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REVIEW ARTICLE

A Study on the Plant Litter Decomposition Using Mycoflora for Sustainable Environment

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ABSTRACT

Most of the agricultural, forest and field crop litters are consisting lignocelluloses, cellulose, hemicellulose and lignin. Among these cellulose is most predominant constituent followed by hemicellulose and lignin. The lignin together with the hemicellulose, encrust the cellulose chains forming a barrier which prevents wetting and access of cellulose-degrading enzymes therefore, the decomposition of litters can be achieved by breaking this association at first. The biodegradation of lignin of field crop litters representing a key step for carbon recycling inland ecosystem, as well as for industrial utilization of plant biomass, humification of dead organic matter by the application of certain bacterial and fungal species. The present study revealed the process of decomposition of plant litters. The fungal species colonized different types of plant litters on the basis of enzymatic activities and resource specificity. The mixtures of microorganisms could degrade lignocellulosic materials of wheat stubbles more efficiently than any individual species; *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus terreus*, *Fusarium equiseti*, *Trichoderma lignorum and Stachybotrys atra*. A mixture of fungi and *Streptomyces* caused 48.0% decomposition while decomposition by an individual species viz. *Aspergillus flavus* was 36.90% only. It was found that, fungi have better abilities to decompose wheat straw than bacteria and actinomycetes. The mineralisation of plant residues could accelerate the rate of decomposition.

Keywords: Plant litters, Resource specificity, Decomposition *Trichoderma lignorum; Stachybotrys atra*

INTRODUCTION

Studies on the role of individual fungal species in the process of decomposition can be traced back to Koning (1904) who inoculated *Trichoderma koningi* and *Cephalosporium koningi* upon sterile leaves covered with a little water. At the end of several weeks, the leaves disappeared, and water contained NH_3. Lindeberg (1944) reported that *Mycena galopus* could decompose 37.0% of the dry matter of Beech, *Fagus* sp. (Angiosperm: Fagaceae) litter in 6 months at 25°C. Hering (1967) found that *Mycena galopus* and another fungus, *Collybia personata* caused the greatest decomposition of oak leaf litter. Frankland (1969) found *Mycena galopus* to cause greatest loss in the bracken petioles when compared with many of the fungi imperfect. Initially, in the first 3 months, it caused small change in weight which was attributed to its slow spread over the litter. Afterwards, the fungus became considerably active, maintained its activity during the following 90 days period of study, while other fungi declined their activity. *Trichoderma viride* decomposed cellulose only when the substrate was treated with calcium nitrate. Singh et al. (2016c) also find out *the decomposer microorganisms on the different substrates.*

PLANT LITTER DECOMPOSERS

Dawson (1949) studied the capacity of a number of individual fungal strains from among soil fungi to decompose wheat straw *in vitro.* However, he did not refer to any species but only numbered the isolates of same genus like *Aspergillus* no. 1, 2, etc. Some of the strains were found to be successful decomposers. It was found that different fungi vary greatly in their ability to attack straw. *Rhizopus* and *Penicillium* were relatively inactive while *Fusarium* and *Chaetomium* were vigorously active. Wani and Shinde (1977) also attempted to screen wheat straw decomposing microorganisms *in vitro*. They studied only a few strains of microorganisms, mostly bacteria. Kapoor et al. (1978) studied the extent of degradation of cellulose and lignin in wheat straw as a result of inoculation with *Botryotrichum* sp., *Masoniella* sp., *Paecilomyces fusisporus*, *Sclerotium* sp. and T*richurus spiralis. Botryotrichum* sp. and *Sclerotium* sp. were found to degrade lignin up to 22% within 15 days. Gaur (1979) found that two species of *Penicillium* and *Aspergillus* could decompose 46% and 36% of the straw respectively. Singh and Charaya (2003) investigate the fungal colonization of decomposing above-ground residues of wheat crop and 46 fungi were isolated. Chatterjee and Nandi (1980) observed that the mixtures of microorganisms could degrade lignin and holocellulose of wheat stubbles more efficiently than any individual species. A mixture of fungi and *Streptomyces* caused 48.0% decomposition while decomposition by an individual species viz. *Aspergillus flavus* was 36.90% only. Chaturvedi (1984) found fungi to have better abilities to decompose wheat straw than bacteria and actinomycetes. The order of ability of individual test fungi to decompose the sterilized litter was *Cunninghamella echinulata*, *Aspergillus flavus, A. niger*, *Trichoderma viride*, *Fusarium oxysporum*, *Penicillium chrysogenum*, *Cladosporium cladosporioides*, *Rhizopus nigricans*, *Myrothecium roridum*, *Neocosmospora vasinfecta. T viride*, *P. chrysogenum and M. roridum* were more active on unsterilized litter. Charaya (1985) tested the capability of a number of fungi to decompose wheat and paddy crop residues *in vitro. Emericella nidulans* was the most successful decomposer of wheat straw followed by *Myrothecium verrucaria*, *Alternaria alternata*, *Penicillium oxalicum*, *Fusarium semitectum, Cladosporium cladosporioides and Stachybotrys atra.* Magan et al. (1989) failed to detect any marked improvement in decomposition of wheat straw in soil as a result of inoculation with *Gliocladium roseum*, *Trichoderma harzianum or Penicillium hordei.* Omar (1994) investigated the decomposition and mineralisation of wheat straw inoculated with cellulolytic fungi in sand culture. *Aspergillus fumigatus* and *Stachybotrys chartarum* showed a great potential to degrade wheat straw. Singh et al. (2017a,b,c; 2018a,b) studied the cellulolytic, hemicellulolytic, pectolytic and lignolytic potential of fungi in the decomposition of wheat straw.

