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EVALUATION OF FIELD PEA GERMPLASM AGAINST RUST DISEASE CAUSED BY *UROMYCES VICIAE FABAE* DE BARY IN GLASS HOUSE AND FIELD CONDITIONS

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Abstract

Seventy three germplasm of field pea were tested under glasshouse and field condition against rust disease caused by *Uromyces viciae fabae* (Pers.) de Bary. Among screened germplasms, 30 susceptible, 40 highly susceptible and 3 belonged to moderately resistance group. The susceptible germplasm showed leaf area with symptoms (LAS) ranged from 30 to 65% with area under disease progressive curve (AUDPC) values from 77.5 to 1290 and apparent infection rate from 0.0134 to 0.1698 and highly susceptible germplasm showed LAS ranged from 60 to 95% with AUDPC values ranged from 1075 to 2179. Apparent infection rate ranged from 0.0616 to 0.6950 while moderately resistance germplasm showed LAS ranged from 20 to 24% with AUDPC values ranged from 350 to 438 and apparent infection rate ranged from 0.1180 to 0.1198 in field as well as glasshouse conditions. The moderate resistance germplasm JPF 99025, KPMR 615 and KPMR 551showed lowest LAS, AUDPC value and apparent infection rate, hence, these germplasms could be used in breeding programme.

Introduction

The pea rust caused by *Uromyces viciae fabae* (Pers.) de Bary is one of the important pathogens of field pea (*Pisum sativum* L.) occurs in severe form in all the major growing areas of India **(**Kumar *et al.* 1994). It is worldwide distributed pathogen of pea and also reported to attack number of host species belonging to family leguminaceae *viz.*, faba bean (*Vicia faba* L.), lentil (*Lens culinaris* Medic) and sweet pea (*Lathyrus sativus* L.) (Chung *et al.* 2004, Kushwaha *et al.* 2006, Shroff and Chand 2010). The disease can cause substantial yield losses particularly in warm weather conditions which ranges from 56.8 to 100 per cent (Upadhyay and Singh 1994, Kushwaha *et al.* 2010) and significant damage in terms of quality and quantity in pea, faba bean and lentil in India (Sharma 1998, Beniwal *et al.* 1993). It is an autoecious and microcyclic fungus and incidence of disease at early growth stages may result in complete failure of the crop. The genetics of rust resistance in pea is still unclear, and workers have reported a single dominant gene (Tyagi and Srivastava 1999), a single oligogene (Vijayalakshmi *et al.* 2005) showing partial dominance along with some minor gene or involvement of one to two major genes (Singh and Ram 2001). Several source of incomplete resistance against *U. viciae fabae* have been reported (Xue and Warkentin 2002, Vijayalakshmi *et al.* 2005, Chand *et al.* 2006, Barilli *et al.* 2009). In India all the

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pea germplasm/cultivars have been tested and reported as susceptible, while no immune or hypersensitive or resistant cultivar was recorded. However, race specific vertical resistance against *Uromyces viciae fabae* has also been reported (Singh and Sokhi 1980 and 1981, Sohi *et al.* 1974, Sokhi *et al.* 1984).

Cultivation of resistant varieties is one of the major options to stabilize the productivity of field pea crop. The varieties of field pea released in India for general cultivation are known to be susceptible against rust. Therefore, enhancement of rust resistance in field pea cultivars is a major challenge, which needs to be addressed on priority. Present investigation was undertaken to characterize leaf area with symptoms (LAS) values, area under disease progress curve (AUDPC) and apparent infection rate (r) in promising germplasm of field pea and to assess its importance as selection criterion in field pea rust resistance improvement programme. These parameters are being used to compare the relative susceptibility or resistance of varieties or lines. The generated information will allow the growers to increase the adaptation of multiple disease resistant cultivars.

