Research Article

Changes in the number of the species and fungal populations colonizing decomposing wheat crop residues

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ABSTRACT

The present study investigated the changes in the number of the species and the fungal population colonizing the decomposing wheat crop residues. There was a slight increase in the number of species in decomposing wheat internodes on 30th day followed by substantial decline on 90th day. On the 150th day a sharp rise was observed followed by a sharp decline on 210th day. From decomposing wheat leaves the number of species isolated was exactly similar to that internode. However on 90th day moderate increase was observed. There was no change in number of species isolated from decomposing chaff on 30th day. On 90th day there is a negligible increase followed by a slight increase on 150th days. The number of fungal species isolated from the mixed straw remain unchanged till 30th day followed by moderate increase on 150th day when it reached almost double the number of species isolated in the beginning.

INTRODUCTION

A number of studies carried out on the pattern of microbial colonization or decomposing wheat straw (Sadasivan ,1939; walker,1941; Butler,1953a,b,c. and 1959 Lal and yadav,1964; Burges and Grifin ,1967; Chang and Hudson,1967; Fermor and Wood ,1979; Moubasher et. al.,1982a,b; Charaya 1985; Broder and Wagner,1988; Bowen and Harber ,1989)—All of these monitoring the development of fungal communities on one combined resource i.e., 'straw' only which include stem (nodes, internodes) as well as leaves. The stem (internodes) and the leaves constitute the major components of the straw and differ greatly in their chemical composition as well as physical construction (Percival, 1921; Harper and Lynch,1981; Collins et al.,1990). The wheat spikelet is composed of several flowers which are enclosed a two pieces of chaff- the outer glums (Howard and Howard, 1979). With increasing mechanization now years are harvested leaving stem and leaf in the field. It would therefore, be interesting to determine the extent to which the distribution of saprobic fungi varies between different components of the straw (Wheat leaves, stem and chaff) separately with respect to intact straw. Though Robinson et al.,(1994) carried out such a study with wheat straw and leaf in U.K., no study have been carried out to compare the fungal colonization and decomposition of wheat chaff, stem and leaves separately with that of the entire straw (combined).

Material and methods

Different components i.e., internodes, leaves and spikes of wheat plants were separated. The seeds were removed from the spikes to collect chaff. Unsaperated straw (without grain) used as combined straw. Hence, four types of samples were prepared for investigation *viz.,* internodes, leaves, chaff and straw. 150 nylon net bags (15x10 cm) with mesh size of 1mm were prepared. These were divided into 4 sets: set I, II and III of 30 bags each and set IV of 60 bags. Each bag of the set I, II and III was filled with 10 grams of internodes, chaff and straw respectively and IV th set with 5 gms of leaves. Six pits (200 x 50 x 50 cm) were dug in the soil. Small holes were made in the side walls of the pits- the distance between the adjacent holes being 15 cm. All bags of wheat residue were placed randomly in the holes- one bag per hole. The pits were filled with soil and the location of different holes as well as the type of litter placed in the holes were recorded. The analysis of samples for mycobiota was done immediately on the first day. Samples for further analysis were collected on 30th, 90th, 150th, 210th, 300th, 390th day. On the specify day 4 bags of each residues- internodes, chaff and straw as well as 8 bags of leaves were collected from different holes for analysis.

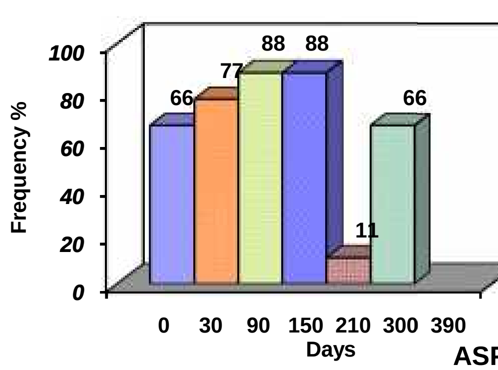
Result

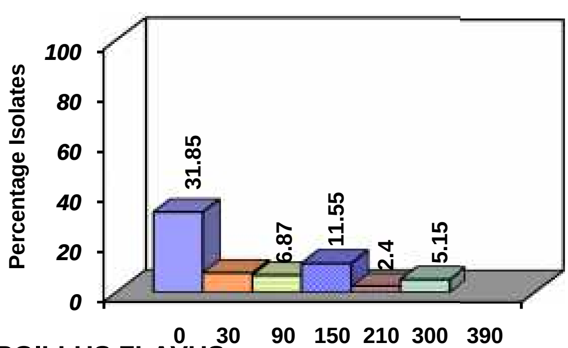
Wheat internodes: Variations in the number of fungal species colonizing decomposing wheat internides at different time intervals presented in fig. 1 and 2. There was a slight increase in the number of species on 30th day followed by substantial decline on 90th day so that the number of species recorded on the 90th day was even lesser than the initial observation. On 150th day, a sharp rise was observed followed by a sharp decline on 210th day reaching the level recorded on 90th day. Thereafter, the number of species isolated appeared to remain unchanged though a neglegible increase was observed on 390th day. Variations in the populations of fungi have been presented in Fig. 3. The fungal population per gram dry litter increased steeply by 30th day and further substantial increase was recorded on 90th day. This was followed by a steep decline on 150th day, and a further substantial decrease by 210th day when the population recorded was even lesser than that recorded initially. This overall trend of increase and decline was repeated as a substantial rise and a moderate decrease was observed on 300th day and 390th day respectively.

Wheat Leaves: Variations in the number of fungal species colonizing decomposing wheat leaves at different time intervals have also been presented in fig. 4 and 5. Variations in the number of fungal species isolated at different intervals from decomposing wheat leaves were not as pronounced as those observed with respect to internodes. On 30th day, the number of species isolated was exactly similar to that recorded initially. However, on 90th day a moderate increase was observed followed by further increase so that on 150th day, the number of species isolated was maximum i.e., 17. Variations in the populations of fungi have been presented in fig. 3. The initial fungal population on leaves was more than 2.5 times of that observed on the internodes; and like internodes, the fungal population on leaves also increased steeply on 30th day being more than double of that observed initially. However, on 90th day there was a steep fall and the population reached a level slightly more than the initial value. On 150th day, it decreased further so that it was substantially lesser than that recorded initially.

