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Response of lentil varieties against Fusarium wilt

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Abstract
The present study was conducted in the field of Pulse Research sub-station, Agriculture Research Institute, Tandojam during Rabi-2012 to find the suitable varieties of lentil for cultivation in Sindh region. Ten lentil varieties were cultivated in the field with three replications in Randomized Complete Block Design (RCBD) having a history of high infection of Fusarium wilt. The disease incidence and mortality percentage by counting infected and dead plants while disease severity was rated at 1-9 disease scale (1 for highly resistant and 9 for highly susceptible). Observations revealed that from ten varieties none was observed immune to disease. NIA-Masoor-05, lentil-25 was comparatively resistant against infection followed by Masoor-93 and Markaz-09. While varieties like DL-2, VM-4 and DL-1 were highly susceptible to disease as compared to other varieties. Maximum disease incidence, disease severity and mortality percentage were recorded in DL-2, VM-4, DL-3 and DL-1 followed by Lentil-85, Masoor-6 and Markaz-9, whereas, minimum was noted in NIA-Masoor-05, Lentil-25 and Masoor-93. The seed weight of ten plants of lentil varieties lowest 1000-seed weight (15.28g, 17.00g, 18.00g) was calculated in DL-2, VM-4 and DL-3 compared to rest of the varieties. While, the highest 1000-seed weight was noted in NIA-Masoor-05 (23.60g) followed by Lentil-25 (23.10g). Similarly highest seed weight of 10 plants was calculated in NIA-Masoor-93 whereas, lowest seed weight of 10 plants was recorded in DL-2, VM-4 and DL-3 followed by DL-1 and lentil-85 lentil varieties.

Keywords: Lentil, Fusarium Wilt, disease incidence, disease severity, mortality percentage

1. Introduction
Lentil (*Lens culinaris* Medic.) is a small but nutritionally dense member of the leguminosae family. It is a very good source of cholesterol-lowering fiber and give special benefit in managing blood-sugar disorders. Lentil provides excellent amounts protein, minerals (K, P, Fe, Zn) and vitamins for human nutrition and with virtually no fat. Similar to other beans, Lentil is a very rich source of fiber [1]. Moreover, due to its high lysine and tryptophane content, the Lentil provides a balance of essential amino acids for human nutrition. Lentil straw is also a valued animal feed [2]. Yield limiting factors is lack of seedling vigour, slow leaf area development, high rate of flower drop, low pod setting, poor dry matter, low harvest index, lack of lodging resistance, low response to inputs and exposure to various biotic and abiotic stresses. Fungi are major pathogens of lentil and cause Fusarium wilt, Collar rot, Wet root rot, dry root rot, stem rot and Damping-off. Among them Fusarium wilt is the most widespread and important disease. It is prevalent in almost every country where lentil is grown. The disease can cause complete failure of the crop, especially in a warm spring and dry hot summer. The fungus is mainly soil-borne but can also be isolated from infected seeds of lentil [3, 4, 5, 6]. *Fusarium oxysporum* f. sp. *Lentis* is important and predominant fungus of lentil as compared to other pathogens and reported, wherever lentil is cultivated. Infection starts in the seedling stage and proceeds later stages of growth and development of plants [7]. Researchers having strong opinions about diversity in virulence of Fusarium isolates while; [8, 9] reported that pathogenic diversity is due to the differences in pathogenic aggressiveness.
Lentil resistant varieties are not immune to the diseases. However, sometimes conditions favor for the spread of disease, crop may surrender to the pressure and undergo some sort of damage [10, 11]. *Fusarium oxysporum* maximum damage recorded was (66.3%) as compared to other fungi with lentil [12]. found that the degree of *F. oxysporum* infection ranged from 25-95% depending on the cultivar tested.

Wilt incidence during reproductive growth was correlated with yield loss estimates, with a reduction in seed yield per unit change in wilt incidence. [11] reported maximum association of *Fusarium oxysporum* (66.3%) as compared to other fungi with lentil.

Keeping in view, the food value and importance of pulse crops in the country; the present research work was planned to find the level of immunity in the available varieties.

2. Materials and Methods

The present study was conducted in the Post Graduate lab of Plant Pathology, Department of Plant Pathology, Sindh Agriculture University Tandojam to determine the varietal response of lentil against Fusarium wilt.

2.1. Lentil Seeds, survey methods, data collection and Analytical methods

The seeds of lentil varieties: Markaz-09, Masoor-06, Masoor-93, NIA-Masoor-05, Lentil-25, Lentil-85, DL-1, DL-2, DL-3 and DL-4 were obtained from the Pulse Research Station, Dokri, National Agriculture Research Center, Islamabad, Nuclear Institute of Agriculture, Tandojam and local market of Hyderabad to screen them against Fusarium wilt.

