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EFFECT OF DIFFERENT CHEMICALS AND BIOLOGICAL AGENTS FOR CONTROLLING FUSARIUM BASAL ROT OF SUMMER ONION

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Abstract

The experiment was conducted at the Regional Spices Research Centre, BARI, Magura during 2020-21 and 2021-22 cropping seasons to investigate the effect of different chemicals and biological agent in controlling f basal rot disease of onion caused by *Fusarium oxysporum* f. sp. *cepae*. A significant difference in yield and yield attributes was observed among different treatments. The highest bulb yield of onion (11.78 t/ha in 202-21 and 13.03 t/ha in 2021-22) was found from the treatment T_7 (*Trichoderma* mixed compost @ 500 kg/ha) followed by the treatment T4 [Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%] (12.22 t/ha in 2020-21 and 11.19 t/ha). Significantly higher plant height, number of leaves per plant, bulb diameter and individual bulb weight were recorded from T_7 treatment followed by T_5 treatment. The lowest disease incidence (6.60 % and 5.42 % in 2020-21 and 2021-22, respectively) were found in *Trichoderma* mixed compost @ 500 kg/ha treated plot followed by T_4 treated plot (8.30% in 2021-22 and 6.99% in 2021-22) while the highest disease incidence (25.78 % and 22.11% in 2020-21 and 2021-22) was observed in the control plot. Application of *Trichoderma* mixed compost @ 500 kg/ha recorded the maximum disease reduction over control (74.38% in 2020-21 and 77.90% in 2021-22) followed by T_4 (71.58% in 2021-22). It is concluded that the treatment *Trichoderma* mixed compost @ 500 kg/ha could be a better option for reducing fusarium basal rot of summer onion and increased bulb yield.

Keywords: Onion, fusarium basal rot, *Trichoderma*, yield, disease incidence.

Introduction

Onion (*Allium cepa L.*), a member of the family Amaryllidaceae, is an important spices crop which has great economic importance worldwide (Pushpalatha *et al.*, 2023; Kavitha and Rami, 2018). It is popularly called 'peyaz' which is one of the important commercial spice crops of Bangladesh. It produces 25.47 lakh metric tons of onion from 5.02 lakh acres area (Anon., 2023). In Bangladesh there is an acute shortage of onion in comparison to its total annual requirement (Ullah *et al*., 2008; Alam and Rahman, 2009). The government of Bangladesh imports around 10 lakh metric tons onions per year expending valuable foreign currency for meeting the demand of the country (Khan *et al.,* 2022). Onion is mainly produced in the winter season but cultivation in summer season is constrained due to adverse weather and

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proper cultural practices (Islam *et al*, 2008). Bangladesh Agricultural Research Institute (BARI) has already developed some onion varieties, namely 'BARI Piaj-2', 'BARI Piaj-3' and 'BARI Piaj-5' which can be grown round the year. So, summer onion cultivation can be a new way to increase the onion production in Bangladesh and make it available throughout the year. Onion production is drastically affected by several diseases throughout its developmental stages. *Fusarium oxysporum* f. sp. *cepae* (Foc) is the causal agent of fusarium basal rot (FBR) that is a major threat for onion (*Allium cepa* L.) bulb production and causes severe losses in the productivity both in the field and in storage condition (Le *et al*., 2021).

Many methods have been developed to control plant pathogens, but only few have provided satisfactory control (Behrani *et al.*, 2015). The antifungal compound isolated from *Sisymbrium irio* L. (Akhtar *et al*., 2020) and numerous fungicides such as Carbendazim and Prochloraz can reduce *Fusarium* spp. growth (Degani *et al*., 2022). Despite many attempts to control, the problem is still important throughout the world. The management practices generally employed for its control include resistant cultivars, chemical applications, cultural practices and biotechnological approaches. However, incorporation of different management provides a better opportunity to manage this disease. The experiment was, therefore, was undertaken to know the appropriate management practices for controlling fusarium basal rot of summer onion.