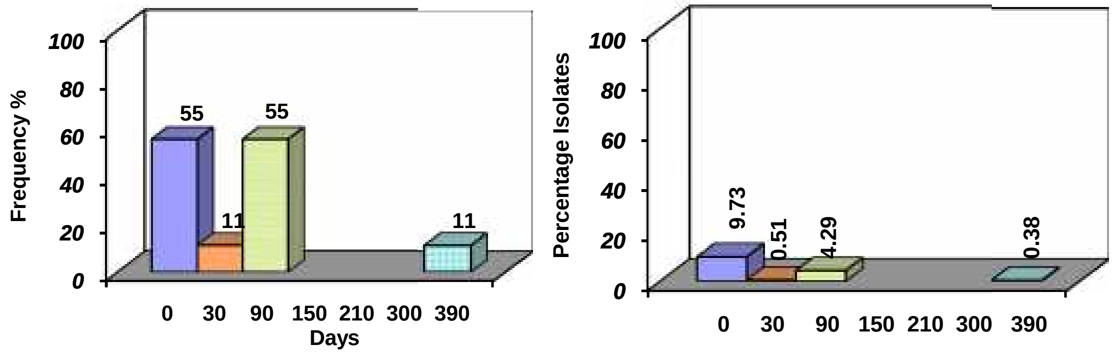
Wheat Chaff: Variations in the number of fungal species colonizing decomposing wheat chaff at different time intervals have been presented in fig. 6-8. There was no change in the number of species isolated from the decomposing chaff on 30th day. On 90th day also, there was negligible increase followed by a slight increase on 150th day. A moderate decline followed as a result of which the number of species isolated on 210th day was slightly lesser than even that recorded initially. Variations in the populations of fungi have been presented in Fig. 3. The fungal population isolated initially from the chaff was more than double of that isolated from the internode. However, it was substantially lower than that isolated from the leaves. Also, in contrast to internodes and leaves where the population increased steeply on 30th day, the fungal population on decomposing chaff increased only slightly on the 30th day followed, of course, by a steep rise so that on 90th day it was more than 1.5 times that recorded on the 30th day. This was followed by a sharp decline and the population reached almost the level recorded on 30th day and this steep decline further continued—as a result of it, on 210th day, the fungal population was less than half of that recorded initially.

Wheat Straw: Variations in the number of fungal species colonizing decomposing wheat straw at different time intervals have been presented in fig. 9-11. The number of fungal species isolated from the mixed straw remained unchanged till 30th day followed by a moderate increase which continued till 150th day when it reached almost double the number of species isolated in the beginning. A sharp decline followed and the number of species recorded on 210th day was almost similar (only slightly more) to that recorded initially. Only a slight rise was observed at the last day of isolation. Variations in the populations of fungi have been presented in Fig. 3. The fungal population isolated from the mixed straw initially was slightly more than that isolated from chaff but was moderately lower than that from leaves. Unlike chaff, but like leaves and internodes, the fungal population on straw increased steeply on 30th day but the population on 30th day was slightly lesser than double of that recorded initially. This was followed by a sharp decline so that the population level reached almost near to that recorded initially. Only a negligible increase was recorded on 150th day followed by a sharp fall on 210th day and a further slight decline. As a result of it, the population isolated ultimately on 300th day was only slightly more than half of that isolated in the beginning.



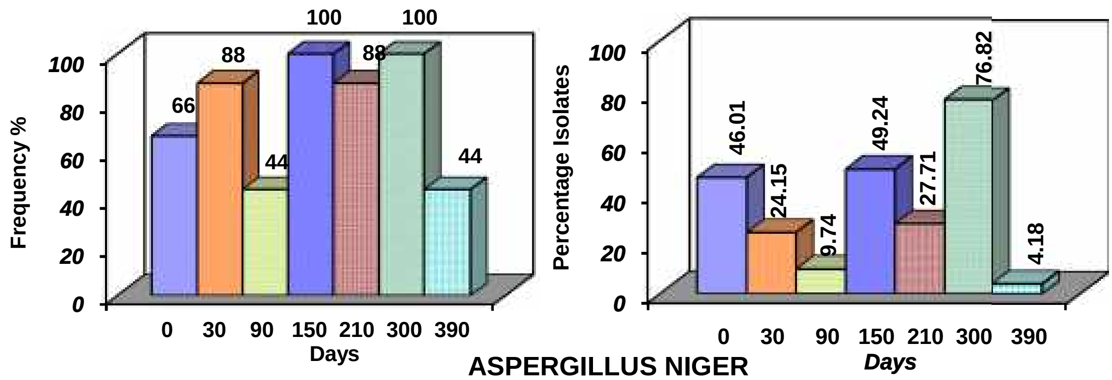


ASPERGILLUS FLAVUS

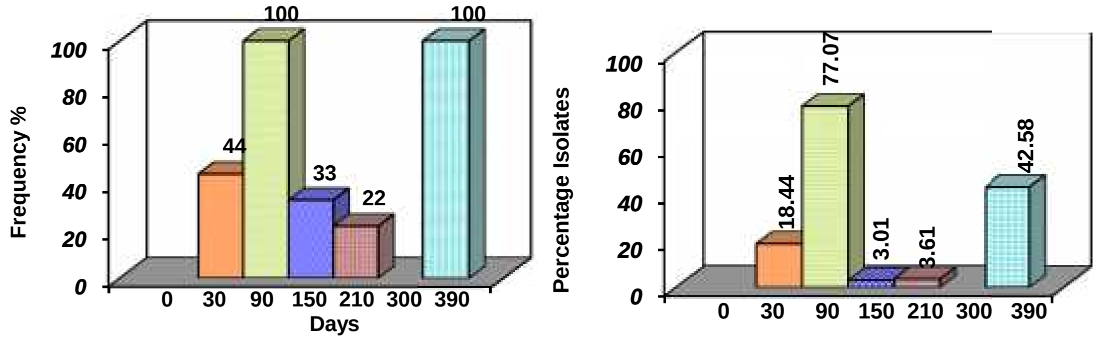


ASPERGILLUS FUMIGATUS

Fig. 1: Frequency percentage and percentage isolates of some fungi colonising wheat internodes decomposing underground



ASPERGILLUS NIGER



ASPERGILLUS LUCHUENSIS

Fig. 2: Frequency percentage and percentage isolates of some fungi colonising wheat internodes decomposing underground

