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Integrated approaches for controlling purple blotch of onion for true seed production in Faridpur of Bangladesh

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ABSTRACT

An experiment was conducted during the Rabi season of 2014–2015 at the farmer's field of Pearpur, Faridpur Sadar, Faridpur under the supervision of On-Farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI), Faridpur to investigate the effective control method of purple blotch of onion during seed production and to develop ecofriendly and cost minimizing approaches for controlling purple blotch. The experiment was conducted using eight treatments *viz.*, T_1 = Combination of Iprodione and Mancozeb with Metalaxyl 4 times spray @ 2 g L^{-1} water each, T_2 = Iprodione + Fenamidone with Mancozeb + Propineb + Mancozeb one time alternative spray each @ 2 g L^{-1} water for 4 times, T_3 = Combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP), T_4 = *Trichoderma harzianum* two times spray @ 50 ml L^{-1} water + Combination of Iprodione and Mancozeb with Metalaxyl 1 time spray @ 2 g L^{-1} water each + Sanitation, T_5 = *Trichoderma harzianum* compost used during final land preparation @ 50 g m^{-2} plot + T_3, T_6 = *Trichoderma harzianum* compost used during final land preparation + *Trichoderma harzianum* 3 times spray @ 50 ml L^{-1} water + Sanitation, T_7 = Difenoconazole 2 times @ 1 ml L^{-1} water + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each and T_8 = Control. Successful control of purple blotch of onion was achieved by spraying fungicide (chemical plus bio) in treatment T_5 followed by T_3 and T_4 treatment. The highest seed yield was 580 kg ha^{-1} obtained from the treatment T_5 in onion seed crop. The highest benefit: cost ratio (3.92) was calculated from T_5 treatment and the lowest from T_8 (2.78).

Keywords: Integrated approach, Onion, Percent Disease Intensity, Purple blotch, True seed production

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1 Introduction

The onion (*Allium cepa* L.) crop suffers from 66 diseases, of which 10 bacterial, 38 fungal, 6 nematodes, three viral, one phytoplasmal, one phanerogamic plant parasite and seven miscellaneous diseases and disorder (Schwartz and Mohan, 2008). Purple blotch caused by *Alternaria porri* (Ellis) Cif. is one of the major fungal diseases in many onion growing countries including Bangladesh (Meah and Khan, 1987).The fungus attacks both leaves and flower stalks resulting considerable yield losses of about 50-100% (Shahanaz et al., 2007). Under tropical conditions, purple blotch is a limiting factor for production of true seeds of onion (Rahman et al., 1988). Seed production is severely affected by purple blotch causes 41-42% yield loss in Bangladesh (Hossain, 1997). The total requirement of onion seeds in Bangladesh is about 910 metric tons per year (BBS, 2017). The average seed yield of onion in Bangladesh is very low (370∼500 kg ha^{-1}) as compared to other countries of the world (1000∼1200 kg ha^{-1}) (HRDP, 1995). Agro ecological conditions influence greatly on seed production.

Faridpur is the predominant onion bulb and seed producing zone of the country which is under Low Ganges River Floodplain of Agro Ecological Zone (AEZ) 12. About 80% of the onion seeds are being produced in this district. In the year of 2010-11, 2011-12, 2012-13, 2013-14, onion seed area was 1850 ha, 1535 ha, 1173 ha and 1443 ha, respectively in Faridpur (Anonymous, 2015).The trend of seed production in Faridpur was decreasing due to the infestation of diseases and higher prices of fungicide. Among the diseases, purple blotch plays an important role in decreasing yields not only in Faridpur but also in whole Bangladesh. Our neighboring country India also suffer low productivity of onion seed production which is chiefly attributed to prevalence of Purple Leaf Blotch in almost all the onion cultivated areas of Northern and Eastern regions (Suhag and Bhatia, 2006).

There are many methods of controlling the disease like chemical (fungicide spray and seed treatment), cultural, physical, biological etc. Different chemicals including systemic and contact fungicides have been used for management of this disease (Rahman et al., 2003). Farmers in Faridpur normally follow this chemical practice. They normally apply fungicides from the early stages of plant (3 to 4 leaves stage) to before harvesting of seed. These synthesized pesticides cause pollution and disturb the microbiotic balance in the soil (Meena and Verma, 2017). The damage due to these chemicals was brought an awareness to find out other alternatives like eco-friendly management with the framework of IDM without affecting our precious eco-system (Mukhopadyay, 1994). Moreover, chemicals are very costly. Poor farmers cannot afford the cost of fungicides to control the disease.

