CHEMICAL CONTROL OF CHARCOAL ROT OF SOYBEAN CAUSED BY *MACROPHOMINA PHASEOLINA* (TASSI) GOID

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Bavistin, Panoram, Calixin and Antracol were the most effective in that order in reducing sclerotial formation of *Macrophomina phaseolina*. Rubigon exhibited intermediate effectiveness while Liromenzeb was the least effective in inhibiting sclerotial production. Panoram was the most effective in retarding sclerotial germination followed by Bavistin. Antracol displayed intermediate action while Calixin was least effective in this connection. The most effective fungicide in reducing sclerotial population in fungicide treated soil was Bavistin followed by Antracol, Panoram and Calixin in that order. Bavistin also proved effective in reducing per cent charcoal rot disease at all the rates ranging from 0.02 to 0.20%. Antracol was effective in controlling charcoal rot at 0.10 and 0.20% drench.

INTRODUCTION

Soybean crop suffers reduction in yield due to charcoal rot, caused by *Macrophomina phaseolina* (Tassi) Goid (Dhingra and Sinclair, 1973) in this part of the world. The genetic resistance against the pathogen in the available commercial soybean cultivars is scarce (Anonymous, 1985), so chemotherapeutic control is the only hope to combat with this disease. Vir *et al.* (1974) tested some fungicides against *M. phaseolina* in the field on soybean and found that Topsin at 1000 ppm concentration gave the best results. Ilyas *et al.* (1975) investigated the effect of some fungicides against the mycelial growth, sclerotial production and germination of *M. phaseolina* on agar plates and on the green house grown soybean seedlings where the fungicides were used as soil drench.

MATERIALS AND METHODS

1. Isolation and Pathogenicity Test: The fungus was isolated from charcoal rot affected soybean plants by usual isolation technique (Pathak, 1987) and identified through morphological characters as described by Barnet and Hunter (1972). The purified culture of *M. phaseolina* was obtained by plating single sclerotium from the isolated fungus on potato dextrose agar (PDA). Mass culture of *M. phaseolina* was prepared on soybean seed. The pathogenicity of the isolate was confirmed on soybean seedlings grown in pots in the usual way.

2. Testing of Fungicides *(in vitro):* Antracol, Bavistin, Calixin, Liromenzeb, Panoram and Rubigon were tested at 5, 10, 20 and 50 ppm concentrations against the mycelial growth of *M. phaseolina* using a technique as described by Borum and Sinclair (1968). To each 90 mm petri plate containing calculated amount of fungicide and solidified potato dextrose agar, 4 mm agar plug of *M. phaseolina* mycelium was placed in the centre. Petri plates containing PDA and the pathogen culture but without the fungicide served as the check. The mean diameter of the fungus mycelium was recorded 5 days after incubation. The number of sclerotia were

counted under stereo microscope and the average number of sclerotia per petri plate for each fungicide concentration was calculated. The germination of sclerotia was studied by slide germination method (Anonymous, 1943). In another experiment the same fungicides were evaluated for their effect on the viability of sclerotia in the soil where these were applied at 250 and 500 ppm concentrations. To each glass container having 50 g of sclerotial soil mixture, fungicidal suspension was mixed with distilled water so that it gave 33% moisture holding capacity. The containers were covered with polyethylene sheet to reduce moisture loss and punctured with needle at several points to allow aeration. All the containers were incubated at 30 ± 2 ° C and 4 g samples were taken out after 24, 48, 72 and 96 hours from each treatment. Soil samples were air-dried for four hours, then crushed in a mortar and pestle. A 50 mg sample was sprinkled evenly over the surface of four Chloroneb Mercury Rosebangal Agar (CMRA) plates which were incubated at 30 ± 2 ° C. *M. phaseolina* colony counts were made after 5-7 days of incubation. The colony counts from all the plates were combined to determine per cent inhibition of sclerotial germination based on sclerotial germination in the control.

3. Effect of fungicides on the charcoal rot affected Greenhouse grown soybean plants: Soybean seeds were grown in each of the four small plastic pots containing sterilized soil. *M. phaseolina* culture was grown on potato dextrose agar medium. Agar plugs were cut with an 8 mm diameter cork borer, from a 7-day old culture and were mixed with the pot soil at the rate of 100 plugs/pot. After planting, pots were kept in the greenhouse. Two weeks after planting, they were drenched with each of the test fungicides at four dosage rates mentioned above. Pots drenched with sterilized water served as

Table 1. Effect of different fungicides on the mycelial growth, sclerotial production and germination (per cent inhibition) of *Macrophomina phaseolina*

