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Occurrence and Distribution of Bacterial blight of Clusterbean incited by *Xanthomonas axonopodis* pv. *cyamopsidis* in major growing area of Rajasthan.

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ABSTRACT

Guar, also known as clusterbean, is a member of the Leguminosae (Fabaceae) family. Its genus Cyamopsis contains three species: C. tetragonoloba, C. senenglensis, and C. serrata. The most extensively farmed of these is C. tetragonoloba, followed by the other two. The pathogen that causes leaf blight, is Xanthomonas axonopodis pv. cyamopsidis, drastically reduces plant stand and can produce up to 58% less in cultivars. The illness simultaneously manifests as leaf spot and blight. During the Kharif seasons of 2018 and 2019, a roving study carried out in the main clusterbean-growing areas of Rajasthan confirmed the presence of the bacterial blight caused by Xanthomonas axonopodis pv. cyamopsidis. No district or location in the examined districts was totally devoid of the bacterial blight illness. Hanumangarh (30.23%) had the highest disease severity, and Barmer (17.54%) recorded the lowest. Cluster bean was more susceptible to Xanthomonas axonopodis pv. cyamopsidis infection at the maturity stage and 30 days after planting in the months of October and November, when the temperature starts to fall. The state's locations varied in terms of the severity of the sickness as a percentage. Results showed that compared to sprinkler and rainfed environments, illness severity was more frequently found under flood irrigation conditions.

Keywords: *Clusterbean, Bacterial blight, Severity, Xanthomonas axonopodis pv. cyamopsidis, Survey.*

1. Introduction

An arid and semi-arid legume crop in the family *Leguminaceae* is the clusterbean [*Cyamopsis tetragonaloba* (L.) Taub.] (2n=14), also known as guar, which means "cow food." Because of its extensive tap roots system and great capacity to recover from water stress, it is a leguminous crop that tolerates drought better than others. The name "guar" for clusterbean comes from the Sanskrit word "gauahar," which means "meal of the cow" or "livestock fodder." Other names for it include khutti, dararretic, guari, etc. It is a drought-tolerant crop suitable for growing under rainfed conditions during India's kharif season. By fixing the nitrogen in the atmosphere, it improves the soil's fertility. Crops are primarily grown during the rainy season, however they can also be grown effectively throughout the summer months if they are watered. Since ancient times, India and Pakistan have farmed clusterbeans as a green manuring, green fodder, and vegetable crop for human use.

The clusterbean gum is also thought to have medical value in the treatment of diabetes and high cholesterol. The green pods are a healthy vegetable with 82.5% water, 3.7% protein, 9.9% carbohydrates, 0.2% fat, 2.3% fiber, and 1.4% other minerals, including 0.13% calcium, 0.25% phosphorus, 5.8mg/100g iron, and 49 mg/100g vitamin (2,4).

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It is primarily grown in South Indian states like Tamilnadu, Maharashtra, Karnataka, and Andhra Pradesh for vegetable use. The north-western region of the country includes states of Rajasthan (Churu, Naguar, Bikaner, Jaipur, Sikar, Jodhpur, Ganganagar, Sirohi, Dausa, Hanumangarh, Jhunjhunu, Chittaurgarh, Rajsamand), Haryana. In India, there are 39.36 lakh hectares of clusterbean crops, which produce 16.24 lac tons, with a yield of 428 kg per hectare. Clusterbean cultivation spans a total of 28.41 lakh hectares in Rajasthan, producing 12.84 lakh tons and yielding 452 kg per hectare. Rajasthan is the top-producing state for cluster beans, with more than 70% of the country's total production.

2. MATERIALS AND METHODS

2.1 Areas Surveyed

A roving survey was conducted to record the occurrence and distribution of bacterial blight in major clusterbean growing districts of Rajasthan *viz.,* Bikaner, Barmer, Jaisalmer, Churu, Hanumangarh, Jodhpur, Jaipur, Sikar, Sri Ganganagar and Alwar during *Kharif* seasons 2018 and 2019. . In each district, minimum three locations/villages were selected, In each district, minimum five locations/villages were selected, in each location/village minimum three fields were selected and, each fields selecting five spots in every field and closely examining 10 plants in each of the four directions of the selected point. Severity of disease in field was recorded as percentage of lesion area infected out of total leaf area examined.

2.2 Data Collection

While surveying, data on the variety grown, soil type, the prevalence in the area, method of irrigation of cluster bean crop, based on infected plants and the total number of plants

observed, disease severity was calculated cluster bean plants showing the bacterial blight symptoms were collected from surveyed areas, packed in labeled paper bags and brought to the laboratory for isolation of the pathogen. The disease situation for each plant was noted on an arbitrary scale of 0 – 5 The disease rating key was used based on leaf spot disease development in which infected plants were categorized in arbitrary classes. Natural symptoms of disease were recorded during this period. The disease severity was recorded by using the following scale (11).

