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Field Screening of Lentil Germplasm against Wilt of lentil caused by *Fusarium oxysporum* f. sp. *lentis*

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ABSTRACT: Fusarium wilt is an economically significant disease, which is a major limiting factor in production of lentil crop. In the present investigation a set of 90 lentil germplasm were screened for their reaction towards lentil wilt for two consecutive years and it was found that based on consistent behaviour for two years, a set of six germplasm namely Mpl-04, Mpl-42, Mpl-52, Mpl-55, Mpl-60 and Mpl-74 exhibited less than 1 per cent wilt incidence which were categorized as resistant germplasm. However, 24 moderately resistant, 21 moderately susceptible, 05 susceptible and 09 highly susceptible germplasm could be identified.

Keywords: Lentil, *Fusarium oxysporum* f. sp. *lentis*, Resistance, susceptibility.

INTRODUCTION

Lentil (*Lens culinaris* Medikus) is a cool season, major edible legume crop after chickpea with genome size of approximately 4 Gbp (Arumuganathan *et al*., 1991). It is commonly known as masoor in Hindi and familiarly known as poor man's meat because of its affluent nutritive values (Sen and Kapoor 1975). Lentil is rich in nutrients with 60-67% carbohydrates, 20-36% protein, <4% lipid and 2-3% ash on a dry weight basis. Owing to its low glycaemic index, it is highly recommended by physicians for people suffering from diabetes, obesity, and cardiovascular diseases (Srivastava and Vasishta 2012; Sen and Kapoor 1975; Erskine and Sarker 2004).

Besides nutritional qualities, lentil has capability of nitrogen fixation from the atmosphere which ultimately helps in improvement of soil fertility for succeeding crops through nitrogen fixation and carbon sequestration. The amount of nitrogen fixed by plants varies from 0 to 192 kg of total N/ha with a mean of around 80 kg total N/ha. This in turn allows crop rotation of cereal crops with lentils crop to enhance sustainable agriculture (Quinn, 2009).

Fusarium wilt caused by *Fusarium oxysporum* f. sp. *lentis* is one of the major diseases affecting lentil all over the world and globally considered as the most harmful soil borne disease of lentil (Bayaa and Erskine 1998; Khare, 1981). It was first reported in Hungary (Fleischmann, 1937) for the first time and later in many countries including India (Padwick, 1941), USA (Wilson and Brandsberg 1965), Syria (Bayaa *et al.*, 1986); Turkey (Bayya *et al*., 1998).

In India, fusarium wilt is a major limiting factor hampering the production of lentil in states including Madhya Pradesh, Uttar Pradesh, West Bengal, Bihar, Assam, Rajasthan, Haryana, Punjab and Himachal Pradesh (Agrawal *et al*., 1993; Chaudhary *et al*., 2009; 2010) with its appearance from seedling stages (Kannaiyan and Nene 1978).

Looking to the enormous losses imposed by this pathogen, there is a dire need for the control of this pathogen. Although use of different chemicals (Kharte *et al.*, 2022) and biocontrol agents (Kumar *et al.*, 2009; Srivastava *et al*., 2009) have so far been advocated for control of different plant diseases including wilt of lentil but so far limited success have been achieved. Further, unscrupulous use of fungicides will certainly lead to impose hazardous effect on soil health and ultimately to human health. Therefore, use of resistant cultivars is one of the most acceptable management tactics for management of lentil wilt. Further, identified resistant germplasm harbouring QTL for lentil wilt could be a useful resource to be incorporated in molecular breeding platform (Chamarthi *et al*., 2011; Kumar *et al*., 2021) and development of elite lentil varieties exhibiting resistance for wilt for new avenues for control of this pathogen. Keeping this in view, the present investigation was conducted to identify the source of resistance for lentil wilt under natural field conditions showing previous history of occurrence of lentil wilt.

MATERIAL AND METHODS

Field screening of lentil germplasm against Fusarium wilt. To identify the source of resistance, a set of ninety lentil germplasm were screened against the wilt disease under field conditions during *rabi* season of 2020-21 and 2021-22 at Regional Agricultural Research Station, Sagar in a plot size of 3×2 m^2 per germplasm. The per cent wilt incidence was calculated based on total number of wilt infected plants with respect to total number of plants per plot using the following formula.

