

DEGRADATION OF RICE STUBBLE BY SOME SOIL FUNGI ISOLATED FROM RICE FIELD

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Soil fungi isolated from rice field associated with stubbles at late phase of degradation proved to be efficient for degradation of stubbles under laboratory conditions. Amongst the test fungi *Aspergillus wentii* showed highest extent of stubble degradation followed by *Verticillium albo-atrum* and *A. candidus*. Holocellulose is the major component of rice stubble constituting 56% of the stubble dry wt. *V. albo-atrum* degraded this component maximally followed by *A. wentii* and *A. candidus*. Lignin is also a major component of the stubble next to holocellulose, for which *Penicillium* sp. proved to be the best degrader followed by *A. wentii* and *V. albo-atrum*. The ratio of holocellulose to lignin in stubble is 2:1. This ratio declined to about 1.8 or less after 60 days of degradation. The highest reduction was found to be in *V. albo-atrum* followed by *A. candidus* and *A. wentii*.

INTRODUCTION

Jaya variety of rice is commonly cultivated in India throughout the year. Due to multiple cropping the interval time between the crops has been reduced to only one or two months, which is too short for complete degradation of the stubbles in fields. As a result, incomplete decay causes reduction in soil nutrients and productivity (Golod, 1967; Mishustin & Erofeev, 1965; Samtsevitch & Berisova, 1963). Moreover, the common practice to remove undergraded stubble from fields before cultivation of the next crop results in the loss of potential soil manure. Such loss can be avoided through degradation of stubbles by selected efficient degraders. The efficiency of the degraders depends mainly on their ability to utilize lignocellulosic component of the stubbles. The present work has been undertaken to determine relative efficiencies of some soil fungi to degrade major components of stubble of rice (Jaya variety).

MATERIALS AND METHODS

Numerically dominant organisms (*Aspergillus wentii* Wehmer, *Aspergillus candidus* Link, *Penicillium* sp. *Verticillium albo-atrum* Reinker and Berthold, *Spicaria* sp. and *Fusarium* sp.) in field soil around Burdwan associated with rice (Jaya variety) stubble at the late phase of degradation, were isolated by dilution plate technique on malt agar media containing streptomycin (Chatterjee and Nandi 1981). Those isolates were tested for their relative efficacies to degrade major components of rice stubble.

Dried pieces (2.5 cm long) of rice stubble (10 g) of 'Jaya' variety were taken in Erlenmeyer flasks (250 ml), soaked in distilled water (200 ml) for 1 h and then the excess water was drained off. Equal volume of distilled water (40 ml) was added to each flask, plugged and sterilized at 15 lbs pressure for one hour. The stubble pieces in flasks were then inoculated with spore suspension (2.25×10^{-6} spores/ml) of each fungus separately. Parallel set (without inoculation) was kept as control. These flasks were incubated at $30^\circ \pm 2^\circ\text{C}$ for 30 days and 60 days. Partially degraded stubbles were taken out from the flasks in triplicate and dried to constant weight at 80°C in small aluminium foil trays and finally powdered.

Holocellulose in the powdered stubble was estimated quantitatively following TAPPI Standard (1954) and Cowling (1961). Powdered stubble (100 mg) was taken in a G_4 sintered glass filter and preextracted with ethanol; benzene, ethanol and hot water to remove extraneous substances. This was followed by a succession of chlorination and monoethanol amine extraction to remove lignin. The paper white holocellulose residue, thus obtained, was dried to constant weight.

Lignin content of rice stubble was estimated by Seaman *et al* (1954) by removing total carbohydrate from powdered stubble (400 mg) by hydrolysis with 72.01% (w/v) ice cold H_2SO_4 (3 ml). The acid mixture was kept agitated for 1 h, for efficient penetration of the acid. The acid strength was then diluted to 4% by adding water and then autoclaved at 121°C for 1 h. After cooling, it was filtered through G_4 sintered glass filter and washed several times with distilled water to render the lignin free of acid. The lignin residue was then air dried to a constant weight.

RESULTS AND DISCUSSION

All the test fungi were capable of causing degradation of rice stubble considerably (Table 1). *A. wentii* showed maximum degradative ability (28%)

after 60 days, followed by *V. albo-atrum*, *A. candidus*, *Penicillium* sp., *Fusarium* sp. and *Spicaria* sp. Chatterjee and Nandi (1981) also reported *V. albo-atrum* as well as *A. wentii* to be two efficient degraders of wheat stubble. Wani and Shinde (1977) reported *Aspergillus* sp. as the most efficient straw degrader. It was interesting to note that after 30 days *V. albo-atrum* degraded stubble maximally (21.47%) followed by *Penicillium* sp. (19.53%), *A. candidus* (17.72%) and *A. wentii* (16.4%). After 60 days the highest efficiency was obtained by *A. wentii* (28%) possibly because the species was capable of utilizing the intermediate products of the degrading stubble more efficiently than the other test fungi.