Materials and Methods

The field experiments were conducted at the research field of the Regional Spices Research Centre, BARI, Magura, during the years 2020-21 and 2021-22 to find out desirable different chemicals (fungicides) and biological agent for controlling fusarium basal rot disease of summer onion. The experimental site belongs to Agro-Ecological Zone (AEZ-11) (High Ganges River Floodplain) and the geographic coordinates are latitude: 23. 489877 N and longitude: 89.402456 E. The soil was moderately deep with clay loam in texture and possessed pH of 7.75. The chemical properties of the soil of experimental plot were assessed. Soil samples were randomly collected at 0-30 cm soil depth for physical and chemical analysis before the commencement of the experiment. The soil sample were air dried, grounded and sieved. The soil sample were analysed in the Regional Laboratory, Soil Resource Development Institute (SRDI), Jhenaidah using standard method to know the soil properties before setting the experiment (Table 1). The experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. The variety 'BARI Piaz-5' was used in this study. Total number of treatments were nine, viz. T_1: Autostin (Carbendazim) @ 0.2%, T_2: Cabriotop (Pyraclostrobin 5%+ metiram 55% WG) @ 0.3%, T_3: Differ 300 EC (Difenoconazole 15% + propiconazole 15%) @ 0.2%, T_4: Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%, T_5: Nativo75 (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.05%, T_6: *Trichoderma* suspension @ 5ml/l, T_7: *Trichoderma* mixed compost @ 500 kg/ha, T_8: *Trichoderma* powder @ 10 kg/ha,

T_9: Control. All the treatments were applied in two times, viz. before planting and 45 days after transplanting as soil drenching.

Table 1. Chemical properties of initial soil before setting the experiment

Soil properties	Analytical Values
Soil texture	Clay loam
pH	7.75
OM (%)	1.60
K (meq/100 g soil)	0.41
Total N (%)	0.09
P (µg/g soil)	65.34
S (µg/g soil)	12.27
Z (µg/g1 soil)	0.97
B (µg.g-1soil)	0.48

N. B.: Field Soil of RSRC, Magura was analyzed by Soil Resource Development Institute (SRDI), Jhenaidah.

The unit plot size of the experiment was 3 m x 1.5 m maintaining the spacing 15 cm x 10 cm. The fertilizer was applied in the form of urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum @ 120-54-75-20 kg ha^{-1} of N-P-k-S kg ha^{-1} and 10 tons well-decomposed cowdung was incorporated before ploughing the land. The entire quantity of P, K, S and one third of N were applied as basal dose during land preparation. The remaining N was used as top dress in two equal splits at 30 and 50 days after seedling transplanting.

Seeds of 'BARI Piaz-5' were sown on 3 m x 1 m nursery beds on 15 February 2021 and 20 February 2022, respectively. Forty day- old seedlings were transplanted in the experimental plot and before transplanting about 5 cm of each seedling top was trimmed out. Three weedings were done at 30, 45 and 60 days after transplanting and two irrigations were applied. Other intercultural operations were done to maintain the normal hygienic condition of crop in the field. The plots were inspected regularly to take observations on fusarium basal rot of the crop. Dead plants were counted in the field. The crop was harvested after 75 days of transplanting on 9 June 2021 and 14 June 2022, respectively.

Data on plant height (cm), number of leaves/plants, bulb diameter (cm), individual bulb weight (g), bulb yield (t/ha) and disease incidence (%) were recorded. The incidence of fusarium basal rot of onion was recorded at every alternate day. The incidence of fusarium basal rot of onion was calculated by the following formula:

$$\text{Incidence of fusarium basal rot (\%)} = \frac{Number\ of\ infected\ plants}{\text{Total number of plants}} x100$$

To determine the cost-efficiency of the treatments, the Benefit Cost Ratio (BCR) was calculated based on the local market price of onion bulbs and input costs. The BCR was measured by the following formula:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost of production}}$$

The recorded data were analyzed statistically using Statitix10 software to find out the level of significance and the variations among the treatments. Mean separation was done by Least Significant difference (LSD) test at 5% probability level.

Results and Discussion

Growth parameters and bulb yield

Growth and yield characters of onion were significantly influenced by different treatments (Table 2). The maximum plant height viz. (45.33 cm and 47.92 cm in 2020-21 and 2021-22, respectively), number of leaves per plant (7 and 9 in 2020-21 and 2021-22, respectively), bulb diameter (27.22 mm and 32.47 mm in 2020-21 and 2021-22, respectively) and individual bulb weight (35.50 g and 39.87 g in 2020-21 and 2021-22, respectively) were recorded from the treatment T_7 (Trichoderma mixed compost @ 500 kg/ha) which was followed by treatment T_4 (Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%). The minimum plant height (38.59 cm and 41.35 cm in 2020-21 and 2021-22, respectively), number of leaves per plant (6 and 8 in 2020-21 and 2021-22, respectively), bulb diameter (18.70 mm in 2020-21 and 23.99 mm in 2021-22) and individual bulb weight (22.50 g and 26.87 g in 2020-21 and 2021-22, respectively) were found from treatment T_9 (control).