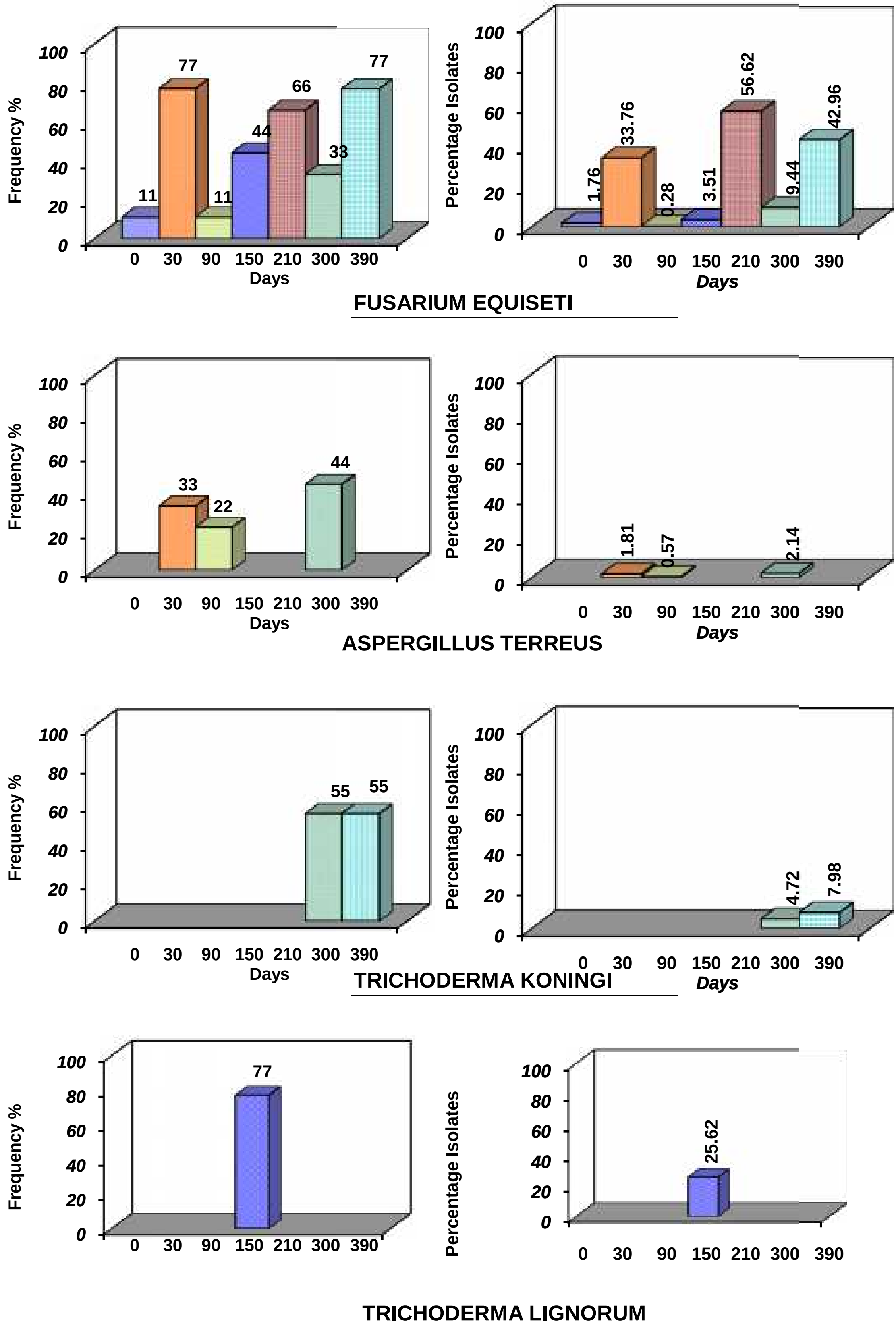


Fig. 3. Fungal population (per g dry liter) isolated at different intervals from aboveground wheat crop residues decomposing underground

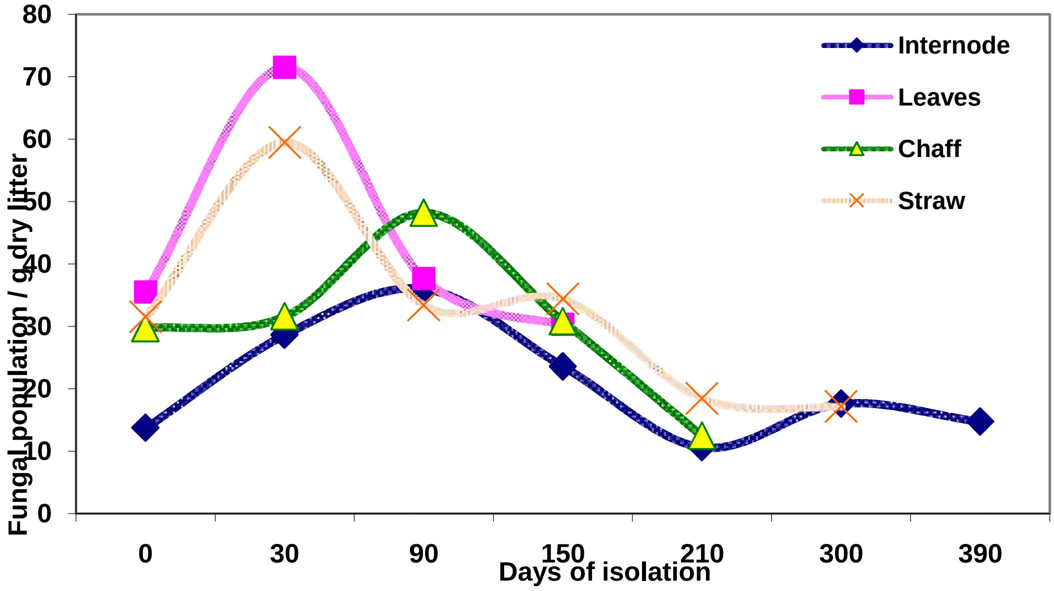
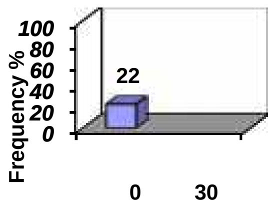
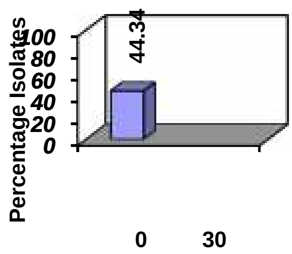
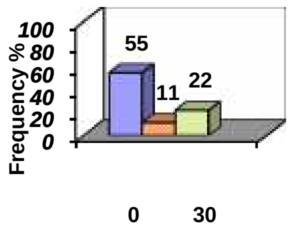


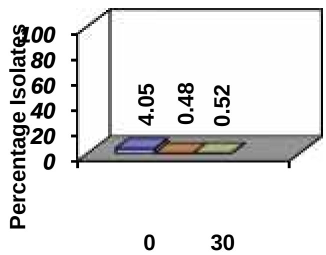
Fig. 4: Frequency percentage and percentage isolates of some fungi colonising wheat leaves decomposing underground





PAPULASPORA SP.





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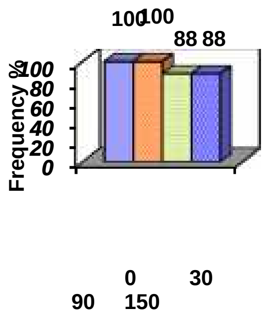
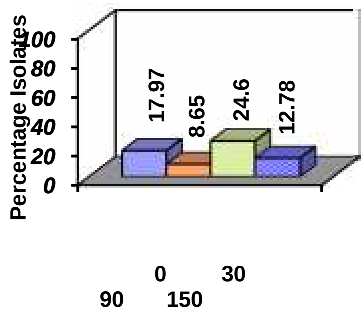
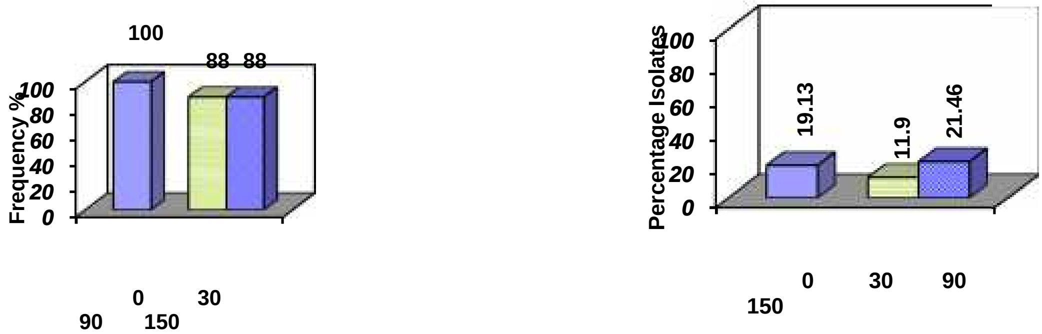




