International Journal of Agriculture, Environment and Biotechnology
Citation: IJAEB: 10(2): 239-243, April 2017
DOI: 10.5958/2230-732X.2017.00028.6

PLANT PATHOLOGY

Effect of different inoculum levels of *Fusarium solani* (Mart.) Sacc on plant growth, biochemical and nutrient parameters of lentil (*Lens culinaris* Medik.)

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Paper No. 573 Received: 14-9-2016 Accepted: 17-3-2017

Abstract

An experiment was conducted to study the effect of root rot fungus *Fusarium solani* on the growth of the plant, number of pods, chlorophyll, carotenoid, nitrogen and phosphorus content and nitrate reducatse activity on an important pulse crop lentil by inoculating the plants with variable inoculum levels from 0.25 g to 4.00 g fungal mycelial mat per kg soil. A reduction was observed in all the plant growth, biochemical and nutrient parameters as the inoculum level increased, with a significant reduction taking place at and above the inoculum level of 1.00 g mycelial mat per kg soil. Maximum damage to the plant was recorded at the highest inoculum level *i.e.* 4.00 g mycelial mat per kg soil. The percentage of root rot was directly proportional to the inoculum level, highest being on 4.00g mycelial mat per kg soil.

Highlights

- Results of the above study reveal that root rot fungus *Fusarium solani* infects and causes morphological and physiological alterations in plants.
- As the inoculum level increases the reduction in plant growth, biochemical and nutrient parameters increases. The inoculum threshold level was found to be 1.00g mycelial mat per kg soil.

Keywords: Pulse, chlorophyll, inoculum, root- rot, plant

Lentil is an important pulse crop grown in India during *rabi* season. It is rich in carbohydrates and proteins and also contains vitamin B and minerals like iron, calcium, magnesium and phosphorous. In India it is mainly grown in Uttar Pradesh, Madhya Pradesh, Bihar and West Bengal of which 37 per cent production is contributed by Uttar Pradesh. Lentil has an average national productivity of 675 kg per ha which is much less than its yield potential. (Chaudhary *et al*., 2009). Lentil is affected by a wide range of pathogens, both seed (De *et al*., 2002) and soil borne which is a major cause of decrease in production of lentil. Root diseases in lentil are caused by various fungi (Khare *et al*., 1979; Karahan and Katircioglu, 1993; Singh and Tripathy, 1999), which infect the plant root and base of the stem causing discoloration and rotting of these areas. *Fusarium solani* is an imperfect fungus which is soil borne in nature and is known to cause root rot. It penetrates by means of infecting hyphae, inducing decay of root cortex followed by infection of plants (Price, 1984, Kamel *et al*., 1973). This fungus leads to economic losses in a variety of crop plants, including lentil (Pandey *et al*., 2000). Thus an experiment was conducted to study the damaging effects of *Fusarium solani* on plant growth, biochemical and nutrient parameters in lentil.

MATERIALS AND METHODS

For the experiment 15 cm diameter clay pots filled with steam sterilized soil were used. Seeds of lentil cv.DPL 62 were surface sterilized with 1% sodium

hypochlorite solution before sowing and three to four seeds were sown per pot. Thinning was done one week after germination to retain only one seedling per pot. *Fusarium solani* was isolated from infected lentil roots. It was maintained on potato dextrose agar medium and mass cultured on Richard's liquid (Riker & Riker, 1936) medium. The conical flasks were incubated for about 15 days and then the liquid medium was filtered through Whatman filter paper No. 1. To remove the traces of the medium, the mycelial mat was washed in distilled water and gently pressed between the folds of blotting paper to remove the excess amount of water. The inoculum was prepared by blending 10g fungal mycelium in 100ml of sterilized distilled water in a mixer for thirty seconds. Thus, each 10 ml of this suspension contained 1.00 g of the fungus. The seedlings of lentil were inoculated with 0.25, 0.50, 1.00, 2.00, 4.00g mycelial mat of fungus per kg soil by pouring the required quantity of fungal inoculum uniformly by exposing the roots and then immediately covering with soil properly. The un-inoculated plants served as control. Each treatment had five replicates. Plants were watered as and when required.