There are several methods like seed treatment, cultural method, bio-agent can use along with chemical fungicide that can be controlled purple blotch of onion more effectively. Maude and Presly (1977) observed that the surface applications of contact fungicides did not eliminate seed infection. So, different method simultaneously used that would be productive, profitable and eco-friendly. The pathogen (*Alternaria porri*) is seed-borne (LaForest, 2011). Therefore, seed treatment agent, Provax (Carboxin 37.5% and Thirum 37.5%) can be used before sowing. Hoque (2008) also reported that the bulb treatment with Iprodione (0.2%) followed by foliar spraying with Iprodione at 7 days interval starting from onset of the disease minimized disease incidence and severity. Field sanitation has been found effective in reducing foliar diseases of some vegetables (Srivastava et al., 2002). Sanitation aims to prevent the entry of inocula into the field and to reduce or eliminate the inocula that are already present in the field (Katan, 2010). Shumsun et al. (2014) reported that occurrence of purple blotch was the minimum in the plots from where 25% of the infected leaves where removed; as a result, purple blotch infection on the leaves, stalks, hills and umbels was low; lesion and damage was the minimum; consequently, yield of true seeds was high as compared to the control plots. Biological control agents are being developed for use in integrated pest management strategies directed at controlling soil borne diseases of vegetables and other crops.

In recent times, biological control of plant pathogenic fungi has received a considerable attention due to several advantages such as possibility of multiple pathogen suppression, low cost and maintaining soil fertility over chemical fungicides (Jagtap and Suryawanshi, 2015). Mohan et al. (2001) found that the lowest disease percentage was observed in *B. subtilis* and *T. viride* in controlling leaf blight in onion caused by *A. porri*. Seed treatment with *Trichoderma harzianum* resulted in less percent disease index and high yield of onion bulb (Chethana et al., 2013).The pathology division and Spices research centre of BARI, Bangladesh has developed foliar spray of fungicide to control the purple blotch of onion. The effect of different methods (cultural, bio-agent, seed treatment) along with fungicides on purple blotch of onion have not yet been studied anywhere in Bangladesh.

Therefore, the present study is undertaken to investigate the effectiveness of fungicides along with combination of other methods to prevent of purple blotch of onion during seed production.

2 Materials and Methods

The experiment was conducted during the period of November 2014 to April 2015 at the farmer's field of Pearpur village at Sadar upazilla of Faridpur un-

der the supervision of On-Farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI), Faridpur. The eight treatment combinations were as follows:

T_1 Combination of Iprodione and Mancozeb with Metalaxyl 4 times spray @ 2 g L^{-1} water each

T_2 Iprodione + Fenamidone with Mancozeb + Propineb + Mancozeb one time alternative spray each @ 2 g L^{-1} water for 4 times

T_3 Combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP)

T_4 *Trichoderma harzianum* two times spray @ 50 ml L^{-1} water + Combination of Iprodione and Mancozeb with Metalaxyl 1 time spray @ 2 g L^{-1} water each + Sanitation

T_5 *Trichoderma harzianum* compost used during final land preparation @ 50 g m^{-2} plot + T_3

T_6 *Trichoderma harzianum* compost used during final land preparation + *Trichoderma harzianum* 3 times spray @ 50 ml L^{-1} water + Sanitation

T_7 Difenoconazole 2 times 1 ml L^{-1} water + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each