ASPERGILLUS FLAVUS

ASPERGILLUS LUCHUENSIS

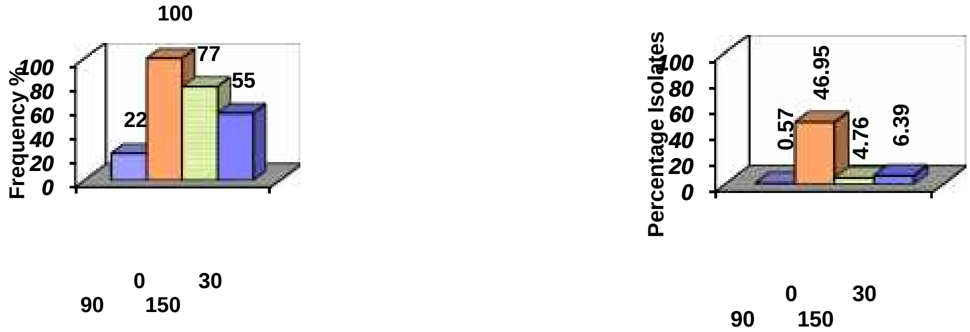
Fig. 5. Frequency percentage and percentage isolates of some fungi colonising wheat leaves decomposing underground



ASPERGILLUS NIGER

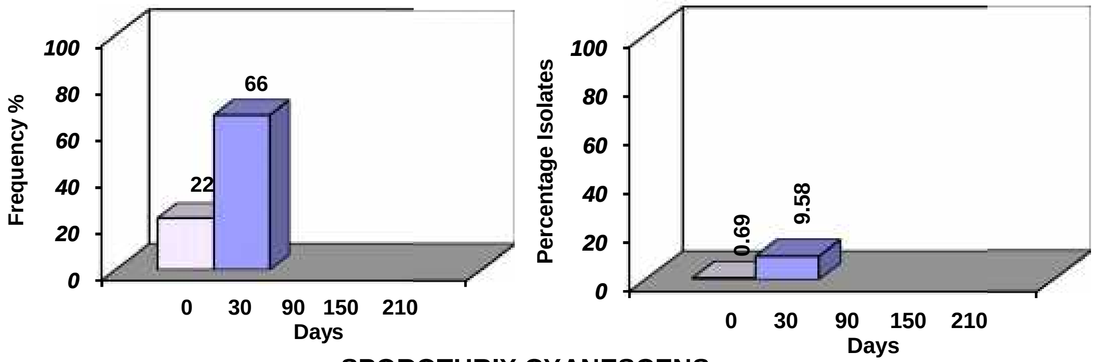
ASPERGILLUS TERREUS

STACHYBOTRYS ATRA

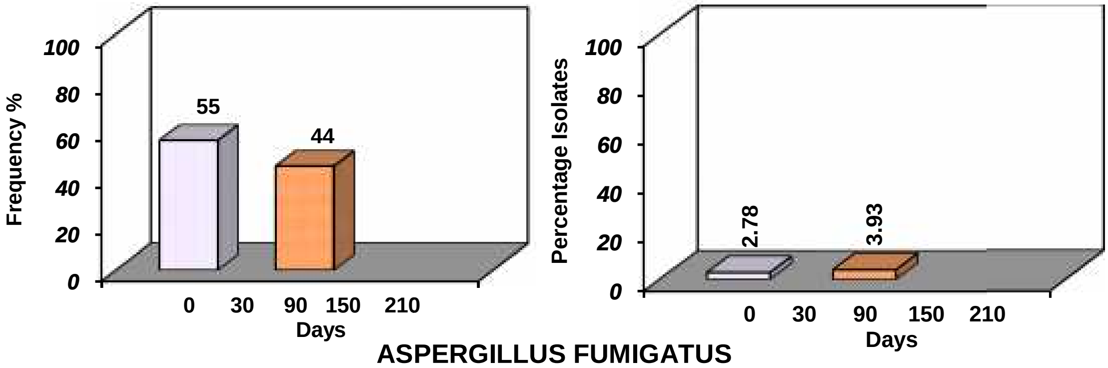


FUSARIUM EQUISETI

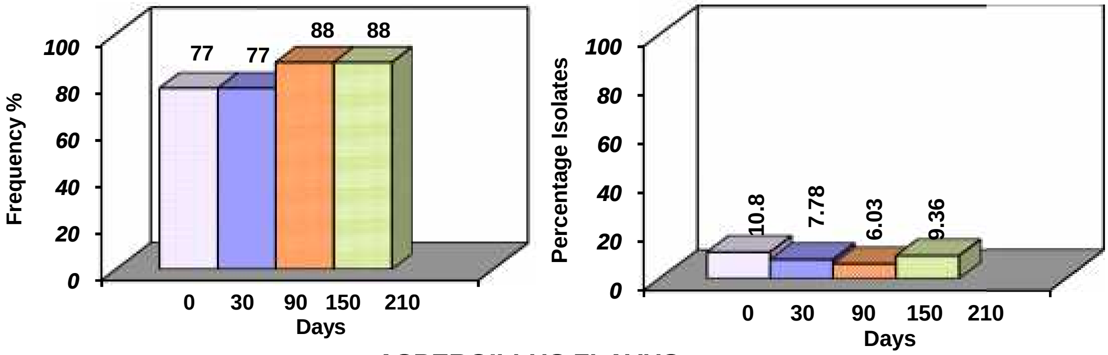
Fig. 6: Frequency percentage and percentage isolates of some fungi colonising wheat chaff decomposing underground



