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Identification of new sources of resistance in Rajmash (*Phaseolus vulgaris* L.) against powdery mildew (*Erysiphe polygoni*) and stem rot (*Sclerotinia sclerotiorum*) diseases

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ABSTRACT

Rajmash (*Phaseolus vulgaris* L.) is one of the important legume crops of North and Central India. This crop is commonly affected by most devastating diseases like powdery mildew and stem rot. Therefore, identification of new resistance source is urgently needed to achieve potential yield. In present investigation fifty-two genotypes of rajmash comprising landraces, cultivars and exotic genotypes were screened against powdery mildew and stem rot diseases under natural field conditions during *rabi* 2014-15 and 2015-16. The results revealed that, out of 52 genotypes screened against powdery mildew disease, four genotypes/cultivars were free from powdery mildew disease, 16 were found resistant, 12 were moderately resistant, 4 were moderately susceptible, 10 were susceptible and 6 lines were highly susceptible. In case of *Sclerotinia* stem rot disease, out of 52 genotypes 20 genotypes exhibited resistance, 12 moderately resistance, 7 found susceptible and 5 genotypes were highly susceptible. Furthermore, only four genotypes *viz*., EC150250, BLF101, EC 565673A and GPR 203 demonstrated resistance reaction against both powdery mildew and stem rot disease. Thus, these genotypes could be used in breeding programme as donor for development of disease resistant varieties against powdery mildew and stem rot disease in future.

Key words: Disease resistance, Powdery mildew, Rajmash, Stem rot.

French bean/Rajmash (*Phaseolus vulgaris* L.) is the third most important grain legume in the world and regarded as “Grain of hope” since it is an important component of subsistence agriculture and feeds about 300 million people in tropics and 100 million people in Africa alone (Kull *et al.,* 2003 ; Miklas *et al.,* 2006). In India, french bean popularly known as rajmash and mainly produced by resource-poor, small and marginal farmers in the traditional cropping system which includes rotation with vegetables and intercropping of climbing/ pole type beans with grain amaranth, potato and maize during rainy season in the mountains/hills while as sole crop of bush types during winters (Sharma *et al.,* 2006; Rana *et al.,* 2012). Rajmash seed contains high nutritional value of proteins (>23%), minerals like Fe, Zn and essential vitamins. In India, it is grown in hilly areas of Himachal Pradesh, Jammu and Kashmir, Uttrakhand, and North-Eastern states during winter season, while in autumn, it is grown in parts of Uttar Pradesh, Maharashtra, Karnataka, and Andhra Pradesh (Vipin *et al.,* 2009).

The productivity of rajmash in India is quite low as compared to other countries due to several prevailing biotic stresses *i.e*. stem rot, powdery mildew, collar rot and bean common mosaic virus (BCMV). Among these stresses, powdery mildew (*Erysiphe polygoni* DC) and stem rot (*Sclerotinia sclerotiorum* (Lib.) de Bary) are the most devastating pathogen which affects the crop drastically at flowering and fruiting stage of the crop (Kolkman *et al.,* 2000; Trabanco *et al.,* 2012; Tanmoy *et al.,* 2016; Singh *et al.,* 2016). Stem rot (SR) is a ubiquitous necrotrophic pathogen that attacks a wide range of cultivated and wild plant species including rajmash, alfalfa, soybean, field-bean, lentil and field pea. Similarly, Powdery mildew (PM) is obligate biotroph fungi that affect all aerial parts of the rajmash plant (Trabanco *et al.,* 2012). Under favourable conditions both disease can cause extensive losses in grain productivity (Singh *et al.,* 2016; Ester *et al.,* 2017). It is well established that the host plant resistance is the cheapest and most efficient approach. Therefore, present investigation was made to assess the genotypic variability and to identify the new sources of resistance for PM and SR disease.

Experiment materials and design: The field experiment was executed to identify the new sources of resistance against powdery mildew and stem rot. Therefore, a panel of fifty-two accessions of rajmash comprising landraces, cultivars and exotic genotypes was screened under natural field condition against powdery mildew and stem rot diseases at Main Research Farm of ICAR-Indian Institute of Pulses Research, Kanpur during *rabi* 2014-15 and 2015-16. The crop was sown in second week of October and continuously

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observed for appearance of both the diseases. Each genotype was planted on raised furrow with spacing of 30×60 cm plant geometry. All agronomic package and practises carried out to raise the good crop. The detailed list of genotype screened for PM and SR diseases under natural field condition are given in Table 1.