Organic manure improved physical properties of the soil which increased the vegetative growth parameters significantly. According to Nahar *et al.* (2012), the chemical analysis of Tricho-compost clearly showed that it was rich in various nutrients. *Trichoderma* also produced phytohormones, vitamins and solubilize minerals which lead to increase the growth in terms of plant height (Uddin *et al*., 2015). These results are in agreement with Alyat and Naggar (2010) who observed application of bio fertilizers with organic amendments resulted in promoting the number of leaves plant^{-1}. Kumar *et al*., (2019) concluded *Trichoderma* based compost enhancing vegetative, morphological and qualitative parameters of onion. Application of *Trichoderma* spp. biocompost had a significant effect on the plant height, number of tillers, number of bulbs per cluster wet weight and dry weight of bulb (Suparlan *et al.,* 2024).

Table 2. Effect of different treatments on growth and yield contributing character of summer onion

Treatments	Plant height (cm)		Number of leaves/plants (nos.)		Bulb diameter (mm)		Individual bulb weight (g)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1	40.50	43.00	6.00	8.00	20.40	26.08	25.53	29.90
T_2	42.38	44.62	6.00	8.00	22.43	27.78	30.10	34.47
T_3	40.30	42.73	6.00	8.00	19.73	25.26	24.23	28.60
T_4	43.37	45.94	7.00	9.00	25.30	30.83	33.47	37.83
T_5	42.27	44.65	6.00	8.00	21.97	27.62	29.07	33.43
T_6	41.47	43.97	6.00	8.00	21.77	27.21	27.77	32.13
T_7	45.33	47.92	7.00	9.00	27.22	32.47	35.50	39.87
T_8	41.13	43.52	6.00	8.00	20.60	26.21	26.53	30.90
T_9	38.59	41.35	6.00	8.00	18.70	23.99	22.50	26.87
CV (%)	0.60	0.84	4.48	3.42	2.71	1.91	1.70	1.47
LSD	0.43	0.63	0.50	0.49	1.03	0.91	0.83	0.83

Y1 = 2020-21, Y_2 = 2021-22; T_1: Autostin (Carbendazim) @ 0.2%, T_2: Cabriotop (Pyraclostrobin 5%+ metiram 55% WG) @ 0.3%, T_3: Differ 300 EC (Difenoconazole 15% + propiconazole 15%) @ 0.2%, T_4: Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%, T_5: Nativo75 (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.05%, T_6: Trichoderma suspension @ 5ml/l, T_7: Trichoderma mixed compost @ 500 kg/ha, T_8: Trichoderma powder @ 10 kg/ha, T_9: Control. CV= Coefficient of variation, LSD = Least significant difference

The yields were varied significantly among the different treatment (Figure 1). The highest yield (11.78 t/ha and 13.03 t/ha in 2020-21 and 2021-22, respectively) was recorded from the treatment Trichoderma mixed compost @ 500 kg/ha followed by Eminent pro (Tetraconazole 12.5% + Carbendazimn 15%) @ 0.1%) (11.19 t/ha and 12.22 t/ha in 2020-21 and 2021-22, respectively) and the lowest bulb yield (7.85 t/ha and 9.07 t/ha in 2020-21 and 2021-22, respectively) was found from treatment T_9 (control). The weight of individual bulb was increased in tricho-compost treated plot because this compost acted as organic manure. Addition of organic manure might have improved the soil structure and enhanced the availability of macro and micro nutrients. Trichoderma solubilized insoluble minerals and captures more nutrients which plants could easily uptake (Ara *et al*., 2019). The yield and bulb weight might be increased due to the availability of many nutrients by plants i.e., nitrogen, phosphorus and potassium. The NPK enhanced the cell division of the plant tissue and hence increased the rate of photosynthesis. For this reason, *Trichoderma harzianum* significantly affected yield of onion (Ara *et al*., 2019).

