.15
29	6.15	5.9	5.95	6.0 ± 0.11
30	6.0	6.0	6.0	6.0 ± 0

Degradation and Utilisation of citrus pectin by Fusarium culmorum

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0.24	0.24	0.24	0.24 ± 0
1	0.49	0.65	0.6	0.58 ± 0.067
2	0.69	0.8	0.85	0.78 ± 0.067
3	0.82	0.98	1.05	0.95 ± 0.096
4	0.32	0.6	0.58	0.5 ± 0.13
5	0.75	0.79	0.86	0.8 ± 0.045
6	1.12	1.25	1.35	1.24 ± 0.094
7	1.66	1.79	1.86	1.77 ± 0.083
8	2.16	2.25	2.4	2.27 ± 0.099
9	2.63	2.68	2.73	2.68 ± 0.041
10	2.66	2.79	2.86	2.77 ± 0.083
11	3.11	3.3	3.25	3.22 ± 0.081
12	3.22	3.3	3.35	3.29 ± 0.054
13	3.27	3.45	3.42	3.38 ± 0.079
14	3.33	3.45	3.48	3.42 ± 0.065
15	4.18	4.25	4.29	4.24 ± 0.045
16	4.33	4.56	4.46	4.45 ± 0.094
18	4.55	4.68	4.75	4.66 ± 0.083
19	4.7	4.7	4.79	4.73 ± 0.042
20	4.75	4.92	4.85	4.84 ± 0.07
21	4.45	4.7	4.65	4.6 ± 0.11
22	4.47	4.63	4.58	4.56 ± 0.067
23	4.42	4.53	4.49	4.48 ± 0.045
25	2.38	2.56	2.5	2.48 ± 0.075
26	2.25	2.45	2.38	2.36 ± 0.083
27	1.92	2.16	1.98	2.02 ± 0.1
28	1.74	1.83	1.8	1.79 ± 0.037
31	1.16	1.45	1.35	1.32 ± 0.12
32	0.76	1.05	0.95	0.92 ± 0.12

Degradation and Utilisation of citrus pectin by Cochliobolus sativus

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	0.24	0.24	0.24	0.24 ± 0
1	0.49	0.52	0.43	0.48 ± 0.037
2	0.55	0.65	0.6	0.6 ± 0.041
3	0.58	0.65	0.6	0.63 ± 0.029
4	0.62	0.71	0.65	0.66 ± 0.037
5	0.62	0.78	0.67	0.69 ± 0.067
6	0.71	0.85	0.81	0.79 ± 0.059
7	0.75	0.85	0.8	0.8 ± 0.041
8	0.75	0.82	0.8	0.79 ± 0.029
9	0.8	0.89	0.8	0.83 ± 0.042
10	0.86	0.86	0.8	0.84 ± 0.028
11	0.9	0.85	0.8	0.85 ± 0.041
12	0.89	0.87	0.82	0.86 ± 0.029
13	0.91	0.89	0.84	0.88 ± 0.029
14	0.95	0.89	0.86	0.9 ± 0.037
15	0.95	0.92	0.89	0.92 ± 0.024
16	0.85	0.85	0.82	0.84 ± 0.014
18	0.85	0.83	0.75	0.81 ± 0.043
19	0.8	0.8	0.8	0.8 ± 0
20	0.95	0.92	0.89	0.92 ± 0.024
21	1.05	0.97	0.92	0.98 ± 0.054
22	1.15	1.1	1.05	1.1 ± 0.041
23	1.2	1.2	1.05	1.15 ± 0.071
25	1.19	1.23	1.15	1.19 ± 0.033
26	1.25	1.28	1.16	1.23 ± 0.051
27	1.6	1.6	1.51	1.57 ± 0.042
28	1.68	1.75	1.46	1.63 ± 0.12
31	1.5	1.54	1.43	1.49 ± 0.045
32	1.5	1.58	1.48	1.52 ± 0.043

Degradation and Utilisation of citrus pectin by <u>G. graminis</u> var <u>tritici</u> isolate og.12.

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0.5	0.5	0.5	0.5 ± 0
1	0.5	0.35	0.4	0.42 ± 0.076
2	0.8	0.8	0.8	0.8 ± 0
3	1.15	1.1	1.08	1.11 ± 0.036
4	1.3	1.1	1.1	1.17 ± 0.12
5	1.3	1.3	1.4	1.33 ± 0.057
6	1.6	1.8	1.6	1.67 ± 0.12
7	1.25	1.35	1.05	1.22 ± 0.15
8	1.1	1.14	1.26	1.17 ± 0.08
9	0.8	0.8	0.8	0.8 ± 0
10	1.35	1.35	1.35	1.35 ± 0
11	1.2	1.28	1.15	1.21 ± 0.065
12	1.25	1.1	0.8	1.05 ± 0.23
13	1.35	1.35	1.35	1.35 ± 0
14	1.1	1.16	1.2	1.15 ± 0.05
15	1.2	1.4	1.1	1.23 ± 0.15
16	1.6	1.6	1.6	1.6 ± 0
18	0.8	0.8	0.8	0.8 ± 0
19	0.55	0.65	0.65	0.62 ± 0.057
20	0.8	0.8	0.9	0.83 ± 0.057
21	1.1	1.05	1.15	1.1 ± 0.05
22	1.35	1.5	1.4	1.42 ± 0.076
23	1.2	1.1	1.25	1.18 ± 0.076
25	0.8	0.8	0.8	0.8 ± 0
26	1.1	1.25	1.5	1.28 ± 0.2
27	1.6	1.5	1.5	1.53 ± 0.057
28	1.9	1.6	1.75	1.75 ± 0.15
31	1.6	1.6	1.6	1.6 ± 0
32	1.3	1.5	1.3	1.37 ± 0.12

Degradation and Utilisation of citrus pectin by *G. graminis* var tritici isolate 43.

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.5	0.5	0.5	0.5 ± 0
1	0.8	0.8	0.8	0.8 ± 0
2	0.75	0.5	0.65	0.63 ± 0.13
3	1.1	1.3	1.15	1.18 ± 0.1
4	1.6	1.6	1.35	1.52 ± 0.14
5	1.6	1.6	1.35	1.52 ± 0.14
6	1.6	1.6	1.6	1.6 ± 0
7	1.05	1.05	0.8	0.97 ± 0.14
8	1.35	1.38	1.45	1.39 ± 0.05
9	1.1	1.1	1.1	1.1 ± 0
10	1.35	1.1	1.23	1.23 ± 0.13
11	1.25	0.8	1.1	1.05 ± 0.23
12	1.35	1.2	1.25	1.27 ± 0.076
13	1.35	1.45	1.35	1.38 ± 0.057
14	1.1	1.15	1.1	1.12 ± 0.03
15	1.3	1.4	1.2	1.3 ± 0.1
16	1.9	1.6	1.75	1.75 ± 0.15
18	1.35	1.35	1.35	1.35 ± 0
19	1.1	1.2	0.8	1.03 ± 0.21
20	0.8	0.8	0.8	0.8 ± 0
21	1.1	1.2	1.15	1.15 ± 0.05
22	1.35	1.25	1.35	1.32 ± 0.057
23	1.35	1.2	1.05	1.2 ± 0.15
25	0.8	0.8	0.8	0.8 ± 0
26	1.1	1.4	1.05	1.18 ± 0.19
27	1.6	1.5	1.3	1.47 ± 0.15
28	1.9	1.6	1.75	1.75 ± 0.15
31	1.9	1.84	1.95	1.9 ± 0.06
32	1.9	1.6	1.75	1.75 ± 0.15

Degradation and Utilisation of Citrus Pectin by G. graminis var tritici isolate WPBS1.

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.5	0.5	0.5	0.5 ± 0
1	0.8	0.5	0.65	0.65 ± 0.15
2	1.1	0.8	1.1	1.0 ± 0.17
3	1.1	1.2	1.09	1.13 ± 0.06
4	0.8	1.1	1.25	1.05 ± 0.23
5	1.1	1.25	1.25	1.2 ± 0.086
6	1.35	1.35	1.35	1.35 ± 0
7	1.3	1.55	1.35	1.3 ± 0.15
8	1.2	1.15	1.1	1.15 ± 0.05
9	1.1	1.1	1.1	1.1 ± 0
10	1.35	1.35	1.35	1.35 ± 0
11	1.4	1.35	1.5	1.28 ± 0.16
12	1.5	1.5	1.5	1.5 ± 0
13	1.6	1.8	1.6	1.41 ± 0.24
14	1.1	1.06	1.11	1.09 ± 0.03
15	1.1	1.15	1.2	1.12 ± 0.05
16	1.6	1.9	1.75	1.75 ± 0.12
18	0.8	0.9	0.8	0.83 ± 0.06
19	0.6	0.4	0.3	0.43 ± 0.15
20	1.1	1.1	1.1	1.1 ± 0
21	1.1	1.1	1.1	1.1 ± 0
22	1.35	1.5	1.45	1.43 ± 0.08
23	1.25	1.35	1.35	1.32 ± 0.08
25	0.8	0.8	0.8	0.8 ± 0
26	1.25	1.3	1.4	1.32 ± 0.07
27	1.5	1.8	1.6	1.63 ± 0.15
28	1.6	1.9	1.75	1.75 ± 0.15
31	1.9	1.9	1.9	1.9 ± 0
32	1.9	2.0	1.85	1.83 ± 0.14

Degradation and Utilisation of Carboxymethyl-cellulose in liquid culture by *Fusarium culmorum*

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0.12	0.12	0.12	0.12 ± 0
1	0.15	0.13	0.14	0.14 ± 0.0082
2	0.13	0.13	0.13	0.13 ± 0
3	0.13	0.12	0.14	0.12 ± 0.0082
4	0.07	0.08	0.09	0.08 ± 0.0082
5	0.12	0.09	0.09	0.1 ± 0.014
6	0.16	0.12	0.14	0.14 ± 0.016
7	0.18	0.16	0.17	0.17 ± 0.0082
8	0.08	0.08	0.08	0.08 ± 0
9	0.09	0.07	0.08	0.08 ± 0.0082
10	0.08	0.08	0.08	0.08 ± 0
11	0.11	0.09	0.13	0.11 ± 0.016
12	0.09	0.05	0.1	0.08 ± 0.022
13	0.07	0.04	0.07	0.06 ± 0.014
14	0.05	0.04	0.06	0.05 ± 0.0082
15	0.13	0.09	0.14	0.12 ± 0.022
16	0.15	0.13	0.17	0.15 ± 0.016
18	0.16	0.16	0.19	0.17 ± 0.014
19	0.18	0.17	0.19	0.18 ± 0.0082
20	0.16	0.16	0.16	0.16 ± 0
21	0.16	0.16	0.16	0.16 ± 0
22	0.14	0.17	0.17	0.16 ± 0.014
23	0.19	0.15	0.18	0.16 ± 0.017
25	0.19	0.17	0.18	0.18 ± 0.0082
26	0.18	0.15	0.15	0.16 ± 0.014
27	0.16	0.12	0.14	0.14 ± 0.016
28	0.14	0.14	0.14	0.14 ± 0

Degradation and Utilisation of Carboxymethyl-cellulose in liquid culture by Cochliobolus sativus

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.12	0.12	0.12	0.12 ± 0
1	0.04	0.07	0.04	0.05 ± 0.014
2	0	0	0	0 ± 0
3	0.03	0.04	0.02	0.03 ± 0.0082
4	0.06	0.07	0.05	0.06 ± 0.0082
5	0.09	0.08	0.07	0.08 ± 0.0082
6	0.07	0.07	0.07	0.07 ± 0
7	0.13	0.13	0.1	0.12 ± 0.014
8	0.09	0.09	0.06	0.08 ± 0.014
9	0.13	0.11	0.09	0.11 ± 0.016
10	0.13	0.12	0.11	0.12 ± 0.082
11	0.13	0.11	0.15	0.13 ± 0.016
12	0.14	0.15	0.13	0.14 ± 0.0082
13	0.1	0.15	0.11	0.12 ± 0.022
14	0.11	0.13	0.12	0.12 ± 0.0082
15	0.15	0.16	0.14	0.15 ± 0.0082
16	0.14	0.14	0.14	0.14 ± 0
18	0.06	0.1	0.11	0.09 ± 0.022
19	0.02	0.05	0.05	0.04 ± 0.014
20	0.12	0.13	0.14	0.13 ± 0.0082
21	0.14	0.14	0.14	0.14 ± 0
22	0.14	0.17	0.17	0.16 ± 0.014
23	0.09	0.07	0.11	0.09 ± 0.016
25	0.14	0.12	0.13	0.13 ± 0.0082
26	0.18	0.16	0.17	0.17 ± 0.0082
27	0.21	0.21	0.18	0.2 ± 0.014
28	0.18	0.17	0.13	0.16 ± 0.022

Degradation and Utilisation of Carboxymethyl-cellulose in liquid culture by *G. graminis var tritici* isolate og.12.

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.5	0.5	0.5	0.5 ± 0
1	0	0	0	0 ± 0
2	0.25	0.25	0.25	0.25 ± 0
3	0.5	0.25	0.38	0.38 ± 0.13
4	0.5	0.5	0.5	0.5 ± 0
5	0.65	0.5	0.5	0.55 ± 0.09
6	0.8	0.5	0.65	0.65 ± 0.15
7	0.8	0.8	0.8	0.8 ± 0
8	0.8	0.5	0.65	0.65 ± 0.15
9	0.5	0.6	0.5	0.53 ± 0.06
10	0.8	0.9	0.8	0.83 ± 0.06
11	1.1	0.8	0.8	0.9 ± 0.17
12	1.1	1.1	0.8	1.0 ± 0.17
13	0.8	0.9	0.8	0.83 ± 0.06
14	0.5	0.6	0.5	0.53 ± 0.06
15	0.25	0.25	0.25	0.25 ± 0
16	1.1	1.35	1.35	1.27 ± 0.14
18	0.9	0.8	0.9	0.87 ± 0.06
19	1.1	1.1	1.25	1.15 ± 0.09
20	1.1	1.1	1.1	1.1 ± 0
21	0.8	0.8	0.8	0.8 ± 0
22	0.8	0.8	0.8	0.8 ± 0
23	0.5	0.3	0.3	0.37 ± 0.12
25	0.5	0.5	0.5	0.5 ± 0
26	0.8	1.1	1.1	1.0 ± 0.17
27	1.25	1.1	1.25	1.2 ± 0.09
28	1.35	1.45	1.35	1.38 ± 0.06
31	1.45	1.35	1.4	1.4 ± 0.05
32	1.35	1.35	1.4	1.37 ± 0.03

Degradation and Utilisation of Carboxymethyl-cellulose in liquid culture by *G. graminis* var tritici isolate 43

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.5	0.5	0.5	0.5 ± 0
1	0.25	0.25	0.25	0.25 ± 0
2	0.25	0.25	0.25	0.25 ± 0
3	0.38	0.5	0.38	0.42 ± 0.07
4	0.5	0.6	0.5	0.53 ± 0.06
5	0.6	0.5	0.65	0.58 ± 0.08
6	0.8	0.8	0.7	0.76 ± 0.06
7	0.8	0.9	0.8	0.83 ± 0.06
8	0.8	0.8	0.8	0.8 ± 0
9	0.5	0.5	0.5	0.5 ± 0
10	0.8	0.9	1.1	0.93 ± 0.15
11	0.65	0.8	0.9	0.78 ± 0.13
12	1.1	0.8	0.8	0.9 ± 0.17
13	1.1	1.1	1.1	1.1 ± 0
14	0.5	0.5	0.5	0.5 ± 0
15	0.25	0.25	0.25	0.25 ± 0
16	1.25	1.3	1.1	1.22 ± 0.1
18	0.5	0.5	0.6	0.53 ± 0.06
19	0.8	0.8	1.1	0.9 ± 0.17
20	1.1	1.1	1.25	1.15 ± 0.09
21	0.8	0.9	0.8	0.83 ± 0.06
22	0.8	0.9	0.9	0.87 ± 0.06
23	0.6	0.5	0.3	0.47 ± 0.15
25	0.5	0.5	0.4	0.47 ± 0.06
26	0.8	0.6	0.5	0.63 ± 0.15
27	1.1	0.7	0.75	0.85 ± 0.22
28	1.1	1.1	1.1	1.1 ± 0
31	1.35	1.35	1.35	1.35 ± 0
32	1.6	1.6	1.6	1.6 ± 0

Degradation and Utilisation of Carboxymethyl-cellulose in liquid culture by *G. graminis* var *tritici* isolate WPBS1.

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	0.5	0.5	0.5	0.5 ± 0
1	0.25	0.25	0.25	0.25 ± 0
2	0.25	0.25	0.28	0.26 ± 0.02
3	0.5	0.38	0.25	0.38 ± 0.13
4	0.5	0.5	0.5	0.5 ± 0
5	0.5	0.5	0.6	0.53 ± 0.06
6	0.8	0.7	0.8	0.77 ± 0.06
7	0.8	0.8	0.9	0.83 ± 0.06
8	0.8	0.8	0.8	0.8 ± 0
9	0.5	0.6	0.5	0.53 ± 0
10	0.7	0.8	0.7	0.73 ± 0.06
11	0.6	0.5	0.8	0.63 ± 0.15
12	0.6	0.8	0.8	0.73 ± 0.12
13	0.8	0.8	0.8	0.8 ± 0
14	0.5	0.5	0.5	0.5 ± 0
15	0.25	0.35	0.25	0.28 ± 0.06
16	1.15	1.35	1.2	1.23 ± 0.08
18	0.6	0.8	0.5	0.63 ± 0.15
19	0.5	0.6	0.5	0.53 ± 0.06
20	0.8	0.9	0.9	0.87 ± 0.06
21	0.5	0.6	0.7	0.6 ± 0.1
22	0.5	0.5	0.5	0.5 ± 0
23	0.3	0.4	0.4	0.37 ± 0.06
25	0.5	0.5	0.5	0.5 ± 0
26	0.8	0.6	0.5	0.63 ± 0.15
27	1.25	1.1	0.8	1.05 ± 0.23
28	1.35	1.1	1.25	1.23 ± 0.13
31	1.1	1.1	1.1	1.1 ± 0
32	0.8	0.8	0.8	0.8 ± 0

Degradation and Utilisation of Xylan in culture by Fusarium culmorum

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.02	0.02	0.02	0.02 ± 0
1	0.05	0.06	0.07	0.06 ± 0.0082
2	0.08	0.09	0.07	0.08 ± 0.0082
3	0.11	0.11	0.08	0.1 ± 0.014
4	0.13	0.15	0.11	0.13 ± 0.016
5	0.2	0.22	0.15	0.19 ± 0.029
6	0.23	0.26	0.23	0.24 ± 0.034
7	0.2	0.35	0.35	0.3 ± 0.071
8	0.34	0.56	0.48	0.46 ± 0.091
9	0.38	0.45	0.4	0.41 ± 0.029
10	0.33	0.42	0.39	0.38 ± 0.037
11	0.26	0.35	0.35	0.32 ± 0.042
12	0.62	0.75	0.7	0.69 ± 0.053
13	0.65	0.75	0.79	0.73 ± 0.059
14	0.42	0.53	0.49	0.48 ± 0.045
15	0.51	0.55	0.5	0.52 ± 0.022
16	0.33	0.42	0.39	0.38 ± 0.037
18	0.15	0.3	0.3	0.25 ± 0.071
19	0.33	0.34	0.29	0.32 ± 0.022
20	0.19	0.22	0.13	0.18 ± 0.037
21	0.19	0.22	0.16	0.19 ± 0.024
22	0.11	0.13	0.09	0.11 ± 0.016
23	0.11	0.14	0.15	0.13 ± 0.017
25	0.13	0.15	0.14	0.14 ± 0.0082
26	0.11	0.13	0.09	0.11 ± 0.016
27	0.05	0.09	0.04	0.06 ± 0.022
28	0	0	0	0 ± 0
31	0	0	0	0 ± 0
32	0	0	0	0 ± 0

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0.02	0.02	0.02	0.02 ± 0
1	0	0	0	0 ± 0
2	0.34	0.43	0.4	0.39 ± 0.037
3	0.59	0.76	0.69	0.68 ± 0.07
4	0.81	0.96	1.05	0.94 ± 0.1
5	1.09	1.35	1.28	1.24 ± 0.11
6	1.82	1.95	1.9	1.89 ± 0.054
7	1.46	1.65	1.6	1.57 ± 0.08
8	1.58	1.72	1.65	1.65 ± 0.057
9	1.93	2.28	2.18	2.13 ± 0.15
10	1.78	2.15	1.95	1.96 ± 0.15
11	1.78	1.86	1.79	1.81 ± 0.036
12	1.09	1.25	1.2	1.18 ± 0.067
13	1.27	1.5	1.43	1.4 ± 0.096
14	0.86	1.15	0.93	0.98 ± 0.12
15	0.24	0.45	0.39	0.36 ± 0.088
16	0.14	0.2	0.2	0.18 ± 0.028
18	0.09	0.1	0.11	0.1 ± 0.0082
19	0.07	0.08	0.09	0.08 ± 0.0082
20	0.02	0.02	0.02	0.02 ± 0
21	0	0	0	0 ± 0
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
25	0	0	0	0 ± 0
26	0	0	0	0 ± 0
27	0	0	0	0 ± 0
28	0	0	0	0 ± 0
31	0	0	0	0 ± 0
32	0	0	0	0 ± 0

Degradation and Utilisation of Xylan in culture by G. graminis var tritici isolate og.12.

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.25	0.25	0.25	0.25 ± 0
3	0.5	0.25	0.38	0.38 ± 0.13
4	1.1	0.8	0.95	0.95 ± 0.15
5	0.8	0.8	0.8	0.8 ± 0
6	0.8	0.8	0.8	0.8 ± 0
7	0.4	0.6	0.3	0.43 ± 0.15
8	0.6	0.6	0.6	0.6 ± 0
9	0.8	0.8	0.8	0.8 ± 0
10	0.5	0.5	0.5	0.5 ± 0
11	0.8	1.35	1.1	1.08 ± 0.28
12	1.1	1.1	0.8	1.0 ± 0.17
13	1.1	1.1	1.1	1.1 ± 0
14	0.8	0.8	0.8	0.8 ± 0
15	0.8	0.8	0.8	0.8 ± 0
16	1.9	1.9	1.9	1.9 ± 0
18	1.1	1.1	1.1	1.1 ± 0
19	0.8	1.1	1.2	1.03 ± 0.2
20	1.35	1.35	1.35	1.35 ± 0
21	1.6	1.6	1.6	1.6 ± 0
22	1.6	1.9	1.75	1.75 ± 0.15
23	1.6	1.6	1.6	1.6 ± 0
25	1.9	1.9	1.9	1.9 ± 0
26	2.2	1.9	2.0	2.03 ± 0.15
27	2.5	2.0	2.0	2.16 ± 0.28
28	2.7	2.7	2.7	2.7 ± 0
31	1.9	1.9	1.9	1.9 ± 0
32	0.8	0.8	0.8	0.8 ± 0

Degradation and Utilisation of Xylan in culture by *G. graminis* var tritici isolate 43

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.25	0.25	0.25	0.25 ± 0
3	0.25	0.25	0.25	0.25 ± 0
4	0.8	0.95	1.1	0.95 ± 0.15
5	0.8	0.8	0.8	0.8 ± 0
6	1.1	1.1	1.1	1.1 ± 0
7	0.8	0.75	0.5	0.68 ± 0.16
8	1.1	0.8	0.9	0.93 ± 0.15
9	1.1	1.1	1.1	1.1 ± 0
10	0.5	0.5	0.5	0.5 ± 0
11	1.1	1.35	1.23	1.23 ± 0.13
12	1.25	1.1	1.1	1.15 ± 0.09
13	1.35	1.35	1.35	1.35 ± 0
14	0.8	0.8	0.8	0.8 ± 0
15	0.8	0.8	0.8	0.8 ± 0
16	1.35	1.35	1.35	1.35 ± 0
18	0.5	0.5	0.5	0.5 ± 0
19	0.5	0.5	0.4	0.47 ± 0.06
20	0.5	0.5	0.5	0.5 ± 0
21	0.8	0.8	0.8	0.8 ± 0
22	0.8	0.8	0.8	0.8 ± 0
23	0.4	0.5	0.4	0.43 ± 0.06
25	0.25	0.25	0.25	0.25 ± 0
26	0.5	0.65	0.5	0.55 ± 0.09
27	0.8	0.65	0.7	0.72 ± 0.08
28	1.1	1.1	1.1	1.1 ± 0
31	1.35	1.25	1.35	1.32 ± 0.06
32	1.3	1.3	1.35	1.32 ± 0.03

Degradation and Utilisation of Xylan in culture by *G. graminis* var tritici isolate WPBS1.

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.25	0.25	0.25	0.25 ± 0
3	0.38	0.25	0.33	0.32 ± 0.06
4	0.8	0.8	0.8	0.8 ± 0
5	0.8	0.8	0.8	0.8 ± 0
6	0.8	1.1	0.95	0.95 ± 0.15
7	0.8	0.8	0.6	0.73 ± 0.11
8	0.8	0.8	0.8	0.8 ± 0
9	0.8	1.1	0.95	0.95 ± 0.15
10	0.5	0.5	0.5	0.5 ± 0
11	1.1	1.1	1.1	1.1 ± 0
12	1.35	1.1	1.2	1.22 ± 0.12
13	1.35	1.35	1.35	1.35 ± 0
14	1.1	1.1	1.1	1.1 ± 0
15	0.8	0.8	0.8	0.8 ± 0
16	1.6	1.8	1.6	1.67 ± 0.11
18	0.8	0.5	0.7	0.67 ± 0.15
19	0.4	0.35	0.6	0.45 ± 0.67
20	0.8	0.9	0.8	0.66 ± 0.24
21	0.5	0.5	0.6	0.53 ± 0.05
22	0.7	0.8	0.8	0.77 ± 0.06
23	0.8	0.4	0.6	0.6 ± 0.2
25	0.5	0.25	0.38	0.38 ± 0.12
26	0.75	0.5	0.5	0.58 ± 0.14
27	1.5	1.5	1.1	1.37 ± 0.23
28	1.6	1.6	1.6	1.6 ± 0
31	1.6	1.6	1.6	1.6 ± 0
32	1.6	1.35	1.48	1.48 ± 0.13

Degradation and Utilisation of Powdered wheat straw in liquid culture by Fusarium culmorum

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0	0	0	0 ± 0
3	0	0	0	0 ± 0
4	0	0	0	0 ± 0
5	0	0	0	0 ± 0
6	0	0	0	0 ± 0
7	0	0	0	0 ± 0
8	0	0	0	0 ± 0
9	0	0	0	0 ± 0
10	0	0	0	0 ± 0
11	0	0	0	0 ± 0
12	0	0	0	0 ± 0
13	0	0	0	0 ± 0
14	0	0	0	0 ± 0
15	0.01	0.01	0.01	0.01 ± 0
16	0.01	0	0.02	0.01 ± 0.0082
18	0.01	0.01	0.01	0.01 ± 0
19	0.04	0.05	0.03	0.04 ± 0.0082
20	0.01	0.01	0.01	0.01 ± 0
21	0.04	0.04	0.04	0.04 ± 0
22	0.02	0.02	0.02	0.02 ± 0
23	0.01	0.02	0	0.01 ± 0.0082
25	0.04	0.04	0.01	0.03 ± 0.014
26	0.03	0.04	0.02	0.03 ± 0.0082
27	0.03	0.03	0.03	0.03 ± 0
28	0.02	0.03	0.04	0.03 ± 0.0082
31	0.02	0.02	0.05	0.03 ± 0.014
32	0	0	0	0 ± 0

Degradation and Utilisation of Powdered wheat straw in liquid culture by Cochliobolus sativus

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0	0	0	0 ± 0
3	0	0	0	0 ± 0
4	0	0	0	0 ± 0
5	0	0	0	0 ± 0
6	0	0	0	0 ± 0
7	0	0	0	0 ± 0
8	0	0	0	0 ± 0
9	0	0	0	0 ± 0
10	0	0	0	0 ± 0
11	0	0	0	0 ± 0
12	0	0	0	0 ± 0
13	0	0	0	0 ± 0
14	0	0	0	0 ± 0
15	0.01	0.02	0	0.01 ± 0
16	0	0	0	0 ± 0
18	0.01	0.01	0.01	0.01 ± 0
19	0.01	0.01	0.01	0.01 ± 0
20	0	0	0	0 ± 0
21	0.01	0.01	0.01	0.01 ± 0
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
25	0.02	0.02	0.02	0.02 ± 0
26	0.01	0.01	0.01	0.01 ± 0
27	0	0	0	0 ± 0
28	0	0	0	0 ± 0
31	0	0	0	0 ± 0
32	0	0	0	0 ± 0

Degradation and Utilisation of Powdered wheat straw in liquid culture by G. graminis var tritici isolate og.12.

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.03	0.03	0.02	0.026± 0.005
3	0.08	0.06	0.06	0.066± 0.01
4	0.04	0.03	0.02	0.03 ± 0.01
5	0.08	0.08	0.08	0.08 ± 0
6	0.8	1.1	0.8	0.9 ± 0.17
7	1.1	1.35	0.65	1.03 ± 0.35
8	1.35	0.8	0.8	0.98 ± 0.32
9	1.77	1.65	1.45	1.62 ± 0.16
10	1.25	1.1	1.1	1.15 ± 0.086
11	1.35	1.35	1.35	1.35 ± 0
12	1.65	1.5	1.5	1.55 ± 0.086
13	1.9	1.4	1.75	1.68 ± 0.26
14	2.5	1.75	2.5	2.25 ± 0.43
15	2.79	2.5	3.0	2.76 ± 0.25
16	3.42	2.48	3.5	3.13 ± 0.56
18	3.25	3.05	3.3	3.2 ± 0.11
19	4.29	4.32	4.35	4.32 ± 0.024
20	4.95	5.18	5.05	5.06 ± 0.094
21	5.66	5.59	5.76	5.67 ± 0.07
22	4.95	4.89	4.95	4.93 ± 0.028
23	3.85	3.66	3.8	3.77 ± 0.08
25	3.5	2.5	2.8	2.93 ± 0.51
26	2.78	2.2	2.1	2.36 ± 0.37
27	2.5	1.89	2.4	2.26 ± 0.33
28	2.0	1.75	2.5	2.08 ± 0.38
31	2.0	1.75	2.5	2.08 ± 0.38
32	1.5	0.95	1.35	1.27 ± 0.28

Degradation and Utilisation of Powdered wheat straw in liquid culture by G. graminis var tritici isolate 43

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.01	0	0.01	0.006± 0.005
3	0.06	0.03	0.04	0.043± 0.015
4	0.08	0.06	0.05	0.063± 0.015
5	1.1	1.25	1.1	1.15 ± 0.086
6	0.08	1.35	1.25	0.89 ± 0.71
7	1.35	1.5	2.0	1.62 ± 0.34
8	0.8	0.8	1.25	0.95 ± 0.26
9	0.15	0.15	0.1	0.13 ± 0.028
10	0.25	0.25	0.3	0.27 ± 0.028
11	0.225	0.2	0.45	0.29 ± 0.14
12	0.14	0.12	0.2	0.15 ± 0.042
13	0.09	0.09	0.15	0.11 ± 0.034
14	0.01	0	0.02	0.01 ± 0.01
15	0.95	0.8	0.8	0.85 ± 0.086
16	1.25	1.5	1.35	1.37 ± 0.13
18	1.75	2.5	1.6	1.95 ± 0.48
19	2.5	3.0	1.8	2.43 ± 0.6
20	3.0	4.5	2.95	3.48 ± 0.88
21	3.5	5.0	3.5	4.0 ± 0.86
22	2.5	3.5	2.5	2.83 ± 0.58
23	1.8	2.5	2.2	2.17 ± 0.35
25	1.35	2.0	2.0	1.78 ± 0.38
26	1.1	1.65	1.8	1.52 ± 0.37
27	1.75	1.8	2.5	2.02 ± 0.42
28	2.0	2.0	2.5	2.17 ± 0.29
31	2.0	2.0	3.0	2.33 ± 0.58
32	1.5	1.5	1.5	1.5 ± 0

Degradation and Utilisation of Powdered wheat straw in liquid culture by G. graminis var tritici isolate WPBS1.

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0	0	0	0 ± 0
3	0.18	0.14	0.2	0.17 ± 0.03
4	1.25	1.08	1.25	1.19 ± 0.09
5	2.5	2.0	1.75	2.08 ± 0.38
6	3.0	2.2	2.0	2.4 ± 0.53
7	3.5	2.5	2.0	2.67 ± 0.76
8	2.5	2.0	1.5	2.0 ± 0.5
9	2.2	1.8	1.6	1.87 ± 0.3
10	2.0	1.65	1.1	1.58 ± 0.45
11	1.5	1.1	0.8	1.13 ± 0.35
12	0.8	0.5	0.5	0.6 ± 0.17
13	0.3	0.2	0.2	0.23 ± 0.06
14	0.04	0.02	0.01	0.023± 0.015
15	0.8	0.5	0.3	0.53 ± 0.25
16	1.25	1.1	0.9	1.08 ± 0.18
18	2.25	1.35	1.75	1.78 ± 0.45
19	3.0	2.0	2.5	2.5 ± 0.5
20	3.75	2.27	3.25	3.01 ± 0.65
21	5.0	3.5	5.0	4.5 ± 0.87
22	4.68	3.2	4.5	4.13 ± 0.81
23	3.5	2.5	3.75	3.25 ± 0.66
25	3.25	2.2	3.5	2.98 ± 0.69
26	2.86	2.0	2.5	2.45 ± 0.43
27	2.5	3.0	3.0	2.83 ± 0.29
28	2.25	3.5	2.75	2.83 ± 0.63
31	2.0	4.0	3.5	3.17 ± 1.04
32	1.8	2.0	1.75	1.85 ± 0.13

Degradation and Utilisation of α-cellulose in liquid culture by Fusarium culmorum

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.01	0.01	0.01	0.01 ± 0
3	0	0	0	0 ± 0
4	0.01	0.01	0.01	0.01 ± 0
5	0.02	0.035	0.035	0.03 ± 0.0071
6	0.065	0.09	0.085	0.08 ± 0.011
7	0.01	0.01	0.01	0.01 ± 0
8	0.06	0.07	0.05	0.06 ± 0.0082
9	0.03	0.06	0.03	0.04 ± 0.014
10	0.01	0.03	0.02	0.02 ± 0.0082
11	0	0	0	0 ± 0
12	0.02	0.03	0.01	0.02 ± 0.0082
13	0.01	0.02	0	0.01 ± 0.0082
14	0	0	0	0 ± 0
15	0.02	0.02	0.02	0.02 ± 0
16	0.01	0.03	0.02	0.02 ± 0.0082
18	0.02	0.03	0.01	0.02 ± 0.0082
19	0.02	0.05	0.02	0.03 ± 0.014
20	0.01	0.01	0.01	0.01 ± 0
21	0.04	0.03	0.02	0.03 ± 0.0082
22	0.02	0.01	0	0.01 ± 0.0082
23	0.02	0.03	0.01	0.02 ± 0.0082
25	0.03	0.04	0.02	0.03 ± 0.0082
26	0.02	0.04	0.03	0.03 ± 0.0082
27	0.01	0.03	0.02	0.02 ± 0.0082
28	0	0.02	0.01	0.01 ± 0.0082
31	0.01	0.03	0.02	0.02 ± 0.0082
32	0	0	0	0 ± 0

Degradation and Utilisation of α-cellulose in liquid culture by Cochliobolus sativus

	Concentration of reducing sugars in culture medium (mg cm^{-3})			
DAYS	1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0.01	0.01	0.01	0.01 ± 0
3	0	0	0	0 ± 0
4	0	0	0	0 ± 0
5	0.01	0.01	0.01	0.01 ± 0
6	0	0	0	0 ± 0
7	0.01	0.01	0.01	0.01 ± 0
8	0.03	0.015	0.015	0.02 ± 0.0071
9	0.02	0.01	0	0.01 ± 0.0082
10	0.02	0.025	0.015	0.02 ± 0.0041
11	0.02	0.03	0.01	0.02 ± 0.0082
12	0	0	0	0 ± 0
13	0	0	0	0 ± 0
14	0	0	0	0 ± 0
15	0	0	0	0 ± 0
16	0.01	0.01	0.01	0.01 ± 0
18	0.01	0.01	0.01	0.01 ± 0
19	0	0	0	0 ± 0
20	0.03	0.02	0.04	0.03 ± 0.0082
21	0.01	0	0.02	0.01 ± 0.0082
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
25	0	0	0	0 ± 0
26	0.01	0.01	0.01	0.01 ± 0
27	0.02	0	0.01	0.01 ± 0
28	0	0	0	0 ± 0
31	0	0	0	0 ± 0
32	0	0	0	0 ± 0

Degradation and Utilisation of Filter paper (Cellulose) in liquid culture by Fusarium culmorum

DAYS	Concentration of reducing sugars in culture medium (mg cm-3) 1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0	0	0	0 ± 0
3	0	0	0	0 ± 0
4	0.01	0.01	0.01	0.01 ± 0
5	0.03	0.01	0.02	0.02 ± 0.0082
6	0.04	0.03	0.02	0.03 ± 0.0082
7	0	0	0	0 ± 0
8	0	0	0	0 ± 0
9	0	0	0	0 ± 0
10	0.01	0.01	0.01	0.01 ± 0
11	0	0	0	0 ± 0
12	0	0	0	0 ± 0
13	0	0	0	0 ± 0
14	0	0	0	0 ± 0
15	0.02	0.02	0.02	0.02 ± 0
16	0	0	0	0 ± 0
18	0.04	0.08	0.06	0.06 ± 0.016
19	0.01	0.01	0.01	0.01 ± 0
20	0	0	0	0 ± 0
21	0	0	0	0 ± 0
22	0.05	0.075	0.055	0.06 ± 0.011
23	0.01	0.01	0.01	0.01 ± 0
25	0	0	0	0 ± 0
26	0	0	0	0 ± 0
27	0.01	0.01	0.01	0.01 ± 0
28	0	0	0	0 ± 0
31	0.03	0.03	0.03	0.03 ± 0
32	0	0	0	0 ± 0

Degradation and Utilisation of Filter paper (Cellulose) in liquid culture by *Cochliobolus sativus*

DAYS	Concentrarion of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	0	0	0	0 ± 0
1	0	0	0	0 ± 0
2	0	0	0	0 ± 0
3	0	0	0	0 ± 0
4	0	0	0	0 ± 0
5	0	0	0	0 ± 0
6	0	0	0	0 ± 0
7	0	0	0	0 ± 0
8	0	0	0	0 ± 0
9	0	0	0	0 ± 0
10	0	0	0	0 ± 0
11	0	0	0	0 ± 0
12	0	0	0	0 ± 0
13	0	0	0	0 ± 0
14	0	0	0	0 ± 0
15	0	0	0	0 ± 0
16	0	0	0	0 ± 0
18	0	0	0	0 ± 0
19	0	0	0	0 ± 0
20	0	0	0	0 ± 0
21	0	0	0	0 ± 0
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
25	0	0	0	0 ± 0
26	0	0	0	0 ± 0
27	0	0	0	0 ± 0
28	0	0	0	0 ± 0
31	0	0	0	0 ± 0
32	0	0	0	0 ± 0

Effect of Glucose on Filter paper (Cellulose) degradation and Utilisation in liquid culture by Fusarium culmorum

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})			
	1	2	3	Mean ± S.D.
0	1.10	1.10	1.10	1.10 ± 0
1	0.89	0.93	0.94	0.92 ± 0.022
2	0.78	0.76	0.8	0.78 ± 0.16
3	0.5	0.47	0.53	0.5 ± 0.24
4	0.28	0.27	0.32	0.29 ± 0.02
5	0.1	0.1	0.1	0.1 ± 0
6	0.07	0.1	0.07	0.08 ± 0.014
7	0	0	0	0 ± 0
8	0	0	0	0 ± 0
9	0	0	0	0 ± 0
11	0	0	0	0 ± 0
12	0	0	0	0 ± 0
13	0	0	0	0 ± 0
14	0	0	0	0 ± 0
15	0	0	0	0 ± 0
16	0	0	0	0 ± 0
17	0.01	0.01	0.01	0.01 ± 0
19	0.01	0	0.02	0.01 ± 0.0082
20	0.03	0.04	0.05	0.04 ± 0.0082
21	0.01	0.02	0.03	0.02 ± 0.0082
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
24	0	0	0	0 ± 0
26	0	0	0	0 ± 0
27	0	0	0	0 ± 0
28	0	0	0	0 ± 0
29	0	0	0	0 ± 0
30	0	0	0	0 ± 0

Effect of Glucose on Filter paper (Cellulose) degradation and Utilisation in liquid culture by Cochliobolus sativus

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	Mean ± S.D.
0	1.08	1.08	1.08	1.08 ± 0
1	1.04	1.03	1.08	1.05 ± 0.022
2	0.81	0.79	0.83	0.81 ± 0.016
3	0.72	0.71	0.76	0.73 ± 0.022
4	0.54	0.58	0.59	0.57 ± 0.022
5	0.25	0.23	0.27	0.25 ± 0.016
6	0.15	0.12	0.12	0.13 ± 0.014
7	0.08	0.08	0.08	0.08 ± 0
8	0.07	0.04	0.04	0.05 ± 0.014
9	0.03	0.03	0.03	0.03 ± 0
11	0.03	0.02	0.01	0.02 ± 0.0082
12	0.01	0.01	0.01	0.01 ± 0
13	0.01	0.01	0.01	0.01 ± 0
14	0	0	0	0 ± 0
15	0	0	0	0 ± 0
16	0	0	0	0 ± 0
17	0	0	0	0 ± 0
19	0	0	0	0 ± 0
20	0	0	0	0 ± 0
21	0	0	0	0 ± 0
22	0	0	0	0 ± 0
23	0	0	0	0 ± 0
24	0.02	0.02	0.02	0.02 ± 0
26	0.02	0.01	0.03	0.02 ± 0.0082
27	0.01	0	0.02	0.01 ± 0.0082
28	0.01	0	0.02	0.01 ± 0.0082
29	0	0	0	0 ± 0
30	0	0	0	0 ± 0

Investigation of culture filtrates of *Fusarium culmorum* for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated (μg ml^{-1})

Enzyme Substrates	Growth Substrates				
	GLUCOSE				
	1	2	3	4	Mean ± S.D.
Citrus pectin	195.6	194.8	196.8	195.2	195.6 ± 0.75
Carboxymethylcellulose	60.4	56.8	58.4	58.8	58.6 ± 1.28
Sodium polypectate	18.3	18.9	18.8	17.68	18.42 ± 0.48
Larchwood xylan	8.2	8.5	7.86	7.92	8.12 ± 0.25
	CITRUS PECTIN				
Citrus pectin	227.4	226.6	228.2	228.12	227.58 ± 0.66
Carboxymethylcellulose	22.5	19.8	20.6	20.89	20.95 ± 0.98
Sodium polypectate	10.8	11.2	10.95	11.15	11.03 ± 0.16
Larchwood xylan	0	0	0	0	0 ± 0
	CELLOBIOSE				
Citrus pectin	114.9	115.6	115.3	114.8	115.15 ± 0.32
Carboxymethylcellulose	52.4	49.8	50.6	50.9	50.93 ± 0.94
Sodium polypectate	25.6	24.9	25.2	24.6	25.08 ± 0.37
Larchwood xylan	0	0	0	0	0 ± 0
	CARBOXYMETHYLCELLULOSE				
Citrus pectin	52.8	53.2	52.5	53.48	52.99 ± 0.37
Carboxymethylcellulose	11.9	12.2	12.5	12.32	12.23 ± 0.22
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	8.52	8.26	8.7	8.46	8.49 ± 0.16
	LARCHWOOD XYLAN				
Citrus pectin	149.8	148.3	148.6	147.9	148.65 ± 0.71
Carboxymethylcellulose	19.4	20.3	19.8	19.52	19.76 ± 0.35
Sodium polypectate	8.2	7.9	8.3	7.86	8.07 ± 0.19
Larchwood xylan	27.9	28.5	28.9	28.3	28.4 ± 0.36

Investigation of culture filtrates of *Fusarium culmorum* for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated (μg ml^{-1}) (contd.)

Growth Substrates

Enzyme Substrates	1	2	3	4	Mean ± S.D.
			FILTER PAPER		
Citrus pectin	0	0	0	0	0 ± 0
Carboxymethylcellulose	10.2	9.8	9.95	10.1	10.01± 0.15
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0
			FILTER PAPER + GLUCOSE		
Citrus pectin	4.8	3.6	2.8	3.8	3.75± 0.71
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0

Investigation of culture filtrates of <u>Cochliobolus sativus</u> for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated (µg ml^{-1})

			Growth Substrates		
			GLUCOSE		
Enzyme Substrates	1	2	3	4	Mean ± S.D.
Citrus pectin	150.4	149.35	150.6	149.8	150.04 ± 0.49
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0
			CITRUS PECTIN		
Citrus pectin	189.3	186.4	187.8	187.26	187.69 ± 1.05
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	19.8	19.6	20.3	20.8	20.13 ± 0.47
Larchwood xylan	0	0	0	0	0 ± 0
			CELLOBIOSE		
Citrus pectin	185.2	184.9	185.5	184.4	185.0 ± 0.41
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	12.3	13.1	12.8	12.6	12.7 ± 0.29
Larchwood xylan	0	0	0	0	0 ± 0
			CARBOXYMETHYLCELLULOSE		
Citrus pectin	52.8	53.3	52.4	52.5	52.75 ± 0.35
Carboxymethylcellulose	11.9	11.58	12.26	11.72	11.87 ± 0.25
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	20.3	19.98	20.15	20.5	20.23 ± 0.19
			LARCHWOOD XYLAN		
Citrus pectin	82.9	83.4	83.6	83.85	83.3 ± 0.29
Carboxymethylcellulose	16.3	16.9	16.6	16.54	16.59 ± 0.21
Sodium polypectate	18.6	18.9	19.2	18.42	18.78 ± 0.3
Larchwood xylan	24.3	24.8	25.2	24.58	24.72 ± 0.33

Investigation of culture filtrates of *Cochliobolus sativus* for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated (μg ml^{-1}) (contd.)

