Varietal screening, *in vitro* and *in vivo* management of Basal Rot of Onion

ABSTRACT

Fusarium basal rot is one of the most important soil borne disease which is caused by *Fusarium oxysporum* f. sp. *cepae* and it was isolated from infected onion bulbs. On the basis of morphological characters, fungus culture was identified as *Fusarium oxysporum* f. sp. *cepae*. In screening, it was observed that all onion varieties screened were highly susceptible while Bhima red was found susceptible but none of the varieties were found resistant to basal rot of onion. Fungicides carbendazim and tebuconazole of the given concentration were cent per cent effective in inhibiting mycelial growth of *Fusarium oxysporum* f. sp. *cepae*. For the field condition, the module of [carbendazim (2 g/kg) followed by tebuconazole (0.1 %) followed by azoxystrobin (0.1 %)] found most effective.

Keywords: Onion, Basal rot, Fusarium oxysporum f. sp. cepae,

1. INTRODUCTION

Onion (*Allium cepa* L., 2n = 2x = 16) a member belongs to the family *Amaryllidaceae* is known as common onion or bulb onion, biennial herb, is one of the most important vegetable crops in India [8]. It is a low latitude horticulture crop and is popularly known as “Queen of Kitchen” [7]. The area, production and productivity of onion in India during the year 2022-23 was 1791.73 thousand ha, 31005.41 thousand tonne and 17.3 MT/ha respectively [1]. Maharashtra is leading state of onion production throughout 2021-22 having 13,301.70 t followed by Madhya Pradesh (4740.60 t) and Karnataka (2779.50 t) [2].

Numerous diseases attack the onion crop, resulting in losses to both quantity and quality. Among the diseases, basal rot of onion which is caused by *F. oxysporum* f. sp. *cepae*, is one of the most significant soil-borne diseases of onion [9], which affects the crop at all stages of development. In susceptible cultivars, yield losses up to 50% [6], 90% losses at the seedling stage [5] and 30% losses occurred in the storage [3]. In India, the occurrence of this disease was first reported from Rajasthan [10].

Early symptoms of the disease in the field include curling, yellowing and wilting and the affected plant shows complete drying of foliage. The bulb of affected plant shows soft rotting and the roots get rotted. The infected plants can be uprooted easily. There will be a whitish mouldy growth on the scale. In addition, when the bulbs are sliced open in excessively hot and dry conditions, diseased bulbs turn discoloured, infected plants wilt, and infected tissue appears brown and watery. The present studies were conducted to screen various onion varieties for resistance against basal rot in pots under glasshouse condition as well as to assess the efficacy of fungicides against the pathogen *in vitro* and *in vivo*.

2. MATERIAL AND METHODS

2.1 Screening of onion variety

Onion varieties were collected from Directorate of Onion and Garlic Research, Rajgurunagar, Pune, were tested for resistance against basal rot disease of onion during *Kharif*-2022 and 2023. In this experiment, total 23 varieties were screened under artificial epiphytotic conditions under glasshouse, Department of Plant Pathology and Microbiology, PGI, MPKV, Rahuri. Three replications were maintained for each treatment.

Fusarium oxysporum f. sp. *cepae* inoculum was multiplied on sand-maize meal agar medium for the pathogenicity test. The medium was prepared by autoclaving 90 g of dry sieved sand and 10 g of maize meal with 40 ml of distilled water for 15-20 minutes at 1.1 kg/cm^2 or 15 PSI pressure. In order to achieve uniform growth, the sterilized medium was inoculated with the respective fungi and incubated for 14 days at 25 ± 1°C with daily shaking of flasks. The inoculums thus prepared and added to the sterilized soil and FYM (3:1) potting mixture @ 10 per cent (w/w) by mixing it with upper layer of soil and allowed for 7 days to infest soil. Forty five days old onion seedlings of all 23 varieties of onion were transplanted into sick soil pots. Periodic observations were recorded on incidence of basal rot by using disease rating scale given by Wellman (1939) and Harrison (1940) as mentioned in the Table 1. The wilt incidence was calculated by using a formula as suggested by Mayee and Datar [11].

$$\text{Per cent wilt incidence} = \frac{\text{Number of wilted plants}}{\text{Total number of plant}} \times 100$$