Disease incidence (%) =

$$\frac{\text{Number of infected plants}}{\text{Total number of observed plants}} \times 100$$

The level of resistance as well as susceptibility of each germplasm were determined by using the 1 to 9 disease rating scale with some modification given by Arya and Kushwaha (2019).

Table 1: Rating scale for reaction of lentil genotypes for wilt.

Rating Scale	Wilt incidence percent	Reaction
1	1% or less plants wilted	Resistant (R)
3	2-10% plants wilted	Moderately Resistant (MR)
5	11-20% plants wilted	Moderately Susceptible (MS)
7	21-50% plants wilted	Susceptible (S)
9	Above 50% plants wilted	Highly Susceptible (HS)

RESULT AND DISCUSSION

A set of ninety lentil germplasm were screened under natural field conditions for recording their behaviour towards wilt. Lentil genotypes exhibited differential expression towards wilt occurrence. Among 90 genotypes, only 9 germplasm exhibited resistant reaction during 2020-21. However, thirty-four germplasm expressed moderate resistant, twenty-nine germplasm moderately susceptible and nine germplasm susceptible and nine germplasm highly susceptible response under natural field condition (Table 2, Fig. 1). During 2021-22, slight variation could be observed in reaction of germplasm towards wilt incidence and it was observed that 8 germplasm exhibited resistance, thirtytree germplasm moderate resistance, thirty-two germplasm moderate susceptible, seven germplasm susceptible and ten germplasm exhibited high susceptibility reaction for fusarium wilt under natural field conditions (Table 2, Fig. 1).

Table 2: Performance of lentil Germplasm against *Fusarium oxysporum* f. sp. *lentis* in field conditions during *Rabi* session in 2020–21 to 2021–22.

Reaction	No. of germplasm		Germplasm	
	2020–21	2021–22	2020–21	2021–22
Resistant (≤1%)	09	08	Mpl-04, Mpl-16, Mpl-28, Mpl-42, Mpl-52, Mpl-55, Mpl-59, Mpl-60 and Mpl-74.	Mpl-04, Mpl-30, Mpl-42, Mpl-52, Mpl-55, Mpl-60, Mpl-74 and Mpl-84.
Moderately resistant (2-10%)	34	33	Mpl-03, Mpl-6, Mpl-07, Mpl-13, Mpl-14, MPL-17, Mpl-20, Mpl-29, Mpl-30, Mpl-31, Mpl-33, Mpl-37, Mpl-41, Mpl-44, Mpl-46, Mpl-49, Mpl-54, Mpl-56, Mpl-61, Mpl-75, Mpl-79, Mpl-81, Mpl-82, Mpl-83, Mpl-84, Mpl-87, Mpl-91, Mpl-92, Mpl-93, Mpl-94, Mpl-95, Mpl-99, Mpl-101 and Mpl-102.	Mpl-6, Mpl-12, Mpl-14, MPL-16, Mpl-17, Mpl-18, Mpl-20, Mpl-24, Mpl-27, Mpl-28, Mpl-29, Mpl-31, Mpl-33, Mpl-41, Mpl-44, Mpl-46, Mpl-49, Mpl-56, Mpl-59, Mpl-61, Mpl-79, Mpl-81, Mpl-82, Mpl-83, Mpl-87, Mpl-92, Mpl-93, Mpl-94, Mpl-97, Mpl-98, Mpl-99, Mpl-101 and Mpl-102.
Moderately susceptible (11-20 %)	29	32	Mpl-09, Mpl-10, MPL-11, Mpl-12, Mpl-18, Mpl-22, Mpl-24, Mpl-25, Mpl-27, Mpl-34, Mpl-36, Mpl-39, Mpl-40, Mpl-47, Mpl-50, Mpl-57, Mpl-58, Mpl-72, Mpl-73, Mpl-76, Mpl-77, Mpl-78, Mpl-80, Mpl-86, Mpl-88, Mpl-90, Mpl-96, Mpl-98 and Mpl-97.	Mpl-2, Mpl-03, Mpl-08, Mpl-07, Mpl-09, MPL-11, Mpl-13, Mpl-22, Mpl-34, Mpl-36, Mpl-37, Mpl-38, Mpl-39, Mpl-40, Mpl-47, Mpl-50, Mpl-54, Mpl-57, Mpl-58, Mpl-72, Mpl-73, Mpl-75, Mpl-76, Mpl-77, Mpl-78, Mpl-80, Mpl-86. Mpl-88, Mpl-90, Mpl-91, Mpl-95 and Mpl-96.
Susceptible (21-50 %)	09	07	MPL-1, Mpl-2, Mpl-08, Mpl-19, Mpl-32, Mpl-38, Mpl-43, Mpl-48 and Mpl-51.	MPL-1, Mpl-10, Mpl-19, Mpl-25, Mpl-32, Mpl-43 and Mpl-51.
Highly susceptible (50%)	09	10	Mpl-05, Mpl-15, Mpl-26, Mpl-31, Mpl-45, Mpl-53, Mpl-62, Mpl-85 and Mpl-100.	Mpl-05, Mpl-15, Mpl-26, Mpl-31, Mpl-45, Mpl-48, Mpl-53, Mpl-62 Mpl-85 and Mpl-100.

