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Impact of abiotic and nutritional factors on growth of *fusarium solani* causing root rot of okra

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Abstract

An experiment was conducted on impact of abiotic and nutritional factors on growth of Fusarium solani *causing root rot of Okra at College of Horticulture, Bidar during 2015-16 indicated that maximum growth (632.00 mg) was obtained at pH 6.0 followed by at pH 7.0 (591.65 mg) and at pH 5.0 (550.34 mg). This shows* Fusarium solani *prefers pH range of 6.0 to 7.0.The fungus* Fusarium solani *thrives well at a temperature of 25^{0}C(612.00 mg) followed by at 30^{0}C (563.00 mg).Light has profound effect on growth and sporulation of fungi. The maximum growth of 81.00 mm was noticed when exposed to 12 hours dark 12 hours light followed by 4 hours dark 20 hours light (78.00mm). Among various carbon compounds tested in the present study, Glucose supported maximum growth (537.00 mg) followed by Sucrose (516.00 mg) and Fructose (495.00 mg). Among nitrogen sources tested, Threonine (595.34 mg) and Asparagine (579.32 mg) supported maximum growth of* Fusarium solani. *These two amino acids may be involved in vegetative and reproductive growth.*

Key words: Abiotic factors, Fusarium solani, Nutritional factors, Okra, Root rot

Introduction

Okra (*Abelmoschus esculentus* L.) is also known as lady's finger or bhendi belongs to the family *Malvaceae* is one of the most important vegetable crops grown extensively throughout the India during the summer and *kharif* seasons. The fruits are harvested when immature and eaten as a vegetable, the roots and stems of okra are used for cleaning the cane juice from which gur or jiggery is prepared. The crop is also used in paper industry as well as for the fiber, fuel extraction (Lyngdoh et al., 2013). It is source of Protein, Vitamin A, Folic acid, Carbohydrates, Phosphorus, Magnesium, Calcium and Potassium. India ranks first in the world with a production of 5.784mt (72% of the total world production) of okra from over 0.498 m ha land.Due to intensive cultivation practices the crop has been found to suffer from many diseases of which, root rot caused by *Fusarium solani* has been contributing significantly for low yield which causes wilting of leaves, tips, loss of turgidity, yellowing and drooping of leaves, underground stem become dry, brown and peeling of epidermis. Roots become soft, watery and browning of vascular bundle was also observed (Gangopadhyay, 1984). Not much light has been shed on impact of abiotic and nutritional factors on mycelial growth of *Fusarium solani* causing root rot of Okra. Hence, the present study has been under taken at College of Horticulture, Bidar during 2015-16 which will be helpful in management strategy.

Materials and Methods

a. Effect of pH

An experiment was conducted on impact of abiotic and nutritional factors on growth of *Fusarium solani* causing root rot of Okra at College of Horticulture, Bidar, Karnataka during 2015-16. Potato dextrose broth was used as basal medium to study the effect of pH on the growth of *Fusarium solani*. The pH of medium was adjusted to various levels *viz*., 3.0 (T1), 4.0 (T2), 5.0 (T3), 6.0(T4), 7.0 (T5), 8.0 (T6), 9.0 (T7) and 10.0 (T8) by adding 0.1 N Sodium hydroxide and 0.1 N Hydrochloric acids and it was determined by electronic pH meter. Thirty ml of the medium with known pH was added to 100 ml conical flasks and then the flasks were sterilised. Discs

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measuring of 5 mm taken from 9 days old culture of *Fusarium solani* were inoculated and incubated at 27± 1^{0}C for 9 days. Three replications were maintained for each treatment. The dry mycelial weight was recorded and data were analysed statistically.

b. Effect of Temperature

Potato dextrose broth was used as basal medium to study the effect of temperature on the growth of *Fusarium solani.* Thirty ml of the medium was added to 100 ml conical flasks and then the flasks were sterilised. Discs measuring of 5 mm taken from 9 days old culture of *Fusarium solani* were inoculated and incubated at different temperatures *viz*, 5, 10, 15, 20, 25, 30, 35 and 40^{0}c for 9 days. Three replications were maintained for each treatment. The dry mycelial weight was recorded and data were analysed statistically.

c. Effect of Light

The effect of light on growth of *Fusarium solani was* studied on potato dextrose agar by exposing the pure cultures to 4 hours dark 20 hours light, 12 hours dark 12 hours light, 8 hours dark 16 hours light, 8 hours light 16 hours dark, 24 hours light 24 hours dark, 48hours light and 48hours dark. The inoculation of cultures to petri plates containing PDA was done as explained earlier. The plates were incubated at 26±1^{0}C for nine days. Observations on colony diameter were recorded.

