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An Overview of Fusarium Wilt of Lentil Status in different Districts of West Bengal, India

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ABSTRACT: The yield potential of lentil remains low in India even under well managed production due to several biotic and abiotic stresses. Fusarium wilt of lentil caused by *Fusarium oxysporum f.sp. lentis* is one of the important biotic stress to the crop with severe reduction or complete reduction in yield. The disease occurs in fields in patches and originates either at early (seedling) crop stage or at reproductive (adult plant) stage. West Bengal is one of the major producers of lentil in India and very little amount of work on survey of lentil wilt disease in West Bengal has been conducted. In order to identify the disease status, hierarchical sampling strategy was conducted in two consecutive rabi seasons (2016 and 2017) in West Bengal in different farmers' field as well as experimental fields covering five major lentil growing districts viz. Hoogly, Nadia, Birbhum, Bankura and Murshidabad. Percent disease incidence was calculated and the result revealed that during *Rabi* 2017, the incidence of *Fusarium* wilt of lentil was varied from 17.60% to 28.13%and during 2018, the disease incidence was in range of 16.38% to 25.39% according to location. The mean data of both the years revealed that the maximum diseases severity (PDI) was recorded 26.71% from C Block instructional field, BCKV, Nadia and the minimum PDI was recorded from farmers' field at Chanditala, Hoogly (16.99%). In other districts the diseases severity was ranges from 19.91% to 20.05%.

Keywords: Lentil, Fusarium wilt, *Fusarium oxysporum f.sp. lentis*, survey.

INTRODUCTION

Pulses are major source of protein, high fibre content and provide ample quantity of vitamins and minerals. Realizing its importance for human health, the United Nation declared 2016 as International Year of Pulses. Lentils are the second important group of crops after chick pea in India. Lentil has a protein concentration estimated at 24%. The crop is currently produced on 5.8 million ha worldwide with production of 6.2 million metric ton (FAOSTAT, 2018). The inclusion of Lentil in various cropping systems benefits the companion crop or succeeding crop by improving the physical and chemical properties of soil was well documented by Das *et al*., (2017); Mondal *et al.*, (2020; 2021) concluded that the carryover of N from grain legumes for succeeding crops (e.g., sorghum, pearl millet, maize, castor) in dry-lands and marginal and sub-marginal lands ranged from 30-120 kg ha^{-1}. In comparison to other grain legumes (i.e., common pea, chickpea), lentils are likely to have positive N balances (Walley *et al*., 2007). In a publication by Suryapani *et al*., (2013) estimated of the total amount of N fixed by lentil range from 0 to 192 kg ha^{-1} with an average value of about 80 kg ha^{-1} in shoots and roots.

Low yield of lentil is primarily attributed to its susceptibility to several fungal, bacterial and viral diseases (Plaxton, 2004). About 67 fungi, 22 viruses, 3 bacteria and 80 nematodes have been reported on lentil (Brouwer *et al.*, 1995) but only few of these are considered as economically important diseases. Among the economically important diseases Wilt (*Fusarium oxysporum)*, Alternaria blight (*Alternaria alternata*), Anthracnose (*Colletotrichum lindemuthianum*), Aschochyta blight (*aschochyta fabae* f.sp. *lentis*), Rust (*Uromyces fabae*) and Root rot (*Rhizoctonia solani*) are the major andwidespread affecting its production and these biotic stresses have been reported to reduce the productivity of lentil by 20-25% (Jiskani *et al.*, 2021). Fusarium wilt (*Fusarium oxysporum* f.sp. *lentis*) is one of most devastating disease of lentil which causes severe damage to leaves, stems, roots and pods and eventually reduces the yield (Pouralibaba *et al*., 2016). Fusarium disease occurs all over the world. This is persistent in the soil and is also related to seeds (Jiskani *et al*., 2021). All the growth stages get severely affected by the pathogen but maximum infection occurs at flowering and pod stages that any other vegetative growth stage.