Table 1. Degradation of rice stubble by some soil fungi after different periods of incubation

Organisms	Incubation days	Loss in dry weight (%)*	
		30	60
<i>Aspergillus wentii</i>		16.40	28.00
<i>Aspergillus candidus</i>		17.72	23.75
<i>Penicillium</i> sp.		19.53	23.29
<i>Verticillium albo-atrum</i>		21.47	27.60
<i>Spicaria</i> sp.		11.44	12.45
<i>Fusarium</i> sp.		11.80	16.65

* Mean of three replicates.

Table 2. Degradation of rice stubble by some soil fungi after different periods of incubation

Organisms	Incubation days	Loss in dry weight (%)*	
		30	60
<i>Aspergillus wentii</i>		14.91	25.60
<i>Aspergillus candidus</i>		18.66	23.92
<i>Penicillium</i> sp.		16.23	22.76
<i>Verticillium albo-atrum</i>		25.25	32.32
<i>Spicaria</i> sp.		13.18	15.90
<i>Fusarium</i> sp.		9.54	20.41

Holocellulose in fresh stubble 56.00%

* Mean of three replicates

Holocellulose, the major component of rice stubble (56%) was found to be degraded by all the test organisms (Table 2). *V. albo-atrum* being the most efficient (32.32% after 60 days) followed sequentially by *A. wentii* (25.60%), *A. candidus* (23.92%), *Penicillium* sp. (22.76%), *Fusarium* sp. (20.41%), and *Spicaria* sp. (15.90%). Obviously the organism which were good holocellulose degraders proved to be good stubble degraders as well. Bhargava (1972) also reported that the efficient cellulose decomposers were efficient also in decomposing wheat straw.

Lignin which is second major component of stubble next to holocellulose is known to be relatively resistant to microbial decay (Kirk *et al.* 1977). As such, although test organisms showed their ability to decompose lignin, the extent of decomposition was much lower than that of holocellulose (Table 3). The maximum lignin degradation was recorded by *Penicillium* sp. (17.74%) followed by *A. wentii* (16.43%), *V. albo-atrum* (14.33%), *Fusarium* sp. (13.75%), *A. candidus* (11.71%) and *Spicaria* sp. (9.97%). Alexender (1977) reported species of *Aspergillus*, *Penicillium* and *Fusarium* to be efficient lignin degraders. Gulyas (1967) reported 20% loss of lignin in wheat straw by *Fusarium* sp. Chatterjee and Nandi (1981) also reported a loss of 11-19% of wheat straw lignin by species of *Penicillium*, *Aspergillus*, *Verticillium* and *Fusarium*.

Table 3. Degradation of lignin of rice stubble by some soil fungi after different periods of incubation

Organisms	Incubation days	Loss in dry weight (%)*	
		30	60
<i>Aspergillus wentii</i>		9.68	16.43
<i>Aspergillus candidus</i>		5.41	11.71
<i>Penicillium</i> sp.		12.74	17.74
<i>Verticillium albo-atrum</i>		8.50	14.33
<i>Spicaria</i> sp.		3.50	9.97
<i>Fusarium</i> sp.		11.91	13.75

Lignin in fresh stubble 28.00%

* Mean of three replicates.

Table 4. Ratio of holocellulose and lignin in rice stubble after different periods of degradation by some soil fungi

Organisms	Incubation days	Holocellulose	Lignin*
		30	60
<i>Aspergillus wentii</i>		1.88	1.82
<i>Aspergillus candidus</i>		1.72	1.72
<i>Penicillium</i> sp.		1.92	1.88
<i>Verticillium albo-atrum</i>		1.63	1.58
<i>Spicaria</i> sp.		1.80	1.87
<i>Fusarium</i> sp.		2.05	1.85

In fresh stubble holocellulose : Lignin :: 2 : 1

* Mean of three replicates.

Ratio of holocellulose to lignin in the fresh rice stubble is 2 : 1 (Table 4). This ratio declined to about 1.8 or less after 60 days of incubation. The maximum reduction was noted in *V. albo-atrum* (1.58) followed by *A. candidus* (1.72) and *A. wentii* (1.82). This reduction in ratio was obviously due to relatively higher rate of utilization of holocellulose than lignin by the organisms.

Organisms that are dominant initially in stubble degradation are known to dependant more on soluble fractions of the stubble. But at the later phase of degradation, due to lack of these resources the lignocellulosic material of the stubble become the site of attack. As such selection of organisms from late phase of stubble degradation are important for selection of efficient degraders.

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