2.2. Field selection and survey time selection

2.2.1. Experimental field

The experiment was carried out as all varieties were sown in Fusarium wilt sick plot of Pulse Research Sub-Station, Tandojam during Rabi seasons 2012.

2.2.2. Survey, plot size management

Each variety was planted in double row plots having size $4m^2$ while inter and intra row distance were maintained at 30 cm and 10 cm respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) having three replications in a naturally infested field with a history of Fusarium wilt of lentil. The seed rate, irrigation intervals, fertilizers and their application and other cultural practices were done at required proper time.

2.3. Data collection

The data on disease symptoms was recorded at the physiological maturity by using formula while, mortality percentage of the number of dead plants was recorded weekly from all treatments.

$$\text{Disease incidence (\%)}: \frac{\text{Number of wilted plants}}{\text{Total No: of Plants}}$$

The level of resistance and susceptibility of each variety was determined by using 1-9 rating scale described by [13].

Where, 1= highly resistant (less than 1% of plant showing wilting)

3= Resistant (1-10% wilted plants).

5= Moderately resistant (11-20% wilted plants).

7= Susceptible (21-50% wilted plants).

9= Highly Susceptible (51% or more wilted plants).

The yield parameters 1000- seed weight and seed weight per 10- plants of lentil were recorded after maturity of the crop.

Seed weight: 1000- seed weight of each variety was recorded in grams.

Seed weight per 10-plants: Seed weights per 10-plants were recorded in grams from each treatment.

2.4. Statistical analysis

All the raw data were processed by Microsoft Office Excel 2007, Microsoft Office Word 2007. Finally the data were statistically analyzed and LSD at 0.05% was also tested by using Statix-8.1 computer software program.

3. Results

The disease incidence and mortality percentage by counting infected and dead plants while disease severity was rated on 1-9 disease scale (1 for highly resistant and 9 for highly susceptible). Observations revealed that from ten varieties none was observed immune to disease. NIA-Masoor-05, lentil-25 was comparatively resistant against infection followed by Masoor-93 and Markaz-09. While varieties like DL-2, VM-4 and DL-1 were highly susceptible to disease as compared to other varieties. Maximum disease incidence, disease severity and mortality percentage were recorded in DL-2, VM-4, DL-3 and DL-1 followed by Lentil-85, Masoor-6 and Markaz-9, whereas, the minimum was noted in NIA-Masoor-05, Lentil-25 and Masoor-93 as shown in Table (1 and 2).

Table 1: Disease prevalence of Fusarium wilt in lentil varieties.

Varieties	Disease Incidence %	Disease Severity%
NIA-Masoor-05	15.00	3.2
Lentil-25	17.00	3.5
Masoor-93	19.00	4.0
Markaz-09	21.00	5.0
Masoor-6	23.00	5.3
Lentil-85	24.00	5.5
DL-1	25.00	5.9
DL-3	26.00	6.0
DL-4	28.00	6.5
DL-2	30.00	7.0

LSD (P=0.05), 1. 7032, 1.0772

Table 2: Disease mortality % of Fusarium wilt in lentil varieties.

Varieties	Mortality %
NIA-Masoor-05	3.00
Lentil-25	4.75
Masoor-93	5.25
Markaz-09	6.00
Masoor-6	7.00
Lentil-85	7.50
DL-1	8.00
DL-3	9.00
DL-4	10.25
DL-2	11.00

LSD (P=0.05), 1. 3193

The results show lowest 1000-seed weight (15.28g, 17.00g, 18.00g) was calculated in DL-2, VM-4 and DL-3, respectively as compared to rest of the varieties. While, highest 1000-seed weight was noted in NIA-Masoor-05 (23.60g) followed by Lentil-25 (23.10g). Similarly the highest seed weight of 10 plants was calculated in NIA-Masoor-93 whereas, lowest seed weight of 10 plants was recorded in DL-2, VM-4 and DL-3 followed by DL-1 and lentil-85 lentil varieties as given in Table (3 and 4).

Table 3: Effect of Fusarium wilt on 1000-seed weight of lentil varieties.

Varieties	1000-seed weight
NIA-Masoor-05	23.60
Lentil-25	23.10
Masoor-93	22.76
Markaz-09	22.00
Masoor-6	21.45
Lentil-85	20.62
DL-1	19.25
DL-3	18.00
DL-4	17.00
DL-2	15.28

LSD (P=0.05), 0. 9329

Table 4: Effect of Fusarium wilt on seed weight of 10-plants of lentil varieties.

