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Status and Distribution of Leaf Spot of Blackgram Incited by *Alternaria alternata* in Krishna and Guntur Districts of Andhra Pradesh

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ABSTRACT: Blackgram is an important pulse crop of *Fabaceae* grown mainly in India as a source of protein. However, yields can be negatively impacted by numerous factors, including disease, particularly those caused by fungi which create problems in both production and storage. Foliar diseases of blackgram such as *Alternaria* leaf spot caused by the *Alternaria alternata* (Fr.) Keissl. is becoming a major problem in blackgram fields of Andhra Pradesh and causes substantial yield losses, with reductions in plant health and seed quality. A minor disease so far, but becoming a major disease in recent times, there is every need to study about the disease. Information regarding work done reports on this disease was found to be scarce across India and abroad. Hence, a systematic and robust survey was conducted during *kharif* 2018 in Krishna and Guntur districts and also during *rabi* 2018-19 in Guntur district of Andhra Pradesh at 30-35, 40-45, 50-55 and 60-70 DAS and revealed that the disease incidence kept on increasing with increase in the age of the crop. There was no disease incidence observed upto 30-35 days old crop. During *kharif* 2018, the disease progressed up to 54.30% in Mangalagiri mandal and 52.64% in Tadikonda mandal at 60 DAS in Guntur district, while during *rabi* 2018-19, the disease progressed up to 49.49% in Mangalagiri and 48.66% in Ponnur mandal at 60 DAS. In Krishna district during *Kharif* 2018, the disease progressed up to 63.04% in Kanchikacherla and 52.20% in Veerullapadu mandal at 60 DAS. Overall, our study provides evidence on the status of disease severity with cultivars adopted by the farmers in both districts, which are helpful in selection of resistant cultivars and developing stable disease management strategies.

Keywords: Blackgram, *Alternaria alternata*, Survey and Disease severity.

INTRODUCTION

Blackgram (*Vigna mungo* (L.) Hepper) (2n=22) is one of the important pulse crops of the tropics and sub tropics. It is the third important annual pulse crop after chickpea and pigeonpea cultivated in the Indian sub-continent. India is a major producer of blackgram with 3.06 million tonnes production harvested from an area of 5.60 million hectares (Department of Agriculture and Cooperation, GOI, 2018-19). Major blackgram growing areas in India are Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu and Uttar Pradesh, accounting for about 75% of total production (Annual report, 2017).

It is important pulse crops having global economic importance as a dietary ingredient of the stable food. It contains 55% carbohydrate, 26% protein, 10% moisture and 3% vitamins. It is also capable of fixing atmospheric nitrogen (222 kg/ha) through symbiotic relationship with Rhizobium in the root nodule of the crop (Salam *et al*., 2009). It is a highly prized pulse with 5-6% rich in phosphoric acid than other pulses and consumed in the form of 'dal' or perched (Rao, 2021). This legume originated in India (Vavilov, 1926), where it has been cultivated from ancient times and is one of the most highly priced legume. This leguminous crop has inevitably marked itself as the most popular legume and can be most appropriately referred to as the "King of legumes" FAO (Rajni, 2019).

There are many constraints responsible for the low yield of blackgram. Consistent yields were not reported in blackgram and in some seasons a marked decline was reported due to its susceptibility to several fungal diseases. Fungal diseases, among other constraints, have a significant impact on crop yields. Important fungal diseases affecting blackram crop are powdery mildew (*Erysiphe polygoni)*, rust (*Uromyces appediculatus)*, leaf spots (*Alternaria alternata*, *Corynespora cassicola and Cercospora canascens).* Alternaria species that cause blackgram leaf spot and blight are becoming endemic and manifesting in severe forms. Only one recent report was found to be available regarding the status of this disease in Andhra Pradesh. Ambarish *et al*., (2021) stated that the pathogen can be able to cause disease severity to an extent of 51.29 per cent in Guntur district of Andhra Pradesh because all the blackgram cultivars adopted for cultivation in the district were found to be susceptible. In greengram, Deshmukh and Sabalpara (2019) noticed the alternaria leaf blight severity to an extent of 19.33 (35 DAS) and 31.97 (65DAS) at college farm of NAU, Navasari in

Gujarath. Since the information on the severity of Alternaria leafspot of black gram is inadequate, there is a need to have a survey on the severity and status of the disease in black gram growing areas of Andhra Pradesh.

Hence, the present study was carried out with a systematic and robust surveys with the main objective to know the incidence of Alternaria disease in Krishna and Guntur district of Andhra Pradesh which is critical in developing stable management approaches to farmers.