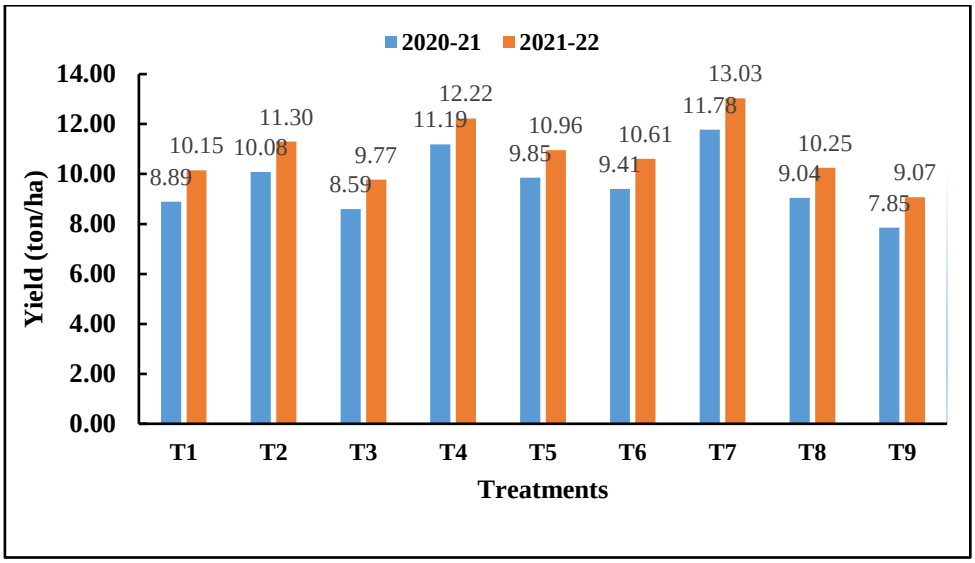

Fig. 1. Effect of different treatments with chemicals and biological agents on the yield of onion

T1: Autostin (Carbendazim) @ 0.2%, T2: Cabriotop (Pyraclostrobin 5%+ metiram 55% WG) @ 0.3%, T3: Differ 300 EC (Difenoconazole 15% + propiconazole 15%) @ 0.2%, T4: Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%, T5: Nativo75 (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.05%, T6: Trichoderma suspension @ 5ml/l, T7: Trichoderma mixed compost @ 500 kg/ha, T8: Trichoderma powder @ 10 kg/ha, T9: Control

Effect of different treatment in controlling basal rot disease of onion

The highest disease incidence (25.78% and 22.11% in 2020-21 and 2021-22, respectively) was observed in the treatment T_9 (Control) and the lowest disease incidence (6.60% and 5.42% in 2020-21 and 2021-22, respectively) from T_7 treatment which was followed by T_4 treatment (8.30% and 6.99% in 2020-21 and 2021-22, respectively) (Table 3). The maximum disease reduction over control (74.38% and 77.90 % in 2020-21 and 2021-22, respectively) was observed from the treatment T_7 (*Trichoderma* mixed compost @ 500 kg/ha) followed by T_5 (55.08%) in 2020-21 and T_4 (71.58%) in 2021-22 (Table 3). From the result it was confirmed that *T. harzianum* isolate mixed with compost was able to reduce the incidence of basal rot compared to control plot. The success of biological control of plant diseases depends on the availability of effective formulations of biocontrol agents (Kumar *et al*., 2017). According to Yagmur *et al*. (2024), *T. harzianum* with soil amendment could be used as an effective biocontrol agent against fusarium basal rot disease of onion. Ghanbarzadeh *et al*. (2016) also reported that *T. harzianum* was the best antagonists for basal rot disease of onion, caused by *Fusarium oxysporum* f. sp. *cepae*, under laboratory, pot and field conditions.

Table 3. Effect of different treatments with chemicals and biological agents for controlling basal rot disease of onion

Treatments	Disease incidence (%)		Disease reduction over control (%)	
	2020-21	2021-22	2020-21	2021-22
T_1	20.22 (4.50)	17.64 (4.20)	25.68 (5.07)	29.20 (5.40)
T_2	12.41 (3.52)	10.30 (3.21)	41.13 (6.41)	58.55 (7.65)
T_3	22.44 (4.74)	19.17 (4.38)	24.55 (4.95)	22.80 (4.77)
T_4	8.30 (2.88)	6.99 (2.64)	48.69 (6.98)	71.58 (8.46)
T_5	13.78 (3.71)	11.20 (3.35)	55.08 (7.42)	55.07 (7.42)
T_6	15.11(3.89)	12.81(3.58)	53.83 (7.34)	48.39 (6.96)
T_7	6.60 (2.57)	5.42 (2.33)	74.38 (8.62)	77.90 (8.83)
T_8	17.11 (4.14)	14.92(3.86)	36.27 (6.02)	40.01 (6.33)
T_9	25.78 (5.04)	22.11(4.70)	9.32 (3.05)	10.67 (3.27)
CV	6.6	7.93	53.01	10.97
LSD	0.50	0.31	0.65	0.50

Figures in parentheses are square root transformed values.