d. Effect of Carbon Sources

Seven carbon sources were tried by incorporating them in Richard's broth. The quantity of each carbon compound tried was determined on the basis of their molecular weight so as to provide equivalent amount of carbon as that of sucrose present in the basal medium. The carbon compounds used were Dextrose, Sucrose, Glucose, Maltose, Fructose, Lactose, Lactic acid and without any carbon source in basal medium was kept as control. The pH of medium was adjusted to seven by using 0.1 N Sodium hydroxide or 0.1 N Hydrochloric acid. Thirty ml of each of the medium was taken in 100 ml flasks, sterilized and then inoculated with 5 mm discs taken from 9 days old culture of *Fusarium solani* and incubated at 27± 1^{0}C for 9 days. Three replications were maintained for each treatment. The dry mycelial weight was recorded and data were analysed statistically.

e. Effect of Nitrogen Sources

Various nitrogen sources were incorporated in Richard's broth. The quantity of nitrogen required in each case was determined on the basis of their molecular weight so as to provide equivalent amount of nitrogen as that of potassium nitrate present in the basal medium. The nitrogen sources were Calcium nitrate, Sodium nitrate, Potassium nitrate, Asparagine, Threonine, Ammonium nitrate and Ammonium sulphate. All the above nitrogen sources were mixed thoroughly and the pH of medium was adjusted to seven by using 0.1 N Sodium hydroxide or 0.1 N Hydrochloric acid. The growth of fungus was studied as described under studies of carbon sources.

Results and Discussion

a. Effect of pH

Highly significant difference in the growth of *Fusarium solani* was obtained at different pH levels. Maximum growth of 632.00 mg was recorded at pH 6.0 followed by 591.65 mg, 550.34 mg,484.67 mg,470.66 mg was recorded at pH 7.0,5.0,4.0,8.0 respectively and least growth of 362.65 mg was obtained at pH 10.0 (Table 1). The results of the experiment indicated that *Fusarium solani* prefers a pH range of 5.0 to 7.0 for its growth. The present findings are in agreement with the reports of Farooq *et al.,* (2005) reported that maximum growth of *Fusarium oxysporum f. sp. ciceri* was at pH 7. Naik *et al.,* (2010) reported that the most suitable pH level for growth of *Fusarium oxysporum f. sp. vanillae* was 5.0 and 6.0. Isolates of Fov-3 and Fov-6 showed highest growth of 62.4 and 62.1mm respectively. The maximum growth of *Fusarium oxysporum f. sp. psidii* was recorded when the pH was at the level of 5.5 (1208 mg) followed by a pH of 5.0 (956 mg) and then pH 6.0 (953 mg) (Gupta *et al.,* 2010). Khan *et al*.,(2011) found that maximum growth of mycelial mat of *Fusarium oxysporum f. sp. ciceri* was recorded at pH 7.0 and was significantly superior to other pH levels followed by pH 6.5 and at pH 6.0. Bhale (2012)

Table 1: Effect of pH on growth of *Fusarium solani*

Treatments	pH	Dry mycelialweight (mg)
T1	3.0	391.32^g
T2	4.0	484.67^d
T3	5.0	550.34^c
T4	6.0	632.00^a
T5	7.0	591.65^b
T6	8.0	470.66^e
T7	9.0	412.64^f
T8	10.0	362.65^h

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01)

reported that maximum radial growth and spore germination of *F. oxysporum f. sp. spinaciae* was found at 6.5 followed by 7.5 pH.

b. Effect of Temperature

There was highly significant difference in the growth of *Fusarium solani* at different temperature levels. Maximum growth of 612.00 mg was recorded at 25^{0}C followed by 563.00 mg,512.67 mg,418.32 mg,396.00 mg at 30^{0}C, 20^{0}C, 35^{0}C, 40^{0}C respectively and least growth of 91.00 mg was obtained at 5^{0}C (Table 2). The results of the experiments indicated that *Fusarium solani* preferred a temperature range of 25^{0}C and 30^{0}C for its growth. Temperature is the most important physical environment factor for regulating vegetative and reproductive activity of the fungi. Similar experiment was conducted by Farooq *et al*., (2005) who observed that temperature of 25ºC and 30ºC were the best for *Fusarium oxysporum f. sp. ciceri* were it has attained maximum growth. Khan *et al.,* (2011) reported that temperature level of 30ºC was the common optimum for growth of *Fusarium oxysporum f. sp. ciceri* followed by 25ºC. Ramteke and Kamble(2011) reported that growth of *Fusarium solani* was good at 20ºC and 30ºC and it was relatively low at 10ºC and 35ºC.Khilare and Ahmed (2012) reported that temperature from 25 to 35ºC were most favorable for the growth of *Fusarium oxysporum f. sp. ciceri*. Gupta *et al,*. (2010) reported optimum temperature for growth of *Fusarium spp*. isolates was 28ºC. Bhale (2012) results revealed that radial growth and sporegermination of *F. oxysporum f. sp. spinaciae* was maximum temperature at 25ºC.

