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Pathogenicity of *Macrophomina phaseolina* Isolates Causing Stem and Root Rot of *Brassica juncea* (L.) Czern and Coss — Effect of Varying Soil Texture, Soil Reaction and Soil Moisture*

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Pathogenicity experiments using two isolates (most highly and weakly virulent) of *M. phaseolina* and a susceptible cultivar of *B. juncea* were conducted under varying conditions of soil texture, soil *p*H and soil moisture, which revealed that development of *Macrophomina* stem and root rot disease of *B. juncea* is favoured by sandy and slightly acidic soils having poor moisture content. Plants of control sets did not show any mortality under varying edaphic conditions, though, plant growth was slightly retarded in clay soils, soils of *p*H 4.5 and 8.5 and at moisture levels of 10% and 40%.

Key Words: Soil texture, Soil *p*H, Soil moisture, *Macrophomina phaseolina, Brassica juncea*

Introduction

A severe stem and root rot of *Brassica juncea* (L.) Czern and Coss. caused by *Macrophomina phaseolina* (Tassai) Goid. was recorded from India by Rai et al. (1974) and considering the economic losses of this oleiferous crop a detailed study on various aspects of this disease was taken up for investigation.

Various edaphic conditions are considered to be the foremost factors governing the development of soil-borne plant diseases as they significantly affect the activity of pathogen in soil and resistance of host plant (Garrett 1944, 1956 Chapman 1965, Raney 1965 & Sewell 1965). Epidemiological observations of the present disease also showed that severity of disease is significantly affected by various soil factors (Srivastava & Dhawan 1979a). Consequently, effect of soil moisture, soil texture and soil reaction on the pathogenicity of most and least virulent isolates of *M. phaseolina* was studied against *B. juncea* and

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results have been embodied in this paper.

Materials and Methods

On the basis of inoculation experiments carried out earlier (Srivastava & Dhawan 1979b and 1980), one highly virulent (Mp—8) and other weakly virulent (Mp-18) isolate of *M. phaseolina* and the highly susceptible cultivar of *B. juncea* (BJ—8) were selected for the present study. Experiments were conducted in 20 cm size earthen pots. For soil moisture experiment a layer of thick polythene bags was placed along the walls of pots before filling the soil so as to avoid the undesired loss of water.

Both the fungal isolates were separately grown on cornmeal sand medium (Riker & Riker 1936) in 250 ml erlenmeyer flasks at 30 $\pm$ 1° C. Ten days old cultures were thoroughly mixed with the desired type of sterilized (previously autoclaved at 30 lbs psi pressure for 2 hr) in the ratio of 1 : 5 (w/w). Such soils infested with isolates of *M. phaseolina* were filled in the lower 12—15 cm layers of the pots, whereas upper 5—8 cm was filled with only sterilized soil. Twenty surface-sterilized seeds of *B. juncea* were sown in each pot and seedlings after emergence were thinned out to 15/pot. A control set with only sterilized soil was also run simultaneously.

In soil texture experiment three types of soils viz., sandy, loam and clay were used. Loam and clay were collected from the fields whereas, sandy soil was prepared by mixing coarse silica sand and loam in the ratio of 3:1.

For the soil reaction experiment, concentrated solution of hydrochloric acid or sodium hydroxide was thoroughly mixed with garden loam soil to obtain acidic or alkaline soils respectively. The quantity of these additives was varied so as to obtain the soils having a final *p*H of 4.5, 5.5, 6.5, 7.5 and 8.5 which were utilized in this trial. The *p*H of experimental soils was regularly checked at weekly intervals. Soils of 6.5, 7.5 and 8.5 did not show much change in their *p*H but those of 4.5 and 5.5 showed very slight drifting towards neutrality with the lapse of time. While watering the pots, the *p*H of such soils was brought back to their original levels by adding appropriate quantities of very weak solution (0.001 N) of HCl instead of water.

For soil moisture experiment soils of 4 different moisture levels viz., 10, 20, 30 and 40% (of oven dried soil) were tried. Soil used in this experiment was prepared by mixing sand, loam and compost in the ratio of 2:2:1 which had the moisture-holding capacity of 30%. Dry soil was filled in the pots lined with polythene bags and moisture content was adjusted to the desired level by weighing the empty and filled pots and adding appropriate amount of water. Moisture content of the soil was readjusted to the same level every third day. Although, this method of adjusting the soil moisture is not foolproof and accurate, but, provides significant differences in the moisture levels of the soil for comparative studies. It had to be used for this study as facilities were not available for better designs of this experiment.

Regular watering was done except for the soil moisture experiment, and observations for the plant mortality were recorded after 45 days of sowing to evaluate the disease incidence under varying edaphic conditions. Five replicates were run for each treatment and data was statistically analysed, variations being expressed as Standard Error.