Table 3: Response of lentil germplasm for wilt incidence based on pooled analysis of 2020-22.

Reaction	No. of germplasm	Germplasm
Resistant (≤1%)	**06**	Mpl-04, Mpl-42, Mpl-52, Mpl-55, Mpl-60 and Mpl-74.
Moderately resistant (2-10%)	**24**	Mpl-6, Mpl-14, Mpl-17, Mpl-20, Mpl-29, Mpl-31, Mpl-33, Mpl-41, Mpl-44, Mpl-46, Mpl-49, Mpl-56, Mpl-61, Mpl-79, Mpl-81, Mpl-82, Mpl-83, Mpl-87, Mpl-92, Mpl-93, Mpl-94, Mpl-99, Mpl-101 and Mpl-102.
Moderately susceptible (11-20%)	**21**	Mpl-09, MPL-11, Mpl-22, Mpl-34, Mpl-36, Mpl-39, Mpl-40, Mpl-47, Mpl-50, Mpl-57, Mpl-58, Mpl-72, Mpl-73, Mpl-76, Mpl-77, Mpl-78, Mpl-80, Mpl-86. Mpl-88, Mpl-90 and Mpl-96.
Susceptible (21-50%)	**05**	MPL-1, Mpl-19, Mpl-32, Mpl-43 and Mpl-51.
Highly susceptible (50%)	**09**	Mpl-05, Mpl-15, Mpl-26, Mpl-31, Mpl-45, Mpl-53, Mpl-62 Mpl-85 and Mpl-100.

Reactions of lentil germplasm against *Fol* under field condition based on two years screening. Overall scenario over a period of two years (2020-22) with same genotypes revealing similar reaction towards resistance or susceptibility for fusarium wilt were considered for categorizing them into the group of reaction. Based on pooled data, it was observed that a set of six lentil germplasm exhibited resistant reaction in both the years. However, twenty-four germplasm expressed moderate resistant, twenty-one germplasm moderately susceptible, five germplasm susceptible and nine germplasm expressed highly susceptibility reaction against the fusarium wilt of lentil (Table 3). In this way, the behaviour of germplasm could be categorized based on their similar reaction during two consecutive years, 2020-21 and 2021-22.

Fig. 1. Field screening of lentil germplasm against *Fusarium oxysporum* f. sp. *lentis*.

In the present investigation, out of ninety germplasm screened, 06 germplasm could be observed as resistant to disease which exhibited less than 1 percent incidence of wilt during two consecutive years. The small differential behaviour of germplasm is possible in different environment/ periods/ years due to difference in prevailing environmental conditions. The findings of present investigation are in agreement with the findings of Arya and Kushwaha (2019) who screened ninety-two germplasm and none were found immune. However, in their study, 11 highly resistant germplasm, 13 resistant germplasm, and 14 moderately resistant germplasm could be identified. In the present investigation, the six germplasm namely Mpl-04, Mpl-42, Mpl-52, Mpl-55, Mpl-60 and Mpl-74 were identified as resistant germplasm and could be utilized in breeding programme for developing the resistant elite lentil varieties. The present findings are in close agreement with Chandra *et al*. (2019; 2020) where they screened around 150 genotypes and identified different categories of resistant and susceptible genotypes.

CONCLUSION AND FUTURE SCOPE

Identification of resistant source for any disease is one of the best methods for management. A set of six germplasm identified here could be a useful resource for using their background in developing elite varieties through conventional breeding. Further, selection of these lines in identification of genetic factor/QTL for wilt resistance will enable their utilization in molecular breeding.

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Conflict of Interest. None.

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