The entire data were pooled together and per cent disease index was calculated by using following formula (15).

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves observed x Maximum rating scale}} \times 100$$

Table: 1 Disease rating scale for bacterial blight of clusterbean.

0	No infection
1	Minute water-soaked spots scattered over the leaves covering about 1-10% leaf area.
2	Little bigger spots covering about 10 - 25% leaf area.
3	Bigger leaf spot covering more than 25 -50% leaf area, few small spots on petiole and stem initiated.
4	More than 50 - 75% leaf area covered by heavy necrotic spotting, distinct enlarged elliptical lesion on petiole and stem.
5	Above 75% leaf area covered with necrotic leaf spots, cracking of stem, leaf spot or infection on pods.

3. Results and Discussion

3.1 Survey and surveillance

Roving survey was conducted in major clusterbean growing districts of Rajasthan during *Kharif* season 2018 and 2019 revealed that the bacterial blight caused by *Xanthomonas axonopodis* pv. *cyamopsidis* (Patel, Dhande and Kulkarni) is an important pathological problem mainly in *viz.,* – Bikaner, Barmer, Jaisalmer, Churu, Hanumangarh, Jodhpur, Jaipur, Sikar, Sri Ganganagar, and Alwar. Results presented in Table 2, Plate. 2 and Fig. 1 indicated that the average disease severity was recorded 22.65 percent of all the districts of Rajasthan. The maximum disease severity was recorded in Hanumangarh (30.23 %) followed by Sri Ganganagar (28.64%), Jaipur (27.23%), Alwar (24.95%), Bikaner (21.55%), Sikar (20.02%), Jodhapur (19.24%), Churu (19.16%), Jaisalmer (17.89%) and Barmer (17.54%). In the surveyed districts, no single district and location was completely free from the bacterial blight disease. The disease was found very common in sandy and sandy loam soil than other types of soil. Disease severity was more in irrigated conditions than the crop grown under rain-fed conditions.

The disease severity in the field was assessed 30 days after sowing till maturity by randomly choosing five places within each field and closely evaluating ten plants in each of the four directions. The proportion of infected lesion area out of the total leaf area examined was used to gauge the disease's severity in the field. The disease spot on the dorsal surface of the leaf is intraveinal, round, and well-defined. Vascular tissues become infected by the infection, resulting in flaccidity in the affected area. The flaccid portions become necrotic and black. The petiole and stem become infected. The stem becomes blackened and breaks as a result. Each plant's disease status was rated from 0 to 5 on a scale. The illness rating key was created using the leaf spot disease's course, and the affected plants were then categorized arbitrarily. The severity of the disease and its natural symptoms were measured using the scale below (11).

Table: 2- Per cent disease severity of bacterial blight of clusterbean incited by X. a. pv. cyamopsidis in Rajasthan

Districts	Locations	Varieties	Soil types	Number of fields	Irrigation method	Per cent disease intensity (PDI)		Mean PDI
						2018-19	2019-20	
Bikaner (BKN)	Dungargarh	RGC-936	Sandy loamy	3	Sprinkler	22.26	24.46	23.36
	khajuwala	RGC-963	Loamy sand	3	Sprinkler	21.40	22.93	22.16
	Lunkaransar	HG-365	Sandy loamy	3	Sprinkler	19.60	21.06	20.33
	Napasar	RGC-936	Sandy loamy	3	Sprinkler	21.80	22.13	21.96
	Nokha	RGC-563	Sandy loamy	3	Sprinkler	19.33	20.53	19.93
	Average					**20.88**	**22.22**	**21.55**
Jaisalmer (JSL)	Bikampur	RGM-112	Sandy loam	3	Rain fed	17.20	19.60	18.40
	Mohangarh	RGC-936	Sandy loam	3	Rain fed	16.06	18.80	17.43
	Nachna	HG-365	Sandy loam	3	Rain fed	16.13	18.53	17.33
	Ramgarh	RGC-963	Clay loam	3	Rain fed	19.26	18.20	18.73
	Sutharmandi	RGM-112	Sandy	3	Rain fed	17.06	18.13	17.59
	Average					**17.14**	**18.65**	**17.89**

