

SURVIVAL OF SOME RICE PATHOGENS IN SOIL UNDER DIFFERENT MOISTURE CONDITIONS.

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The survival of three rice pathogens namely *Xanthomonas oryzae*, *Helminthosporium oryzae* and *Sclerotium oryzae* in soil under two different moisture conditions were studied. They survived in unsterilized soil with 50% moisture content for 7, 30 and 72 days respectively and in sterilized soil for 30, 100 and 140 days respectively. When the three were inoculated together the survival period of all the three were reduced. When infected tissues of the pathogens (i. e. bacterial leaf blight, brown spotted leaves and infected rice culm with sclerotia) were inoculated all the three pathogens could survive for shorter periods.

In soils with lower (20%) moisture content the survival periods of two of the three rice pathogens were reduced while that of *S. oryzae* increased significantly.

INTRODUCTION

For the past few years a number of diseases are recurring almost annually on the rice crop particularly under conditions of intensive rice cropping under high nitrogen fertilized conditions. Also for sometime one or two components of the disease complex of rice (Chattopadhyay *et al.*, 1966) remained suppressed but often re-appeared with an added vigour.

The present investigation was taken up to find out how some of the major pathogens could survive all the year round particularly when the crop itself was absent in the field. Rangaswamy and Ramalingam (1962) studied the survival of *H. oryzae* in soil and also demonstrated how *H. oryzae* was inhibited by one soil bacteria *Bacillus mycoides*.

In order to determine the relative potentialities of the three pathogens namely *Xanthomonas oryzae* (Uyeda & Ishiyama) Dowson (Causal organism of Bacterial leaf blight), *Helminthosporium oryzae* Breda de Haan (Causal organism of Brown spot of rice) and *Sclerotium oryzae* Cat. (Causal organism of Stem rots of rice) to survive in soil under different moisture conditions the following experiments were conducted.

MATERIALS AND METHODS

The cultures of the three pathogens were obtained by isolation from infected rice tissues following usual techniques of isolation.

Small 250 ml. wide mouthed glass jars were used in the experiments. Glass stoppers were replaced with non-absorbent cotton plugs. The jars were filled three fourth of their volume with well pulvurised soil collected from Haringhata Farm of the university. Half of the jars were sterilized at 20 lbs of pressure for three hours.

Twentyfour hour old cultures of *X. oryzae* (X. O.₂₂) was brought to $10^7 - 10^8$ cells per ml. dilution by addition of sterile distilled water and used for inoculation. Twenty days old sporulating cultures of *H. oryzae* (H. O. 2) was used for preparation of spore-suspension. Twenty day old cultures of *S. oryzae*, grown in Sabourad's broth were taken, made suspension and used.

Moisture contents of soils were brought to 48 - 52% and 18 - 22% of water holding capacity respectively in cases of 'optimum moisture' and 'field dry' soils. These moisture conditions were maintained by keeping the weight of jar+soil+fungus constant by addition of water time to time if and when needed. Jars were incubated at room temperature (27-29 C°).

To determine the population of pathogens and different groups of microbes straw infusion agar (Chattopadhyay and Mukhopadhyay, 1967) for actinomycetes, soil extract agar (Lochhead *et al.*, 1943) for bacteria and PDA (McLean and Cook, 1952)+rose bengal for fungi were used for plating. For *S. oryzae* only sclerotium are plated to test their viability.

For inoculation of soil with infected tissue always freshly collected materials were used. Jars used for this purpose were larger (500 ml.). At intervals diseased tissues if present, were unearthed and tried for isolation of the respective pathogens following usual isolation techniques.

RESULTS AND DISCUSSIONS

From the data presented in Tables 1 to 4 it has been found that *X. oryzae* and *S. oryzae* survived for a longer period in sterilized soil than unsterilized soil both individually and together. Both in sterilized and unsterilized soils their populations declined gradually with a comparatively faster rate of decrease in case of unsterilized soil. There was an increase in actinomycetes population in the cases of the individual unsterilized soil by addition of plant-pathogens (Table 1). The results are in aggrement with that of Rangaswami and Ramalingam (1962) excepting the absence of the temporary and slight increase of the pathogens in the present investigation.

