



Prevalence and distribution of *Alternaria* leaf spot in soybean growing areas of Rajasthan

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Received: 09 June 2020; Accepted: 28 December 2020

ABSTRACT

Soybean is one of the most important oil seed crops grown in India with high amount of protein and oil content in it. To understand the prevalence and distribution pattern of *Alternaria* leaf spot disease a study was carried out in six major soybean growing districts of Rajasthan during *kharif* 2018-19. The pathogen associated with leaf spot disease was isolated and identified as *Alternaria alternata*. The study revealed that the disease had more occurrences in those districts where soybean is mainly grown. The maximum percent disease index 22.02-29.08% and 37.52-42.35% was found in Udaipur region followed by Chittorgarh district having PDI 21.33-25.08 and 30.57-37.72% and minimum PDI (14.70-19.39 and 23.27-28.33%) was recorded in Kota region at flowering and pod formation stage during both the years. The favourable temperatures range of 21.8-29.4°C and relative humidity in the range of 73.3-92.4% for occurrence, development and spread of this disease. The overall PDI was observed more in the year 2019 as compared to 2018. This disease was found to cause severe losses on a wider area under soybean cultivation in Rajasthan.

Keywords: *A. alternata*, Leaf spot, Percent disease index, Soybean

Soybean (*Glycine max* L.) is a member of family *Leguminosae* and sub-family *Papilionaceae*. It has about 43.2% protein, 20.9% oil, 19.5% fat, 3.7% fibre and small amount of vitamin B complex and vitamin E (Singh 2010). In India, it is widely distributed and its production is concentrated mainly in Madhya Pradesh, Uttar Pradesh, Maharashtra and Rajasthan covering an area of 10.47 million ha with total production of 1.07 million tonnes and average yield 1207 kg/ha. In Rajasthan, it is mainly grown in Jhalawar, Chittorgarh, Kota, Bundi, Baran, Banswara, Pratapgarh, Udaipur and Bhilwara districts, covering an area of 0.89 million ha with production of 1.07 million tonnes and average yield 1049 kg/ha. (Anonymous 2017-18). Among different production constraints in soybean production, the most serious is diseases like anthracnose, bacterial blight, bacterial pustule, brown spot, charcoal rot, frog eye leaf spot, *Fusarium* root rot, pod and stem blight, purple seed stain and *Cercospora* leaf blight, *Rhizoctonia* aerial blight, *Sclerotium* blight, rust, virus and seedling diseases have been reported in India (Wrather *et al.* 2006). Leaf spot disease incited by *A. alternata* is distributed throughout the soybean growing areas of India but it is

of special significance in Madhya Pradesh, Maharashtra, Rajasthan and Delhi (Shrivastva and Gupta 2001, Gupta and Chauhan 2005). It appears during first week of September when crop is in vegetative growth stage and manifests as brown necrotic spots with concentric rings that appear on foliage, these spots coalesce and form large necrotic areas in advanced stages. Infected leaves eventually dry out and drop prematurely. A yellow halo was recorded around the spots on leaves (Kamthane and Rakh 2014, Kumar *et al.* 2015). *Alternaria* leaf spot of soybean is one of the major destructive disease in recent times and many districts of Rajasthan showing decline in yield. Hence, the present investigation was undertaken to study the occurrence, distribution and yield losses in soybean caused by *Alternaria* leaf spot.

MATERIALS AND METHODS

Occurrence and distribution of Alternaria leaf spot in soybean: Extensive and intensive surveys were conducted during *kharif* 2018-19 to know the occurrence and distribution of *Alternaria* leaf spot of soybean on farmers' fields in major soybean growing areas of Rajasthan including Udaipur, Chittorgarh, Pratapgarh, Kota, Baran and Jhalawar. In the 30 surveyed fields, both prevalence and distribution of disease in the form of percent disease index was recorded. Observations on percent disease index were taken at flowering and pod formation stage of soybean crop and counting 10 infected plants in randomly selected 5 sites of 1 sqm area in each field. From each district, five villages

