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SOME ASPECTS OF FUNGISTASIS IN PADDY SOIL

BY

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The fungistatic effect was quite distinct in paddy soil and showed considerable fluctuation in response to the changing agro-climatic conditions of the soil. Fungistasis was more pronounced during the water-logged period than in the dry period of the year. The inhibitory effect could be reversed temporarily by addition of organic materials like glucose, straw and green grasses and also through the action of rice roots.

INTRODUCTION

The phenomenon of inhibition of fungal spore germination in natural soil is termed as "fungistasis".

Extensive studies (Dobbs and Hinson, 1953; Jackson 1958; Lingappa and Lockwood, 1961; Dobbs, 1962; Mishra and Pandey, 1974, 1975; Pandey, 1977) reveal that the fungistasis is widespread in the surface of natural soil and can be attributed much to the action of water-soluble inhibitor, mostly of biological origin and can also be reversed by various treatments without altering the nutrient status of the soil. No such information is, however, available regarding the fungistasis in low-lying paddy soil. The present investigation, therefore, is an attempt to study some aspects of fungistasis occuring in low-lying paddy soil.

Paddy soils, by themselves do not represent a great soil group, but refer to the soils of the other groups where rice is grown annually under submerged conditions. Such soils are subjected to various agronomic treatments like ploughing and puddling before the cultivation. The soils also undergo a natural annual cyclic change alternately from water-logging to drying, and in course of such changes the soils receive periodically the various left over post-harvest materials and some kinds of weed flora which grow luxuriently during fallow period, just precceding water-logging.

MATERIALS AND METHODS

Soil samples from paddy field were collected from the surface layer as well as from the three different depths (7.5-15, 15-22.5 and 22.5-30 cm) of it at monthly intervals.

All undecomposed organic matters were carefully removed from the soil samples. The soil samples, were then packed tightly in dry and clean petridishes and the moisture level was maintained at 60% of the waterholding capacity by addition of distilled water. In case of water-logged soil samples, excess of water was drained off and treated as above.

The levels of fungistasis were evaluated by the agar-disc method of Ko and and Lockwood (1967). Spores of three different fungi, viz; *Penicillium frequentans*, *Mucor racemosus* and *Trichoderma viride* were taken separately for the test. The percentage of germination of the test fungal spores were calculated. The effects of various amendments such as glucose, straw and green vegetation, in reversing the effect of fungistasis in soil were studied. Glucose water of various strengths were added to the soil samples, two hours before subjecting to the agar-disc test. Dry straw powder was mixed with the soil samples under normal condition of temperature and moisture and allowed to decompose. Similarly, pieces of green grasses (*Fimbristylis* sp.) which grow luxuriently during the fallow period were mixed with the soil (5g/100g of soil) samples and were allowed to decompose. In both the cases the soil samples were then removed periodically to Petridishes and were subjected to the above mentioned agar-disc test. The effect of the growth of vegetation was studied by growing rice seedlings for 15 days in Petridishes packed with soil sample and then subjected to the agar-disc test after removing the seedlings from the soils with intact roots.

RESULTS

Studies on the rate of germination of spores of the three test fungi revealed that the fungistatic effect was quite distinct in the surface layer of paddy soil (Table 1) and showed significant periodic fluctuation. Considerably higher percentage of germination was observed in dry soil during the winter than in the water-logged soil during the summer season which indicated that the fungistatic effect was more pronounced in the water-logged soil than in the dry soil.

It was noted that the effect of fungistasis considerably decreased with the increasing depths of the soil (Table 2). More fungistatic effect was observed in the surface layer of the soil. It was also noted that the period of water-logging had significant influence on fungistasis. The fungistasis increased with the duration of water-logging (Table 3).

The fungistasis which was found to be prevelent in the paddy soil could also be reversed by various amendments and treatments. It was observed in the addition of organic amendments such as glucose (Table 4).

Table 1. *The rate (%) of germination of the test fungal spores in surface soil in different months of the year*

Test spores of	Months											
	Jan	Feb	Mar	Apri	May	June	July	Aug	Sept	Oct	Nov	Dec
Penicillium	58.8	64.4	65.5	65.6	57.1	34.4	27.7	30.0	38.4	49.9	52.0	57.7
Trichoderma	66.5	72.5	69.1	67.6	69.2	42.5	38.2	42.1	33.5	43.6	62.8	64.4
Mucor	59.4	64.8	55.9	66.4	60.2	28.8	32.3	36.8	39.7	43.5	53.4	57.6

Periods		*Soil conditions*
January and February	:	Dry soil
March to May	:	Desiccated soil
June	:	Pre-water-lagged soil
July to September	:	Water-logged soil
October to December	:	Wet soil

C.D for periods and for spores are highly significant at 1 % level.