Table 1. Disease rating scale for basal rot disease of onion

Sr. No.	Reaction/grade	Per cent/Rating (%)
1.	Total resistance (TR)	0
2.	Highly resistance (HR)	1-10
3.	Moderately resistance (MR)	11-30
4.	Moderately susceptible (MS)	31-50
5.	Susceptible (S)	51-70
6.	Highly susceptible (HS)	71-100

2.2 *In vitro* efficacy of fungicides against *Fusarium oxysporum* f. sp. *cepae*

In vitro studies were undertaken at Department of Plant Pathology and Microbiology, PGI, MPKV, Rahuri in completely randomized design with seven treatments and three replications. Six fungicides were tested against *Fusarium oxysporum* f. sp *cepae* by using poisoned food technique. Control was maintained without fungicide. The plates were incubated at 25 ± 1^{0}C. The colony's radial growth was

recorded and per cent (%) growth inhibition was determined using Vincent's method [15] when the mycelial growth in control plate reached to 90 mm.

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Per cent inhibition

C = Radial growth of fungus in control

T = Radial growth of fungus in treatment

2.3 *In vivo* evaluation of fungicides and bio-agents (modules) against basal rot of onion during *Kharif*-2022 and 2023

The experiment was conducted on the experimental farm of the Department of Plant Pathology and Microbiology, PGI, MPKV, Rahuri. The onion cultivar “Phule Samarth” was grown in randomized block design (RBD) with nine treatments and three replications. Onion seeds were treated with fungicide and raised in nursery. Forty five days after sowing, the seedlings were uprooted from nursery, pre-plant dipping with bioagents/fungicides and transplanted in the main field at 15 cm × 10 cm and after 30 days drenching was done with fungicides. Control plots were maintained without any treatment. Disease incidence was recorded from appearance of disease in field upto harvesting of the crop.

2.4 Statistical analysis

The methodologies outlined by Panse and Sukhatme [13] were used for statistical analyze of the data collected throughout several different studies.

3. RESULTS AND DISCUSSION

3.1 Screening of different varieties of onion against basal rot disease in pots under glasshouse condition

Twenty three varieties of onion were evaluated for resistance to *Fusarium oxysporum* f. sp. *cepae* in glasshouse by sowing in sick soil. The results of these studies carried out in pot culture are presented in Table 2. All the varieties were found highly susceptible to basal rot disease of onion caused by pathogen *F. oxysporum* f. sp. *cepae* while Bhima red was found susceptible. Average wilt incidence was ranged between 70 to 100 per cent during both years *i.e*. *Kharif*-2022 and 2023. Highest mean wilt incidence (100 %) was recorded on cultivar NHRDF red -03, N-2-4-1, Palampur white and PKV white. While, lowest mean wilt incidence (70%) was recorded on cultivar Bhima red. The data revealed that there is no any resistant variety of onion against basal rot in India.

Ilhe et al. [8] screened genotypes of onion against *F. oxysporum* f. sp. *cepae* under artificial epiphytotic condition. Among the genotypes screened, the highest disease incidence was found in N-2-4-1 (100 %) followed by Bhima Shakti (90 %), Bhima Super (90 %), Phule Smarth (90 %), B-780 (90 %)

and Bhima Shubhra (90 %). The genotypes Bhima Kiran, Bhima Raj, Bhima Shweta exhibited 80 per cent disease incidence. However, lowest incidence was observed on Bhima red (60 %).

Table 2. Screening of different varieties of onion against basal rot in pots under glass-house condition during *Kharif*-2022 and 2023 (Pooled data)

Sr. No.	Variety	*Kharif*-2022 (Wilt incidence %)	*Kharif*-2023 (Wilt incidence %)	Mean incidence (%)	Disease Reaction
1.	Agrifound Dark Red	90	90	90	Highly Susceptible
2.	Agrifound White	80	90	85	Highly Susceptible
3.	Arka Kalyan	90	80	85	Highly Susceptible
4.	Arka Yojith	90	90	90	Highly Susceptible
5.	Bhima Dark Red	80	80	80	Highly Susceptible
6.	Bhima Raj	80	90	85	Highly Susceptible
7.	Bhima Red	70	70	70	Susceptible
8.	Bhima Kiran	80	80	80	Highly Susceptible
9.	Bhima Safed	90	90	90	Highly Susceptible
10.	Bhima Shubhra	90	80	85	Highly Susceptible
11.	Bhima Shweta	80	80	80	Highly Susceptible
12.	Bhima Super	90	80	85	Highly Susceptible
13.	GWO-1	90	90	90	Highly Susceptible
14.	NHRDF Red-3	100	100	100	Highly Susceptible
15.	NHRDF Red-4	80	90	85	Highly Susceptible
16.	N-2-4-1	100	100	100	Highly Susceptible
17.	Palampur White	100	100	100	Highly Susceptible
18.	Phule Baswant	90	80	85	Highly Susceptible
19.	Phule Samarth	90	90	90	Highly Susceptible
20.	PKV White	100	100	100	Highly Susceptible
21.	Pusa Madhavi	80	90	85	Highly Susceptible
22.	Pusa Shobha	90	80	85	Highly Susceptible
23.	Pusa White Round	90	90	90	Highly Susceptible

