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REACTION OF CHICKPEA VARIETIES TO *MACROPHOMINA PHASEOLINA* AND THEIR EFFECT ON PEROXIDASE ACTIVITY

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Abstract

Out of 56 chickpea varieties screened for their resistance against *Macrophomina phaseolina*, only one variety (BGD -98) was found resistant. Three varieties viz., BG-1108, BGD-117 and RSG-143 were moderately resistant and six varieties viz., BG-390, BG-1095, Biogreen, GPF-2, ICCV-92337 and SBD-77 were tolerant. Rest of the varieties were either susceptible or highly susceptible to *M. phaseolina*. A positive correlation was found between peroxidase activity and resistance to the varieties.

Introduction

Chickpea (*Cicer arietinum*) is an important leguminous crop being grown on a large scale in Asia particularly in India which is the largest producer of chickpea in the world. *Macrophomina phaseolina* (Tassi) Goid is an important pest of chickpea causing significant loss in its yield. Growing of resistant cultivars seems to be relatively cheaper and appropriate method to control the pest because it requires no special equipment or extra capital investment. Furthermore, screening of germplasms to get resistant or tolerant cultivars may be important because it can be used as a source of resistance in plant breeding programes.

Peroxidase may have an important role in the resistance mechanism of plant (Daly *et al.*, 1971; Noel & McClure, 1978; Siddiqui & Mahmood, 1992; Mantoo & Siddiqui, 1996) and it is a key enzyme for lignin synthesis as well as other terpenoids involved in phytoalexin production. Peroxidase catalyses several reactions including those involved in the mechanism of phenols and indoles. Higher peroxidase activity resulted in an increase in the phenolic contents of plant, which plays an important role in the resistance of cultivar (Mahmood & Saxena, 1986). In the present study 56 varieties of chickpea were screened against *M. phaseolina* and peroxidase activity of both control and inoculated plants were determined for its correlation with resistant response.

Materials and Methods

The chickpea varieties used in the present study were obtained from Division of Genetics, Indian Agricultural Research Institute, New Delhi. Five seeds of each chickpea variety were sown in 15 cm diameter earthen pots, containing one kg sterilized soil, river sand and farmyard manure (3:1:1) mixture. Soon after germination thinning was done to maintain one seedling per pot. One-week-old seedlings were inoculated with 10 ml of mycelial suspension of *M. phaseolina*. Plants were watered

whenever needed and each set was replicated six times (3 for dry shoot weight and root-rot index and three for peroxidase). The experiment was terminated 90 days after inoculation and data on dry shoot weight and root-rot index were recorded.

The fungus used in this experiment was isolated from chickpea roots and maintained on PDA. The inoculum of fungus was prepared by culturing the isolate in Richard's liquid medium (Riker & Riker, 1936) for 15 days at 25˚**C**. Mycelium was collected on blotting sheets and excess of water and nutrients were removed by pressing it between two folds of blotting sheets. Hundred grams of mycelium was macerated in one liter distilled water and 10ml of this suspension containing 1g fungus was inoculated around the root by carefully removing the top layer of soil and after inoculation the soil was replaced.

Peroxidase activity of control and inoculated plants was determined after 5 days of inoculation by the method of Chance & Maehly (1955). A calibrated standard curve was prepared by graded concentration of pure purpurogallin. Specific activity of peroxidase was calculated by purpurogallin formed per mg protein per minute.

Resistance - susceptibility rating were based on reduction in dry shoot weight and root - rot index according to 0-5 scale proposed by Husain (1986) with slight modification (using root-rot index in place of nematode reproduction), where 0 = no root-rot and 5 = severe root - rot. Scale on the basis of suppression in dry shoot weight was also determined on 0-5 scale as:

0 = no suppression in dry shoot weight = Immune (I); 1 = upto 5% suppression in dry shoot weight = Resistant (R); 2= 5.1 to l0.0% suppression in dry shoot weight = Moderately Resistant (MR); 3 = 10.1-15.0% suppression in dry shoot weight = Tolerant (T); 4 = 15.1-25.0% suppression in dry shoot weight = Susceptible (S) and 5 = more than 25% suppression in dry shoot weight = Highly susceptible (HS).

Results and Discussion

Data presented in Table 1 shows that out of 56 chickpea varieties tested none of the variety was found immune to *M. phaseolina* on the basis of suppression in dry shoot weight and root - rot index. One variety (BGD-98) was found as resistant, three moderately resistant (BG-1108, BGD-117 and RSG-143) and 6 varieties (BG-390, BG-1095, Biogreen, GPF-2, ICCV-92337 and SBD-77) were found tolerant to *M. phaseolina*. The varieties viz., BG-217, BG-267, BG.-1006,BG-1032, BG-1072, BG-1082, BG-1086, BG-1087, BG-1107, BG-10863, BGD-7, BGD-112, CSG-9505, EC-442360, EC-4422507, ICC-88503, ICCV-5, KPG-59, L-550, Pusa-212, Pusa-362, Pusa-391, Pusa-1053 and RYT-411 were found susceptible and the remaining varieties viz., BG-276, BG-376, BG-1044, BG-1063, BG-1079, BG-1091, BG-1100, BG-1106, BG-1121, BGD-1104, C-235, CIYTSL-2, EC-44285, ICC-8803, lCCV-2, Pusa-256, Pusa-372, Pusa-1003, Pusa-1062, SAKI-9303 and Vijay were rated as highly susceptible to *M. phaseolina*.