Table 2: Effect of Temperature on growth of *Fusarium solani*

Treatments	Temperature (^{0}C)	Dry mycelialweight (mg)
T1	5	91.00^h
T2	10	160.00^g
T3	15	272.65^f
T4	20	512.67^c
T5	25	612.00^a
T6	30	563.00^b
T7	35	418.32^d
T8	40	396.00^e

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01)

Table 3: Effect of Light on growth of *Fusarium solani*

Treatments	Exposed intervals (hours)	Colony diameter (mm)
T1	4 h dark 20 h light	78.00^b
T2	12 h dark 12 h light	81.00^a
T3	8 h dark 16 h light	75.00^c
T4	8 h light 16 h dark	63.00^f
T5	24 h light 24 h dark	71.32^d
T6	48 h light	68.65^e
T7	48 h dark	57.67^g

Note1: h-hour

Note 2: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01).

c. Effect of Light

This experiment was conducted to study the effect of light on the growth of *Fusarium solani.* The fungus was exposed to alternate cycles of dark and light and continuous light and continuous darkness for different period of time for 9 days as described in material and methods. The maximum growth of 81.00 mm was noticed when exposed to 12 hours dark 12 hours light followed by 4 hours dark 20 hours light (78.00 mm), 8 hours dark 16 hour light (75.00 mm), 24 hours light 24 hours dark (71.32 mm) and least radial growth of 57.67 mm was recorded in treatment with exposure to 48 hours dark (Table 3). Light has profound effect on growth and sporulation of fungi. The preliminary studies carried out in the present investigation with

Fusarium solani indicating a maximum growth when inoculated plates were exposed to alternate dark and light condition (12 hours dark alternated with 12 hours light). Similar observations were recorded by Sharma *et al*.., (2005) who found that the growth and sporulation of *Fusarium oxysporum f. sp. lini* was excellent at alternate cycles of 12 hours each of light and darkness. Bhale(2012) reported that continuous light and white light were found ideal for maximum radial growth and spore germination of *F. oxysporum f. sp. spinaciae.*

d. Effect of Carbon Sources

Carbon is one of the most important nutrients needed by living organisms for its growth. In the present experiment utilisation of seven carbon sources by the pathogen was studied as described in material and methods. Among the carbon sources tested, Glucose supported maximum dry mycelial weight (537.00 mg) followed by Sucrose (516.00 mg), Fructose (495.00 mg), Lactose (486.00 mg),Dextrose (469.67 mg) and least growth of the fungus was

Table 4: Effect of different Carbon sources on growth of *Fusarium solani*

Treatments	Carbon Source	Dry mycelialweight (mg)
T1	Dextrose	469.67[e]
T2	Sucrose	516.00[b]
T3	Glucose	537.00[a]
T4	Maltose	392.65[f]
T5	Fructose	495.00[c]
T6	Lactose	486.00[d]
T7	Lactic Acid	199.64[g]
T8	Control	108.32[h]

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01).

observed in control (108.32 mg) (Table4). These results are similar with Ramteke and Kamble (2011) in case of source for growth of *Fusarium solani* causing rhizome rot of Ginger.

e. Effect of Nitrogen Sources

Utilization of seven different nitrogen sources by *Fusarium solani* was studied in this experiment. The dry mycelial weight was recorded after ninth day of inoculation of the fungus (Table 5). Among the nitrogen sources, threonine supported maximum dry mycelial weight (595.34 mg) followed by asparigine (579.32 mg), Calcium Nitrate (557.00 mg), Sodium Nitrate (512.67mg), Potassium Nitrate (499.32 mg) and least growth was observed in control (207.65 mg). Similar experiment was conducted by Ramteke and Kamble(2011) who observed that Calcium nitrate was best nitrogen source for *Fusarium solani* causing rhizome rot of Ginger.

Table 5: Effect of different Nitrogen sources on growth of *Fusarium solani*

Treatments	Nitrogen Source	Dry mycelialweight (mg)
T1	Calcium Nitrate	557.00[c]
T2	Sodium Nitrate	512.67[d]
T3	Potassium Nitrate	499.32[e]
T4	Asparagine	579.32[b]
T5	Threonine	595.34[a]
T6	Ammonium nitrate	485.00[f]
T7	Ammonium Sulphate	436.65[g]
T8	Control	207.65[h]

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01).

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