3.2 *In vitro* evaluation of fungicides against *Fusarium oxysporum* f. sp. *cepae*

The results presented in Table 3 showed that, the fungicides carbendazim and tebuconazole of the given concentration were cent per cent effective in inhibiting mycelial growth of *Fusarium oxysporum* f. sp. *cepae*. However, the fungicides *viz*., Azoxystrobin (0.1%), Thiophanate methyl (0.1%), Metiram 55 % + Pyraclostrobin 5 % (0.1%) and Fludioxonil + Sedaxane (0.1%) alone inhibited 87.03, 83.70, 79.63

and 56.29 per cent growth of the pathogen respectively. This showed that Fludioxonil + Sedaxane was less effective.

Table 3. Evaluation of fungicides on growth of *Fusarium oxysporum* f. sp. *cepae*

Tr. No.	Fungicides	Concentration (%)	Mean colony diameter (mm*) after 7 days of inoculation	Per cent growth inhibition
T_1	Carbendazim 50 % WP	0.1	0.00	100.00
T_2	Metiram 55 % + Pyraclostrobin 5 % WG	0.1	18.33	79.63
T_3	Azoxystrobin 23 % SC	0.1	11.67	87.03
T_4	Thiophanate methyl 70 % WP	0.1	14.67	83.70
T_5	Tebuconazole 25.9 % EC	0.1	00.00	100.00
T_6	Fludioxonil + Sedaxane	0.1	39.33	56.29
T_7	Control	-	90.00	00.00
	S.Em. (±)	-	0.25	-
	CD at 1%	-	0.76	-

*= Average of three replications

Yadav et al. [16], who evaluated seven systemic fungicides against *F. oxysporum* f. sp. *cepae* and reported that, tebuconazole and carbendazim were most effective showing 100 % mycelial growth inhibition, followed by thiophanate methyl showing 90.03 per cent growth inhibition. Chethan et al. [3] who evaluated the efficacy of seven fungicides against *F. oxysporum* f. sp. *cepae* and reported that, tebuconazole was effective showing 92.59 per cent mycelial growth inhibition.

3.3 *In vivo* disease management studies of basal rot of onion during *Kharif*-2022 and 2023 (Pooled data)

The basal rot disease of onion over control was reduced by all treatments as compared to control. Two years cropping season pooled data presented in Table 4, revealed that, at 90 DAT, the per cent disease incidence was ranged from 12.33 to 24.33 per cent as compared to control (34.67 %). The least incidence was observed in treatment T_3 [carbendazim (2 g/kg) followed by tebuconazole (0.1 %) followed by azoxystrobin (0.1 %)] (12.33 %) and T_4 [carbendazim (2 g/kg) followed by tebuconazole (0.1 %) followed by thiophanate methyl (0.3 %)] (13.17 %) which were statistically at par with each other. It was followed by T_1 [carbendazim (2 g/kg) followed by (metiram+pyraclostrobin) (0.1 %) followed by azoxystrobin (0.1 %)] (14.17 %) and T_2 [carbendazim (2 g/kg) followed by (metiram + pyraclostrobin) (0.1 %) followed by thiophanate methyl (0.3 %)] (15.50 %). Maximum disease incidence (34.67 %) was found in T_9 (Control). Maximum per cent disease control over control (64.43 %) and yield (128.33 q/ha) was found in treatment T_3.