Increase in peroxidase activity in response to *M. phaseolina* infection over control in resistant var., BGD-98 was 45.24%. This increase was 39.62, 38.54 and 42.52% in moderately resistant varieties viz., BG-1108, BGD-117 and RSG-143 respectively. In tolerant varieties, the increase in peroxidase activity ranged between 28.88% to 37.43%, whereas in susceptible varieties it ranged from 13.51% to 25.54%. However, in highly susceptible varieties the increase in peroxidase activity due to infection of *M. phaseolina* over control ranged between 1.32% to 14.01% (Table 1).

Table 1. Reaction of 56 chickpea varieties to *Macrophomina phaseolina* and their effect on peroxidase activity.

Varieties	Treatments	Shoot dry weight (g)	% Reduction over control	Root – rot index	Peroxidase activity		Reaction
					Activity/mg protein/min.	% Increase over control	
BG-217	Control	5.6	-	-	0.128	-	
	Inoculated	4.4	21.4	4	0.153	16.3	S
BG-267	Control	6.2	-	-	0.098	-	
	Inoculated	5.2	16.1	4	0.127	22.83	S
BG-276	Control	5.2	-	-	0.130	-	
	Inoculated	3.8	30.7	5	0.142	8.45	HS
BG-376	Control	8.8	-	-	0.161	-	
	Inoculated	6.2	29.5	5	0.180	10.55	HS
BG-390	Control	6.6	-	-	0.097	-	
	Inoculated	5.7	13.6	3	0.139	30.21	T
BG-1006	Control	8.0	-	-	0.115	-	
	Inoculated	6.2	22.5	4	0.144	20.13	S
BG-1032	Control	6.2	-	-	0.129	-	
	Inoculated	5.1	17.7	4	0.169	23.66	S
BG-1044	Control	7.3	-	-	0.146	-	
	Inoculated	5.2	28.7	5	0.167	12.57	HS
BG-1063	Control	6.1	-	-	0.131	-	
	Inoculated	3.8	37.7	5	0.139	5.75	HS
BG-1072	Control	7.2	-	-	0.151	-	
	Inoculated	5.8	19.4	4	0.197	23.35	S
BG-1079	Control	6.2	-	-	0.124	-	
	Inoculated	3.7	40.3	5	0.129	3.87	HS
BG-1082	Control	5.2	-	-	0.147	-	
	Inoculated	4.0	23.0	4	0.182	19.23	S
BG-1086	Control	7.2	-	-	0.102	-	
	Inoculated	5.6	22.2	4	0.132	22.72	S
BG-1087	Control	3.9	-	-	0.107	-	
	Inoculated	3.2	17.9	4	0.127	15.74	S

Table 1 (Cont'd.)

Varieties	Treatments	Shoot dry weight (g)	% Reduction over control	Root – rot index	Peroxidase activity		Reaction
					Activity/mg protein/min.	% increase over control	
BG-1091	Control	4.5	-	-	0.194	-	
	Inoculated	3.1	31.1	5	0.207	6.28	HS
BG-1095	Control	7.3	-	-	0.103	-	
	Inoculated	6.4	12.3	3	0.159	35.22	T
BG-1100	Control	5.8	-	-	0.127	-	
	Inoculated	3.5	39.6	5	0.133	4.51	HS
BG-1106	Control	6.8	-	-	0.139	-	
	Inoculated	4.8	29.4	5	0.153	9.15	HS
BG-1107	Control	6.4	-	-	0.155	-	
	Inoculated	4.9	23.4	4	0.205	24.39	S
BG-1108	Control	5.3	-	-	0.128	-	
	Inoculated	5.1	3.7	2	0.212	39.62	MR
BG-1121	Control	7.9	-	-	0.141	-	
	Inoculated	4.8	39.2	5	0.147	4.08	HS
BG-10863	Control	4.2	-	-	0.111	-	
	Inoculated	3.4	19.0	4	0.133	16.54	S
BGD- 7	Control	4.6	-	-	0.102	-	
	Inoculated	3.5	23.9	4	0.137	25.54	S
BGD- 72	Control	3.0	-	-	0.175	-	
	Inoculated	2.1	30.0	5	0.191	8.37	HS
BGD- 98	Control	3.3	-	-	0.144	-	
	Inoculated	3.2	3.0	1	0.263	45.24	R
BGD- 112	Control	7.5	-	-	0.128	-	
	Inoculated	6.3	16.0	4	0.148	13.51	S
BGD- 117	Control	7.9	-	-	0.118	-	
	Inoculated	7.2	8.8	2	0.192	38.54	MR
BGD- 1104	Control	6.4	-	-	0.182	-	
	Inoculated	3.8	40.6	5	0.188	3.19	HS

Table 1 (Cont'd.)