MATERIALS AND METHODS

The Survey was conducted during *kharif* 2018 in Krishna and Guntur districts and also during *rabi* 2018-19 in Guntur district of Andhra Pradesh at 30-35, 40-45, 50-55 and 60-70 DAS Based on crop statistics of the preceding year, two fields from each village, two villages from each mandal and two mandals from the district were chosen and a survey was conducted. In each field, five square meters area (one square meter each) were selected. Four from each of the four corners, leaving the border rows and another at the centre to record the severity of Alternaria leaf spot disease. Disease severity was assessed by the following disease rating scale given by Alice and Nadarajan, 2007 (Table 1). Per cent disease index (PDI) for Alternaria leaf spot disease was calculated by using the following formula (Wheeler, 1969).

$$PDI = \frac{\text{Sum of individual disease ratings}}{\text{No. of observations assessed} \times \text{maximum disease rating}} \times 100$$

RESULTS AND DISCUSSION

A. Disease symptomology under field conditions

The typical leaf spot symptoms of *Alternaria* were first appeared on lower leaves at flower initiation stage. The symptoms were initiated from centre as well as margins of the leaves as small (1 to 5 mm in diameter) brown spots that were circular to irregular in shape with definite yellow halo. Later, as the disease progressed, the spots enlarged and fused into irregular shaped lesions with distinct or indistinct concentric rings. Affected portions in the leaf got separated and fell down resulting in shot holes. Defoliation occurred on severely affected plants on later stages of the crop growth (Fig. 1). Symptoms were matched with the description made by Abawi *et al*., (1977), Susuri *et al*., (1982), Kwon *et al*., (2016) and Darai *et al*., (2017).

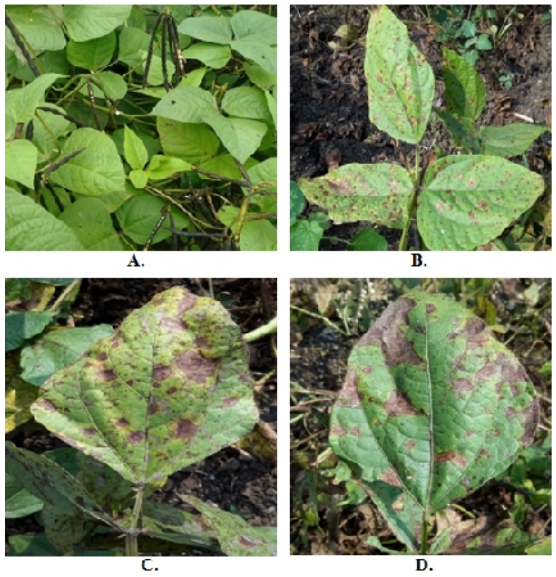

Fig. 1. Symptoms (Lesions with concentric zonations) and progression of *Alternaria* leaf spot on blackgram (A. Healthy leaves, B-D. Infected leaves).

B. Status of the disease in blackgram

A survey for the severity of Alternaria leaf spot disease was taken up in farmers' fields during *kharif* and *rabi* 2018-19. The survey was done in two villages in each of the two selected mandals, in Mangalagiri and Tadikonda of Guntur district and in Kanchikacherla and Veerullapadu mandals of Krishna district during *kharif* 2018. During *rabi* 2018-19, the survey was done in Mangalagiri and Ponnur mandals of Guntur district. Disease severity was assessed at five locations in each field surveyed. Alternaria leaf spot disease severity was recorded at a 10 day interval starting from 30-35 DAS to 60-70 DAS (Table 2 to 4). The overall mean PDI of Alternaria leaf spot in Guntur district during *kharif* 2018 was 0% at 30-35 DAS, 7.32% at 40-45 DAS, 22.38% at 50-55 DAS and 54.52% at 60-70 DAS (Table 2). Whereas during *rabi* 2018-19, the overall mean PDI in Guntur was 0% at 30-35 DAS, 5.99% at 40-45 DAS, 19.41% at 50-55 DAS and 49.07% at 60-70 DAS (Table 4).

Table 1: Disease scale for *Alternaria* leaf spot (1-9 scale).

Grade	Description	Reaction type
1	Free from diseases	Immune
2	Traces to pin head size spots on leaves	Highly resistant
3	Spots slightly larger than pin heads	Resistant
4	Spots occupying 2-5 % leaf area	Moderately resistant
5	Spots occupying 5-10 % leaf area	Moderately susceptible
6	Spots occupying 10-25 % leaf area	Susceptible
7	Spots occupying 25-50 % leaf area	Susceptible
8	Spots occupying 50-75 % leaf area	Highly susceptible
9	Spots occupying more than 75 % leaf area	Highly susceptible

Table 2: Severity of Alternaria leaf spot disease on blackgram in Guntur district of A.P. during *kharif*, 2018.