Enzyme Substrates	Growth Substrates				
	FILTER PAPER				
	1	2	3	4	Mean ± S.D.
Citrus pectin	0	0	0	0	0 ± 0
Carboxymethylcellulose	10.75	10.6	9.9	10.9	10.54± 0.38
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0
	FILTER PAPER + GLUCOSE				
Citrus pectin	3.9	2.95	3.46	3.6	3.48± 0.34
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0

Investigation of culture filtrates of *G. graminis* var *tritici* for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated ($\mu g\ ml^{-1}$).

Isolate og.12.

	Growth Substrates				
			GLUCOSE		
Enzyme Substrates	1	2	3	4	Mean ± S.D.
Citrus pectin	156.5	154.8	156.9	156.3	156.13 ± 0.79
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0
			CITRUS PECTIN		
Citrus pectin	176.9	177.3	177.8	177.5	173.38 ± 0.33
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	22.4	20.8	20.9	21.6	21.43 ± 0.64
Larchwood xylan	0	0	0	0	0 ± 0
			CARBOXYMETHYLCELLULOSE		
Citrus pectin	37.8	36.5	37.5	37.2	37.25 ± 0.48
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	14.98	15.4	15.15	15.2	15.18 ± 0.15
			LARCHWOOD XYLAN		
Citrus pectin	27.8	26.9	27.4	27.5	27.4 ± 0.32
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	10.68	10.42	10.5	10.9	10.63 ± 0.18

Investigation of culture filtrates of G. graminis var tritici for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated (µg ml^{-1}).

Isolate 43.

			Growth Substrates		
			GLUCOSE		
Enzyme Substrates	1	2	3	4	Mean ± S.D.
Citrus pectin	148.6	147.9	148.24	148.2	148.24 ± 0.25
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0
			CITRUS PECTIN		
Citrus pectin	168.4	167.8	168.7	168.2	168.23 ± 0.33
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	13.2	12.9	12.85	12.76	12.93 ± 0.17
Larchwood xylan	0	0	0	0	0 ± 0
			CARBOXYMETHYLCELLULOSE		
Citrus pectin	44.2	43.8	43.56	43.6	43.79 ± 0.25
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0.07	0.12	0.09	0.08	0.09 ± 0
			LARCHWOOD XYLAN		
Citrus pectin	25.9	25.28	26.3	25.7	25.8 ± 0.37
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	9.96	10.1	10.23	9.85	10.04 ± 0.14

Investigation of culture filtrates of *G. graminis* var *tritici* for cell-wall polysaccharide degrading enzymes by measuring reducing sugars liberated (µg ml^{-1})

Isolate WPBS1

	Growth Substrates				
			GLUCOSE		
Enzyme Substrates	1	2	3	4	Mean ± S.D.
Citrus pectin	141.6	142.3	140.8	141.4	141.53± 0.54
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0	0	0	0	0 ± 0
			CITRUS PECTIN		
Citrus pectin	159.6	158.8	158.2	158.6	158.8 ± 0.51
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	19.3	21.1	19.8	19.5	19.93± 0.7
Larchwood xylan	0	0	0	0	0 ± 0
			CARBOXYMETHYLCELLULOSE		
Citrus pectin	42.6	42.76	43.3	42.9	42.89± 0.26
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0.07	0.045	0.05	0.06	0.06± 0.01
			LARCHWOOD XYLAN		
Citrus pectin	32.8	33.5	33.2	33.8	33.33± 0.37
Carboxymethylcellulose	0	0	0	0	0 ± 0
Sodium polypectate	0	0	0	0	0 ± 0
Larchwood xylan	0.05	0.07	0.05	0.04	0.053± 0.011

Further investigations of enzyme activity in culture filtrates of *Fusarium culmorum* and *Cochliobolus sativus*

Growth Substrate : Larchwood xylan

Reducing sugar assay: (µg ml^{-1})

(a) CULTURE FILTRATE:

Fusarium culmorum:

Enzyme Substrates	1	2	3	Mean ± S.D.
Citrus pectin	149.3	148.6	148.9	148.93 ± 0.29
Carboxymethylcellulose	16.5	16.18	15.98	16.22 ± 0.21
Larchwood xylan	20.5	21.2	20.8	20.83 ± 0.29
H.W.I.C.X.	46.8	47.2	47.4	47.13 ± 0.25
H.W.S.C.X.	80.1	79.9	81.3	80.43 ± 0.62

(b) LYOPHILIZED CULTURE FILTRATE:

Enzyme Substrates	1	2	3	Mean ± S.D.
Citrus pectin	____	____	____	___ _
Carboxymethylcellulose	9.6	9.9	9.2	9.57 ± 0.29
Larchwood xylan	27.8	28.5	28.2	28.17 ± 0.29
H.W.I.C.X.	----	----	----	---- --

Cochliobolus sativus

(a) CULTURE FILTRATE:

Enzyme Substrates	1	2	3	Mean ± S.D.
Citrus pectin	8.85	8.98	9.2	9.01 ± 0.14
Carboxymethylcellulose	8.6	8.25	8.8	8.55 ± 0.23
Larchwood xylan	12.2	11.95	12.1	12.08 ± 0.1
H.W.I.C.X.	8.9	8.6	9.2	8.9 ± 0.24
H.W.S.C.X.	24.6	24.9	25.3	24.93 ± 0.29

(b) LYOPHILIZED CULTURE FILTRATE:

Enzyme Substrates	1	2	3	Mean ± S.D.
Citrus pectin	---	---	---	-- --
Carboxymethylcellulose	8.8	8.4	8.25	8.48 ± 0.23
Larchwood xylan	20.2	21.3	20.8	20.77 ± 0.45
H.W.I.C.X.	---	---	---	-- --
H.W.S.C.X.	---	---	---	-- --

H.W.I.C.X.= Hot Water Insoluble Component of Xylan
H.W.S.C.X.= Hot Water Soluble Component of Xylan

Effect of varying nitrate concentrations in liquid culture on utilisation of Glucose by Fusarium culmorum

100% NITRATE (5g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	11.5	11.4	11.83	10.6	11.15	11.15	11.27 ± 0.38
1	11.95	12.6	12.35	11.4	12.03	11.55	11.98 ± 0.42
2	11.0	11.0	11.55	10.85	11.4	10.85	11.11 ± 0.27
3	9.65	10.05	11.5	9.93	10.3	9.8	10.21 ± 0.61
4	9.38	9.65	9.8	8.97	9.7	9.5	9.5 ± 0.27
6	8.15	8.1	9.53	7.75	8.7	7.35	8.26 ± 0.7
7	7.48	7.35	8.1	6.1	8.25	6.8	7.35 ± 0.74
8	6.85	7.08	5.9	6.33	6.2	6.75	6.5 ± 0.41
9	5.98	6.05	5.45	6.25	5.88	6.15	5.96 ± 0.26
10	5.2	5.4	4.8	4.98	4.6	4.6	4.93 ± 0.3
11	3.91	3.83	3.2	3.4	2.86	3.6	3.51 ± 0.37
13	1.45	1.36	1.5	1.85	1.25	2.13	1.59 ± 0.3
14	0.89	0.81	0.94	0.96	0.89	1.45	0.99 ± 0.21
15	0.4	0.38	0.41	0.38	0.27	0.49	0.39 ± 0.065
16	0.07	0.08	0.06	0.09	0.04	0.08	0.07 ± 0.016
17	0	0	0	0	0	0	0 ± 0
18	0	0	0	0	0	0	0 ± 0
20	0	0	0	0	0	0	0 ± 0
21	0	0	0	0	0	0	0 ± 0
22	0	0	0	0	0	0	0 ± 0
23	0	0	0	0	0	0	0 ± 0
24	0	0	0	0	0	0	0 ± 0
25	0	0	0	0	0	0	0 ± 0
27	0	0	0	0	0	0	0 ± 0

Fusarium culmorum (contd.):

50% NITRATE (2g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	11.4	10.85	11.13	10.6	11.15	11.4	11.08 ± 0.29
1	12.7	12.5	13.0	12.7	12.2	12.2	12.55 ± 0.29
2	10.85	10.73	11.55	10.45	10.73	10.85	10.86 ± 0.34
3	10.3	10.05	10.18	10.05	10.33	10.3	10.2 ± 0.12
4	10.05	9.36	9.89	9.75	10.05	10.0	9.85 ± 0.24
6	9.65	8.4	8.4	8.55	9.38	8.83	8.86 ± 0.49
7	8.25	7.6	7.6	7.06	8.25	8.0	7.79 ± 0.42
8	7.35	7.48	7.5	7.6	8.1	6.37	7.4 ± 0.52
9	7.075	6.9	6.9	7.15	7.33	7.31	7.11 ± 0.17
10	6.5	5.8	5.25	7.1	6.38	6.83	6.31 ± 0.62
11	3.95	3.79	3.5	5.05	4.1	4.81	4.2 ± 0.55
13	3.25	2.6	1.75	3.8	3.0	2.88	2.88 ± 0.63
14	2.82	1.76	1.35	2.25	2.51	2.39	2.18 ± 0.49
15	1.28	1.48	1.31	1.56	1.49	1.34	1.41 ± 0.1
16	0.49	0.55	0.64	0.61	0.65	0.72	0.61 ± 0.073
17	0.1	0.09	0.13	0.13	0.12	0.15	0.12 ± 0.02
18	0.06	0.06	0.08	0.08	0.1	0.1	0.08 ± 0.016
20	0.01	0.01	0.01	0.01	0.01	0.01	0.01 ± 0
21	0	0	0	0	0	0	0 ± 0
22	0	0	0	0	0	0	0 ± 0
23	0	0	0	0	0	0	0 ± 0
24	0	0	0	0	0	0	0 ± 0
25	0	0	0	0	0	0	0 ± 0
27	0	0	0	0	0	0	0 ± 0

Fusarium culmorum (contd.):

10% NITRATE (0.5g/1)

DAYS	Concentration of reducing sugars (mg cm^{-3}) 1	2	3	4	5	6	Mean ± S.D.
0	10.6	10.85	11.15	10.3	10.85	10.85	10.77 ± 0.26
1	11.15	11.13	12.75	11.15	11.4	11.95	11.59 ± 0.59
2	11.83	10.6	10.6	11.63	11.63	10.58	11.14 ± 0.56
3	10.33	10.3	10.05	9.65	10.18	10.3	10.14 ± 0.24
4	10.15	10.2	9.95	9.45	10.16	10.15	10.01 ± 0.26
6	7.85	7.9	5.85	6.78	5.7	6.65	6.79 ± 0.86
7	5.6	5.4	4.6	4.6	3.53	4.6	4.72 ± 0.67
8	4.75	3.13	3.7	2.45	3.0	3.43	3.41 ± 0.71
9	3.48	2.15	3.5	2.6	2.2	2.33	2.71 ± 0.57
10	1.8	0.93	1.25	1.65	0.95	2.0	1.43 ± 0.41
11	0.92	0.73	0.79	0.98	0.84	1.08	0.89 ± 0.12
13	0	0	0	0	0	0	0 ± 0
14	0	0	0	0	0	0	0 ± 0
15	0	0	0	0	0	0	0 ± 0
16	0	0	0	0	0	0	0 ± 0
17	0	0	0	0	0	0	0 ± 0
18	0	0	0	0	0	0	0 ± 0
20	0	0	0	0	0	0	0 ± 0
21	0	0	0	0	0	0	0 ± 0
22	0	0	0	0	0	0	0 ± 0
23	0	0	0	0	0	0	0 ± 0
24	0	0	0	0	0	0	0 ± 0
25	0	0	0	0	0	0	0 ± 0
27	0	0	0	0	0	0	0 ± 0

Effect of varying nitrate concentrations in liquid culture on utilisation of Glucose by *Fusarium culmorum* (2nd Experiment).

100% NITRATE (5g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	15.5	13.3	13.3	12.7	13.0	13.0	13.46 ± 0.93
1	14.4	13.3	13.3	13.0	13.0	13.85	13.48 ± 0.5
2	12.35	13.0	12.7	12.7	12.45	12.5	12.62 ± 0.21
3	11.35	11.5	11.7	11.55	11.5	11.1	11.45 ± 0.19
4	9.9	9.75	10.3	10.3	9.1	10.05	9.9 ± 0.41
6	7.1	6.68	7.3	7.15	6.62	6.85	6.95 ± 0.25
7	6.25	5.65	6.4	6.9	5.3	5.2	5.95 ± 0.62
8	4.88	4.27	5.25	5.7	3.8	4.9	4.8 ± 0.62
9	2.75	2.35	3.2	4.45	3.25	2.6	3.1 ± 0.68
10	0.85	0.9	1.15	1.25	0.95	0.82	0.98 ± 0.16
11	0.59	0.68	0.78	0.78	0.72	0.65	0.7 ± 0.069
13	0.32	0.41	0.48	0.45	0.44	0.36	0.41 ± 0.055
14	0.01	0.01	0.01	0.01	0.01	0.01	0.01 ± 0

50% NITRATE (2.5g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.75	13.15	14.65	13.3	12.5	12.5	13.14 ± 0.74
1	13.3	14.4	13.6	13.0	13.6	12.5	13.4 ± 0.59
2	14.95	13.6	12.9	12.88	12.75	13.3	13.4 ± 0.75
3	11.57	11.83	11.7	11.4	11.4	11.25	11.53 ± 0.2
4	10.48	11.4	10.98	9.75	10.15	10.0	10.46 ± 0.57
6	8.3	8.95	8.85	7.45	8.15	7.86	8.26 ± 0.53
7	6.51	7.32	5.6	7.2	6.8	8.15	6.93 ± 0.78
8	5.25	5.68	4.9	4.6	4.45	6.8	5.28 ± 0.79
9	4.15	4.4	3.98	3.13	3.13	4.49	3.88 ± 0.56
10	2.85	3.15	3.0	2.78	2.9	3.5	3.03 ± 0.24
11	1.2	1.15	0.96	0.89	0.98	1.6	1.13 ± 0.24
13	1.25	1.28	1.23	1.05	1.15	1.48	1.24 ± 0.13
14	1.8	1.82	1.74	1.75	1.85	1.96	1.82 ± 0.073

Fusarium culmorum (2nd Experiment) (contd.)

10% NITRATE (0.5g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.5	12.5	13.3	13.0	12.7	14.1	13.02 ± 0.56
1	12.75	12.7	12.6	13.85	13.0	13.0	12.98 ± 0.41
2	13.0	12.5	12.2	13.3	12.45	12.7	12.69 ± 0.37
3	10.98	11.7	11.7	11.83	11.1	11.45	11.46 ± 0.32
4	10.21	10.85	9.75	9.75	10.0	10.58	10.19 ± 0.41
6	6.25	6.48	5.95	6.15	5.88	6.37	6.18 ± 0.21
7	2.45	3.22	3.13	2.1	3.38	2.7	2.83 ± 0.45
8	1.05	1.18	1.25	1.12	1.35	1.25	1.2 ± 0.097
9	0.15	0.25	0.25	0.2	0.35	0.3	0.25 ± 0.065
10	0.025	0.04	0.04	0.04	0.045	0.05	0.04 ± 0.008
11	0.03	0.015	0.02	0.02	0.01	0.025	0.02 ± 0.07
13	0	0	0	0	0	0	0 ± 0
14	0	0	0	0	0	0	0 ± 0

Effect of varying nitrate concentrations in liquid culture on utilisation of Glucose by *Cochliobolus sativus*

100% NITRATE (5g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	11.95	12.85	12.6	12.85	12.6	12.6	12.58 ± 0.3
1	11.85	11.73	11.9	11.78	11.68	11.56	11.75 ± 0.11
2	11.15	10.59	10.85	10.88	10.85	10.78	10.85 ± 0.17
3	11.28	11.4	11.73	11.55	10.6	11.0	11.26 ± 0.38
4	9.8	9.93	9.5	10.45	9.5	9.25	9.74 ± 0.39
6	9.65	9.65	9.58	9.75	9.8	9.65	9.68 ± 0.073
7	10.18	10.05	6.38	11.0	9.38	9.8	9.47 ± 1.46
8	8.9	8.95	8.83	8.83	8.8	8.85	8.87 ± 0.053
9	8.3	8.25	7.3	8.93	8.25	8.83	8.31 ± 0.53
10	8.15	7.9	7.89	8.45	8.15	8.3	8.14 ± 0.2
11	7.95	8.4	7.31	7.35	7.9	8.25	7.86 ± 0.41
13	7.85	7.9	7.89	7.75	7.85	7.8	7.84 ± 0.052
14	7.8	7.85	7.89	7.6	7.8	7.8	7.79 ± 0.091
15	7.65	7.68	7.8	7.8	7.7	7.75	7.73 ± 0.058
16	7.65	7.7	7.69	7.75	7.65	7.7	7.69 ± 0.034
17	7.2	8.25	6.8	7.83	7.73	8.25	7.66 ± 0.53
18	7.42	7.42	6.4	7.7	7.48	8.1	7.42 ± 0.51
20	6.7	6.68	6.61	6.85	6.95	7.25	6.84 ± 0.22
21	5.98	5.9	5.7	5.75	5.45	6.8	5.93 ± 0.42
22	6.18	6.15	5.85	6.25	5.8	6.25	6.08 ± 0.18
23	7.15	6.58	6.95	6.8	6.9	6.0	6.73 ± 0.37
24	6.85	6.53	6.95	6.5	6.45	5.9	6.53 ± 0.34
25	5.95	6.35	5.95	5.55	5.35	5.35	5.75 ± 0.37
26	5.45	5.56	6.35	5.55	6.35	5.48	5.79 ± 0.4
28	4.75	4.7	5.58	5.9	5.78	5.35	5.34 ± 0.47
29	4.58	4.5	5.25	5.9	5.38	5.05	5.11 ± 0.48
30	5.55	4.5	5.15	5.4	5.25	5.05	5.15 ± 0.33
31	5.25	4.78	4.9	5.2	4.85	5.2	5.03 ± 0.19
36	3.95	3.8	3.11	4.5	3.3	4.38	3.84 ± 0.51
38	3.5	3.25	2.8	3.5	3.1	3.05	3.2 ± 0.25
39	3.18	2.95	3.15	3.15	2.85	3.2	3.08 ± 0.13

100% NITRATE (contd.):

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
42	2.85	2.5	2.8	2.9	2.25	3.5	2.8 ± 0.39
43	2.5	2.4	2.38	2.6	2.32	2.8	2.5 ± 0.16
44	2.3	2.15	2.25	2.3	2.25	2.25	2.25 ± 0.05

50% NITRATE (2.5g/1)

	Concentration of reducing sugars (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	11.95	11.7	11.95	11.68	11.95	11.95	11.86 ± 0.12
1	11.65	11.5	11.45	10.76	11.6	11.5	11.41 ± 0.3
2	11.0	11.0	10.85	11.0	10.6	10.6	10.84 ± 0.18
3	10.6	10.85	10.45	10.85	10.18	10.3	10.54 ± 0.26
4	10.18	10.85	11.0	10.05	9.9	9.64	10.27 ± 0.49
6	9.85	9.85	9.95	9.75	9.7	10.06	9.86 ± 0.12
7	7.05	9.38	9.5	9.5	9.78	9.78	9.17 ± 0.96
8	8.47	9.2	8.95	8.95	9.1	9.15	8.97 ± 0.24
9	8.57	8.7	8.55	8.83	8.68	8.15	8.58 ± 0.21
10	8.45	8.6	8.5	8.6	8.55	8.66	8.56 ± 0.07
11	8.52	8.4	8.7	8.7	8.4	8.4	8.52 ± 0.13
13	8.6	8.58	8.7	8.65	8.56	8.57	8.61 ± 0.05
14	8.7	8.69	8.65	8.6	8.75	8.69	8.68 ± 0.046
15	8.7	8.71	8.75	8.7	8.75	8.71	8.72 ± 0.022
16	8.8	8.6	8.85	8.8	8.85	8.9	8.8 ± 0.096
17	8.87	8.55	8.7	8.95	9.38	8.95	8.9 ± 0.26
18	9.28	9.15	8.6	8.25	8.55	8.25	8.68 ± 0.4
20	8.5	8.5	7.54	8.25	8.4	8.25	8.24 ± 0.33
21	7.15	6.99	6.8	6.93	7.2	7.35	7.07 ± 0.18
22	7.4	7.34	7.05	7.35	7.6	7.48	7.37 ± 0.17
23	7.8	7.75	7.73	7.48	7.9	7.9	7.76 ± 0.14
24	7.75	7.7	7.38	7.45	7.9	7.48	7.61 ± 0.19
25	7.25	7.3	7.24	6.93	7.6	7.3	7.27 ± 0.19
26	7.25	7.25	7.25	7.05	7.35	7.35	7.25 ± 0.1
28	7.4	7.45	7.28	7.2	7.75	7.2	7.38 ± 0.19
30	7.05	7.15	6.85	6.95	7.6	6.4	7.0 ± 0.36
31	7.2	7.2	6.44	6.89	7.2	6.65	6.93 ± 0.3
36	6.48	6.52	5.78	6.75	7.05	5.7	6.38 ± 0.49

50% NITRATE (contd.):

DAYS	Concentration of reducing sugars (mg cm^{-3})						
	1	2	3	4	5	6	Mean ± S.D.
38	6.3	6.25	5.78	6.6	7.05	5.4	6.23 ± 0.53
39	4.6	4.6	4.6	4.6	4.6	4.6	4.6 ± 0
42	4.5	4.9	4.8	4.8	4.75	4.75	4.75 ± 0.12
43	3.55	4.5	4.3	4.3	4.35	4.2	4.2 ± 0.3
44	3.27	3.68	3.6	3.5	3.6	3.53	3.53 ± 0.13

10% NITRATE (0.5g/1)

DAYS	Concentration of reducing sugars (mg cm^{-3})						
	1	2	3	4	5	6	Mean ± S.D.
0	12.1	11.7	11.43	11.4	11.55	12.20	11.73 ± 0.31
1	11.85	11.6	11.5	11.1	11.1	11.25	11.4 ± 0.28
2	11.15	10.33	10.45	11.15	10.85	11.15	10.85 ± 0.34
3	11.15	11.15	10.6	11.15	10.6	10.85	10.92 ± 0.25
4	11.4	11.0	11.0	10.85	10.73	10.73	10.95 ± 0.23
6	10.25	9.95	10.0	10.0	9.75	9.75	9.95 ± 0.17
7	10.05	9.25	9.65	10.05	9.65	9.65	9.72 ± 0.27
8	9.25	8.35	9.05	9.3	8.98	8.95	8.98 ± 0.31
9	8.0	7.85	7.75	8.10	7.75	7.89	7.89 ± 0.13
10	8.55	8.5	8.45	8.45	8.43	8.5	8.48 ± 0.041
11	8.65	8.95	8.95	8.55	8.4	8.4	8.65 ± 0.23
13	8.75	8.85	8.85	8.68	8.75	8.47	8.73 ± 0.13
14	8.7	8.85	8.85	8.7	8.85	8.85	8.8 ± 0.071
15	8.85	8.9	8.9	8.85	8.92	8.92	8.89 ± 0.029
16	9.0	9.25	9.15	9.0	8.8	8.8	9.0 ± 0.17
17	9.02	8.95	8.95	9.25	9.25	8.7	9.02 ± 0.19
18	8.75	8.66	8.95	8.95	8.55	8.4	8.71 ± 0.2
20	8.6	8.5	8.65	8.68	8.6	8.45	8.58 ± 0.081
21	7.95	7.31	7.75	8.0	7.63	7.2	7.64 ± 0.3
22	5.65	5.14	5.4	5.55	5.3	5.3	5.39 ± 0.17
23	8.6	8.6	8.3	8.4	8.4	8.1	8.4 ± 0.17
24	8.6	8.5	8.2	8.4	8.4	8.3	8.4 ± 0.13
25	7.85	7.85	7.78	8.0	7.9	7.6	7.83 ± 0.12
26	7.85	7.85	7.78	8.0	7.75	7.75	7.83 ± 0.087
28	8.3	8.3	7.85	8.1	8.25	8.1	8.15 ± 0.16

10% NITRATE (contd.):

Concentration of reducing sugars (mg cm^{-3})

DAYS	1	2	3	4	5	6	Mean ± S.D.
29	7.5	7.5	7.28	7.35	7.35	7.6	7.43 ± 0.11
30	7.6	7.6	7.32	7.55	7.6	7.45	7.52 ± 0.1
31	7.75	7.75	7.73	7.5	8.0	7.35	7.68 ± 0.21
36	7.25	7.15	7.5	5.83	6.5	7.35	6.93 ± 0.58
38	6.95	6.8	6.98	6.47	6.25	7.35	6.8 ± 0.36
39	7.55	7.5	7.15	7.15	7.4	7.35	7.35 ± 0.16
42	7.3	7.2	6.5	6.55	7.1	6.93	6.93 ± 0.31
43	7.95	7.8	7.5	7.15	7.6	7.6	7.6 ± 0.25
44	7.75	7.5	7.35	7.3	7.5	7.48	7.48 ± 0.14

Effect of varying nitrate concentrations in liquid culture on utilisation of Glucose by *G. graminis* var *tritici* isolate og.12.

100% NITRATE CONCENTRATION (5g/l)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	11.7	11.95	11.95	11.7	11.7	11.95	11.83 ± 0.13
2	11.95	12.2	12.2	12.2	12.2	12.2	12.15 ± 0.093
4	12.5	13.0	13.0	12.7	13.0	12.5	12.78 ± 0.23
5	12.2	12.7	12.5	12.2	12.5	12.2	12.38 ± 0.2
7	12.7	12.7	13.0	12.7	13.0	12.7	12.8 ± 0.14
8	12.5	12.5	12.7	12.5	12.7	12.7	12.6 ± 0.1
9	12.5	12.2	12.2	12.2	12.5	12.5	12.35 ± 0.15
11	11.7	11.4	11.7	11.4	11.7	11.7	11.6 ± 0.14
12	11.1	11.2	11.1	11.3	11.1	11.4	11.2 ± 0.12
13	10.6	10.6	10.6	10.6	10.6	10.6	10.6 ± 0
14	10.6	10.3	10.4	10.5	10.3	10.3	10.4 ± 0.12
15	10.3	10.3	10.3	10.3	10.0	10.0	10.2 ± 0.14
18	10.0	9.75	10.0	9.75	9.75	10.0	9.88 ± 0.13
19	9.5	10.0	9.5	9.5	9.5	9.75	9.63 ± 0.19
20	8.95	9.25	8.7	8.7	8.95	8.95	8.88 ± 0.2
21	8.1	7.9	8.1	8.1	7.9	8.1	8.03 ± 0.094
22	7.2	6.9	7.05	6.8	6.5	7.01	6.91 ± 0.22
25	6.5	6.5	6.5	6.5	6.5	6.5	6.5 ± 0
26	6.0	5.7	5.8	5.9	6.0	5.7	5.85 ± 0.13
27	5.7	5.7	5.7	5.7	5.7	5.7	5.7 ± 0
28	4.9	5.15	5.15	4.9	4.9	5.15	5.03 ± 0.13
29	4.6	4.0	4.35	4.35	4.0	4.35	4.28 ± 0.21
32	3.5	3.5	3.5	3.2	3.2	3.5	3.4 ± 0.14
33	1.9	2.2	2.2	1.9	2.2	2.2	2.1 ± 0.14
34	1.9	1.9	1.9	1.9	1.9	1.9	1.9 ± 0
35	1.9	2.2	2.4	1.9	2.2	1.9	2.08 ± 0.2
36	1.1	1.35	1.35	1.35	1.1	1.1	1.23 ± 0.13
39	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
40	0.5	0.5	0.25	0.25	0.5	0.25	0.38 ± 0.13

Ggt. isolate og12. 100% Nitrate Concentration (contd.)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
41	0.25	0.25	0.5	0.25	0.25	0.25	0.29 ± 0.093
42	0.25	0.25	0.25	0	0.25	0	0.17 ± 0.12

50% NITRATE CONCENTRATION (2.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	11.4	11.95	11.7	11.4	11.7	11.7	11.64 ± 0.19
2	12.2	12.5	12.5	12.2	12.2	12.5	12.35 ± 0.15
4	13.0	12.7	13.0	13.0	12.7	13.0	12.9 ± 0.14
5	12.7	12.7	12.7	12.7	12.7	12.7	12.7 ± 0
7	13.0	12.7	13.0	12.7	13.0	13.0	12.9 ± 0.14
8	12.7	12.5	12.5	12.5	12.7	12.5	12.57 ± 0.094
9	12.2	11.95	12.2	12.2	11.95	11.95	12.08 ± 0.13
11	11.7	11.4	11.1	11.1	11.1	11.7	11.35 ± 0.27
12	10.85	10.85	10.6	10.6	10.6	11.1	10.77 ± 0.19
13	9.75	10.3	10.0	10.0	10.3	9.75	10.02 ± 0.22
14	9.75	9.75	9.5	9.5	9.75	0.75	9.67 ± 0.12
15	9.5	8.95	9.5	8.95	9.5	9.5	9.32 ± 0.26
18	8.4	8.4	8.7	8.1	8.7	8.4	8.45 ± 0.21
19	7.6	7.6	7.9	7.9	7.6	7.9	7.75 ± 0.15
20	7.1	7.1	7.35	7.35	7.1	7.38	7.23 ± 0.13
21	6.5	6.5	6.5	6.8	6.5	6.8	6.6 ± 0.14
22	6.25	6.0	6.0	6.25	6.0	6.25	6.13 ± 0.13
25	6.0	5.15	5.7	5.7	5.4	5.15	5.52 ± 0.31
26	6.0	5.7	5.7	5.7	6.0	5.7	5.8 ± 0.14
27	4.35	4.9	4.9	4.35	4.9	4.9	4.72 ± 0.26
28	5.4	5.4	5.3	5.14	5.15	5.75	5.36 ± 0.2
29	6.15	6.0	6.35	6.2	6.15	6.15	6.17 ± 0.1
32	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
33	5.7	5.7	5.7	6.0	5.7	6.0	5.8 ± 0.14
34	5.7	5.7	5.7	6.0	5.7	6.0	5.8 ± 0.14

Ggt. isolate og12. 50% Nitrate Concentration (contd.)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
35	6.5	6.0	5.7	6.5	6.25	6.0	6.16 ± 0.29
36	5.15	4.9	4.6	4.9	4.6	4.9	4.84 ± 0.19
39	4.6	4.6	4.6	4.6	4.6	4.6	4.6 ± 0
40	4.0	3.8	3.8	4.0	4.0	4.0	3.93 ± 0.094
41	3.8	3.8	3.5	3.8	3.5	3.8	3.7 ± 0.14
42	3.8	3.5	3.8	3.2	3.8	3.2	3.55 ± 0.27

10% NITRATE CONCENTRATION (0.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	11.7	11.95	11.7	12.2	11.7	11.95	11.87 ± 0.19
2	12.2	12.2	12.5	12.2	12.2	12.5	12.3 ± 0.14
4	13.0	12.7	13.0	13.3	12.7	13.3	13.0 ± 0.24
5	12.5	12.5	12.2	12.5	12.2	12.7	12.43 ± 0.18
7	12.2	12.5	12.2	12.5	12.2	12.2	12.3 ± 0.14
8	11.95	12.2	11.95	12.2	12.2	12.2	12.12 ± 0.12
9	11.95	11.7	11.7	11.95	11.7	11.7	11.78 ± 0.12
11	11.1	10.6	10.6	10.3	10.85	10.85	10.72 ± 0.25
12	9.75	9.5	9.5	9.75	10.0	10.0	9.75 ± 0.2
13	8.1	8.1	8.1	8.1	8.1	8.1	8.1 ± 0
14	7.9	7.6	7.6	7.6	7.9	7.6	7.7 ± 0.14
15	7.6	7.6	7.35	7.35	7.6	7.35	7.48 ± 0.13
18	7.6	7.6	7.6	7.6	7.6	7.6	7.6 ± 0
19	7.6	7.6	7.35	7.35	7.35	7.35	7.43 ± 0.12
20	7.1	7.1	6.8	6.8	6.8	7.1	6.95 ± 0.15
21	6.5	6.5	6.5	6.5	6.5	6.5	6.5 ± 0
22	6.5	6.5	6.5	6.25	6.5	6.5	6.46 ± 0.093
25	6.25	6.25	6.25	6.25	6.25	6.25	6.25 ± 0
26	6.0	6.0	5.7	5.7	6.0	6.0	5.9 ± 0.14
27	5.7	5.7	5.7	5.7	5.7	5.7	5.7 ± 0
28	5.15	4.9	5.15	5.15	5.15	4.9	5.07 ± 0.12

Ggt. isolate Og12. 10% Nitrate Concentration (contd.)

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})						
	1	2	3	4	5	6	Mean ± S.D.
29	4.9	4.9	4.9	4.9	4.9	4.9	4.9 ± 0
32	4.9	4.9	4.9	4.9	5.15	4.9	4.94 ± 0.093
33	5.15	4.9	4.9	5.15	4.9	4.9	4.98 ± 0.12
34	4.9	4.9	4.35	4.9	4.35	4.9	4.72 ± 0.26
35	4.35	4.0	4.0	4.35	3.8	4.0	4.08 ± 0.2
36	4.6	4.0	4.6	4.4	4.3	4.5	4.4 ± 0.21
39	5.15	4.6	5.15	5.1	5.0	4.8	4.97 ± 0.2
40	4.6	4.6	4.6	4.9	4.6	4.6	4.65 ± 0.11
41	4.45	4.8	4.35	4.6	4.35	4.35	4.48 ± 0.17
42	4.35	4.3	3.85	4.3	4.05	3.8	4.11 ± 0.22

Effect of varying nitrate concentrations in liquid culture on utilisation of Glucose by *G. graminis* var *tritici* isolate 43

100% NITRATE CONCENTRATION (5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	11.95	11.7	11.7	11.95	11.95	11.7	11.83 ± 0.13
2	11.95	11.95	11.95	11.7	11.7	11.95	11.87 ± 0.12
4	11.95	11.95	11.7	11.95	11.7	11.95	11.87 ± 0.12
5	12.2	12.2	11.95	12.2	12.2	11.95	12.12 ± 0.12
7	12.7	12.5	12.7	12.5	12.7	12.5	12.6 ± 0.1
8	12.5	12.5	12.2	12.2	12.5	12.2	12.35 ± 0.15
9	11.95	12.2	11.95	12.2	11.95	11.95	12.03 ± 0.12
11	11.1	11.4	11.4	11.4	11.1	11.4	11.3 ± 0.14
12	11.1	10.85	11.1	11.1	10.85	10.85	10.98 ± 0.13
13	10.6	10.3	10.6	10.0	10.3	10.6	10.4 ± 0.22
14	10.0	9.75	9.75	9.5	9.75	10.0	9.79 ± 0.17
15	9.5	9.55	9.5	9.29	9.4	9.35	9.43 ± 0.092
18	8.7	8.7	8.7	8.7	8.95	8.7	8.74 ± 0.093
19	8.4	8.4	8.1	8.1	8.1	8.4	8.25 ± 0.15
20	8.1	7.6	7.9	7.6	7.6	7.9	7.78 ± 0.2
21	7.6	7.1	7.6	7.1	7.1	7.6	7.35 ± 0.25
22	7.35	7.25	7.6	7.35	7.1	7.35	7.35 ± 0.14
25	7.6	7.6	7.6	7.6	7.6	7.6	7.6 ± 0
26	6.25	6.25	6.5	6.5	6.25	6.5	6.38 ± 0.13
27	6.5	6.5	6.5	6.5	6.5	6.5	6.5 ± 0
28	6.5	6.25	6.25	6.25	6.5	6.25	6.33 ± 0.12
29	6.0	6.0	6.25	6.0	6.25	6.0	6.08 ± 0.12
32	6.25	6.25	6.25	6.0	6.25	6.0	6.17 ± 0.12
33	6.0	6.0	6.25	6.0	6.0	6.25	6.08 ± 0.12
34	5.7	5.7	6.0	6.0	5.7	5.7	5.8 ± 0.14
35	5.15	5.15	5.4	5.15	5.3	5.5	5.28 ± 0.14
36	5.7	5.9	6.0	6.1	5.7	6.0	5.9 ± 0.15
39	5.7	5.7	5.7	5.7	5.7	5.7	5.7 ± 0
40	4.3	4.45	4.3	4.0	4.0	4.35	4.23 ± 0.17
41	3.6	3.5	3.8	3.5	3.5	3.7	3.6 ± 0.12
42	2.7	2.9	2.7	3.3	2.8	2.6	2.83 ± 0.23

Ggt. isolate 43 (contd.):

50% NITRATE CONCENTRATION (2.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	12.5	12.7	12.5	12.5	12.5	12.7	12.54 ± 0.094
2	12.5	12.2	12.2	12.5	12.2	12.2	12.3 ± 0.14
4	11.7	11.95	11.7	11.7	11.95	11.95	11.83 ± 0.13
5	12.5	12.5	12.2	12.5	12.2	12.5	12.4 ± 0.14
7	11.7	11.95	11.7	11.7	11.95	11.7	11.78 ± 0.12
8	11.95	11.95	11.7	11.95	11.7	11.95	11.87 ± 0.12
9	11.95	11.95	11.95	11.95	11.95	11.95	11.95 ± 0
11	12.2	12.5	12.5	11.95	12.5	12.2	12.31 ± 0.21
12	11.1	10.85	11.4	10.85	11.1	11.4	11.12 ± 0.22
13	9.75	10.3	10.3	9.25	9.75	9.75	9.85 ± 0.36
14	10.0	10.0	10.3	9,75	10.0	10.3	10.06 ± 0.19
15	10.6	10.3	10.6	10.6	10.6	10.3	10.5 ± 0.15
18	9.25	8.95	9.5	9.25	9.5	9.25	9.28 ± 0.19
19	8.7	8.95	8.95	8.95	8.7	8.7	8.83 ± 0.13
20	8.4	8.4	8.7	8.7	8.4	8.4	8.5 ± 0.14
21	8.1	8.1	8.4	8.4	8.1	8.1	8.2 ± 0.14
22	7.9	7.9	7.9	8.1	8.1	7.9	7.97 ± 0.094
25	7.6	7.6	7.9	7.6	7.9	7.6	7.7 ± 0.14
26	7.6	7.6	7.6	7.6	7.6	7.6	7.6 ± 0
27	6.8	7.1	7.1	7.1	7.1	6.8	7.0 ± 0.14
28	6.8	6.5	6.8	6.8	6.5	6.5	6.65 ± 0.15
29	5.15	5.4	5.4	5.7	5.4	5.15	5.37 ± 0.19
32	4.35	4.6	4.6	4.6	4.9	4.35	4.57 ± 0.19
33	3.8	4.0	4.0	4.0	4.35	4.0	4.03 ± 0.16
34	4.35	3.8	4.35	3.8	4.35	3.8	4.08 ± 0.28
35	3.5	3.5	3.5	3.2	3.5	3.2	3.4 ± 0.14
36	2.65	2.45	2.7	2.8	2.7	2.3	2.6 ± 0.17
39	2.9	2.9	3.2	2.9	3.1	2.7	2.95 ± 0.16
40	2.1	2.1	2.25	2.1	1.9	1.8	2.04 ± 0.15
41	2.8	2.8	3.1	2.5	3.1	2.8	2.85 ± 0.21
42	2.5	2.5	2.45	2.8	2.31	2.8	2.56 ± 0.18

Ggt. isolate 43 (contd.):

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})						
	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	11.4	11.7	11.95	11.7	11.4	11.45	11.6 ± 0.2
2	11.95	11.7	11.7	11.95	11.7	11.95	11.83 ± 0.13
4	12.7	12.7	12.5	12.5	12.2	12.7	12.55 ± 0.18
5	13.0	12.7	13.0	12.7	13.0	12.7	12.85 ± 0.15
7	12.7	13.0	12.7	13.0	13.0	13.0	12.9 ± 0.14
8	12.2	11.95	11.95	11.95	12.2	12.2	12.08 ± 0.13
9	11.7	11.95	11.7	12.2	11.7	11.95	11.87 ± 0.19
11	10.6	11.1	10.85	11.1	10.85	10.6	10.85 ± 0.2
12	9.5	9.75	9.25	9.75	9.5	8.95	9.45 ± 0.28
13	7.9	7.9	7.9	7.9	7.9	7.9	7.9 ± 0
14	7.1	7.1	6.8	7.1	7.35	7.35	7.13 ± 0.19
15	6.5	6.25	6.5	6.25	6.5	6.5	6.42 ± 0.12
18	6.25	6.0	6.0	6.0	6.0	6.25	6.08 ± 0.12
19	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
20	5.4	5.7	5.4	5.7	5.7	5.7	5.6 ± 0.14
21	5.15	5.15	4.9	4.9	5.15	5.15	5.07 ± 0.12
22	5.15	5.4	5.15	5.7	5.7	5.4	5.42 ± 0.22
25	5.7	6.0	5.7	5.7	6.0	6.0	5.85 ± 0.15
26	5.7	5.7	5.7	5.7	5.7	5.7	5.7 ± 0
27	5.15	5.3	5.1	5.25	5.15	5.15	5.18 ± 0.069
28	4.9	5.15	4.95	5.1	4.9	4.9	4.98 ± 0.1
29	4.35	4.3	4.7	4.3	4.8	4.4	4.48 ± 0.2
32	3.7	3.58	3.8	3.8	3.5	4.0	3.73 ± 0.16
33	3.5	3.6	3.5	3.5	3.7	3.5	3.55 ± 0.076
34	3.85	3.75	4.0	4.0	3.85	3.95	3.9 ± 0.091
35	3.2	3.0	3.3	3.0	3.4	3.2	3.18 ± 0.15
36	3.8	3.8	3.5	3.5	3.8	3.8	3.7 ± 0.14
39	4.35	4.35	4.0	4.0	4.35	4.35	4.23 ± 0.16
40	3.8	3.8	3.8	3.5	3.5	3.8	3.7 ± 0.14
41	3.5	3.8	3.2	3.5	3.2	3.2	3.4 ± 0.22
42	3.2	3.2	3.0	3.2	3.2	3.0	3.13 ± 0.094

Effect of varying nitrate concentrations in liquid culture on utilisation of Glucose by *G. graminis* var *tritici* isolate WPBS1.