Barmer (BME)	Chauhtan	RGC-936	Sandy	3	Rain fed	18.86	17.20	18.03
	Shiv	RGM-112	Sandy	3	Sprinkler	19.40	18.33	18.86
	Balotra	RGC-1017	Sandy loam	3	Rain fed	16.26	17.66	16.96
	kalyanpur	RGC-1002	Sandy loam	3	Rain fed	17.73	15.20	16.46
	Siwana	RGC-1003	Sandy loam	3	Sprinkler	16.86	17.93	17.39
	Average					**17.82**	**17.26**	**17.54**
Churu (CHR)	Rajgarh	RGC-936	Sandy loam	3	Rain fed	19.73	20.80	20.26
	Sardarshahar	RGC-963	Sandy loam	3	Rain fed	16.20	18.93	17.56
	Ratangarh	HG-563	Sandy loam	3	Rain fed	17.06	19.20	18.13
	Sidhmukh	RGC-563	Sandy loam	3	Sprinkler	18.40	19.20	18.80
	Sujangarh	HG-884	Sandy loam	3	Rain fed	20.53	21.60	21.06
	Average					**18.38**	**19.94**	**19.16**
Hanumangarh (HMH)	Bhadra	RGC-963	Sandy loam	3	Flood	31.4	30.13	30.76
	Pilibangan	RGC-1003	Clay loam	3	Flood	28.93	29.67	29.3
	Nohar	RGC-1031	Sandy loam	3	Flood	30.26	27.13	28.69
	Rawatsar	HG-563	Clay loam	3	Flood	29.2	30.86	30.03
	Hanumangarh	RGC-963	Clay loam	3	Flood	33.2	31.53	32.36
	Average					**30.59**	**29.86**	**30.23**
Jodhpur (JDP)	Bapini	RGC-986	Loamy	3	Rain fed	18.93	20.53	19.73
	Bap	RGC-1002	Loamy sand	3	Rain fed	17.06	16.20	16.63
	Lohawat	RGM-112	Loamy sand	3	Rain fed	21.60	19.73	20.66
	Mandore	RGC-1038	Sandy loam	3	Sprinkler	17.86	18.93	18.39
	Phalodi	RGC-365	Sandy loam	3	Rain fed	22.40	19.20	20.80
	Average					**19.57**	**18.91**	**19.24**
Jaipur (JPR)	Bassi	HG-884	Loamy sand	3	Sprinkler	25.73	27.53	26.63
	Chomu	RGC-1038	Loamy sand	3	Sprinkler	24.20	27.33	25.76
	Durgapura	RGC-936	Loamy sand	3	Sprinkler	28.53	30.66	29.59
	Jobner	HG-563	Loamy sand	3	Rain fed	26.93	28.86	27.89
	Phulera	RGC-1031	Loamy sand	3	Rain fed	27.26	25.27	26.26
	Average					**26.53**	**27.93**	**27.23**
Sikar (SKR)	Dataramgarh	RGC-1003	Sandy loam	3	Rain fed	19.73	20.53	20.13
	Laxmangarh	RGC-1002	Sandy loam	3	Sprinkler	19.20	21.33	20.26
	Losal	RGC-1017	Sandy loam	3	Sprinkler	20.53	18.66	19.60
	Fatehpur	RGC-1038	Sandy loam	3	Rain fed	18.93	17.86	18.39
	Neem kathana	HG-365	Sandy loam	3	Rain fed	21.26	22.27	21.76
	Average					**19.93**	**20.13**	**20.02**

Sri Ganganagar (SGNR)	Suratgarh	RGC-1031	Sandy loam	3	Flood	28.93	27.53	28.23
	Sadulshahar	RGC-1066	Clay loam	3	Flood	31.06	28.20	29.63
	Padampur	RGC-1017	Clay loam	3	Flood	27.60	25.73	26.66
	Sri Ganganagar	RGC-986	Sandy loam	3	Flood	31.86	28.93	30.39
	Raishinagar	RGC-563	Sandy loam	3	Flood	29.40	27.20	28.30
	Average					**29.77**	**27.52**	**28.64**
Alwar (AWL)	Bansur	RGC-936	Loamy sand	3	Rain fed	26.73	23.80	25.26
	Kotkasim	HG 2-20	Sandy loam	3	Sprinkler	24.20	22.93	23.56
	Tijara	HG-563	Sandy loam	3	Sprinkler	23.06	25.20	24.13
	Behror	RGC-986	Loamy sand	3	Rain fed	25.46	28.26	26.86
	Kishangarh bas	RGC-936	Sandy loam	3	Sprinkler	26.00	23.86	24.93
	Average					**25.09**	**24.81**	**24.95**
Total average						**22.57**	**22.73**	**22.65**