Materials and Methods

The experiment was conducted under glasshouse as well as in field conditions at Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar. Seventy five germplasm included in advanced varietal trail-1, advanced varietal trail-2 and initial varietal trails of All India Coordinated Research Project on MULLaRP, evaluated under field and greenhouse conditions for LAS, AUDPC and apparent infection rate in 2003 - 2004 and 2004 - 2005.

Field experiment was planned in randomized block design with 4 replications and, standard agronomic practices were followed to raise healthy crop. Each germplasm was sown in 4 m row length with 30 × 15 cm line to line and plant to plant spacing, respectively. A highly susceptible variety 'Aparana' was sown after every 3 rows as spreader infector row. Pathogen inoculum was multiplied on susceptible variety 'Aparana' sown 30 days before planting of main experiment by inoculating aeciospores derived from single pustules. The rust infected plants were uprooted, incision their roots with knife and soaked in distilled water to prepare a suspension of 10^5 spore/ml. Standard inoculation technique (Chand *et al.* 2004) was followed and inoculation was done by spraying the spore suspension at the pre flowering stage of the plants (i.e., 55 - 60 days after sowing) during evening hours. Immediately after inoculation, field was lightly irrigated and two additional irrigations were given at 10 days intervals to maintain proper moisture level. The disease severity for each germplasm was visually estimated on a 0 - 9 scale (Sokhi *et al.* 1984). Ten plants were randomly selected tagged from each row used for recording disease severity and other released parameters. First observation was recorded when disease severity was around 50% on the susceptible check (Aparana) and accordingly, two more observations were taken at 4 days interval to calculate AUDPC (Kushwaha 2007).

The 73 germplasms were sown at the same time in plastic pots (30 cm diameter) filled with normal soil amended with farm yard manure to support luxuriant plants growth. Five plants were grown per pot and three pots of each germplasm treated as a single replication. The replicated pots of each germplasm were arranged in a randomized block design in the experiment. All pots were kept in growth chamber at 25^0C in day and 20^0C in night temperature with a 16 hrs photoperiod and watered twice in the week to maintain the adequate moisture level. Plants were inoculated at most susceptible stage i.e., four to six node stage, which occurred at 15 to 20 days after planting (Xue and Warkentin 2002).

The suspension of aeciospores/urediospores of *U. viciae fabae* was prepared by mixing the spore with light mineral oil (Soltrol 170) and adjusted to 10^5 spore/ml using a haemocytometer.

The spore suspension was applied at 1 ml/plant through atomizer. After natural drying, the plants were placed in a mist chamber with 100 per cent relative humidity at 20^0C in dark for 24 hrs and then returned to glasshouse for pathogenesis (Chand *et al.* 2004). Six pots of "Aparana" sprayed only with mineral oil were included as checks (control) against extraneous airborne inoculum. Under glasshouse condition, 3 pots of individual genotypes were considered for disease severity. Observation on disease severity was recorded on individual plants 10,12,14 days intervals from the first scoring done when disease appeared in pots plant.

Leaf area with symptoms was used to quantify the disease severity of field pea germplasm to rust. The LAS was assessed on two leaf disks (15 mm diameter) taken from each of the 4th and 6th nodes of each plant 20 days after inoculation. Disease severity score was then converted to LAS values using the equation LAS = $\sum$ (medium value in a category × number of leaf disk in the category) /Total no of leaf disks. Per cent LAS was used to quantify the disease severity of the field pea germplasm against rust. Data were analyzed by analysis of variance and germplasm means were separated by the least significant difference (LSD) test at a probability level of 0.05. The area under disease progress curve (AUDPC) values was calculated with the help of computer software developed at CIMMYT as $\sum[\{(Yi + Y_{(i+1)} 2 \} \times (t_{(i+1)} - t_i)\}$ where Y = disease severity at time t_i and $(t_{(i+1)} - t_{i)} =$ number of days between 2 disease scores and apparent infection rate (r) values was calculated by Vander Plank (1963) for field rust as r per days = $2.3/T_1 - T_2 \log X2/X1$ where r = apparent rate of infection/spread, X_1 = Per cent disease severity at time T_1, X_2 = Per cent disease severity at time T2, $T_2 - T_1$ = Time interval in days between two observation. On the basis of LAS (%) values obtained in experimental result, the screened germplasm characterized in moderately resistant, susceptible and highly susceptible and, finally tabulated separately.