Table 1. *Survival of rice pathogens in soil under 50% moisture conditions.*

Treatments	Microorganisms in millions/gm. of soil.									
	Days after soil inoculation.									
Microbes	3	7	15	30	72	100	140	162	170	190
I. USS ; Control, uninoculated.										
Bacteria	16.12	15.01	13.61	12.13	11.73	11.05	10.11	8.01	7.62	—
Actinomycetes	0.52	0.52	0.73	0.87	0.73	0.68	0.62	0.57	0.47	—
Fungi	4.61	3.92	3.85	3.76	3.63	3.50	3.31	3.12	3.01	—
Total	21.25	19.45	18.19	16.76	16.09	15.23	14.04	11.64	11.10	—
II. USS+ <i>X. oryzae</i>										
<i>X. oryzae</i>	41.67	19.11	0.00	—	—	—	—	—	—	—
Other bacteria	14.07	23.80	23.80	16.97	—	—	—	—	—	—
Actinomycetes	0.73	0.92	0.99	0.82	—	—	—	—	—	—
Fungi	4.11	3.10	2.89	2.52	—	—	—	—	—	—
Total	18.91	27.82	26.61	19.31	—	—	—	—	—	—
III. SS+ <i>X. oryzae</i>										
<i>X. oryzae</i>	50.69	41.72	17.21	9.32	0.00	—	—	—	—	—
IV. USS+ <i>H. oryzae</i>										
<i>H. oryzae</i>	2.31	1.71	0.89	0.11	0.00	—	—	—	—	—
Bacteria	22.70	32.54	29.88	25.91	16.27	15.37	—	—	—	—
Actinomycetes	0.61	0.78	1.01	1.27	1.03	0.82	—	—	—	—
Other Fungi	14.41	23.40	22.26	12.69	2.51	—	—	—	—	—
V. SS+ <i>H. oryzae</i>										
<i>H. oryzae</i>	4.76	4.12	3.55	3.33	2.21	1.62	0.00	—	—	—
VI. USS+ <i>S. oryzae</i>										
<i>S. oryzae</i> *	36%	—	17%	—	3%	—	0	—	—	—
Bacteria	17.79	—	33.28	—	18.49	—	16.23	—	—	—
Actinomycetes	0.62	—	0.92	—	0.71	—	0.60	—	—	—
Other Fungi	4.30	—	5.01	—	2.52	—	2.08	—	—	—
Total	22.61	—	37.21	—	21.72	—	18.91	—	—	—
VII. <i>S. oryzae</i>										
<i>S. oryzae</i> *	62%	—	32%	—	18%	6%	0	—	—	—

USS—Unsterilized soil ; SS—Sterilized soil ; '—' No counting made ;

*—Data presented as percentage of sclerotia germinated.

The survival period of *X. oryzae*, *H. oryzae*, and *S. oryzae* both in sterilized and unsterilized soils were much low when inoculated with infected tissues. The periods in all the cases of three pathogens individually and their combination in suspension-inoculation were longer in sterile soil than in unsterile soil (Tables 2 and 3). In cases of *X. oryzae* and *H. oryzae* infected tissue inoculations, these periods were equal in sterilized and unsterilized soils but longer in sterilized soils only in case of *S. oryzae* infected tissue (Table 3).

The pathogens, *X. oryzae*, *H. oryzae* and *S. oryzae* survived at least 30, 100 and 140 days in sterile soil and 7, 30 and 72 days in case of unsterilized soils respectively. While inoculated together in unsterilized soil *X. oryzae*, *H. oryzae* and *S. oryzae* survived 7, 30 and 15 days and in sterilized soil 30, 72 and 72 days respectively. Thus in combined inoculation in unsterilized soil *S. oryzae* survived for shorter period than it did individually while others showed no such change. In sterilized soil only *X. oryzae* showed no change but other two survived much shorter periods. Of all the pathogens *H. oryzae* survived better as was found in unsterilized soil though not decidedly so in comparison with *S. oryzae* and *X. oryzae*, the bacterial pathogen was a bad competitor (Table 1 and 2).

In general the lower period of survival in cases of host-tissue inoculations appears to be due to harbouring of larger number of microorganisms on the plant tissue. Survival of *X. oryzae* in soil is so short that it can have nothing to help the pathogen in carrying over of the host-less periods in the field. The survival of *H. oryzae* in unsterilized soil for 30 days appears to be a matter to be considered though might not be so important from phytopathological point of view. Similarly the 72 days' survival of the sclerotial pathogen is also not very important. The adverse field conditions might not help the organisms of such capabilities to carry over the long host-less periods in the field.

