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Inheritance of resistance to rust (*Uromyces viciae fabae*) in pea

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ABSTRACT

Inheritance of resistance to rust caused by *Uromyces vicae fabae* in pea was studied in four crosses involving one resistant line, JP 4 and four susceptible lines. Inheritance of tolerance was studied in 18 crosses including 3 reciprocals, involving four tolerant lines (FC 1, EC 1, P 930 and P 1438-2) and five susceptible lines. The results of F_1 and F_2 generations suggested involvement of a single recessive gene in the inheritance of resistance and tolerance to rust in pea.

Key words: Inheritance, Pea, *Pisum sativum*, Rust, *Uromyces*

Rust caused by *Uromyces vicae fabae* is one of the most destructive diseases of peas (*Pisum sativum* L.) in northern plains of India. So far, there is no variety resistant to rust in pea. Sources of resistance/tolerance have been identified but information on inheritance of resistance to the disease is scanty. In view of this, the present investigation was conducted to study the inheritance of resistance and tolerance to rust disease.

MATERIALS AND METHODS

Pantnagar is the hot spot for the rust disease of peas. It is located at the foothills of the Shivalik range of the Himalayas and falls in the humid sub-tropical zone. Forty-four germplasm lines were screened in natural epiphytotic conditions. From these germplasm lines, one resistant (JP 4), four tolerant (FC 1, EC 1, P 930 and P 1438-2) and five susceptible (S 143, HFP 4, P 108-1, P 278-2 and P 1594) genotypes were selected. Due to severe rust disease, some of the crosses involving susceptible lines as female were not successful. Therefore, only four crosses involving resistant x susceptible and 18 crosses involving tolerant x susceptible (including three reciprocals) genotypes could be studied. The parental lines, F_1, F_2 and backcross generations were screened in the field. In the parental and F_1 generations, scoring for rust was done on row basis because individual plants showed uniform rust score. In the F_2 and backcross generations, individual plants were scored following a rating scale of 1-9 where 1= no visible pustules (free from rust) and 9 =>50% infection *i.e.*, pustules extensive on all parts causing death of leaves and other plant parts (highly susceptible to rust) (5). The experimental materials in all the generations were scored for their disease reaction thrice. The first scoring was done 90 days after sowing and subsequent at 15 days interval. However, data from the final scoring was taken into consideration because it was the maximum score for each plant. For assessing the overall disease reaction, individual plants with 1 and 3 scores were considered as resistant and with 5 score as tolerant. Those with a score of 7 and 9 were classified as susceptible. The F_2 plants were classified into two categories, resistant and susceptible in the resistant x susceptible crosses and into tolerant and susceptible in tolerant x susceptible crosses. Chi-square test was applied to test the goodness of fit for the appropriate genetic ratios. Yates correction was applied in cases where the sample size was very small (expected frequency between 5 and 10).

RESULTS AND DISCUSSION

The screening results showed that JP 4 exhibited resistant reaction (score 3) while P 1594 had a disease score of 7 and S 143, P 108-1 and P 278-2 scored 9 on the scale. JP 4 has been classified as resistant by Singh and Singh (4). All the F_1 hybrids from the crosses of resistant and susceptible parents (S 143 x JP 4, JP 4 x P 108-1, JP 4 x P 278-2 and JP 4 x P 1594) showed susceptible reaction indicating dominance of susceptibility over resistance (Table 1). In the F_2 generation of all the resistant x susceptible crosses, a segregation pattern of 1 (resistant): 3 (susceptible) was observed, suggesting monogenic recessive inheritance. Similar results have earlier been reported by Singh (6). Monogenic inheritance with

Table 1. Observed segregation for rust resistance in the F_2 generation of resistance x susceptible crosses in peas

Parent/cross	Generation	Number of plants		Expected ratio	X^2	P-value
		Resistant	Susceptible			
S 143	P_1	-	12			
JP 4	P_2	17	-			
S 143 x JP 4	F_1	-	15			
S 143 x JP 4	F_2	131	326	1:3	3.28	0.10-0.05
JP 4	P_1	17	-			
P 108-1	P_2	-	24			
JP 4 x P 108 -1	F_1	-	5			
JP 4 x P 108 -1	F_2	40	107	1:3	0.39	0.70-0.50
JP 4	P_1	17	-			
P 278-2	P_2	-	23			
JP 4 x P 278-2	F_1	-	5			
JP 4 x P 278 -2	F_2	45	130	1:3	0.06	0.80
JP 4	P_1	17	-			
P 1594	P_2	-	26			
JP 4 x P 1594	F_1	-	3			
JP 4 x P 1594	F_2	39	129	1:3	0.28	0.70-0.50