T_1: Autostin (Carbendazim) @ 0.2%, T_2: Cabriotop (Pyraclostrobin 5% + metiram 55% WG) @ 0.3%, T_3: Differ 300 EC (Difenoconazole 15% + propiconazole 15%) @ 0.2%, T_4: Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%, T_5: Nativo75 (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.05%, T_6: Trichoderma suspension @ 5ml/l, T_7: Trichoderma mixed compost @ 500 kg/ha, T_8: Trichoderma powder @ 10 kg/ha, T_9: Control. CV= Coefficient of variation, LSD = Least Significant Difference

Cost benefit analysis

The profitability of summer onion as influenced by different management practices are presented in Table 4. The highest Benefit Cost Ratio (BCR) was found (2.48 2020-21 and 2.74 in 2021-22) the treatment T_7 (Trichoderma mixed compost @ 500 kg/ha) followed by treatment T_4 [Eminent pro (Tetraconazole 12.5% + Carbendazimn 15%)] @ 0.1%) with BCR (2.33 in 2020-21 and 2.54 2021-22) and the lowest BCR was recorded against the treatment T_9 (control) (1.87 and 2.16). Due to the maximum marketable bulb yield with low disease incidence BCR was higher in tricho compost treated plot. Ara *et al*. (2019) also obtained the maximum BCR was noted in *Trichoderma* treated plot.

Table 4: Profitability of onion as influenced by different treatments with chemicals and biological agents

Treatments	Total cultivation cost (Tk./ha)		Gross return (Tk./ha)		Net return (Tk./ha)		BCR	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
T_1	186400	191400	355600	191400	169200	219600	1.91	2.18
T_2	188400	193400	403080	193400	214680	263480	2.14	2.39
T_3	187300	192300	343600	192300	156300	203620	1.83	2.09
T_4	192000	197000	447480	197000	255480	296800	2.33	2.54
T_5	190000	195000	394000	195000	204000	248400	2.07	2.31
T_6	187500	192500	376280	192500	188780	237020	2.01	2.26
T_7	190000	195000	471080	195000	281080	331200	2.48	2.74
T_8	190000	199000	361600	200000	166600	215000	1.90	2.06
T_9	168000	173000	314120	173000	146120	194800	1.87	2.16

Y_1 = 2020-21, Y_2 = 2021-22; Urea-Tk. 16/kg, TSP-Tk. 15/kg, MoP-Tk.15/kg, Gypsum-Tk. 10/kg, Zinc sulphate –Tk.100/kg, Boric acid-Tk. 100/kg, Labour- Tk. 400/man/day, Irrigation- 3000/ha/irrigation, Leas value- Tk. 25000/ha for 5 months, Seed-3000/kg, Sale price-Tk. 40 /kg bulb, T_1: Autostin (Carbendazim) @ 0.2%, T_2: Cabriotop (Pyraclostrobin 5%+ metiram 55% WG) @ 0.3%, T_3: Differ 300 EC (Difenoconazole 15% + propiconazole 15%) @ 0.2%, T_4: Eminent pro (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1%, T_5: Nativo75 (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.05%, T_6: Trichoderma suspension @ 5ml/l, T_7: Trichoderma mixed compost @ 500 kg/ha, T_8: Trichoderma powder @ 10 kg/ha, T_9: Control; BCR = Benefit Cost Ratio

Conclusion

Two years' experimental results revealed that application of *Trichoderma* mixed compost @ 500 kg/ha could be used for controlling fusarium basal rot disease of onion caused by *Fusarium oxysporum* f. sp. *cepae*. Vegetative growth and yield parameters of summer onion were also found maximum from this treatment. Application of this treatment would be effective for getting maximizing economic return. The fungicide 'Eminent pro' (Tetraconazole 12.5% + Carbendazim 15%) @ 0.1% applied as soil drenching twice, viz. before planting and 45 days after transplanting would also be beneficial for reducing disease incidence of fusarium basal rot of summer onion.

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