100% NITRATE CONCENTRATION (5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	12.5	12.5	12.7	12.5	12.2	12.5	12.48 ± 0.15
2	12.7	13.0	13.0	13.0	12.7	13.0	12.9 ± 0.14
4	13.3	13.3	13.3	13.3	13.0	13.0	13.2 ± 0.14
5	13.3	13.0	13.3	13.0	13.3	13.0	13.15 ± 0.15
7	12.5	12.7	12.7	12.5	12.5	12.5	12.57 ± 0.094
8	12.5	12.5	12.5	12.5	12.5	12.5	12.5 ± 0
9	12.5	12.2	12.5	12.2	12.5	12.5	12.4 ± 0.14
11	11.95	11.95	11.7	11.4	11.95	11.7	11.78 ± 0.2
12	10.3	10.6	10.0	10.0	10.3	10.0	10.2 ± 0.22
13	9.25	8.95	9.25	9.25	9.25	9.25	9.2 ± 0.11
14	9.5	9.5	9.25	9.75	9.75	9.5	9.54 ± 0.17
15	9.75	9.75	9.75	10.0	9.75	10.0	9.83 ± 0.12
18	8.1	8.4	8.7	8.7	8.4	8.7	8.5 ± 0.22
19	7.1	7.6	7.6	7.6	7.1	7.35	7.39 ± 0.22
20	6.8	6.8	6.8	6.8	6.5	6.8	6.75 ± 0.11
21	6.25	6.0	6.25	5.7	6.0	5.7	5.98 ± 0.22
22	6.25	5.7	6.0	5.7	5.7	6.0	5.89 ± 0.21
25	5.7	5.7	6.0	5.7	6.0	5.7	5.8 ± 0.14
26	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
27	5.7	5.7	5.7	5.7	5.7	5.7	5.7 ± 0
28	6.25	6.25	6.0	6.25	6.0	6.25	6.17 ± 0.12
29	5.7	5.7	5.7	6.0	5.7	6.0	5.8 ± 0.14
32	5.15	5.15	4.9	5.15	4.9	5.15	5.07 ± 0.12
33	4.6	4.35	4.6	4.6	4.35	4.6	4.52 ± 0.12
34	5.4	5.15	5.15	5.4	5.15	5.15	5.23 ± 0.12
35	6.0	5.7	6.0	6.0	5.7	5.4	5.8 ± 0.22
36	4.35	4.35	4.6	4.9	4.35	4.6	4.53 ± 0.2
39	1.9	1.9	1.9	1.9	1.9	1.9	1.9 ± 0
40	1.35	1.6	1.35	1.6	1.35	1.35	1.43 ± 0.12
41	0.8	1.1	0.8	1.1	0.8	0.8	0.9 ± 0.14
42	0	0.25	0.25	0	0.25	0.25	0.21 ± 0.17

Ggt. isolate WPBS1 (contd.):

50% NITRATE CONCENTRATION (2.5g/l)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	12.7	12.7	12.7	12.7	12.7	12.7	12.7 ± 0
2	12.7	12.5	12.7	12.7	12.5	12.7	12.63 ± 0.094
4	11.95	12.2	12.2	12.2	11.95	12.2	12.12 ± 0.12
5	12.2	12.2	11.95	11.95	12.2	12.2	12.12 ± 0.12
7	12.7	12.5	12.7	12.5	12.7	12.7	12.63 ± 0.094
8	12.5	12.5	12.7	12.7	12.5	12.5	12.57 ± 0.094
9	11.95	11.95	11.95	12.2	11.95	12.2	12.03 ± 0.12
11	11.4	11.1	11.1	11.4	11.4	11.1	11.25 ± 0.15
12	10.3	10.85	10.85	10.6	10.85	10.6	10.68 ± 0.2
13	9.75	10.3	9.75	10.0	10.3	10.0	10.02 ± 0.22
14	9.25	10.0	9.25	9.75	9.5	9.25	9.5 ± 0.29
15	8.95	8.95	8.4	8.7	8.7	8.1	8.63 ± 0.3
18	8.1	7.9	7.9	7.6	7.9	7.6	7.83 ± 0.18
19	6.5	6.5	7.1	7.1	7.1	6.5	6.8 ± 0.3
20	6.25	6.25	6.5	6.8	6.8	6.25	6.48 ± 0.25
21	6.25	6.0	6.5	6.5	6.5	6.0	6.29 ± 0.22
22	6.25	6.25	6.5	5.25	6.5	6.5	6.38 ± 0.13
25	6.5	6.5	6.5	6.5	6.5	6.5	6.5 ± 0
26	6.0	5.7	5.7	6.0	6.0	5.7	5.85 ± 0.15
27	5.15	5.4	5.15	5.4	5.15	5.15	5.23 ± 0.12
28	5.4	5.4	5.4	5.15	5.4	5.15	5.32 ± 0.12
29	5.15	5.15	4.9	5.15	4.9	4.9	5.03 ± 0.13
32	5.15	4.9	4.9	5.15	4.9	4.9	4.98 ± 0.12
33	3.8	3.8	4.0	4.0	3.8	3.8	3.87 ± 0.094
34	4.9	4.35	4.9	4.6	4.6	4.35	4.62 ± 0.22
35	3.8	3.8	4.0	3.8	3.8	3.8	3.83 ± 0.075
36	3.0	3.2	3.0	3.0	3.2	3.0	3.07 ± 0.094
39	1.6	1.6	1.9	1.6	1.9	1.6	1.7 ± 0.14
40	1.6	1.35	1.4	1.35	1.55	1.35	1.43 ± 0.1
41	1.35	1.35	1.1	1.35	1.1	1.1	1.23 ± 0.13
42	1.1	0.8	1.1	1.1	0.8	1.35	1.04 ± 0.19

Ggt. isolate WPBS1 (contd.):

10% NITRATE CONCENTRATION (0.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
1	11.95	11.95	12.2	12.2	11.95	11.95	12.03 ± 0.12
2	11.95	11.95	11.95	12.2	11.95	11.95	11.99 ± 0.093
4	12.5	12.5	12.2	12.5	12.2	12.5	12.4 ± 0.14
5	12.5	13.0	13.0	12.5	13.0	12.7	12.78 ± 0.23
7	11.7	11.7	11.95	11.4	12.2	11.95	11.82 ± 0.25
8	10.85	11.1	10.85	10.6	11.1	11.4	10.98 ± 0.25
9	10.0	10.3	9.75	9.25	10.0	10.3	9.93 ± 0.36
11	9.25	9.25	9.5	9.25	9.75	9.5	9.42 ± 0.19
12	7.9	8.1	8.4	7.9	8.1	8.1	8.08 ± 0.17
13	7.1	7.35	6.8	7.1	6.8	7.1	7.04 ± 0.19
14	7.35	7.35	7.1	7.35	7.1	7.1	7.23 ± 0.13
15	7.6	7.1	7.6	7.6	7.35	7.35	7.43 ± 0.19
18	7.6	7.6	7.6	7.6	7.6	7.6	7.6 ± 0
19	7.6	7.6	7.6	7.6	7.6	7.6	7.6 ± 0
20	7.1	6.8	7.1	6.8	6.8	7.1	6.95 ± 0.15
21	6.5	6.25	6.25	6.5	6.5	6.5	6.42 ± 0.12
22	6.5	6.25	6.5	6.5	6.5	6.8	6.51 ± 0.16
25	6.8	7.1	6.8	6.8	7.1	7.1	6.95 ± 0.15
26	7.1	7.1	7.1	7.1	7.1	7.1	7.1 ± 0
27	6.25	6.5	6.5	6.25	6.3	6.2	6.33 ± 0.12
28	5.7	6.0	6.0	5.9	5.7	5.5	5.8 ± 0.18
29	5.4	5.6	5.6	5.2	5.8	5.4	5.5 ± 0.19
32	5.4	5.4	5.4	5.4	5.4	5.4	5.4 ± 0
33	5.15	4.9	5.15	4.9	5.15	5.15	5.07 ± 0.12
34	5.7	5.4	5.7	5.4	6.0	6.0	5.7 ± 0.24
35	4.9	5.15	4.9	4.9	5.15	5.15	5.03 ± 0.13
36	5.7	6.0	5.7	6.0	6.0	5.7	5.85 ± 0.15
39	4.9	5.4	5.4	4.9	5.4	4.9	5.15 ± 0.25
40	4.9	5.15	5.15	4.9	4.9	4.9	4.98 ± 0.12
41	4.6	4.6	4.9	4.6	4.6	4.35	4.61 ± 0.16
42	4.35	4.35	4.6	4.35	4.6	4.0	4.38 ± 0.2

Effect of varying nitrate concentrations in liquid on degradation and utilisation of Citrus pectin by Fusarium culmorum.

100% NITRATE CONCENTRATION (5g/l)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0.6	0.6	0.6	0.6	0.6	0.6	0.6 ± 0
1	0.95	0.98	0.87	0.98	0.89	1.01	0.95 ± 0.051
2	1.35	1.25	1.3	1.27	1.14	1.25	1.26 ± 0.064
5	2.4	3.0	1.9	2.05	2.45	2.05	2.31 ± 0.37
6	4.6	4.85	3.0	4.6	4.6	3.8	4.24 ± 0.64
7	4.1	4.6	4.5	4.05	3.8	4.35	4.23 ± 0.28
8	5.56	7.1	5.2	4.9	5.4	5.2	5.56 ± 0.72
9	5.4	6.25	5.18	5.4	5.45	4.9	5.43 ± 0.41
12	6.0	6.5	6.25	5.29	6.0	6.5	6.09 ± 0.41
13	5.75	5.7	5.4	5.33	6.0	6.5	5.78 ± 0.39
14	8.6	9.1	8.95	8.48	7.85	9.1	8.68 ± 0.44
15	7.3	7.45	7.9	7.1	7.2	7.33	7.38 ± 0.26
16	7.33	7.48	7.35	7.75	7.35	7.2	7.41 ± 0.17
19	6.76	6.85	6.8	6.93	6.78	6.8	6.82 ± 0.056
20	5.69	5.69	5.6	5.7	5.85	5.55	5.68 ± 0.094
21	5.6	5.58	6.5	5.3	5.2	5.3	5.58 ± 0.44
22	4.95	4.61	5.3	5.1	4.9	4.9	4.96 ± 0.21
23	4.7	4.55	4.85	4.75	4.75	4.6	4.7 ± 0.1
26	4.6	4.35	4.7	4.6	4.75	4.3	4.55 ± 0.17
27	4.29	4.29	4.5	4.33	4.45	4.3	4.36 ± 0.084
28	4.35	4.35	4.5	4.45	4.45	4.3	4.4 ± 0.071
29	3.25	3.25	3.7	3.6	3.65	3.25	3.45 ± 0.2
30	3.85	3.78	3.85	3.95	3.93	3.8	3.86 ± 0.062
33	2.52	2.31	2.6	2.5	2.55	2.4	2.48 ± 0.097
34	1.5	1.5	1.5	1.5	1.6	1.4	1.5 ± 0.058
35	1.5	1.5	1.5	1.5	1.6	1.4	1.5 ± 0.058
36	1.4	1.4	1.4	1.4	1.4	1.4	1.4 ± 0
37	1.45	1.45	1.5	1.5	1.5	1.48	1.48 ± 0.022
40	0.3	0.45	0.2	0.15	0.15	0.25	0.25 ± 0.1
41	0	0	0	0	0	0	0 ± 0
42	0	0	0	0	0	0	0 ± 0

Fusarium culmorum (contd.):

50% NITRATE CONCENTRATION (2.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0.6	0.6	0.6	0.6	0.6	0.6	0.6 ± 0
1	0.98	0.81	1.11	0.79	1.01	0.81	0.92 ± 0.12
2	1.25	1.2	1.21	1.11	1.34	1.14	1.21 ± 0.07
5	1.9	1.6	2.2	1.9	1.9	2.4	1.98 ± 0.25
6	4.1	2.85	3.65	3.25	3.25	3.25	3.39 ± 0.39
7	4.1	4.6	4.35	3.5	4.3	4.1	4.16 ± 0.34
8	4.78	5.2	4.6	4.3	4.9	4.9	4.78 ± 0.28
9	4.32	3.8	4.75	3.93	4.05	5.05	4.32 ± 0.45
12	5.66	5.98	5.2	6.25	5.45	5.4	5.66 ± 0.36
13	6.32	6.0	6.78	6.0	6.8	6.0	6.32 ± 0.35
14	7.31	7.63	8.1	6.8	7.2	6.8	7.31 ± 0.46
15	6.29	6.58	6.25	6.53	6.8	6.25	6.45 ± 0.2
16	6.93	7.15	6.93	6.93	7.1	7.2	7.04 ± 0.11
19	6.14	6.14	5.95	6.38	6.38	5.85	6.14 ± 0.2
20	5.85	5.6	5.55	5.4	5.98	6.0	5.73 ± 0.23
21	5.9	5.81	5.2	5.7	6.65	5.9	5.86 ± 0.43
22	5.0	5.0	4.86	5.4	4.6	4.9	4.96 ± 0.24
23	5.25	5.3	5.25	5.4	5.4	5.2	5.3 ± 0.076
26	4.6	3.45	4.8	4.6	4.3	3.93	4.28 ± 0.46
27	3.9	3.92	3.95	4.05	4.05	3.65	3.92 ± 0.13
28	3.48	3.85	3.8	3.8	3.8	3.53	3.71 ± 0.15
29	3.34	3.6	3.55	3.6	3.53	3.5	3.52 ± 0.088
30	3.65	3.65	3.65	3.65	3.65	3.65	3.65 ± 0
33	2.45	2.68	2.65	2.75	2.85	2.4	2.63 ± 0.16
34	1.15	1.85	1.95	2.05	1.9	1.6	1.75 ± 0.3
35	1.38	1.7	1.7	1.75	1.35	1.9	1.63 ± 0.2
36	1.9	1.9	1.9	1.9	1.9	1.9	1.9 ± 0
37	1.1	1.3	1.25	1.5	1.6	1.35	1.35 ± 0.16
40	0.4	0.3	0.6	0.6	0.6	0.5	0.5 ± 0.12
41	0.4	0.65	0.8	0.6	0.8	0.65	0.65 ± 0.14
42	0.45	0.7	0.8	0.6	0.7	0.65	0.65 ± 0.11

Fusarium culmorum (contd.):

10% NITRATE CONCENTRATION (0.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0.6	0.6	0.6	0.6	0.6	0.6	0.6 ± 0
1	1.16	0.93	1.14	1.16	1.01	1.14	1.09 ± 0.088
2	1.35	1.2	1.2	1.22	1.22	1.28	1.25 ± 0.054
5	2.15	1.75	1.75	2.4	1.1	1.48	1.77 ± 0.42
6	3.65	2.83	3.0	3.25	3.0	3.55	3.21 ± 0.3
7	3.5	2.4	3.25	3.25	3.5	3.0	3.15 ± 0.38
8	3.9	3.83	4.3	3.54	4.3	3.95	3.97 ± 0.27
9	4.22	3.5	4.75	4.75	4.45	3.65	4.22 ± 0.49
12	5.3	5.13	5.7	5.7	5.3	5.15	5.38 ± 0.24
13	5.6	5.8	5.7	5.6	5.7	5.26	5.61 ± 0.17
14	7.05	7.25	7.69	7.9	7.35	6.98	7.37 ± 0.33
15	6.17	6.17	6.1	6.1	6.5	5.98	6.17 ± 0.16
16	6.92	7.15	7.05	7.05	7.2	6.93	7.05 ± 0.1
19	5.75	6.3	6.25	5.55	6.5	5.83	6.03 ± 0.34
20	5.7	5.7	6.0	5.85	5.55	5.4	5.7 ± 0.19
21	5.7	5.7	6.0	5.3	5.45	5.45	5.6 ± 0.23
22	4.98	4.95	5.3	4.9	5.15	5.2	5.08 ± 0.15
23	5.75	4.58	5.5	5.4	5.4	5.05	5.28 ± 0.37
26	4.9	4.9	4.9	4.9	4.9	4.9	4.9 ± 0
27	4.9	5.5	5.5	5.4	5.3	5.2	5.3 ± 0.21
28	4.75	5.2	5.2	5.05	5.2	4.9	5.05 ± 0.17
29	4.4	4.55	4.6	4.58	4.6	4.45	4.53 ± 0.077
30	4.3	4.3	4.3	4.3	4.3	4.3	4.3 ± 0
33	3.7	4.15	4.2	4.15	4.05	4.05	4.05 ± 0.17
34	3.48	4.05	4.1	4.1	4.05	3.8	3.93 ± 0.23
35	3.8	3.6	3.0	3.6	3.5	3.5	3.5 ± 0.24
36	3.15	3.25	2.67	3.25	3.28	3.18	3.13 ± 0.21
37	2.4	2.5	1.9	2.5	2.7	2.4	2.4 ± 0.24
40	1.6	1.6	1.6	1.6	1.6	1.6	1.6 ± 0
41	1.75	2.05	2.05	2.15	2.25	2.05	2.05 ± 0.15
42	1.55	1.6	1.35	1.7	1.8	1.6	1.6 ± 0.14

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Citrus pectin by *Cochliobolus sativus*.

100% NITRATE CONCENTRATION (5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0.6	0.6	0.6	0.6	0.6	0.6	0.6 ± 0
1	0.68	0.68	0.71	0.68	0.66	0.68	0.68 ± 0.015
2	1.25	1.3	1.33	1.33	1.33	1.33	1.31 ± 0.03
5	1.6	2.15	1.6	1.63	1.63	1.48	1.68 ± 0.22
6	2.7	3.25	2.4	3.4	3.25	3.0	3.0 ± 0.35
7	3.0	3.25	2.85	3.1	3.4	3.0	3.1 ± 0.18
8	3.76	3.8	3.68	3.68	3.8	3.83	3.76 ± 0.059
9	3.18	3.25	3.13	2.7	3.25	3.55	3.18 ± 0.25
12	4.37	4.35	4.2	5.2	4.05	4.05	4.37 ± 0.39
13	4.44	4.6	4.6	4.75	4.2	4.05	4.44 ± 0.24
14	6.79	7.33	6.5	6.8	6.78	6.53	6.79 ± 0.27
15	5.1	6.45	5.7	6.0	5.7	5.73	5.78 ± 0.4
16	5.43	6.18	5.7	5.85	5.7	6.0	5.81 ± 0.24
19	6.2	6.26	5.85	6.25	6.38	6.5	6.24 ± 0.2
20	6.14	6.3	6.13	6.0	6.5	6.25	6.22 ± 0.16
21	5.79	5.79	5.7	5.7	6.0	5.7	5.78 ± 0.11
22	4.9	4.9	4.9	4.9	4.9	4.9	4.9 ± 0
23	4.1	4.25	4.4	4.35	4.05	4.35	4.25 ± 0.13
26	3.39	3.9	3.95	3.53	3.8	3.93	3.75 ± 0.21
27	3.16	3.6	3.7	3.38	3.3	3.8	3.49 ± 0.23
28	3.11	3.2	3.15	3.0	3.25	3.25	3.16 ± 0.088
29	3.21	3.15	3.15	3.25	3.25	3.13	3.19 ± 0.049
30	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
33	1.21	1.3	1.25	1.4	1.35	1.23	1.29 ± 0.068
34	0.3	0.25	0.25	0.2	0.25	0.25	0.25 ± 0.029
35	0.25	0.25	0.4	0.4	0.2	0	0.25 ± 0.14
36	1.05	1.15	1.3	1.3	0.7	1.1	1.1 ± 0.2
37	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
40	1.0	1.05	0.98	0.9	0.82	0.95	0.95 ± 0.074
41	1.63	1.52	1.5	1.5	1.25	1.48	1.48 ± 0.11
42	1.38	1.02	1.3	1.25	1.25	1.3	1.25 ± 0.11

Cochliobolus sativus (contd.):

50% NITRATE CONCENTRATION (2.5g/1)

Concentration of reducing sugars in culture medium (mg cm^{-3})

DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0.6	0.6	0.6	0.6	0.6	0.6	0.6 ± 0
1	0.68	0.67	0.61	0.64	0.68	0.68	0.66 ± 0.026
2	1.27	1.3	1.3	1.33	1.39	1.27	1.31 ± 0.041
5	2.7	2.4	2.7	3.0	2.2	2.3	2.55 ± 0.28
6	2.95	3.25	2.45	3.4	3.0	2.73	2.96 ± 0.31
7	1.6	1.9	1.75	2.3	2.2	1.6	1.89 ± 0.27
8	3.38	3.25	3.4	3.5	3.5	3.25	3.38 ± 0.1
9	3.5	3.25	3.38	3.0	4.35	3.5	3.5 ± 0.42
12	4.23	4.35	3.93	4.6	4.05	4.2	4.23 ± 0.23
13	3.82	3.8	4.2	3.93	3.93	3.25	3.82 ± 0.29
14	5.87	5.7	6.5	5.7	6.0	5.45	5.87 ± 0.33
15	5.85	5.56	5.7	6.0	5.85	5.3	5.71 ± 0.23
16	6.23	6.23	6.25	6.25	6.38	5.98	6.22 ± 0.12
19	5.85	5.85	5.7	5.85	5.85	6.0	5.85 ± 0.087
20	6.23	6.35	6.53	6.0	6.13	6.5	6.29 ± 0.19
21	6.25	5.25	5.45	5.85	5.7	6.0	5.75 ± 0.33
22	5.95	4.9	5.58	5.4	5.2	5.85	5.48 ± 0.36
23	5.5	4.9	5.2	5.2	5.2	5.2	5.2 ± 0.17
26	4.9	4.8	5.15	5.05	5.05	4.75	4.95 ± 0.14
27	4.5	3.93	4.5	4.3	4.45	4.18	4.31 ± 0.21
28	3.75	2.75	3.8	3.25	3.5	3.53	3.43 ± 0.35
29	3.4	2.9	3.5	3.2	3.25	3.25	3.25 ± 0.19
30	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
33	2.13	2.15	2.2	2.25	2.3	2.05	2.18 ± 0.082
34	1.6	1.6	1.6	1.6	1.6	1.6	1.6 ± 0
35	0.8	0.6	0.5	0.7	0.5	0.8	0.65 ± 0.13
36	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
37	0.25	0.25	0.25	0.3	0.2	0.25	0.25 ± 0.029
40	0.2	0.25	0.4	0.2	0.2	0.25	0.25 ± 0.071
41	0.3	0.2	0.35	0.15	0.25	0.25	0.25 ± 0.065
42	0	0	0	0	0	0	0 ± 0

Cochliobolus sativus (contd.):

10% NITRATE CONCENTRATION (0.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0.6	0.6	0.6	0.6	0.6	0.6	0.6 ± 0
1	0.66	0.73	0.68	0.76	0.68	0.75	0.71 ± 0.038
2	1.39	1.38	1.39	1.21	1.33	1.3	1.33 ± 0.064
5	1.1	1.6	2.05	1.1	1.23	1.1	1.36 ± 0.35
6	2.83	2.4	2.85	2.15	2.73	2.73	2.62 ± 0.26
7	2.58	2.43	2.25	2.35	2.5	2.35	2.41 ± 0.11
8	2.82	2.7	3.13	2.55	2.7	3.0	2.82 ± 0.2
9	2.76	2.55	2.85	2.7	2.85	2.85	2.76 ± 0.11
12	3.65	3.38	3.5	3.93	3.8	3.65	3.65 ± 0.18
13	4.1	4.35	3.8	4.65	3.65	4.2	4.13 ± 0.33
14	5.85	5.55	5.98	6.13	5.72	6.0	5.87 ± 0.19
15	6.95	6.7	6.8	6.8	6.93	6.8	6.83 ± 0.086
16	7.84	7.84	7.9	7.75	7.75	7.9	7.83 ± 0.062
19	7.08	7.5	7.2	7.35	7.2	7.35	7.28 ± 0.14
20	7.6	7.69	7.33	7.9	7.48	7.9	7.65 ± 0.21
21	7.8	7.9	7.76	7.9	7.9	7.9	7.86 ± 0.058
22	6.6	6.95	7.25	6.93	7.05	6.8	6.93 ± 0.2
23	5.79	5.79	6.25	5.7	5.98	6.13	5.94 ± 0.2
26	5.6	5.6	5.9	5.7	5.7	5.7	5.7 ± 0.1
27	5.65	5.8	5.9	5.7	5.7	5.85	5.77 ± 0.09
28	3.95	4.15	4.8	4.3	4.3	4.3	4.3 ± 0.26
29	4.5	4.4	4.5	4.4	4.45	4.45	4.45 ± 0.041
30	4.3	4.3	4.3	4.3	4.3	4.3	4.3 ± 0
33	5.05	5.3	5.15	5.1	4.9	5.4	5.15 ± 0.16
34	4.18	4.35	4.5	4.5	4.45	4.3	4.38 ± 0.12
35	3.5	2.95	4.25	3.9	3.5	3.8	3.65 ± 0.4
36	2.7	2.95	3.8	3.5	3.3	3.25	3.25 ± 0.36
37	3.8	3.8	3.8	3.8	3.8	3.8	3.8 ± 0
40	2.2	2.5	2.2	1.7	2.15	2.15	2.15 ± 0.23
41	2.1	2.2	1.8	2.0	2.15	2.05	2.05 ± 0.13
42	2.6	2.8	2.95	2.95	2.95	2.85	2.85 ± 0.13

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Larchwood xylan by Fusarium culmorum.

100% NITRATE CONCENTRATION (5g/1)

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})						
	1	2	3	4	5	6	Mean ± S.D.
0	0	0	0	0	0	0	0 ± 0
1	0	0	0	0	0	0	0 ± 0
3	0.13	0.25	0.25	0.38	0.25	0.25	0.25 ± 0.072
4	0.13	0.13	0.13	0.13	0.13	0.13	0.13 ± 0
7	0.5	0.5	0.49	0.65	0.58	0.5	0.54 ± 0.059
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
10	0.57	0.65	0.65	0.65	0.55	0.65	0.62 ± 0.043
11	0.65	0.65	0.65	0.65	0.65	0.65	0.65 ± 0
14	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
15	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
17	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
18	0.83	1.25	0.95	1.1	1.1	0.95	1.03 ± 0.14
21	0.4	0.6	0.5	0.5	0.5	0.5	0.5 ± 0.058
22	0.65	0.65	0.5	0.65	0.65	0.5	0.6 ± 0.071
24	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
25	0.65	0.65	0.65	0.65	0.65	0.65	0.65 ± 0
28	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
29	0.11	0.38	0.4	0.45	0.38	0.38	0.38 ± 0.11
31	0.65	0.5	0.4	0.45	0.5	0.5	0.5 ± 0.076
32	0.6	0.6	0.4	0.4	0.5	0.5	0.5 ± 0.082
35	0.2	0.3	0.2	0.3	0.25	0.25	0.25 ± 0.041
36	0.6	0.4	0.45	0.55	0.5	0.5	0.5 ± 0.065
38	0.25	0.25	0.3	0.2	0.25	0.25	0.25 ± 0.029
39	0.37	0.4	0.4	0.35	0.38	0.38	0.38 ± 0.017
42	0.2	0.3	0.3	0.2	0.25	0.25	0.25 ± 0.041

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Larchwood xylan by <u>Fusarium culmorum</u>.

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3}) 1	2	3	4	5	6	Mean ± S.D.
0	0	0	0	0	0	0	0 ± 0
1	0	0	0	0	0	0	0 ± 0
3	0.13	0.25	0.25	0	0.13	0.19	0.16 ± 0.086
4	0.28	0.38	0.38	0.28	0.35	0.25	0.32 ± 0.052
7	0.5	0.38	0.38	0.5	0.38	0.38	0.42 ± 0.057
8	0.13	0.13	0.13	0.13	0.13	0.13	0.13 ± 0
10	0.75	0.65	0.8	0.65	0.65	0.58	0.68 ± 0.073
11	0.8	0.65	0.8	0.65	0.8	0.8	0.75 ± 0.071
14	0.8	0.8	0.8	0.65	0.8	0.8	0.78 ± 0.056
15	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
17	0.59	0.8	0.65	0.65	0.65	0.75	0.68 ± 0.071
18	0.75	0.65	0.5	0.8	0.65	0.8	0.69 ± 0.11
21	0.45	0.5	0.5	0.38	0.38	0.5	0.45 ± 0.054
22	0.65	0.5	0.8	0.5	0.8	0.65	0.65 ± 0.12
24	0.65	0.65	0.65	0.65	0.65	0.65	0.65 ± 0
25	0.65	0.65	0.65	0.65	0.65	0.65	0.65 ± 0
28	0.3	0.4	0.25	0.25	0.25	0.25	0.28 ± 0.055
29	0.3	0.2	0.25	0.35	0.25	0.25	0.27 ± 0.047
31	0.58	0.5	0.65	0.58	0.58	0.5	0.57 ± 0.052
32	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
35	0.25	0.25	0.2	0.25	0	0	0.16 ± 0.11
36	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
38	0.6	0.5	0.6	0.5	0.5	0.5	0.53 ± 0.047
39	0.3	0.4	0.25	0.35	0.25	0.25	0.3 ± 0.058
42	0.25	0.2	0.25	0.15	0.25	0.25	0.23 ± 0.038

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Larchwood xylan by Fusarium culmorum.

10% NITRATE CONCENTRATION (0.5g/1)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0	0	0	0	0	0	0 ± 0
1	0.13	0.13	0.13	0.13	0.13	0.13	0.13 ± 0
3	0	0.13	0.13	0.25	0.13	0.13	0.13 ± 0.072
4	0.28	0.28	0.3	0.38	0.25	0.25	0.29 ± 0.044
7	0.35	0.38	0.38	0.29	0.38	0.44	0.37 ± 0.045
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
10	0.91	0.8	1.15	0.88	0.8	1.1	0.94 ± 0.14
11	0.93	1.1	1.1	0.85	0.8	1.1	0.98 ± 0.13
14	1.1	1.1	1.1	1.1	1.1	1.1	1.1 ± 0
15	1.6	1.6	1.6	1.6	1.6	1.6	1.6 ± 0
17	0.89	0.89	1.1	0.8	0.8	0.8	0.88 ± 0.11
18	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
21	0.59	0.8	0.65	0.65	0.65	0.8	0.69 ± 0.081
22	0.85	0.85	0.85	0.95	0.8	0.8	0.85 ± 0.05
24	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
25	0.65	0.65	0.65	0.65	0.65	0.65	0.65 ± 0
28	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
29	0.55	0.6	0.4	0.45	0.5	0.5	0.5 ± 0.065
31	0.7	0.75	0.85	0.9	0.8	0.8	0.8 ± 0.065
32	0.9	0.75	0.8	0.75	0.8	0.8	0.8 ± 0.05
35	1.2	0.95	1.05	1.2	1.1	1.1	1.1 ± 0.087
36	0.6	0.7	0.8	0.95	0.95	0.8	0.8 ± 0.13
38	1.3	1.1	0.95	1.1	1.05	1.1	1.1 ± 0.1
39	0.9	0.85	0.75	0.8	0.7	0.8	0.8 ± 0.065
42	0.4	0.5	0.6	0.5	0.5	0.5	0.5 ± 0.058

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Larchwood xylan by cochliobolus sativus.

100% NITRATE CONCENTRATION (5g/1)

Concentration of reducing sugars in culture medium (mg cm^{-3})

DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
3	0.13	0.13	0	0.13	0.13	0	0.09 ± 0.061
4	0.34	0.38	0.25	0.38	0.38	0.25	0.33 ± 0.058
7	0.25	0.25	0.25	0.25	0.25	0.13	0.23 ± 0.045
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
10	0.8	0.8	0.8	0.8	0.95	0.65	0.8 ± 0.087
11	0.56	0.53	0.65	0.65	0.65	0.5	0.59 ± 0.062
14	0.69	0.65	0.82	0.68	0.8	0.8	0.74 ± 0.068
15	1.27	1.25	1.23	1.35	1.23	1.23	1.26 ± 0.043
17	0.77	0.92	0.8	0.95	0.8	0.8	0.84 ± 0.069
18	1.29	1.3	1.35	1.35	1.23	1.1	1.27 ± 0.086
21	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
22	0.5	0.85	0.6	0.65	0.5	0.8	0.65 ± 0.14
24	0.85	0.9	0.65	0.8	0.8	0.8	0.8 ± 0.076
25	0.8	0.85	0.75	0.8	0.8	0.8	0.8 ± 0.029
28	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
29	0.5	0.45	0.45	0.6	0.5	0.5	0.5 ± 0.05
31	0.3	0.2	0.2	0.3	0.25	0.25	0.25 ± 0.041
32	0.25	0.25	0.3	0.2	0.25	0.25	0.25 ± 0.029
35	0.15	0.11	0.11	0.15	0.13	0.13	0.13 ± 0.016
36	0.2	0.25	0.35	0.2	0.25	0.25	0.25 ± 0.05
38	0.2	0.3	0.35	0.2	0.2	0.25	0.25 ± 0.058
39	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Larchwood xylan by Cochliobolus sativus.

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	Concentration of reducing sugars in culture medium (mg cm^{-3})						
	1	2	3	4	5	6	Mean ± S.D.
0	0	0	0	0	0	0	0
1	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
3	0.13	0.13	0.13	0.25	0.13	0	0.13 ± 0.072
4	0.31	0.31	0.31	0.38	0.31	0.25	0.31 ± 0.038
7	0	0	0	0	0	0	0
8	0.38	0.38	0.38	0.38	0.38	0.38	0.38 ± 0
10	0.47	0.5	0.68	0.65	0.56	0.5	0.56 ± 0.079
11	0.38	0.5	0.38	0.38	0.38	0.25	0.38 ± 0.072
14	0.86	0.8	0.8	0.95	0.8	0.95	0.86 ± 0.067
15	0.93	1.15	1.1	1.1	0.95	0.95	1.03 ± 0.089
17	0.35	0.65	0.5	0.5	0.5	0.5	0.5 ± 0.087
18	1.1	1.25	1.28	1.24	1.1	1.23	1.2 ± 0.072
21	0.5	0.45	0.55	0.5	0.5	0.5	0.5 ± 0.029
22	0.75	0.6	0.6	0.65	0.8	0.5	0.65 ± 0.1
24	0.6	0.7	0.5	0.5	0.8	0.5	0.6 ± 0.12
25	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
28	0.4	0.45	0.29	0.38	0.38	0.38	0.38 ± 0.047
29	0.75	0.75	0.8	0.63	0.65	0.8	0.73 ± 0.067
31	0.18	0.25	0.25	0.2	0.19	0.25	0.22 ± 0.031
32	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
35	0	0	0	0	0	0	0
36	0.2	0.2	0.3	0.2	0.35	0.25	0.25 ± 0.058
38	0.25	0.2	0.3	0.25	0.25	0.25	0.25 ± 0.029
39	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0
42	0	0	0	0	0	0	0

Effect of varying nitrate concentrations in liquid culture on degradation and utilisation of Larchwood xylan by Cochliobolus sativus

10% NITRATE CONCENTRATION (0.5g/l)

	Concentration of reducing sugars in culture medium (mg cm^{-3})						
DAYS	1	2	3	4	5	6	Mean ± S.D.
0	0	0	0	0	0	0	0
1	0.13	0.13	0.13	0.13	0.13	0.13	0.13 ± 0
3	0	0.17	0.13	0	0.13	0.14	0.1 ± 0.068
4	0.13	0.38	0.38	0.25	0.25	0.19	0.26 ± 0.092
7	0	0	0	0	0	0	0
8	0.38	0.38	0.38	0.38	0.38	0.38	0.38 ± 0
10	0.48	0.5	0.5	0.5	0.38	0.5	0.48 ± 0.044
11	0.33	0.38	0.38	0.38	0.25	0.25	0.33 ± 0.058
14	1.2	1.35	1.1	1.35	1.1	1.1	1.2 ± 0.11
15	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
17	0.73	0.75	0.8	0.8	0.65	0.65	0.73 ± 0.062
18	1.32	1.38	1.35	1.35	1.35	1.23	1.33 ± 0.048
21	0.8	0.8	0.8	0.8	0.8	0.8	0.8 ± 0
22	0.82	1.25	1.23	0.95	1.1	1.25	1.1 ± 0.16
24	0.6	0.9	0.9	0.8	0.8	0.8	0.8 ± 0.1
25	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
28	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ±
29	0.9	0.8	0.7	0.8	0.8	0.8	0.8 ± 0.058
31	0.6	0.5	0.63	0.65	0.6	0.5	0.58 ± 0.059
32	0.5	0.5	0.6	0.4	0.5	0.5	0.5 ± 0.058
35	0.25	0.25	0.3	0.2	0.25	0.25	0.25 ± 0.029
36	0.55	0.5	0.6	0.4	0.45	0.5	0.5 ± 0.065
38	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
39	0.5	0.5	0.5	0.5	0.5	0.5	0.5 ± 0
42	0.25	0.25	0.25	0.25	0.25	0.25	0.25 ± 0

Influence of nitrate concentrations on enzyme production by *C. sativus*

Growth Substrate : GLUCOSE

Enzyme activity by measuring reducing sugars liberated ($\mu g\ ml^{-1}$) Mean ± S.D.

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	148	149	147	149	149	149	148.5 ± 0.76
	SPP	7	7	7.5	8	7	7	7.25 ± 0.38
	CMC	0	0	0	0	0	0	0
14	CP	174.6	174	176	177	175	176	175.43± 1.0
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	208	210	208	209	209	209	208.83± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	260.0	262.0	261.0	261.0	260.0	260.5	260.75 ± 0.69
	SPP	15.0	15.0	15.0	15.0	15.0	15.0	15.0 ± 0
	CMC	12.0	12.0	13.0	13.0	11.5	13.0	12.42 ± 0.61

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	153.5	153.0	155.0	155.0	154.0	154.0	154.08 ± 0.73
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	144.0	146.0	145.0	145.0	144.0	146.0	145.0 ± 0.82
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	203.0	203.5	203.0	204.0	204.0	205.0	203.75 ± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	238.0	241.0	239.0	239.0	238.0	239.0	239.0 ± 1.0
	SPP	17.0	18.0	18.0	16.8	17.5	19.0	17.72 ± 0.73
	CMC	5.0	5.0	5.0	5.0	5.0	5.0	5.0 ± 0

C. sativus : Enzyme activity by reducing sugars liberated (Contd.)

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	144.0	146.0	146.0	145.5	146.0	145.5	145.5 ± 0.71
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	133.0	135.0	135.0	134.0	134.5	135.0	134.42 ± 0.73
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	189.0	189.0	188.0	188.0	186.0	187.0	187.67 ± 0.94
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	253.0	252.5	254.0	253.0	253.0	254.0	253.25 ± 0.56
	SPP	22.5	23.0	24.0	22.5	22.0	23.0	22.83 ± 0.62
	CMC	13.0	13.0	14.0	14.0	12.5	13.0	13.25 ± 0.56

Enzyme activity by viscosity (units ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	38.0	40.0	39.0	39.0	38.0	39.5	38.92 ± 0.73
	SPP	12.0	13.0	11.7	12.0	12.0	13.0	12.28 ± 0.52
14	CP	14.0	13.6	14.5	15.0	16.0	14.5	14.5 ± 0.76
	SPP	18.0	18.0	17.5	19.0	18.0	20.0	18.42 ± 0.84
21	CP	70.0	72.0	69.5	70.0	71.0	70.0	70.42 ± 0.84
	SPP	20.0	21.0	21.0	19.5	19.5	20.0	20.17 ± 0.62
28	CP	24.0	26.0	25.0	25.0	24.0	24.5	24.75 ± 0.69
	SPP	16.5	16.0	16.0	17.0	17.0	16.5	16.5 ± 0.41

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	18.0	18.0	18.0	18.0	17.5	19.0	18.08 ± 0.45
	SPP	16.9	16.0	17.0	18.0	18.0	17.5	17.23 ± 0.7

C. sativus (Contd.): Enzyme activity by viscosity (units ml^{-1})

50% NITRATE CONCENTRATION (2.5g/1)(Contd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
14	CP	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
	SPP	14.0	14.0	14.0	14.0	14.0	14.0	14.0 ± 0
21	CP	54.5	56.0	55.0	56.0	56.0	55.5	55.5 ± 0.58
	SPP	18.0	18.0	20.0	19.0	19.0	18.0	18.67± 0.75
28	CP	34.0	34.5	34.5	35.0	35.0	36.0	34.83 ± 0.62
	SPP	18.0	18.0	18.0	18.0	18.0	18.0	18.0 ± 0

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	18.0	18.0	17.5	19.0	19.0	17.5	18.17 ± 0.62
	SPP	8.0	8.5	8.0	9.0	8.0	9.0	8.42 ± 0.45
14	CP	4.0	4.0	4.5	5.0	5.0	4.5	4.5 ± 0.41
	SPP	12.0	11.5	11.5	12.0	13.0	13.0	12.17 ± 0.62
21	CP	84.0	84.5	85.0	85.0	86.0	86.0	85.08 ± 0.73
	SPP	20.0	20.0	20.0	21.0	22.0	20.5	20.7 ± 0.75
28	CP	16.0	16.0	16.0	16.0	16.0	16.0	16.0 ± 0
	SPP	16.5	18.0	17.0	16.3	16.0	16.0	16.63 ± 0.7

CP = Citrus pectin
SPP = Sodium polypectate
CMC = Sodium carboxymethylcellulose

Effect of Nitrate Concentrations on Enzyme production by F. culmorum

GROWTH SUBSTRATE : GLUCOSE

100% NITRATE CONCENTRATION (5g/1)

Enzyme activity by measuring reducing sugars liberated (µg ml^{-1})

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
4	CP	165.0	165.0	165.2	166.0	164.0	167.0	165.53 ± 0.94
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
8	CP	146.5	148.0	146.0	148.0	147.0	146.0	146.92 ± 0.84
	SPP	10.0	10.0	9.5	9.5	11.0	11.0	10.17 ± 0.62
	CMC	0	0	0	0	0	0	0
12	CP	154.5	157.0	156.0	156.0	156.0	156.5	156.0 ± 0.76
	SPP	15.0	16.0	14.5	14.5	15.0	16.0	15.17 ± 0.62
	CMC	0	0	0	0	0	0	0

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
4	CP	138.0	137.0	139.0	139.0	138.0	137.0	138.0 ± 0.82
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
8	CP	144.0	144.0	145.0	146.0	143.8	145.0	144.63± 0.78
	SPP	17.0	18.0	17.0	19.0	17.5	18.0	17.75± 0.69
	CMC	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
12	CP	153.5	155.0	154.0	154.0	153.0	155.0	154.08± 0.73
	SPP	12.0	13.0	11.5	10.8	13.0	13.0	12.22± 0.86
	CMC	0	0	0	0	0	0	0

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
4	CP	142.0	142.0	142.5	143.0	143.0	143.0	142.58 ± 0.45
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

F. culmorum (Contd.): Enzyme activity by measuring reducing sugars liberated ($\mu g\ ml^{-1}$)

10% NITRATE CONCENTRATION (0.5g/l)(Contd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
8	CP	134.0	134.8	136.0	136.0	136.0	137.0	135.63 ± 0.45
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
12	CP	123.0	122.0	123.0	124.0	124.0	124.0	123.33 ± 0.75
	SPP	7.0	7.5	8.0	7.0	6.5	8.0	7.33 ± 0.55
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
4	CP	26.0	26.5	27.0	26.0	27.0	26.0	26.42 ± 0.45
	SPP	7.0	7.0	7.0	7.0	7.0	7.0	7.0 ± 0
8	CP	16.8	16.0	17.5	18.0	16.0	17.0	16.88 ± 0.73
	SPP	8.0	8.5	9.0	9.0	8.0	9.0	8.58 ± 0.45
12	CP	10.0	10.0	12.0	11.0	10.0	10.5	10.58 ± 0.73
	SPP	8.0	8.0	8.0	7.5	9.0	9.0	8.25 ± 0.56

50% NITRATE CONCENTRATION (2.5g/l)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
4	CP	10.0	10.0	10.0	10.0	10.0	10.0	10.0 ± 0
	SPP	0	0	0	0	0	0	0
8	CP	17.0	16.8	16.5	17.0	18.0	17.0	17.05± 0.46
	SPP	0	0	0	0	0	0	0
12	CP	24.0	25.0	24.7	25.0	25.0	26.0	24.95± 0.59
	SPP	0	0	0	0	0	0	0

10% NITRATE CONCENTRATION (0.5g/l)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
4	CP	26.0	26.5	27.0	27.0	28.0	27.0	26.92 ± 0.61
	SPP	14.0	14.0	14.5	14.0	15.0	16.0	14.58 ± 0.73
8	CP	30.0	29.6	30.0	31.0	32.0	31.0	30.6 ± 0.82
	SPP	4.0	4.0	5.0	4.0	3.5	4.0	4.1 ± 0.49
12	CP	26.0	26.0	26.0	25.5	27.0	26.0	26.08 ± 0.45
	SPP	4.0	4.0	4.0	4.0	4.0	4.0	4.0 ± 0

CP = Citrus pectin SPP = Sodium polypectate
CMC = Sodium carboxymethylcellulose

Influence of nitrate concentrations on enzyme production by G. graminis var tritici isolate og.12.

GROWTH SUBSTRATE : GLUCOSE

Enzyme activity by measuring reducing sugars liberated (µg ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	168.0	168.5	169.0	170.0	169.5	168.0	168.83± 0.75
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	170.0	170.0	171.0	171.0	169.5	171.0	170.42 ± 0.61
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	201.0	199.0	199.5	201.0	198.5	200.0	199.83 ± 0.94
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	180.0	179.0	179.0	178.5	179.0	178.0	178.92 ± 0.61
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	164.0	164.5	165.0	163.5	164.0	162.6	163.93 ± 0.76
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	176.0	175.0	174.5	175.0	175.0	174.5	175.0 ± 0.5
	CMC	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
21	CP	195.0	196.0	194.5	194.0	195.0	195.0	194.92 ± 0.61
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	172.6	172.0	173.0	174.0	173.5	174.0	173.18 ± 0.73
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

G. graminis var tritici isolate og.12 (Contd.):

Enzyme activity by measuring reducing sugars liberated (µg ml^{-1})

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	185.0	183.5	184.0	183.0	184.0	183.5	183.83 ± 0.62
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	155.0	155.0	152.8	155.0	153.5	154.0	154.22 ± 0.86
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	182.0	181.5	180.6	182.0	182.0	181.5	181.6 ± 0.5
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	170.0	171.0	169.5	172.0	171.5	170.5	170.75 ± 0.85
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring viscosity (units ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	112.0	111.5	112.0	112.0	111.0	111.5	111.67 ± 0.37
	SPP	10.0	9.5	10.0	10.0	9.5	10.0	9.83 ± 0.24
21	CP	152.0	153.0	151.6	151.0	152.0	152.5	152.02 ± 0.63
	SPP	6.5	7.0	7.0	6.8	8.0	7.5	7.13 ± 0.49
28	CP	16.5	16.5	16.5	17.0	16.5	18.0	16.83 ± 0.55
	SPP	10.0	10.0	11.0	10.0	11.0	10.5	10.42 ± 0.45

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	2.0	2.0	1.6	2.0	1.5	2.0	1.85 ± 0.21
	SPP	0	0	0	0	0	0	0
14	CP	109.0	110.0	109.5	108.5	109.0	109.0	109.17± 0.47
	SPP	0	0	0	0	0	0	0

G. graminis var tritici isolate og.12 (Contd.):

Enzyme activity by measuring viscosity (units ml^{-1})

50% NITRATE CONCENTRATION (5g/1)(COntd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
21	CP	133.0	131.5	132.0	132.5	133.0	131.0	132.17± 0.75
	SPP	3.5	4.0	3.5	3.5	4.0	3.8	3.72 ± 0.23
28	CP	14.0	13.5	13.5	14.0	13.0	13.5	13.58 ± 0.34
	SPP	6.0	6.0	4.5	6.0	4.5	6.0	5.5 ± 0.71

10% NITRATE CONCENTRATION (0.25g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	3.8	5.0	4.0	3.5	4.0	5.0	4.22 ± 0.58
	SPP	4.5	3.5	3.5	3.0	4.5	3.5	3.75 ± 0.56
14	CP	103.5	105.0	105.0	104.5	105.0	104.0	104.5 ± 0.58
	SPP	0	0	0	0	0	0	0
21	CP	126.0	126.0	125.5	126.0	125.0	126.0	125.75± 0.38
	SPP	0	0	0	0	0	0	0
28	CP	6.5	7.0	7.0	6.5	6.0	6.5	6.58 ± 0.34
	SPP	0	0	0	0	0	0	0

CP = Citrus pectin SPP = Sodium polypectate
CMC = Sodium carboxymethylcellulose

Influence of Nitrate concentrations on Enzyme production by G. graminis var tritici isolate 43

GROWTH SUBSTRATE : GLUCOSE

Enzyme activity by measuring reducing sugars liberated (µg ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	160.0	160.0	158.0	159.5	159.0	160.0	159.42 ± 0.73
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	156.0	156.0	154.5	156.0	157.0	155.5	155.83 ± 0.75
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring reducing sugars liberated (μg ml^{-1})

GGT. isolate 43 (Contd.):

100% NITRATE CONCENTRATION (5g/1)(Contd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
21	CP	188.0	186.5	187.0	188.0	189.0	187.5	187.67 ± 0.8
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	141.0	140.5	140.0	139.5	141.0	139.5	140.25 ± 0.63
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	136.0	135.5	135.0	136.0	135.0	135.0	135.42 ± 0.45
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	128.0	129.0	129.0	127.5	128.0	130.0	128.58 ± 0.84
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	198.0	196.0	197.5	197.0	197.0	196.5	197.0 ± 0.65
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	148.0	148.0	147.0	146.5	147.0	146.0	147.08 ± 0.73
	SPP	5.0	4.5	4.5	5.0	4.5	5.5	4.83 ± 0.37
	CMC	0	0	0	0	0	0	0

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	162.0	161.8	159.6	161.0	161.5	162.0	161.32 ± 0.84
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	170.0	169.0	169.5	168.7	170.0	169.0	169.37 ± 0.51
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	190.0	190.2	189.0	189.5	190.0	188.7	189.57 ± 0.56
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

GGT. 43(Contd.): Enzyme activity by measuring reducing groups liberated.