Varieties	Treatments	Shoot dry weight (g)	% Reduction over control	Root – rot index	Peroxidase activity		Reaction
					Activity/mg protein/min.	% increase over control	
Biogreen	Control	9.3	-	-	0.096	-	
	Inoculated	8.0	13.9	3	0.135	28.88	T
C-235	Control	4.1	-	-	0.134	-	
	Inoculated	3.7	9.7	5	0.143	6.29	HS
CSG-9505	Control	7.9	-	-	0.150	-	
	Inoculated	6.4	18.9	4	0.188	20.21	S
CIYTSL-2	Control	4.0	-	-	0.135	-	
	Inoculated	2.9	27.5	5	0.157	14.01	HS
EC- 442360	Control	4.7	-	-	0.122	-	
	Inoculated	3.6	23.4	4	0.157	22.29	S
EC- 4422507	Control	4.8	-	-	0.112	-	
	Inoculated	4.0	16.6	4	0.132	15.15	S
EC- 442585	Control	7.0	-	-	0.154	-	
	Inoculated	4.8	31.4	5	0.174	10.46	HS
GPF-2	Control	4.1	-	-	0.117	-	
	Inoculated	3.6	12.1	3	0.187	37.43	T
ICC-88503	Control	4.6	-	-	0.120	-	
	Inoculated	3.6	21.7	4	0.139	13.66	S
ICC-8803	Control	7.9	-	-	0.182	-	
	Inoculated	4.7	40.5	5	0.186	2.15	HS
ICCV-2	Control	7.4	-	-	0.118	-	
	Inoculated	4.5	39.1	5	0.135	12.59	HS
ICCV-5	Control	5.0	-	-	0.141	-	
	Inoculated	4.1	18.0	4	0.183	22.95	S
ICCV-92337	Control	7.0	-	-	0.109	-	
	Inoculated	6.2	11.4	3	0.162	32.71	T
KPG-59	Control	6.8	-	-	0.122	-	
	Inoculated	5.3	22.0	4	0.150	18.66	S

Table 1 (Cont'd.)

Varieties	Treatments	Shoot dry weight (g)	% Reduction over control	Root – rot index	Peroxidase activity		Reaction
					Activity/mg protein/min.	% increase over control	
L-550	Control	7.1	-	-	0.140	-	
	Inoculated	5.4	23.9	4	0.168	16.66	S
Pusa-212	Control	4.3	-	-	0.131	-	
	Inoculated	3.3	23.2	4	0.155	15.40	S
Pusa-256	Control	5.2	-	-	0.162	-	
	Inoculated	3.3	36.5	5	0.173	6.35	HS
Pusa-362	Control	9.6	-	-	0.164	-	
	Inoculated	7.5	21.8	4	0.202	18.81	S
Pusa-372	Control	4.5	-	-	0.187	-	
	Inoculated	2.8	37.7	5	0.197	5.07	HS
Pusa-391	Control	5.5	-	-	0.110	-	
	Inoculated	4.2	23.6	4	0.132	16.66	S
Pusa-1003	Control	6.2	-	-	0.114	-	
	Inoculated	4.4	29.0	5	0.129	11.62	HS
Pusa-1053	Control	8.1	-	-	0.124	-	
	Inoculated	6.3	22.2	4	0.151	17.88	S
Pusa-1062	Control	7.4	-	-	0.138	-	
	Inoculated	5.0	32.4	5	0.148	6.75	HS
RSG-143	Control	8.0	-	-	0.150	-	
	Inoculated	7.4	7.5	2	0.261	42.52	MR
RYT-411	Control	9.2	-	-	0.149	-	
	Inoculated	7.2	21.7	4	0.190	21.57	S
SAKI-9303	Control	6.9	-	-	0.149	-	
	Inoculated	2.7	60.8	5	0.151	1.32	HS
SBG-77	Control	3.2	-	-	0.129	-	
	Inoculated	2.8	12.5	3	0.182	29.12	T
Vijay	Control	5.8	-	-	0.151	-	
	Inoculated	4.0	31.0	5	0.167	9.58	HS

It is clear from the results presented in Table 1, that increase in peroxidase activity resulted in resistant response of the chickpea varieties, which is in agreement with the findings of Siddique & Mahmood (1993), who also reported that the increase in peroxidase activity resulted in the resistant response of chickpea varieties. Fehrman & Diamond (1967), Noel & McCulter (1978), Mantoo & Siddiqui (1996) and Chakrabarti & Mishra (2002) also reported that peroxidase plays an important role in resistant response of the plant. Higher peroxidase activity resulted in an increase in the phenolic contents of plant, which plays an important role in the resistance of cultivar (Mahmood & Saxena, 1986). A positive correlation was found between peroxidase activity and resistant response of the varieties.

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