The field dry soils* (with 18 - 22% moisture) represents the soil in Rabi (winter) season in Haringhata area, Nadia, West Bengal. In this case difference in survival of pathogens between sterilized and unsterilized soils could be detected only in case of *S. oryzae*. The organisms survived approximately 140 days in sterilized soil and 100 days in unsterilized soil (Table 4). *X. oryzae* and *H. oryzae* could survive only for two days and 10 days respectively in both sterilized and unsterilized soils while *S. oryzae* could survive 140 and 100 days respectively (Table 4). From the tables it also becomes apparent that under a dry (20%) condition both *X. oryzae* and *H. oryzae* disappeared earlier than in a higher moisture (50%) condition while *S. oryzae* behaved reverse. This observation is clearly supported by the physiology of sclerotia formation in a fungus. This also stresses the point of the possibility of survival of *S. oryzae* in soil under a dry field condition. In general

Table 2. *Survival of rice pathogens in soil with 50% moisture when inoculated together.*

Treatments	Microorganisms in millions/gm. of dry soil.						
	Days after inoculation.						
Microbes	3	7	15	30	72	100	140
I. USS+ <i>X. oryzae</i> + <i>H. oryzae</i> + <i>S. oryzae</i> .							
<i>X. oryzae</i>	42.71	20.11	0.00				
<i>H. oryzae</i>	2.12	1.65	0.93	0.20	0.00		
<i>S. oryzae</i> *	39%	—	12%	—	0		
Other total	25.21	23.10	20.31	19.11	17.21	—	—
II. SS+ <i>X. oryzae</i> + <i>H. oryzae</i> + <i>S. oryzae</i> .							
<i>X. oryzae</i>	47.72	32.11	27.19	19.13	0.00		
<i>H. oryzae</i>	2.51	2.11	1.62	0.92	0.56	0.00	—
<i>S. oryzae</i> *	45%	—	17%	—	13%	—	0

USS—Unsterilized soil. SS—Sterilized soil. '—' no counting was done.

* Data presented as percentage of sclerotia germinated.

Table 3. *Survival of rice pathogens inside host tissue in the soil with 50% moisture.*

Treatments	Percentage of successful isolation.							
	Days after incubation in soil.							
Microbes	1	2	3	4	5	10	30	60
I. SS+stem infected with <i>S. oryzae</i>	87	36	31	20	13	12	2	0
II. USS+stem infected with <i>S. oryzae</i>	82	31	30	21	8	1	0	
III. SS+leaves infected with <i>H. oryzae</i>	67	19	12	7	2	0		
IV. USS+leaves infected with <i>H. oryzae</i>	51	18	13	6	2	0		
V. SS+leaves infected with <i>X. oryzae</i>	50	21	9	0				
VI. USS+leaves infected with <i>X. oryzae</i>	49	18	3	0				

SS—sterilized soil ; USS—Unsterilized soil ;

Table 4. *Survival of rice pathogens in soil with low (20%) moisture content.*

Treatments	Millions of microbes per gm. dry soil.											
	Days after inoculation.											
	1	2	3	4	5	10	30	60	70	80	100	120
Microbes												
SS+ <i>X. oryzae</i>	30.41	3.72	0.0	0.0	—							
USS+ <i>X. oryzae</i>	30.10	4.91	0.0	—								
SS+ <i>S. oryzae</i> *	51%		47%		41%		37%	23%	—	14%	9%	3%
USS+ <i>S. oryzae</i> *	49%	—	39%	—	35%	—	22%	13%	—	10%	3%	0
SS+ <i>H. oryzae</i>	2.16	1.56	1.12	0.93	0.13	0						
USS+ <i>H. oryzae</i>	2.21	1.42	1.21	0.96	0.90	0.11	0					

* Data presented as percentage of sclerotia germinated.

USS—unsterilized soil ; SS—sterilized soil. '—' no isolation has been made.

low moisture in soil was helpful to this externally applied pathogens survival possibility by suppressing the normal microbial activity in the low moisture condition of soil. *S. oryzae* potentially could utilize this condition in soil while others like *H. oryzae* and *X. oryzae* having no such low-moisture withstanding potentiality, succumb to this condition in soil more quickly.

It is evident from the results that radically different changes occur in behaviour of the three rice pathogens due to the facts that (i) the sclerotium is able to withstand low moisture condition and (ii) other microorganisms in soil have been inactivated somewhat under low moisture conditions.

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