Plants were uprooted after ninety days of inoculation and plant growth was determined on the basis of plant length, fresh weight and dry weight and number of pods. Leaf chlorophyll was estimated by method of Arnon, 1949. Estimation of leaf carotenoid was done by Machlachlan and Zalik, 1963 method. Leaf Nitrate reductase activity was estimated by intact tissue method (Jaworski, 1971). Leaf Nitrogen content was estimated according to the method of Lindner,1944. The method of Fiske and Subba Row, 1925 was used to estimate the total phosphorus content in lentil leaves. The root-rot estimation was done by taking the percentage of rotting per root-system. Data analysis was done by one-way analysis of variance and least significant difference was calculated at p = 0.05 to test for significance. Software R (R Development Core Team, 2011) was used for analysis.

RESULTS AND DISCUSSION

The effect of increasing inoculum levels of *F. solani* on lentil were studied and it was found that the reduction in plant length, fresh and dry weight and number of pods was directly proportional to increasing inoculum levels from 0.25-4.00 grams mycelial mat per kg soil, with significant reduction taking place at and above the inoculum level of 1.00 gram mycelial mat per kg soil. Maximum reduction in plant length, fresh and dry weight and number of pods was observed at 4.00 g mycelial mat per kg soil. *i.e.* 27.26%, 29.14%, 31.72% and 36.15% respectively (Table 1). Similar results were observed in case of chlorophyll and carotenoid contents with a decrease of 22.79% and 20.10 % at highest inoculum level. (Fig. 1 and 2).

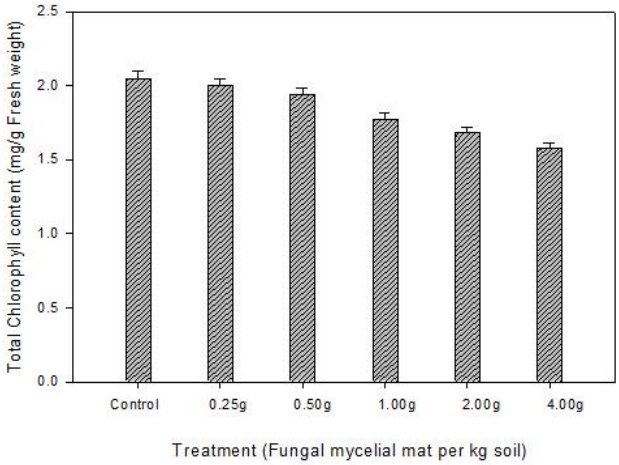

Fig. 1: Effect of different inoculum levels of *Fusarium solani* on Total chlorophyll content in lentil leaves

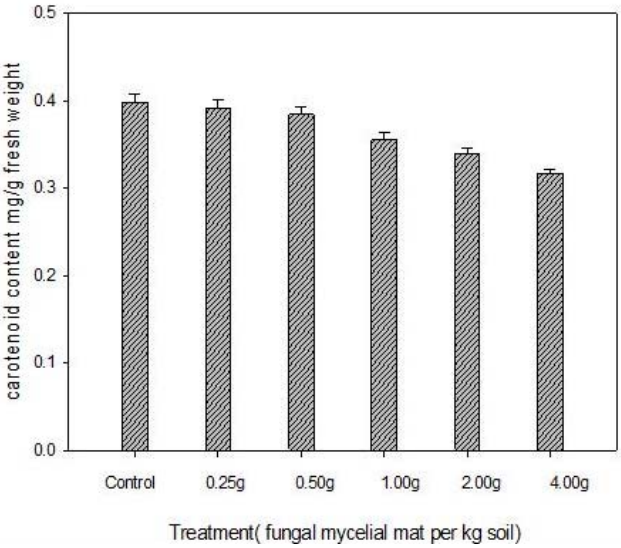

Fig. 2: Effect of different inoculum levels of *Fusarium solani* on carotenoid content in lentil leaves

A decline in phosphorus and nitrogen content and nitrate reductase activity was also observed with successive inoculum levels, with maximum

reduction taking place at the highest inoculum level *i.e.* 17.30%, 21.20% and 18.71% respectively (Fig. 3, 4 and 5) and significant decrease starting at 1.00g mycelial mat per kg soil.