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were selected and in each village 4 fields were selected and 10 infected plants were examined randomly. In the surveyed fields, percent disease index was calculated and diseased samples were collected from different locations for isolation and identification of the pathogens. The pathogen was also identified as *Alternaria alternata* by Indian Type Culture Collection (ITCC), Division of Plant Pathology, IARI, New Delhi using the pure culture collected from district Udaipur.

$$\text{PDI} = \frac{\frac{n \times 1 + n \times 2 + n \times 3 + n \times 4 + n \times 5}{N} \times \frac{100}{\text{Maximum disease score (5)}}}{1}$$

where, n, number of plants in each score; 1-5, disease score; N, Total number of plants under observation.

Observations on disease rating were recorded two times first at pre-flowering stage and second at pod formation stage, when the crop was 45 days old and the expression of disease was clear, using a standard (0-5 disease rating scale). Observations for percent disease index were recorded by visual scoring as per the standard disease rating 0-5 scale (Sangeetha and Siddaramaiah 2007).

Standard disease rating scale:

Scale	Description of the symptom
0.	Leaves free from infection
1.	Small irregular spots covering <5% leaf area.
2.	Small irregular brown spots with concentric rings covering 5.1-10% leaf area.
3.	Lesions enlarge, irregular brown with concentric rings covering 10.1-25% leaf area.
4.	Lesions coalesce to form irregular and appears as a typical leaf spotting symptom covering 25.1-50% leaf area.
5.	Lesions coalesce to form irregular and appears as a typical leaf spotting symptom covering >50% leaf area.

For epidemiological study of soybean cultivar RKS-24 was planted during *kharif* 2018 and 2019 at Instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur. The disease intensity was recorded weekly during crop growth stage. The meteorological parameters, viz. temperature, humidity and rainfall were also recorded for crop season and correlation and regression was worked out using statistical standard formulas.

RESULTS AND DISCUSSION

The present experiment was conducted to study the occurrence, distribution and loss incurred due to *Alternaria* leaf spot of soybean incited by *A. alternata* in major soybean growing areas of Rajasthan. It was revealed that the percent disease index ranged in between 14.00–42.00 and 16.30–42.35 at flowering and pod formation stage in the year of *kharif* 2018 and 2019, which indicated its wide

distribution and occurrence in large areas. The percent disease index data indicated that the disease was initiated on 45 days after sowing (DAS). Borah (2019) also reported the similar results in *Alternaria* leaf spot of soybean that appeared in first week of September at vegetative stage of crop growth and also flowering and pod formation stage in Assam during the year 2018. Furthermore, Kushwaha *et al.* (2010) reported 18.0-37.5% disease incidence in pigeon pea.

Six major soybean growing districts of Rajasthan surveyed during the *kharif* 2018 and 2019. In 2018, maximum percent disease index 29.80-42.00 was recorded, whereas minimum PDI 15.45-31.55% was recorded in Udaipur district. This was followed by Chittorgarh district with PDI 30.70-39.60 and 14.00-22.75% at flowering and pod formation stage, while Pratapgarh district, maximum PDI was observed 25.00-35.70%, whereas minimum PDI 15.90-22.10%, further in Jhalawar district, maximum PDI with 24.50-32.75 and minimum PDI with 14.20-21.90% at flowering and pod formation stage and Baran district with PDI 21.50-27.25 and 15.15-17.00% recorded at flowering and pod formation stage, whereas minimum disease severity of *Alternaria* leaf spot was recorded in Kota district having PDI 12.15-18.50% at flowering stage and 18.50-32.00% at pod formation stage (Table 1). The similar results were reported by Tatarwal and Rai (2007) in a survey of *Alternaria* leaf blight disease of gerbera with incidence from 50.0 to 68.0%. Tomar (2000) in a survey of *Alternaria* blight disease of guar with severity from 8.80 to 28.10% in Gwalior and Morena districts.