T_8 Control

The experiment was conducted following Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 2m × 2m, separated from each other by 30 cm. Taherpuri variety of onion bulb was used @ 1.6 t ha^{-1} with 4 to 6 cm diameter and planted on 15 November 2014. Planting system was line and row to row distance was 20 cm and plant to plant distance was 15 cm. A fertilizer dose of 120, 66, 80, 25, and 1.5 kg ha^{-1} N, P, K, S, and B, respectively (BARC, 2012) with decomposed cowdung @ 3 t ha^{-1} was used. All of organic manure, P, S and B, and half of N and K was applied as basal during final land preparation. Remaining N and K was applied as top dress in three equal splits at 25, 50 and 75 days after planting under moist soil condition and mixed thoroughly with the soil as soon as possible for better utilization. One time irrigation was provided at 25 days after planting (DAP). Hand weeding was done two times at 40 DAP and 65 DAP. Days to harvest was 140 DAP. Sanitation was done by removal of 25% infected leaves from the plots at 77 DAP with the help of knife. Rovral (contact fungicide), Ridomil (contact and systemic fungicide), secure (contact and systemic fungicide), Antracol (contact fungicide), Indofil M-45 (contact fungicide) and Score (systemic fungicide) were used as Iprodione, Mancozeb with Metalaxyl, Fenamidone with Mancozeb, Propineb, Mancozeb and Difenoconazole chemical group, respectively. Bio-agent named *Trichoderma harzianum* @ 50 ml L^{-1} water was used as foliar spray for controlling disease. Again, Trichoderma harzianum was used as compost during final land preparation @ 50 g m^{-2} plot in treatment number 5 and 6. Detergent powder @ 10 g L^{-1} of water as sticky agent was used during the time of fungicide spray. Data on Percent Disease Intensity, yield parameters like number of umbel m^{-2}, effective umbel m^{-2}, seed weight (g) $umbel^{-1}$, thousand seed weight (g), seed yield (kg ha^{-1}) were collected and statistically analyzed following MSTAT-C package while the mean separation was done by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960).

The chemicals and biological agents were sprayed beginning from the first appearance of the disease at 47 DAP and repeated at 10 days intervals for 4 times. Disease scoring was done at 10 days interval using 0∼5 scale following Sharma (1986) are as follows:

Score 0 No symptom of disease

Score 1 A few spots towards the tip covering less than 10% of leaf area

Score 2 Several dark purplish brown patches covering less than 20% of leaf area

Score 3 Several dark purplish brown patches covering less than 40% of leaf area

Score 4 Long streaks, covering up to 75% of leaf area or breaking of the leaves from the center

Score 5 Complete drying of the leaves or breaking of the leaves from the base

The percent disease intensity (PDI) was calculated by using the formula published by Wheeler (1969).

$$\text{PDI} = \frac{\text{TNR}}{\text{TIL} \times \text{MDR}} \times 100 \quad (1)$$

where, PDI = percent disease intensity, TNR = total sum of numerical ratings, TIL = total number of infected leaves observed, and MDR = maximum disease rating.

The economics of treatments was worked out by considering the prevailing rates of inputs, produce, and expressed as benefit: cost ratio (BCR). The BCR was calculated using formula:

$$\text{Benefit : cost ratio (BCR)} = \frac{\text{Gross return}}{\text{Variable cost}} \quad (2)$$

3 Results and Discussion

3.1 Percent disease intensity

The Percent disease intensity (PDI) of purple blotch complex of onion due to application of different treatment combinations at ten days interval is shown in

Table 1. Percent of Disease Intensity (PDI) of different treatments for onion true seed production at Faridpur during 2014-15

Treatment†	Percent disease incidence (PDI)				
	DAP 47	DAP 57	DAP 67	DAP 77	DAP 87
T_1	11.99 bc	12.85 bc	20.39 c	35.02 c	46.37 cde
T_2	13.33 ab	12.85 bc	20.39 c	37.68 c	47.95 bcd
T_3	12.44 abc	12.10 c	20.83 bc	37.68 c	42.92 de
T_4	10.66 c	13.63 abc	23.05 ab	39.45 c	45.26 de
T_5	11.10 c	13.74 abc	20.39 c	35.02 c	39.37 e
T_6	12.44 abc	14.51 ab	25.27 a	45.66 b	53.50 b
T_7	11.55 bc	12.80 bc	23.05 ab	38.12 c	48.50 bc
T_8	14.22 a	14.63 a	25.27 a	50.54 a	71.40 a
CV (%)	10	7.05	6.69	6.36	6.15
LSD (0.05)	2.14	0.9	2.62	4.44	5.21

