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Survey on Onion Basal Rot Disease Incidence and Evaluation of Aggregatum Onion (*Allium cepa* L. Var. *Aggregatum* Don.) Genotypes Against *Fusarium oxysporum* f. sp. *cepae*

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A B S T R A C T

Basal rot is a major fungal disease that occurs in onion crop caused by *Fusarium oxysporum* f. sp. *cepae* (Hanazawa) Snyder &Hansen. Severe yield losses occur in the onion crop due to the rotting of bulbs. Survey was conducted in onion growing areas of Tirunelveli, Thoothukudi and Tenkasi districts and five isolates of *Fusarium* were isolated under *in vitro*. The isolates were confirmed by both morphological and cultural characters. Among the five isolates, FBR1 isolate from Vallanadu village was identified as a virulent isolate from the pathogenicity experiments and it covers the Petri Plate within seven days. The least growth was observed in the FBR5 isolate collected from Muthukrishnaperi village. Use of disease resistant sources is one of the non-chemical method to be suggested as an alternative approach to chemical methods. Among the eight genotypes screened against *Fusarium oxysporum* f. sp. *cepae*, Settikulam local (Perambalur) was found to record lower disease incidence (33.30 %) as compared to the check variety CO (On) 5 (11.11 %).

Introduction

Onion (*Allium cepa* L. var. *aggregatum* Don.) is the most important vegetable grown in different parts of India for its efficient consumption in local as well as it has good export value. It is pungent because of the presence of a volatile oil-allyl-propyl-disulphide. The largest producer of onion in the world is China followed by United States, Turkey, Pakistan, Russia, Indonesia, Vietnam, and Myanmar.

In India, onion grows in an area of 1.3 million ha with an output of 23 million tons of bulbs per year (Indiastat, 2018-19). In India, Maharashtra is the leading onion producing state which produces 4505 thousand tons

(APEDA, 2019). Onion is affected by several fungal and bacterial diseases. Among the soil borne diseases of onion, basal rot is one of the most serious disease, causing high economic losses in the field as well as in storage (Coskuntuna and Ozer 2008). Fifty percent of yield loss has been recorded in susceptible cultivars (Everts *et al.,* 1985).

Basal rot incidence in India was reported by Mathur and Shukla (1963). Progressive yellowing and dieback from the tips of leaves are the key symptoms followed by rotten roots and bulbs. Optimum temperature required for the development of the pathogen is 25-32 ° C (Schwartz and Mohan 1995).

Due to the hazardous impacts caused by the continuous application of synthetic fungicides, there is a need to develop the alternative strategies. Hence, this study is focused on identification of disease resistant sources for basal rot disease.

Materials and Methods

Survey and collection of disease samples

A survey was conducted during 2018-19 in Tirunelveli, Thoothukudi and Tenkasi districts of Tamil Nadu for the occurrence of Fusarium basal rot disease. The disease infected samples were collected from the surveyed are as *viz*., Vallanadu, Puthur, Alangulam, Agaram and Muthukrishnaperi villages at maturity stage of crop.

The disease incidence was calculated by counting the total number of infected plants out of total number of plants in each field. The percent disease incidence of basal rot was calculated by using a formula(McKinney 1923).

$$\text{Per cent Disease incidence} = \frac{\text{Total number of plants infected}}{\text{Total number of plants observed}} \times 100$$

Isolation of pathogen

Five isolates of *Fusarium oxysporum* f. sp. *cepae* were isolated by tissue segment method (Rangaswami 1958) from the basal rot affected onion samples collected from five surveyed places. The infected portions were cut into several pieces using a sterilized scalpel and washed in 0.1 % mercuric chloride for 1 min and subsequently washed in three changes of sterile water.

After washing, moisture in the tissues were dried using sterile tissue paper and three bits were placed in each Petri plate containing PDA medium and incubated at 28±2^0 C for 7 days. The hyphal tips of fungi were transferred to the PDA medium to maintain the pure culture. Based on the cultural and morphological characters, the pathogen was identified (Brayford 1996).

Morphological characters of *Fusarium oxysporum* f. sp. *cepae*

All the five isolates of *Fusarium* were observed for the colour of the mycelium and growth pattern, as well as for the production of micro conidia, macro conidia, and chlamydospores. A nine mm culture disc of each isolate was transferred to Petri Plates containing PDA medium and incubated for seven days to study the cultural and morphological characters using a compound microscope.