In 2019, maximum percent disease index was recorded (33.65-48.65%), whereas minimum PDI was recorded (22.35-37.70%) in Udaipur district followed by Chittorgarh district PDI with 30.20-44.70 and 18.90-34.50% at flowering and pod formation stage, while Pratapgarh district, maximum PDI was observed 28.00-37.70%, whereas minimum PDI 22.15-28.90%, further in Jhalawar district, maximum PDI with 25.60-35.10 and minimum PDI with 17.30-26.90% at flowering and pod formation stage and Baran district with PDI 27.50-36.10 and 16.30-24.70% recorded at flowering and pod formation stage, whereas minimum disease severity of *Alternaria* leaf spot was recorded in Kota district having PDI 17.00-23.20% at flowering stage and 23.25-36.80% at pod formation stage (Table 2). Similar results were found in fruit rot of chilli caused by *A. alternata* with incidence (14.33-36.66%) by Soomro *et al.* (2019). Joshi *et al.* (2014) revealed 15 to 35% bacterial leaf blight and *Alternaria* blight diseases of guar during different crop seasons in their survey and surveillance studies in Haryana. Furthermore, Kumar (2005) reported diseases of arid legumes causing considerable yield loss (10-95%).

The percent disease index varied in six surveyed major soybean growing districts of Rajasthan during the *kharif* 2018 and 2019. The maximum PDI 22.02-29.08% and 37.52-42.35% was found in Udaipur followed by Chittorgarh district having PDI 21.33-25.08 and 30.57-37.72% and Pratapgarh, PDI with 21.03-24.68% and 29.65-32.58%, further Jhalawar PDI with 18.60-21.46% and 26.56-29.90%

Table 1 Distribution and prevalence of Alternaria leaf spot of soybean percent disease index in different villages of Rajasthan districts during *kharif* season 2018

District	Percent Disease Index* (PDI)									
	Flowering stage					Pod formation stage				
	Minimum	Maximum	Mean	Sd	CV	Minimum	Maximum	Mean	Sd	CV
Udaipur	15.45 (23.14)	29.80 (33.09)	22.02 (27.99)	6.096	11.37	31.55 (34.17)	42.00 (40.39)	37.52 (37.77)	5.670	10.60
Chittorgarh	14.00 (21.97)	30.70 (33.64)	21.33 (27.51)	3.653	4.05	22.75 (28.49)	39.60 (39.00)	30.57 (33.57)	4.113	4.87
Pratapgarh	15.90 (23.50)	25.00 (30.00)	21.03 (27.30)	3.212	4.80	22.10 (28.04)	35.70 (36.69)	29.65 (32.99)	4.447	5.12
Kota	12.15 (20.92)	18.50 (25.47)	14.70 (22.54)	2.377	3.64	18.50 (25.47)	32.00 (34.45)	23.27 (28.84)	4.789	4.03
Baran	15.15 (23.04)	21.50 (26.97)	17.75 (24.80)	5.189	3.99	17.00 (24.35)	27.25 (31.29)	25.27 (37.77)	4.391	6.61
Jhalawar	14.20 (22.13)	24.50 (29.67)	18.60 (25.55)	6.200	6.19	21.90 (27.90)	32.75 (34.91)	26.56 (31.02)	6.289	3.37

* Percent disease index based on 3 soybean fields randomly selected from each village of different places (Figures in parentheses are arcsine $\sqrt{\text{percent}}$ transformed values).

Table 2 Distribution and prevalence of Alternaria leaf spot of soybean percent disease index in different villages of Rajasthan districts during *kharif* 2019

District	Percent Disease Index* (PDI)									
	Flowering stage					Pod formation stage				
	Minimum	Maximum	Mean	Sd	CV	Minimum	Maximum	Mean	Sd	CV
Udaipur	22.35 (28.21)	33.65 (35.45)	29.08 (32.63)	5.014	10.50	37.70 (37.88)	48.65 (44.22)	42.35 (40.60)	6.529	10.83
Chittorgarh	18.90 (25.77)	30.20 (33.33)	25.08 (30.05)	3.421	5.64	34.50 (35.97)	44.70 (41.96)	37.72 (37.89)	3.210	4.89
Pratapgarh	22.15 (28.07)	28.00 (31.95)	24.68 (29.79)	3.338	7.44	28.90 (32.52)	37.70 (37.88)	32.58 (34.80)	3.375	5.21
Kota	17.00 (24.35)	23.20 (28.79)	19.39 (26.13)	2.494	5.28	23.25 (28.83)	36.80 (37.34)	28.33 (32.16)	4.853	4.05
Baran	16.30 (23.81)	27.50 (31.63)	21.39 (27.55)	3.922	3.60	24.70 (29.79)	36.10 (36.93)	29.32 (32.78)	4.252	5.19
Jhalawar	17.30 (24.57)	25.60 (30.39)	21.46 (27.60)	4.340	5.41	26.90 (31.24)	35.10 (36.33)	29.90 (33.15)	4.462	6.45