Rege (1927) studied the decomposition of rice straw by *Coprinus* sp., *Aspergillus fumigatus* and *Acremonium velutina*, individually as well as in combinations. The maximum decomposition was achieved in combination of all the three. All the three fungi could decompose rice straw to different degrees. Prakash and Saksena (1952) studied the capacity of 22 fungi to decompose paddy straw. Maximum loss in weight of the straw was recorded in the case of *Penicillium luteum* but maximum total carbon decomposition was recorded in the case of *Chaetomium* sp. pH of straw or the oxidase activity of fungi were not found to have a correlation with decomposition. Mukhopadhyay and Nandi (1979) found *Curvularia* sp. to be most efficient decomposer of rice stumps while Chatterjee and Nandi (1981) found *Geotrichum candidum* and *Oospora lactis* to be the best degraders of rice stumps. Slight decomposition (6-8%) of *Sphagnum* spp. incubated with *Trichoderma lignorum* or *Penicillium spinulosum* was recorded by Minchevich (1969). In similar cultures, *Collybia dryophila* can destroy about 30% of the dry matter in less than four months, but this is considerably less than in the Bryales (53-56%) and angiosperm litter (46-69%) tested under same conditions (Mikola, 1956).

Hering (1967) found that the difference in the rates of decomposition of autoclaved and irradiated litter (when inoculated with *Trichoderma viride*) were not large though the rate was only slightly more in the former which, in his

opinion, was due to the breakage of cellulose fibres and hydrolytic release of nutrients. Singh et al. (2015a; 2016a) stated that different biochemical constituent *viz* lignin, cellulose, hemicellulose and pectin degraded at different rate inoculated by *Trichoderma lignorum.*

Ivarson (1974) studied the survival and decomposing ability of four dominant fungi isolated from coniferous-deciduous leaves over a period of 45 months and found that *Rhizoctonia* sp., whether alone or in association with other fungi, had low survival ability and would seem to be of little importance in the decomposition of the litter. *Mucor spinescens* alone, at 10°C and room temperature, survived and brought about some decomposition. In mixed culture, it aided in the process of decomposition. Singh et al. (2016b, d) established the role of microorganism and microfauna in plant litter decomposition.

Aneja (1978) found *Chaetomium erectum* and *Aspergillus flavus* to possess maximum ability to decompose *Desmostachya* and *Chenopodium* litter respectively. Dube et al. (1980) observed that *Cladosporium herbarum*, *Aspergillus niger* and *Aspergillus flavus* possessed very good capacity to decompose mango leaves. The decomposition was rapid in the first 11 days, slowing down during the next 10 days. Singh et al. (2015b,C) investigated the lignocellulolytic potential of *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus terreus*, *Fusarium equiseti*, *Trichoderma lignorum* and *Stachybotrys atra.*

FACTORS INFLUENCING THE LITTER DECOMPOSITION

Kang et al. (1995) found that the addition of ammonium sulfate [$(NH_4)_2SO_4$] promoted the composting of paddy straw inoculated with cellulolytic microorganisms. Nandi *et al.* (1999) found that *Phanerochaete chrysosporium*, in combination with *Trichurus spiralis*, caused maximum decomposition of sawdust. Cox et al. (2001) have established the importance of understanding the effects of specific fungi in the process of litter decomposition as compared to diverse communities. Singh et al. (2016b,d) find out the host-specific decomposers of plant litters.

Koutev et al. (2001) studied the rate of mineralisation of nitrogen from straw using "BIOSMOSEO" (a special microbiological strain adapted in decomposition of plant residues). They found that the agent increased the rate of mineralisation of nitrogen from straw for the first 14 days of incubation. Singh and Charaya (2010); Singh et al. (2015d) find out the effect of Nitrogen and Phosphorous on the decomposition of post-harvested wheat crop residues.

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