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Girija Shankar
Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Kamal Narayan Koshale
Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Manoj Kumar Sahu
Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

RK Dantre
Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Correspondence
Girija Shankar
Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Screening of soybean genotypes and effect of weather parameter on disease development against bacterial pustule epidemiological study on bacterial pustule of soybean

Girija Shankar, Kamal Narayan Koshale, Manoj Kumar Sahu and RK Dantre

Abstract
A field experiment was conducted to evaluate the sixteen genotypes for its resistance or response against bacterial pustule disease of soybean during *kharif* 2014 under natural field condition at AICRP Soybean, College of Agriculture, Raipur (Chhattisgarh). Screening of sixteen genotype of soybean was sown to record the per cent incidence and severity. Results indicated that five genotype *viz.*, JS-72-44, JS-75-46, JS-71-05, JS-335 and Shivalic were free from the disease. Maximum bacterial pustule was recorded in variety Punjab-1 (64.34%) followed by NRC-7 (46.51%) and Monatta (38.73%). Among the sixteen genotypes, eight genotypes exhibited resistant reaction, five genotypes were moderately resistant, reaction and three genotypes showed susceptible reaction, whereas no any genotype have moderately susceptible and tolerant reaction. In correlation studies there was significant positive and negative association of disease spread among the plants with maximum temperature and relative humidity, respectively for all genotypes. Morning vapor pressure was significant and positively correlated with disease spread among the plant for two genotypes *viz.*, NRC-7 and Monatta whereas, rainfall and evening relative humidity was negatively associated with disease spread among the plant for same genotypes. Minimum temperature was significant negatively correlated with disease spread among the plant for all three genotypes. There was non-significant correlation between diseases spread on within the plant and weather parameters except wind velocity which was negatively associated for all three genotypes. Maximum disease spread among the plant was found in genotype between 1st August to 10th August, while within the plants maximum progress of disease was found in genotype Monatta between 21th August to 30th August.

Keywords: bacterial pustule, epidemiology, incidence, severity, weather parameter

Introduction
Soybean, *Glycine max* (L.) Merill has become a miracle crop of the twentieth century. It is a triple beneficiary crop, a unique food, a valuable feed and an industrial raw material with considerable potential [4]. Soybean belongs to the family Leguminosae is a world's first rank crop as a source of vegetable oil. Soybeans are the world's largest source of animal protein feed and the second largest source of vegetable oil [12]. In oilseed scenario of India, it occupies 1st place. Global area and production of soybean is 111.27 m ha and 276.4 million tonnes respectively [3]. In India area, production and productivity of soybean during *kharif*- 2014 were 108.83 lakh ha, 104.3 lakh metric tonnes and 959 kg ha^{-1}., respectively [16]. Soybean builds up the soil fertility by fixing atmospheric nitrogen through the root nodules, and also through leaf fall on the ground on maturity. It is able to leave residual nitrogen effect for succeeding crop equivalent to 35-40 kg N ha^{-1}.

More than hundred pathogens are known to affect soybean of which, 35 are of economic importance [15]. Generally, one or more disease can be found in fields wherever soybean is grown. Among the bacterial diseases bacterial pustule is the most serious problems in soybean production since they reduce the total production, and important protein. Pre-flowering appearance of disease causes economic losses in yield. It can be estimated that soybean yield losses of 15, 21, 38 and 53% are encountered at the 10.1-25, 25.1-50, 50.1-75 and >75% infection rates, respectively [2]. The earliest definitive recognition of bacterial pustule came in 1992 when Hedge described the disease and isolated the organism [6]. The disease has been reported in most soybean-growing areas of the world where warm weather and frequent showers prevail during the growing season. Keeping in view the economic importance of the crop and losses caused by bacterial pustule disease, present studies were undertaken under field condition to identify the resistance sources available against pustule. Correlation against

bacterial pustule with weather parameters helps to assess the favourable conditions for the pathogen to develop and adopt suitable control measures.

Materials and Method

Screening of soybean genotypes against bacterial pustule

A field experiment was conducted to evaluate the 16 genotypes for its resistance or response against bacterial pustule disease of soybean during *kharif* 2014 under natural field condition at AICRP Soybean, College of Agriculture, Raipur (Chhattisgarh). The experiment was laid out in Randomized complete block design and treatment consist sixteen soybean varieties with three replications. For recording the disease intensity at field condition, 1 to 9 disease rating scale developed by Mayee and Datar [9] was used. For this purpose five leaves located at the bottom, five from middle portion and five top of the plant were chosen and scored. Measurement of disease severity was carried out on five randomly selected plants in each plot after initiation of the disease. Observations on disease incidence and disease severity were recorded and calculated by using following formula. Effect of weather parameters on development of pustules in infected genotypes was also recorded.