*Percent disease index based on 3 soybean fields randomly selected from each village of different places (Figures in parentheses are arcsine $\sqrt{\text{percent}}$ transformed values).

while minimum PDI was recorded in Baran (17.75-21.39 and 25.27-29.32%) and Kota (14.70-19.39 and 23.27-28.33%) at flowering and pod formation stage during both the years (Table 1 and 2). The similar results were reported by Balai *et al.* (2013) in a survey of Alternaria blight disease of pigeon pea with disease intensity in different areas varied from 16.93-35.89% and 15.12-38.86%. The overall percent disease index was higher in 2019 as compared to 2018 because disease is favoured by temperature range of 21.8-29.4°C and relative humidity in the range of 73.3-92.4%. The rate of disease build-up was correlated with the weather parameters during the crop growth in Udaipur

district. In 2018, the correlation studies indicated that, the maximum temperature and relative humidity showed a positive correlation with the disease development, whereas the minimum temperature, relative humidity and rainfall showed negative correlation. The weather conditions during 3rd September to 14th October were observed to be the most congenial for the crop infection and further rapid build-up of the disease. During this period, a total of 74.4 mm rainfall was received coupled with relative humidity in the range of 40.4 to 80.4% and favourable temperatures in the range of 18.1 to 31.4°C. In 2019, the correlation studies indicated that, maximum, minimum temperature

and relative humidity showed a positive correlation with the disease development, whereas the rainfall showed negative correlation. The weather conditions during 3rd September to 14th October were observed to be the most congenial for the crop infection and further sharp build-up of the disease. During this period, a total of 262.8 mm rainfall was received coupled with relative humidity in the range of 73.3 to 92.4% and favourable temperatures in the range of 21.8 to 29.4°C. So, the disease was observed more during year 2019 rather than in the year 2018. The percent disease index may also increase at pod formation stage under favourable weather conditions as the disease progress was fast, which ultimately affects the yield. Hence, percent disease index ranges indicate that favourable climate along with infected seed and crop residue is important. The similar results were reported by Kumar and Barnwal (2017) and Pachori and Sharma (2016) while surveying for early blight of tomato caused by *A. solani* reported incidence of 12.0 to 34.6% and 14.2 to 26.6% at Ranchi and 27.50 to 63.36 percent at Madhya Pradesh, respectively.

In Rajasthan, the peak period for soybean production is September to mid October. None of varieties cultivated in these surveyed districts in Rajasthan found completely free from *Alternaria* leaf spot disease. The study revealed that PDI in most of the surveyed fields range between 12.15–33.65% at flowering stage and 17.00–48.65% at pod formation stage during both years, which indicates its wide distribution and occurrence in large areas. It has also been found as a serious disease year after year in major soybean growing areas of Rajasthan during *khari*f and all cultivated varieties (JS- 335, RKS-24, JS-9560, JS-2029, RKS-113, RKS-45, RKS-18, JS-2034 and local land races) were found susceptible and JS-9305, RVS 2002-04 and JS-9752 were found moderately resistant to the pathogen. The favourable temperatures range of 21.8 to 29.4°C and relative humidity in the range of 73.3 to 92.4% for occurrence, development and spread of this disease.

ACKNOWLEDGEMENTS

Authors are grateful to Department of Plant Pathology, Rajasthan College of Agriculture under the Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan (India) for providing opportunity and financial assistance during my research work.

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