Screening of onion genotypes

Eight local onion genotypes were collected from different districts of Tamil Nadu and the genotypes were screened against *Fusarium oxysporum* f. sp. *cepae* for the resistance/ susceptibility along with a check variety CO (On)5. Screening was done in glasshouse of Department of Plant Pathology, Agricultural college and Research institute, Killikulam

under pot culture condition. Three replications were maintained for each treatment. FBR 1culture was inoculated into the sand maize media and allowed for mass multiplication to prepare the sick soil.

After the multiplication of the pathogen, the sick soil was prepared by mixing the sand maize medium with sterilized soil and FYM. The quantity of the sand maize medium was added @50g/kg of soil.

This mixture was kept in a sealed basket for ten days for the multiplication of pathogen. Then the pots were filled with the mixture and three bulbs/pot were planted. The pots were maintained and observations were taken after 60 days after planting. The basal rot symptom observations were recorded using (Wellman 1939) and (Harrison 1940) method. The percent disease incidence was calculated by using a formula;

$$\text{Wilt incidence}(\%) = \frac{\text{Number of wilted plants}}{\text{Total number of plants}} \times 100$$

Table.A

SI. No	Reaction/grade	Percentage/Rating (%)
1	Total resistance	0
2	Highly resistance	1-10
3	Moderately resistance	11-30
4	Moderately susceptible	31-50
5	Susceptible	51-70
6	Highly susceptible	71-100

Results and Discussion

Survey on the occurrence of *Fusarium* basal rot

A detailed survey was conducted to assess the percent disease incidence of basal rot in Tirunelveli and Thoothukudi and Tenkasi districts of Tamil Nadu. The disease incidence ranged from 27 to 74.33 percent and the result is presented in Table1.

Maximum disease incidence was observed in Vallanadu village of Thoothukudi district (74.33%) followed by Agaram village 73.00 per cent. Minimum basal rot incidence (27.00%) was observed in Muthukrishnaperi village of Tirunelveli district.

Morphological characters of *Fusarium oxysporum* f. sp. *cepae*

Five isolates of *Fusarium* were isolated from the infected bulbs collected from five places surveyed. The five isolates were observed for the colony morphology and conidial character separately. The isolates were named as FBR1, FBR2, FBR3, FBR4 and FBR5.

Among the five isolates of FBR, FBR1 shows vigorous growth and the mycelium is creamy white in colour with violet colour pigmentation in the centre of the mycelium and it covered the plate within seven days. FBR2 isolate produced cottony white mycelial growth with slight shrinkage of mycelium in the ends and vigorous growth.

FBR3 isolate generates profuse white mycelium with pink to violet pigmentation in the centre of the mycelium and fast growth. FBR4 isolate produced slight fluffy mycelial growth and light pink color pigmentation in the later stage with slow growth. FBR5 produced dull white colour thin mycelium (Table 2 and Figure 1).

The production of micro conidia, macro conidia and chlamydospores were observed separately. All the isolates produced micro conidia which were oval to kidney shaped and the macro conidia was sickle shaped with three to four septa.

Chlamydospores were observed in FBR1 and FBR2 isolates and it was one to two celled having a thick cell wall. Similarly, Mandal *et al.,* (2018) isolated 14 isolates of *FOC* and they differ in colour of the mycelium (slight pink, violet and white) and also varied in growth.

According to Patra and Biswas (2017), the micro conidia of *Fusarium oxysporum* f. sp. *cepae* was oval to kidney shaped having 0-1 septa and macro conidia was sickle shaped having 3 septa.

Screening of onion genotypes

Among the eight onion genotypes screened against *Fusarium oxysporum* f. sp. *cepae*, Settikulam local (Perambalur) recorded minimum disease incidence (33.30 %) followed by Palani local (44.40 %) as compared to the check variety CO (On) 5 which recorded 11.11 per cent disease incidence. Other genotypes viz., Pavithram local (77.70%), Thuraiyur local I (77.70 %), Thuraiyur local II (77.70 %), Musiri local (83.30%), Surandailocal (88.80 %) and Ottanchathiram local (88.80%) were considered as highly susceptible genotypes to basal rot disease (Table 3 and Figure 2).

Based on the disease assessment method (Harrison,1940), the genotype CO (On) 5 was found to be moderately resistant to the disease while the genotypes Palani local(Dindigul) and Settikulam local (Perambalur) types were moderately susceptible to *Fusarium oxysporum* f. sp. *cepae.* Other genotypes *viz.*,Pavithram local (Namakkal), Thuraiyur-I local (Trichy), Thuraiyur-II local (Trichy), Musiri local (Trichy) Surandai local (Tenkasi) and Ottanchathiram local (Dindigul) were highly susceptible to onion basal rot disease.