Results and Discussion

Field and glasshouse studies indicated that none of the tested field pea germplasm was found immune to *U. viciae fabae*. Among 73 germplasms tested, only 30 showed susceptible reaction under glasshouse and field condition. The susceptible germplasm HUP 2 showed minimum AUDPC value 77.5 in field condition and 85.1 in glasshouse condition, however, the maximum AUDPC value 1285.0 in field condition and 1290.0 in glasshouse condition was observed in KMPR 171 followed by KPMR 569 susceptible germplasm. The apparent infection rate in susceptible germplasm was recorded from 0.0134 to 0.1668 per cent in field condition and 0.0158 to 0.1698 per cent in glasshouse condition (Table 1).

Only 40 germplasms showed highly susceptible reaction in both condition, their LAS ranged from 60 to 90 per cent in field condition and 61 to 95 per cent in glasshouse condition. The germplasm KPMR 526 showed minimum AUDPC value i.e., 1075 in field condition and 1079 in glasshouse condition , While the maximum AUDPC value 2175.0 in field condition and 2179.0 in glasshouse condition was observed in DDR 49, which was considered as highly susceptible germplasm. The apparent infection rate in highly susceptible germplasm ranged from 0.0616 to 0.6922 per cent in field condition and 0.0615 to 0.6950 per cent in glasshouse condition (Table 2).

The disease resistance in commercial field pea varieties against rust has not previously been reported in India. Pal *et al.* (1980) reported three accessions of *Pisum* species resistant to rust under field condition in India, however these resistant accessions were not considered suitable for commercial cultivation. All the tested germplasms under field as well as glasshouse condition showed compatible reaction to rust. Out of 73 germplasms screened, not a single germplasm showed complete resistance, however three germplasm JPF 99025, KPMR 615 and KPMR 551 showed moderately resistance reaction with minimum LAS ranged in both condition 20 to 24 per cent, AUDPC ranged between 350 and 438.0 and apparent infection rate from 0.1180 to 0.1198

(Table 3) than highly susceptible and susceptible germplasm. Low LAS, AUDPC and apparent infection rate values associated with high level of resistance (Chand *et al.* 2004 and 2006, Upadhyay and Singh 1994, Xue and Warkentin 2002, Singh *et al.* 2012). LAS, AUDPC value and apparent infection rate under glass house condition and field condition almost similar, however slightly higher values of tested parameters are reported in glasshouse condition that might be due

Table 1. Leaf area with symptoms, area under disease progress curve values, apparent infection rate of susceptible germplasm of field pea screened during 2003-04 and 2004-2005.