† T_1 = Combination of Iprodione and Mancozeb with Metalaxyl 4 times spray @ 2 g L^{-1} water each; T_2 = Iprodione + Fenamidone with Mancozeb + Propineb + Mancozebone alternative spray each @ 2 g L^{-1} water for 4 times; T_3 = Combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP); T_4 = *Trichoderma harzianum* two times spray @ 50 ml L^{-1} water + Combination of Iprodione and Mancozeb with Metalaxyl 1 time spray @ 2 g L^{-1} water each + Sanitation (25% removal of infected leaves at 77 DAP); T_5 = *Trichoderma harzianum* compost used during final land preparation @ 50 g m^{-2} plot + T_3; T_6 = *Trichoderma harzianum* compost used during final land preparation + *Trichoderma harzianum* 3 times spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP); T_7 = Difenoconazole 2 times 1 ml L^{-1} water + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each, and T_8 = Control.
§ In a column, means followed by same letter(s) are statistically similar at 5% level by DMRT.

Table 1. The initial data of PDI was recorded at 47 DAP before spraying. The spraying effect on diseases was found in next 57 to 87 DAP. Among the tested treatments, T_3 (12.10) was found most effective which was statistically similar with T_1, T_2, T_4, T_5, and T_7 and differed significantly from T_6 and T_8 tested at 57 DAP. At 67 DAP, the highest PDI (25.27) was observed from T_6 (fully bio control) and T_8 whereas the lowest (20.39) from T_1, T_2 and T_5 (combination of chemical and bio fungicide). Again, at 77 DAP, T_8 showed the highest (50.54) PDI followed by T_6 and the lowest PDI (35.02) from T_1 and T_5. The lowest (39.37) PDI was observed in treatment T_5 where *Trichoderma* compost used during final land preparation @ 50 g m^{-2} plot + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each after disease appearance + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + 25% removal of infected leaves at 77 DAP (sanitation) treatment was applied which was statistically similar with T_1 (chemical fungicide), T_3 (chemical and bio fungicide) and T_4 (Bio and chemical fungicide) at the final scoring period 87 DAP. Uddin et al. (2006) also found Mancozeb (0.45%) and Iprodione(0.2%) effective in controlling the disease incidence and severity of purple blotch complex of onion. Yadav et al. (2017) reported that under glasshouse and field conditions, seed treatment, seedling dip and three foliar sprays of *Trichoderma harzianum* expressed disease reduction and growth promotion in susceptible onion. The disease intensity was lower at 87 DAP in treatment T_3 and T_4 may be due to combined effect of chemical and bio fungicide. Absolute control treatment (T_8) where no control measure was taken showed the highest PDI (71.40). The treatment T_6 (using only bio fungicide) showed the second highest (53.50) PDI at 87 DAP. So, it can be seemed that only bio fungicide application for controlling of disease is not judicious. This result has the similar result of the findings of Wanggikar et al. (2014) whom reported that fungal antagonist were found not so effective to reduce incidence and intensity, attempt increased the bulb yield of onion over unsprayed control. Combined of chemical and bio fungicide or sole bio fungicide had the effect for reducing more or less disease intensity which could be supported by the report of Bajwa et al. (2003) whom have also reported the the efficacy of *T. harzianumin* in controlling purple blotch pathogen. The treatment T_3 in which chemical fungicide spraying at first then bio fungicide spray showed better performance (42.92) than treatment T_4 (bio fungicide first then chemical fungicide (45.26). The disease percentage was 14, 15 and 12 in treatment T_3, T_4 and T_5 at 87 DAP, respectively over 77 DAP. The only dependent on chemical fungicidal treatment like T_1 (46.37) showed better performance than treatment T_2 (47.95). Farmer's practice (T_7) showed satisfactory result over T_6 and T_8. However, successful control of purple blotch of onion was

achieved by spraying fungicide (chemical plus bio) with *Trichoderma* compost in treatment T_5 followed by T_3 and T_4 treatment. This result also is in line with that of Jhala et al. (2017) whom reported that the combined application of fungicide and botanical resulted in significantly great disease control, over their individual applications as well as over untreated control. Rashid et al. (2015) also found that the performance of eco-friendly components *Trichoiderma* and Neem leaf extract against the disease were significantly better than control but not up to the mark compared to the fungicide alone or in combination.