$$\text{Per cent incidence (PI)} = \frac{\text{No. of diseased plants}}{\text{Total no. of plants observed}} \times 100$$

$$\textbf{Per cent disease index (PDI)} = \frac{\text{Sum of observed numerical ratings}}{\text{No. of leaves observed} \times \text{maximum grade}} \times 100$$

The data were statistically analyzed and interpretation of data was carried out in accordance with [20]. The level of significance used in 'F' and 'T' test was P=0.05 and P=0.01. Critical differences were calculated wherever 'F' test was significant. The values percent disease index was subjected to angular transformation according to the table given by Sundarraj *et al* [17]. Observations of selected genotypes for their level of resistance were also measured by following the scale given by Mayee and Datar [9] which is as follows.

Rating	Description	Category
1	Normal, no spots, no lesions	Resistant
3	Spots on–few plants, up to 6% leaf area covered	Moderately resistant
5	Spots on many plants, 6-15% leaf area covered, no defoliation	Tolerant
7	Spots on all plants, 16-50% leaf area covered, dropping of few leaves	Moderately susceptible
9	Full size lesions / spots on all plants, more than 50% leaf area covered, defoliation and death of plant is common	Susceptible

Effect of weather parameter on disease development of bacterial pustule

Three genotype *viz.*, Panjab-1, Monatta and NRC-7 were selected for studies on effect of weather parameters on disease development as well as spread of the disease within the plant and between the plants. The observations on among the plant and within the plant disease spread were recorded on ten days interval. First observation (D_1), second observation (D_2), third observation (D_3) and forth observation (D_4) were recorded on 1st August, 11th August, 21st August and 31st August, respectively. Observation was started just after initiation of disease and tagged the plants. We count the infected leaves within the plant for vertical disease spread and infected plants within 60 cm^2 area around the tagged plant for horizontal disease spread, then these counts were converted into disease incidence within the plants and among the plants with the help of following formula:

$$\text{Per cent incidence (PI)} = \frac{\text{No. of diseased plants}}{\text{Total no. of plants observed}} \times 100$$

Analysis of variance (ANOVA) was used to test the difference between the means. Means of the treatments were distinguished using the least significance difference (LSD) test.

Results and Discussion

Screening of soybean genotypes against bacterial pustule

Sixteen varieties were sown to record the per cent incidence of bacterial pustule of soybean at last growth stages. Result presented in Table 1 and Table 2 indicated that five varieties *viz.*, JS-72-44, JS-75-46, JS-71-05, JS-335 and Shivalic were free from the disease. Maximum disease incidence was recorded in var. Punjab-1 (64.34%) followed by NRC-7 (46.51%) and Monatta (38.73%).Varieties such as PK-262 (5.70%), JS-72-280 (4.66%), MACS (4.15%), PK-472 (3.57%), KHSB-2 (3.55%), VLS-58 (3.10%) and JS-93-05 (1.95%) showed analogous results. The results are in agreement with the findings of Verma and Dantre [19] they recorded major disease incidence of sixteen varieties of soybean and found that nine varieties out of total entries showed nil disease incidence in case of bacterial pustule. Nandini [10] carried out a survey on incidence of cowpea bacterial blight caused by *Xanthomonas axonopodis* pv. *vignicola* and revealed that the highest disease severity (14.32 PDI) was observed in Belgaum district followed by Gadag and Dharwad districts. Lowest disease severity (9.58 PDI) was observed in Haveri district. Jagtap *et al*. [7] carried out a survey in 8 districts (Parbhani, Nanded, Hingoli, Beed, Osmanabad, Jalna, Latur and Aurangabad) of Marathwada region during June to August in Kharif, 2009 to 2010. In all, 69 soybean fields were surveyed (roving survey) for recording the severity and incidence of soybean blight. The most serious pod disease was noticed on the soybean field of Parbhani district, followed by Hingoli, Nanded, Latur and Beed. The variety JS-335 showed the maximum pod blight severity in all surveyed districts.

Screening of sixteen genotype of soybean was sown to record the per cent of severity. Among sixteen genotype, eight genotypes exhibited resistant reaction, five genotypes were moderately resistant, no any genotype showed moderately susceptible reaction and three genotype showed susceptible reaction, whereas none gentype had tolerant reaction. The results are coincided with the findings of Mahesha [8] who recorded that thirteen out of 204 genotypes (Bragg, EC-245988, Hardee, Himso-1597, Lee, MACS-450, MAUS-681, NRC-2, NRC-12, PK-472, PS-1092, PS-1347 and SL-518) were resistant against bacterial pustule of soybean. Suryadi *et al*. [18] evaluated resistant genotypes of soybean to three major soybean foliar diseases, viz., Soybean Stunt Virus (SSV), Bacterial Blight (BB), and Bacterial Pustule (BP) was done by screening 100 soybean accessions of ICABIOGRAD - Bogor germplasm collections. They found that 43 genotypes were resistant, 41 moderately resistant, 14 moderately susceptible and 2 were susceptible. Gaikwad *et al*. [5] screened 91 varieties of soybean against bacterial pustules of these, 39 were totally free of the disease and 11 were resistant.