Sl. No.	Germplasm (Name)	LAS (%)		AUDPC Values		Apparent infection rate	
		In field	In glasshouse	In field	In glasshouse	In field	In glasshouse
1	MPMR-284	40.0	43.0	820.0	824.0	0.1206	0.1218
2	KPMR 65	40.0	41.0	732.5	738.1	0.1136	0.1143
3	KPMR 420	50.0	52.0	937.5	942.8	0.1318	0.1421
4	KPMR 171	50.0	48.0	1285.0	1290.0	0.0643	0.0648
5	KPMR 427	48.0	50.0	1050.0	1054.0	0.1053	0.1083
6	JP28	50.0	50.0	1050.0	1055.0	0.1053	0.1083
7	DMR 35	45.0	50.0	1165.0	1169.0	0.1039	0.1042
8	HUP 6	45.0	49.0	927.5	935.8	0.1318	0.1365
9	HUP 2	40.0	45.0	77.5	85.1	0.1010	0.1015
10	ET 45191	30.0	31.0	600.0	619.0	0.1026	0.1136
11	NIC20395	40.0	42.0	930.0	931.0	0.0745	0.0813
12	KSP 26	50.0	50.0	1165.0	1170.0	0.1039	0.1045
13	KPMR 27	30.0	32.0	650.0	653.0	0.1206	0.1283
14	KPMR 485	40.0	48.0	860.0	890.0	0.1206	0.1290
15	KPMR 226	40.0	45.0	827.5	838.0	0.1010	0.1015
16	KPMR 5	30.0	35.0	652.5	657.0	0.1114	0.1118
17	KPMR 46	30.0	31.0	630.0	638.0	0.1287	0.1290
18	DMR 44	50.0	50.0	1020.0	1021.0	0.1668	0.1698
19	HFP 92-12	45.0	50.0	1152.5	1156.0	0.0134	0.0158
20	HUDP 19	50.0	50.0	1065.0	1067.0	0.1053	0.1083
21	HUDP 17	40.0	45.0	750.0	756.0	0.1361	0.1371
22	JPF 99-31	30.0	32.0	577.5	580.0	0.0191	0.0195
23	JPF 99-26	43.0	50.0	1145.0	1148.0	0.1053	0.1063
24	DDR 60	50.0	50.0	1050.0	1058.0	0.1053	0.1083
25	DDR 23	60.0	65.0	1087.0	1090.0	0.0952	0.0960
26	DDR 27	45.0	50.0	937.0	940.0	0.1318	0.1352
27	KPMR 619	40.0	42.0	827.5	830.0	0.1531	0.1561
28	JPF 98-16	40.0	45.0	930.0	935.0	0.0745	0.0789
29	LEP 283	50.0	50.0	1140.0	1145.0	0.1053	0.1063
30	KPMR 569	50.0	50.0	1225.0	1227.0	0.0650	0.0658
LSD (p = 0.05%)		12.76	14.67	50.78	56.89	0.301	0.350

*Average of two years data.

Table 2. Leaf area with symptoms, area under disease progress curve values, apparent infection rate of highly susceptible germplasm of field pea screened in 2003-04 and 2004-2005.