10% NITRATE CONCENTRATION (0.5g/1)(Contd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
28	CP	150.0	150.0	151.5	152.0	150.5	150.5	150.75 ± 0.75
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring viscosity (units ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	112.0	112.0	111.5	112.0	112.0	112.0	111.92 ± 0.19
	SPP	10.0	10.0	10.0	10.0	9.5	10.0	9.92 ± 0.19
21	CP	148.0	147.0	147.0	147.5	148.0	147.0	147.42 ± 0.45
	SPP	4.0	4.0	4.0	4.5	5.0	4.0	4.25 ± 0.38
28	CP	11.5	11.0	11.8	11.0	12.0	12.5	11.63 ± 0.54
	SPP	13.0	10.5	10.5	11.0	11.0	10.5	11.083± 0.89

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	1.5	1.8	2.0	1.5	1.5	1.5	1.66 ± 0.21
	SPP	0	0	0	0	0	0	0
14	CP	119.5	121.0	120.0	120.5	121.0	119.0	120.17 ± 0.75
	SPP	0	0	0	0	0	0	0
21	CP	142.0	140.5	142.0	142.0	141.5	142.0	141.67 ± 0.55
	SPP	0	0	0	0	0	0	0
28	CP	1.5	1.2	1.5	1.5	1.4	1.5	1.43 ± 0.11
	SPP	0	0	0	0	0	0	0

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	4.5	4.5	4.0	4.0	3.5	4.5	4.17 ± 0.37
	SPP	3.8	4.5	4.0	3.5	4.5	4.0	4.05 ± 0.36
14	CP	105.0	105.0	104.5	104.5	105.0	106.0	105.0 ± 0.5
	SPP	0	0	0	0	0	0	0

GGT. 43 (Contd.): Enzyme activity by measuring viscosity (units ml^{-1})

10% NITRATE CONCENTRATION (0.5g/1)(Contd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
21	CP	132.0	132.0	128.5	129.0	131.0	131.5	130.67 ± 1.4
	SPP	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0

Influence of nitrate concentrations on enzyme production by
G. graminis var tritici isolate WPBS1 when grown on glucose.

Enzyme activity by measuring reducing groups liberated (μg ml^{-1})

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	155.0	155.0	153.5	154.5	156.0	155.0	154.83 ± 0.75
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	136.0	136.0	135.5	136.0	134.0	135.0	135.42 ± 0.73
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	181.0	181.0	182.0	179.5	180.0	181.5	180.83 ± 0.85
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	151.0	152.0	151.5	150.0	152.0	151.0	151.25 ± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	142.8	143.0	142.5	141.6	143.0	143.0	142.65 ± 0.5
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	155.6	156.0	155.0	157.0	155.5	156.0	155.85 ± 0.62
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	174.0	173.0	172.5	172.0	172.5	173.0	172.83 ± 0.62
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	175.0	175.0	172.5	174.0	173.5	175.0	174.17 ± 0.94
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

GGT. WPBS1 (Contd.): Enzyme activity by measuring reducing groups liberated.

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	156.5	158.0	157.0	156.8	157.0	156.0	156.88 ± 0.61
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	148.0	149.0	148.5	147.6	147.0	148.0	147.85 ± 0.74
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	162.0	160.8	161.0	161.5	160.5	161.0	161.13 ± 0.49
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	166.5	168.0	166.4	168.0	166.5	167.0	167.07 ± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring viscosity (units ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	120.0	120.0	118.5	120.0	119.5	120.0	119.67 ± 0.55
	SPP	4.5	6.0	4.8	5.0	4.5	4.5	4.88 ± 0.53
21	CP	144.0	147.0	146.5	146.0	145.0	146.0	145.75 ± 0.99
	SPP	6.0	5.5	6.0	6.0	6.0	6.0	5.92 ± 0.19
28	CP	6.5	7.0	6.0	7.0	6.5	6.5	6.58 ± 0.34
	SPP	8.5	9.0	9.0	9.5	8.5	8.0	8.75 ± 0.48

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	MEAN ± S.D.
7	CP	1.8	1.5	2.0	1.5	2.0	2.0	1.8 ± 0.22
	SPP	2.0	1.5	3.0	2.5	1.5	2.0	2.08± 0.53
14	CP	126.0	126.0	124.5	125.0	125.0	126.0	125.42 ± 0.61
	SPP	0	0	0	0	0	0	0
21	CP	142.0	142.0	140.5	141.0	140.5	142.0	141.33 ± 0.069
	SPP	0	0	0	0	0	0	0
28	CP	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
	SPP	0	0	0	0	0	0	0

GGT. WPBS1 (Contd.): Enzyme activity by measuring viscosity (units ml^{-1})

10% NITRATE CONCENTRATION (0.5g/l)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
	SPP	2.0	1.8	2.5	2.0	2.5	2.0	2.13 ± 0.27
14	CP	128.0	126.0	125.5	127.0	126.0	127.5	126.67 ± 0.9
	SPP	0	0	0	0	0	0	0
21	CP	141.0	141.5	139.5	141.0	142.0	139.5	140.75 ± 0.95
	SPP	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0

Influence of nitrate concentrations on enzyme production by Cochliobolus sativus when grown on citrus pectin.

Enzyme activity by measuring reducing sugars liberated(μg/ml)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	164.0	165.0	164.5	165.0	166.0	166.0	165.08 ± 0.73
	SPP	10.0	11.0	10.0	10.5	10.5	11.0	10.5 ± 0.41
	CMC	0	0	0	0	0	0	0
14	CP	227.0	227.5	228.0	228.0	229.0	277.0	277.75 ± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	153.5	154.0	153.0	154.0	153.0	152.5	153.33 ± 0.55
	SPP	22.0	21.5	22.5	23.0	23.0	24.0	22.67 ± 0.8
	CMC	0	0	0	0	0	0	0
28	CP	107.0	107.0	107.5	108.0	108.0	109.0	107.75 ± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

50% NITRATE CONCENTRATION (2.5g/l)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	MEAN ± S.D.
7	CP	179.0	178.5	179.0	178.5	180.0	180.0	179.17 ± 0.62
	SPP	10.0	10.0	10.0	10.0	10.0	10.0	10.0 ± 0
	CMC	0	0	0	0	0	0	0
14	CP	227.0	229.0	228.0	227.0	228.0	227.5	227.75 ± 0.69
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

C. sativus : Enzyme activity by measuring reducing sugars liberated(μg/1)

50% NITRATE CONCENTRATION (2.5g/1)(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
21	CP	144.0	145.0	143.5	144.0	145.0	145.0	144.42 ± 0.61
	SPP	17.0	17.0	16.5	18.0	18.0	16.0	17.08 ± 0.73
	CMC	0	0	0	0	0	0	0
28	CP	107.0	107.0	107.5	108.0	108.0	107.0	107.42 ± 0.45
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	177.0	177.0	177.0	178.0	178.0	178.0	177.5 ± 0.5
	SPP	9.0	9.0	9.5	10.0	9.5	11.0	9.67 ± 0.69
	CMC	0	0	0	0	0	0	0
14	CP	211.0	211.0	209.5	210.0	209.0	210.0	210.08± 0.73
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	140.0	141.0	141.0	142.0	141.0	140.6	140.93± 0.6
	SPP	14.0	14.0	13.5	15.0	15.0	13.5	14.17± 0.62
	CMC	0	0	0	0	0	0	0
28	CP	104.0	105.0	104.5	105.0	105.0	105.0	104.75 ± 0.38
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	26.0	28.0	27.0	26.0	26.5	27.0	26.75 ± 0.69
	SPP	19.0	19.0	19.5	20.0	19.0	20.0	19.42 ± 0.45
14	CP	28.0	27.5	28.0	29.0	29.0	30.0	28.58 ± 0.84
	SPP	24.0	24.0	25.0	25.0	25.0	26.0	24.83 ± 0.69
21	CP	60.0	59.0	59.0	60.0	60.0	61.0	59.83 ± 0.69
	SPP	38.0	40.0	38.0	39.0	39.0	38.5	38.75 ± 0.69
28	CP	66.0	67.0	66.0	67.0	67.0	67.0	66.67 ± 0.47
	SPP	20.0	21.5	21.0	21.0	20.0	21.0	20.75 ± 0.56

C. sativus (Contd.): Enzyme activity by measuring viscosity (units/ml)

50% NITRATE CONCENTRATION (2.5g/l)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	31.0	30.0	30.5	32.0	30.0	30.0	30.58 ± 0.73
	SPP	10.0	10.0	10.0	11.0	10.5	10.0	10.25 ± 0.38
14	CP	39.0	39.0	38.5	39.0	39.0	40.0	39.08 ± 0.45
	SPP	12.0	14.0	13.0	13.0	12.5	13.0	12.92 ± 0.61
21	CP	70.0	69.5	69.5	71.0	70.0	71.0	70.17 ± 0.62
	SPP	38.0	38.5	39.0	39.0	38.0	38.0	38.42 ± 0.45
28	CP	78.0	80.0	79.5	79.0	79.0	79.0	79.08 ± 0.61
	SPP	20.0	22.0	20.0	21.5	21.5	20.0	20.83 ± 0.85

10% NITRATE CONCENTRATION (0.5g/l)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	47.0	47.0	48.0	46.0	48.0	47.5	47.25 ± 0.69
	SPP	9.0	9.0	10.0	9.5	9.0	9.5	9.33 ± 0.37
14	CP	60.0	60.0	60.0	59.0	61.0	60.5	60.08 ± 0.61
	SPP	20.0	20.0	21.0	21.0	21.0	22.0	20.83 ± 0.69
21	CP	120.0	119.5	120.0	121.0	120.0	121.0	120.25± 0.56
	SPP	46.5	47.0	47.0	48.0	47.5	47.0	47.17 ± 0.47
28	CP	100.0	100.0	100.0	101.0	99.8	102.0	100.47± 0.79
	SPP	20.0	21.0	21.5	21.0	20.0	22.0	20.92 ± 0.73

Influence of Nitrate cocentrations on Enzyme production by Fusarium culmorum when grown on citrus pectin.

Enzyme activity by measuring reducing groups liberated(μg/ml)

100% NITRATE CONCENTRATION (5g/l)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	165.0	165.0	165.5	166.0	164.0	165.0	165.08 ± 0.61
	SPP	27.0	27.0	26.5	28.0	27.0	28.0	27.25 ± 0.56
	CMC	0	0	0	0	0	0	0
14	CP	183.5	184.0	182.9	183.0	184.0	184.0	183.57 ± 0.47
	SPP	22.0	23.0	22.0	23.0	22.0	22.5	22.42 ± 0.45
	CMC	0	0	0	0	0	0	0
21	CP	151.0	149.0	150.0	149.0	151.0	150.0	150.0 ± 0.82
	SPP	27.0	26.0	26.5	28.0	28.0	27.0	27.08 ± 0.73
	CMC	0	0	0	0	0	0	0

F. culmorum (Contd.): Enzyme activity by measuring reducing groups liberated

100% NITRATE CONCENTRATION (5g/1)(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
28	CP	212.0	212.0	212.0	213.0	211.0	211.5	211.92 ± 0.61
	SPP	57.5	59.0	57.0	58.0	58.0	58.5	58.0 ± 0.65
	CMC	0	0	0	0	0	0	0

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	169.0	171.0	169.0	170.0	169.0	169.5	169.58 ± 0.73
	SPP	22.0	23.0	21.5	22.0	24.0	22.0	22.42 ± 0.84
	CMC	0	0	0	0	0	0	0
14	CP	187.0	188.0	189.0	188.0	189.0	187.5	188.08 ± 0.73
	SPP	22.5	24.0	23.0	24.0	23.5	23.0	23.33 ± 0.55
	CMC	0	0	0	0	0	0	0
21	CP	164.5	166.0	167.0	166.0	165.5	166.0	165.83 ± 0.75
	SPP	34.5	36.0	35.0	34.0	35.0	34.5	34.83 ± 0.62
	CMC	5.0	5.0	5.0	4.5	5.0	6.0	5.08 ± 0.45
28	CP	194.0	196.0	195.0	195.0	194.5	195.0	194.92 ± 0.61
	SPP	27.5	29.0	28.0	28.0	26.5	29.0	28.0 ± 0.87
	CMC	0	0	0	0	0	0	0

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	162.5	164.0	163.0	163.5	164.0	163.0	163.33 ± 0.55
	SPP	26.0	27.0	26.5	27.0	25.0	25.8	26.22 ± 0.71
	CMC	0	0	0	0	0	0	0
14	CP	185.0	188.0	188.0	187.5	186.0	187.0	186.92 ± 1.1
	SPP	12.0	13.0	12.0	11.5	11.5	13.0	12.17 ± 0.62
	CMC	0	0	0	0	0	0	0
21	CP	154.0	156.0	154.0	155.0	155.0	155.5	154.92 ± 0.73
	SPP	29.0	29.0	30.5	30.5	29.0	31.0	29.83 ± 0.85
	CMC	2.0	2.0	2.0	2.0	2.0	2.0	2.0 ± 0
28	CP	177.0	179.0	178.0	178.0	177.0	177.5	177.75 ± 0.69
	SPP	28.0	30.0	29.0	29.5	29.0	28.5	29.0 ± 0.65
	CMC	0	0	0	0	0	0	0

F. culmorum (Contd.): Enzyme activity by measuring viscosity (units ml^{-1})

100% NITRATE CONCENTRATION (5g/1)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	144.0	144.0	145.0	145.0	144.5	145.0	144.58 ± 0.45
	SPP	88.5	88.5	90.0	89.0	89.0	89.5	89.08 ± 0.53
14	CP	180.0	180.0	181.5	182.0	181.5	181.0	181.0 ± 0.76
	SPP	146.0	148.0	146.5	144.0	146.0	148.0	146.42 ± 1.37
21	CP	193.0	192.0	194.0	193.5	193.8	194.0	193.38 ± 0.71
	SPP	136.0	138.0	138.0	137.5	137.0	137.0	137.25 ± 0.69
28	CP	196.0	195.8	198.0	197.0	196.0	197.0	196.63 ± 0.78
	SPP	189.0	188.0	190.0	188.5	189.0	189.0	188.92 ± 0.61

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	142.0	139.5	140.0	142.0	140.5	141.0	140.83 ± 0.94
	SPP	49.5	50.0	51.0	51.0	49.0	49.8	50.05 ± 0.74
14	CP	183.0	182.0	182.0	183.0	182.5	182.0	182.42 ± 0.45
	SPP	136.0	136.0	135.5	137.0	135.0	137.0	136.08 ± 0.73
21	CP	150.0	151.0	149.0	149.0	152.0	150.5	150.25 ± 1.07
	SPP	83.0	83.0	82.4	82.5	83.0	81.9	82.63 ± 0.41
28	CP	20.0	21.0	20.0	20.0	19.6	22.0	20.43 ± 0.82
	SPP	120.0	121.0	121.5	122.0	121.0	120.0	120.92 ± 0.73

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	132.5	134.0	133.0	133.0	132.5	133.0	133.0 ± 0.5
	SPP	52.5	52.0	52.8	53.0	53.0	52.5	52.63 ± 0.35
14	CP	164.0	164.0	164.5	165.0	165.0	164.0	164.42 ± 0.45
	SPP	114.0	115.0	114.0	114.0	114.0	115.0	114.33 ± 0.47
21	CP	134.5	135.0	135.0	134.0	135.0	135.0	134.75 ± 0.38
	SPP	57.5	58.0	56.7	57.0	57.0	56.5	57.12 ± 0.5
28	CP	12.0	12.0	11.5	12.0	12.0	13.0	12.08 ± 0.45
	SPP	68.5	70.0	70.0	69.0	69.5	69.5	69.42 ± 0.53

CP = Citrus pectin SPP = Sodium polypectate
CMC = Sodium carboxymethylcellulose

Effect of Nitrate concentrations in culture medium on growth of organisms when grown on glucose.

Dry weight of mycelium produced (mg)

100% NITRATE CONCENTRATION (5g/1)

DAYS	Fusarium culmorum			Cochliobolus sativus		
7	26.9	24.8	25.85 ± 1.05	23.4	24.4	23.9 ± 0.5
14	87.2	89.1	88.15 ± 0.95	47.2	48.1	47.65 ± 0.45
21	98.4	97.8	98.1 ± 0.3	48.6	48.9	48.75 ± 0.15
28	164.9	166.2	165.5 ± 0.7	65.8	67.2	66.5 ± 0.7
35	187.5	186.9	187.2 ± 0.3	94.5	96.7	95.6 ± 1.1
42				78.9	79.3	79.1 ± 0.2

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	Fusarium culmorum			Cochliobolus sativus		
7	24.3	23.6	23.95 ± 0.35	32.1	33.6	32.85 ± 0.75
14	84.9	83.7	84.3 ± 0.6	46.8	48.9	47.85 ± 1.05
21	107.1	110.3	108.7 ± 1.6	52.8	55.1	53.95 ± 1.15
28	137.6	136.5	137.05 ± 0.55	63.9	67.3	65.6 ± 1.7
35	162.9	164.5	163.7 ± 0.8	38.9	39.2	39.05 ± 0.15
42				42.1	43.6	42.85 ± 0.75

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	Fusarium culmorum			Cochliobolus sativus		
7	62.9	64.8	63.85 ± 0.95	24.1	22.9	23.5 ± 0.6
14	104.6	105.2	104.9 ± 0.3	52.8	53.4	53.1 ± 0.3
21	108.3	108.9	108.6 ± 0.3	46.9	47.2	47.05 ± 0.15
28	162.7	164.8	163.75 ± 1.05	47.6	48.4	48.0 ± 0.4
35	175.2	176.8	176.0 ± 0.8	28.3	28.9	28.6 ± 0.3
42				21.6	22.8	22.2 ± 0.6

Effect of Nitrate concentrations in culture medium on growth of Fusarium culmorum when grown on glucose (Second Experiment).

Dry weight of mycelium produced (mg)

DAYS	100% NITRATE (5g/1)			50% NITRATE (2.5g/1)			10% NITRATE (0.5g/1)		
2	23.6	25.2	24.4 ± 0.8	16.4	17.2	16.8 ± 0.4	18.4	17.6	18.0 ± 0.4
4	63.8	64.5	64.15 ± 0.35	65.6	67.2	66.35 ± 0.75	58.4	59.6	59.0 ± 0.6
7	82.4	86.2	84.3 ± 1.9	68.2	69.4	68.8 ± 0.6	87.6	89.4	88.5 ± 0.9
9	93.8	95.6	94.7 ± 0.9	76.3	77.4	76.85 ± 0.55	116.2	117.8	117.0 ± 0.8
11	117.2	118.4	117.8 ± 0.6	102.4	106.2	104.3 ± 1.9	124.6	125.8	125.2 ± 0.6
14	109.6	110.3	109.95 ± 0.35	89.6	88.6	89.1 ± 0.5	87.9	86.8	87.35 ± 0.55

Effect of nitrate concentrations in culture medium on growth of G. graminis var tritici isolates when grown on Glucose.

Dry weight of mycelium produced (mg).

DAYS	GGT. og12			GGT. 43			GGT. WPBS1		
				100% NITRATE CONCENTRATION (5g/1)					
7	21.8	22.1	21.95 ± 0.15	21.6	22.0	21.8 ± 0.2	18.6	19.2	18.9 ± 0.3
14	41.7	42.3	42.0 ± 0.3	38.5	37.9	38.2 ± 0.3	29.3	28.9	29.1 ± 0.2
21	60.9	62.1	61.5 ± 0.6	52.2	54.6	53.4 ± 1.2	51.9	53.2	52.55 ± 0.65
28	81.2	81.9	81.55 ± 0.35	62.9	64.1	63.5 ± 0.6	62.7	64.6	63.65 ± 0.95
35	117.5	118.6	118.05 ± 0.55	87.3	85.9	86.6 ± 0.7	86.4	85.9	86.15 ± 0.25
42	186.6	187.2	186.4 ± 0.8	118.6	119.2	118.9 ± 0.3	113.9	114.8	114.35 ± 0.45
				50% NITRATE CONCENTRATION (2.5g/1)					
7	17.6	16.2	17.75 ± 0.15	15.8	16.2	16.0 ± 0.2	16.5	17.2	16.85 ± 0.35
14	29.3	28.6	28.95 ± 0.35	28.6	29.4	29.0 ± 0.4	21.8	22.9	22.35 ± 0.55
21	50.8	51.7	51.25 ± 0.45	41.5	40.6	41.05 ± 0.45	41.7	42.8	42.25 ± 0.55
28	71.6	72.8	72.2 ± 0.6	50.9	51.5	51.2 ± 0.3	50.6	51.5	51.05 ± 0.45
35	84.4	82.9	83.65 ± 0.75	67.3	66.3	66.8 ± 0.5	70.9	69.8	70.35 ± 0.55
42	92.9	94.1	93.5 ± 0.6	85.8	87.1	86.45 ±	90.3	91.1	90.7 ± 0.4
				10% NITRATE CONCENTRATION (0.5g/1)					
7	18.3	18.9	18.6 ± 0.3	18.6	18.9	18.75 ± 0.15	18.4	19.2	18.8 ± 0.4
14	51.6	53.1	52.35 ± 0.75	44.5	46.2	45.35 ± 0.85	45.9	47.4	46.65 ± 0.75
21	72.2	73.2	72.7 ± 0.5	58.7	59.2	58.95 ± 0.25	54.6	53.6	54.1 ± 0.5
28	101.8	102.5	102.15 ± 0.35	92.9	93.6	93.25 ± 0.35	82.7	84.1	83.4 ± 0.7
35	86.3	85.9	86.1 ± 0.2	80.6	81.9	81.25 ± 0.65	62.6	65.4	64.0 ± 1.4
42	67.9	68.8	68.35 ± 0.45	67.3	68.4	67.85 ± 0.55	45.8	44.9	45.35 ± 0.45

Effect of nitrate concentrations in culture medium on growth of F. culmorum & C. sativus when grown on Citrus pectin

Dry weight of mycelium produced (mg)

100% NITRATE CONCENTRATION (5g/l)

DAYS	F. culmorum			C. sativus		
7	36.6	35.3	35.95 ± 0.65	33.4	31.9	32.65 ± 0.75
14	35.7	34.9	35.3 ± 0.4	54.2	52.7	53.45 ± 0.75
21	60.2	62.1	61.15 ± 0.95	83.6	84.6	84.1 ± 0.5
28	100.3	103.6	101.95 ± 1.65	192.7	190.8	191.75 ± 0.95
35	146.4	148.2	147.3 ± 0.9	187.1	186.5	186.8 ± 0.3
42	188.4	190.2	189.3 ± 0.9	160.3	162.5	161.4 ± 1.1

50% NITRATE CONCENTRATION (2.5g/l)

DAYS	F. culmorum			C. sativus		
7	21.3	24.1	22.7 ± 1.4	43.6	41.0	42.3 ± 1.3
14	43.6	46.4	45.0 ± 1.4	45.5	47.5	46.5 ± 1.0
21	87.3	83.9	85.6 ± 1.7	65.8	68.0	66.9 ± 1.1
28	124.4	126.1	125.25 ± 0.85	209.1	210.6	209.85 ± 0.75
35	141.4	143.9	142.65 ± 1.25	197.3	199.3	198.3 ± 1.0
42	161.7	163.1	162.4 ± 0.7	218.0	219.3	218.65 ± 0.65

10% NITRATE CONCENTRATION (0.5g/l)

DAYS	F. culmorum			C. sativus		
7	22.8	23.6	23.2 ± 0.4	31.3	32.6	31.95 ± 0.65
14	32.7	34.4	33.55 ± 0.85	45.1	47.2	46.15 ± 1.05
21	67.0	67.8	67.4 ± 0.4	53.9	56.3	55.1 ± 1.2
28	97.5	99.2	98.35 ± 0.85	84.3	87.2	85.75 ± 1.45
35	107.5	108.9	108.2 ± 0.7	94.6	95.5	95.05 ± 0.45
42	166.1	164.5	165.3 ± 0.8	128.3	127.4	127.85 ± 0.45

Effect of nitrate concentrations in culture medium on growth of F. culmorum & C. sativus when grown on larchwood xylan

Dry weight of mycelium produced (mg)

100% NITRATE CONCENTRATION (5g/1)

DAYS	F. culmorum			C. sativus		
7	44.8	43.9	44.35 ± 0.45	73.2	74.6	73.9 ± 0.7
14	102.6	103.1	102.85 ± 0.25	106.1	104.9	105.5 ± 0.6
21	423.6	425.2	424.4 ± 0.8	363.7	364.9	364.3 ± 0.6
28	409.0	410.2	409.6 ± 0.6	332.4	331.2	331.8 ± 0.6
35	314.7	316.2	315.45 ± 0.75	298.2	296.9	297.55 ± 0.65
42	275.6	274.1	274.85 ± 0.75	222.1	221.2	221.65 ± 0.45

50% NITRATE CONCENTRATION (2.5g/1)

DAYS	F. culmorum			C. sativus		
7	37.6	38.5	38.05 ± 0.45	47.0	48.2	47.6 ± 0.6
14	88.5	89.8	89.15 ± 0.65	76.8	75.9	76.35 ± 0.45
21	386.3	387.6	386.95 ± 0.65	333.4	335.5	334.45 ± 1.05
28	329.8	326.3	328.05 ± 1.75	327.5	325.7	326.6 ± 0.9
35	256.4	258.4	257.4 ± 1.0	283.1	284.9	284.0 ± 0.9
42	122.6	126.3	124.45 ± 1.85	151.4	149.6	150.5 ± 0.9

10% NITRATE CONCENTRATION (0.5g/1)

DAYS	F. culmorum			C. sativus		
7	27.2	26.6	26.9 ± 0.3	20.7	22.9	21.8 ± 1.1
14	62.7	64.2	63.45 ± 0.75	61.6	63.3	62.45 ± 0.85
21	269.3	267.9	268.6 ± 0.7	143.8	146.5	144.7 ± 1.27
28	145.6	142.9	144.25 ± 1.35	191.7	193.0	192.35 ± 0.65
35	94.4	95.6	95.0 ± 0.6	171.9	170.7	170.95 ± 0.25
42	84.9	86.3	85.6 ± 0.7	144.2	141.4	142.8 ± 1.4

Influence of nitrate concentrations on enzyme production by Fusarium culmorum when grown on Glucose.

Reducing sugar concentrations in culture filtrates at harvest(mg cm^{-3})

100% Nitrate Concentration (5g/1)

DAYS	1	2	3	4	5	6	Mean ± S.D.
4	7.7	7.4	8.1	7.6	7.6	7.8	7.7 ± 0.22
8	4.7	4.5	5.2	4.4	4.6	4.8	4.7 ± 0.26
12	2.2	2.0	1.9	2.4	2.3	2.5	2.22 ± 0.21

50% Nitrate Concentration (2.5g/1)

DAYS	1	2	3	4	5	6	Mean ± S.D.
4	9.0	8.6	8.8	9.2	9.2	9.2	9.0 ± 0.23
8	4.0	4.3	3.9	3.8	4.1	3.9	4.0 ± 0.16
12	3.1	2.9	3.1	3.3	3.3	2.9	3.1 ± 0.16

10% Nitrate Concentration (0.5g/1)

DAYS	1	2	3	4	5	6	Mean ± S.D.
4	8.0	7.8	8.1	7.9	8.2	8.0	8.0 ± 0.13
8	2.7	2.9	2.9	2.8	2.8	2.7	2.8 ± 0.082
12	0.6	0.6	0.5	0.5	0.7	0.7	0.6 ± 0.082

pH of culture filtrates at harvest

100% Nitrate Concentration (5g/1)

DAYS	1	2	3	4	5	6	Mean ± S.D.
4	6.2	6.2	6.15	6.15	6.2	6.3	6.2 ± 0.05
8	6.6	6.65	6.6	6.7	6.6	6.45	6.6 ± 0.076
12	7.2	7.2	7.2	7.2	7.2	7.2	7.2 ± 0

50% Nitrate Concentration (2.5g/1)

DAYS	1	2	3	4	5	6	Mean ± S.D.
4	6.7	6.7	6.8	6.7	6.7	6.6	6.7 ± 0.058
8	7.4	7.4	7.3	7.3	7.4	7.3	7.35 ± 0.05
12	6.9	7.0	6.9	6.9	6.8	6.9	6.9 ± 0.058

10% Nitrate Concentration (0.5g/1)

DAYS	1	2	3	4	5	6	Mean ± S.D.
4	6.6	6.7	6.3	6.4	6.6	6.7	6.55 ± 0.15
8	6.2	6.2	6.2	6.2	6.2	6.2	6.2 ± 0
12	6.3	6.3	6.6	6.5	6.6	6.4	6.45 ± 0.13

Influence of nitrate concentrations on enzyme production by Cochliobolus sativus when grown on Glucose.

Reducing sugar concentrations in culture filtrates at harvest(mg cm^{-3})

DAYS	1	2	3	4	5	6	Mean ± S.D.
			100% Nitrate Concentration (5g/1)				
7	9.3	9.8	9.6	9.0	8.9	9.2	9.3 ± 0.32
14	4.6	4.8	3.9	4.9	5.1	4.3	4.6 ± 0.4
21	3.9	4.1	3.7	3.7	3.6	4.4	3.9 ± 0.28
28	1.2	1.2	1.5	0.9	0.9	1.5	1.2 ± 0.24
			50% Nitrate Concentration (2.5g/1)				
7	9.0	8.8	8.7	9.2	9.1	9.2	9.0 ± 0.19
14	8.4	8.4	8.3	8.2	8.5	8.6	8.4 ± 0.13
21	4.1	4.2	3.9	4.1	4.2	4.1	4.1 ± 0.1
28	3.9	3.9	3.7	3.8	3.9	4.2	3.9 ± 0.15
			10% Nitrate Concentration (0.5g/1)				
7	9.9	9.8	10.2	9.8	9.9	9.8	9.9 ± 0.14
14	7.9	7.9	8.1	7.7	8.2	7.6	7.9 ± 0.21
21	5.5	5.7	5.5	5.8	5.6	4.9	5.5 ± 0.29
28	4.2	4.3	4.2	4.0	4.1	4.4	4.2 ± 0.13

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
			100% Nitrate Concentration (5g/1)				
7	5.3	5.4	5.4	5.2	5.3	5.2	5.3 ± 0.082
14	3.8	3.7	3.7	3.9	3.8	3.9	3.8 ± 0.082
21	3.6	3.6	3.6	3.6	3.6	3.6	3.6 ± 0
28	2.9	2.9	2.9	2.7	2.8	2.9	2.85 ± 0.076
			50% Nitrate Concentration (2.5g/1)				
7	4.7	4.7	4.7	4.8	4.7	4.6	4.7 ± 0.058
14	4.2	4.1	4.3	4.3	4.2	4.1	4.2 ± 0.082
21	6.1	6.0	6.0	6.2	6.1	6.2	6.1 ± 0.082
28	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
			10% Nitrate Concentration (0.5g/1)				
7	6.3	6.3	6.3	6.3	6.3	6.3	6.3 ± 0
14	4.5	4.6	4.6	4.4	4.4	4.5	4.5 ± 0.082
21	4.3	4.3	4.4	4.2	4.2	4.4	4.3 ± 0.082
28	5.5	5.5	5.5	5.5	5.5	5.5	5.5 ± 0

Influence of nitrate concentrations on enzyme production by Fusarium culmorum when grown on Glucose.

Dry weight of mycelium produced (mg)

DAYS	100% NITRATE (5g/1)			50% NITRATE (2.5g/1)			10% NITRATE (0.5g/1)		
4	57.1	57.3	57.2 ± 0.1	55.1	55.3	55.2 ± 0.1	54.6	55.4	55.0 ± 0.4
8	73.8	73.4	73.6 ± 0.2	56.9	58.2	57.55 ± 0.65	80.2	81.1	80.65 ± 0.45
12	123.8	125.5	124.65 ± 0.85	98.3	100.2	99.25 ± 0.95	141.1	138.9	140.0 ± 1.1

Influence of nitrate concentrations on enzyme production by Cochliobolus sativus when grown on Glucose.

Dry weight of mycelium produced (mg)

DAYS	100% NITRATE (5g/1)			50% NITRATE (2.5g/1)			10% NITRATE (0.5g/1)		
7	17.5	18.4	17.95 ± 0.45	28.5	26.6	27.55 ± 0.95	14.6	15.2	14.9 ± 0.3
14	44.0	43.3	43.65 ± 0.35	41.0	40.5	40.75 ± 0.25	28.3	26.6	27.45 ± 0.85
21	66.9	64.3	65.6 ± 1.3	51.0	52.4	51.7 ± 0.7	37.1	35.8	36.45 ± 0.65
28	72.6	74.3	73.45 ± 0.85	56.1	56.5	56.3 ± 0.2	29.3	27.6	28.45 ± 0.85

Influence of nitrate concentrations on enzyme production by G. graminis var tritici isolates when grown on glucose.

Dry weight of mycelium produced (mg)

100% Nitrate Concentration (5g/1)

DAYS	GGT. ogl2.				GGT. 43				GGT. WPBS1			
7	20.5	21.6	20.8	20.97 ± 0.46	21.2	21.8	20.2	21.07 ± 0.66	18.6	18.4	19.3	18.77 ± 0.39
14	42.0	41.2	40.8	41.33 ± 0.5	38.9	38.4	38.1	38.47 ± 0.33	29.6	28.6	29.4	29.2 ± 0.43
21	61.6	60.9	62.5	61.67 ± 0.65	53.5	52.9	51.8	52.73 ± 0.7	55.3	54.5	52.1	53.97 ± 1.36
28	81.2	81.6	79.8	80.87 ± 0.77	63.4	62.5	62.1	62.67 ± 0.54	64.3	62.9	61.7	62.97 ± 1.06

50% Nitrate Concentration (2.5g/1)

DAYS	GGT. ogl2				GGT. 43				GGT. WPBS1			
7	18.6	18.1	17.9	18.2 ± 0.29	16.4	15.8	16.2	16.13 ± 0.25	17.4	16.9	16.3	16.87 ± 0.45
14	31.4	29.6	30.2	30.4 ± 0.75	29.4	28.7	31.2	29.77 ± 1.05	21.2	24.7	22.8	22.9 ± 1.43
21	51.9	52.1	50.4	51.47 ± 0.76	42.0	41.5	40.9	41.47 ± 0.45	41.9	42.5	40.9	41.77 ± 0.66
28	71.6	72.5	71.1	71.73 ± 0.58	51.4	52.1	49.7	51.07 ± 1.01	50.7	52.7	51.3	51.57 ± 0.84

10% Nitrate Concentration (0.5g/1)

DAYS	GGT. ogl2				GGT. 43				GGT. WPBS1			
7	21.0	18.7	19.2	19.63 ± 0.99	19.7	18.8	18.6	19.03 ± 0.48	18.8	19.1	19.6	19.17 ± 0.33
14	52.6	53.3	51.9	52.6 ± 0.57	45.6	43.2	47.2	45.33 ± 1.64	45.4	43.1	47.6	45.37 ± 1.84
21	71.5	72.8	70.6	71.63 ± 0.9	58.7	57.3	61.2	59.07 ± 1.61	54.7	56.3	57.4	56.13 ± 1.11
28	102.5	101.7	103.2	102.47 ± 0.61	94.7	92.9	90.9	92.83 ± 1.55	82.9	88.3	84.4	85.2 ± 2.28

Influence of nitrate concentrations on enzyme production by C. sativus when grown on citrus pectin.

Reducing sugar concentrations in culture filtrates at harvest(mg cm^{-3})

DAYS	1	2	3	4	5	6	Mean ± S.D.
		100% Nitrate Concentration (5g/1)					
7	2.2	1.95	2.3	2.15	2.3	2.3	2.2 ± 0.13
14	4.6	4.85	4.45	4.35	4.35	4.4	4.5 ± 0.18
21	3.8	3.9	3.8	3.9	3.6	3.8	3.8 ± 0.1
28	5.0	5.2	4.9	4.8	5.1	5.0	5.0 ± 0.13
		50% Nitrate Concentration (2.5g/1)					
7	1.7	2.0	1.6	1.6	1.6	1.7	1.7 ± 0.14
14	3.7	3.8	3.5	3.9	3.6	3.7	3.7 ± 0.13
21	4.5	4.8	4.4	4.4	4.5	4.4	4.5 ± 0.14
28	5.4	5.2	5.2	5.6	5.5	5.5	5.4 ± 0.15
		10% Nitrate Concentration (0.5g/1)					
7	2.2	2.3	2.4	2.1	2.1	2.1	2.2 ± 0.12
14	4.8	4.6	4.7	4.9	5.0	4.8	4.8 ± 0.13
21	4.7	4.5	4.7	4.6	4.8	4.9	4.7 ± 0.13
28	5.3	5.5	5.1	5.2	5.3	5.4	5.3 ± 0.13

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
		100% Nitrate Concentration (5g/1)					
7	3.1	3.1	3.1	3.1	3.1	3.1	3.1 ± 0
14	3.1	3.1	3.0	3.1	3.2	3.1	3.1 ± 0.058
21	2.9	2.9	2.9	2.9	2.9	2.9	2.9 ± 0
28	2.85	2.8	2.8	2.9	2.8	2.95	2.85 ± 0.058
		50% Nitrate Concentration (2.5g/1)					
7	3.4	3.4	3.5	3.2	3.2	3.4	3.3 ± 0.11
14	3.15	3.2	3.2	3.1	3.1	3.15	3.15 ± 0.041
21	2.9	2.7	2.9	2.8	3.0	3.1	2.9 ± 0.13
28	2.9	2.8	2.9	2.9	2.8	3.1	2.9 ± 0.1
		10% Nitrate Concentration (0.5g/1)					
7	3.3	3.2	3.3	3.4	3.2	3.4	3.3 ± 0.082
14	3.2	3.1	3.2	3.2	3.1	3.1	3.15 ± 0.05
21	3.0	3.0	2.9	3.1	3.1	2.9	3.0 ± 0.082
28	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0

Influence of nitrate concentrations on enzyme production by Fusarium culmorum when grown on citrus pectin.

Reducing sugar concentrations in culture filtrates at harvest(mg cm^{-3})

DAYS	1	2	3	4	5	6	Mean ± S.D.
100% Nitrate Concentration (5g/l)							
7	4.0	4.2	3.9	3.8	4.1	4.0	4.0 ± 0.13
14	4.5	4.6	4.3	4.3	4.6	4.7	4.5 ± 0.15
21	3.8	3.85	3.7	3.55	3.9	4.0	3.8 ± 0.14
28	1.3	0.9	0.85	1.2	0.95	1.4	1.1 ± 0.21
50% Nitrate Concentration (2.5g/l)							
7	4.0	4.3	3.9	3.9	3.8	4.1	4.0 ± 0.16
14	3.5	3.85	3.6	3.6	3.3	3.15	3.5 ± 0.23
21	0.8	0.8	0.6	0.6	0.55	0.45	0.6 ± 0.1
28	0.2	0.4	0.2	0.15	0.15	0.1	0.2 ± 0.096
10% Nitrate Concentration (0.5g/l)							
7	2.5	2.85	2.7	2.5	2.15	2.3	2.5 ± 0.23
14	3.5	3.75	3.5	3.7	3.3	3.25	3.5 ± 0.18
21	0.6	0.7	0.6	0.55	0.6	0.55	0.6 ± 0.05
28	0.2	0.3	0.2	0.15	0.2	0.15	0.2 ± 0.05

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
100% Nitrate Concentration (5g/l)							
7	3.2	3.2	3.2	3.2	3.2	3.2	3.2 ± 0
14	3.1	3.3	3.3	3.1	2.9	2.9	3.1 ± 0.16
21	4.25	4.3	4.3	4.2	4.25	4.2	4.25 ± 0.041
28	7.5	7.6	7.5	7.6	7.4	7.4	7.5 ± 0.082
50% Nitrate Concentration (2.5g/l)							
7	3.35	3.3	3.3	3.4	3.4	3.35	3.35 ± 0.041
14	3.55	3.7	3.7	3.4	3.4	3.55	3.55 ± 0.12
21	7.85	7.7	7.9	7.7	7.9	8.05	7.85 ± 0.12
28	8.15	8.1	8.1	8.2	8.2	8.15	8.15 ± 0.041
10% Nitrate Concentration (0.5g/l)							
7	3.85	3.8	3.8	3.9	3.9	3.85	3.85 ± 0.041
14	3.55	3.4	3.7	3.4	3.7	3.55	3.55 ± 0.12
21	7.75	7.8	7.7	7.7	7.8	7.75	7.75 ± 0.041
28	8.3	8.3	8.3	8.3	8.3	8.3	8.3 ± 0

Influence of nitrate concentrations on enzyme production
by Cochliobolus sativus when grown on citrus pectin.

Dry weight of mycelium produced (mg)

DAYS	100% NITRATE (5g/1)			50% NITRATE (2.5g/1)			10% NITRATE (0.5g/1)		
7	38.5	37.8	38.15 ± 0.35	43.6	44.3	43.95 ± 0.35	32.1	33.0	32.55 ± 0.45
14	67.6	68.1	67.85 ± 0.25	50.7	49.8	50.25 ± 0.45	44.7	45.1	44.9 ± 0.2
21	90.6	89.7	90.15 ± 0.45	65.4	64.9	65.15 ± 0.25	51.2	52.1	51.65 ± 0.45
28	143.6	145.6	144.6 ± 1.0	87.9	89.3	88.6 ± 0.7	65.3	64.5	64.9 ± 0.4

Influence of nitrate concentrations on enzyme production
by Fusarium culmorum when grown on citrus pectin.