Mandal	Village	Variety	Field	Alternaria Leaf Spot (PDI)			
				30-35 DAS*	40-45 DAS	50-55 DAS	60-70 DAS
Mangalagiri	Pedavadlapudi	PU 31	1	0	10.57	27.10	60.44
			2	0	6.04	22.39	56.62
	Mean			0	8.30	24.74	58.53
	Atmakur	PU 31	1	0	6.57	21.95	52.35
			2	0	6.48	24.44	56.26
	Mean			0	6.52	23.19	54.30
	Mandal mean			0	7.41	23.96	56.41
Tadikonda	Tadikonda	PU 31	1	0	9.87	25.68	53.64
			2	0	6.04	20.61	55.72
	Mean			0	7.95	23.14	54.68
	Kantheru	PU 31	1	0	6.57	19.64	56.61
			2	0	6.48	17.33	44.62
	Mean			0	6.52	18.48	50.61
	Mandal mean			0	7.23	20.81	52.64
	Overall mean			0	7.32	22.38	54.52

*DAS: Days after sowing PDI: Per cent Disease Index

Table 3: Severity of Alternaria leaf spot disease on blackgram in Krishna district of A.P. during *kharif*, 2018.

Mandal	Village	Variety	Field	Alternaria Leaf Spot (PDI)			
				30-35 DAS*	40-45 DAS	50-55 DAS	60-70 DAS
Kanchikacherla	Vemulapalle	PU 31	1	0	10.57	27.10	60.44
			2	0	6.04	22.39	56.62
	Mean			0	8.30	24.74	58.53
	Seri Amaravarm	PU 31	1	0	6.57	21.95	52.35
			2	0	6.48	24.44	56.26
	Mean			0	6.52	23.19	54.30
	Mandal mean			0	7.41	23.96	56.41
Veerullapadu	Alluru	PU 31	1	0	9.87	25.68	53.64
			2	0	6.04	20.61	55.72
	Mean			0	7.95	23.14	54.68
	Jayanthi	PU 31	1	0	6.57	19.64	56.61
			2	0	6.48	17.33	44.62
	Mean			0	6.52	18.48	50.61
	Mandal mean			0	7.23	20.81	52.64
	Overall mean			0	8.96	23.65	57.62

*DAS: Days after sowing PDI: Per cent Disease Index

In Krishna district during *kharif* 2018, the overall mean PDI of Alternaria leaf spot was 0% at 30-35 DAS, 8.96% at 40-45 DAS, 23.65% at 50-55 DAS and 57.62% at 60-70 DAS (Table 3). Lack of disease occurrence upto 30-35 DAS may be attributed to higher sugar content in leaves. Horsfall and Dimond (1957) and Bhargava and Khare (1988) reported that *Alternaria* is a low sugar pathogen and occurs at or after the flowering stage. In the present investigation, disease occurrence was noticed at 40-45 DAS, *i.e.*, at flower initiation stage when sink was established.

As previously stated, *Alternaria* is a low sugar requiring pathogen, and the disease became more prevalent as the crop grew older. During *kharif* 2018, the disease progressed from 7.41% at 40 DAS to 23.96% at 50 DAS and 56.41% at 60 DAS in Mangalagiri mandal of Guntur district. In Tadikonda mandal, of Guntur district, the disease progress was 7.23% at 40 DAS to 20.81% at 50 DAS and 52.64% at 60 DAS (Table 2). In Krishna district during *kharif* season, the disease progressed from 10.12% at 40 DAS to 27.64% at 50 DAS and further to 63.04% at 60 DAS in Kanchikacherla mandal, while in Veerullapadu mandal, the disease progressed from 7.81% at 40 DAS to 19.66% at 50 DAS and further to 52.20% at 60 DAS (Table 3). In Guntur district during *rabi* 2018-19, the disease progressed from 5.57% at 40 DAS to 19.34% at 50 DAS and further to 49.49% at 60 DAS in Mangalagiri mandal, and from 6.41% at 40 DAS to 19.49% at 50 DAS and 48.66% at 60 DAS in Ponnur mandal (Table 4).

Table 4: Severity of Alternaria leaf spot disease on blackgram in Guntur district of A.P. during *rabi*, 2018-19.