These research findings are confirmatory with Sintayehu et al. [14] who dipped shallot bulb in Prochloraz, Tebuconazole, Carbendazim, Mancozeb for bulb treatment and found that Prochloraz and

Carbendazim reduced basal rot incidence (40 and 43 %). Similarly, Mondani et al. [12] evaluated the efficacy of commercial chemicals and bioagents, for reducing disease incidence of *Fusarium* spp. in garlic in the field stage and found that Tebuconazole was the most effective for reducing disease incidence, showing 26.5 per cent reduction of basal plate rots and 44 per cent reduction of bulb rots and 33.4 per cent reduction in visible symptoms on cloves relative to the untreated controls.

4. CONCLUSION

In the present study, total 23 onion cultivars were screened against basal rot disease of onion were found highly susceptible while, Bhima red was found susceptible to the disease. The efficacy of six fungicides was tested by poison food technique against *F. oxysporum* f. sp. *cepae*, among all of them, tebuconazole (0.1 %) and carbendazim (0.1 %) were found effective. Modules *i.e*., [carbendazim (2 g/kg) followed by tebuconazole (0.1 %) followed by azoxystrobin (0.1 %)] and [carbendazim (2 g/kg) followed by tebuconazole (0.1 %) followed by thiophanate methyl (0.1 %)] were found statistically at par with each other for effective against management of basal rot disease of onion under field condition.

Table 4. *In vivo* disease management of basal rot of onion during *Kharif*-2022 and 2023 (Pooled data)

Tr. No.	Treatments	% disease incidence of basal rot of onion					Yield (q/ha)	PDC over control
	(Seed treatments followed by Pre-plant followed by dipping followed by Drenching)	15 DAS	Before Trans-planting	30 DAT	60 DAT	90 DAT		
T_1	Carbendazim (2 g/kg) followed by (Metiram+Pyraclostrobin) (0.1 %) followed by Azoxystrobin (0.1 %)	6.00 (14.17)	7.83 (16.25)	10.17 (18.59)	12.33 (20.55)	14.17 (22.11)	118.05	59.12
T_2	Carbendazim (2 g/kg) followed by (Metiram + Pyraclostrobin) (0.1 %) followed by Thiophanate methyl (0.3 %)	6.00 (14.17)	7.83 (16.25)	11.67 (19.97)	13.50 (21.55)	15.50 (23.18)	112.5	55.29
T_3	Carbendazim (2 g/kg) followed by Tebuconazole (0.1 %) followed by Azoxystrobin (0.1 %)	6.00 (14.17)	7.83 (16.25)	9.17 (17.62)	10.83 (19.22)	12.33 (20.55)	128.33	64.43
T_4	Carbendazim (2 g/kg) followed by Tebuconazole (0.1 %) followed by Thiophanate methyl (0.3 %)	6.00 (14.17)	7.83 (16.25)	9.83 (18.27)	11.33 (19.67)	13.17 (21.27)	123.61	62.01
T_5	(Fludioxonil+Sedaxane) (0.1 %) followed by *Trichoderma viridae* (5 g/kg) followed by Azoxystrobin (0.1 %)	8.5 (16.95)	10.50 (18.90)	13.17 (21.28)	14.50 (22.38)	16.67 (24.09)	106.66	51.91
T_6	(Fludioxonil + Sedaxane) (0.1 %) followed by *Trichoderma viridae* (5 g/kg) followed by Thiophanate methyl (0.3 %)	8.5 (16.95)	10.50 (18.90)	13.67 (21.69)	15.17 (22.92)	17.50 (24.72)	99.44	49.52
T_7	(Fludioxonil + Sedaxane) (0.1 %) followed by *Trichoderma harzianum* (5 g/kg) followed by Azoxystrobin (0.1 %)	8.5 (16.95)	10.50 (18.90)	15.50 (23.18)	18.00 (25.10)	21.33 (27.51)	88.60	38.47
T_8	(Fludioxonil+Sedaxane) (0.1 %) followed by *Trichoderma harzianum* (5 g/kg) followed by Thiophanate methyl (0.3 %)	8.5 (16.95)	10.50 (18.90)	17.17 (24.48)	19.50 (26.21)	24.33 (29.55)	84.44	29.82
T_9	Control	12.83 (20.99)	18.33 (25.47)	28.83 (29.22)	29.83 (33.11)	34.67 (36.07)	55.27	00.00
	S.Em. (±)	0.27	0.32	0.30	0.37	0.44	1.77	-
	CD at 5%	0.82	0.97	0.90	1.11	1.32	5.33	-

(Figures in parenthesis are angular transformed values)

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