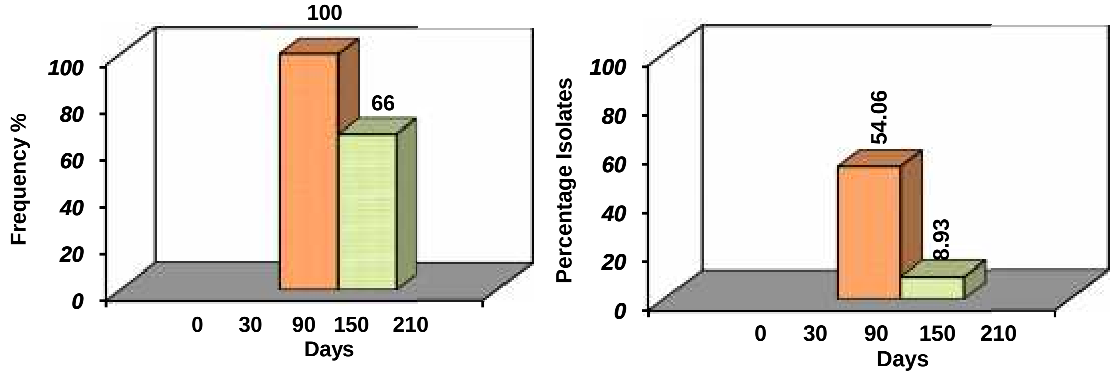
SPOROTHRIX CYANESCENS



ASPERGILLUS FUMIGATUS

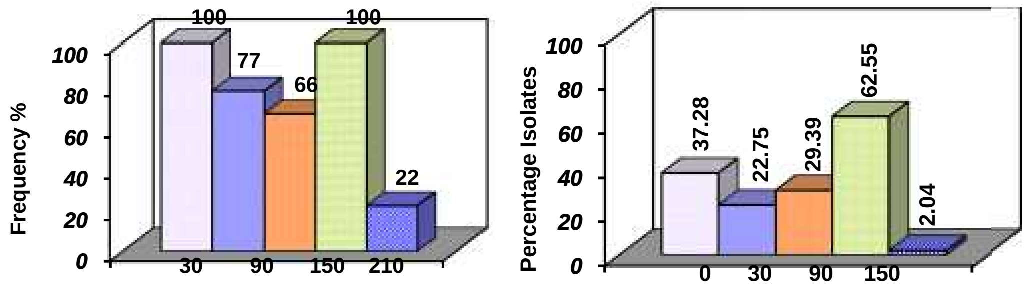


ASPERGILLUS FLAVUS

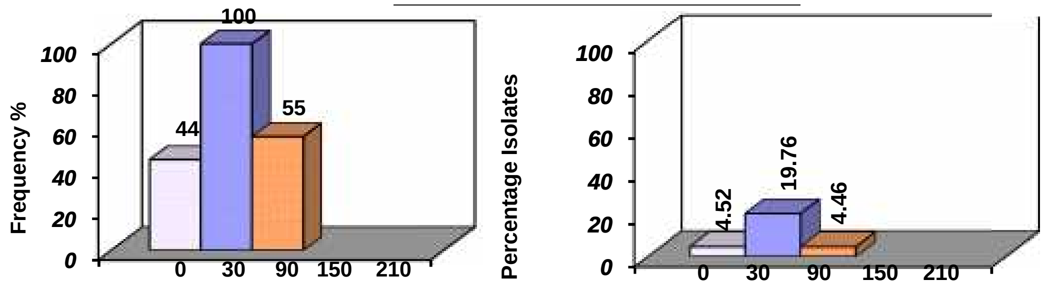


ASPERGILLUS LUCHUENSIS

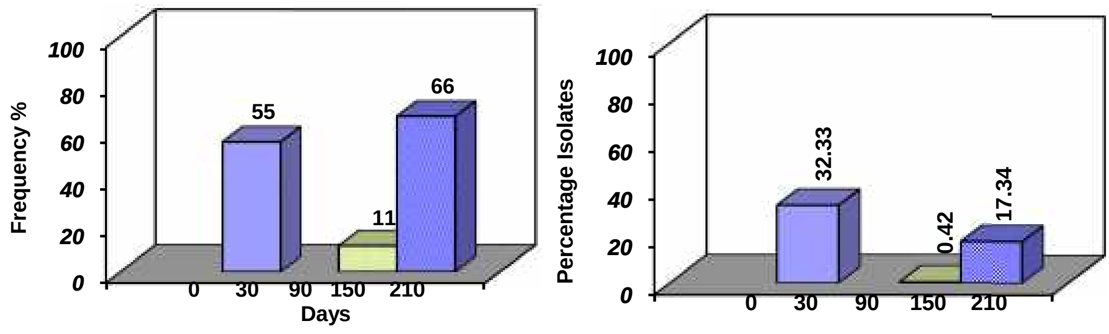
Fig. 7: Frequency percentage and percentage isolates of some fungi colonising wheat chaff decomposing underground



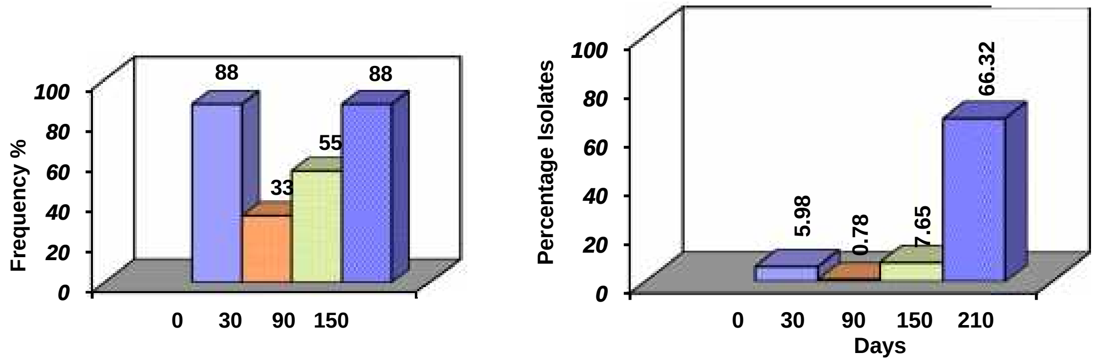
ASPERGILLUS NIGER



ASPERGILLUS TERREUS

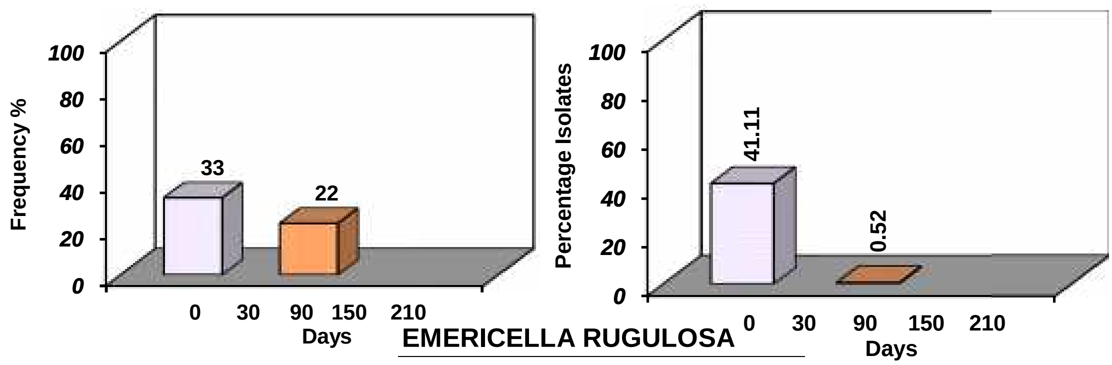


STACHYBOTRYS ATRA

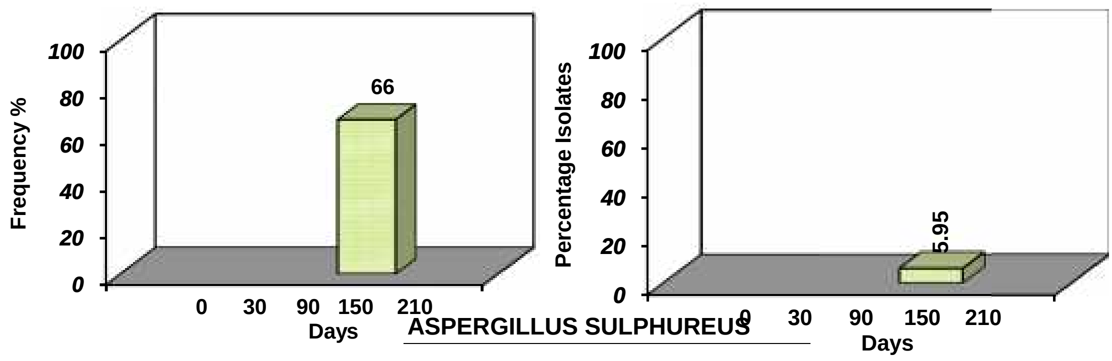


FUSARIUM EQUISETI

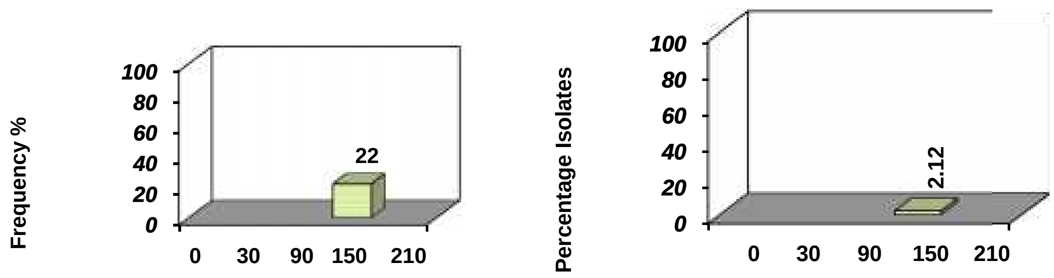
Fig 8: Frequency percentage and percentage isolates of some fungi colonising wheat chaff decomposing underground