3.2 Plant height

There were insignificant relationship among the treatments for plant height was found due to application of different fungicide (Table 2). The maximum plant height (71.0 cm) was obtained from combination of Iprodione and Mancozeb with Metalaxyl 4 times spray @ 2 g L^{-1} water each (T_1).The lowest plant height of onion (67.6 cm) was obtained from T_8 treatment where no fungicide was sprayed.

3.3 Number of umbel

There was no significant effect of different fungicide application on the number of umbel m^{-2} (Table 2). The maximum No. of umbel m^{-2} (64.3) was obtained from Difenoconazole 2 times @ 1 ml L^{-1} water + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each starting from the disease incidence (T_7) and the lowest 57.6 from Iprodione + Fenamidone with Mancozeb + Propineb + Mancozebone time alternative spray each @ 2 g L^{-1} water for 4 times (T_2).

3.4 Number of effective umbel

The significant variation of number of effective umbel m^{-2} was found due to the application of different chemical and bio fungicides (Table 2). The highest effective umbel m^{-2} was obtained from T_7 (51.6) which were statistically similar with other treatment except T_8. Control treatment (T_8) produced minimum value (41.6) for this parameter. Comparatively maximum number of umbel m^{-2} obtained from combined application of chemical and bio-fungicide (T_3 to T_6) might be due to less disease severity, which contributed increasing in number of effective umbel m^{-2}.

3.5 Seed weight

The application of all combined (chemical and bio fungicide) treated treatments showed a significant effect on the seed weight per umbel as compared to only chemical or only bio fungicide treated treatments (Table 2). The application of combined fungicides minimized the diseases attack and consequently increased the seed weight per umbel. The maximum seed weight per umbel (1.18 g) was recorded from the seed crops which were sprayed by *Trichoderma* compost used during final land preparation + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each after disease appearance + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + 25% removal of infected leaves at 77 DAP (sanitation) (T_5) followed by T_3 (1.10 g) but significantly similar by T_1, T_2 and T_4. The minimum seed weight per umbel was attained (0.83 g) in control treatment.

3.6 Thousand seed weight

Thousand seed weight (Table 2) illustrated that the treatment T_5 exerted the maximum value for this trait (3.24 g) due to might be maximum seed weight per umbel which was significantly followed by all treatments except T_7 and T_8. The control treatment (T_8) showed the minimum value (3.04 g) for this parameter. The application of combined fungicides minimized the diseases attack and consequently increased thousand seed weight.

3.7 Seed yield

The seed yield of onion was significantly affected by different combinations of chemical and bio fungicide treatments (Table 2). In respect of seed yield, the highest value (580 kg ha^{-1}) for this trial was obtained in the treatment T_5 where *Trichoderma* compost used during final land preparation @ 50 g m^{-2} plot + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each after disease appearance + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + 25% removal of infected leaves at 77 DAP (sanitation) was applied. The second highest yield (553 kg ha^{-1}) was obtained from T_3 where no *Trichoderma* compost during final land preparation was used but significantly similar with T_1 (chemical fungicide) and T_4 (combination of bio and chemical fungicide).In the treatment, T_1, T_3, T_4, T_5, and T_7, Iprodione group and Metalaxyl + Mancozeb group was used. Georgy et al. (1983) also reported that the Iprodione group and Metalaxyl + Mancozeb group proved the most effective in reducing the disease severity and increasing seed yield. In control treatment where no fungicide was applied, the yield was the lowest (367 kg ha^{-1}). The application of fungicides minimized the diseases attack and consequently increased yield and this result has the similarity with the findings of Yadav et al. (2013). However, increase in seed yield of onion might be due to synergistic effect of combined fungicides. The maximum seed

Table 2. Yield and yield characters of onion as influenced by different chemical and bio fungicides at OFRD, Faridpur during 2014-15