Under field conditions, typical wilt symptoms can be noticed after two to three weeks of sowing if the variety is susceptible to the pathogen (Taylor *et al*., 2007). Yield losses depends upon different stages, 100% wilt can occur if the pathogen attacks at seedling and pre-pod stages, whereas about 60-70% can be notice when it occurs at flowering and podding stages (Garkoti *et al*., 2014). Kumar *et al*., (2013) reported that Fusarium wilt is the most devastating of all lentil diseases worldwide that can cause extensive yield losses reaching up to 100% in prolonged favourable environments. It is considered as the most damaging soil-borne disease of lentil and is a major lentil production-limiting agent worldwide. Even though lentil is growing widely in West Bengal but there is less report the involvement of wilt pathogens and has never been investigated uniformly covering different districts. A comprehensive survey of lentil diseases in 5 different districts of West Bengal, India was conducted in 2016-17, 2017-18 with the objectives to find out the occurrence and distribution of Fusarium wilt in lentil and to find out the status of the disease.

METHODS

Areas Surveyed. The survey on the incidence of *Fusarium* wilt of lentil was conducted between October and December 2017-18 and 2018-19 at different districts of West Bengal during the *rabi* season of 2016-17 and 2017-18 (Fig. 2). To conduct the survey, a total 5 districts of West Bengal *viz.* Hoogly, Nadia, Birbhum, Bankura and Murshidabad district were selected *viz.* Chanditala farmer's field, Balagarh farmer's field, C Block BCKV instructional field, AB Block BCKV instructional field, Rampurhat farmer's field, Bolpur farmer's field, Bishnupur farmer's field and Berhampore farmer's field were undertaken for the study (Fig. 1). In each location, four fields of more or less uniform size were selected at random. In each field, 20 plants were selected randomly. The observations were taken periodically at 30, 45 and 60 days after sowing. The incidence of *Fusarium* wilt of lentil field was assessed by recording the number of plants showing wilt disease symptoms such as root rotting, yellowing of leaves, wilting of plants /m^2 of a randomly selected area. Per cent disease incidence was calculated by using the following formula,

$$\text{Incidence } \% = \frac{\text{Diseased plants}}{\text{Total no.of plants}} \times 100$$

Data Collection. A Global positioning system (GPS) based survey sheet was prepared to collect information on disease incidence (Table 1).

Fig. 1. Survey on the natural incidence of Fusarium wilt of lentil in different locations of West Bengal.

Fig. 2. Typical symptom of Fusarium wilt.

RESULT

Occurrence and natural incidence on *Fusarium* wilt disease of lentil. It was observed that lentil wilt disease was caused by *Fusarium oxysporum* f. sp. *Lentis* and according to Pouralibaba *et al*., (2016), typical seedling wilt is characterized by sudden drooping, followed by drying of leaves and seedling death. Adult wilt symptoms appear from flowering to late pod-filling stage and are characterized by sudden drooping of top leaflets of the affected plant, leaflet closure without premature shedding, dull green foliage followed by wilting of the whole plant or individual branches. Wilt symptoms in the field also includes wilting of older leaves, stunting of plants, shrinking, and curling of leaves from the lower part of the plants that progressively move up to the stems of the infected plant and the plant eventually dies.

Natural disease incidence and severity assessment showed that during *Rabi* 2017, the incidence of *Fusarium* wilt of lentil was varied from 17.60% to 28.13% according to location of different area. The maximum percentage of disease incidence (PDI) of *Fusarium* wilt, 28.13% was recorded from Berhampore farmers' field of Murshidabad followed by C Block instructional field, BCKV, Nadia (28.04%), farmer's field at Rampurhat, Birbhum (24.66%) and instructional farm AB-block field of Kalyani at BCKV, Nadia (24.09%), Shekhampur, Birbhum (22.39 %) and Bishnupur farmers field of Bankura (19.42%). The minimum PDI was recorded from farmers' field at Chanditala of Hoogly (17.60%) followed by farmers filed at Bolpur of Birbhum (17.67%), farmer's field at Balagarh of Hoogly (18.37%) (Table 1).