Dry weight of mycelium produced (mg)

DAYS	100% NITRATE (5g/1)			50% NITRATE (2.5g/1)			10% NITRATE (0.5g/1)		
7	24.1	23.3	23.7 ± 0.4	24.8	25.1	24.95 ± 0.15	30.9	29.9	30.4 ± 0.5
14	77.2	75.9	76.55 ± 0.65	93.8	95.2	94.5 ± 0.7	142.0	139.4	140.7 ± 1.3
21	135.8	137.0	136.4 ± 0.6	242.5	241.2	241.85 ± 0.65	228.8	230.6	229.7 ± 0.9
28	197.2	197.5	197.35 ± 0.15	217.3	215.6	216.45 ± 0.85	251.8	255.4	253.6 ± 1.8

Influence of phosphate on pectin degrading enzymes production by F. culmorum when grown on 2% Malt extract with added phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	12.0	11.5	12.0	12.0	11.5	12.0	11.83 ± 0.24
	SPP	6.0	6.0	6.0	6.0	6.5	7.0	6.25 ± 0.38
14	CP	24.0	25.0	24.5	25.0	25.0	25.0	24.75 ± 0.38
	SPP	18.0	19.0	18.5	18.5	19.0	19.0	18.67 ± 0.37
21	CP	24.0	25.0	24.5	24.5	25.0	26.0	24.83 ± 0.62
	SPP	46.0	47.0	47.0	46.5	46.0	46.5	46.5 ± 0.41
28	CP	22.0	21.0	22.0	21.5	22.0	21.5	21.67 ± 0.37
	SPP	12.0	12.0	11.5	11.0	12.0	12.0	11.75 ± 0.38

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	263.2	262.8	262.4	262.8 ± 0.33
14	381.9	383.2	382.6	382.57 ± 0.53
21	525.8	524.9	525.2	525.3 ± 0.37
28	526.6	526.8	527.2	526.87 ± 0.25

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	4.7	4.6	4.7	4.6	4.7	4.7	4.67 ± 0.047
14	4.7	4.7	4.7	4.7	4.7	4.7	4.7 ± 0
21	4.3	4.2	4.3	4.3	4.3	4.3	4.28 ± 0.037
28	4.5	4.4	4.5	4.4	4.4	4.4	4.43 ± 0.047

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on 2% Malt extract with added phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	7.0	6.5	7.0	7.0	6.0	6.5	6.67 ± 0.37
	SPP	3.0	3.0	3.0	2.5	3.0	2.5	2.83 ± 0.24

C. sativus (Contd.): Enzyme activity by measuring viscosity(units/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
14	CP	12.0	12.5	11.5	12.0	12.0	11.5	11.92 ± 0.34
	SPP	14.0	13.0	14.0	13.5	14.0	13.5	13.67 ± 0.37
21	CP	14.0	14.0	15.0	14.5	15.0	15.0	14.58 ± 0.45
	SPP	26.0	27.0	26.5	27.0	26.0	27.0	26.58 ± 0.45
28	CP	30.0	30.0	31.0	30.5	30.0	31.0	30.42 ± 0.45
	SPP	13.0	13.5	14.0	13.5	14.0	13.0	13.5 ± 0.41

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	194.6	193.7	193.9	194.07 ± 0.39
14	202.1	203.3	202.8	202.73 ± 0.49
21	275.5	276.3	275.9	275.9 ± 0.33
28	280.6	281.4	281.8	281.27 ± 0.5

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	4.6	4.6	4.6	4.6	4.6	4.6	4.6 ± 0
14	4.7	4.6	4.6	4.7	4.7	4.7	4.67 ± 0.047
21	4.6	4.6	4.5	4.7	4.6	4.6	4.6 ± 0.058
28	4.9	4.9	4.8	4.8	4.9	4.9	4.87 ± 0.047

Influence of phosphate on pectin degrading enzymes production by F. culmorum when grown on 2% Malt extract without phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	12.0	11.5	12.0	11.8	13.0	12.5	12.13 ± 0.49
	SPP	0	0	0	0	0	0	0
21	CP	16.0	15.8	15.5	16.0	15.5	16.0	15.8 ± 0.22
	SPP	5.0	4.5	5.0	4.8	5.0	4.5	4.5 ± 0.22
28	CP	29.0	28.5	29.0	29.0	29.0	28.5	28.83 ± 0.24
	SPP	16.0	16.0	17.0	16.5	15.5	16.0	16.17 ± 0.47

F. culmorum (Contd.): Malt extract without phosphate

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	122.8	122.6	123.2	122.87 ± 0.25
14	231.2	230.8	231.5	231.17 ± 0.29
21	208.5	207.9	208.2	208.2 ± 0.24
28	198.7	197.9	198.5	198.37 ± 0.34

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	5.1	5.1	5.0	5.1	5.1	5.0	5.07 ± 0.047
14	4.4	4.5	4.4	4.4	4.4	4.4	4.42 ± 0.037
21	4.7	4.65	4.7	4.6	4.6	4.7	4.66 ± 0.045
28	4.7	4.7	4.7	4.7	4.7	4.7	4.7 ± 0

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on 2% Malt extract without phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	2.0	1.5	2.0	2.0	1.5	2.0	1.83 ± 0.24
	SPP	1.5	1.5	1.5	1.5	1.5	1.5	1.5 ± 0
21	CP	1.5	1.5	1.5	2.0	1.5	2.0	1.67 ± 0.24
	SPP	6.0	6.5	7.0	6.0	6.0	6.5	6.33 ± 0.37
28	CP	1.5	1.5	1.5	1.5	1.5	1.5	1.5 ± 0
	SPP	12.0	12.5	11.8	12.0	12.0	12.0	12.05 ± 0.21

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	13.6	12.9	13.3	13.27 ± 0.29
14	38.6	37.9	38.2	38.23 ± 0.29
21	45.6	44.8	45.9	45.43 ± 0.46
28	62.8	63.8	64.1	63.57 ± 0.56

C. sativus (Contd.): Malt extract without phosphate

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	5.3	5.3	5.2	5.2	5.3	5.2	5.25 ± 0.05
14	3.2	3.1	3.2	3.3	3.2	3.2	3.2 ± 0.058
21	3.3	3.3	3.3	3.3	3.3	3.3	3.3 ± 0
28	3.4	3.5	3.45	3.4	3.5	3.45	3.45 ± 0.041

Influence of phosphate on pectin degrading enzymes production by F. culmorum when grown on 2% Malt extract without KH_2PO_4 (2^{nd}Expt.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	10.0	9.5	9.0	10.0	10.0	9.5	9.67 ± 0.37
	SPP	1.0	1.5	1.0	1.2	1.5	1.2	1.23 ± 0.21
21	CP	8.0	8.5	7.5	8.0	8.0	8.0	8.0 ± 0.29
	SPP	6.0	6.0	6.5	6.0	7.0	6.5	6.33 ± 0.37
28	CP	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
	SPP	8.0	9.0	8.5	8.0	8.0	8.5	8.33 ± 0.37

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	66.7	67.3	66.9	66.97 ± 0.25
14	103.0	102.7	103.5	103.07 ± 0.33
21	135.3	136.3	135.9	135.83 ± 0.41
28	165.6	166.2	165.9	165.9 ± 0.24

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	3.2	3.2	3.15	3.2	3.1	3.2	3.18 ± 0.038
14	3.3	3.3	3.3	3.2	3.3	3.2	3.27 ± 0.047
21	3.4	3.5	3.45	3.5	3.45	3.5	3.47 ± 0.037
28	3.7	3.7	3.7	3.7	3.7	3.7	3.7 ± 0

Influence of phosphate on pectin degrading enzymes production by F. culmorum when grown on 2% Malt extract with KH_2PO_4 (2nd Expt.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	30.0	30.0	31.0	30.5	31.5	31.0	30.67 ± 0.55
	SPP	5.0	5.0	5.0	5.0	5.0	5.0	5.0 ± 0
21	CP	12.0	12.0	13.0	12.5	13.0	12.0	12.42 ± 0.45
	SPP	34.0	34.0	35.0	33.5	34.0	34.5	34.17 ± 0.47
28	CP	18.0	18.0	18.0	18.0	18.0	18.0	18.0 ± 0
	SPP	18.0	19.0	18.5	19.0	18.0	19.0	18.58 ± 0.45

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	219.4	218.9	219.1	219.13 ± 0.21
14	312.8	313.6	313.2	313.2 ± 0.33
21	350.2	351.3	350.9	350.8 ± 0.45
28	640.4	639.7	641.2	640.43 ± 0.61

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	4.5	4.5	4.4	4.6	4.5	4.5	4.5 ± 0.058
14	4.8	4.8	4.8	4.75	4.8	4.8	4.79 ± 0.019
21	4.8	4.8	4.8	4.8	4.8	4.8	4.8 ± 0
28	4.7	4.7	4.75	4.7	4.7	4.7	4.71 ± 0.019

Influence of phosphate on pectin degrading enzymes production by F. culmorum when grown on 2% Malt extract with K_2HPO_4.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	6.0	6.0	5.5	6.0	6.5	6.5	6.08 ± 0.34

F. culmorum(Contd.): 2% Malt extract with K_2HPO_4

Enzyme activity by measuring viscosity (units ml^{-1})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
14	CP	12.0	12.0	11.5	13.0	12.5	12.0	12.17 ± 0.47
	SPP	11.0	11.0	10.5	11.0	11.5	10.5	10.92 ± 0.34
21	CP	20.0	20.0	19.5	21.0	20.0	20.0	20.08 ± 0.45
	SPP	38.0	39.0	38.0	38.5	38.5	39.0	38.33 ± 0.37
28	CP	28.0	27.0	27.5	27.5	28.0	27.5	27.58 ± 0.34
	SPP	25.0	24.0	25.0	25.0	24.0	25.0	24.67 ± 0.47

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	57.7	57.3	58.1	57.63 ± 0.34
14	302.0	302.8	302.6	302.47 ± 0.34
21	324.8	323.9	324.4	324.37 ± 0.37
28	272.8	272.2	271.6	272.2 ± 0.49

pH of filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	5.1	5.1	5.1	5.1	5.1	5.1	5.1 ± 0
14	5.9	5.8	5.9	5.85	5.9	5.9	5.88 ± 0.038
21	5.9	5.9	5.9	5.9	5.9	5.9	5.9 ± 0
28	6.2	6.2	6.2	6.2	6.2	6.2	6.2 ± 0

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on 2% Malt extract without phosphate(2nd Expt.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
14	CP	1.0	1.2	1.5	1.0	1.0	1.2	1.15 ± 0.18
	SPP	0	0	0	0	0	0	0
21	CP	6.0	5.5	6.0	6.5	5.5	6.0	5.92 ± 0.34
	SPP	6.0	6.0	5.5	6.0	6.5	5.5	5.92 ± 0.34
28	CP	12.0	11.5	12.0	11.5	11.5	12.5	11.8 ± 0.4
	SPP	8.0	8.5	7.5	8.0	8.0	8.0	8.0 ± 0.29

C. sativus (Contd.): 2% Malt extract without phosphate(2nd Expt.)

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	60.2	60.9	61.3	60.8 ± 0.45
14	85.2	85.7	86.1	85.67 ± 0.37
21	92.2	93.2	92.9	92.77 ± 0.42
28	196.1	196.8	196.3	196.4 ± 0.29

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	3.2	3.1	3.2	3.2	3.1	3.1	3.15 ± 0.05
14	3.3	3.3	3.2	3.1	3.3	3.3	3.25 ± 0.076
21	3.3	3.3	3.3	3.3	3.3	3.3	3.3 ± 0
28	3.4	3.3	3.4	3.5	3.4	3.4	3.4 ± 0.058

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on 2% Malt extract with KH_2PO_4(2nd Expt.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	1.5	1.5	1.5	1.5	1.5	1.5	1.5 ± 0
14	CP	30.0	29.0	31.0	29.5	31.0	31.0	30.25 ± 0.81
	SPP	14.0	14.0	14.5	13.5	14.0	14.0	14.0 ± 0
21	CP	38.0	38.6	39.0	37.5	39.0	39.0	38.52 ± 0.58
	SPP	26.0	26.0	28.0	27.0	27.5	28.0	27.08 ± 0.84
28	CP	28.0	28.0	27.5	29.0	27.5	28.0	28.0 ± 0.5
	SPP	22.0	21.5	22.0	23.0	21.5	22.0	22.0 ± 0.5

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	106.8	107.3	107.1	107.067± 0.21
14	197.5	197.9	198.4	197.93 ± 0.37
21	354.7	353.9	354.3	354.3 ± 0.33
28	285.2	285.6	285.8	285.53 ± 0.25

C. sativus (Contd.): 2% Malt extract with KH_2PO_4 (2nd Expt.)

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	4.7	4.7	4.7	4.8	4.7	4.6	4.7 ± 0.058
14	4.9	4.9	4.9	4.9	4.9	4.9	4.9 ± 0
21	4.9	4.9	4.9	4.85	4.8	4.9	4.88 ± 0.038
28	5.0	5.0	5.0	5.0	5.0	5.0	5.0 ± 0

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on 2% Malt extract with added K_2HPO_4.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	1.0	1.5	1.0	1.0	1.5	1.0	1.17 ± 0.24
	SPP	8.0	8.0	7.5	9.0	8.5	8.0	8.17 ± 0.47
14	CP	18.0	18.0	18.0	19.0	18.5	18.0	18.25 ± 0.38
	SPP	8.0	8.0	8.0	8.5	8.0	8.0	8.08 ± 0.19
21	CP	18.0	17.5	17.5	19.0	18.0	18.5	18.08 ± 0.54
	SPP	22.0	21.5	22.0	22.0	21.5	22.0	21.83 ± 0.24
28	CP	28.0	29.0	28.5	28.0	28.0	28.0	28.25 ± 0.38
	SPP	12.0	12.0	12.0	11.5	12.0	12.0	11.92 ± 0.19

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	262.1	262.8	262.4	262.43 ± 0.29
14	332.4	333.1	332.7	332.73 ± 0.29
21	232.3	232.8	233.2	232.77 ± 0.37
28	273.9	274.4	274.1	274.13 ± 0.21

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	5.1	5.0	5.1	5.1	5.0	5.1	5.07 ± 0.047
14	5.6	5.6	5.6	5.6	5.6	5.6	5.6 ± 0
21	5.8	5.8	5.75	5.75	5.8	5.8	5.78 ± 0.024
28	6.0	6.1	6.0	6.0	6.1	6.1	6.05 ± 0.05

Influence of phosphate on pectin degrading enzymes production by *F. culmorum* when grown on a mixture of malt extract and citrus pectin without added phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	18.0	18.0	17.5	19.0	18.0	18.5	18.17 ± 0.47
	SPP	2.0	2.0	2.0	2.5	2.0	3.0	2.25 ± 0.38
14	CP	58.0	57.5	58.0	59.0	58.6	58.0	58.18 ± 0.48
	SPP	40.0	41.4	42.0	41.5	40.6	41.0	41.08 ± 0.65
21	CP	60.0	61.0	60.5	60.0	61.0	60.8	60.55 ± 0.42
	SPP	88.0	88.0	87.5	88.0	87.0	87.5	87.67 ± 0.37
28	CP	26.0	27.0	25.6	26.0	27.0	27.0	26.43 ± 0.58
	SPP	56.0	56.0	55.4	57.0	55.8	56.5	56.12 ± 0.51

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	133.7	134.3	135.1	134.37 ± 0.57
14	149.4	149.9	150.2	149.83 ± 0.33
21	162.5	163.1	162.9	162.83 ± 0.25
28	383.4	385.2	383.7	384.1 ± 0.79

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	3.5	3.5	3.6	3.5	3.5	3.5	3.52 ± 0.037
14	3.8	3.8	3.8	3.8	3.8	3.8	3.8 ± 0
21	3.85	3.8	3.9	3.8	3.8	3.8	3.83 ± 0.038
28	3.9	3.9	4.0	3.9	3.9	4.0	3.93 ± 0.047

Influence of phosphate on pectin degrading enzymes production by *F. culmorum* when grown on a mixture of 2% malt extract and 1% citrus pectin with added KH_2PO_4

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	60.0	60.0	61.0	59.5	61.0	60.0	60.25 ± 0.56
	SPP	18.0	18.0	17.0	18.0	17.5	18.0	17.75 ± 0.38

F. culmorum (Contd.): 2% malt extract and 1% citrus pectin

Enzyme activity by measuring viscosity (units ml^{-1})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
14	CP	262.0	261.0	261.0	262.0	260.5	261.0	261.25 ± 0.56
	SPP	68.0	69.0	68.0	68.5	67.8	68.0	68.22 ± 0.41
21	CP	276.0	276.0	276.0	275.6	277.0	276.0	276.1 ± 0.43
	SPP	126.0	125.0	126.0	125.3	125.0	126.0	125.55 ± 0.46
28	CP	188.0	188.0	187.3	187.8	188.0	187.5	187.77 ± 0.27
	SPP	72.0	73.0	71.5	72.0	72.5	72.0	72.17 ± 0.47

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	287.4	288.2	286.9	287.5 ± 0.54
14	418.8	418.7	419.3	418.93 ± 0.26
21	604.0	604.6	603.7	604.1 ± 0.37
28	629.6	629.8	629.1	629.5 ± 0.29

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	3.9	3.8	3.9	3.9	3.8	3.8	3.85 ± 0.05
14	4.1	4.1	4.0	4.1	4.1	4.1	4.08 ± 0.037
21	3.9	3.9	3.9	3.8	3.9	3.9	3.88 ± 0.037
28	4.8	4.7	4.8	4.75	4.8	4.8	4.78 ± 0.038

Influence of phosphate on pectin degrading enzymes production by F. culmorum when grown on a mixture of 2% malt extract and 1% citrus pectin with added K_2HPO_4.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	26.0	26.0	25.8	26.0	26.0	26.0	25.97 ± 0.075
	SPP	8.0	7.5	8.0	8.0	7.5	8.5	7.92 ± 0.34
14	CP	146.0	146.0	146.0	147.0	146.5	146.0	146.25± 0.38
	SPP	52.0	51.5	53.0	52.5	52.0	52.0	52.17 ± 0.47

F. culmorum (Contd.): Mixture of 2% malt extract & 1% citrus pectin with added K_2HPO_4.

Enzyme activity by measuring viscosity (units ml^{-1})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
21	CP	182.0	182.0	181.5	181.5	182.0	182.0	181.83± 0.24
	SPP	108.0	108.0	109.0	108.5	108.5	108.0	108.33± 0.37
28	CP	134.0	133.0	135.0	134.5	134.0	134.0	134.08± 0.61
	SPP	58.0	59.0	58.0	57.5	59.0	59.0	58.42 ± 0.61

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	185.1	185.6	186.2	185.63 ± 0.45
14	195.6	194.8	196.2	195.53 ± 0.57
21	368.2	367.7	368.8	368.23 ± 0.45
28	651.3	651.8	652.1	651.73 ± 0.33

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	6.8	6.8	6.8	6.8	6.8	6.8	6.8 ± 0
14	6.8	6.7	6.8	6.7	6.8	6.9	6.78 ± 0.069
21	6.7	6.7	6.6	6.6	6.7	6.7	6.67 ± 0.047
28	7.0	7.0	7.0	7.0	7.0	7.0	7.0 ± 0

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on a mixture of 2% malt extract and 1% citrus pectin without phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	2.0	2.0	1.6	2.3	2.0	2.0	1.98 ± 0.2
	SPP	0	0	0	0	0	0	0
14	CP	40.0	41.0	40.5	41.2	40.7	41.0	40.73 ± 0.4
	SPP	55.0	56.0	55.5	56.0	55.0	55.0	55.42 ± 0.45

C. sativus (Contd.): Mixture of 2% malt extract & 1% citrus pectin without phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
21	CP	52.0	52.5	52.5	53.0	52.7	53.0	52.62 ± 0.34
	SPP	82.0	83.0	81.8	82.5	83.0	82.0	82.38 ± 0.48
28	CP	20.0	19.5	18.7	20.0	19.5	20.0	19.62 ± 0.47
	SPP	42.0	42.0	41.5	42.5	42.0	42.0	42.0 ± 0.29

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	107.0	108.2	107.6	107.6 ± 0.49
14	120.8	121.3	121.5	121.2 ± 0.29
21	255.7	256.2	256.7	256.2 ± 0.41
28	236.7	237.4	235.9	236.67 ± 0.61

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	3.6	3.6	3.6	3.6	3.6	3.6	3.6 ± 0
14	3.8	3.8	3.7	3.8	3.8	3.7	3.77 ± 0.047
21	3.15	3.2	3.2	3.2	3.2	3.2	3.18 ± 0.038
28	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on a mixture of 2% malt extract and 1% citrus pectin with KH_2PO_4 as phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
7	CP	28.0	28.0	27.5	28.5	28.0	27.0	27.83 ± 0.47
	SPP	8.0	8.0	8.0	7.5	8.0	8.5	8.0 ± 0.29
14	CP	262.0	260.5	261.5	261.0	261.0	261.0	261.17 ± 0.47
	SPP	146.0	145.5	147.0	146.0	146.5	146.0	146.17 ± 0.47

C.sativus (Contd.): Mixture of 2% malt extract and 1% citrus pectin with KH_2PO_4 as phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
21	CP	272.0	270.8	271.0	271.0	272.0	271.5	271.38 ± 0.48
	SPP	186.0	185.0	186.0	186.0	187.0	186.4	186.07 ± 0.6
28	CP	179.0	180.0	179.5	180.2	179.0	179.0	179.45± 0.5
	SPP	108.0	108.0	107.6	108.4	108.0	107.8	107.97 ± 0.24

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	165.6	165.9	164.8	165.43 ± 0.46
14	310.8	311.3	311.7	311.27 ± 0.37
21	477.6	476.6	478.4	477.53 ± 0.74
28	380.7	381.2	381.6	381.17 ± 0.37

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	3.9	3.8	3.9	3.9	3.9	3.9	3.88 ± 0.037
14	3.9	3.9	3.9	3.9	3.9	3.9	3.9 ± 0
21	3.4	3.5	3.4	3.5	3.5	3.4	3.45 ± 0.05
28	3.5	3.5	3.5	3.5	3.55	3.6	3.53 ± 0.038

Influence of phosphate on pectin degrading enzymes production by C. sativus when grown on a mixture of 2% malt extract and 1% citrus pectin with K_2HPO_4 as phosphate.

Enzyme activity by measuring viscosity units (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	18.0	18.0	18.0	19.0	18.5	18.0	18.25 ± 0.38
	SPP	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
14	CP	98.0	99.0	98.6	100.2	99.5	98.5	98.97 ± 0.72
	SPP	72.0	73.0	72.5	72.0	72.0	72.0	72.25 ± 0.38
21	CP	163.0	162.0	164.0	163.0	162.5	162.0	162.75 ± 0.69
	SPP	95.0	95.0	96.0	97.0	95.0	95.5	95.58 ± 0.73

C. sativus (Contd.): Mixture of 2% malt extract and 1% citrus pectin with K_2PO_4 as phosphate.

Enzyme activity by measuring viscosity (units ml^{-1})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
28	CP	85.0	86.0	84.6	85.5	86.0	86.0	85.52 ± 0.55
	SPP	56.0	56.0	56.0	57.0	56.5	56.0	56.25 ± 0.38

Dry weight of mycelium produced (mg)

DAYS	1	2	3	Mean ± S.D.
7	174.3	172.6	173.8	173.57 ± 0.71
14	245.6	245.9	244.6	245.37 ± 0.56
21	254.8	254.2	255.2	254.73 ± 0.41
28	388.9	387.6	389.4	388.63 ± 0.76

pH of culture filtrates at harvest

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	6.8	6.8	6.7	6.7	6.8	6.7	6.75 ± 0.05
14	6.8	6.8	6.7	6.8	6.8	6.8	6.78 ± 0.037
21	6.9	6.9	6.9	6.9	7.0	6.9	6.92 ± 0.037
28	7.0	7.1	7.0	7.1	7.1	7.1	7.07 ± 0.047

Pectin degrading enzyme production by Fusarium culmorum when grown on citrus pectin as carbon source.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
3	CP	6.0	6.0	6.0	6.0	5.5	6.5	6.0 ± 0.29
	SPP	6.0	6.0	5.5	6.5	6.5	6.0	6.08 ± 0.34
6	CP	82.0	82.0	83.0	82.0	83.0	82.0	82.33 ± 0.47
	SPP	44.0	44.0	44.5	45.0	44.0	44.0	44.25 ± 0.38
9	CP	156.0	156.0	157.0	157.0	156.0	156.5	156.42 ± 0.45
	SPP	68.0	69.0	67.0	69.0	68.5	68.0	68.25 ± 0.69
11	CP	130.0	130.0	131.0	131.5	130.0	130.5	130.5 ± 0.58
	SPP	78.0	79.0	78.5	78.0	79.0	78.0	78.42 ± 0.45
13	CP	172.0	172.0	173.0	172.0	171.5	173.0	172.25 ± 0.56
	SPP	84.0	84.0	84.0	84.5	84.5	84.0	84.17 ± 0.24
16	CP	256.0	257.0	256.5	258.0	256.0	255.0	256.42 ± 0.93
	SPP	128.0	129.0	128.0	129.0	128.0	128.0	128.33 ± 0.47
18	CP	256.0	256.0	257.0	257.0	258.0	256.0	256.67 ± 0.75
	SPP	128.0	128.0	128.5	129.0	129.0	129.0	128.58 ± 0.45
20	CP	262.0	263.0	262.0	262.0	262.0	263.0	262.5 ± 0.38
	SPP	206.0	206.0	207.0	206.5	206.0	206.0	206.25 ± 0.38
23	CP	267.0	266.0	268.0	268.0	266.5	267.0	267.08 ± 0.73
	SPP	210.0	210.0	209.0	211.0	211.0	210.0	210.17 ± 0.69
25	CP	276.0	276.0	276.0	277.0	276.0	276.5	276.25 ± 0.38
	SPP	250.0	251.0	250.5	250.5	250.0	250.0	250.33 ± 0.37
27	CP	278.0	279.0	278.0	279.0	278.5	277.0	278.25 ± 0.69
	SPP	256.0	256.0	258.0	256.0	256.5	256.0	256.42 ± 0.73
30	CP	84.0	84.0	85.0	84.5	85.0	84.0	84.42 ± 0.45
	SPP	78.0	79.0	78.0	80.0	79.0	79.0	78.83 ± 0.69
32	CP	84.0	84.0	84.0	85.0	84.0	84.0	84.17 ± 0.37
	SPP	48.0	48.0	49.0	49.0	48.0	48.5	48.42 ± 0.45
34	CP	42.0	42.0	41.5	42.5	41.0	43.0	42.0 ± 0.65
	SPP	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
37	CP	4.0	4.5	5.0	4.5	4.5	4.5	4.5 ± 0.29
	SPP	2.0	2.0	2.5	2.5	2.0	3.0	2.33 ± 0.37
39	CP	6.0	6.5	6.0	5.8	6.5	6.0	6.13 ± 0.27
	SPP	2.0	2.4	2.5	2.8	2.0	2.2	2.32 ± 0.29

Fusarium culmorum (Contd.): Enzyme activity by viscosity(Contd.)

DAYS	ENZYME SUBSTRATES	1	2	3	4	5	6	Mean ± S.D.
41	CP	7.0	7.8	8.0	7.5	8.2	7.0	7.58 ± 0.46
	SPP	0	0	0	0	0	0	0
44	CP	7.0	7.5	7.0	8.2	7.0	7.0	7.28 ± 0.45
	SPP	0	0	0	0	0	0	0
46	CP	4.0	4.5	4.0	4.5	4.0	4.2	4.2 ± 0.22
	SPP	0	0	0	0	0	0	0

Pectin degrading enzyme production by Cochliobolus sativus when grown on citrus pectin as carbon source.

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
3	CP	8.0	8.0	7.5	9.0	8.5	8.0	8.17 ± 0.47
	SPP	0	0	0	0	0	0	0
6	CP	2.0	2.0	2.0	2.5	2.0	2.5	2.17 ± 0.24
	SPP	0	0	0	0	0	0	0
9	CP	2.0	2.0	2.5	3.0	2.0	2.0	2.25 ± 0.38
	SPP	0	0	0	0	0	0	0
11	CP	4.0	4.5	4.5	4.0	5.0	4.0	4.33 ± 0.37
	SPP	6.0	6.0	6.5	6.0	6.5	6.5	6.25 ± 0.25
13	CP	8.0	8.0	7.5	8.5	8.0	7.0	7.83 ± 0.47
	SPP	7.0	7.0	7.5	7.0	8.0	7.0	7.25 ± 0.38
16	CP	12.0	12.0	12.5	12.0	13.0	12.0	12.25 ± 0.38
	SPP	2.0	2.0	2.0	2.0	2.0	2.0	2.0 ± 0
18	CP	7.0	7.0	8.0	7.5	7.5	7.5	7.42 ± 0.34
	SPP	2.0	2.0	2.5	2.5	2.5	2.5	2.33 ± 0.24
20	CP	7.0	7.0	7.5	7.5	8.0	7.5	7.42 ± 0.34
	SPP	6.0	6.0	6.5	7.0	6.0	6.0	6.25 ± 0.38
23	CP	4.0	4.5	4.0	4.5	4.0	4.0	4.17 ± 0.24
	SPP	12.0	12.0	13.0	12.5	13.0	12.0	12.42 ± 0.45
25	CP	4.0	4.0	4.0	5.0	4.0	5.0	4.33 ± 0.47
	SPP	8.0	8.0	8.5	8.0	8.0	8.0	8.08 ± 0.19
27	CP	30.0	31.0	30.0	29.5	31.0	30.0	30.25 ± 0.56
	SPP	36.0	36.0	37.0	37.0	36.0	36.0	36.33 ± 0.47

Cochliobolus sativus(Contd.): Enzyme activity by viscosity (Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
30	CP	18.0	18.0	19.0	18.0	19.0	18.5	18.42 ± 0.45
	SPP	14.0	14.0	14.0	14.5	15.0	14.0	14.25 ± 0.38
32	CP	14.0	14.5	15.0	15.0	14.0	14.0	14.42 ± 0.45
	SPP	14.0	15.0	14.0	15.0	14.0	15.0	14.5 ± 0.5
34	CP	14.0	14.0	15.0	14.5	14.5	14.5	14.42 ± 0.34
	SPP	6.0	6.0	6.2	6.8	6.0	6.0	6.17 ± 0.29
37	CP	7.0	7.4	7.0	7.5	7.0	7.3	7.2 ± 0.21
	SPP	6.0	6.8	6.5	6.0	6.5	7.0	6.47 ± 0.37
39	CP	7.0	7.0	7.5	8.0	7.0	7.0	7.25 ± 0.38
	SPP	8.0	8.3	8.2	8.0	8.5	8.0	8.17 ± 0.19
41	CP	7.0	7.6	7.5	7.0	8.0	7.5	7.43 ± 0.35
	SPP	8.0	8.5	8.0	8.0	8.5	7.5	8.08 ± 0.34
44	CP	7.0	7.0	7.5	7.5	7.0	7.5	7.25 ± 0.25
	SPP	2.0	2.0	2.0	2.0	2.5	2.0	2.08 ± 0.19
46	CP	7.0	7.6	7.2	7.8	7.0	7.5	7.35 ± 0.3
	SPP	2.6	2.6	2.3	2.5	2.0	2.5	2.32 ± 0.24

Pectin degrading enzyme production by Fusarium culmorum & Cochliobolus sativus when grown on citrus pectin as carbon source.

Enzyme activity by measuring reducing groups liberated (μg ml^{-1})

Fusarium culmorum

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
3	CP	137.0	137.0	136.0	137.0	136.5	136.0	136.58 ± 0.45
	SPP	19.0	19.0	18.0	18.5	19.0	18.0	18.58 ± 0.45
6	CP	147.0	146.0	148.0	147.0	147.0	147.0	147.0 ± 0.58
	SPP	27.0	27.5	28.0	27.0	28.0	27.5	27.5 ± 0.41
9	CP	159.0	160.0	161.0	159.5	160.0	160.0	159.92 ± 0.61
	SPP	27.0	27.0	28.0	26.5	27.5	28.0	27.33 ± 0.55
11	CP	164.0	165.0	164.0	164.5	165.0	165.0	164.58 ± 0.45
	SPP	27.0	27.0	28.0	27.0	28.0	27.0	27.33 ± 0.47
13	CP	164.0	166.0	166.0	165.0	165.0	166.0	165.33 ± 0.75
	SPP	27.0	28.0	26.5	28.0	28.0	28.0	27.58 ± 0.61

Enzyme activity by measuring reducing groups liberated (Contd.)

Fusarium culmorum (Contd.):

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
16	CP	138.0	138.0	139.0	137.5	138.0	139.0	138.25 ± 0.56
	SPP	23.0	23.0	24.0	23.5	24.0	24.0	23.58 ± 0.45
18	CP	129.0	131.0	130.0	129.5	131.0	131.0	130.25 ± 0.8
	SPP	9.0	9.0	9.0	9.0	9.5	9.0	9.08 ± 0.19
20	CP	132.0	132.0	133.0	132.5	133.0	133.0	132.58 ± 0.45
	SPP	17.0	17.0	18.0	17.5	17.5	17.0	17.33 ± 0.37
23	CP	155.0	156.0	155.0	157.0	155.0	155.0	155.5 ± 0.76
	SPP	17.0	17.5	17.0	18.0	17.0	17.0	17.25 ± 0.38
25	CP	147.0	148.0	147.0	147.0	148.0	147.5	147.42 ± 0.45
	SPP	29.0	31.0	30.0	29.5	30.0	30.0	29.92 ± 0.61
27	CP	132.0	132.0	131.0	130.0	133.0	131.0	131.5 ± 0.96
	SPP	44.0	44.0	46.0	45.0	45.0	45.5	44.92 ± 0.73
30	CP	137.0	137.5	137.0	138.0	137.0	137.5	137.33 ± 0.27
	SPP	19.0	19.5	19.0	18.5	19.0	19.5	19.08 ± 0.34
32	CP	137.0	137.0	137.8	138.0	137.0	137.5	137.38 ± 0.41
	SPP	17.0	17.0	18.0	17.5	17.5	17.0	17.33 ± 0.27
34	CP	139.0	140.0	139.5	141.0	139.0	138.0	139.42 ± 0.93
	SPP	34.0	34.0	33.5	34.0	33.0	34.0	33.75 ± 0.38
37	CP	139.0	141.0	140.0	139.5	141.0	139.0	139.92 ± 0.84
	SPP	39.0	40.0	41.0	41.0	39.5	39.0	39.92 ± 0.84
39	CP	127.0	128.0	129.0	128.5	128.0	128.0	128.08 ± 0.61
	SPP	19.0	20.0	19.0	19.5	19.5	19.5	19.42 ± 0.34
41	CP	139.0	138.0	138.5	138.0	138.0	138.0	138.25 ± 0.38
	SPP	32.0	32.0	31.0	32.0	31.5	31.5	31.67 ± 0.37
44	CP	150.0	151.0	150.0	151.0	151.0	152.0	150.83 ± 0.69
	SPP	34.0	36.0	35.0	35.5	35.0	35.0	35.08 ± 0.61
46	CP	190.0	190.0	190.0	189.5	190.0	191.0	190.08 ± 0.45
	SPP	42.0	42.0	41.0	41.5	41.0	42.0	41,58 ± 0.45

Cochliobolus sativus

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
3	CP	134.0	134.0	135.0	134.5	134.0	134.0	134.25 ± 0.38
	SPP	29.0	29.0	28.5	29.0	28.0	29.5	28.83 ± 0.47

Enzyme activity by measuring reducing groups liberated (Contd.)

Cochliobolus sativus (Contd.):

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
6	CP	129.0	129.0	130.0	130.0	129.0	129.5	129.42 ± 0.45
	SPP	17.0	17.0	18.0	18.0	17.5	17.5	17.5 ± 0.41
9	CP	122.0	122.0	123.0	123.5	123.0	122.0	122.58 ± 0.61
	SPP	9.0	9.5	9.5	9.5	9.0	9.2	9.28 ± 0.23
11	CP	122.0	123.0	122.0	122.5	122.5	122.0	122.33 ± 0.37
	SPP	15.0	15.0	16.0	15.5	16.0	16.0	15.58 ± 0.45
13	CP	122.0	121.5	122.0	123.0	122.0	122.0	122.08± 0.45
	SPP	15.0	15.5	16.0	15.5	15.0	15.0	15.33 ± 0.37
16	CP	104.0	104.0	105.0	105.0	104.0	104.0	104.33 ± 0.47
	SPP	0	0	0	0	0	0	0
18	CP	107.0	108.0	107.5	107.0	107.0	107.0	107.25 ± 0.38
	SPP	0	0	0	0	0	0	0
20	CP	122.0	122.0	123.0	122.5	123.0	122.0	122.42 ± 0.45
	SPP	23.0	24.0	23.0	23.5	23.5	23.0	23.33 ± 0.37
23	CP	132.0	131.5	133.0	132.0	132.0	132.0	132.08 ± 0.45
	SPP	17.0	18.0	17.5	17.5	17.0	17.0	17.33 ± 0.37
25	CP	144.0	144.0	145.0	144.0	144.5	144.0	144.25 ± 0.38
	SPP	17.0	17.0	17.5	17.0	18.0	17.0	17.25 ± 0.38
27	CP	157.0	157.0	158.0	157.0	157.0	157.5	157.25 ± 0.38
	SPP	47.0	48.0	47.5	47.0	48.0	47.0	47.42 ± 0.45
30	CP	154.0	154.0	155.0	155.0	154.0	154.0	154.33 ± 0.47
	SPP	42.0	42.0	42.5	43.0	42.5	42.0	42.33 ± 0.37
32	CP	169.0	169.0	170.0	169.0	169.5	170.0	169.42 ± 0.45
	SPP	65.0	66.0	66.0	65.0	65.0	65.0	65.33 ± 0.47
34	CP	147.0	147.5	147.0	147.0	147.5	147.5	147.25 ± 0.25
	SPP	54.0	55.0	53.0	55.0	55.0	54.0	54.33 ± 0.75
37	CP	142.0	141.0	141.5	143.0	142.0	141.0	141.75 ± 0.69
	SPP	5.0	5.0	5.0	5.0	6.0	5.0	5.17 ± 0.37
39	CP	125.0	126.0	125.5	125.0	125.0	125.0	125.25 ± 0.38
	SPP	5.0	5.0	5.5	5.0	5.5	6.0	5.33 ± 0.37
41	CP	128.0	127.0	129.0	128.0	128.0	128.5	128.08 ± 0.61
	SPP	2.5	2.5	3.0	2.5	2.5	2.5	2.58 ± 0.19
44	CP	128.0	128.0	127.5	128.5	128.0	128.0	128.0 ± 0.29
	SPP	5.0	5.0	6.0	5.0	6.0	5.5	5.42 ± 0.45
46	CP	128.0	129.0	128.0	129.0	128.0	128.0	128.33 ± 0.47
	SPP	5.0	5.0	5.0	5.5	5.0	5.5	5.17 ± 0.24

Pectin degrading enzyme production by *Fusarium culmorum* and *Cochliobolus sativus* when grown on citrus pectin.

Dry weight of mycelium produced (mg)

DAYS	Fusarium culmorum			Cochliobolus sativus		
3	19.4	20.1	19.75 ± 0.35	10.2	10.7	10.45 ± 0.25
6	26.7	27.3	27.0 ± 0.3	20.1	20.6	20.35 ± 0.25
9	39.4	39.8	39.6 ± 0.2	26.5	27.3	26.9 ± 0.4
11	50.2	50.8	50.5 ± 0.3	59.5	60.1	59.8 ± 0.3
13	62.1	63.1	62.6 ± 0.5	55.8	56.3	56.05 ± 0.25
16	74.1	74.6	74.35 ± 0.25	78.0	78.8	78.4 ± 0.4
18	89.1	90.2	89.65 ± 0.55	88.9	90.2	89.55 ± 0.65
20	76.5	77.1	76.8 ± 0.3	96.5	97.1	96.8 ± 0.3
23	49.9	50.6	50.25 ± 0.35	52.3	52.9	52.6 ± 0.3
25	62.6	63.3	62.95 ± 0.35	49.2	50.1	49.65 ± 0.45
27	189.6	190.2	189.9 ± 0.3	137.1	136.9	137.0 ± 0.1
30	236.8	237.3	237.05 ± 0.25	44.6	45.3	44.95 ± 0.35
32	249.3	250.1	249.7 ± 0.4	92.4	93.2	92.8 ± 0.4
34	218.1	217.9	218.0 ± 0.1	87.4	86.9	87.15 ± 0.25
37	241.4	239.9	240.65 ± 0.75	36.1	36.8	36.45 ± 0.35
39	207.1	208.8	207.45 ± 0.35	47.3	47.9	47.6 ± 0.3
41	180.7	179.9	180.3 ± 0.4	48.5	49.2	48.85 ± 0.35
44	170.7	171.2	170.95 ± 0.25	47.2	47.8	47.5 ± 0.3
46	201.4	200.9	201.15 ± 0.25	46.8	47.3	47.05 ± 0.25

pH of culture filtrates at harvest

Fusarium culmorum

DAYS	1	2	3	4	5	6	Mean ± S.D.
3	3.0	3.0	3.0	3.1	3.1	3.1	3.05 ± 0.05
6	2.8	2.8	2.8	2.7	2.75	2.7	2.76 ± 0.04
9	2.8	2.8	2.8	2.8	2.8	2.8	2.8 ± 0
11	2.7	2.7	2.65	2.7	2.75	2.7	2.7 ± 0.03
13	2.7	2.7	2.7	2.7	2.65	2.7	2.69 ± 0.02
16	2.9	2.9	3.0	3.0	2.9	2.9	2.93 ± 0.05
18	2.9	2.9	3.1	2.9	2.95	2.9	2.94 ± 0.07
20	2.9	2.9	2.9	2.9	2.9	2.9	2.9 ± 0
23	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0

pH of culture filtrates at harvest

Fusarium culmorum (Contd.)

DAYS	1	2	3	4	5	6	Mean ± S.D.
25	3.1	3.2	3.1	3.2	3.1	3.2	3.15 ± 0.05
27	5.4	5.3	5.3	5.3	5.3	5.3	5.32 ± 0.04
30	7.2	7.15	7.2	7.25	7.2	7.2	7.2 ± 0.03
32	7.0	7.0	7.0	7.0	7.0	7.0	7.0 ± 0
34	8.1	8.15	8.15	8.1	8.1	8.1	8.12 ± 0.02
37	7.6	7.7	7.7	7.6	7.6	7.6	7.63 ± 0.05
39	8.0	8.0	8.0	8.0	8.0	8.0	8.0 ± 0
41	8.1	8.1	8.1	8.1	8.1	8.1	8.1 ± 0
44	8.4	8.3	8.4	8.4	8.4	8.5	8.4 ± 0.06
46	8.4	8.4	8.4	8.4	8.4	8.4	8.4 ± 0

Cochliobolus sativus

DAYS	1	2	3	4	5	6	Mean ± S.D.
3	3.9	3.85	3.9	3.8	3.8	3.8	3.84 ± 0.04
6	3.5	3.5	3.5	3.6	3.5	3.6	3.53 ± 0.05
9	3.5	3.5	3.5	3.5	3.5	3.5	3.5 ± 0
11	3.3	3.25	3.3	3.3	3.2	3.3	3.28 ± 0.04
13	3.0	3.0	3.1	3.1	3.0	3.0	3.03 ± 0.05
16	2.9	2.9	2.9	2.9	2.9	2.9	2.9 ± 0
18	2.9	2.8	2.9	2.8	2.9	2.9	2.86 ± 0.05
20	2.9	3.0	2.9	2.9	3.0	2.9	2.93 ± 0.05
23	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
25	3.1	3.2	3.1	3.2	3.2	3.1	3.15 ± 0.05
27	6.3	6.4	6.3	6.35	6.3	6.3	6.33 ± 0.04
30	3.4	3.3	3.4	3.4	3.4	3.4	3.38 ± 0.04
32	3.4	3.4	3.4	3.4	3.4	3.4	3.4 ± 0
34	3.6	3.7	3.6	3.65	3.7	3.6	3.64 ± 0.04
37	3.3	3.3	3.3	3.3	3.3	3.3	3.3 ± 0
39	3.3	3.4	3.2	3.2	3.4	3.3	3.3 ± 0.08
41	3.3	3.3	3.3	3.3	3.3	3.3	3.3 ± 0
44	3.4	3.4	3.4	3.4	3.4	3.4	3.4 ± 0
46	3.5	3.4	3.4	3.5	3.5	3.4	3.45 ± 0.05

Influence of carbon source in growth medium on enzyme production by Fusarium culmorum and Cochliobolus sativus.

Reducing sugar concentrations in culture filtrates at harvest($\mu g\ cm^{-3}$)

Fusarium culmorum

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	GLUCOSE	7.2	6.93	7.26	6.98	7.25	7.58	7.2 ± 0.21
	CELLOBIOSE	3.18	3.35	2.89	3.5	3.28	3.1	3.22 ± 0.19
	CP	2.25	2.18	2.32	2.2	2.15	2.1	2.2 ± 0.07
	XYLAN	0.23	0.25	0.19	0.2	0.15	0.18	0.2 ± 0.03
	CMC	0.21	0.19	0.18	0.18	0.23	0.21	0.2 ± 0.02
14	GLUCOSE	0.58	0.46	0.39	0.52	0.49	0.56	0.5 ± 0.06
	CELLOBIOSE	1.75	1.69	1.56	1.8	1.65	1.75	1.7 ± 0.08
	CP	3.56	3.49	3.68	3.65	3.5	3.72	3.6 ± 0.09
	XYLAN	0.52	0.56	0.64	0.49	0.38	0.41	0.5 ± 0.09
	CMC	0.38	0.45	0.33	0.39	0.39	0.46	0.4 ± 0.04

Cochliobolus sativus

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	GLUCOSE	9.15	8.95	8.89	9.26	9.35	9.0	9.1 ± 0.17
	CELLOBIOSE	4.65	4.39	4.73	4.8	4.58	4.45	4.6 ± 0.15
	CP	1.75	1.68	1.8	1.65	1.78	1.54	1.7 ± 0.09
	XYLAN	0.48	0.45	0.54	0.39	0.52	0.62	0.5 ± 0.07
	CMC	0.19	0.2	0.23	0.18	0.19	0.21	0.2 ± 0.02
14	GLUCOSE	7.23	7.75	7.82	7.25	8.32	7.83	7.7 ± 0.37
	CELLOBIOSE	2.95	2.86	3.2	3.15	2.75	2.49	2.9 ± 0.24
	CP	2.68	2.46	2.72	2.59	2.5	2.55	2.6 ± 0.08
	XYLAN	0.22	0.21	0.18	0.23	0.18	0.18	0.2 ± 0.02
	CMC	0.52	0.46	0.48	0.56	0.49	0.49	0.5 ± 0.03

pH of culture filtrates at harvest

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
7	GLUCOSE	7.1	6.9	7.0	7.1	7.2	7.3	7.1 ± 0.13
	CELLOBIOSE	6.8	6.75	6.75	6.8	6.85	6.85	6.8 ± 0.04
	CP	3.35	3.4	3.35	3.3	3.2	3.2	3.3 ± 0.08

pH of culture filtrates at harvest(Contd.)