Assessment of PM and SR disease severity: Disease incidence was recorded two times first just after appearance of the disease and second after 15 days of intervals. Ten plants for each genotype were randomly selected for observation. Powdery mildew disease scoring was done as described by Gawande and Patil, (2003) using 0-5 rating scale: 0= Highly resistance (no infection); 1= resistance (0.1-10.0% leaf area infection); 2= moderately resistance (10.1-25.0% leaf area infection); 3= moderately susceptible (25.1-50% leaf area infection); 4= susceptible (50.1-75% leaf area infection); and 5=highly susceptible (75.7-100% leaf area infection). Likewise, stem rot disease scoring was done as suggested by Kandel *et al.*, (2018) and accordingly genotypes were rated on 0–4 scale: 0 = no symptoms (Highly resistant); 1 = less than half stem girdled (Resistant); 2 = more than half stem girdled (Moderate resistant); 3 = whole stem girdled (Susceptible); 4 = plant dead (Highly Susceptible).

A total 52 exotic and land races of rajmash (Table 1) were evaluated for their reaction to *Sclerotinia* stem rot and powdery mildew resistance under field condition in two consecutive years. Depending upon their genetic makeup of each accession responded differently to powdery mildew disease. In case of powdery mildew, results revealed that out of 52 genotypes screened, 4 genotypes/cultivars *viz.*, EC-500232, LD-2-1, IC-1435, AMBER were free from powdery mildew disease; these genotypes could be utilized as donor parents in future for powdery mildew resistance breeding programme. In addition, 16 genotypes were found resistant, 12 were moderate resistant, 4 were moderate susceptible, 10 were susceptible and 6 genotypes were observed to be highly susceptible during both the year *i.e.* 2014-15 and 2015-16. (Table 2). Besides, the disease incidence was observed more during winter season 2014-15 as compared to 2015-16. The disease severity was oscillated over the years which might be due to environmental factors such as humidity, temperature or light which were influenced development of the disease. Generally high moisture and temperature favors disease development, as well as germination and proliferation of fungal spores of diverse pathogens particularly powdery mildew (Agrios, 2005). The weather parameters *viz.*, mean temperature, rainfall and evaporation recorded at Kanpur condition clearly witnessed fluctuation over the years (Fig 1). The high temperature along with rainfall created congenial condition for disease development during study period. The development of powdery mildew disease in pea associated with high

Table 1: The detailed list of genotype screened for PM and SR diseases under natural field condition.

Genotypes	Source	Genotypes	Source
EC500407	Exotic	EC 150250	Exotic
GPR 118A	Indigenous	BD 9116291	Exotic
Roxinha	Exotic	EC 400407	Exotic
EC 391834	Exotic	EC 14920	Exotic
EC500232	Exotic	EC 8409	Exotic
IC 14851	Indigenous	EC 400445	Exotic
IC 25537	Indigenous	ET 8490	Exotic
EC 400400	Exotic	BLF 101	Land race
N0 3107	Land race	EC 540173	Exotic
GPR 203	Indigenous	HURG 53	Breeding lines
EC 564797	Exotic	LD-2-1	Land race
EC 400419	Exotic	IC 14351	Indigenous
EC 565673	Exotic	N03127	Exotic
EC 565673A	Exotic	IC 311676	Indigenous
IC 84607	Indigenous	PLB 438	Indigenous
EC 564797	Exotic	EC 400401	Exotic
EC 541708	Exotic	EC 400408	Exotic
HURG 53	Breeding lines	ET84490	Exotic
EC 400361	Exotic	IC340835	Indigenous
PL 227648	Exotic	GPR8189	Indigenous
HURG 48B	Breeding lines	ET84030	Exotic
HURG 58	Breeding lines	PDR-14	Released variety
IC 31084	Indigenous	IPR 98-3-1 (Arun)	Released variety
EC 31176	Exotic	IPR-98-5 (Utkarsh)	Released variety
ET 8415	Exotic	IPR96-4 (Amber)	Released variety
GPR 4180	Indigenous	HUR-15	Released variety

temperatures (25°C) has been reported by Fondevilla *et al.*, 2006. Similarly, in regarding *Sclerotinia* stem rot disease, out of 52 genotypes/cultivars evaluated to identify the sources of resistance, none of the genotype found free from stem rot but 28 genotypes were showed resistant reaction, 12 genotypes were moderate resistant, 7 were found susceptible and 5 genotypes were exhibited highly susceptible reaction against stem rot during both the years (Table 3). These results indicating that sufficient amount of variability was there for stem rot resistance and powdery mildew resistance in evaluated rajmash materials. In the past, several researchers have been reported that there is variation in resistance reaction among the genotypes against powdery mildew and stem rot in various pulse crops (Mueller *et al.*, 2002a, Kull *et al.*, 2003, Prashanthi *et al.*, 2010, Nandrajan and Nandgupta, 2010, Zeng *et al.*, 2012a, Singh *et al.*, 2016). Besides, all released varieties *viz.*, PDR 14, Amber, Arun, and Utkarsh of rajmash were portrayed resistance reaction for stem rot and powdery mildew which indicates sincere efforts have been made towards development of resistant varieties. Most importantly, out of 52 genotypes new four genotypes *viz.*, EC150250, BLF101, EC 565673A and GPR 203 exhibited consistent resistance reaction for both diseases over the years. The identified new and stable genetic sources could be used in future rajmash breeding program to develop resistant varieties for the benefit of farmer.