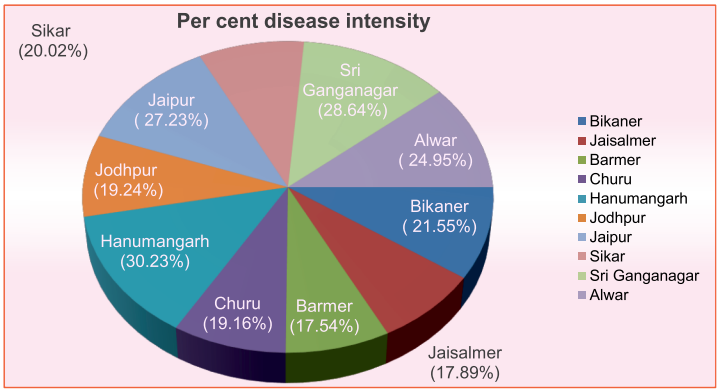

Fig. 1- Per cent disease intensity of bacterial blight of clusterbean major growing area of Rajasthan.

Results also compared among the irrigation method effect on disease severity of bacterial blight of clusterbean. All 50 locations found 10 locations with flood irrigation, 17 location was found with sprinkler system and 23 locations record rain fed. That the disease severity was recorded maximum (29.44%) under flood irrigated conditions in comparison to sprinkler system conditions (22.10%) as well as rain-fed conditions (20.10%) [Fig.1(a)].

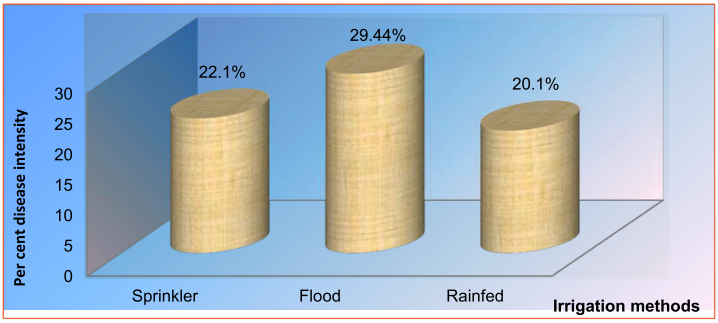

Fig.1(a) Effect of different irrigation methods on per cent intensity of bacterial blight of cluster bean in Rajasthan

Variation was also found in soil types. Sandy loam, Loamy sand and clay loam soil types were found in thirty-three, eleven and six locations of Rajasthan, respectively. Results given in Table 2 and

Fig.1(b) indicated that the maximum average disease intensity was recorded in clay loam (27.78%) followed by Loamy sand soil (24.31%). Minimum disease intensity was recorded in Sandy loam soil (21.16%).

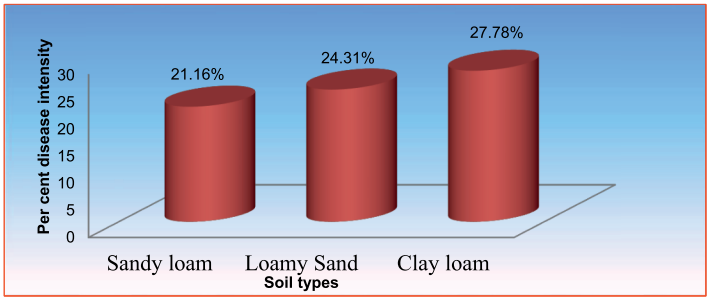

Fig.1(b) Effect of different soil types on per cent intensity of bacterial blight of cluster bean in Rajasthan

Survey was conducted in the districts of Rajasthan during *Kharif* season 2018 and 2019, which revealed that the bacterial blight caused by *X. a.* pv. *cyamopsidis* (Patel, Dhande and Kulkarni) is an important pathological problem mainly in *viz.,* – Bikaner, Barmer, Jaisalmer, Churu, Hanumangarh, Jodhpur, Jaipur, Sikar, Sri Ganganagar and Alwar. Disease severity was recorded in Rajasthan. Maximum disease severity was found in Hanumangarh (30.23) while minimum in Barmer (17.54) district. Sandy and sandy loam soil was most susceptible for the disease than other types of soil. Disease severity was higher in irrigated conditions than the crop grown under rainfed conditions. Five locations were also surveyed in Bikaner district *viz.,* Dungergarh, khajuwala, Lunkaransar, Napasar and Nokha. The average disease severity from 20.88 to 22.22 per cent was recorded during the 2018 and 2019. Highest PDS was observed in clusterbean fields at Dungergarh location that is followed by Khajuwala, Napasar, Lunkaransar and Nokha. Maximum PDS in Jaisalmer was observed in clusterbean fields at Ramgarh location. In Barmer, the average disease severity was recorded during the 2018 and 2019. The maximum PDS was found in clusterbean fields at Shiv location and followed by Chauhtan, Siwana, Balotra and Kalyanpur. In Churu, the maximum disease severity was reported in Sujangarh while minimum disease severity was observed in Sardarshahar.