Fusarium culmorum(Contd.):

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	XYLAN	6.0	6.15	5.95	5.9	5.9	6.1	6.0 ± 0.1
	CMC	7.1	6.95	6.9	6.85	6.95	6.95	6.95 ± 0.08
14	GLUCOSE	6.9	7.0	6.8	7.1	6.8	6.8	6.9 ± 0.12
	CELLOBIOSE	6.1	6.15	6.2	6.25	6.2	6.3	6.2 ± 0.06
	CP	3.4	3.25	3.3	3.25	3.3	3.3	3.3 ± 0.05
	XYLAN	7.35	7.45	7.55	7.6	7.35	7.7	7.5 ± 0.13
	CMC	7.15	7.3	7.25	7.25	7.15	7.1	7.2 ± 0.07

Cochliobolus sativus

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	GLUCOSE	7.2	7.1	7.2	7.3	7.1	7.3	7.2 ± 0.08
	CELLOBIOSE	7.25	7.2	7.15	7.1	6.95	7.25	7.15 ± 0.1
	CP	3.25	3.15	3.3	3.25	3.1	3.15	3.2 ± 0.07
	XYLAN	4.3	4.15	4.2	4.35	4.1	4.1	4.2 ± 0.1
	CMC	6.15	6.25	6.25	6.15	6.2	6.2	6.2 ± 0.04
14	GLUCOSE	7.3	7.1	7.2	7.3	7.1	7.3	7.2 ± 0.08
	CELLOBIOSE	7.3	7.15	7.3	7.25	7.3	7.2	7.25 ± 0.06
	CP	3.15	3.15	3.1	3.15	2.95	3.1	3.1 ± 0.07
	XYLAN	3.9	3.95	4.1	3.95	4.0	4.1	4.0 ± 0.08
	CMC	6.1	5.95	6.15	5.95	5.9	5.95	6.0 ± 0.09

Dry weight of mycelium produced (mg) Mean ± S.D.

DAYS	Growth Substrates	F.culmorum			C. sativus		
7	GLUCOSE	67.4	68.6	68.0 ± 0.6	38.0	36.8	37.4 ± 0.6
	CELLOBIOSE	35.4	36.5	35.95 ± 0.55	44.7	42.3	43.5 ± 1.2
	CP	23.9	23.6	23.75 ± 0.15	27.5	27.7	27.6 ± 0.1
	XYLAN	85.7	82.5	84.1 ± 1.6	79.7	77.4	78.55 ± 1.15
	CMC	13.45	13.65	13.55 ± 0.1	43.8	41.4	42.6 ± 1.2
14	GLUCOSE	96.8	98.2	97.5 ± 0.7	96.5	97.3	96.9 ± 0.4
	CELLOBIOSE	106.8	108.2	107.5 ± 0.7	125.5	122.9	124.2 ± 1.3
	CP	67.8	68.5	68.15 ± 0.35	35.1	35.0	35.05 ± 0.05
	XYLAN	187.3	184.2	185.75 ± 1.55	99.1	98.2	98.65 ± 0.45
	CMC	39.4	38.0	38.7 ± 0.7	72.7	73.9	73.3 ± 0.6

Influence of carbon source in growth medium on enzyme production by Fusarium culmorum and Cochliobolus sativus.

Enzyme activity in culture filtrates by measuring reducing groups liberated.

GROWTH SUBSTRATE : GLUCOSE

Fusarium culmorum

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	115.7	115.8	116.2	115.4	115.6	115.6	115.72 ± 0.25
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
14	CP	182.4	182.0	181.8	180.9	182.0	181.6	181.78 ± 0.46
	SPP	12.5	12.2	11.9	11.9	11.9	12.1	12.08 ± 0.22
	CMC	7.3	7.6	7.5	7.5	7.2	7.5	7.43 ± 0.14
	XYLAN	25.1	24.6	24.8	24.3	25.0	25.0	24.8 ± 0.28

Cochliobolus sativus

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	86.5	85.9	86.3	86.8	86.0	85.9	86.23 ± 0.33
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
14	CP	129.0	128.8	128.5	128.5	129.0	129.2	128.83 ± 0.26
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0

GROWTH SUBSTRATE : CELLOBIOSE

Fusarium culmorum

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	127.2	126.9	126.8	126.6	127.2	126.9	126.93 ± 0.21
	SPP	0	0	0	0	0	0	0
	CMC	20.4	20.2	19.9	19.8	19.9	19.9	20.02 ± 0.21
	XYLAN	0	0	0	0	0	0	0
14	CP	149.0	148.0	148.5	149.2	148.9	148.0	148.6 ± 0.47
	SPP	15.0	16.0	16.0	15.8	15.4	16.0	15.7 ± 0.38
	CMC	7.3	7.6	7.0	7.5	7.5	7.2	7.35 ± 0.21
	XYLAN	27.2	27.0	27.5	28.3	27.5	28.3	27.6 ± 0.5

Growth Substrate: Cellobiose (Contd.)

Cochliobolus sativus

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	115.0	114.8	114.3	115.2	115.0	114.8	114.85 ± 0.28
	SPP	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
	XYLAN	10.0	9.5	9.8	10.2	9.8	10.1	9.9 ± 0.23
14	CP	147.0	146.8	146.6	146.9	147.0	147.3	146.93 ± 0.21
	SPP	7.5	7.5	7.5	7.15	7.35	7.5	7.42 ± 0.13
	CMC	0	0	0	0	0	0	0
	XYLAN	20.0	20.5	19.9	19.75	20.2	20.0	20.06 ± 0.24

GROWTH SUBSTRATE : CITRUS PECTIN

Fusarium culmorum

7	CP	189.2	188.9	189.0	189.0	189.3	189.0	189.07 ± 0.14
	SPP	20.8	20.5	21.2	21.5	20.6	21.2	20.96 ± 0.36
	CMC	0	0	0	0	0	0	0
	XYLAN	17.5	17.2	17.6	17.2	17.6	17.6	17.45 ± 0.18
14	CP	247.2	247.8	247.0	248.2	247.6	247.6	247.57 ± 0.39
	SPP	16.5	16.8	16.0	16.0	16.0	15.9	16.2 ± 0.33
	CMC	0	0	0	0	0	0	0
	XYLAN	16.1	16.0	16.4	15.85	16.3	16.0	16.1 ± 0.19

Cochliobolus sativus

7	CP	140.0	139.6	140.2	139.8	140.2	139.6	139.9 ± 0.25
	SPP	14.0	13.85	14.0	13.9	13.95	14.0	13.95 ± 0.058
	CMC	3.8	3.6	3.3	3.5	3.5	3.5	3.53 ± 0.15
	XYLAN	24.2	24.5	24.5	24.0	24.5	24.2	24.32 ± 0.2
14	CP	164.0	164.5	164.2	165.0	164.5	164.6	164.47 ± 0.31
	SPP	9.5	9.9	9.5	9.3	9.25	9.5	9.49 ± 0.21
	CMC	0	0	0	0	0	0	0
	XYLAN	19.5	19.15	19.3	19.5	19.5	19.8	19.46 ± 0.2

GROWTH SUBSTRATE : LARCHWOOD XYLAN

Fusarium culmorum

7	CP	167.0	166.0	166.6	167.0	166.0	166.8	166.57 ± 0.42
	SPP	25.2	25.0	26.0	25.8	26.0	26.0	25.67 ± 0.41
	CMC	12.5	12.8	12.2	11.9	11.95	12.0	12.23 ± 0.33
	XYLAN	37.4	37.2	38.0	37.6	37.8	38.0	37.67 ± 0.3

Growth Substrate : Larchwood xylan (Contd.)

Enzyme activity by measuring reducing groups (µg cm^{-3})(Contd.)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
14	CP	182.0	181.8	181.2	180.9	182.5	182.0	181.73 ± 0.53
	SPP	25.0	24.8	25.2	25.0	24.6	25.0	24.9 ± 0.19
	CMC	12.0	11.6	11.8	12.2	11.8	11.8	11.87 ± 0.19
	XYLAN	35.5	35.8	35.5	36.0	36.2	35.8	35.8 ± 0.25
				Cochliobolus sativus				
7	CP	149.6	149.3	149.5	149.0	150.2	149.8	149.57 ± 0.38
	SPP	25.2	25.0	25.5	25.0	25.6	24.9	25.2 ± 0.26
	CMC	5.5	5.5	5.45	5.25	5.5	5.45	5.44 ± 0.089
	XYLAN	37.5	37.8	37.5	38.0	37.8	37.5	37.68 ± 0.2
14	CP	154.0	154.2	153.9	154.0	153.6	154.5	154.03 ± 0.27
	SPP	30.0	29.5	28.8	28.5	29.3	28.5	29.1 ± 0.55
	CMC	10.2	9.9	9.9	10.1	9.85	9.9	9.98 ± 0.13
	XYLAN	40.0	41.5	40.8	40.7	40.5	40.5	40.67 ± 0.45
				GROWTH SUBSTRATE : SODIUM CARBOXYMETHYLCELLULOSE				
				Fusarium culmorum				
7	CP	157.5	157.4	156.8	157.2	157.0	157.0	157.15 ± 0.24
	SPP	20.0	19.8	19.4	18.9	19.6	20.0	19.62 ± 0.38
	CMC	7.5	7.8	7.3	7.8	7.8	7.5	7.62 ± 0.2
	XYLAN	20.4	19.9	20.0	18.95	19.9	20.5	19.98 ± 0.51
14	CP	147.6	147.0	146.5	147.0	146.0	147.0	146.85 ± 0.5
	SPP	27.0	26.6	26.3	26.5	26.8	26.5	26.61 ± 0.23
	CMC	12.5	12.8	12.5	12.6	12.9	12.5	12.6 ± 0.16
	XYLAN	32.3	32.5	32.8	32.6	32.0	32.5	32.45 ± 0.25
				Cochliobolus sativus				
7	CP	133.0	132.8	132.5	132.5	133.2	133.0	132.83 ± 0.26
	SPP	27.0	26.8	26.4	27.2	27.0	27.5	26.98 ± 0.34
	CMC	7.5	7.5	7.8	7.35	7.4	7.4	7.49 ± 0.15
	XYLAN	37.0	37.5	37.35	37.2	37.5	37.5	37.34 ± 0.19
14	CP	132.0	132.2	131.8	131.5	132.8	132.3	132.1 ± 0.41
	SPP	27.8	27.5	27.5	27.4	27.5	27.6	27.53 ± 0.12
	CMC	12.5	12.2	12.5	12.25	12.3	12.5	12.38 ± 0.13
	XYLAN	37.8	38.5	37.65	37.5	37.5	38.2	37.86 ± 0.37

Enzyme activity by measuring viscosity (units ml^{-1})

ENZYME SUBSTRATE : CITRUS PECTIN

Cochliobolus sativus

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	GLUCOSE	12.0	12.0	10.0	12.0	12.0	12.0	11.67 ± 0.75
	CELLOBIOSE	10.0	10.0	9.0	10.0	10.0	11.0	10.0 ± 0.58
	CP	46.0	45.0	44.0	46.0	46.0	45.0	45.33 ± 0.75
	CMC	3.0	3.0	4.0	2.0	3.0	4.0	3.17 ± 0.69
	XYLAN	6.0	7.0	7.0	5.0	5.0	6.0	6.0 ± 0.82
14	GLUCOSE	6.0	7.0	6.0	7.0	5.0	6.0	6.17 ± 0.69
	CELLOBIOSE	14.0	13.0	14.0	14.0	15.0	13.0	13.83 ± 0.69
	CP	58.0	56.0	58.0	57.0	58.0	58.0	57.5 ± 0.76
	CMC	12.0	11.0	12.0	10.0	12.0	11.0	11.33 ± 0.75
	XYLAN	6.0	5.0	7.0	7.0	7.0	6.0	6.33 ± 0.75

Fusarium culmorum

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	GLUCOSE	6.0	6.0	7.0	6.0	5.0	6.0	6.0 ± 0.58
	CELLOBIOSE	0	0	0	0	0	0	0
	CP	240.0	239.0	240.0	242.0	240.0	240.0	240.17 ± 0.89
	CMC	6.0	6.0	7.0	6.0	5.0	6.0	6.0 ± 0.58
	XYLAN	130.0	129.0	128.0	129.0	127.0	129.0	128.67 ± 0.94
14	GLUCOSE	16.0	18.0	18.0	16.0	15.0	16.0	16.5 ± 1.12
	CELLOBIOSE	12.0	12.0	13.0	12.0	14.0	12.0	12.5 ± 0.76
	CP	262.0	261.0	262.0	262.0	260.0	261.0	261.33 ± 0.75
	CMC	8.0	9.0	8.0	7.0	8.0	7.0	7.83 ± 0.69
	XYLAN	24.0	22.0	24.0	24.0	24.0	24.0	23.67 ± 0.75

ENZYME SUBSTRATE : SODIUM POLYPECTATE

Cochliobolus sativus

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
7	GLUCOSE	6.0	6.0	7.0	5.0	6.0	6.0	6.0 ± 0.58
	CELLOBIOSE	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
	CP	12.0	11.0	12.0	12.0	13.0	11.0	11.83 ± 0.69
	CMC	8.0	9.0	8.0	7.0	8.0	8.0	8.0 ± 0.58
	XYLAN	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0

Enzyme activity by measuring viscosity(units ml^{-1})(Contd.)

ENZYME SUBSTRATE : SODIUM POLYPECTATE

DAYS	Growth Substrates	1	2	3	4	5	6	Mean ± S.D.
				Cochliobolus sativus				
14	GLUCOSE	6.0	6.0	6.0	7.0	5.0	5.0	5.83 ± 0.69
	CELLOBIOSE	8.0	9.0	8.0	9.0	7.0	8.0	8.17 ± 0.69
	CP	18.0	18.0	19.0	17.0	18.0	18.0	18.0 ± 0.58
	CMC	8.0	8.0	8.0	8.0	8.0	8.0	8.0 ± 0
	XYLAN	8.0	8.0	7.0	9.0	8.0	8.0	8.0 ± 0
				Fusarium culmorum				
7	GLUCOSE	16.0	16.0	17.0	18.0	16.0	16.0	16.5 ± 0.76
	CELLOBIOSE	3.0	2.0	3.0	4.0	4.0	2.0	3.0 ± 0.82
	CP	36.0	38.0	37.0	36.0	36.0	36.0	36.5 ± 0.76
	CMC	0	0	0	0	0	0	0
	XYLAN	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
14	GLUCOSE	3.0	2.0	3.0	3.0	2.0	4.0	2.83 ± 0.69
	CELLOBIOSE	14.0	13.0	14.0	14.0	14.0	12.0	13.5 ± 0.76
	CP	120.0	122.0	120.0	118.0	120.0	120.0	120.0 ± 1.15
	CMC	12.0	10.0	12.0	11.0	10.0	12.0	11.16 ± 0.9
	XYLAN	14.0	14.0	12.0	13.0	12.0	13.0	13.0 ± 0.82

Enzyme production by F. culmorum, C. sativus and G. graminis var tritici isolates when grown on powdered wheat straw, extracts of powdered wheat straw or glucose (contol) as the carbon source.

Powdered wheat straw as carbon source:

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
7	CP	6.0	8.0	6.0	8.0	7.0	8.0	7.17 ± 0.9
	SPP	8.0	6.0	8.0	7.5	7.5	8.0	7.5 ± 0.71
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	10.0	12.0	10.0	9.0	10.0	9.5	10.08 ± 0.93
	SPP	8.0	6.0	8.0	8.0	8.0	8.0	7.67 ± 0.75
	XYLAN	5.0	5.0	5.0	6.0	7.0	5.0	5.5 ± 0.76
	CMC	4.5	5.0	5.0	3.5	4.0	5.0	4.5 ± 0.58
28	CP	9.0	8.0	7.0	8.0	10.0	6.0	8.0 ± 1.29
	SPP	3.0	4.0	3.0	3.5	3.0	3.0	3.25 ± 0.38
	XYLAN	6.0	7.5	7.5	8.5	8.0	8.0	7.58 ± 0.79
	CMC	6.0	8.0	8.0	8.5	8.0	8.0	7.75 ± 0.8
56	CP	6.0	4.0	5.5	5.5	5.0	5.0	5.17 ± 0.62
	SPP	6.0	6.0	5.0	5.0	5.0	5.0	5.33 ± 0.47
	XYLAN	40.0	36.0	36.0	37.0	36.0	36.0	36.83 ± 1.46
	CMC	120.0	118.0	124.0	119.0	120.0	120.0	120.17 ± 1.86
				Cochliobolus sativus				
7	CP	6.0	4.0	6.0	4.5	6.0	5.0	5.25 ± 0.8
	SPP	6.0	5.5	5.5	6.0	5.0	6.0	5.67 ± 0.37
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	8.0	6.0	8.0	6.5	7.0	8.0	7.25 ± 0.8
	SPP	5.0	5.0	5.5	5.0	5.5	5.0	5.17 ± 0.24
	XYLAN	4.0	3.0	4.0	3.0	2.5	3.0	3.25 ± 0.56
	CMC	4.0	4.0	3.5	4.5	4.0	4.0	4.0 ± 0.29

Powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Cochliobolus sativus				
28	CP	6.0	5.5	6.0	5.0	5.5	5.5	5.58 ± 0.34
	SPP	3.0	2.5	2.0	2.5	2.5	2.5	2.5 ± 0.29
	XYLAN	7.0	8.0	6.0	7.5	6.0	6.0	6.75 ± 0.8
	CMC	6.0	4.0	5.0	5.5	5.5	5.0	5.17 ± 0.62
56	CP	6.0	5.5	5.5	5.0	5.0	5.0	5.33 ± 0.37
	SPP	4.5	4.0	4.0	4.5	3.0	4.0	4.0 ± 0.5
	XYLAN	40.0	36.0	37.0	37.0	36.0	37.0	37.17 ± 1.34
	CMC	68.0	78.0	72.0	78.0	74.0	78.0	74.67 ± 3.77
				G. graminis var tritici isolate og.12				
7	CP	6.0	5.5	5.0	6.0	6.0	6.0	5.75 ± 0.38
	SPP	4.0	6.5	7.0	6.0	6.5	5.0	5.83 ± 1.03
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	6.0	7.0	8.0	8.0	8.0	8.0	7.5 ± 0.76
	SPP	5.0	5.5	7.0	6.0	6.5	6.0	6.0 ± 0.65
	XYLAN	4.0	4.0	5.0	4.0	4.0	4.0	4.17 ± 0.37
	CMC	6.0	7.0	6.0	7.5	7.5	6.0	6.67 ± 0.69
28	CP	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
	SPP	4.5	4.0	4.5	3.5	4.0	4.5	4.17 ± 0.37
	XYLAN	8.0	10.0	8.0	9.0	8.5	8.0	8.58 ± 0.73
	CMC	7.0	7.0	7.5	7.5	7.5	7.0	7.25 ± 0.25
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	36.0	34.0	36.0	34.0	34.0	36.0	35.0 ± 1.0
	CMC	38.0	34.0	36.0	34.0	38.0	38.0	36.33 ± 1.8
				G. graminis var tritici isolate 43				
7	CP	5.0	4.0	5.0	4.5	4.5	4.5	4.58 ± 0.34
	SPP	5.0	5.0	5.0	4.5	5.0	5.0	4.92 ± 0.19
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate 43						
14	CP	9.0	6.5	7.0	6.5	7.5	7.0	7.25 ± 0.85
	SPP	5.0	5.5	5.0	5.5	4.0	5.0	5.0 ± 0.5
	XYLAN	4.0	4.0	3.5	4.0	3.5	4.0	3.83 ± 0.24
	CMC	5.0	5.0	3.5	3.0	2.5	3.0	3.67 ± 0.99
28	CP	4.0	3.0	4.0	4.0	4.0	4.5	3.92 ± 0.45
	SPP	2.5	2.5	3.0	3.0	2.5	2.0	2.58 ± 0.34
	XYLAN	5.0	6.0	5.5	5.5	6.0	6.0	5.67 ± 0.37
	CMC	6.0	5.0	5.5	5.0	5.5	5.5	5.42 ± 0.34
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	27.0	28.0	29.0	29.0	28.0	28.0	28.17 ± 0.69
	CMC	30.0	32.0	34.0	32.0	31.0	31.0	31.67 ± 1.25
		G. graminis var tritici isolate WPBS1						
7	CP	6.0	6.0	8.0	8.0	7.0	8.0	7.17 ± 0.9
	SPP	3.0	3.0	4.5	4.0	4.5	3.0	3.67 ± 0.69
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	8.0	9.0	8.5	8.5	9.0	9.0	8.67 ± 0.37
	SPP	3.0	3.0	3.5	3.0	3.5	2.5	3.08 ± 0.34
	XYLAN	4.0	4.0	4.5	3.5	3.5	3.5	3.83 ± 0.37
	CMC	4.0	3.5	3.0	3.5	4.0	4.0	3.67 ± 0.37
28	CP	4.0	3.5	3.5	3.0	4.0	4.0	3.67 ± 0.37
	SPP	2.5	1.5	1.5	1.5	2.0	1.5	1.75 ± 0.38
	XYLAN	7.0	6.5	6.0	6.5	6.0	6.0	6.33 ± 0.37
	CMC	8.0	7.5	7.5	6.0	6.0	6.0	6.83 ± 0.85
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	32.0	32.0	29.0	32.0	30.0	32.0	31.17 ± 1.21
	CMC	26.0	24.0	26.0	26.0	26.0	26.0	25.67 ± 0.75

Powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring reduing groups liberated (µg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
7	CP	12.0	14.0	12.0	10.0	12.0	10.0	11.67 ± 1.37
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	10.0	8.0	8.0	6.0	10.0	8.0	8.33 ± 1.37
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	3.0	4.0	5.0	5.0	4.0	4.33 ± 0.75
	CMC	2.0	4.0	4.0	3.0	2.0	2.0	2.83 ± 0.9
21	CP	4.0	2.0	4.0	2.0	2.0	2.0	2.67 ± 0.94
	SPP	0	0	2.0	3.0	2.0	0	1.17 ± 1.21
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	8.0	10.0	9.0	9.0	8.0	9.0	9.0 ± 0.58
	CMC	2.0	3.0	2.0	2.0	2.0	2.0	2.17 ± 0.37
56	CP	0	0	0	0	0	0	0
	SPP	5.0	5.0	5.0	4.0	5.0	5.0	4.83 ± 0.37
	XYLAN	28.0	29.0	27.0	28.0	29.0	29.0	28.33 ± 0.75
	CMC	17.0	17.0	17.0	17.0	18.0	16.0	17.0 ± 0.58
				Cochliobolus sativus				
7	CP	10.0	9.0	10.0	10.0	8.0	9.0	9.33 ± 0.75
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	8.0	6.0	6.0	8.0	6.0	6.0	6.67 ± 0.94
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	5.0	4.0	5.0	4.0	5.0	4.67 ± 0.47
	CMC	2.0	2.0	2.0	2.0	2.0	2.0	2.0 ± 0

Powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring reducing groups liberated (µg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Cochliobolus sativus				
21	CP	2.0	2.0	2.0	3.0	2.0	3.0	2.33 ± 0.47
	SPP	2.0	2.0	2.0	2.0	0	2.0	1.33 ± 0.94
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	10.0	10.0	8.0	9.0	10.0	9.0	9.33 ± 0.75
	CMC	2.0	3.0	3.0	2.0	2.0	2.0	2.33 ± 0.47
56	CP	0	0	0	0	0	0	0
	SPP	5.0	4.0	4.0	5.0	4.0	4.0	4.33 ± 0.47
	XYLAN	33.0	34.0	32.0	34.0	33.0	34.0	33.33 ± 0.75
	CMC	12.0	14.0	14.0	12.0	14.0	13.0	13.17 ± 0.9
				G. graminis var tritici isolate og.12				
7	CP	12.0	13.0	12.0	12.0	13.0	12.0	12.33 ± 0.47
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	5.0	5.0	7.0	7.0	5.0	5.67 ± 0.94
	CMC	2.0	2.0	0	2.0	0	2.0	1.33 ± 0.94
14	CP	9.0	8.0	6.0	8.0	8.0	6.0	7.5 ± 1.12
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	3.0	5.0	3.0	3.0	3.0	3.67 ± 0.94
	CMC	4.0	2.0	4.0	2.0	2.0	2.0	2.67 ± 0.94
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	4.5	5.0	5.0	4.5	5.0	4.83 ± 0.24
	CMC	5.0	5.0	5.0	4.0	5.0	4.0	4.67 ± 0.47
21	CP	0	2.0	0	2.0	2.0	2.0	1.33 ± 0.94
	SPP	0	3	0	3.0	0	0	1.0 ± 1.41
	XYLAN	0	2.0	0	2.0	0	0	0.67 ± 0.94
56	CP	17.0	16.0	18.0	16.0	17.0	17.0	16.83 ± 0.69
	SPP	5.0	5.0	5.0	5.0	4.0	4.0	4.67 ± 0.47
	XYLAN	7.0	6.0	7.0	8.0	7.0	6.0	6.83 ± 0.69
	CMC	2.0	2.0	2.0	0	2.0	0	1.33 ± 0.94

Powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring reducing groups liberated (μg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				G. graminis var tritici isolate 43				
7	CP	10.0	10.0	8.0	9.0	9.0	9.0	9.17 ± 0.69
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	7.0	7.0	5.0	7.0	7.0	6.33 ± 0.94
	CMC	0	0	0	0	0	0	0
14	CP	6.0	6.0	8.0	6.0	6.0	6.0	6.33 ± 0.75
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
21	CP	0	2.0	0	0	3.0	2.0	0.83 ± 1.21
	SPP	2.0	0	2.0	0	0	0	0.67 ± 0.94
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	2.5	2.0	2.0	3.0	2.0	2.0	2.25 ± 0.38
	CMC	5.0	5.0	3.0	3.0	5.0	5.0	4.33 ± 0.94
56	CP	0	0	0	0	0	0	0
	SPP	7.0	6.0	7.0	6.0	7.0	7.0	6.67 ± 0.47
	XYLAN	9.0	8.0	9.0	8.0	9.0	9.0	8.67 ± 0.47
	CMC	5.0	3.0	5.0	3.0	5.0	5.0	4.33 ± 0.94
				G. graminis var tritici isolate WPBS1				
7	CP	9.0	9.0	10.0	9.0	8.0	9.0	9.0 ± 0.58
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	4.0	3.0	5.0	5.0	3.0	4.17 ± 0.9
	CMC	0	0	0	0	0	0	0
14	CP	6.0	8.0	7.0	8.0	6.0	8.0	7.17 ± 0.9
	SPP	0	0	0	0	0	0	0
	XYLAN	2.0	3.0	2.0	2.0	3.0	2.0	2.33 ± 0.47
	CMC	0	0	0	0	0	0	0
21	CP	0	2.0	3.0	0	2.0	2.0	1.5 ± 1.12
	SPP	2.0	3.0	0	0	2.0	0	1.17 ± 1.21
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Powdered wheat straww as carbon source (Contd.):

Enzyme activity by measuring reducing groups liberated (µg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
G. graminis var tritici isolate WPBS1								
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	2.0	2.0	2.0	3.0	3.0	2.0	2.33 ± 0.47
	CMC	5.0	5.0	3.0	5.0	5.0	5.0	4.66 ± 0.75
56	CP	0	0	0	0	0	0	0
	SPP	18.0	19.0	17.0	19.0	18.0	18.0	18.17 ± 0.69
	XYLAN	8.0	7.0	7.0	6.0	6.0	6.0	6.67 ± 0.75
	CMC	2.0	2.0	2.0	2.0	2.0	2.0	2.0 ± 0

Salts' extract of powdered wheat straw as carbon source

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
Fusarium culmorum								
7	CP	6.0	4.0	4.0	3.0	6.0	6.0	4.83 ± 1.21
	SPP	14.0	12.0	14.0	10.0	11.0	14.0	12.5 ± 1.61
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	12.0	14.0	12.0	10.5	12.0	11.0	11.92 ± 1.1
	SPP	2.0	2.0	1.5	1.5	2.0	2.0	1.83 ± 0.24
	XYLAN	18.0	18.0	20.0	18.0	18.0	18.0	18.33 ± 0.75
	CMC	12.0	10.0	8.0	10.0	8.0	10.0	9.67 ± 1.37
28	CP	0	3.0	4.0	0	3.0	3.0	2.17 ± 1.57
	SPP	3.0	2.0	1.5	1.5	1.0	1.5	1.75 ± 0.63
	XYLAN	19.0	18.0	18.0	19.0	19.0	19.0	18.67 ± 0.47
	CMC	11.0	10.0	11.0	9.0	10.0	9.5	10.08 ± 0.73
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	3.0	2.0	2.0	4.0	3.0	3.0	2.83 ± 0.69
	CMC	0	3.0	2.0	3.0	3.0	0	1.83 ± 1.34

Salts' extract of powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substates	1	2	3	4	5	6	Mean ± S.D.
		Cochliobolus sativus						
7	CP	4.0	2.5	3.0	4.0	3.0	3.0	3.25 ± 0.56
	SPP	7.0	6.0	7.0	6.5	5.0	7.0	6.42 ± 0.73
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	7.0	8.0	7.0	6.5	7.0	7.0	7.08 ± 0.45
	SPP	1.0	0	1.5	0	2.0	1.0	0.92 ± 0.73
	XYLAN	13.0	11.0	11.5	13.0	13.0	13.0	12.42 ± 0.84
	CMC	7.0	6.0	7.0	6.0	6.0	6.0	6.33 ± 0.47
28	CP	2.0	1.0	1.5	1.5	2.0	2.0	1.67 ± 0.37
	SPP	0	0	0	0	0	0	0
	XYLAN	19.0	17.0	17.5	18.0	17.0	21.0	18.25 ± 1.41
	CMC	7.0	8.0	8.0	6.5	6.5	8.0	7.33 ± 0.69
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	3.0	2.0	1.5	1.5	2.0	2.0	2.0 ± 0.5
	CMC	1.5	1.0	0	1.0	0	0	0.58 ± 0.61
		G. graminis var tritici isolate og.12						
7	CP	6.0	4.0	3.5	3.5	4.0	4.0	4.17 ± 0.85
	SPP	7.0	6.0	6.0	7.0	7.0	7.0	6.67 ± 0.47
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	6.0	6.0	4.0	5.0	6.0	6.0	5.5 ± 0.76
	SPP	2.0	2.0	1.5	2.0	2.0	2.0	1.92 ± 0.19
	XYLAN	13.0	12.0	13.0	11.5	13.0	13.0	12.58 ± 0.61
	CMC	16.0	16.0	13.0	15.0	16.0	14.0	15.0 ± 1.15
28	CP	4.0	4.0	4.0	3.5	4.0	4.0	3.92 ± 0.19
	SPP	0	0	0	0	0	0	0
	XYLAN	18.0	18.0	19.0	19.5	19.0	18.0	18.58 ± 0.61
	CMC	18.0	18.0	16.0	16.5	18.0	18.0	17.42 ± 0.84

Salts' extract of powdered wheat straw as carbon source (Contd.):

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var titici isolate og.12						
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	1.0	2.0	1.5	3.0	2.0	2.0	1.92 ± 0.61
	CMC	3.0	5.0	4.5	4.5	3.0	3.0	3.83 ± 0.85
		G. graminis var tritici isolate 43						
7	CP	3.0	2.5	4.0	2.5	3.0	3.0	3.0 ± 0.5
	SPP	9.0	7.0	7.0	7.5	8.0	9.0	7.92 ± 0.84
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	12.0	10.0	12.0	10.0	9.0	10.0	10.5 ± 1.12
	SPP	2.0	2.0	2.0	2.0	2.0	2.0	2.0 ± 0
	XYLAN	13.0	13.0	11.0	12.0	11.0	13.0	12.17 ± 0.9
	CMC	13.0	11.5	11.5	13.0	12.0	11.0	12.0 ± 0.76
28	CP	4.0	6.0	4.0	6.0	3.5	6.0	4.92 ± 1.1
	SPP	0	0	0	0	0	0	0
	XYLAN	13.0	13.0	11.0	12.0	11.0	13.0	12.17 ± 0.9
	CMC	15.0	16.0	16.0	15.5	15.0	15.0	15.42 ± 0.45
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	1.0	1.5	1.5	2.0	2.0	2.0	1.67 ± 0.37
	CMC	3.0	4.5	4.5	3.0	4.0	3.0	3.67 ± 0.69
		G. graminis var tritici isolate WPBS1						
7	CP	11.0	8.0	10.0	9.0	8.0	8.0	9.0 ± 1.15
	SPP	0	1.5	2.0	0	1.5	0	0.83 ± 0.85
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	12.0	12.0	14.0	16.0	14.0	13.0	13.5 ± 1.38
	SPP	1.5	1.0	2.0	1.5	1.5	1.5	1.5 ± 0.29
	XYLAN	10.0	8.0	8.5	9.0	8.5	8.0	8.67 ± 0.69
	CMC	14.0	13.0	11.5	11.5	14.0	14.0	13.0 ± 1.12

Salts' extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate WPBS1						
28	CP	4.0	4.0	3.0	4.0	4.0	4.0	3.83 ± 0.37
	SPP	0	0	0	0	0	0	0
	XYLAN	17.0	13.0	13.0	16.5	15.0	15.0	14.92 ± 1.54
	CMC	15.0	16.0	16.0	16.0	16.0	16.0	15.83 ± 0.37
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	3.0	2.5	3.0	2.5	2.0	3.0	2.67 ± 0.37
	CMC	2.0	2.5	3.0	4.0	3.0	4.0	3.08 ± 0.73

Enzyme activity by measuring reducing groups liberated (µg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		Fusarium culmorum						
7	CP	28.0	29.0	27.0	29.0	29.0	27.0	28.17 ± 0.9
	SPP	0	0	0	6.0	5.0	8.0	3.17 ± 3.29
	XYLAN	3.0	3.0	4.0	4.0	3.0	3.0	3.33 ± 0.47
	CMC	0	0	0	0	0	0	0
14	CP	2.0	3.0	2.0	2.0	3.0	2.0	2.33 ± 0.47
	SPP	2.0	3.0	2.0	2.0	2.0	2.0	2.17 ± 0.37
	XYLAN	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
	CMC	7.0	5.0	6.0	6.0	6.0	6.0	6.0 ± 0.58
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	9.0	9.0	9.0	8.0	9.0	7.0	8.5 ± 0.76
	CMC	2.0	3.0	2.5	3.0	2.0	3.0	2.58 ± 0.45
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	6.0	5.0	6.0	5.0	6.0	6.0	5.67 ± 0.47
	CMC	2.0	2.5	2.5	2.0	2.0	3.0	2.33 ± 0.37
		Cochliobolus sativus						
7	CP	19.0	21.0	19.0	22.0	19.0	19.0	19.83 ± 1.21
	SPP	0	6.0	0	6.0	0	0	2.0 ± 2.83
	XYLAN	4.0	4.0	4.0	3.0	4.0	4.0	3.83 ± 0.37
	CMC	0	0	0	0	0	0	0

Salts' extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring reducing groups liberated (µg ml^{-1})

Cochliobolus sativus

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
14	CP	2.0	2.0	2.0	2.0	2.0	2.0	2.0 ± 0
	SPP	2.0	2.0	2.5	2.0	2.0	3.0	2.25 ± 0.38
	XYLAN	5.0	4.0	5.0	6.0	5.0	5.0	5.0 ± 0.58
	CMC	2.0	2.0	3.0	2.0	2.0	3.0	2.33 ± 0.47
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	7.0	6.0	7.0	7.0	6.0	7.0	6.67 ± 0.47
	CMC	2.0	1.5	1.5	2.0	2.0	2.0	1.83 ± 0.24
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	3.0	5.0	3.5	3.5	5.0	4.17 ± 0.85
	CMC	2.0	2.0	1.5	2.0	1.5	2.0	1.83 ± 0.24

G. graminis var tritici isolate og.12

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	17.0	19.0	17.0	18.0	19.0	19.0	18.17 ± 0.9
	SPP	3.5	5.0	3.5	5.0	3.5	4.0	4.08 ± 0.67
	XYLAN	3.4	2.0	3.5	2.0	3.0	2.5	2.75 ± 0.63
	CMC	0	0	0	0	0	0	0
14	CP	2.0	1.5	2.0	2.0	2.0	2.0	1.92 ± 0.19
	SPP	0	0	0	0	0	0	0
	XYLAN	7.0	9.0	7.0	9.0	7.0	7.0	7.67 ± 0.94
	CMC	5.0	5.0	5.0	4.0	5.0	5.0	4.83 ± 0.37
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	9.0	9.0	9.0	9.0	9.0	8.0	8.83 ± 0.37
	CMC	5.0	3.0	5.0	3.0	3.0	3.0	3.67 ± 0.94
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	3.0	3.0	3.0	3.0	3.0	3.0	3.0 ± 0
	CMC	2.0	3.0	3.0	3.0	2.0	2.0	2.5 ± 0.5

Salts' extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring reducing groups liberated (μg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate 43						
7	CP	22.0	20.0	22.0	21.0	20.0	22.0	21.17 ± 0.9
	SPP	5.0	5.0	5.0	5.0	5.0	5.0	5.0 ± 0
	XYLAN	2.0	2.5	2.0	2.0	1.5	2.0	2.0 ± 0.29
	CMC	0	0	0	0	0	0	0
14	CP	9.0	7.0	9.0	9.0	8.0	9.0	8.5 ± 0.76
	SPP	5.0	2.5	3.0	5.0	3.0	5.0	3.92 ± 1.1
	XYLAN	2.0	2.0	2.0	2.5	3.0	2.0	2.25 ± 0.38
	CMC	2.0	2.0	2.0	1.5	1.5	2.0	1.83 ± 0.24
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	5.0	5.0	6.0	6.0	5.0	5.0	5.33 ± 0.47
	CMC	3.0	3.0	3.0	3.0	2.5	3.0	2.92 ± 0.19
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	3.0	2.5	2.5	1.5	2.0	3.0	2.42 ± 0.53
	CMC	2.0	1.5	1.5	1.5	2.0	1.5	1.67 ± 0.24
		G. graminis var tritici isolate WPBS1						
7	CP	50.0	49.0	50.0	49.0	51.0	50.0	49.83 ± 0.69
	SPP	3.0	2.5	3.0	2.0	3.0	2.0	2.58 ± 0.45
	XYLAN	2.0	2.5	2.0	2.0	1.5	2.0	2.0 ± 0.29
	CMC	0	0	0	0	0	0	0
14	CP	7.0	6.0	8.0	7.0	7.0	7.0	7.0 ± 0.58
	SPP	5.0	4.0	5.0	3.0	5.0	5.0	4.5 ± 0.76
	XYLAN	5.0	4.0	4.0	5.0	4.0	4.0	4.33 ± 0.47
	CMC	5.0	5.0	3.0	4.5	4.0	5.0	4.42 ± 0.73
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	9.0	8.0	7.0	9.0	8.0	9.0	8.33 ± 0.75
	CMC	5.0	3.0	4.5	4.0	4.0	5.0	4.25 ± 0.69
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	2.0	2.0	2.5	2.5	2.5	3.0	2.42 ± 0.34
	CMC	2.0	3.0	2.5	3.0	2.0	3.0	2.58 ± 0.45

Glucose in salts' medium as carbon source (control)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
7	CP	16.0	14.0	16.0	15.0	18.0	16.0	15.83 ± 1.21
	SPP	6.0	4.0	4.0	4.0	6.0	4.0	4.67 ± 0.94
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	58.0	64.0	58.0	68.0	58.0	58.0	60.66 ± 3.94
	SPP	12.0	12.0	8.0	8.0	12.0	8.0	10.0 ± 2.0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	6.0	6.0	5.0	6.0	6.0	6.0	5.83 ± 0.37
	SPP	36.0	42.0	38.0	46.0	46.0	40.0	41.33 ± 3.77
	XYLAN	0	0	0	0	0	0	0
	CMC	8.0	8.0	6.0	5.0	8.0	8.0	7.17 ± 1.21
56	CP	6.0	4.0	4.0	3.5	3.5	4.0	4.17 ± 0.85
	SPP	16.0	10.0	12.0	11.5	15.0	12.0	12.75 ± 2.08
	XYLAN	0	0	0	0	0	0	0
	CMC	2.0	1.5	3.0	3.0	2.0	2.0	2.25 ± 0.56
				Cochliobolus sativus				
7	CP	38.0	35.0	36.0	34.0	38.0	32.0	35.5 ± 2.14
	SPP	12.0	8.0	10.0	10.0	10.0	7.0	9.5 ± 1.61
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	46.0	38.0	38.0	38.0	46.0	38.0	40.67 ± 3.77
	SPP	10.0	7.0	8.0	8.0	10.0	8.0	8.5 ± 1.12
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	3.0	3.0	4.0	5.0	3.0	3.0	3.5 ± 0.76
	SPP	30.0	38.0	42.0	38.0	45.0	36.0	38.17 ± 4.71
	XYLAN	0	0	0	0	0	0	0
	CMC	12.0	8.0	10.0	12.0	9.0	9.0	10.0 ± 1.53

Glucose in salts' medium as carbon source (Control)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Cochliobolus sativus				
56	CP	3.0	1.5	2.0	1.5	2.0	1.5	1.92 ± 0.53
	SPP	22.0	26.0	26.0	26.0	22.0	20.0	23.66 ± 2.43
	XYLAN	0	0	0	0	0	0	0
	CMC	1.5	0	0	2.0	0	2.0	0.58 ± 0.84
				G. graminis var tritici isolate og.12				
7	CP	16.0	10.0	14.0	10.0	10.0	12.0	12.0 ± 2.31
	SPP	4.0	3.0	2.0	3.0	3.0	3.0	3.0 ± 0.58
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	36.0	38.0	36.0	36.0	36.0	38.0	36.67 ± 0.94
	SPP	12.0	12.0	12.0	10.0	12.0	12.0	11.67 ± 0.75
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	80.0	92.0	86.0	92.0	112.0	98.0	93.33 ± 10.04
	SPP	106.0	114.0	108.0	111.0	106.0	118.0	110.5 ± 4.39
	XYLAN	0	0	0	0	0	0	0
	CMC	9.0	9.0	7.0	7.0	6.0	7.0	7.5 ± 1.12
56	CP	18.0	25.0	16.0	28.0	34.0	28.0	24.83 ± 6.18
	SPP	54.0	56.0	56.0	56.0	56.0	54.0	55.33 ± 0.94
	XYLAN	0	0	0	0	0	0	0
	CMC	3.0	2.0	0	2.0	0	2.0	1.5 ± 1.12
				G. graminis var tritici isolate 43				
7	CP	14.0	13.0	11.0	8.0	8.0	11.0	10.83 ± 2.27
	SPP	3.0	2.0	2.0	2.0	2.0	2.5	2.25 ± 0.38
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	36.0	36.0	36.0	36.0	36.0	36.0	36.0 ± 0
	SPP	12.0	10.0	10.0	10.0	12.0	10.0	10.67 ± 0.94
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose in salts' medium as carbon source (Control)(Contd.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var *tritici* isolate 43						
28	CP	48.0	58.0	62.0	49.0	62.0	56.0	55.83 ± 5.61
	SPP	56.0	58.0	58.0	56.0	64.0	58.0	58.33 ± 2.69
	XYLAN	0	0	0	0	0	0	0
	CMC	12.0	10.0	8.0	9.0	9.0	9.0	9.5 ± 1.26
56	CP	12.0	12.0	10.0	8.0	8.0	12.0	10.33 ± 1.8
	SPP	26.0	28.0	28.0	27.0	28.0	28.0	27.5 ± 0.76
	XYLAN	0	0	0	0	0	0	0
	CMC	3.0	3.0	1.5	0	1.5	0	1.5 ± 1.22
		G. graminis var *tritici* isolate WPBS1						
7	CP	12.0	10.0	8.0	8.0	8.0	9.0	9.17 ± 1.46
	SPP	2.0	1.5	1.5	2.0	2.0	2.0	1.83 ± 0.24
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	30.0	30.0	36.0	32.0	32.0	30.0	31.67 ± 2.13
	SPP	12.0	10.0	8.0	8.0	12.0	11.0	10.17 ± 1.67
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	48.0	52.0	52.0	46.0	48.0	48.0	49.0 ± 2.24
	SPP	48.0	58.0	48.0	56.0	50.0	56.0	52.66 ± 4.11
	XYLAN	0	0	0	0	0	0	0
	CMC	8.0	6.0	6.0	6.0	7.0	7.0	6.67 ± 0.75
56	CP	10.0	10.0	8.0	8.0	10.0	10.0	9.33 ± 0.94
	SPP	20.0	20.0	18.0	18.0	18.0	17.0	18.5 ± 1.12
	XYLAN	0	0	0	0	0	0	0
	CMC	2.0	1.5	2.0	0	2.0	0	1.25 ± 0.9

Enzyme activity by measuring reducing groups liberated (µg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		Fusarium culmorum						
7	CP	166.0	166.0	168.0	166.0	167.0	166.0	166.5 ± 0.76
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose in salts' medium as carbon source (Control)(Contd.)

