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Genetics of resistance to P_3 isolate of Phytophthora blight in pigeonpea

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Summary

Seedlings from six crosses between susceptible × resistant and two between susceptible parents were screened against P_3 isolate of *Phytophthora drechsleri* f. sp. *cajani* in the glasshouses. Disease reaction was scored on a rating scale of 1–5. Resistance was found to be controlled by one dominant gene and some minor genes and is affected by ontogeny. The resistance gene appeared to be different from the one reported earlier (Pd_1) and is designated here as Pd_3.

Introduction

Phytophthora blight (PB) first recognised by Williams et al. (1968) and caused by *Phytophthora drechsleri* Tucker var. *cajani* Pal, Grewal, and Sarbhoy leads to a drastic yield reduction in short-duration pigeonpeas (Reddy et al., 1990) and of fungal pathogens it is second only to fusarium wilt in incidence (Kannaiyan et al., 1984). At present, no early maturing cultivar is known to have resistance/tolerance to this disease. The possibility of occurrence of more than one race(s) of PB has been indicated Sharma et al. (1982) among others. Subsequently the presence of different isolates of the pathogen has been confirmed by Reddy et al. (1990).

The presence of a new and virulent P_3 isolate and its severity on pigeonpea prompted us to determine the number of gene(s) in a resistant line (KPBR 80-2-1).

Materials and methods

The present research work was conducted at Pantnagar and ICRISAT Asia Centre (IAC), Patancheru, India. The F_1s were developed at Pantnagar and IAC while final screening of test material was done exclusively in the glasshouse at IAC.

Parents and crosses

Six PB susceptible early maturing pigeonpea lines viz., UPAS 120, Pant A3, ICPL 84023, ICPL 87119, ICPL 90005 and ICPL 90035 were selected. A single late maturing line (KPBR 80-2-1) having field resistance to PB was used as resistant parent.

All six susceptible lines were crossed with the resistant line, and two crosses between susceptible parents (UPAS 120 × ICPL 84023 and Pant A3 × ICPL 84023) were made. Since there were huge differences in flowering time of the susceptible and the resistant parents a ratoon crop of the susceptible parents was used for synchronising flowering time. The F_1 plants were selfed with muslin cloth bags to prevent outcrossing. The F_1s were also back-crossed to both parents (P_1 and P_2) to obtain BC_1P_1 and BC_1P_2, respectively.

Pathogen isolate

The pathogen isolate was isolated from a small piece of stem 3 mm in length including portions of lesions on healthy tissues. The stem piece was washed in run-

Table 1. Seedling reaction of parents, F_1s, F_2s and their backcrosses to P_3 isolate of *Phytophthora drechsleri* f. sp. *cajani* in eight crosses of pigeonpea

Parents and crosses	Generations	Observed number of plants		Expected ratio, tested	χ^2 value
		Resistant	Susceptible		
UPAS 120		12	181	–	–
Pant A3		16	169	–	–
ICPL 84023		15	171	–	–
ICPL 87119		21	168	–	–
ICPL 90005		11	152	–	–
ICPL 90035		10	154	–	–
KPBR 80-2-1		183	12	–	–
UPAS 120 × KPBR 80-2-1	F_1	12	0	–	–
	F_2	308	82	3:1	3.285
	BC_1P_1	7	5	1:1	0.333
	BC_1P_2	14	0	–	–
Pant A3 × KPBR 80-2-1	F_1	13	0	–	–
	F_1	286	101	3:1	0.249
	BC_1P_1	19	23	1:1	0.381
	BC_1P_2	12	0	–	–
ICPL84023 × KPBR 80-2-1	F_1	20	0	–	–
	F_2	273	93	3:1	0.033
	BC_1P_1	10	7	1:1	0.529
	BC_1P_2	15	1	–	–
ICPL87119 × KPBR 80-2-1	F_1	18	0	–	–
	F_2	292	81	3:1	2.146
	BC_1P_1	11	14	1:1	0.360
	BC_1P_2	14	0	–	–
ICPL90005 × KPBR 80-2-1	F_1	16	2	–	–
	F_2	293	86	3:1	1.077
	BC_1P_1	10	8	1:1	0.222
	BC_1P_2	17	1	–	–
ICPL90035 × KPBR 80-2-1	F_1	8	1	–	–
	F_2	275	102	3:1	0.850
	BC_1P_1	11	8	1:1	0.474
	BC_1P_2	18	0	–	–
UPAS 120 × ICPL84023	F_1	2	11	–	–
	F_2	16	361	–	–
	BC_1P_1	3	15	–	–
	BC_1P_2	4	14	–	–
Pant A3 × ICPL84023	F_1	4	34	–	–
	F_2	26	346	–	–
	BC_1P_1	5	14	–	–
	BC_1P_2	3	9	–	–