Sl. No.	Germplasm (Name)	LAS (%)		AUDPC Values		Apparent infection rate	
		In field	In glasshouse	In field	In glasshouse	In field	In glasshouse
1	KPMR 593	60.0	65.0	1350.0	1352.0	0.0951	0.0960
2	KPMR 65-1	70.0	73.0	1617.50	1620.50	0.1114	0.1123
3	KPMR 212	70.0	71.0	1512.50	1537.50	0.1114	0.1118
4	6238 R	60.0	61.0	1477.50	1487.61	0.0778	0.0797
5	JP21	60.0	62.0	1500.0	1525.00	0.0616	0.0615
6	KSP 9	60.0	65.0	1350.0	1380.0	0.0951	0.0983
7	JM6	70.0	75.0	1425.0	1435.0	0.1697	0.1705
8	DPFD 8	80.0	83.0	1682.5	1690.0	0.1523	0.1585
9	JP 9	70.0	73.0	1520.0	1525.0	0.0643	0.0663
10	JP181	60.0	68.0	1300.0	1345.0	0.1361	0.1387
11	HFP 94-22	60.0	63.0	1175.0	1180.0	0.1361	0.1391
12	DMR 36	60.0	65.0	1200.0	1235.0	0.1361	0.1381
13	DDR 44	70.0	78.0	1250.0	1268.0	0.1647	0.1785
14	DDR 50	60.0	65.0	1212.5	1225.1	0.1143	0.1183
15	PM 5	60.0	63.0	1325.0	1340.1	0.1361	0.1371
16	JP 169	60.0	62.0	1237.5	1240.01	0.1143	0.1185
17	EC292161	60.0	61.0	1175.0	1179.0	0.1361	0.1371
18	HUP 2	70.0	78.0	1425.0	1430.0	0.0643	0.0683
19	HFP 8909	80.0	83.0	1655.0	1673.0	0.1697	0.1792
20	NBP 1	70.0	76.0	1500.0	1520.0	0.1287	0.1290
21	LEP 323	70.0	78.0	1278.50	1290.0	0.1478	0.1490
22	DDR 56	60.0	65.0	1380.0	1385.0	0.1316	0.1318
23	DDR 57	90.0	92.0	1650.0	1658.0	0.1977	0.2010
24	DDR 59	80.0	80.5	1665.0	1665.80	0.1361	0.1362
25	KPMR 602	70.0	73.0	1537.5	1540.0	0.1114	0.1116
26	KPMR 606	90.0	91.0	1825.0	1830.0	0.1978	0.1980
27	HBP 2	70.0	73.0	1537.0	1537.5	0.1114	0.1118
28	KPMR 603	90.0	91.0	2062.5	2064.0	0.1822	0.1911
29	JPF 98-1	70.0	71.0	1425.0	1428.0	0.1287	0.1290
30	DDR 55	90.0	92.0	1912.0	1930.0	0.1822	0.1835
31	IPF 98-9	70.0	76.0	1690.0	1695.0	0.0951	0.0981
32	DDR 40	80.0	82.0	1715.0	1723.0	0.1356	0.1386
33	DDR 39	70.0	75.0	1400.0	1420.00	0.1112	0.1163
34	DMR 42	90.0	92.0	2150.0	2160.0	0.1669	0.1735
35	DDR 50	80.0	85.0	1802.5	1807.1	0.1200	0.1210
36	DDR 49	90.0	92.0	2175.0	2179.0	0.1669	0.1679
37	DDR 54	90.0	95.0	2165.0	2170.0	0.1669	0.1680
38	KPMR 526	70.0	76.0	1075.0	1079.0	0.6922	0.6950
39	HUDP 16	70.0	72.0	1320.0	1323.0	0.1270	0.1285
40	KPMR 583	70.0	71.0	1552.0	1554.0	0.1112	0.1115
LSD (p = 0.05%)		14.70	16.87	58.80	60.09	0.531	0.550

*Average of two years data.

Table 3. Leaf area with symptoms, area under disease progress curve values, apparent infection rate of moderately resistance germplasm of field pea screened in 2003-04 and 2004-2005.

Sl. No.	Germplasm (Name)	LAS (%)		AUDPC Values		Apparent infection rate	
		In field	In glasshouse	In field	In glasshouse	In field	In glasshouse
1	JPF 99025	22.0	24.0	432.5	438.0	0.1184	0.1198
2	KPMR 615	20.0	22.0	410.0	412.0	0.1904	0.1908
3	KPMR 551	20.0	20.0	350.0	351.0	0.1180	0.1181
LSD (p = 0.05%)		10.70	9.87	41.98	43.78	0.031	0.068

*Average of two years data.

to more congenial environments for the disease development (Chand *et al.* 2004). The higher disease severity and AUDPC was recorded in glasshouse. Negussie *et al.* (2005) also observed that the high heritability of disease severity and AUDPC suggested that selection of pea rust resistance can be made under polyhouse conditions using either disease severity or AUDPC as disease reaction indicator. Thus it is proposed that germplasm lines should be screened under the glasshouse also to identify reliable resistant plants or genotypes during breeding for resistance. Resistant varieties are most economical and ecofriendly way to manage the diseases. The generated information will allow the growers to increase the adaptation of multiple disease resistant cultivars. On the basis of these findings it can be proposed that germplasm JPF 99025, KPMR 615 and KPMR 551 identified as moderately resistant lines can be utilized as donor parent for further breeding programme of disease resistance field pea and will also be helpful in testing of breeding material and selection of best fieldpea genotype for further breeding work.

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