Enzyme activity by measuring reducing groups liberated ($\mu g\ ml^{-1}$)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
Fusarium culmorum								
14	CP	146.0	144.0	148.0	146.0	148.0	146.0	146.33 ± 1.37
	SPP	20.0	18.0	20.0	19.0	21.0	20.0	19.67 ± 0.94
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	168.0	167.0	169.0	166.0	168.0	166.0	167.33 ± 1.11
	SPP	14.0	12.0	14.0	13.0	12.0	14.0	13.17 ± 0.98
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	3.0	3.0	0	0	1.0 ± 1.41
56	CP	68.0	67.0	69.0	68.0	68.0	67.0	67.83 ± 0.69
	SPP	12.0	10.0	11.0	11.0	10.0	12.0	11.0 ± 0.82
	XYLAN	0	0	0	0	0	0	0
	CMC	6.0	8.0	6.0	6.0	5.0	6.0	6.17 ± 0.9
Cochliobolus sativus								
7	CP	154.0	153.0	152.0	153.0	154.0	154.0	153.33 ± 0.75
	SPP	7.0	6.0	6.0	6.0	7.0	7.0	6.5 ± 0.5
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	170.0	169.0	170.0	169.0	170.0	170.0	169.67 ± 0.47
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	2.0	3.0	0	2.0	1.17 ± 1.21
28	CP	172.0	169.0	169.0	169.0	170.0	172.0	170.17 ± 1.34
	SPP	18.0	16.0	18.0	18.0	18.0	18.0	17.67 ± 0.75
	XYLAN	0	0	0	0	0	0	0
	CMC	5.0	3.0	3.0	5.0	3.5	5.0	4.08 ± 0.93
56	CP	70.0	69.0	68.0	69.0	68.0	68.0	68.67 ± 0.75
	SPP	8.0	8.0	7.0	8.0	7.0	7.0	7.5 ± 0.5
	XYLAN	0	0	0	0	0	0	0
	CMC	5.0	4.0	3.5	3.5	5.0	4.0	4.17 ± 0.62

Glucose in salts' medium as carbon source (Control)(Contd.)

Enzyme activity by measuring reducing groups liberated (μg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate og.12						
7	CP	164.0	166.0	168.0	168.0	164.0	166.0	166.0 ± 1.63
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	169.0	172.0	169.0	170.0	170.0	172.0	170.33 ± 1.25
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	168.0	169.0	168.0	170.0	170.0	169.0	169.0 ± 0.82
	SPP	2.0	3.0	2.5	3.0	2.5	2.5	2.58 ± 0.34
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	69.0	68.0	69.0	72.0	72.0	68.0	69.67 ± 1.7
	SPP	2.0	2.5	2.5	3.0	2.5	2.5	2.5 ± 0.29
	XYLAN	0	0	0	0	0	0	0
	CMC	7.0	9.0	8.0	9.0	8.5	8.0	8.25 ± 0.69
		G. graminis var tritici isolate 43						
7	CP	160.0	158.0	158.0	159.0	160.0	159.0	160.67 ± 3.82
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	149.0	149.0	148.0	150.0	149.0	148.0	148.83 ± 0.69
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	150.0	149.0	150.0	148.0	149.0	149.0	149.17 ± 0.69
	SPP	0	2.0	3.0	0	1.5	2.0	1.42 ± 1.1
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose in salts' medium as carbon source (Control)(Contd.)

Enzyme activity by measuring reducing groups liberated ($\mu g\ ml^{-1}$)

G. graminis var tritici isolate 43

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
56	CP	49.0	48.0	48.0	49.0	48.0	48.0	48.33 ± 0.47
	SPP	2.0	1.5	0	0	1.5	2.0	1.17 ± 0.85
	XYLAN	0	0	0	0	0	0	0
	CMC	2.0	1.5	0	2.0	0	0	0.92 ± 0.93

G. graminis var tritici isolate WPBS1

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	152.0	151.0	151.0	149.0	152.0	152.0	151.17 ± 1.1
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	138.0	140.0	139.0	140.0	139.0	138.0	139.0 ± 0.82
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	152.0	149.0	149.0	150.0	150.0	148.0	149.67 ± 1.25
	SPP	2.0	0	1.5	0	2.0	0	0.58 ± 0.84
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	46.0	48.0	46.0	46.0	46.0	47.0	46.5 ± 0.76
	SPP	2.0	2.0	1.5	2.0	1.5	1.5	1.75 ± 0.25
	XYLAN	0	0	0	0	0	0	0
	CMC	10.0	8.0	8.0	8.0	9.0	8.5	8.58 ± 0.73

Distilled water extract of powdered wheat straw as carbon source

Enzyme activity by measuring viscosity (nuits ml^{-1})

Fusarium culmorum

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Distilled water extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
14	CP	2.0	2.0	1.5	1.5	2.0	2.0	1.83 ± 0.24
	SPP	0	0	0	0	0	0	0
	XYLAN	0.5	0	0	0.5	0.5	0.5	0.33 ± 0.24
	CMC	0.6	0	0.5	0	0.4	0	0.25 ± 0.26
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0.5	1.0	0.5	0.8	0.5	0.8	0.68 ± 0.2
	CMC	0.5	0.5	0.5	1.0	0.5	0.5	0.58 ± 0.19
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
				Cochliobolus sativus				
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	1.5	1.5	1.0	1.0	1.5	1.5	1.33± 0.24
	SPP	0	0	0	0	0	0	0
	XYLAN	0.3	0	0.5	0	0.5	0.5	0.3 ± 0.22
	CMC	0.6	0.3	0	0.2	0	0	0.18 ± 0.22
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0.5	0.5	0.5	0.5	0.5	0.8	0.55 ± 0.11
	CMC	0.5	0.8	0.5	0.5	0.3	0.5	0.52 ± 0.15
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Distilled water extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate og.12						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	1.5	1.5	2.0	1.5	1.0	1.5	1.5 ± 0.29
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0.5	0.5	0.8	0.5	0.5	0.5	0.55 ± 0.11
	CMC	0.5	0.5	0.3	0.8	0.3	0.3	0.45 ± 0.18
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
		G. graminis var tritici isolate 43						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	1.5	2.0	1.0	1.0	1.0	0.5	1.17 ± 0.47
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0.5	0.5	0.5	0	0.5	0	0.33 ± 0.24
	CMC	0.3	0.2	0.3	0.3	0.3	0.3	0.28 ± 0.04

Distilled water extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring viscosity (units ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate 43						
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
		G. graminis var tritici isolate WPBS1						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0.8	0.6	0	1.0	1.5	1.0	0.82 ± 0.46
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0.3	0.5	0.5	0.5	0.5	0.3 ± 0.22
	CMC	0.5	0	0.5	0.5	0	0.3	0.3 ± 0.22
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring reducing groups liberated (µg ml^{-1})

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		Fusarium culmorum						
7	CP	9.0	6.0	7.0	9.0	6.0	6.0	7.17 ± 1.34
	SPP	5.0	4.0	0	0	2.0	0	1.83 ± 2.03
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0

Distilled water extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring reducing groups liberated (μg/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
14	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	2.0	1.5	1.5	2.0	2.0	2.0	1.83 ± 0.24
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
				Cochliobolus sativus				
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	1.5	1.5	1.5	1.0	1.5	0.5	1.08 ± 0.45
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
				G. graminis var tritici isolate og.12				
7	CP	9.0	12.0	6.0	9.0	6.0	7.0	8.17 ± 2.11
	SPP	0	2.0	0	0	3.0	0	0.83 ± 1.21

Distilled water extract of powdered wheat straw as carbon source(Contd)

Enzyme activity by measuring reducing groups liberated (μg/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate og.12						
7	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
		G. graminis var tritici isolate 43						
7	CP	6.0	4.0	4.0	6.0	3.0	4.0	4.5 ± 1.12
	SPP	0	2.0	1.5	0	2.0	0	0.92 ± 0.93
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0.8	0.8	1.5	1.5	0.8	0.8	1.03 ± 0.33
	CMC	1.5	1.0	1.5	0	0	1.5	0.92 ± 0.67
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Distilled water extract of powdered wheat straw as carbon source (Contd.)

Enzyme activity by measuring reducing groups liberated (µg/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate WPBS1						
7	CP	0	0	0	0	0	0	0
	SPP	0	1.5	0	1.5	0	0	0.5 ± 0.71
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	2.0	1.5	0.7	0.8	1.0	1.0	1.22 ± 0.48
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Control)

Enzyme activity by measuring viscosity (units/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		Fusarium culmorum						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Control)

Enzyme activity by measuring viscosity (units/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		Fusarium culmorum						
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
		Cochliobolus sativus						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
		G. graminis var tritici isolate og.12						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Control)

Enzyme activity by measuring viscosity (units/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
		G. graminis var tritici isolate og.12						
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
		G. graminis var tritici isolate 43						
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Contd.)

Enzyme activity by measuring viscosity (units/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				G. graminis var tritici isolate WPBS1				
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Enzyme activity by measuring reducing groups liberated (μg/ml)

Fusarium culmorum

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
7	CP	9.0	7.0	9.0	6.0	9.0	9.0	8.17 ± 1.21
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Contd.)

DAYS	Enzyme Substrates	Enzyme activity by measuring reducing groups liberated (μg/ml)						
		1	2	3	4	5	6	Mean ± S.D.
				Fusarium culmorum				
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
				Cochliobolus sativus				
7	CP	6.0	4.0	3.0	3.0	4.0	3.0	3.83 ± 1.07
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
				G. graminis var tritici isolate og12				
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Contd.)

Enzyme activity by measuring reducing groups liberated (μg/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
G. graminis var tritici isolate og.12								
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
G. graminis var tritici isolate 43								
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
G. graminis var tritici isolate WPBS1								
7	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Glucose dissolved in distilled water as carbon source (Contd.)

Enzyme activity by measuring reducing groups liberated (μg/ml)

DAYS	Enzyme Substrates	1	2	3	4	5	6	Mean ± S.D.
				G. graminis var tritici isolate WPBS1				
14	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
28	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0
56	CP	0	0	0	0	0	0	0
	SPP	0	0	0	0	0	0	0
	XYLAN	0	0	0	0	0	0	0
	CMC	0	0	0	0	0	0	0

Dry weight of mycelium produced at harvest (mg)

Powdered wheat straw as carbon source

DAYS	Fusarium culmorum			Cochliobolus sativus		
7	43.1	42.9	43.0 ± 0.1	39.3	37.9	38.6 ± 0.7
14	83.5	84.1	83.8 ± 0.3	86.5	86.1	86.3 ± 0.2
21	242.9	243.9	243.4 ± 0.5	222.7	223.9	223.3 ± 0.6
28	339.8	341.4	340.6 ± 0.9	296.7	298.3	297.5 ± 0.8
56	337.9	339.7	338.8 ± 0.9	299.8	302.2	301.0 ± 1.2

Salts' extract of powdered wheat straw as carbon source

DAYS	Fusarium culmorum			Cochliobolus sativus		
7	8.5	8.1	8.3 ± 0.2	13.4	13.6	13.5 ± 0.1
14	33.9	33.6	33.75 ± 0.15	22.8	23.3	23.05 ± 0.25
28	78.4	79.3	78.85 ± 0.45	42.5	41.9	42.2 ± 0.3
56	89.9	90.2	90.05 ± 0.15	63.6	64.4	64.0 ± 0.4

Glucose dissolved in salts' medium as carbon source (Contol)

DAYS	Fusarium culmorum			Cochliobolus sativus		
7	35.9	35.2	35.55 ± 0.35	33.2	29.5	31.35 ± 1.85
14	95.6	97.2	96.4 ± 0.8	56.5	55.9	56.2 ± 0.3
28	179.7	180.4	180.05 ± 0.5	87.2	86.6	86.9 ± 0.3
56	163.8	164.1	163.95 ± 0.15	139.4	139.9	139.65 ± 0.25

Dry weight of mycelium produced at harvest (mg)

DAYS	GGT og.12			GGT. 43			GGT. WPBS1		
	Powdered wheat straw as carbon source								
7	29.8	30.2	30.0 ± 0.2	38.7	39.1	38.9 ± 0.2	29.8	29.4	29.6 ± 0.2
14	79.1	78.4	78.75 ± 0.35	79.3	79.7	79.5 ± 0.2	83.6	84.1	83.85 ± 0.25
21	201.8	201.4	201.6 ± 0.2	208.5	209.1	208.3 ± 0.3	206.8	207.3	207.05 ± 0.25
28	490.8	491.2	491.0 ± 0.2	491.9	492.3	492.1 ± 0.2	439.5	440.2	439.85 ± 0.35
56	489.6	490.7	490.15 ± 0.55	478.6	477.9	478.25 ± 0.35	437.5	439.2	438.35 ± 0.85
	Salts' extract of powdered wheat straw as carbon source								
7	12.6	12.3	12.45 ± 0.15	11.9	11.6	11.75 ± 0.15	11.8	12.1	11.95 ± 0.15
14	34.6	35.2	34.9 ± 0.3	45.1	45.3	45.2 ± 0.1	39.9	40.2	40.05 ± 0.15
28	77.6	76.9	77.25 ± 0.35	78.9	79.3	79.1 ± 0.2	58.9	59.3	59.1 ± 0.2
56	83.6	84.1	83.85 ± 0.25	89.3	88.7	89.0 ± 0.3	70.2	70.4	70.3 ± 0.1
	Glucose dissolved in salts' medium as carbon source (Control)								
7	22.5	21.8	22.15 ± 0.35	26.5	25.6	26.05 ± 0.45	27.8	28.1	27.95 ± 0.15
14	45.6	46.2	45.9 ± 0.3	41.8	42.4	42.1 ± 0.3	35.9	35.3	35.6 ± 0.3
28	72.9	73.7	73.3 ± 0.4	64.7	65.2	64.95 ± 0.25	68.9	69.5	69.2 ± 0.3
56	83.1	82.9	83.0 ± 0.1	72.3	71.8	72.05 ± 0.25	68.8	67.9	68.35 ± 0.45
	Distilled water extract of powdered wheat straw as carbon source								
7	21.2	20.8	21.0 ± 0.2	20.6	19.8	20.2 ± 0.4	29.4	27.9	28.65 ± 0.75
14	22.0	23.1	22.55 ± 0.55	18.9	17.9	18.4 ± 0.5	14.4	13.9	14.15 ± 0.25
28	10.8	9.7	10.25 ± 0.55	8.6	7.9	8.25 ± 0.35	8.6	8.9	8.75 ± 0.15
56	4.5	3.9	4.2 ± 0.3	3.9	4.3	4.1 ± 0.2	5.2	4.6	4.9 ± 0.3

Dry weight of mycelium produced at harvest (mg)

Glucose dissolved in distilled water as carbon source (Control)

DAYS	GGT. og.12			GGT. 43			GGT. WPBS1		
7	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0

DAYS	F. culmorum			C. sativus		
7	4.9	5.1	5.0 ± 0.1	3.9	4.1	4.0 ± 0.1
14	5.1	4.6	4.85 ± 0.25	4.4	4.0	4.2 ± 0.2
28	2.7	2.4	2.55 ± 0.15	2.2	1.9	2.05 ± 0.15
56	1.4	1.2	1.3 ± 0.1	1.1	0.9	1.0 ± 0.1

Distilled water extract of powdered wheat straw as carbon source

7	24.2	23.6	23.9 ± 0.3	33.9	32.2	33.05 ± 0.85
14	22.1	23.8	22.95 ± 0.85	20.1	18.6	19.35 ± 0.75
28	4.8	4.1	4.45 ± 0.35	11.6	10.6	11.1 ± 0.5
56	2.6	1.6	1.85 ± 0.25	6.7	5.9	6.3 ± 0.4

Reducing sugar concentrations in culture filtrates at harvest (mg/ml)

1. Powdered wheat straw as carbon source

DAYS	Fusarium culmorum							Cochliobolus sativus						
7	2.5	0	2.0	2.5	2.5	0	1.58 ± 1.13	0	2.0	2.5	2.5	2.0	2.0	1.83 ± 0.85
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	7.1	5.9	7.0	4.8	7.1	7.0	6.48 ± 0.86	5.0	5.0	3.5	5.0	2.5	2.5	3.92 ± 1.13
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2. Salts' extract of powdered wheat straw as carbon source

7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3. Distilled water extract of powdered wheat straw as carbon source

7	2.0	2.5	2.0	2.0	2.5	1.5	2.08 ± 0.34	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4. Glucose dissolved in salts' medium as carbon source

Fusarium culmorum

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	6.85	7.2	6.65	7.06	6.75	6.85	6.89 ± 0.18
14	0	0	0.24	0.12	0	0.09	0.08 ± 0.09
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

Cochliobolus sativus

7	10.33	11.2	10.58	10.8	10.66	10.3	10.65 ± 0.3
14	6.95	6.33	6.72	6.84	6.07	6.99	6.65 ± 0.34
28	3.14	3.2	2.8	2.53	3.43	3.2	3.05 ± 0.3
56	0	0	0	0	0	0	0

5. Glucose dissolved in distilled water as carbon source

Fusarium culmorum

7	10.4	11.3	10.25	10.68	11.6	10.85	10.85 ± 0.48
14	11.95	11.75	12.02	11.96	11.96	11.75	11.9 ± 0.16
28	11.75	11.75	12.02	11.96	12.02	12.2	11.95 ± 0.16
56	12.2	12.2	12.2	12.02	12.2	12.2	12.17 ± 0.07

5. Glucose dissolved in ditilled water as carbon source (Contd.)

Cochliobolus sativus

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	10.85	11.4	11.86	10.68	11.32	10.4	11.09 ± 0.49
14	11.85	11.98	11.86	10.95	11.1	10.85	11.43 ± 0.47
28	12.2	12.02	11.98	12.2	11.75	11.85	12.0 ± 0.17
56	12.2	12.2	12.2	12.3	12.3	12.02	12.2 ± 0.09

G. graminis var tritici isolate og.12

7	11.96	12.2	12.38	11.8	12.2	12.06	12.1 ± 0.19
14	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
28	12.2	12.06	12.2	11.98	12.2	12.2	12.14 ± 0.09
56	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0

G. graminis var tritici isolate 43

7	12.2	12.2	12.06	12.2	12.2	12.2	12.18 ± 0.05
14	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
28	12.2	12.2	12.06	11.98	12.2	12.2	12.14 ± 0.09
56	12.2	12.3	12.2	12.3	12.2	12.2	12.23 ± 0.05

G. graminis var tritici isolate WPBS1

7	12.2	12.2	12.2	12.2	12.2	11.98	12.16 ± 0.08
14	12.2	12.2	12.2	12.2	12.2	12.2	12.2 ± 0
28	12.2	12.06	12.2	11.98	12.06	12.2	12.12 ± 0.09
56	12.3	12.2	12.2	12.3	12.3	12.3	12.27 ± 0.05

Glucose dissolved in salts' medium as carbon source

GGT. og.12

7	12.06	11.95	12.73	11.89	12.13	12.06	12.14 ± 0.28
14	8.96	9.33	8.25	8.7	9.05	8.25	8.76 ± 0.4
28	5.45	6.08	4.83	5.3	4.92	4.66	5.21 ± 0.47
56	0	0	0	0	0	0	0

GGT. 43

7	11.86	11.89	12.13	12.65	12.78	11.95	12.21 ± 0.37
14	9.95	8.23	9.05	8.69	9.33	8.96	9.04 ± 0.53
28	6.08	5.93	6.75	5.3	6.15	5.98	6.03 ± 0.42
56	0	0	0	0	0	0	0

Glucose dissolved in salts' medium as carbon source (Contd.)

GGT. WPBS1

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	12.13	12.38	12.73	11.95	11.89	12.65	12.29 ± 0.32
14	9.69	9.02	8.96	8.75	9.23	8.96	9.1 ± 0.3
28	5.93	6.15	4.83	4.92	6.08	4.65	5.43 ± 0.63
56	0	0	0	0	0	0	0

Powdered wheat straw as carbon source

GGT. og.12

7	0	0	0	0	0	0	0
14	2.5	2.5	2.0	2.0	2.5	2.5	2.23 ± 0.24
28	7.0	7.0	5.0	7.0	5.0	7.0	6.33 ± 0.94
56	2.5	2.0	2.0	2.5	2.0	2.0	2.17 ± 0.24

GGT. 43

7	2.0	2.0	1.5	2.0	1.0	2.0	1.75 ± 0.38
14	0	0	0	0	0	0	0
21	3.5	5.0	5.0	3.5	3.5	5.0	4.25 ± 0.75
28	0	0	0	0	0	0	0
56	2.0	2.0	2.0	3.0	3.0	2.0	2.33 ± 0.47

GGT. WPBS1

7	3.5	2.5	2.0	2.5	2.0	2.0	2.42 ± 0.53
14	0	0	0	0	0	0	0
21	5.0	3.5	5.0	3.0	5.0	5.0	4.42 ± 0.84
28	0	0	0	0	0	0	0
56	2.0	4.0	3.5	2.0	3.0	2.0	2.75 ± 0.8

Salts' extract of powdered wheat straw as carbon source

GGT. og.12

7	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

GGT. 43

7	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

Salts' extract of powdered wheat straw as carbon source (Contd.)

GGT. WPBS1

DAYS	1	2	3	4	5	6	Mean ± S.D.
7	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

Distilled water extract of powdered wheat straw as carbon source

GGT. og.12

7	1.0	1.5	1.5	0	0	1.5	0.92 ± 0.67
14	0	1.5	0	1.5	1.0	0	0.67 ± 0.69
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

GGT. 43

7	0	0	0	0	0	0	0
14	1.5	1.5	2.0	0	1.0	0	1.0 ± 0.76
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

GGT. WPBS1

7	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0

pH of culture filtrates at harvest

Fusarium culmorum

Salts' extract of powdered wheat straw as carbon source

7	7.9	7.9	7.8	7.9	7.9	7.9	7.88 ± 0.04
14	8.1	8.1	8.1	8.0	8.1	8.0	8.07 ± 0.05
28	8.1	8.0	8.1	8.1	8.1	8.1	8.08 ± 0.04
56	8.1	7.9	8.1	8.1	8.1	8.0	8.05 ± 0.08

Cochliobolus sativus

7	7.7	7.8	7.8	7.7	7.8	7.8	7.77 ± 0.05
14	7.6	7.7	7.7	7.6	7.6	7.6	7.63 ± 0.05
28	8.2	8.2	8.1	8.1	8.2	8.2	8.17 ± 0.05
56	8.1	8.2	8.2	8.3	8.1	8.1	8.17 ± 0.07

pH of culture filtrates at harvest(Contd.)

Salts' extract of powdered wheat straw as carbon source

DAYS	1	2	3	4	5	6	Mean ± S.D.
			GGT. og.12				
7	7.6	7.6	7.6	7.6	7.7	7.7	7.63 ± 0.05
14	7.7	7.7	7.6	7.8	7.6	7.7	7.68 ± 0.07
28	8.1	8.1	8.1	8.1	8.1	8.1	8.1 ± 0
56	8.1	8.1	8.1	8.2	8.1	8.2	8.13 ± 0.05
			GGT. 43				
7	7.7	7.7	7.8	7.7	7.9	7.7	7.75 ± 0.08
14	8.0	8.0	7.9	8.0	7.9	7.9	7.95 ± 0.05
28	8.3	8.4	8.3	8.3	8.3	8.4	8.33 ± 0.05
56	8.4	8.4	8.3	8.3	8.3	8.4	8.35 ± 0.05
			GGT. WPBS1				
7	7.7	7.7	7.6	7.8	7.6	7.7	7.68 ± 0.07
14	7.9	7.9	8.0	7.9	7.9	8.0	7.93 ± 0.05
28	8.0	8.0	8.0	8.0	8.0	8.0	8.0 ± 0
56	8.1	8.0	8.1	8.1	8.1	8.1	8.08 ± 0.03

Distilled water extract of powdered wheat straw as carbon source

			Fusarium culmorum				
7	7.5	7.7	7.5	7.6	7.7	7.7	7.62 ± 0.09
14	7.8	7.8	7.7	7.8	7.7	7.8	7.77 ± 0.05
28	8.3	8.3	8.3	8.3	8.3	8.3	8.3 ± 0
56	8.3	8.3	8.3	8.3	8.3	8.3	8.3 ± 0
			Cochliobolus sativus				
7	7.5	7.5	7.5	7.6	7.5	7.6	7.53 ± 0.05
14	7.8	7.7	7.7	7.8	7.7	7.7	7.73 ± 0.05
28	8.3	8.1	8.3	8.2	8.3	8.3	8.25 ± 0.08
56	8.3	8.2	8.3	8.2	8.2	8.3	8.25 ± 0.05
			GGT. og.12				
7	7.7	7.7	7.7	7.8	7.7	7.8	7.73 ± 0.05
14	7.5	7.5	7.5	7.5	7.6	7.5	7.52 ± 0.04
28	8.3	8.2	8.2	8.3	8.2	8.3	8.25 ± 0.05
56	8.3	8.3	8.3	8.3	8.3	8.3	8.3 ± 0

Distilled water extract of powdered wheat straw as carbon source (Contd.)

pH of culture filtrates at harvest (Contd.)

DAYS	1	2	3	4	5	6	Mean ± S.D.
				GGT. 43			
7	7.5	7.5	7.5	7.6	7.6	7.5	7.53 ± 0.05
14	7.5	7.5	7.6	7.5	7.6	7.5	7.53 ± 0.05
28	8.0	8.0	8.0	8.0	8.0	8.0	8.0 ± 0
56	8.1	8.2	8.2	8.2	8.1	8.1	8.15 ± 0.05
				GGT. WPBS1			
7	7.5	7.6	7.6	7.5	7.6	7.6	7.57 ± 0.05
14	7.9	7.8	7.9	7.9	7.9	7.9	7.88 ± 0.04
28	8.2	8.1	8.2	8.2	8.2	8.2	8.18 ± 0.04
56	8.2	8.2	8.2	8.3	8.1	8.1	8.22 ± 0.07
			Glucose dissolved in salts' medium as carbon source				
				Fusarium culmorum			
7	7.2	7.1	7.1	7.2	7.1	7.1	7.13 ± 0.05
14	7.4	7.4	7.3	7.4	7.4	7.4	7.38 ± 0.04
28	8.1	8.1	8.2	8.2	8.1	8.1	8.13 ± 0.05
56	8.2	8.2	8.2	8.2	8.2	8.2	8.2 ± 0
				Cochliobolus sativus			
7	7.2	7.2	7.2	7.2	7.1	7.1	7.17 ± 0.05
14	7.3	7.3	7.3	7.3	7.3	7.3	7.3 ± 0
28	8.5	8.6	8.5	8.4	8.5	8.5	8.5 ± 0.06
56	8.5	8.5	8.6	8.5	8.5	8.5	8.52 ± 0.04
				GGT. og12			
7	7.1	7.1	7.1	7.2	7.2	7.2	7.15 ± 0.05
14	7.1	7.1	7.1	7.2	7.1	7.2	7.13 ± 0.05
28	6.7	6.8	6.7	6.8	6.8	6.7	6.75 ± 0.05
56	6.6	6.6	6.6	6.6	6.6	6.6	6.6 ± 0
				GGT. 43			
7	7.1	7.1	6.9	7.0	7.1	7.1	7.05 ± 0.08
14	7.2	7.2	7.2	7.2	7.2	7.2	7.2 ± 0
28	6.5	6.5	6.6	6.5	6.6	6.6	6.55 ± 0.05
56	6.5	6.4	6.5	6.5	6.5	6.5	6.48 ± 0.04

Glucose dissolved in salts' medium as carbon source (Contd.)

pH of culture filtrates at harvest (Contd.)

DAYS	1	2	3	4	5	6	Mean ± S.D.
GGT. WPBS1							
7	7.1	7.1	7.1	7.1	7.1	7.1	7.1 ± 0
14	7.3	7.3	7.2	7.3	7.3	7.3	7.28 ± 0.04
28	6.0	6.0	6.0	6.0	6.0	6.0	6.0 ± 0
56	5.8	5.8	5.7	5.7	5.8	5.7	5.75 ± 0.05
Glucose dissolved in distilled water as carbon source							
Fusarium culmorum							
7	6.2	6.9	5.8	6.5	6.9	6.9	6.53 ± 0.42
14	7.2	7.0	6.9	6.9	7.4	7.3	7.12 ± 0.2
28	5.9	6.4	5.7	5.9	6.2	5.6	5.95 ± 0.28
56	5.8	4.9	5.2	5.2	5.1	4.9	5.18 ± 0.3
Cochliobolus sativus							
7	6.9	5.5	6.3	5.9	6.2	5.9	6.12 ± 0.43
14	5.6	4.8	5.6	4.9	5.9	5.2	5.33 ± 0.4
28	5.8	5.7	5.3	5.4	5.6	5.6	5.57 ± 0.17
56	5.3	4.9	5.3	5.4	4.9	4.9	5.12 ± 0.22
GGT. og.12							
7	5.8	5.8	5.6	5.6	5.6	5.6	5.67 ± 0.09
14	5.6	5.8	5.6	5.6	5.6	5.8	5.67 ± 0.09
28	5.8	5.8	5.8	5.6	5.8	5.8	5.77 ± 0.07
56	5.8	5.8	5.5	5.6	5.5	5.5	5.62 ± 0.13
GGT. 43							
7	5.8	5.6	5.6	5.8	5.8	5.8	5.73 ± 0.09
14	5.6	5.6	5.6	5.7	5.8	5.6	5.65 ± 0.08
28	5.5	5.8	5.8	5.5	5.6	5.6	5.63 ± 0.12
56	5.6	5.6	5.5	5.5	5.6	5.6	5.57 ± 0.05
GGT. WPBS1							
7	5.8	5.8	5.6	5.8	5.8	5.6	5.73 ± 0.09
14	5.7	5.5	5.8	5.5	5.7	5.7	5.65 ± 0.11
28	5.7	5.6	5.6	5.6	5.7	5.6	5.63 ± 0.05
56	5.7	5.6	5.7	5.6	5.7	5.7	5.67 ± 0.05

Calibration of Sephadex G-75 column with proteins of known molecular weigts.

Fraction No.	Absorbance at 280nm			Mean ± S.D.
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0.03	0.025	0.035	0.03 ± 0.004
5	0.08	0.07	0.09	0.08 ± 0.008
6	0.11	0.08	0.11	0.1 ± 0.01
7	0.18	0.19	0.17	0.18 ± 0.008
8	0.29	0.29	0.26	0.28 ± 0.01
9	0.35	0.36	0.34	0.35 ± 0.008
10	0.28	0.28	0.25	0.27 ± 0.01
11	0.18	0.18	0.21	0.19 ± 0.01
12	0.15	0.16	0.14	0.15 ± 0.008
13	0.11	0.11	0.11	0.11 ± 0
14	0.06	0.045	0.045	0.05 ± 0.007
15	0.05	0.05	0.05	0.05 ± 0
16	0.05	0.06	0.04	0.05 ± 0.008
17	0.08	0.08	0.08	0.08 ± 0
18	0.13	0.12	0.11	0.12 ± 0.008
19	0.165	0.18	0.18	0.175 ± 0.007
20	0.22	0.20	0.24	0.22 ± 0.02
21	0.165	0.17	0.16	0.165 ± 0.04
22	0.1	0.09	0.11	0.1 ± 0.008
23	0.08	0.09	0.07	0.08 ± 0.008
24	0.04	0.04	0.04	0.04 ± 0
25	0.02	0.02	0.02	0.02 ± 0
26	0.02	0.02	0.02	0.02 ± 0
27	0.06	0.05	0.07	0.06 ± 0.008
28	0.13	0.1	0.13	0.12 ± 0.008
29	0.18	0.18	0.21	0.19 ± 0.01
30	0.27	0.25	0.29	0.27 ± 0.02
31	0.21	0.2	0.22	0.21 ± 0.008
32	0.18	0.18	0.18	0.18 ± 0
33	0.13	0.11	0.12	0.12 ± 0.008
34	0.13	0.12	0.11	0.12 ± 0.008
35	0.11	0.11	0.11	0.11 ± 0

Calibration of Sephadex G-75 column with proteins of known molecular weights. (Contd.)

Fraction No.	Absorbance at 280nm			Mean ± S.D.
36	0.08	0.08	0.08	0.08 ± 0
37	0.03	0.04	0.02	0.03 ± 0.008
38	0.03	0.03	0.03	0.03 ± 0
39	0.06	0.07	0.05	0.06 ± 0.008
40	0.12	0.12	0.12	0.12 ± 0
41	0.15	0.16	0.14	0.15 ± 0.008
42	0.11	0.12	0.10	0.11 ± 0.008
43	0.10	0.10	0.10	0.10 ± 0
44	0.09	0.09	0.09	0.09 ± 0
45	0.07	0.08	0.06	0.07 ± 0.008
46	0.05	0.07	0.06	0.06 ± 0.005
47	0.04	0.04	0.04	0.04 ± 0
48	0.03	0.03	0.03	0.03 ± 0
49	0.07	0.06	0.08	0.07 ± 0.008
50	0.09	0.09	0.09	0.09 ± 0
51	0.10	0.10	0.10	0.10 ± 0
52	0.11	0.11	0.11	0.11 ± 0
53	0.09	0.10	0.08	0.09 ± 0.008
54	0.07	0.09	0.05	0.07 ± 0.02
55	0.05	0.05	0.05	0.05 ± 0
56	0.02	0.02	0.02	0.02 ± 0
57	0.01	0.01	0.01	0.01 ± 0
58	0.01	0.01	0.01	0.01 ± 0
59	0.01	0.01	0.01	0.01 ± 0
60	0.01	0.01	0.01	0.01 ± 0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0

Calibration of Sephadex G-75 column with proteins of known molecular weights (Contd.).

Fraction No.	Absorbance at 280nm			Mean ± S.D.
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0

Enzyme Separation on Sephadex G-75 column

GROWTH SUBSTRATE : GLUCOSE

Fr.No.	F. colmorum				C. sativus			
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0.005	0.005	0.005	0.005 ± 0
8	0	0	0	0	0.005	0.005	0.01	0.006 ± 0.002
9	0	0	0	0	0.005	0.01	0.01	0.008 ± 0.002
10	0.005	0.01	0.005	0.006 ± 0.002	0.005	0.01	0.01	0.008 ± 0.002
11	0.01	0.01	0.005	0.008 ± 0.002	0.01	0.01	0.01	0.01 ± 0
12	0.01	0.01	0.01	0.01 ± 0	0.01	0.01	0.01	0.01 ± 0
13	0.01	0.02	0.01	0.013 ± 0.005	0.015	0.02	0.01	0.015 ± 0.004
14	0.04	0.03	0.04	0.036 ± 0.005	0.04	0.06	0.04	0.046 ± 0.009
15	0.06	0.05	0.04	0.05 ± 0.008	0.11	0.10	0.11	0.106 ± 0.005
16	0.08	0.08	0.08	0.08 ± 0	0.13	0.13	0.13	0.13 ± 0
17	0.13	0.15	0.17	0.15 ± 0.02	0.16	0.18	0.18	0.173 ± 0.009
18	0.11	0.12	0.12	0.116 ± 0.005	0.23	0.25	0.24	0.24 ± 0.008

Enzyme Separation on Sephadex G-75 column(Contd.)

GROWTH SUBSTRATE : GLUCOSE

Fr.No.	Fusarium culmorum				Cochliobolus sativus			
19	0.08	0.09	0.09	0.086 ± 0.005	0.18	0.19	0.21	0.193 ± 0.01
20	0.05	0.04	0.04	0.043 ± 0.005	0.16	0.15	0.16	0.156 ± 0.005
21	0.02	0.02	0.02	0.02 ± 0	0.12	0.12	0.12	0.12 ± 0
22	0.01	0.01	0.01	0.01 ± 0	0.09	0.08	0.10	0.09 ± 0.008
23	0.01	0.01	0.01	0.01 ± 0	0.05	0.05	0.05	0.05 ± 0
24	0.005	0.005	0.005	0.005 ± 0	0.02	0.05	0.04	0.036 ± 0.01
25	0	0	0	0	0.02	0.04	0.04	0.033 ± 0.009
26	0	0	0	0	0.02	0.02	0.03	0.023 ± 0.005
27	0	0	0	0	0.02	0.01	0.02	0.016 ± 0.005
28	0	0	0	0	0.01	0.01	0.02	0.013 ± 0.005
29	0	0	0	0	0.01	0.005	0.01	0.008 ± 0.002
30	0	0	0	0	0.01	0.005	0.005	0.006 ± 0.002
31	0	0	0	0	0.005	0.005	0.005	0.005 ± 0
32	0	0	0	0	0.005	0.005	0.005	0.005 ± 0
33	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0

Enzyme Separation on Sephadex G-75 column (Contd.)

GROWTH SUBSTRATE : GLUCOSE

Fr.No.	Fusarium culmorum				Cochliobolus sativus			
54	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0

GROWTH SUBSRTATE : CITRUS PECTIN

Absorbance at 280nm Mean ± S.D.

Fract. No.	Fusarium culmorum				Cochliobolus sativus			
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0

Enzyme Separation on Sephadex G-75 column (Contd.)

GROWTH SUBSTRATE : CITRUS PECTIN

Absorbance at 280nm Mean ± S.D.

Fract. No.	*Fusarium culmorum*				*Cochliobolus sativus*			
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0.005	0.01	0.01	0.008 ± 0.002
11	0	0	0	0	0.02	0.03	0.02	0.023 ± 0.005
12	0	0	0	0	0.05	0.08	0.06	0.063 ± 0.01
13	0	0	0	0	0.08	0.08	0.08	0.08 ± 0
14	0	0	0	0	0.10	0.10	0.10	0.10 ± 0
15	0	0	0	0	0.11	0.10	0.10	0.103 ± 0.005
16	0	0	0	0	0.13	0.12	0.12	0.123 ± 0.005
17	0	0	0	0	0.10	0.10	0.10	0.10 ± 0
18	0.005	0	0.005	0.003 ± 0.002	0.08	0.06	0.08	0.073 ± 0.009
19	0.005	0.005	0.005	0.005 ± 0	0.05	0.04	0.05	0.046 ± 0.005
20	0.01	0.02	0.01	0.013 ± 0.005	0.02	0.02	0.02	0.02 ± 0
21	0.04	0.06	0.03	0.043 ± 0.01	0.01	0.01	0.01	0.01 ± 0
22	0.08	0.11	0.10	0.096 ± 0.01	0.005	0.01	0.01	0.008 ± 0.002
23	0.13	0.14	0.13	0.133 ± 0.005	0.01	0.01	0.01	0.01 ± 0
24	0.13	0.14	0.14	0.136 ± 0.005	0.03	0.03	0.04	0.033 ± 0.005
25	0.16	0.16	0.16	0.16 ± 0	0.06	0.05	0.06	0.056 ± 0.005
26	0.16	0.16	0.16	0.16 ± 0	0.08	0.08	0.08	0.08 ± 0
27	0.18	0.19	0.17	0.18 ± 0.008	0.10	0.09	0.08	0.09 ± 0.008
28	0.20	0.20	0.20	0.20 ± 0	0.12	0.13	0.12	0.123 ± 0.005
29	0.21	0.20	0.20	0.203 ± 0.005	0.13	0.13	0.13	0.13 ± 0
30	0.21	0.21	0.21	0.21 ± 0	0.15	0.15	0.13	0.143 ± 0.009
31	0.21	0.21	0.21	0.21 ± 0	0.17	0.15	0.15	0.156 ± 0.009
32	0.21	0.23	0.24	0.226 ± 0.01	0.17	0.17	0.18	0.173 ± 0.005
33	0.20	0.21	0.20	0.203 ± 0.005	0.19	0.21	0.22	0.206 ± 0.01
34	0.17	0.18	0.18	0.176 ± 0.005	0.16	0.18	0.18	0.173 ± 0.009
35	0.14	0.16	0.15	0.15 ± 0.008	0.16	0.16	0.16	0.16 ± 0
36	0.12	0.10	0.12	0.113 ± 0.009	0.13	0.12	0.12	0.123 ± 0.005
37	0.10	0.10	0.09	0.096 ± 0.005	0.10	0.10	0.11	0.103 ± 0.005

Enzyme Separation on Sephadex G-75 column (Contd.)

GROWTH SUBSTRATE : CITRUS PECTIN

Fract. No.	Absorbance at 280nm Mean ± S.D.							
	Fusarium culmorum				Cochliobolus sativus			
38	0.06	0.07	0.05	0.06 ± 0.008	0.08	0.07	0.08	0.076 ± 0.005
39	0.03	0.04	0.02	0.03 ± 0.08	0.06	0.05	0.06	0.056 ± 0.005
40	0.05	0.06	0.04	0.05 ± 0.008	0.02	0.02	0.02	0.02 ± 0
41	0.08	0.10	0.09	0.09 ± 0.008	0.04	0.05	0.05	0.046 ± 0.005
42	0.12	0.12	0.11	0.116± 0.005	0.08	0.09	0.08	0.083 ± 0.02
43	0.14	0.13	0.13	0.133± 0.005	0.11	0.12	0.11	0.113 ± 0.005
44	0.14	0.14	0.14	0.14 ± 0	0.13	0.12	0.13	0.126 ± 0.005
45	0.16	0.18	0.16	0.166± 0.009	0.15	0.15	0.15	0.15 ± 0
46	0.13	0.13	0.12	0.126± 0.005	0.13	0.13	0.13	0.13 ± 0
47	0.09	0.09	0.09	0.09 ± 0	0.10	0.11	0.10	0.103 ± 0.005
48	0.06	0.05	0.05	0.053± 0.005	0.06	0.06	0.07	0.063 ± 0.005
49	0.04	0.02	0.02	0.026± 0.009	0.03	0.04	0.04	0.036 ± 0.005
50	0.01	0.01	0.01	0.01 ± 0	0.02	0.02	0.02	0.02 ± 0
51	0.01	0.01	0.01	0.01 ± 0	0.02	0.02	0.02	0.02 ± 0
52	0.01	0.005	0.01	0.0083± 0.002	0.01	0.01	0.01	0.01 ± 0
53	0.005	0.005	0.005	0.005± 0	0.01	0.01	0.005	0.008 ± 0.002
54	0.005	0.005	0.005	0.005± 0	0.001	0.001	0.001	0.008 ± 0.002
55	0	0	0	0	0.005	0.005	0.005	0.005 ± 0
56	0	0	0	0	0.005	0.005	0.005	0.005 ± 0
57	0	0	0	0	0.005	0.005	0.005	0.005 ± 0
58	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0

Enzyme Separation on Sephadex G-75 column (Contd.)

GROWTH SUBSTRATE : CITRUS PECTIN

Fract. No.	Absorbance at 280nm Mean ± S.D. Fusarium culmorum				Cochliobolus sativus			
71	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0

GROWTH SUBSTRATE : SODIUM POLYPECTATE

Fract. No.	Fusarium culmorum				Cochliobolus sativus			
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0.01	0.01	0.005	0.0083± 0.002
7	0	0	0	0	0.01	0.01	0.01	0.01 ± 0
8	0	0	0	0	0.03	0.03	0.04	0.033± 0.005
9	0.01	0.01	0.01	0.01 ± 0	0.07	0.08	0.10	0.083± 0.01
10	0.05	0.07	0.05	0.056± 0.009	0.10	0.12	0.10	0.106 ± 0.009
11	0.10	0.13	0.12	0.116± 0.01	0.15	0.15	0.14	0.146 ± 0.005
12	0.15	0.19	0.17	0.17 ± 0.02	0.20	0.18	0.20	0.193 ± 0.009
13	0.20	0.22	0.20	0.206± 0.009	0.25	0.25	0.25	0.25 ± 0
14	0.32	0.34	0.34	0.333± 0.009	0.27	0.25	0.25	0.256 ± 0.009
15	0.40	0.42	0.45	0.423± 0.02	0.30	0.29	0.28	0.29 ± 0.008
16	0.36	0.37	0.40	0.376± 0.02	0.25	0.24	0.24	0.243 ± 0.005
17	0.30	0.32	0.34	0.32 ± 0.02	0.20	0.20	0.20	0.20 ± 0
18	0.25	0.27	0.26	0.26 ± 0.008	0.18	0.16	0.18	0.173 ± 0.009
19	0.20	0.21	0.20	0.203± 0.005	0.15	0.15	0.15	0.15 ± 0
20	0.18	0.19	0.19	0.186± 0.005	0.12	0.12	0.11	0.116 ± 0.005
21	0.15	0.16	0.16	0.156± 0.005	0.10	0.09	0.10	0.096 ± 0.005

Enzyme Separation on Sephadex G-75 column (Contd.)