$BC_1P_1 = F_1 \times P_1$; $BC_1P_2 = F_1 \times P_2$.

ning tap water and surface-sterilized in 2% sodium hypochlorite solution for 1–3 minutes and placed on potato dextrose agar (PDA) slants. On the basis of growth characteristics, slants with the fungus in pure form were identified and confirmed by microscopic examination. In virulence test it was confirmed as P_3 isolate because seedlings of ICP 7119 (susceptible to P_2 and P_3) and ICP 2376 (resistant to P_2 but susceptible to P_3) were killed.

Inoculation technique

After extensive testing of inoculation technique (Drench- vs. spray-inoculation), inoculum concentration, plant age, humidity period, humidity percentage and temperature through a series of experiments, it was found that optimum inoculations resulted with 12-day-old seedlings with one trifoliate leaf, a temperature range of 25–30 °C at 100% humidity for 36 hrs and an inoculum concentration of 1 g of mycelium/100 ml of water (Gupta, 1995).

Preparation of inoculum

The fungal isolate was grown on solid sterile medium in Petri dishes on v-8 juice agar (v-8 juice, 100 ml; $CaCo_3$, 2 g; agar, 20 g; and distilled water, 900 ml) [Riberio, 1978]). Then single 5 mm disks of a week-old culture were transferred to v-8 juice broth and incubated at 25–30 °C for 15 days. The mycelial mats were removed, weighed and macerated with a small amount of water in a waring blender. This suspension was diluted to a final concentration of 1 g of mycelium/100 ml of deionized water.

Plant culture and screening procedure

Up to 10 seeds were planted in a glasshouse in plastic pots (15 cm diameter) filled with natural red soil. Seedlings were inoculated using an automizer and the technique decribed by Nene et al. (1981).

Observational procedure

Observations were recorded, after 10 days of inoculation, on a rating scale of 1–5 for assessing overall disease reaction. The seedlings were classified as resistant (surviving) with infection scores from 1 to 4 and a fully susceptible score of 5 (killed).

Statistical analysis

Simple χ^2 test as described by Snedecor & Cochran (1980) was used to test the goodness of fit of expected segregation ratios.

Results and discussion

Disease reactions of the seedlings of the parents, F_1s, F_2s and back crosses to P_3 isolate of PB are given in Table 1. Nearly 90% of plants were killed in each of the susceptible parents (P_1) verifying he virulence of P_3 isolate while more than 90% plants survived in the resistant line. In the two crosses between susceptible parents, plants from all generations studied were susceptible. Virtually all the F_1s between susceptible and resistant parents were resistant except for 2 of 18 plants in ICPL 90005 × KPBR 80-2-1 and 1 of 9 plants in ICPL 90035 × KPBR 80-2-1. Thus resistance to the P_3 isolate was completely dominant over susceptibility. Dominance of resistance was further confirmed by the segregation ratio in the backcrosses to the resistant parent (BC_1P_2). However, again one susceptible plant was observed in BC_1P_2 of each of the two crosses (ICPL 84023 × KPBR 80-2-1, ICPL 90005 × KPBR 80-2-1). All six crosses segregated 3:1 resistant:susceptible in the F_2 populations and 1:1 in BC_1P_1 (Table 1). Sharma et al. (1982) reported the monogenic dominant control of resistance to P_2 isolate of PB but, one of their resistant parents (Pant A3) was susceptible to the P_3 isolate of PB in the present investigation. Therefore, the resistance gene in KPBR 80-2-1 must be different from that reported earlier (Pd_1) and so here it is designated as Pd_3. Not all the surviving plants were fully resistant and gave scores ranging from 1–4. About 6% of plants were susceptible. Such variation in the disease reaction among the surviving plants indicate that the gene for resistance to PB either had variable penetrance or some minor genes are involved in controlling the resistance. Gene Pd_3 has been found to be stable due to its resistant reaction to PB at several locations (Mishra & Shukla, 1986; Amin et al., 1993).

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