Table 1: Prevalence of Fusarium wilt disease in lentil in West Bengal during *Rabi* 2017 and 2018.

Sr. No.	SAMPLE	LOCATIONS	LATITUDE AND LONGITUDE	DISEASE INCIDENCE (%)		
				2017	2018	MEAN
1.	W1	Chanditala	22°41′32.00″N 88°15′35.00″E	17.60 (24.80)	16.38 (23.89)	16.99 (24.27)
2.	W2	Balagarh	23°12′44.00″N 88°46′32.00″E	18.37 (25.40)	21.46 (27.62)	19.91 (26.49)
3.	W3	Rampurhat	24° 47'17.00"N 87° 23'78.00"E	24.66 (29.73)	22.02 (27.97)	23.34 (28.86)
4.	W4	Bolpur	23°39'46.01"N 87°41'49.02"E	17.67 (24.88)	19.97 (26.49)	18.82 (25.70)
5.	W5	Shekhampur	23°55'0.12"N 87°31'59.88"E	22.39 (28.25)	19.73 (26.35)	21.06 (27.69)
6.	W6	Bishnupur	23°04'48.00"N 87°19'12.00"E	19.42 (26.13)	20.69 (27.06)	20.05 (26.92)
7.	W7	Berhampore	24°14'62.00"N 88°25'64.00"E	28.13 (32.01)	22.28 (28.18)	25.20 (30.13)
8.	W8	AB Block (Nadia)	22°29'7.90"N 52°15'09.30"E	24.09 (29.93)	20.52 (26.92)	22.30 (28.25)
9	W10	C Block (Nadia)	22°59'12.90"N 88°27'17.50"E	28.04 (32.20)	25.39 (30.26)	26.71 (31.18)

Figures in parenthesis are angular transformed values

During *Rabi* 2018, the incidence of *Fusarium* wilt of lentil varied from 16.38% to 25.39% according to location. The maximum percentage of disease incidence (PDI) of *Fusarium* wilt, 25.39% was recorded from C Block instructional field, BCKV, Nadia followed by Berhampore farmers' field at Murshidabad (22.28%), farmer's field at Rampurhat, Birbhum (22.02%), farmer's field at Balagarh of Hoogly (21.46%), Bishnupur farmers field of Bankura (20.69%), instructional farm AB-block Kalyani farmer's field at BCKV (20.52%). The minimum PDI was recorded from farmer's field at Chanditala of Hoogly (16.38%) followed by Berhampore farmers' field of Murshidabad (19.73%), farmer's field at Bolpur of Birbhum (19.97%) (Fig. 3).

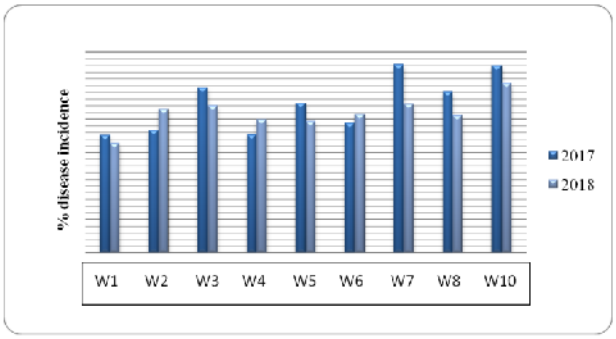

Fig. 3. Prevalence of Fusarium wilt of lentil in West Bengal during *Rabi* 2017 and 2018.

The mean data (Table 1) of both the years revealed that the maximum PDI was recorded 26.71% from C Block instructional field, BCKV, Nadia followed by Berhampore farmers' field at Murshidabad (25.20%) and farmer's field at Rampurhat, Birbhum (23.34%) and the minimum PDI was recorded from farmers' field at Chanditala, Hoogly (16.99%). The variation in percent disease incidence from location to location may be attributed to the weather factors, availability of pathogen inoculum in field which affected the growth and development of the disease. During the survey of the fields, it was also observed that most of the fields were having sole crop lentil which may lead to the increase of the pathogen population and enhanced the disease. Fusarium wilt of lentil cause by *Fusarium* sp.was prevalent in all the places surveyed. The data on survey revealed that *Fusarium* wilt incidence varied from location to location because of varied agro-climatologically situations, cropping pattern, varieties grown and cultural practices and doses of inoculums present.