Table 2: Reaction of rajmash genotypes against powdery mildew under natural condition during *rabi* 2014-15 and 2015-16.

Disease reaction	Name of genotypes	No. of genotypes
Highly Resistant	EC565673A, LD-2-1, IC-1435, AMBER	4
Resistant	EC-397834, IG-14851, IC-25537, EC-400400, ND-3107, GPR-203, PDR-14, EC-564797, HUR-15, EC-400445, ET-8490, Arun, Utkarsh, PLB-438, EC-500407, BIF-101, EC150250	16
Moderately resistant	IPR-98-8-1, EC-564795, EC-541708, HGRG-13B, GPR-118A, HURGO-48B, ARON, EC-391834, HURG-58, Roxihna, GPR-113A, EC-565673,	12
Moderately susceptible	EC-391834, EC-400419, EC-665673A, EC-400361	4
Susceptible	EC-400401, EC-14920, HURG-53,ND-3127, PL-227648, IC-81184, EC-311670, GPR-4180, EC-540173	10
Highly susceptible	BO-9116291, EC-400407, EC-8409, IC-311676, EC-460407, ET-8415	6

Table 3: Reactions of rajmash genotypes against stem rot under natural condition during Rabi 2014-15 and 2015-16.

Disease reaction	Name of genotypes	No. of genotypes
Highly resistant	Nil	Nil
Resistant	GPR-118A, EC565673A, IC- 25537, GPR- 203, PDR-14, EC-564797, EC-400419, EC-565673A, EC-400361, PL-227648, HURG-58, EC-311670, GPR-4180, EC150250, EC-400407, IPR-98-3-1, EC-14920, HUR-15, EC-400445, ET-8490, IC-84607, IC-311676, BLF-101, Roxinha, Amber, Arun, Utkarsh	28
Moderate resistant	EC-500407, IG-14851, ND-3107, EC-500232,, IPR-98-8-1, EC-564795, EC-541708, HGRG-13B, HURGO-48B, EC-391834, BO-9116291, EC 84607	12
Susceptible	EC-540173,PLB-438, EC-400401, HURG-53, EC-8490, IC-81084, EC 400400	7
Highly susceptible	PDR-14, BLF-101, LD-2-1, IC-1435, ND-1327, GPR-113B,	5

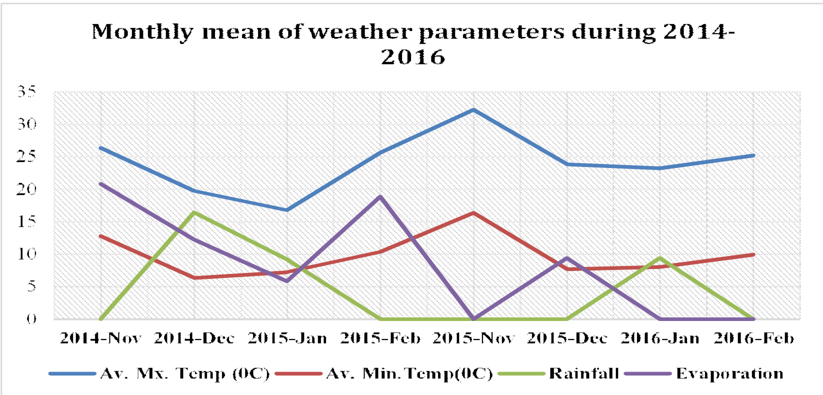

Fig 1: Monthly mean of weather parameters during experiment period (2014-2016).

CONCLUSION

In the present study significant amount of genotypic variability was observed against powdery mildew and stem rot resistance. It was also witnessed that the weather parameter especially high temperature and rainfall influenced the development of powdery mildew and stem rot disease in rajmash. In addition, out of 52 genotypes only four genotypes *viz.*, EC150250, BLF101, EC 565673A and GPR 203 portrayed resistance reaction against both the diseases over the years. The newly identified sources of resistance in this study could be further utilized in future breeding program for understanding inheritance pattern of resistance and also for devolvement of resistant cultivar against powdery mildew and stem rot disease.

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