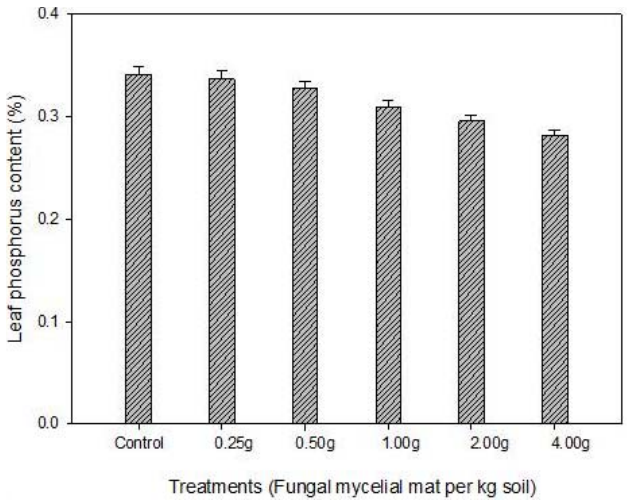

Fig. 3: Effect of different inoculum levels of *Fusarium solani* on phosphorus content in lentil leaves

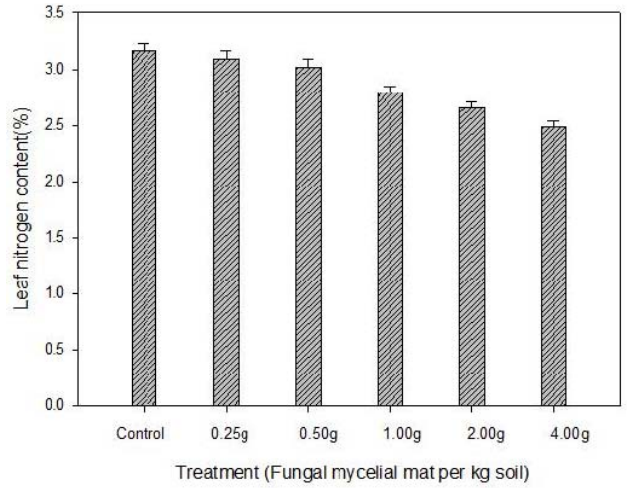

Fig.4: Effect of different inoculum levels of *Fusarium solani* on nitrogen content in lentil leaves

The percentage of root rot increased with an increase in inoculum levels of *F. solani* with highest rotting (27.61%) taking place at 4.00g mycelial mat per kg soil (Fig. 6). The results are in agreement with Haseeb *et al.* 2005; Safiuddin *et al.* 2011 and Ahmed *et al.* 2013, where also an increase in inoculum levels of root infecting fungi lead to a corresponding decrease in plant growth and yield parameters. Chlorophyll is a vital pigment that plants use during photosynthesis to absorb light and carotenoid pigments acts as auxiliary antennae due to which the rate of light absorption by photosynthetic membranes is increased and serve a photoprotective role (Andrew, 1993). Nitrate reductase catalyses the reduction of nitrate to nitrite and plays a key role in regulation of nitrate assimiliation (Mazid *et al.*, 2012) The reduction in plant growth and chlorophyll content by root infecting fungi was also reported by Tiyagi *et al.* (1999) in lentil.

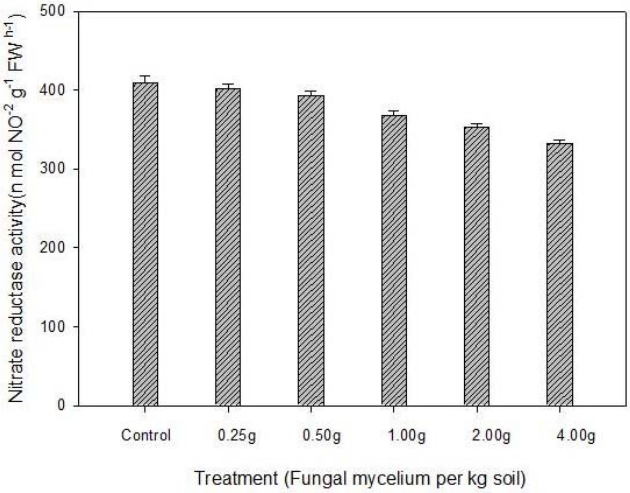

Fig. 5: Effect of different inoculum levels of *Fusarium solani* on nitrate reductase activity in lentil leaves