Table 2. Observed segregation for rust tolerance in the F_2 and backcross generations in peas

Parent/ cross	Generation	Number of plants		Expected ratio	X^2	P-value
		Resistant	Susceptible			
S 143 x FC 1	F_2	41	104	1:3	0.83	0.50-0.30
S 143 x EC 1	F_2	67	247	1:3	2.24	0.20-.010
(S 143 x EC 1) x S 143	BC_1F_1	-	8	All Susceptible	-	>0.95
S 143 x P 930	F_2	21	89	1:3	2.25	0.20-.010
(S 143 x P 930) x P 930	BC_1F_1	4	4	1:1	0.00	>0.95
HFP 4 x FC 1	F_2	27	82	1:3	0.00	>0.95
(HFP 4 x FC 1) x FC 1	BC_1F_1	4	4	1:1	0.00	>0.95
HFP 4 x EC 1	F_2	68	214	1:3	0.12	0.80-0.70
(HFP 4 x EC 1) x HFP 4	BC_1F_1	-	9	All susceptible	-	-
(HFP 4 x EC 1) x EC 1	BC_1F_1	3	6	1:1	0.00	0.50-0.30
HFP 4 x P 1438-2	F_2	7	22	1:3	0.01	0.95-0.90
(HFP 4 x P 1438-2) x HFP 4	BC_1F_1	-	9	All susceptible	-	-
(HFP 4 x P 1438-2) x P 1438-2	BC_1F_1	6	6	1:1	0.00	>0.95
FC 1 x P 278 –2	F_2	106	277	1:3	1.47	0.30-0.20
(FC 1 x P 278 –2) x FC 1	BC_1F_1	4	4	1:1	0.00	>0.95
P 278-2 x FC 1	F_2	67	190	1:3	0.16	0.70-050
(P 278-2 x FC 1) x FC 1	BC_1F_1	5	4	1:1	0.10	0.80-0.70
FC 1 x P 1594	F_2	111	271	1:3	3.36	0.10-0.05
FC 1 x P 108-1	F_2	121	316	1:3	1.68	0.20-0.10
EC 1 x P 1594	F_2	85	261	1:3	0.04	0.90-0.80
EC 1 x P 108-1	F_2	24	62	1:3	0.39	0.70-0.50
EC 1 x P 108-2	F_2	75	263	1:3	1.43	0.30-0.20
P 278-2 x EC 1	F_2	88	238	1:3	0.69	0.50-0.30
(P 278-2 x EC) x P 278-2	BC_1F_1	-	10	All susceptible	-	-
(P 278-2 x EC 1) x EC 1	BC_1F_1	9	6	1:1	0.60	0.50-0.30
P 930 x P 278-2	F_2	87	276	1:3	0.20	0.70-0.50
(P 930 x P 278-2) x P 930	BC_1F_1	4	6	1:1	0.40	0.70-0.50
(P 930 x P 278-2) x P 278-2	BC_1F_1	-	14	All susceptible	-	-
P 278-2 x P 930	F_2	31	111	1:3	0.52	0.50-0.30
(P 278-2 x P 930) x P 278-2	BC_1F_1	-	12	All susceptible	-	-
(P 278-2 x P 930) x P 930	BC_1F_1	5	6	1:1	0.33	0.70-0.50
P 930 x P 108-1	F_2	73	216	1:3	0.01	0.95-0.90
P 930 x P 1594	F_2	57	219	1:3	2.79	0.10-0.05

resistance being dominant over susceptibility was found in other reports (1, 2, 3, 7). The discordance in the findings of the present investigation and those reported earlier could be due to variation in isolate of rust pathogen and environmental conditions at Pantnagar and in other parts of India.

The results of 18 crosses including three reciprocals of tolerant and susceptible parents revealed that all the F_1 hybrids were susceptible indicating that susceptibility was also dominant over tolerance. In the F_2 generation all the crosses, a good fit to 1 (tolerant): 3 (susceptible) segregation ratio was noticed, suggesting that inheritance of tolerance to rust disease was also governed by a single recessive gene (Table 2). The results of three reciprocal crosses suggested that the rust tolerance was not influenced by the cytoplasmic factors. Six backcrosses of the F_1 with the susceptible parents produced all susceptible plants (Table 2) and the 9 backcrosses of the F_1 with the tolerant parents gave a segregation ratio of 1 (tolerant): 1 (susceptible). The findings of the backcrosses also verified the dominance of susceptibility over tolerance and that the inheritance of tolerance to rust was governed by a single recessive gene.

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