Spread of bacterial pustules disease

The observations on disease spread among the plants and within the plants were recorded on ten days interval. First observation (D_1), second observation (D_2), third observation (D_3) and forth observation (D_4) were recorded on 1st August, 11th August, 21th August and 31th August, respectively.

In case of disease spread among the plants, during initial days of disease appearance, first observation (D_1) was recorded with 6.0, 3.9 and 4.1 per cent disease spread in genotype Punjab-1, Monatta and NRC-7, respectively (Table 3). At second observation (D_2) disease incidence 29.5, 21 and 24 per cent were observed in genotype Punjab-1, Monatta and NRC-7, respectively. At third observation (D_3) 40.5, 33.5 and 37.0 per cent progress in disease among the plants were observed in genotype Punjab-1, Monatta and NRC-7, respectively. At last observation (D_4) spread of disease was 56.0, 39.5 and 41.5 per cent progress in disease among the plants were observed genotype Punjab-1, Monatta and NRC-7, respectively. In overall view maximum disease spread among the plant was found in genotype between 1st August to 10th August, while within the plants maximum progess of disease was observed in genotype Monatta between 21th to 30th August. Based on above observations maximum disease spread was recorded in genotype Punjab-1 followed by NRC-7 and Monatta.

Disease spread within the plants during initial days of disease appearance was recorded with 7.3, 3.6 and 4.2 per cent in genotype Punjab-1, Monatta and NRC-7, respectively at first observation (D_1). At the time of second observation (D_2) 24, 21.7 and 22.7 per cent disease incidence was observed in genotype Punjab-1, Monatta and NRC-7, respectively (Table 4). At third observation (D_3) spread in disease within the plants was observed 34.4, 33.5 and 37.1 per cent in genotype Punjab-1, Monatta and NRC-7, respectively. At last observation (D_4) disease incidence 60.0, 64.8 and 65.6 per cent were recorded in genotype Punjab-1, Monatta and NRC-7, respectively. Based on above observations maximum disease spread was recorded in genotype Punjab-1 followed by NRC-7 and monatta. It can be noticed that disease spread of within the plant was higher than disease spread of among the plant.

The data presented in the Table 5 showed that there was a significant positive correlation between maximum temperature and disease spread for all the varieties Monatta (R=0.98*), NRC-7 (R=0.97*) and Punjab-1 (R=0.96*) while there was highly significant negative correlation between morning relative humidity (%) and disease spread, Monatta (R=-0.99**), NRC-7 (R=-0.99**) and Punjab-1 (R= -0.99**). There was significant positive correlation between minimum temperature and disease spread in case of two varieties, NRC-7 (R=0.98*) and Monatta (R=0.96*) and morning vapor pressure and horizontal spread for same varieties (R=0.96* and 0.96*) for NRC-7 and Monnatta respectively. There was significant negative correlation between rainfall, evening relative humidity (%) with disease spread among the plant for two varieties NRC-7 (R= -0.97* and -0.97*) and Monatta (R= -0.96* and -0.97*).

The experimental data presented in Table 6 revealed that there was no significant correlation between spread of disease within the plant and all weather parameter only were wind velocity parameter showed negatively significant correlation with disease spread of bacterial pustule within the plant for all the varieties, Punjab-1(R=-0.97*), NRC-7 (R=-0.97*) and Monatta (R=-0.96*). So we may conclude that by all the weather parameters except wind velocity did not significantly increase or decrease the disease spread of bacterial pustule within the plant during the observation period.

These results were contradicted with the findings of Naqvi [11] he suggested that there was significant correlation among incidence of bacterial blight of sesamum caused by *Xanthomonas campestris* pv. *sesami* with environmental parameters such as maximum and minimum temperature, relative humidity and rainfall at 15 variety/line. Roberts [13] investigated the effect of weather conditions on simultaneous local (plant to plant) spread and infection of peas (*Pisum sativum*) with bacterial blight (*Pseudomonas syringae* pv. *pisi*) by exposing susceptible bait plants for 24 hrs periods in infected field plots. He found that rainfall rate and wind run were the most important explanatory variables for the mean number of lesions followed by maximum temperature, rainfall duration and rainfall in the previous week and disease incidence in the surrounding crop. Shrivastava *et al*. [14] conducted an experiment to find out correlation between disease incidence of bacterial blight of sesamum (*Xanthomonas campestris* pv. *sesami*) and observed that temperature (29 -29.4 ºC), rainfall (8.90-9.97 mm), relative humidity (88–90%) and 3 to 4 cloudy days enhances the disease severity. Adhikari *et al*. [1] suggested that there was highly positive correlation between bacterial blight progressions with environmental factors such as temperature, rainfall and relative humidity.