Table.1 Survey on the incidence of Fusarium basal rot in Tirunelveli, Thoothukudi and Tenkasi districts of Tamil Nadu

Sl. No.	Village	District	Isolate code	Crop stage	*PDI (%)
1	Vallanadu	Thoothukudi	FBR1	Maturity	74.33 (59.59)[a]
2	Puthur	Thoothukudi	FBR2	Maturity	52.00 (46.33)[d]
3	Alangulam	Tenkasi	FBR3	Maturity	61.60 (51.75)[c]
4	Agaram	Thoothukudi	FBR4	Maturity	73.00 (58.40)[b]
5	Muthukrishnaperi	Tirunelveli	FBR5	Maturity	27.00 (31.08)[e]
		CD(P=0.05)			2.95

*Per cent Disease Index (PDI); Values in the parentheses are arcsine transformed values
Means in a column followed by same superscript are not significantly different by Duncan's Multiple Range Test at P = 0.05

Table.2 Morphological variation of different isolates of *Fusarium oxysporum* f. sp. *cepae* on Potato Dextrose Agar medium

S. No.	Isolates	Morphological characters	Shape of conidia	Radial mycelia growth (cm) *	Days to cover the plate (days)*
1	FBR1	Creamy white colour mycelium with aerial hyphae, violet pigmentation and vigourous growth	Micro conidia-oval to kidney Macro conidia-Falcate Chlamydospores-One celled	8.97[a]	7
2	FBR2	Cottony, profuse white mycelium with light shrinkage and vigorous growth	Micro conidia-oval to kidney Macro conidia-Falcate Chlamydospores-One to two celled	8.75[b]	8
3	FBR3	Profuse white mycelium, cottony growth, dark violet pigmentation in the centre and fast growth	Micro conidia-oval to kidney Macro conidia-Falcate	8.42[c]	10
4	FBR4	Cottony thin white colourmycelium ,light pink colour in the centre and poor growth	Micro conidia-oval to kidney Macro conidia-Falcate	7.40[d]	12
5	FBR5	Dull white colour mycelium, slow growth and raised growth at centre	Micro conidia-oval to kidney Macro conidia-Falcate	6.37[e]	12
			CD(P=0.05)	0.21	

* Mean of four replications; Means in a column followed by same superscript are not significantly different by Duncan's Multiple Range Test at P = 0.05

Table.3 Screening of onion genotypes against *Fusarium oxysporum* f. sp. *cepae* under in vivo

Sr. No	Genotypes	District	Disease incidence(%)	Disease reaction/ Grade
1	Palani local	Dindigul	44.40 (41.75)[bc]	**Moderately susceptible**
2	Pavithram local	Namakkal	77.70 (66.39)[ab]	**Highly susceptible**
3	Settikulam local	Perambalur	33.30 (30.09)[c]	**Moderately susceptible**
4	Thuraiyur-I local	Trichy	77.70 (66.39)[ab]	**Highly susceptible**
5	Musirilocal	Trichy	83.30 (74.80)[ab]	**Highly susceptible**
6	Surandai local	Tenkasi	88.80 (78.05)[a]	**Highly susceptible**
7	Ottanchathiram local	Dindigul	88.80 (78.05)[a]	**Highly susceptible**
8	Thuraiyur-II local	Trichy	77.70 (66.39)[ab]	**Highly susceptible**
	Check CO (On) 5	Dindigul	11.11 (11.94)[c]	**Moderately resistant**
	CD(0.05)		**36.17**	

* Mean of three replications; Values in the parentheses are arcsine transformed values
Means in a column followed by same superscript are not significantly different by Duncan's Multiple Range Test at P = 0.05