EMERICELLA RUGULOSA



ASPERGILLUS SULPHUREUS



BOTRYTIS CINEREA

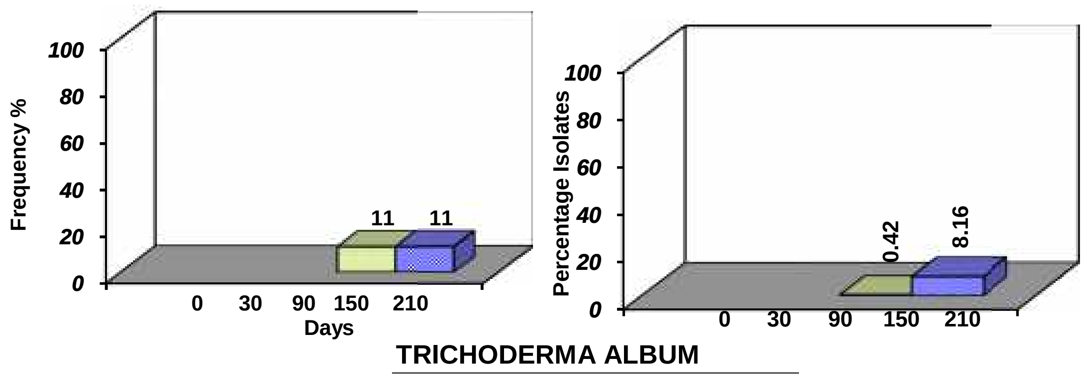
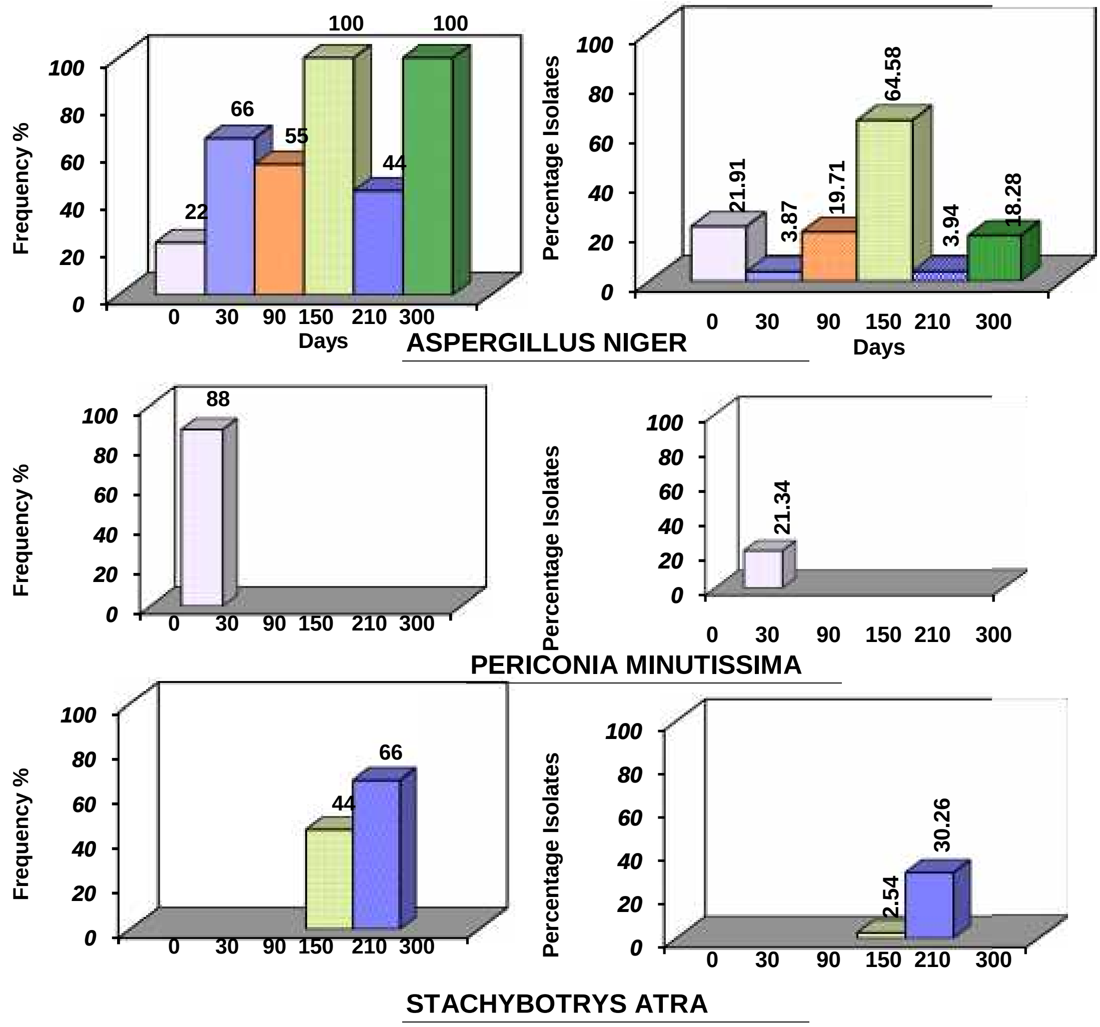
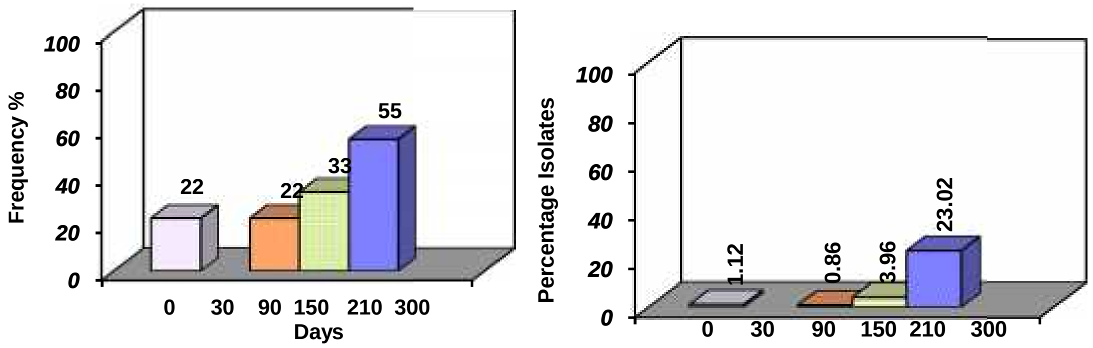