DISCUSSION

This study is a comprehensive examination of the relative importance of Fusarium wilt in different parts of West Bengal. Based on survey results, wilt incidence was found to be a relatively major disease of lentil in many districts. Widespread distribution of Fusarium wilt in all lentil cultivars was observed in all 5 states irrespective of cultivars grown by the farmers and it is a matter of concern. During the survey of the fields, it was also observed that most of the fields were having sole crop lentil which may lead to the increase of the pathogen population and enhanced the disease. Rangaswamy *et al.* (2016) reported that Fusarium sp. is one of the most diverse fungi in the world under different soil and climate conditions. Pathogenic variation is a common phenomenon of Fusarium sp. Hiremani and Dubey (2018) reported that wilt incidence was highly variable ranging from 6.7% to 92.9% in 89 genotypes evaluated against Fol isolate (FLS75) during 2012-2013. Drooping, yellowing and drying of the leaves were observed in young seedlings. Drying of the branches and complete wilting of the plant was also observed. Infected plants remained weak and did not produce flowers. Rafique *et al.* (2015) conducted wilt surveys in seven districts. The average incidence rate of disease in Punjab was 100%, with an average incidence of 25.7%, including those of Chakwal, Jhelum, Gujrat, Sialkot, Layyah, Bhakkar, and Khushab. Altaf *et al.* (2014) conducted survey of 28 locations in 9 regions of Pakistan during the 2012-13 crop season, with a disease prevalence of lentil wilt 100% in the 21 regions. In a report by Meena *et al.* (2017) showed that the genotypes L 9-12, L 4147, L 4730, LL 1316, Sehore 74-3, IPL 81, IPL 316, IPL 329, IPL 330, IPL 331, PL 6-9, PL 165, KLS 14-1, KLS 13-3, KLS 218, RLG 192, RL3-5, KLB14-12, RKL1003-21C, RKL12-11E-119, RVL11-6, RVL13-5, RVL13-7, VL148, VL149, VL525, DKL137, SLC101 expressed moderate to very high susceptibility reaction (>50%) against the fusarium wilt. Chaudhary (2009) investigated the area of the Bundelkhand region of Uttar Pradesh and found that the mortality rate of lentil plants caused by various soil-borne pathogens was in the middle of 19.95-33.30%. The mortality rate in 2006-07 (24.68-33.30%) was higher than that in 2005-2006 (19.95-25.69%). Fusarium wilt of Lentil was most significant and widespread in all examined areas. The proportion of plant death was 49.76-59.17%. The incidence rate was 5-18% in 2005-06 and 7-23% in 2006-07. In 2005-06, the incidence rate of the largest wilt disease in the Mahsi area was 13-18%, and 2006-07 was 9-23% (Srivastava *et al.*, 2008). According to Sehgal *et al.*, 2017, The yield of lentil remains low (1.5 tons ha^{-1}) in India and still relatively low compared to its yielding potential (3.6 tons ha^{1}) under well managed production due to biotic and abiotic stresses. The significant information about disease incidence is necessary for successful surveying. Well-established per cent disease incidence formula is useful for field screening and to calculate the disease severity. The identified wilt affected areas in West Bengal would be expressed as less, moderate to high susceptibility reaction against the fusarium wilt and can be used through differential display expression analysis in future research programs.

CONCLUSION

The Fusarium isolates from different geographical locations of West Bengal lentil field showed differences in their disease-causing capacity. Among the all isolates of Fusarium, W10 considered as most virulent as the mean data showed it caused highest disease incidence i.e., 26.71% and the lowest percent of disease incidence was showed by the isolate W1(16.99%).

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Conflict of Interest. None.

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