Table 1: Disease incidence of different varieties of soybean

S. No	Genotype	Bacterial pustule (Per cent incidence)
1.	JS-72-44	0.00
2.	JS-75-46	0.00
3.	JS-71-05	0.00
4.	JS-72-280	4.66
5.	PK-262	5.70
6.	PK-472	3.57
7.	MACS-58	4.15
8.	JS-93-05	1.95
9.	Punjab-1	64.38
10.	Bragg	3.12
11.	Monatta	38.73
12.	KHBS-2	3.55
13.	NRC-7	46.51
14.	VLS-58	3.10
15.	JS-335	0.00
16.	Shivalic	0.00

Table 2: Disease rating scale of different varieties of soybean

S. No.	Rating	Category	Varieties
1.	1	Resistant	JS-72-44, JS-75-46, JS-71-05, PK-472, JS-93-05,VLS-58, Bragg JS-335,
2.	3	Moderately resistant	JS-72-280, PK-262, MACS-58, KHBS-2, Shivalic
3.	5	Tolerant	Nil
4.	7	Moderately susceptible	Nil
5.	9	Susceptible	Punjab-1, NRC-7, Monatta
Total Entries			16

Table 3: Disease spread among the plants in terms of percentage incidence in three genotype *viz.*, Punjab-1, Monatta and NRC-7

S. No.	Date of observation	% disease incidence		
		Punjab-1	Monatta	NRC-7
1.	1 st Aug.(D_1)	6	3.9	4.1
2.	11th Aug.(D_2)	29.5	21	24
3.	21th Aug.(D_3)	40.5	33.5	37
4.	31th Aug.(D_4)	56	39.5	41

*Average of three replication

Table 4: Disease spread within the plants in terms of percentage incidence in three genotype *viz.*, Punjab-1, Monatta and NRC-7

S. No.	Date of observation	% disease incidence		
		Punjab-1	Punjab-1	Punjab-1
1.	1 st Aug.(D_1)	7.3	3.6	4.2
2.	11th Aug.(D_2)	24.0	21.7	22.7
3.	21 th Aug.(D_3)	34.4	33.5	37.1
4.	31 th Aug.(D_4)	60.0	64.8	65.6

*Average of three replication

Table: 5: Correlation coefficient of disease spread among the plants and weather parameters in variety Punjab-1, Monatta and NRC-7

Weather parameter	Panjab- 1	Monatta	NRC-7
Maximum Temperature (^{0}C)	0.96*	0.98*	0.97*
Minimum Temperature (^{0}C)	0.93	0.96*	0.98*
Rainfall (mm)	-0.95*	-0.96*	-0.97*
Morning Relative humidity (%)	-0.99**	-0.99**	-0.99**
Evening Relative humidity (%)	-0.94	-0.97*	-0.97*
Morning Vapor pressure (mm)	0.91	0.96*	0.96*
Evening Vapor pressure (mm)	0.49	0.48	0.43
Wind velocity (WS km/h)	-0.93	-0.92	-0.89
Wind velocity (Ep km/h)	0.69	0.79	0.80
Sunshine hours (hours)	0.76	0.85	0.87

Degree of freedom = 2
* r at 0.05% = 0.95
** r at 0.01% = 0.99

Table 6: Correlation coefficient of disease spread within the plants and weather parameters in variety Punjab-1, Monatta and NRC-7

Weather parameter	Punjab-1	Monatta	NRC-7
Maximum Temperature (^{0}C)	0.92	0.90	0.91
Minimum Temperature (^{0}C)	0.75	0.72	0.74
Rainfall (mm)	-0.78	-0.76	-0.77
Morning Relative humidity (%)	-0.89	-0.87	-0.86
Evening Relative humidity (%)	-0.86	-0.84	-0.86
Morning Vapor pressure (mm)	0.79	0.76	0.78
Evening Vapor pressure (mm)	0.70	0.71	0.71
Wind velocity (WS km/h)	-0.97*	-0.96*	-0.97*
Wind velocity (Ep km/h)	0.53	0.49	0.52
Sunshine hours (hours)	0.55	0.50	0.53

Degree of freedom = 2
* r at 0.05% = 0.95
** r at 0.01% = 0.99

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