Table 2. *The rate (%) of germination of the test fungal spores in soil collected from different depths*

Test spores of	Soil depths (cm)			
	0-7.5	7.5-15	15-22.5	22.5-30
Penicillium	26.7	45.6	53.4	65.2
Ttichoderma	37.7	49.8	58.3	7C.4
Mucor	34.4	58.1	62.6	72.3

Table 3. *The rates (%) of germination of the test fungal spores in waterlogged soil*

Test spores of	Days of water-logging									
	0	2	3	5	7	10	15	30	60	90
Penicillium	39.3	41.5	35.0	35.1	23.1	22.0	17.7	11.3	5.1	5.5
Trichoderma	32.0	41.7	40.5	33.6	30.9	25.1	20.0	8.0	10.0	7.3
Mucor	42.5	38.0	36.5	29.7	25.2	28.3	17.1	18.8	8.9	4.1

Table 4. *The rates (%) of germination of the test fungal spores in soil amended with various concentratian of glucose*

Test spores of	% of glusose				
	0.05	0.1	0.2	0.5	0.00 (Control)
Penicillium	43.0	60.9	62.4	78.8	27.0
Trichoderma	49.9	61.7	76.1	86.6	38.5
Mucor	56.5	67.4	73.5	82.6	26.1

Table 5. *The rates (%) of germination of the test fungal spores in soil amended with rice straw and green grass (Fimbristylis sp.)*

Days of decomposition	*Penicillium*		*Trichoderma*		*Mucor*	
	Straw	Grass	Straw	Grass	Straw	Grass
0	28.1	32.3	37.1	41.5	45.1	45.0
2	25.6	38.2	39.3	40.3	47.5	48.2
5	32.3	63.8	42.1	62.5	53.3	50.2
10	42.1	6.09	50.3	70.3	53.8	55.3
20	51.3	31.6	58.5	39.6	45.0	53.5
40	30.1	21.5	39.6	25.5	43.4	40.7
60	15.3	28.1	22.7	23.6	37.5	35.8
90	5.0	23.3	8.7	31.2	35.9	25.1

Table 5. *The rates (%) of germination of the test fungal spores in soil having rice seedlings and without seedlings*

Test spores of	Soil	
	Having seedlings	Without seedlings
Penicillium	71.3	32.0
Trichoderma	75.9	40.9
Mucor	52.7	31.4

Straw and green grasses (Table 5) could considerably reduce the fungistatic effect. But in case of straw and green grasses, the level of fungistasis increased significantly at the later stages of their decomposition.

The inhibitory effect was also found to be substancially reversed by the action of roots in its surrounding soil (Table 6).

DISCUSSION

The present investigation indicates that fungistasis is quite distinct in paddy soil. The inhibitory effect on the rate of germination of fungal spores in soil varies considerably in response to the cyclic changes in various edaphic and non-edaphic factors.

The inhibitory effect which was highly pronounced in the surface soil of paddy soil decreased considerably in the subsequent lower layers and showed

wide fluctuation in response to the changing soil conditions. The trend of such fluctuation is in conformity with the trend of fluctuation in microbial population in paddy soil as investigated by Kagti and Bhattacharjee (1969, 1979) which indicates that the inhibitory substance(s) may be of microbial origin. This is also in agreement with Hora and Baker (1972) and Pandey (1977).

The fungistatic effect which was found to increase with the duration of water-logging might probably be due to the accumulation of some products of microbal metabalism which changed stepwise from an oxygemic respiratory regime to an anoxygenic respiratory regime to an an anoxygenic fermentative one (Takai, 1961) or may be due to accumulation of such products resulted from changed microbial processes due to transition of soil from oxidized state to the reduced state in an open system (Kobo *et al*, 1963).

Regarding the effect of organic amendments in soil in reversing the fungistatic effect, the present investigator agrees with Dobbs and Hinson (1953). Adams and Papavizas (1969), Emmaty and Green (1969), who also observed similar results in natural soils. The cause of such reversal is not, however, clearly understood. There may have some relationship of sugar (Dobbs, 1962) or availability of nutrients (Ko and Lockwood, 1967) with the germination of fungal spores. The fact that the fungistasis increased at the later stages of decomposition of straw and green grasses indicated that the initial increase in microbial activities due to the availability of food from the added substances might have lead to the accumulation of toxic by-products of their metabalism which probably restricted the population increase later by inhibiting the spore germination. Similarly, the observed reduction in fungistatic effect in test soil having rice seedlings was probably be due to excretion of amino acids, sugars, vitamins etc by the roots into its surrounding soil which might significantly altered the nutritional status of the microoganisms surrounding the roots. Jackson (1958) also made similar observation.

In conclusion, it may be said that (1) the fungistasis is a distinct phenomenon in paddy soil; (2) the fungistatic action varies considerably in response to the changes in soil climate; (3) the inhibitory substances may be of microbial origin; and (4) various amendments may temporarily revers this inhibitory action.

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