GROWTH SUBSTRATE : SODIUM POLYPECTATE

Fract. No.	Absorbance at 280nm Mean ± S.D.							
	Fusarium culmorum				Cochliobolus sativus			
22	0.15	0.15	0.15	0.15 ± 0	0.08	0.09	0.09	0.086 ± 0.005
23	0.12	0.10	0.12	0.113± 0.009	0.05	0.06	0.05	0.053 ± 0.005
24	0.10	0.10	0.10	0.10 ± 0	0.03	0.03	0.04	0.033 ± 0.005
25	0.08	0.06	0.08	0.073± 0.009	0.02	0.02	0.02	0.02 ± 0
26	0.05	0.05	0.04	0.046± 0.005	0.04	0.04	0.04	0.04 ± 0
27	0.02	0.02	0.02	0.02 ± 0	0.08	0.07	0.09	0.08 ± 0.008
28	0.02	0.02	0.02	0.02 ± 0	0.13	0.14	0.12	0.13 ± 0.008
29	0.06	0.05	0.06	0.056± 0.005	0.16	0.16	0.16	0.16 ± 0
30	0.10	0.10	0.12	0.106± 0.009	0.16	0.16	0.16	0.16 ± 0
31	0.15	0.15	0.17	0.156± 0.009	0.17	0.19	0.16	0.173 ± 0.01
32	0.18	0.19	0.20	0.19 ± 0.008	0.18	0.20	0.18	0.186 ± 0.009
33	0.21	0.22	0.20	0.21 ± 0.008	0.18	0.22	0.20	0.20 ± 0.02
34	0.23	0.25	0.22	0.233± 0.01	0.16	0.20	0.17	0.176 ± 0.02
35	0.25	0.27	0.25	0.256± 0.009	0.13	0.13	0.13	0.13 ± 0
36	0.22	0.21	0.22	0.226± 0.009	0.10	0.11	0.10	0.103 ± 0.005
37	0.20	0.20	0.20	0.20 ± 0	0.08	0.07	0.07	0.073 ± 0.005
38	0.16	0.17	0.16	0.163± 0.005	0.06	0.04	0.05	0.05 ± 0.008
39	0.15	0.15	0.15	0.15 ± 0	0.02	0.02	0.02	0.02 ± 0
40	0.12	0.11	0.11	0.113± 0.005	0.02	0.02	0.02	0.02 ± 0
41	0.10	0.10	0.10	0.10 ± 0	0.02	0.02	0.02	0.02 ± 0
42	0.08	0.06	0.06	0.066± 0.009	0.01	0.01	0.015	0.0116± 0.002
43	0.04	0.04	0.03	0.036± 0.005	0.01	0.01	0.015	0.0116± 0.002
44	0.03	0.03	0.03	0.03 ± 0	0.01	0.01	0.01	0.01 ± 0
45	0.02	0.02	0.02	0.02 ± 0	0.01	0.01	0.01	0.01 ± 0
46	0.01	0.01	0.01	0.01 ± 0	0.005	0.005	0.005	0.005 ± 0
47	0.01	0.01	0.01	0.01 ± 0	0.005	0.005	0.005	0.005 ± 0
48	0.01	0.01	0.01	0.01 ± 0	0	0	0	0
49	0.01	0.01	0.01	0.01 ± 0	0	0	0	0
50	0.01	0.005	0.01	0.0083± 0.002	0	0	0	0
51	0.005	0.005	0.01	0.0066± 0.002	0	0	0	0
52	0.005	0.005	0.005	0.005± 0	0	0	0	0
53	0.005	0.005	0.005	0.005± 0	0	0	0	0
54	0	0	0	0	0	0	0	0

Enzyme Separation on Sephadex G-75 column (Contd.)

GROWTH SUBSRTATE : SODIUM POLYPECTATE

Absorbance at 280nm Mean ± S.D.

Fract. No.	Fusarium culmorum				Cochliobolus sativus			
55	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0

Column Chromatography of pectin degrading enzymes produced in liquid culture by Fusarium culmorum & Cochliobolus sativus.

GROWTH SUBSTRATE : GLUCOSE

1. Protein Content Determinations (Lowry et. al., 1951) (μg/ml)

	Fusarium culmorum							Cochliobolus sativus						
Cul. Filtrate	180	183	208	218	198	218	200.83 ± 16.74	300	310	322	310	304	310	309.3 ± 7.45
$(NH_4)_2SO_4$ PPT.	153	138	128	153	143	158	145.5 ± 11.29	183	190	208	198	198	213	198.3 ± 11.67
Fil. AFT. PPT.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GROWTH SUBSTRATE : CITRUS PECTIN

Cul. Filtrate	260	263	276	276	270	276	270.16 ± 7.17	253	253	232	253	236	232	243.16 ± 10.0
$(NH_4)_2SO_4$ PPT.	166	183	166	190	180	190	179.16 ± 10.92	168	180	158	183	153	183	170.83 ± 13.19
FIL. AFT. PPT.	0	8	13	0	8	3	5.33 ± 5.2	3	8	0	3	0	13	4.5 ± 4.65

GROWTH SUBSTRATE : SODIUM POLYPECTATE

Cul. Filtrate	346	340	356	340	356	356	349.0 ± 7.28	286	286	312	293	300	286	293.83 ± 9.6
$(NH_4)_2SO_4$ PPT.	232	236	236	260	232	263	243.16 ± 13.09	232	232	218	213	230	218	223.83 ± 7.71
FIL. AFT. PPT.	0	3	0	8	0	8	3.17 ± 3.58	8	0	0	8	0	0	2.66 ± 3.77

FIL. AFT. PPT. = Culture filtrate after precipitation with ammonium sulphate.

Column Chromatography of pectin degrading enzymes produced in liquid culture by Fusarium culmorum & Cochliobolus sativus.

2. Enzyme activity by measuring concentrations of reducing groups liberated (units/ml)

GROWTH SUBSTRATE : GLUCOSE

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
(i) CULTURE FILTRATES:														
CP	25.9	30.3	31.3	25.9	33.3	31.2	29.6 ± 3.1	21.1	23.1	21.1	20.2	20.1	21.1	21.1 ± 1.1
SPP	14.7	16.6	14.7	15.5	18.3	13.7	15.6 ± 1.6	10.9	10.9	13.7	10.9	12.7	9.9	11.3 ± 1.1
(ii) $(NH_4)_2SO_4$ Fractionation Precipitates:														
CP	22.0	24.1	24.9	24.1	24.1	26.6	24.3 ± 1.5	22.9	25.7	24.7	22.9	24.1	22.9	23.9 ± 1.2
SPP	11.8	14.6	12.7	12.7	12.7	14.6	13.2 ± 1.2	9.2	8.1	7.2	9.2	8.1	9.2	8.5 ± 0.8
(iii) Filtrate after $(NH_4)_2SO_4$ Precipitation:														
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(iv) Sephadex Column Fractions:														
CP	15.5	15.5	16.5	15.5	14.7	14.7	15.4 ± 0.7	12.7	14.7	14.7	13.7	14.7	12.7	13.8 ± 0.9
SPP	3.7	3.7	1.8	3.7	2.6	1.8	2.9 ± 0.9	1.8	2.6	1.8	3.7	1.8	2.6	2.4 ± 0.7

N.B. Only one fraction was obtained with glucose as growth substrate.

2. Enzyme activity by measuring concentrations of reducing groups liberated (units/ml)(Contd.)

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
GROWTH SUBSTRATE : CITRUS PECTIN														
(i) CULTURE FILTRATES:														
CP	53.4	49.8	53.4	50.6	53.5	55.4	52.7 ± 2.1	44.2	37.0	40.5	41.4	40.5	40.5	40.7 ± 0.2
SPP	19.2	23.1	21.1	24.1	24.1	24.1	22.6 ± 2.0	27.7	27.7	29.6	31.2	27.7	33.3	29.5 ± 2.3
(ii) $(NH_4)_2SO_4$ Fractionation Precipitates:														
CP	48.0	49.7	49.9	48.0	48.8	49.9	49.1 ± 0.8	44.2	45.1	44.2	44.2	45.1	45.1	44.6 ± 0.5
SPP	31.2	33.3	33.3	31.2	34.0	33.3	32.7 ± 1.2	37.7	35.9	35.9	33.0	34.0	33.0	34.9 ± 1.9
(iii) Filtrate after $(NH_4)_2SO_4$ Precipitation:														
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GROWTH SUBSTRATE : SODIUM POLYPECTATE														
(i) CULTURE FILTRATES:														
CP	26.6	24.1	25.7	26.6	22.9	26.6	25.4 ± 1.6	24.1	24.1	22.0	20.2	24.1	20.2	22.4 ± 1.9
SPP	7.3	3.7	3.7	2.6	3.7	3.7	4.1 ± 1.6	5.3	5.3	3.7	4.1	5.3	4.4	4.7 ± 0.7
(ii) $(NH_4)_2SO_4$ Fractionation Precipitates:														
CP	33.3	34.9	29.6	31.4	33.3	33.3	32.6 ± 1.8	29.6	28.5	27.7	31.5	27.7	29.6	29.1 ± 1.5
SPP	5.55	3.7	3.7	3.7	4.4	3.7	4.1 ± 0.7	3.7	5.5	3.7	3.7	5.5	3.7	4.3 ± 0.9

2. Enzyme activity by measuring reducing groups liberated (units/ml)(Contd.)

GROWTH SUBSTRATE : SODIUM POLYPECTATE

(iii) Filtrate after $(NH_4)_2SO_4$ Precipitation:

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(iv) Sephadex Column Fractions:

	Peak 1				Peak 2				Peak 1				Peak 2			
CP	20.1	22.0	20.1	20.7 ± 1.1	7.2	7.2	7.2	7.2 ± 0	16.6	17.4	19.2	17.7 ± 1.3	8.14	8.14	8.14	8.14 ± 0
SPP	8.14	8.14	8.14	8.14 ± 0	7.2	9.3	8.1	8.2 ± 1.1	3.7	3.7	4.4	3.9 ± 0.4	5.36	5.36	5.36	5.36 ± 0

Growth Substrate : Citrus pectin

Fusarium culmorum

	Peak 2				Peak 3			
CP	25.9	25.9	25.9	25.9 ± 0	8.1	8.1	6.3	7.5 ± 1.0
SPP	1.8	3.5	1.8	2.3 ± 0.9	19.2	20.1	21.5	20.3 ± 1.1

Cochliobolus sativus

	PEAK 1				PEAK 2				PEAK 3			
CP	14.7	16.6	17.4	16.25± 1.4	8.1	7.2	8.1	7.8 ± 0.5	5.4	3.7	3.7	4.2 ± 0.9
SPP	3.7	3.7	3.7	3.7 ± 0	10.9	10.9	9.2	10.3 ± 0.9	25.7	24.1	24.1	24.6 ± 0.9

3. Enzyme activity by measuring viscosity (Holden & Ashby 1978) (units/ml)

GROWTH SUBSTRATE : GLUCOSE

(i) Culture Filtrates:

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
CP	5.0	5.0	3.0	5.0	5.0	3.0	4.33 ± 1.03	0	0	0	0	0	0	0
SPP	6.0	10.0	12.0	10.0	12.0	12.0	10.33 ± 2.34	4.0	4.0	4.0	6.0	4.0	6.0	4.66 ± 1.03
(ii) $(NH_4)_2SO_4$ Fractionation Precipitates:														
CP	2.0	2.0	3.0	2.0	3.0	2.0	2.33 ± 0.52	3.0	3.0	5.0	3.0	5.0	3.0	3.66 ± 1.13
SPP	18.0	18.0	19.5	18.0	19.5	18.0	18.5 ± 0.84	22.0	25.0	27.0	27.0	27.0	27.0	25.83 ± 2.04
(iii) Culture Filtrates after $(NH_4)_2SO_4$ precipitation:														
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(iv) Sephadex Column Fractions:														
				Peak 1							Peak 1			
CP	4.0	6.0	4.0	4.0	4.0	6.0	4.66 ± 1.03	0	0	2.0	2.0	2.0	2.0	1.33 ± 1.03
SPP	12.0	12.0	14.0	10.0	12.0	12.0	12.0 ± 1.26	19.5	18.0	22.0	22.0	19.5	22.0	20.5 ± 1.86

CP = Citrus pectin SPP = Sodium polypectate

3. Enzyme activity by measuring viscosity (Holden & Ashby 1978)(units/ml)(Contd.)

GROWTH SUBSTRATE : CITRUS PECTIN

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
	(i) Culture Filtrates:													
CP	34.0	40.0	34.0	34.0	40.0	42.0	37.33 ± 3.72	10.0	8.0	10.0	8.0	10.0	10.0	9.33 ± 1.03
SPP	14.0	10.0	10.0	14.0	10.0	10.0	11.33 ± 2.06	29.0	32.0	34.0	34.0	34.0	29.0	32.0 ± 2.45
	(ii) $(NH_4)_2SO_4$ Fractionation precipitates:													
CP	48.0	54.0	54.0	54.0	52.0	52.0	52.5 ± 2.34	25.0	29.0	29.0	29.0	25.0	29.0	27.66 ± 2.06
SPP	32.0	32.0	27.0	32.0	27.0	32.0	30.33 ± 2.58	25.0	25.0	22.0	22.0	25.0	22.0	23.5 ± 1.64
	(iii) Culture Filtrates after $(NH_4)_2SO_4$ precipitation:													
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(iv) Sephadex Column Fractions:

Cochliobolus sativus

	Peak 1				Peak 2				Peak 3			
CP	35.0	35.0	35.0	35.0 ± 0	10.0	10.0	10.0	10.0 ± 0	15.0	18.0	18.0	17.0 ± 1.73
SPP	12.0	10.0	10.0	10.66 ± 1.15	19.5	22.0	19.5	20.33± 1.53	6.0	14.0	12.0	10.66 ± 4.16

Fusarium culmorum

	Peak 2				Peak 3			
CP	126.0	112.0	133.0	123.66 ± 10.69	25.0	27.0	25.0	25.66 ± 1.15
SPP	14.0	14.0	14.0	14.0 ± 0	64.0	82.0	73.0	73.0 ± 9.0

3. <u>Enzyme activity by measuring viscosity (Holden & Ashby 1978)(units/ml)(Contd.)</u>

GROWTH SUBSTRATE : SODIUM POLYPECTATE

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
	(i) Culture Filtrates:													
CP	10.0	6.0	6.0	10.0	6.0	6.0	7.33 ± 2.19	4.0	4.0	2.0	2.0	4.0	4.0	3.33 ± 1.03
SPP	32.0	32.0	32.0	34.0	34.0	34.0	33.0 ± 1.09	29.0	29.0	29.0	32.0	32.0	29.0	30.0 ± 1.55
	(ii) $(NH_4)_2SO_4$ Fractionation precipitates:													
CP	12.0	6.0	6.0	6.0	6.0	6.0	7.0 ± 2.45	4.0	4.0	2.0	2.0	2.0	4.0	3.0 ± 1.09
SPP	45.0	42.0	45.0	48.0	45.0	45.0	45.0 ± 1.89	40.0	42.0	45.0	45.0	42.0	45.0	43.16 ± 2.14
	(iii) Culture Filtrates after $(NH_4)_2SO_4$ precipitation:													
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(iv) <u>Sephadex Column Fractions:</u>

Cochliobolus sativus

	Peak 1				Peak 2			
CP	2.0	4.0	2.0	2.66 ± 1.15	4.0	6.0	6.0	5.33 ± 1.15
SPP	12.0	10.0	12.0	11.33 ± 1.15	79.0	82.0	80.0	80.33 ± 1.53

Fusarium culmorum

CP	4.0	4.0	4.0	4.0 ± 0	6.0	4.0	6.0	5.33 ± 1.15
SPP	12.0	16.0	15.0	14.33 ± 2.08	88.0	92.0	89.0	89.66 ± 2.08

Lyase Activity Assays at 235nm: Sherwood, (1966); Olutiola & Akintunde (1979)(units/ml)

GROWTH SUBSTRATE : GLUCOSE

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
(i) Culture Filtrates:														
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(ii) $(NH_4)_2SO_4$ Fractionation precipitates:														
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(iii) Sephadex Column Fractions:														
	Peak 1							Peak 1						
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GROWTH SUBSTRATE : CITRUS PECTIN														
(i) Culture Filtrates:														
CP	30.0	29.0	29.0	28.0	29.0	29.0	29.0 ± 0.63	14.0	14.0	12.0	12.0	14.0	12.0	13.0 ± 1.09
SPP	26.0	27.0	27.0	26.0	25.0	23.0	25.66 ± 1.37	0	0	0	0	0	0	0
(ii) $(NH_4)_2SO_4$ Fractionation precipitates														
CP	12.0	10.0	8.0	12.0	10.0	10.0	10.33 ± 1.26	14.0	14.0	12.0	12.0	14.0	12.0	13.0 ± 1.09
SPP	11.0	10.0	10.0	10.0	9.0	10.0	10.0 ± 0.63	0	0	0	0	0	0	0

Lyase activity assays at 235nm (Contd.) (units/ml)

Growth Substrate : Citrus pectin

Cochliobolus sativus

(iii) Sephadex Column Fractions:

Enzyme Substrates	Peak 1				Peak 2				Peak 3			
CP	7.0	8.0	7.0	7.33 ± 0.57	8.0	8.0	8.0	8.0 ± 0	8.0	8.0	9.0	8.33 ± 0.58
SPP	0	0	0	0	0	0	0	0	0	0	0	0

Fusarium culmorum

	Peak 2				Peak 3			
CP	0	0	0	0	4.0	4.0	4.0	4.0 ± 0
SPP	4.0	6.0	6.0	5.33 ± 1.15	8.0	7.0	8.0	7.66 ± 0.57

Growth Substrate : Sodium polypectate

(i) Culture Filtrates:

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
CP	8.0	6.0	8.0	8.0	6.0	9.0	7.5 ± 1.22	6.0	7.0	4.0	6.0	6.0	4.0	5.5 ± 1.22
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(ii) $(NH_4)_2SO_4$ Fractionation precipitates:

CP	10.0	12.0	12.0	10.0	9.0	12.0	10.83 ± 1.33	9.0	9.0	8.0	10.0	9.0	9.0	8.83 ± 0.63
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Lyase activity assays at 235nm (Contd.) (units/ml)

Growth Substrate : Sodium polypectate

(iii) Sephadex Column Fractions:

Enzyme Substrates	Peak 1				Peak 2			
	Cochliobolus sativus							
CP	4.0	5.0	4.0	4.33 ± 0.58	5.0	3.0	4.0	4.0 ± 1.0
SPP	0	0	0	0	0	0	0	0
	Fusarium culmorum							
CP	6.0	6.0	5.0	5.66 ± 0.58	4.0	6.0	4.0	4.66 ± 1.15
SPP	0	0	0	0	0	0	0	0

LYASE ACTIVITY (TBA Procedure): Neukom (1960); Olutiola & Akintunde, (1979) (units/ml)

Growth Substrate : Glucose

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
	(i) Culture Filtrates:													
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	(ii) $(NH_4)_2SO_4$ Fractionation precipitates:													
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Lyase activity (TBA Procedure) (Contd.) (units/ml)

Growth Substrate : Glucose

(iii) Sephadex Column Fractions:

Enzyme Substrates	F. culmorum (Peak 1)							C. sativus (Peak 1)						
CP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Growth Substrate : Citrus pectin

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
(i) Culture Filtrates:														
CP	8.0	9.0	9.0	11.0	9.0	11.0	9.5 ± 1.32	7.0	9.0	7.0	7.0	9.0	10.0	8.16 ± 1.33
SPP	6.0	7.0	7.0	6.0	8.0	7.0	6.83 ± 0.75	1.0	1.0	2.0	1.0	1.0	1.0	1.16 ± 0.41
(ii) $(NH_4)_2SO_4$ Fractionation precipitates:														
CP	8.0	7.0	8.0	8.0	7.0	8.0	7.66 ± 0.52	7.0	7.0	7.0	8.0	6.0	7.0	7.0 ± 0.63
SPP	5.0	4.0	5.0	6.0	4.0	5.0	4.83 ± 0.75	0	0	0	0	0	0	0

(iii) Sephadex Column Fractions:

Cochliobolus sativus

	Peak 1				Peak 2				Peak 3			
CP	3.0	2.0	3.0	2.66 ± 0.58	4.0	4.0	4.0	4.0 ± 0	2.0	1.0	1.0	1.33 ± 0.58
SPP	0	0	0	0	0	0	0	0	0	0	0	0

Lyase activity (TBA Procedure) (Contd.) (units/ml)

Growth Substrate : Citrus pectin

(iii) Sephadex Column Fractions:

Fusarium culmorum

Enzyme Substrates	Peak 2				Peak 3			
CP	0	0	0	0	2.0	3.0	2.0	2.33 ± 0.57
SPP	2.0	3.0	2.0	2.33± 0.58	4.0	5.0	4.0	4.33 ± 0.58

Growth Substrate : Sodium polypectate

Enzyme Substrates	Fusarium culmorum							Cochliobolus sativus						
(i) Culture Filtrates:														
CP	6.0	6.0	7.0	6.0	7.0	6.0	6.33 ± 0.52	6.0	5.0	4.0	6.0	6.0	4.0	5.16 ± 0.98
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(ii) $(NH_4)_2SO_4$ Fractionation precipitates:														
CP	8.0	8.0	9.0	8.0	9.0	10.0	8.66 ± 0.82	8.0	8.0	7.0	8.0	7.0	8.0	7.66 ± 0.52
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(iii) Sephadex Column Fractions

	Peak 1				Peak 2				Peak 1				Peak 2			
CP	4.0	4.0	4.0	4.0 ± 0	3.0	4.0	4.0	3.66 ± 0.58	4.0	3.0	3.0	3.33 ± 0.58	3.0	3.0	3.0	3.0 ± 0
SPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dry weight of mycelium produced (mg)

Fusarium culmorum

Growth Substrates							
GLUCOSE	13.45	12.79	12.98	13.23	14.09	13.84	13.39 ± 0.46
CITRUS PECTIN	15.33	14.18	14.68	15.13	14.78	16.08	15.03 ± 0.64
NaPP	10.4	10.53	10.79	11.23	10.67	10.52	10.69 ± 0.29

Cochliobolus sativus

Growth Substrates							
GLUCOSE	10.64	11.38	11.09	10.95	11.26	10.78	11.01 ± 0.28
CITRUS PECTIN	13.38	13.79	14.63	14.35	13.98	14.49	14.1 ± 0.47
NaPP	10.71	10.27	12.08	9.65	9.87	9.06	10.27 ± 1.05

Pectinesterase Activity: Kertesz, (1951); Olutiola & Akintunde,(1979)
Talboys & Bush, (1970)

CULTURE FILTRATES:

Growth Substrate : Glucose

Activity (units/ml) Mean ± S.D.

Time (Secs)	F. culmorum				C. sativus			
30	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0

Growth Substrate : Citrus pectin

Time (Secs)	F. culmorum				C. sativus			
30	3.6	3.2	3.6	3.46 ± 0.19	2.4	2.4	2.4	2.4 ± 0
60	5.6	5.6	6.0	5.73 ± 0.19	4.0	3.6	4.0	3.87 ± 0.19
90	7.2	7.6	6.8	7.2 ± 0.33	5.6	6.4	5.6	5.87 ± 0.38
120	8.0	8.0	8.0	8.0 ± 0	6.8	6.4	6.4	6.53 ± 0.19
150	8.9	9.2	9.8	9.3 ± 0.37	7.6	7.2	7.6	7.47 ± 0.19
180	9.2	9.2	10.0	9.46 ± 0.38	8.0	7.6	7.6	7.73 ± 0.19

Growth Substrate : Sodium polypectate

Time (Secs)	F. culmorum				C. sativus			
30	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0

APPENDIX B

RAW DATA FOR STANDARD CURVES

Preparation of Standard Curve for the determination of Reducing sugars. (Glucose):

From a standard solution of glucose containing 1mg cm^{-3}, solutions containing 0.02 - 0.2mg cm^{-3} were prepared. These solutions were then estimated for their reducing sugar content using Somogyi's method as adapted for colorimetry by Nelson, (1944). The absorbances obtained were then plotted against the glucose concentrations. The graph obtained was used as a standard curve to estimate reducing sugar or group concentrations in unknown solutions.

CONCENTRATION OF GLUCOSE SOLUTIONS (mg cm^{-3})	ABSORBANCE AT 520nm MEAN ± S.D.
0.02	0.07 ± 0.0071
0.04	0.12 ± 0.0041
0.06	0.25 ± 0.14
0.08	0.33 ± 0.0082
0.10	0.39 ± 0.14
0.12	0.42 ± 0
0.14	0.54 ± 0.14
0.16	0.65 ± 0.0082
0.18	0.71 ± 0.14
0.20	0.81 ± 0

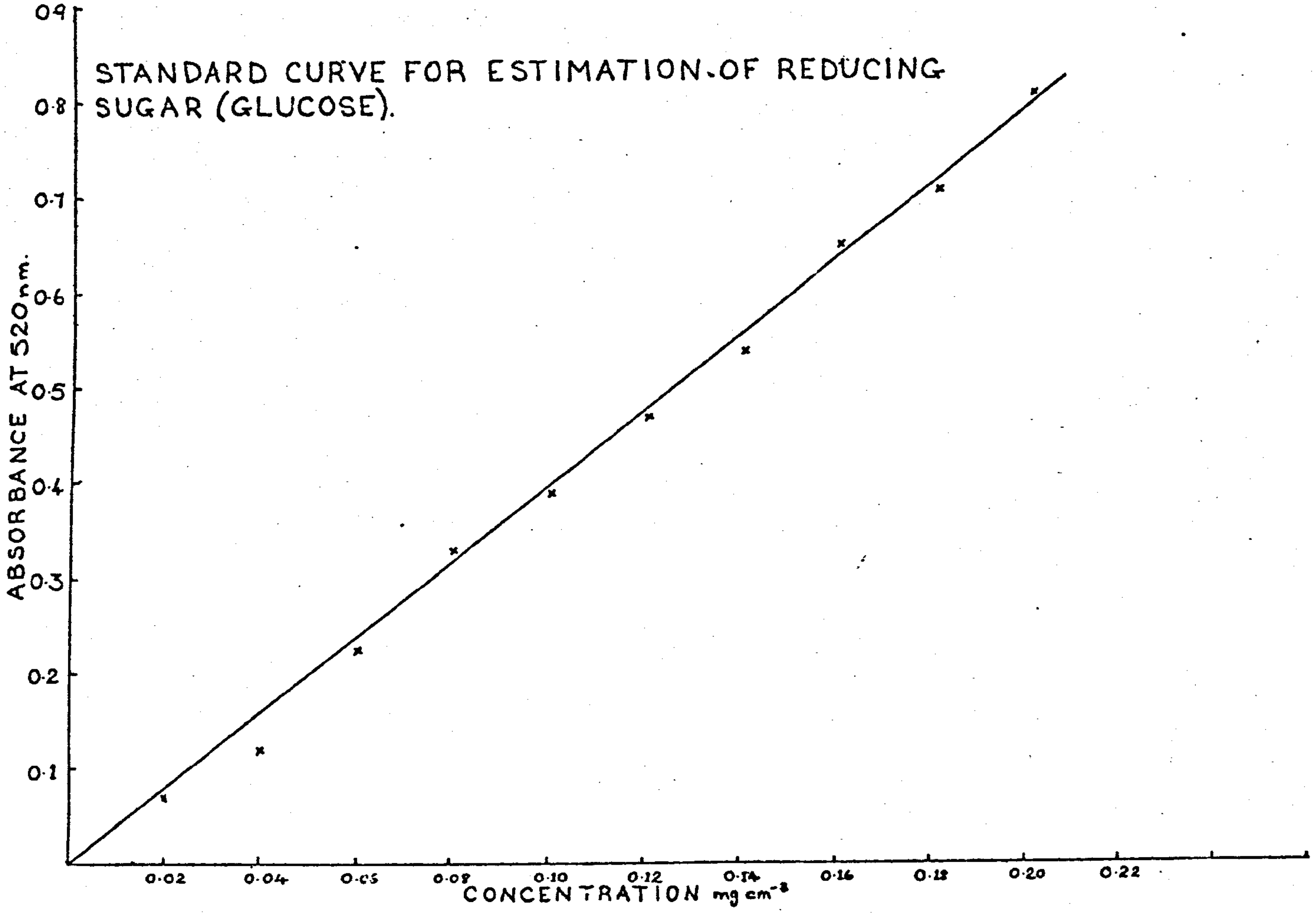
All readings are an average of three determinations. For Raw data see Appendix page A1.

Protein Determination (Lowry, et. al., 1951): Standard Curve.

CONCENTRATION OF STANDARD ALBUMEN SOLUTIONS (mg cm^{-3})	ABSORBANCE AT 750nm		MEAN ± S.D.
0.05	0.12	0.10	0.11 ± 0.05
0.10	0.23	0.21	0.22 ± 0.1
0.15	0.31	0.27	0.29 ± 0.2
0.20	0.39	0.38	0.385 ± 0.05
0.25	0.49	0.47	0.48 ± 0.1
0.30	0.55	0.53	0.54 ± 0.1
0.35	0.60	0.61	0.605 ± 0.05
0.40	0.66	0.68	0.67 ± 0.1
0.45	0.72	0.74	0.73 ± 0.1
0.50	0.83	0.85	0.84 ± 0.1

APPENDIX C

STANDARD CURVES.



STANDARD CURVE FOR ESTIMATION OF REDUCING SUGAR (GLUCOSE).

Fig. 1: shows a graph of absorbance at 520nm against concentrations of glucose solutions (0.02 - 0.2mg cm^{-3}) The standard curve was constructed by estimating the reducing sugar concentrations in the graded glucose solutions using the Somogyi method as adapted for colorimetry by Nelson (1944). The curve was used to estimate the reducing sugar or group in unknown solutions.

Data used in preparing the standard curve are on page A1 & A215 of the Appendix.

PROTEIN DETERMINATION (LOWRY et. al. 1951) -
STANDARD CURVE.

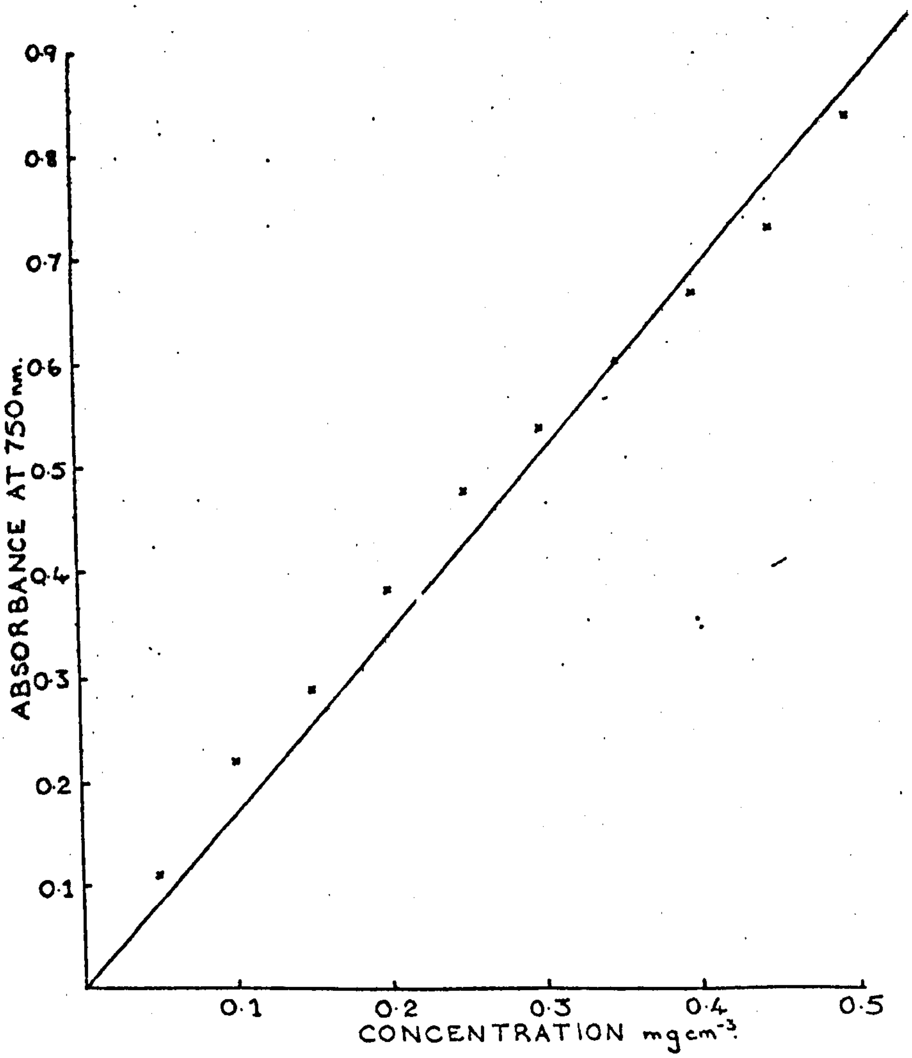


Fig. 2: is a graph of absorbance at 750nm against concentrations of standard albumen solutions (0.1 - 0.5mg cm^{-3}). The standard curve was constructed by estimating the protein content of the standard albumen solutions by the Folin - Lowry method (Lowry, et. al., 1951) and was used to estimate the protein content of unknown solutions.

For Data see Appendix page A216.

PGase. CALIBRATION CURVE.

CALIBRATION CURVE FOR CALCULATING THE ACTIVITY OF ENZYME SOLUTIONS.

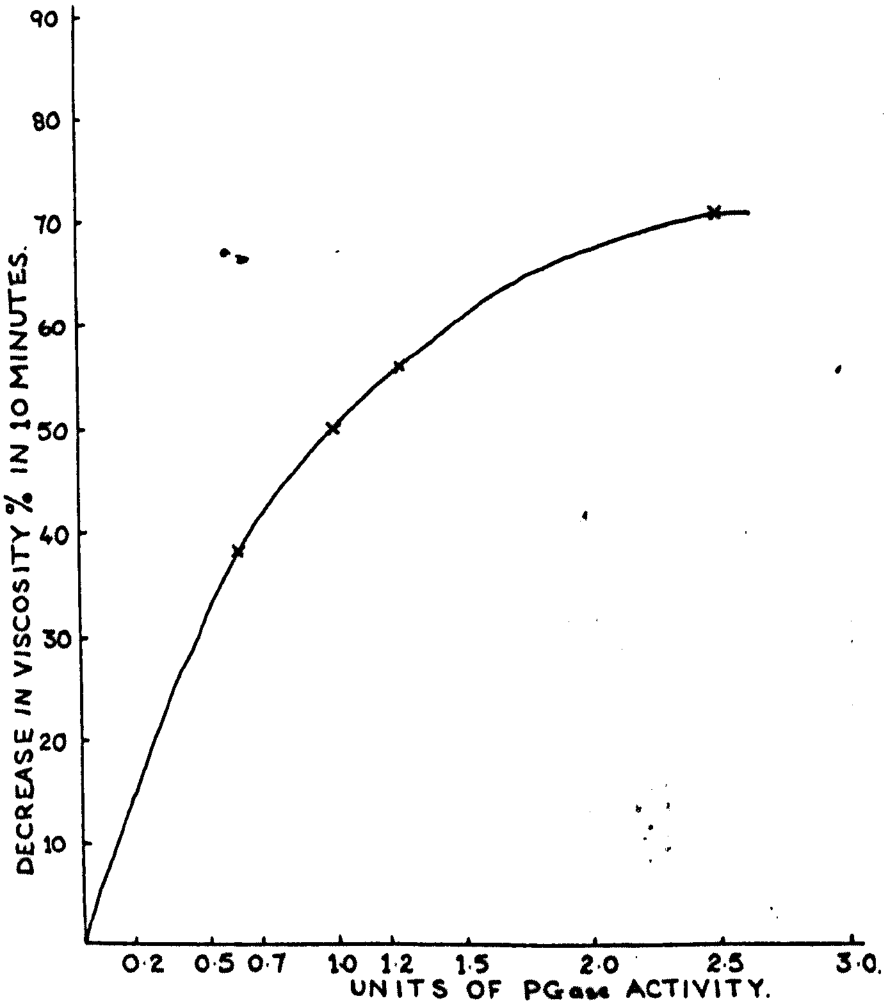


Fig. 3: is a graph of decrease in viscosity % in 10 minutes against units of PGase activity. The curve was according to Goodenough & Maw, (1974). It was used to estimate the units of activity of enzymes in culture filtrates.

APPENDIX D

ELUTION PROFILES OF PROTEIN FRACTIONS.

CALIBRATION OF SEPHADEX G-75 COLUMN USING PROTEINS OF KNOWN MOLECULAR WEIGHTS.

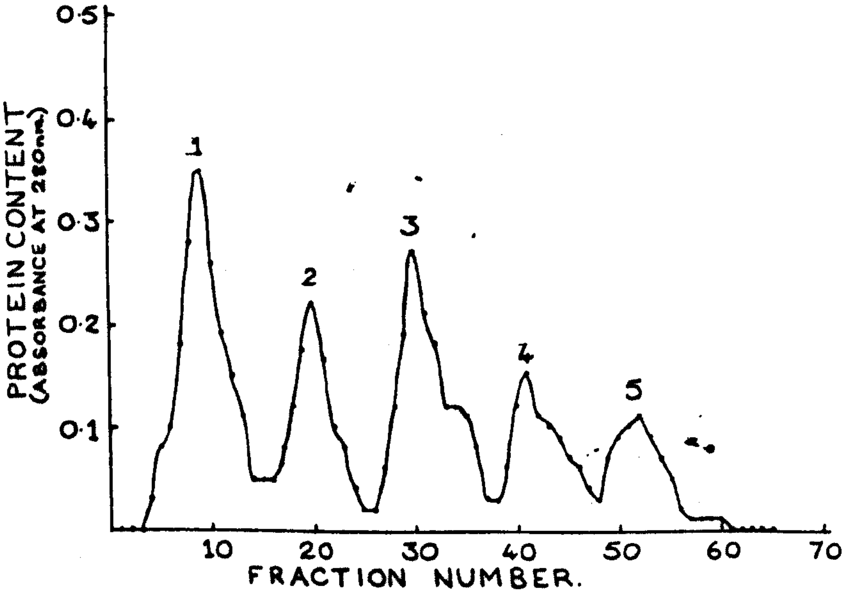


Fig. 4: shows the elution profiles of proteins used in calibrating the Sephadex column. The profiles were obtained by plotting a graph of protein content (absorbance at 280nm) against fraction number; (according to Olutiola, 1976).

Peak 1 = Calf catalase (MW. 240,000)
Peak 2 = Aldolase (MW. 147,000)
Peak 3 = Bovine serum albumin (MW. 67,000)
Peak 4 = Chymotrypsinogen A (MW. 25,000)
Peak 5 = Cytochrome C (MW. 12,4000)

For Data see Appendix page

ELUTION PROFILES.

Fusarium culmorum.

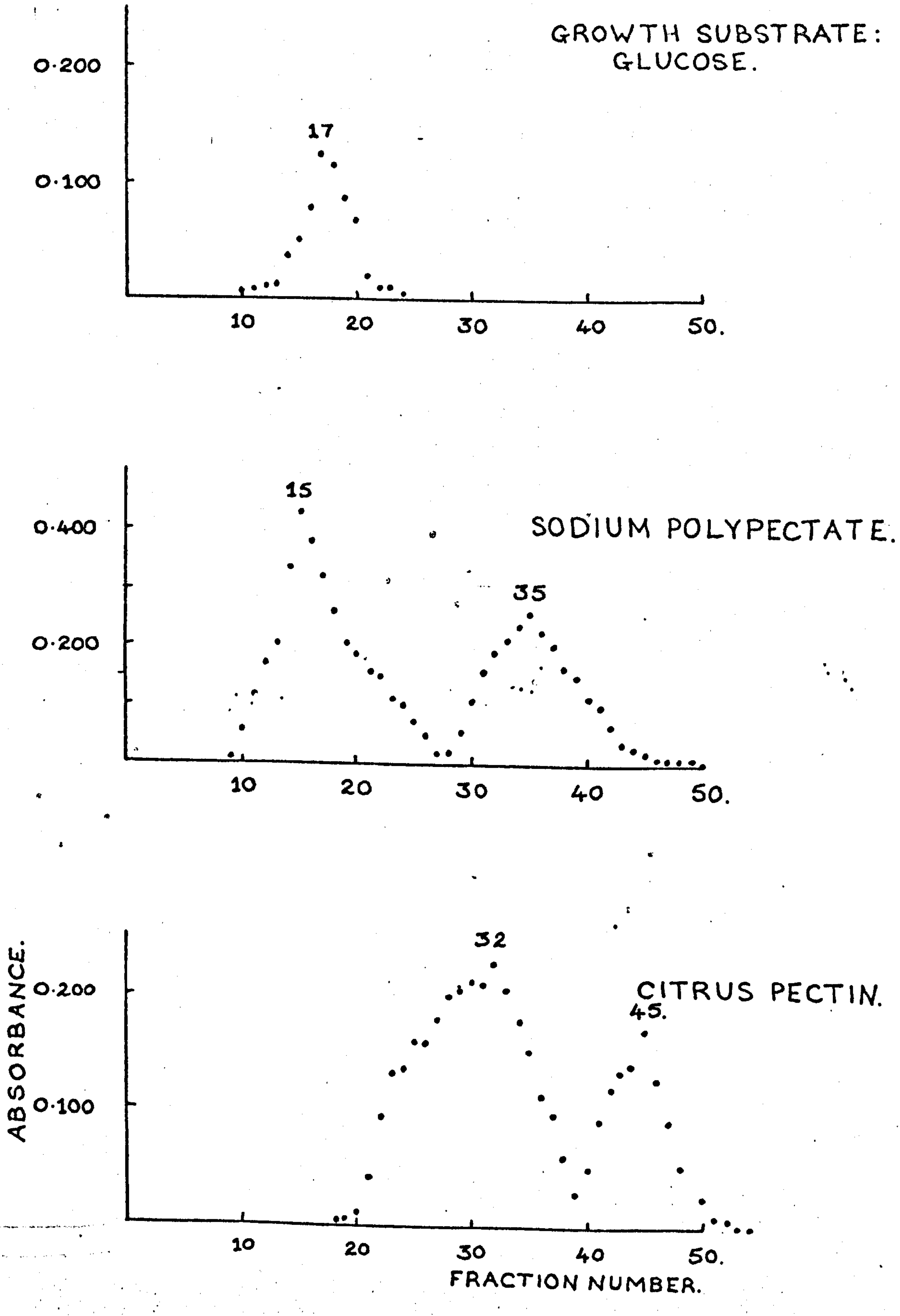


Fig. 5: shows the elution profiles of protein peaks obtained when dialysed concentrated culture filtrates of Cochliobolus sativus grown on glucose, citrus pectin or sodium polypectate were passed through the calibrated sephadex column. The profiles were obtained by plotting a graph of protein content (absorbance at 280nm) against fraction numbers.

ELUTION PROFILES.

Cochliobolus sativus.

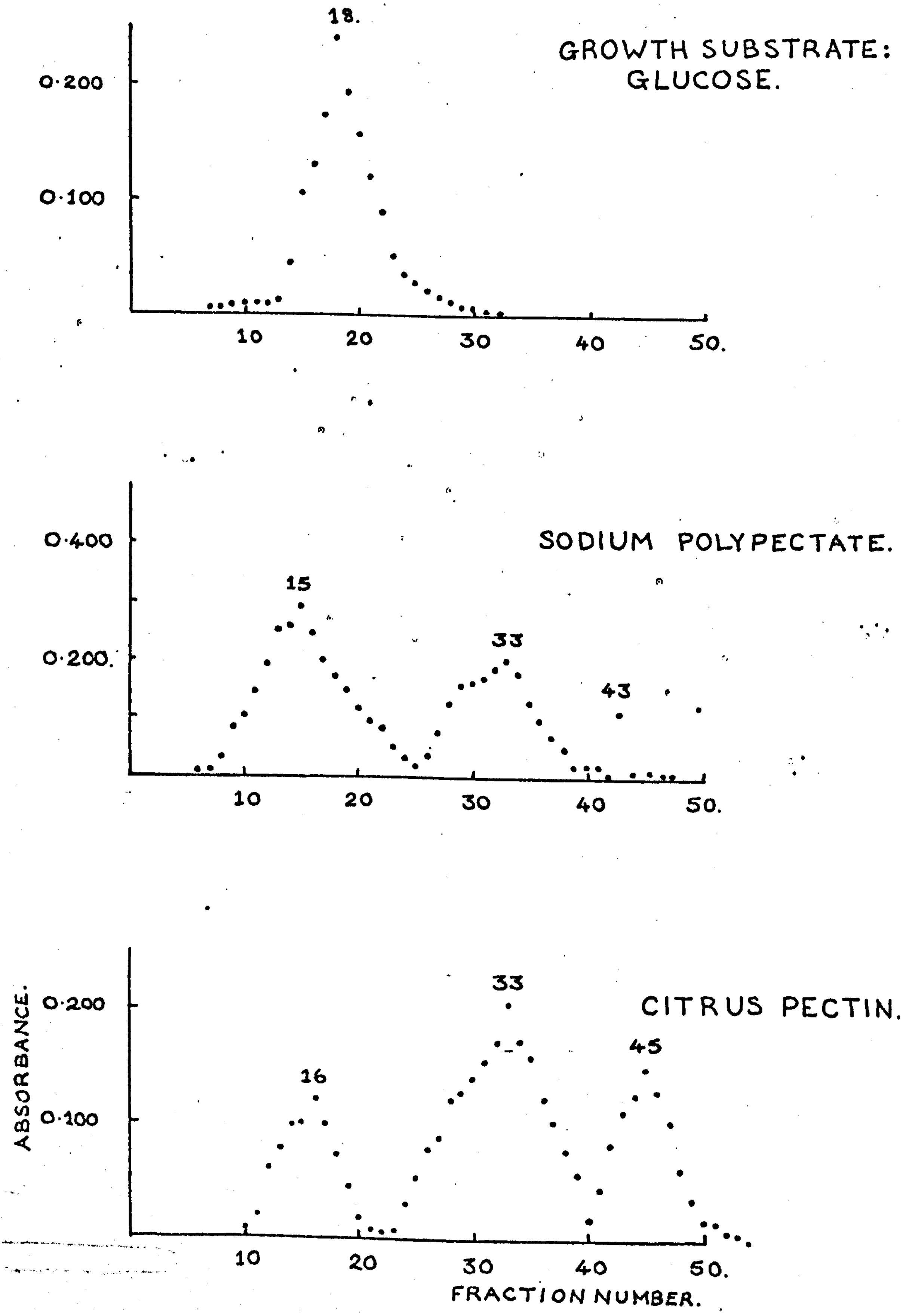


Fig. 6: shows the elution profiles of protein peaks obtained when concentrated dialysed culture filtrates of Fusarium culmorum grown on glucose, citrus pectin or sodium polypectate were passed through the calibrated sephadex column. The profiles were obtained by plotting a graph of protein content (absorbance at 280nm) against fraction numbers.

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