Mandal	Village	Variety	Field	Alternaria Leaf Spot (PDI)			
				30-35 DAS*	40-45 DAS	50-55 DAS	60-70 DAS
Mangalagiri	**Pedavadlapudi**	**PU 31**	1	0	6.21	20.79	55.50
			2	0	5.68	23.28	51.82
	Mean			0	5.94	22.03	53.66
	Atmakur	**PU 31**	1	0	4.88	13.95	38.84
			2	0	5.55	19.37	51.81
	Mean			0	5.21	16.66	45.32
	Mandal mean			0	5.57	19.34	49.49
Ponnur	**Kasukarru**	**LBG 752**	1	0	5.86	18.31	52.17
			2	0	8.17	17.56	41.51
	Mean			0	7.01	17.93	46.84
	Upparapalem		1	0	5.06	23.46	54.21
		LBG 752	2	0	6.57	18.66	46.75
	Mean			0	5.81	21.06	50.48
	Mandal mean			0	6.41	19.49	48.66
	Overall mean			0	5.99	19.41	49.07

*DAS: Days after sowing PDI: Per cent Disease Index

During *kharif* 2018 at 40-45 DAS, in Guntur district, the mean PDI of Alternaria leaf spot in the surveyed villages ranged from 6.52% (Atmakur village of Mangalagiri mandal and Kantheru village of Tadikonda mandal) to 8.30% (Pedavadlapudi village of Mangalagiri mandal). At 50-55 DAS, the PDI was in the range of 18.48% (Kantheru village of Tadikonda mandal) to 24.74% (Pedavadlapudi village of Mangalagiri mandal). At 60-70 DAS, the mean PDI of Alternaria leaf spot was in the range of 50.61% (Kantheru village of Tadikonda mandal) to 58.53% (Pedavadlapudi village of Mangalagiri mandal) (Table 2).

In Krishna district during *kharif* 2018-19at 40-45 DAS, the mean PDI of Alternaria leaf spot in the surveyed villages ranged from 6.49% (Jayanthi village of Veerullapadu mandal) to 10.85% (Vemulapalle village of Kanchikacherla mandal). At 50-55 DAS, the PDI was in the range of 17.01% (Jayanthi village of Veerullapadu mandal) to 28.49% (Vemulapalle village of Kanchikacherla mandal). At 60-70 DAS, the PDI of Alternaria leaf spot was in the range of 48.98% (Jayanthi village of Veerullapadu mandal) to 64.43% (Vemulapalle village of Kanchikacherla mandal) (Table 3).

In Guntur district during *rabi* 2018-19 at 40-45 DAS, the mean PDI in the surveyed villages ranged from 5.21% (Atmakur village of Mangalagiri mandal) to 7.01% (Kasukarru village of Ponnur mandal). At 50-55 DAS, the PDI ranged from 16.66% (Atmakur village of Mangalagiri mandal) to 22.03% (Pedavadlapudi village of Mangalagiri mandal). At 60-70 DAS, the PDI was in the range of 45.32% (Atmakur village of Mangalagiri mandal) to 53.66% (Pedavadlapudi village of Mangalagiri mandal) (Table 4).

The survey results revealed that the age of the plant could influence the extent and intensity of damage by *A. alternata*. The disease prevalence and severity increased with crop age, implying that disease prevalence and severity were lower in young and vigorous plants and higher in old, senescing plants. Variation in severity of Alternaria leaf spot observed in the mandals and the selected villages of each mandal in two districts was attributed to variation in sowing time of the crop, impact of weather factors and the differences in adoption of recommended package of practices by the farmers. The results obtained in the current study was in agreement with reports made by Ambarish *et al*., (2021) that severity of Alternaria leaf spot of blackgram was ranged from 50.62 to 51.29 per cent at 60-70 DAS during *rabi* 2017. Review on the occurrence of Alternaria leaf spot in different crops indicated that the pathogen *Alternaria* is capable of causing as high as 92% disease severity (Fula, 2005).

CONCLUSION

This is the first ever research on status and distribution of Alternaria leaf spot of blackgram in major blackgram growing regions in Krishna and Guntur district, Andhra Pradesh. This research documented that leaf spot disease is widespread and uniform in blackgram fields during *kharif* as well as *rabi* seasons. It indicated that environmental conditions prevailing during *kharif* and *rabi* season were congenial for pathogen to cause disease. The information generated through this study could help the blackgram growers regarding disease management and selection of resistant cultivars, improving profitability and achieving food security. Furthermore, an exhaustive survey across all blackgram growing zones in Andhra Pradesh is required to identify the hot spot for the disease, as well as characterization of the pathogen population prevailing in blackgram growing is required to design regional specific management strategies. The easiest way of managing the disease is through direct deployment of resistant cultivars into cultivation. Hence, the reaction of newly developed genotypes needs to be assessed.

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