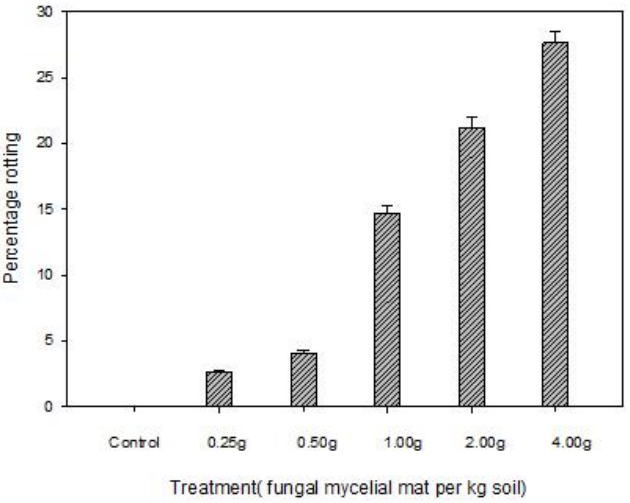

Fig. 6: Effect of different inoculum levels of *Fusarium solani* on rotting percentage in roots

A significant reduction in the activity of nitrate reductase and chlorophyll content was observed by Hayat and Gautam, 1995 in chickpea due to infection by root infecting fungi. Al-Tuwaijri, 2009 observed reduced chlorophyll and carotenoid contents due to infection by *Fusarium oxysporum* and *Fusarium solani* in cucumber. Similar results were reported in rice, broad-bean and groundnut due to

Table 1: Effect of different inoculum levels of *Fusarium solani* on plant growth and yield parameters of lentil (*Lens culinaris*)

Treatment (mycelial mat/kg soil)	Plant length (cm)	Plant fresh weight(g)	Plant dry weight(g)	No. of pods
Control	*57.40*	13.90	3.72	26.00
0.25g	56.20	13.58	3.60	25.20
0.50g	54.75	13.15	3.49	24.00
1.00g	47.80	11.45	3.01	19.80
2.00g	44.85	10.70	2.78	18.40
4.00g	41.75	9.85	2.54	16.60
L.S.D(0.05)	3.44	1.04	0.29	2.24

infection by root rot fungi by Lakshmi *et al.* (2011). Nitrogen is a macronutrient involved in amino acid formation, cell division, photosynthesis, serve as a building block for proteins and is necessary for the plants (Schwartz and Corrales, 1989). Phosphorus also plays an important role in photosynthesis, respiration and energy storage and transfer, cell elongation and division and bud growth (Marschner, 2002). Increasing inoculum levels of the fungus caused greater damage to root system leading to reduced uptake of nutrients resulting in nutrient scarcity. A significant decrease in nitrogen and phosphorus contents was observed in chickpea plants when root rot fungus *Macrophomina phaseolina* was inoculated alone (Siddique and Akhtar, 2006). The reduction in plant growth and biochemical parameters may be due to changes in host metabolism and production of toxic substances by the root infecting fungi (Pinto *et al*., 2006), which are known to cause stunting, chlorosis and interferes with host-enzyme systems.

CONCLUSION

Root rot fungi are an important group of plant pathogens which cause diseases in wide variety of plants, thus it is important to study their effects on morphology and physiology of plants, to establish their inoculum threshold levels and to understand their disease development mechanisms, which can help in the development of ideal management strategies for the pathogens.In the above study as the inoculum level increases from 0.25g to 4.00g fungal mycelial mat per kg soil, the reduction in plant growth, biochemical and nutrient parameters increases. A significant reduction in all the parameters was observed at and above the inoculum level of 1.00g mycelial mat per kg soil and thus the inoculum threshold level was found to be 1.00g mycelial mat per kg soil.

ACKNOWLEDGEMENTS

Authors are thankful to the Department of Botany, AMU, Aligarh for providing necessary facilities for the research work.

Conflict of Interest

Authors declare no conflict of interest.

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