Fungicides	Mycelial growth (mm)				Sclerotial production				Sclerotial germination			
	Fungicides concentrations (µg/ml) –				Fungicides concentrations (µg/ml) –				Fungicides concentration (µg/ml) –			
	5	10	20	50	5	10	20	50	5	0	20	50
Antracol	40.1[l*]	45.5[j]	54.1[i]	53.8[i]	68.9[f]	71.5[e]	78.2[c]	90.0[a]	34.6[j]	39.2[i]	45.2i	48.5
Bavistin	77.9[c]	76.3[bc]	78.6[ab]	78.9[a]	90.0[a]	90.0[a]	90.0[a]	90.0[a]	51.9[f]	55.4[c]	59.9[d]	61.8
Calixin	64.2[fg]	67.2[e]	69.9[d]	70.8[d]	74.8[d]	81.6[b]	90.0[a]	90.0[a]	23.2[l]	29.4[k]	38.2[i]	49.2
Liromenzeb	14.5[q]	17.5[p]	25.3[k]	44.5[jk]	10.7[m]	20.3[l]	29.4[k]	40.6[j]	-	-	-	-
Panoram	32.6[m]	36.9[m]	40.1[l]	43.1[k]	80.8[b]	90.0[a]	90.0[a]	90.0[a]	59.5[d]	61.1[c]	66.5[b]	71.5
Rubigon	60.4[h]	61.7[gh]	66.8[ef]	68.6[de]	44.8[l]	52.5[h]	61.2[g]	67.9[f]	-	-	-	-

Figures with similar letter(s) are statistically non-significant at P = 0.05.

the control. The experiment was conducted in four replications, each pot representing a replication. After 7 days of drenching, the data were recorded on per cent plants diseased and were analysed statistically.

The most effective fungicides that inhibited sclerotial germination by the colonies of the fungus at all the concentrations in descending order were Bavistin, Panoram and Calixin (Table 1). Antracol and Rubigon ex-

Table 2. Effect of fungicide concentration on the per cent decrease in viable sclerotia of *M. phaseolina* in soil

Fungicides	Dose (μg/g of soil)	Exposure time (hours)			
		24	48	72	96
Antracol	250	26.6^{mno*}	26^{nop}	25^{op}	62^{def}
	500	54.71^{i}	60^{efgh}	58^{fghi}	67^{e}
Bavistin	250	28.2^{mno}	38^{l}	70^{b}	70^{b}
	500	53.2^{i}	67^{e}	83^{a}	84^{a}
Calixin	250	26.6^{mno}	29^{mno}	29^{p}	35^{i}
	500	35.9^{j}	30^{mno}	66^{cd}	61^{efg}
Panoram	250	31.3^{m}	42^{k}	49^{j}	49^{j}
	500	43.8^{l}	55^{i}	70^{b}	63^{de}

* Figures bearing similar letter are non-significantly different at P = 0.05.

RESULTS AND DISCUSSION

Bavistin proved to be the most effective fungicide against the mycelial growth, sclerotial production and germination of *M. phaseolina*, Calixin and Rubigon reduced mycelial growth significantly but decrease in sclerotial production and germination was lower as compared to Panoram. Bavistin, Calixin, Antracol and Rubigon were equally effective at 20 and 50 μg/ml dosage rates in reducing mycelial growth, however, Bavistin and Rubigon at 5 and 10 μg/ml showed significantly more inhibition in colony diameter compared to the other fungicides (Table 1). hibited intermediate effectiveness while, least effective fungicide in this case was Liromenzeb. Bavistin caused 90% inhibition of the formation of sclerotia even at 5 μg/ml concentration while Panoram, Calixin and Antracol did so at 10-50, 20-50 and 50 μg/ml, respectively. Panoram and Antracol inhibited 61.0 and 39.2 % sclerotial germination, respectively, at 10 μg/ml concentration whereas Bavistin and Calixin gave similar results at 20 μg/ml. The relative efficacy of fungicides in reducing mycelial growth, sclerotial production and germination depends upon the fungicide formulation and its dosage rate. Bavistin and Panoram

are broad spectrum systemic fungicide which show fungitoxicity towards Ascomycetes and Deuteromycetes (Vyas, 1984).

rate of the drench. The reason for this differential activity is not known.

Table 3. Effect of fungicides on the control of charcoal rot of soybean caused by *Macrophomina phaseolina*

Fungicides	Per cent solution of fungicide			
	0.02	0.05	0.10	0.20
	Per cent charcoal rot infection			
Antracol	53.7	40	26.31	17.5
Bavistin	36.3	22.5	11.3	5

Bavistin was found the most effective fungicide in reducing sclerotial population in fungicide treated soil, followed by Panoram, Antracol and Calixin (Table 2). At dosage rates of 500 μg/g of soil in ED 50 for Bavistin and Antracol was recorded at about 24 hours. This may be attributed to their similar pattern of uptake or similar mode of action. However, ED 50 for Panoram at 500 μg/g of soil occurred at 48 hours, and for Calixin after 72 hours. The delayed occurrence of ED 50 for Panoram may be due to slower uptake of this fungicide but its mode of action was stronger after 72 hours but it lost its efficiency after 96 hours, whereas Bavistin reduced sclerotial population even after 96 hours. Besides these differences in uptake or mode of action, Bavistin controlled charcoal rot even at 0.02% drench while Antracol controlled the disease only at 0.2% drench (Table 3). Bavistin belongs to the benzimidazol group of fungicides, gives similar mode of action (Vyas, 1984), yet it exhibited different effectiveness in controlling charcoal rot of soybean at low dosage

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