Varieties	Seed weight of 10-plants
NIA-Masoor-05	10.70
Lentil-25	10.25
Masoor-93	9.75
Markaz-09	8.90
Masoor-6	8.25
Lentil-85	7.63
DL-1	7.00
DL-3	6.00
DL-4	5.00
DL-2	4.23

LSD (P=0.05), 0. 9329

Fig 1: Shows growth of Lentil-25 Variety

Fig 2: Shows growth of Lentil-85 Variety

Fig 3: Shows growth of DL-3 lentil variety

Fig 4: Shows growth of Masoor-93 variety

Fig 5: Healthy and infected lentil plants growth

Fig 6: Growth of NIA-Masoor-05 variety

Fig 7: Plot showing poor growth of DL-4 variety

4. Discussion

The present study was conducted in the field of the Pulse sub-station, Agriculture Research Institute, Tandojam during Rabi-2012 to find the suitable varieties of lentil for cultivation in Sindh region. Ten lentil varieties were cultivated in the field with three replications in Randomized Complete Block Design (RCBD) having a history of high infection of Fusarium wilt. The disease incidence and mortality percentage by counting infected and dead plants while disease severity was rated at 1-9 disease scale (1 for highly resistant and 9 for highly susceptible). Observations revealed that from ten varieties none was observed immune to disease. NIA-Masoor-05, lentil-25 was comparatively resistant against infection followed by Masoor-93 and Markaz-09. While DL-2, VM-4, and DL-1, were highly susceptible to disease as compared to other varieties. Maximum disease incidence, disease severity and mortality percentage were recorded in DL-2, VM-4, DL-3 and DL-1 followed by Lentil-85, Masoor-6 and Markaz-9, whereas, the minimum was noted in NIA-Masoor-05, Lentil-25 and Masoor-93.

The results of the present study agree with those of [14] who screen out thirty eight lentil lines, included in the Lentil International Fusarium wilt nursery. It was found from their results that no any line was completely resistance except lentil-25 to Fusarium wilt. The present study also partially agree with [15] who tested seven exotic lentil genotypes resistant to Fusarium wilt by comparing a local check variety Simrik. All the genotypes tested were found susceptible to Fusarium wilt. The results of the present study also agree with [16] who conducted a field experiment to screen the available lentil germplasms in India for resistance to Fusarium wilt. The result showed that *Fusarium oxysporum* caused the severe outbreak and none was immune to disease except one (NIA-Masoor-05) and gave the highest yield as compared to other germplasms. The present study further depicted that significant difference in 1000 seed weight and seed weight of ten plants of lentil varieties lowest 1000-seed weight (15.28g, 17.00g, and 18.00g) was calculated in DL-2, VM-4 and DL-3 respectively, as compared to other varieties. While, highest 1000-seed weight was noted in NIA-Masoor-05 (23.60g) followed by Lentil-25 (23.10g). Similarly highest seed weight of 10 plants was calculated in NIA-Masoor-93 whereas, lowest seed weight of 10 plants was recorded in DL-2, VM-4 and DL-3 followed by DL-1 and lentil-85 lentil varieties. The present study results also agree with those of [17] evaluated that wilt disease of lentil has potential to cause 100% yield losses or total crop failure under specific conditions. An annual loss in grain yield of about 10 to 15% has been reported for this disease. However [4], described that annual yield loss of 10-15% is a regular feature. In Pakistan the disease may cause 10-50% crop loss every year [18]. observed heavy plant mortality of lentil due to wilt at different growth stages of the crop. Highest association (30.8%) of *Fusarium oxysporum* was recorded while percentage involvement of the fungus with lentil roots with the increase in crop age. [19] studied variability in pathogenic character of isolates of *Fusarium oxysporum* and reported highest wilting (65-80%) mortality due to 27 isolates followed by 52.67-63.33% due to 32 of isolates.

5. Conclusion

It was concluded from results that NIA-Masoor-05, lentil-25 was comparatively resistant against infection followed by Masoor-93 and Markaz-09; whereas, DL-2, VM-4 and DL-1 were highly susceptible to disease as compared to other varieties. Maximum disease incidence, disease severity and mortality percentage were recorded in DL-2, VM-4, DL-3 and DL-1 followed by Lentil-85, Masoor-6 and Markaz-9, while, minimum was noted in NIA-Masoor-05, Lentil-25 and Masoor-93. Significant difference in 1000 seed weight and seed weight of ten plants of lentil varieties lowest 1000-seed weight was calculated in DL-2, VM-4 and DL-3 respectively as compared to other varieties. The highest 1000-seed weight and seed weight of 10 plants was calculated in NIA-Masoor-05 followed Lentil-25 whereas, lowest seed weight of 10 plants was recorded in DL-2, VM-4 and DL-3 followed by DL-1 and lentil-85 lentil varieties.

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