Treatment†	Plant height (cm)	No. umbel m^{-2}	No. effective umbel m^{-2}	Seed weight umbel^{-1} (g)	TSW (g)	Seed yield (kg ha^{-1})	Seed yield incr. (%)
T_1	71	61.6	49 ab	1.04 ab	3.19ab	530 ab	44
T_2	70.2	57.6	48 ab	0.97 ab	3.08 ab	460 bc	25
T_3	70.6	60	51.3 a	1.10 a	3.22 ab	553 a	51
T_4	69.2	62	51.0 a	1.00 ab	3.10 ab	510 ab	38
T_5	69.2	63.3	48.6 ab	1.18 a	3.24 a	580 a	58
T_6	70.6	63	49.6 ab	0.87 b	3.09 ab	430 c	17
T_7	68.1	64.3	51.6 a	0.91 b	3.16 b	470 bc	28
T_8	67.6	60.3	41.6 b	0.83 b	3.04 b	367 d	–
CV (%)	4	7.8	10.12	13.16	3.26	8.86	
LSD (0.05)	NS	NS	8.73	0.23	0.18	75.26	

† T_1 = Combination of Iprodione and Mancozeb with Metalaxyl 4 times spray @ 2 g L^{-1} water each; T_2 = Iprodione + Fenamidone with Mancozeb + Propineb + Mancozebone alternative spray each @ 2 g L^{-1} water for 4 times; T_3 = Combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP); T_4 = *Trichoderma harzianum* two times spray @ 50 ml L^{-1} water + Combination of Iprodione and Mancozeb with Metalaxyl 1 time spray @ 2 g L^{-1} water each + Sanitation (25% removal of infected leaves at 77 DAP); T_5 = *Trichoderma harzianum* compost used during final land preparation @ 50 g m^{-2} plot + T_3; T_6 = *Trichoderma harzianum* compost used during final land preparation + *Trichoderma harzianum* 3 times spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP); T_7 = Difenoconazole 2 times 1 ml L^{-1} water + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each, and T_8 = Control. § TSW = Thousand seed weight. ‡ In a column, means followed by same letter(s) are statistically similar at 5% level by DMRT.

Table 3. Cost and return analysis of onion as influenced by different combination of chemical and bio fungicides at OFRD, Faridpur during 2014-15

Treatment†	Seed yield (kg ha-1)	Gross return (Tk ha-1)	Variable cost (Tk ha-1)	Gross margin (Tk ha-1)	BCR
T_1	530	662500	185186	477314	3.58
T_2	460	575000	173069	401931	3.32
T_3	553	691250	183778	507472	3.76
T_4	510	637500	185219	452281	3.44
T_5	580	725000	184778	540222	3.92
T_6	430	537500	187120	350380	2.87
T_7	470	587500	177528	409972	3.31
T_8	367	458750	164870	293880	2.78

† T_1 = Combination of Iprodione and Mancozeb with Metalaxyl 4 times spray @ 2 g L^{-1} water each; T_2 = Iprodione + Fenamidone with Mancozeb + Propineb + Mancozebone alternative spray each @ 2 g L^{-1} water for 4 times; T_3 = Combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP); T_4 = *Trichoderma harzianum* two times spray @ 50 ml L^{-1} water + Combination of Iprodione and Mancozeb with Metalaxyl 1 time spray @ 2 g L^{-1} water each + Sanitation (25% removal of infected leaves at 77 DAP); T_5 = *Trichoderma harzianum* compost used during final land preparation @ 50 g m^{-2} plot + T_3; T_6 = *Trichoderma harzianum* compost used during final land preparation + *Trichoderma harzianum* 3 times spray @ 50 ml L^{-1} water + Sanitation (25% removal of infected leaves at 77 DAP); T_7 = Difenoconazole 2 times 1 ml L^{-1} water + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each, and T_8 = Control.

‡ Price of input (Tk kg^{-1}): *Fertilizers*– Urea Tk 16.00, TSP Tk 22.00, MoP Tk 15.00, Gypsum Tk 10.00, Boric acid Tk 300.00; *Rovral Chemical fungicide*– (Iprodione) Tk 3780.00, Ridomil (Mancozeb with Metalaxyl) Tk 1300.00, Secure (Fenamidone with Mancozeb) 2500.00, Antracol (Propineb) Tk 920.00, Indofil M-45 (Mancozeb) Tk 1000.00, Score (Difenoconazole) Tk 2500.00; B*io fungicide*– *Trichoderma harzianum* solution 250 Tk L^{-1} and *Trichoderma harzianum* compost 5 Tk kg^{-1}; Average output price of onion seed (Tk kg^{-1}): 1250.00.

yield increase (58%) was found in treatment over control which was followed by the treatment T_3 (51%). However, the lowest increase (17%) of seed yield was observed T_6 where only bio fungicide was applied.