During survey of bacterial blight of clusterbean, the disease prevailed maximum in Hanumangarh area followed while minimum disease severity was observed in Nohar. Bapini, Bap, Lohawat, Mandor, Phalodi were surveyed for bacterial blight severity in Jodhpur district revealed that the maximum disease severity in Phalodi block while minimum disease severity recorded in Bap. The survey was carried out of five location of Jaipur district *viz.,* Bassi, Chomu, Durgapura, Jobner and Pholera. The maximum severity was observed in Durgapura and minimum in Chomu. In Sikar, Neem kathana noted maximum disease severity which followed by Dataramgarh, Laxmangarh and Fatehpurwhile minimum severity was found in Losal.In Sri Ganganagar, maximum disease severity was recorded in Sadulsahar while minimum severity was noticed in Padampur. In Alwar, maximum PDS was observed in clusterbean fields at Behror districts whereas lower disease severity was recorded at Kotkasim.

In Rajasthan's dry regions, disease surveys conducted between 1977 and 1987 found yield losses of about 50.66% owing to bacterial blight. *X. a*. pv. *cyamopsidis* causes bacterial blight on crops (10, 5, 12).

58–68% losses in grain production were recorded by several researchers (13, 6, 4), and In 132, 147, and 149 seed samples from 25 districts, respectively, asymptomatic (0.5-91%), noticeably discolored (2.75-97.5%), and shrivelled-discolored (0.25-100%) seeds were discovered. The discolorations included water-soaked translucent shimmering regions and cream to purple brown spots. Most of the diseased seeds had cracked seed coverings. After the symptomatic seeds were incubated, *X. a.* pv. *cyamopsidis* began to grow.

The disease has been described in several Indian states, including Rajasthan (12), Haryana (4), and Karnataka (12). The pathogen's presence in seeds grown in Rajasthan, India, as well as the transfer of seed-borne inoculum from seed to plant, were the subjects of this study.

Similar findings were previously reported by (5), who identified just five *X.* species. *X. cyamopsidis* was thought to be a sub-species of *X. campestris* because the two species could only be distinguished by their host range. The bacterium was identified as *X. campestris* pv. *cyamopsidis* (Patel, Dhande, and Kulkarni) Dye by the International Society of Plant Pathology, Committee of Taxonomy of Phytopathogenic bacteria. The primary damage caused by this disease is seedling mortality. Plant components that are above ground become infected as a result of secondary disease spread.

The bacterial leaf spot bacterium (*Xanthomonas axonopodis* pv. *vignaeradiatae*) of green gram causes significant damage every year during the Kharif season and can occasionally become very severe, which causes a significant loss in grain yield, according to (9). In surveys conducted in the years 2013 and 2014, Vallabhnagar was found to have the highest mean percent disease index, followed by Kotra, Mavli, Jhadol, Gogunda, and Salumber Tehsil, and Kherwara Tehsil in Udaipur districts had the lowest mean percent disease index. In 2013 and 2014, respectively, the percent illness index ranged from 07.56 to 32.60 and 08.56 to 29.42. In comparison to 2014, the overall disease severity was higher in 2013.

4. Conclusion

Bacterial blight of clusterbean incited by *Xanthomonas axonopodis* pv. *cyamopsidis* is an important disease in arid and semi-arid regions of Rajasthan. Rajasthan during the *Kharif* seasons of 2018 and 2019. Occurrence and distribution of the bacterial blight were observed as an important disease in Bikaner, Barmer, Jaisalmer, Churu, Hanumangarh, Jodhpur, Jaipur, Sikar, Sri Ganganagar, and Alwar. However, the bacterial blight disease was found almost in all the clusterbean growing areas. The maximum disease severity was recorded in Hanumangarh, followed by Sri Ganganagar, Jaipur, Alwar, Bikaner, Sikar, Jodhpur, Churu, Jaisalmer and Barmer in the surveyed districts. Per cent, disease severity varied from location to location of the state. Variation in disease severity was also observed among the soil types, clay loam was found more conducive to bacterial blight disease followed by loamy sand and sandy loam soils. The disease severity was observed more under flood irrigation conditions in compression to sprinkler and rain-fed conditions.

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Conflict of interest

The authors declare no conflict of interest.

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