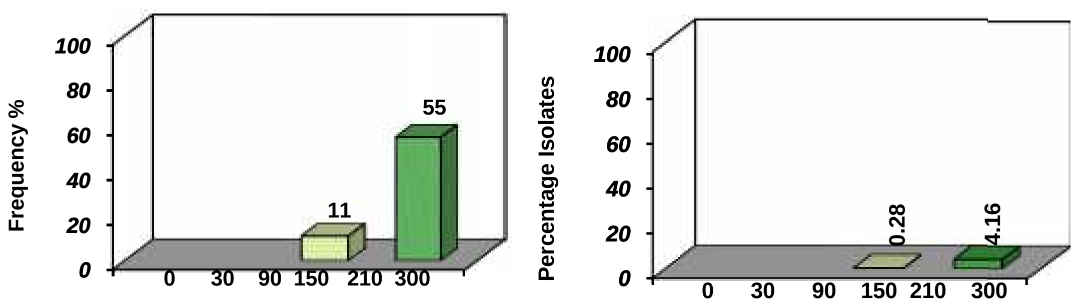
Fig. 9: Frequency percentage and percentage isolates of some fungi colonising wheat straw decomposing underground



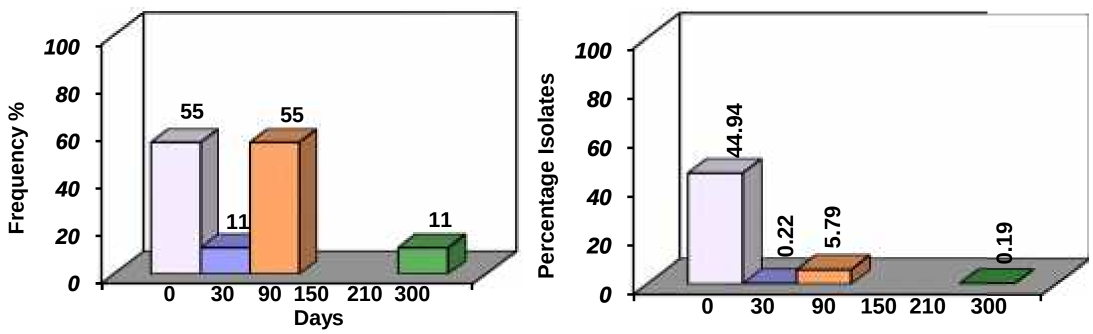


FUSARIUM EQUISETI

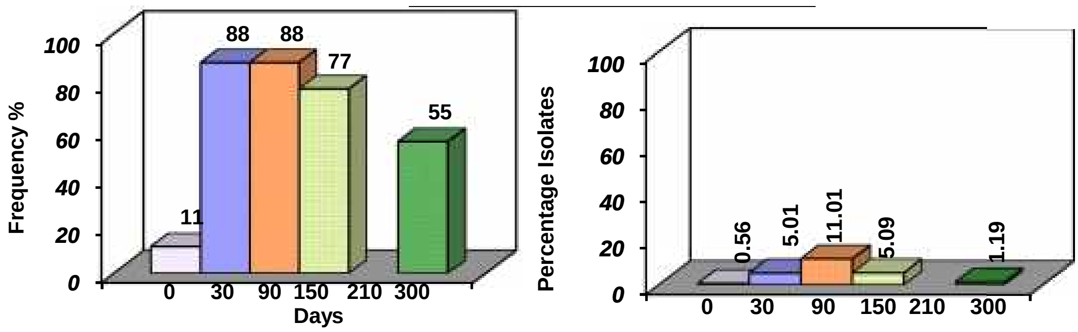
Fig. 10: Frequency percentage and percentage isolates of some fungi colonising wheat straw