Results and Discussion

Soil Type

There are great variations in the texture, compaction, organic and inorganic contents and water-holding capacity of different type of soils. Both plant as well as pathogen growth are affected by these factors either directly or indirectly. Some soil-borne plant diseases particularly wilts and root rots are known to be favoured by loose textured sandy and sandy loam soils (Garrett 1944, Walker & Snyder 1933 and Chauhan 1962). Results show that there are significant differences in the pathogenesis of both the isolates in different type of soils (table 1). Both the isolates showed maximum mortality in sandy soils and minimum in pots having clay soils. Plant mortality was very poor in isolate Mp-18 in comparison to Mp-8 and uninoculated control plants remained healthy. Plant growth was slightly poor in clay soils but, normal growth was observed in other two types of soils. These findings support the epidemiological observations of this disease recorded in field conditions (Srivastava & Dhawan 1979a). In sandy soils quick leaching results into poor nutritional status which predisposes the host plant to the attack of pathogen but does not appreciably affect the pathogen which has much lower nutritional requirements. The well-aerated environment of sandy soils might be favouring both but the balance seems to be in favour of pathogen due to the effect of some other factors.

Table 1 *Pathogenicity of most highly and weakly virulent isolates of* M. phaseolina *against* B. juncea *plants grown in different types of soils*

Soil Texture	% mortality of *B. juncea* plants*		
	Control	Isolate Mp-8	Isolate Mp-18
Sandy	0.00 ± 0.00	90.6 ± 4.00	14.6 ± 2.47
Loam	0.00 ± 0.00	77.0 ± 3.40	12.0 ± 2.47
Clay	0.00 ± 0.00	52.0 ± 2.47	5.4 ± 2.47

*Average of 5 replicates, variations being expressed as S.E.

Soil pH

Soil *p*H is one of the most important edaphic factors influencing the nutritional-uptake by plants and microbes alike and has been much emphasized by Chapman (1965) in relation to plant as well as pathogen growth. During the present study acidic soil reaction was found to favour the development of disease. Maximum plant mortality was observed in soils of *pH* 5.5 and disease intensity decreased with the increase in soil *pH* above 5.5 (table 2). Plant mortality in soils of *pH* 4.5 and 8.5 was very poor. Although, mortality was very poor and slow in case of isolate Mp-18 but showed the same trend in relation to soil *pH*. There was no mortality in pots of control set, but control plants growing in soil of *p*H 4.5 and 8.5 were comparatively weaker and had a retarded growth. Epidemiological data of the disease also revealed that disease incidence was greater in soils of low *pH* (Srivastava & Dhawan 1979a). Acidic soil reactions are known to favour the fusarial wilts also (Garrett 1944, 1956 and Walker 1957). According to Chapman (1965) soils which become acidic due to leaching of several soluble substances are characteristically deficient in many essential nutrients. These conditions predispose the host to the attack of pathogen and thus favours the development of disease.

Soil Moisture

Observations recorded in table 3 revealed that maximum number of plants were killed at 20% moisture level and plant mortality showed a sharp decrease with the increase in soil moisture above 20%, minimum being recorded at 40% level. Disease severity of 10% moisture level was slightly lower than that of 20%. Both the isolates showed similar trend but mortality was very poor in isolate Mp-18. All the plants in control set grew healthy. There was not too much difference in the plant growth at different moisture levels, though it was slightly poor at 10% and 40% moisture level. Soils of 20% and 30% moisture level supported best growth of plants. Thus, disease severity appeared to be slightly higher at low soil moisture which is in accordance with the epidemiological data of the disease recorded from fields (Srivastava & Dhawan 1979a). Mycelial growth of *M. phaseolina* in soil is known to decrease with increasing soil moisture (Norton 1953 and Kavoor 1954) and sclerotial population in soil also decreases with increasing soil moisture (Dhingra & Sinclair 1975). Low soil moisture seems to affect the growth of plants thus, predisposing them to the disease. On the other hand, good aeration may take place under low soil moisture condition which facilitates the growth and activity of microbial life of soil. At high moisture levels plant growth was very poor but pathogen itself is affected by this unfavourable condition hence, could not cause much damage.

It is evident from the results of present study that various edaphic factors have a pronounced effect on the development of stem and root rot disease of *B. juncea* caused by *M. phaseolina*. Thus, taking into consideration the findings of present investigation as also the epidemiological observations of this disease, attempts may be made to explore the possibilities of minimising the damage by properly altering the cultural practices in the *B. juncea* fields.

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Table 2 *Pathogenicity of most highly virulent and weakly virulent isolates of* M. phaseolina *against* B. juncea *plants at different soil* pH

Soil pH	% mortality of *B. juncea* plants*		
	Control	Isolate Mp — 8	Isolate Mp — 18
4.5	0.0±0.00	77.0±3.40	6.7±2.13
5.5	0.0±0.00	90.0±1.66	13.2±3.00
6.5	0.0±0.00	86.7±2.13	10.7±2.60
7.5	0.0±0.00	81.3±2.47	8.0±1.33
8.5	0.0±0.00	77.0±1.60	6.7±2.13

*Average of 5 replicates, variations being expressed as S.E.

Table 3 *Pathogenicity of most highly and weakly virulent isolate of* M. phaseolina *against* B. juncea *plants at different moisture levels of soil*

Soil Moisture	% mortality of *B. juncea* plants*		
	Control	Isolate Mp — 8	Isolate Mp — 18
10%	0.0±0.00	84.0±2.60	12.0±2.46
20%	0.0±0.00	90.0±1.66	13.2±3.00
30%	0.0±0.00	66.7±2.13	5.4±1.33
40%	0.0±0.00	38.7±2.46	2.7±1.66

*Average of 5 replicates, variations being expressed as S.E.

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