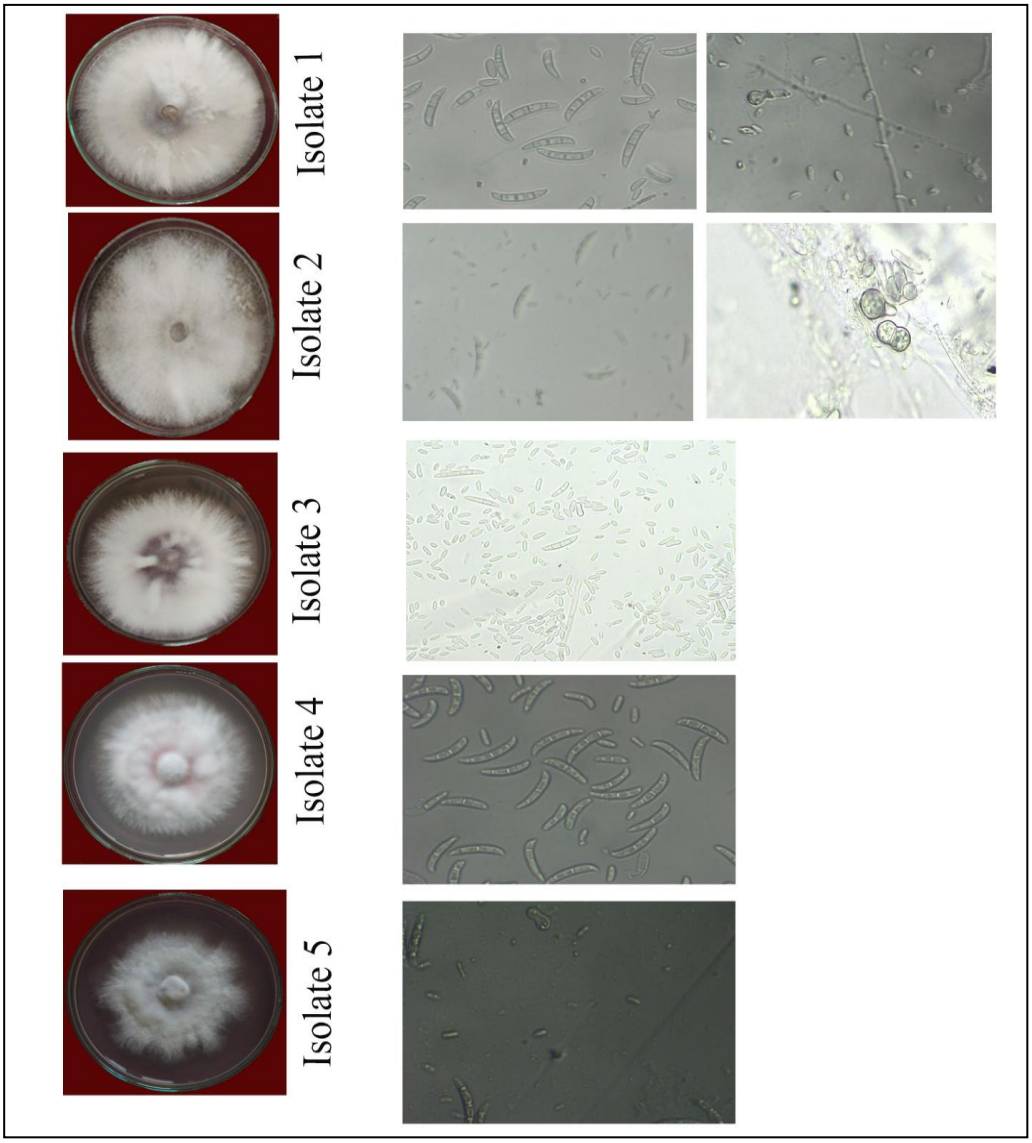

Figure.1 Morphological characters of Fusarium basal rot

Figure.2 Screening of onion genotypes against *Fusarium oxysporum* f. sp. *cepae* under *in vivo*

Sintayehu *et al.,* (2011) evaluated 16 genotypes of shallots, among which DZ-Sht-054-3A and DZ-Sht- 201-1C were found to be highly susceptible while DZ-Sht-157-1B and DZ-Sht-168-1A were tolerant to FBR. Sudhasa *et al.,* (2008)found that aggregate onion showed 25.50 per cent lesser disease incidence than the local varieties.

From this study, it was concluded that onion basal rot disease incidence in Tirunelveli, Thoothukudi and Tenkasi districts of Tamil Nadu ranged from 27.00 to 74.33 per cent. Among the five isolates of Fusarium basal rot pathogen (*Fusarium oxysporum* f. sp. *cepae*), Vallanadu isolate (FBR 1) was identified as a virulent isolate. Screening of onion genotypes revealed that Settikulam local genotype (Perambalur) only showed lower disease incidence of 33.30 per cent compared to check variety CO (On) 5 which recorded 11.11 per cent disease incidence.

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