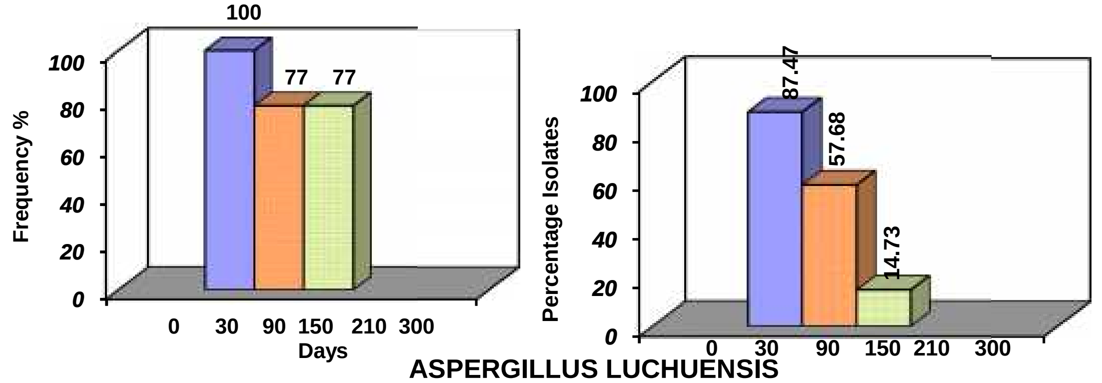
ASPERGILLUS FUNICULOSUS



ASPERGILLUS FUMIGATUS

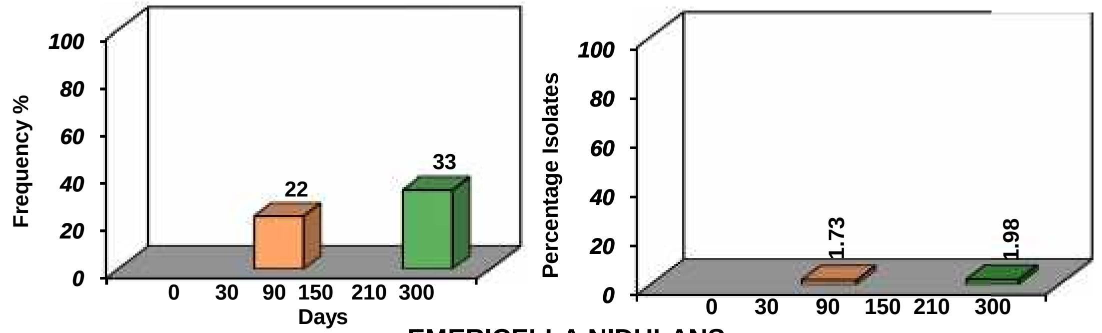


ASPERGILLUS FLAVUS

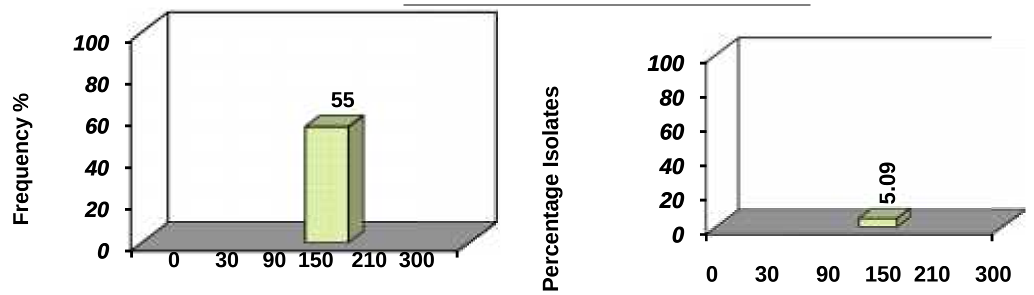


ASPERGILLUS LUCHUENSIS

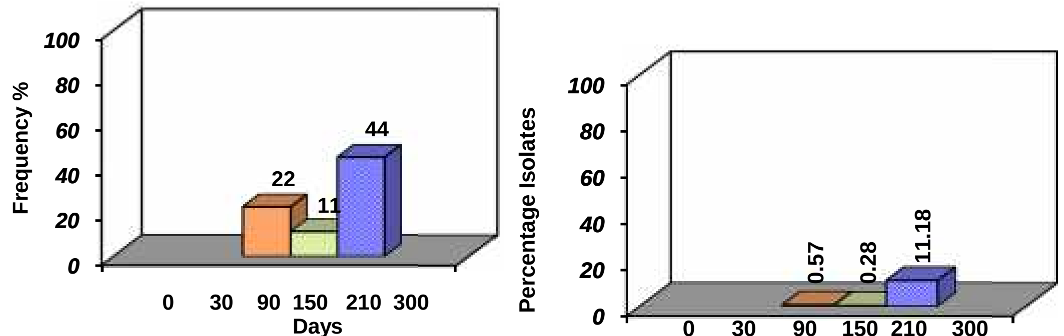
Fig. 11: Frequency percentage and percentage isolates of some fungi colonising wheat straw decomposing underground



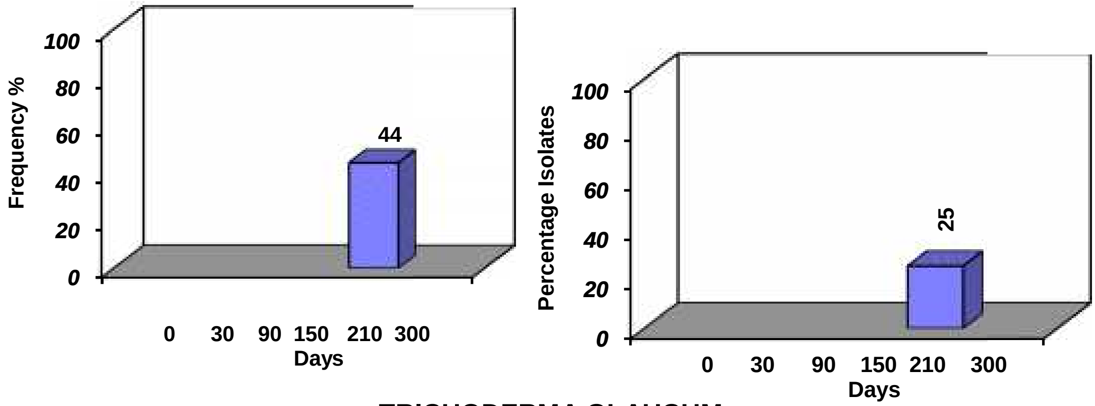
EMERICELLA NIDULANS



ASPERGILLUS SULPHUREUS



TRICHODERMA LIGNORUM



TRICHODERMA GLAUCUM

Discussion

The changes in the species diversity: The change in the number of species colonizing different species, as the decomposition progressed, exhibited some degrees of variation. In the case of leaves and straw, the number of species isolated at the terminal stage of decay was higher than that in the beginning—the difference in the case of leaves being very large. In the case of internodes and chaff, slightly lesser number of species were isolated than in the beginning. Hogg and Hudson (1966), while studying the succession of fungi on beech leaves, found a decline in the number of species in the terminal stages of decay. Charaya (1985), Singh and Charaya (2003) also recorded' similar observations in the case of decomposition of paddy straw and wheat crop residues respectively. In general : (i) the number of species remained more or less constant in the early stages of decomposition except in the case of internodes where slight increase in the number of species was observed; (ii) the species diversity in the middle phase of decomposition increased as the decomposition progressed except in the case of internodes where substantial decrease was observed first and then a substantial increase, again followed by substantial decrease; (iii) the species diversity decreased in the final stages of the decomposition except that (a) in the case of decomposing leaves no such decrease in species diversity was observed; and (b) number of species isolated at terminal stage of decay was slightly greater than that in the subterminal stage in case of decomposing internodes and straw. Yadava and Madelin (1968) had also observed that in decaying stems of wheat the secondary mycoflora was much more diverse than the primary mycoflora. The seasonal variation may be one of the factors governing the colonization of the resources as a peak in the number of species is observed during the months August to December. A similar peak in the number of fungal species isolated from soil in the months of August, September and October was observed in soil by Singh and Charaya (1975) and in the months of October by Dube et al. (1980). The number of articles, reviews and books have appeared from time to time to discuss the various aspects of microbial colonization and changes during plant litter decomposition (Charaya and Singh, 2005; Rani et al., 2015; Singh et al., 2015a, b, c, d, e; Singh et al., 2016a, b, c, d; Potthoff et al., 2008; Londoño et al., 2013.

The Fungal Populations: Initially, the fungal population was maximum in wheat leaves followed by straw, chaff and internodes (fig. 3). On all the residues, the population rose markedly in the first 30 days except the chaff where the increase was only slight. In the next 60 days, however, the residues exhibited two different trends. While the fungal populations of internodes and chaff continued to increase, that of wheat leaves and straw decreased markedly so that it came back almost to the initial level. In remaining periods of decomposition, the fungal population exhibited an overall decreasing trend. Ultimately, the number of species' isolated at the last stages of decomposition were quite lower than that in the beginning except in the case of internodes where it was slightly more. Lacey (1979) is of the opinion that fungi require a minimum water activity `$a_w$' for growth about 0.65. Thus, the crop residues are initially colonized by those fungi which are capable of growing at low moisture contents. As a result of decomposition, the water activity `a_w' of residues is increased to 0.9, which is suitable for the growth of many fungi. Moisture and moisture flow are now widely recognized as key factors in the biodegradation of waste refuses (McDougall et al., 2000). Therefore, increase in fungal colonization takes places. As far as leaves are concerned, the sharp fall in the fungal population in October is understandable because of its rapid rate of decomposition and obvious decrease in nutrients availability. But the fall in the number of fungi on straw needs some other explanation. Singh and Charaya (2010) and Singh et al., (2015c, e) demonstrated the role of nutrients in the fungus colonization of wheat crop residues. A comparison of the trends of fungal population on decomposing straw closely resembles that of the fungal population in the soil (Singh and Charaya, 1975) where the fungal population was found to be very low in October followed by an increase in December followed by a decrease in February and June. In the case of internodes and chaff, however, fungal population is greater in October followed by a regular decrease till end, except in the case of internodes the populations is increased during June only to decrease in September. Thus, though the fluctuations in the fungal population in soil might be responsible for fluctuations in fungal colonization of decomposing residues, these do not match completely. The factor operating in an environment are rarely constant but may fluctuate irregularly, oscillate cyclically, or show a progressive trend. The system is dynamic and the changes may be relatively great, with large alternations in the characteristics of microhabitats and hence, of the microflora (Park 1968). Therefore, it is perhaps not logical to look for any unqualified correlation between any factor and fungal numbers in such a complex medium as the soil where so many conflicting influences operate (Ramakrishnan, 1955). Similar views have been expressed by Saksena (1955) and Rama Rao (1970).

Acknowledgement

Author express his profound sense of gratitude and indebtness to research supervisor, Dr. M.U. Charaya, Professor, Department. of Botany, CCS University, Meerut. Who with high tenacity, subverted all snags in the progress of the work and has throughout been a constant source of motivation, imagination and information.

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