3.8 Cost and return analysis

Cost and return analysis of onion as influenced by different combination of fungicides was developed and shown in Table 3. The highest gross return (Tk. 725000 ha^{-1}) and gross margin (Tk. 540222 ha^{-1}) were observed from T_5 due to obtain highest seed yield followed by T_3. The lowest gross return (Tk. 458750 ha^{-1}) was calculated from control treatment (T_8) for getting the lowest seed yield. Again the lowest gross margin (Tk. 293880 ha^{-1}) was calculated from control treatment where no fungicide was used but variable cost was Tk. 164870 ha^{-1}. The highest benefit: cost ratio (BCR) (3.92) was observed from T_5. The lowest BCR was calculated from T_8 (2.78).

4 Conclusion

From the study, it can be concluded that, *Trichoderma* compost used during final land preparation @ 50 g m^{-2} plot + combination of Iprodione and Mancozeb with Metalaxyl 2 times spray @ 2 g L^{-1} water each after disease appearance + *Trichoderma harzianum* one time spray @ 50 ml L^{-1} water + 25% removal of infected leaves at 77 DAP (sanitation) treatment showed the lowest percent disease intensity, highest seed yield and monetary return. So, combination of chemical and bio fungicide might be suitable for onion seed production at the Sadar upazilla of Faridpur under Low Ganges River Floodplain of AEZ 12.

References

Anonymous. 2015. Annual Report in Regional Research and Extension Review Workshop 2013-14 and Future Research Planning 2014-15 by Department of Agriculture Extension (DAE) held on 27 May-29 May in RARS, BARI, Rahmatpur, Barisal .

Bajwa R, Khalid A, Cheema TS. 2003. Antifungal activity of allelopathic plant extracts. III. Growth response of some pathogenic fungi to aqueous extract of *Parthenium hysterophorus*. Pakistan J plant path 2(3):145–156.

BARC. 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka 1215. p. 130 .

BBS. 2017. Yearbook of Agricultural Statistics 2016. 28th series. Bangladesh Bureau of Statistics. Statistics and informatics Division (SID). Ministry of Planning. Government of the People's Republic of Bangladesh. p. 394 .

Chethana B, Ganeshan G, Rao AS, Bellishree K. 2013. In vitro evaluation of plant extracts, bioagents and fungicides against *Alternaria porri* (Ellis) Cif., causing purple blotch disease of onion. Pest Manag Hort Ecosys 18(2):194–198.

Georgy NI, Radwan IA, Mohamed HA, Shahabi AE. 1983. Chemical control of downy mildew and purple leaf blotch of onion in Egypt. Agril Res Rev 61(2):25–41.

Hoque A. 2008. Control of Stemphylium blight (*Stemphylium botryosum*) of onion through selected fungicides and plant extracts for seed production. Plant Pathology Department, Sher-e-Bangla Agricultural University, Dhaka, 1-58 .

Hossain M. 1997. An integrated approach to the control of purple blotch of onion seed crop. PhD Thesis in Botany. Department of Botany, University of Rajshahi .

HRDP. 1995. Training Manual. Winter Vegetable and Species Production. Horticulture Research and Development Project (FAO/UNDP/AsDBProject;BGD/87025) and BADC, Dhaka, Bangladesh .

Jagtap JD, Suryawanshi NS. 2015. Potential of biocontrol agents against basal rot of onion caused by *Fusarium oxysporum* sp. cepae. Int J Life Sci A5:65–69.

Jhala P, Mali BL, Meena MK. 2017. Effective management of purple blotch of onion caused by *Alternaria porri* (Ellis) through host resistance, fungicides and botanicals. Int J Curr Microbiol App Sci 6:1737–1745. doi: 10.20546/ijcmas.2017.605.188.

Katan J. 2010. Cultural approaches for disease management: present status and future prospects. J Plant Path 4 (Supplement):S7–S9.

LaForest J. 2011. Integrated Pest Management-Pest Information Platform for Extension and Education.

Maude RB, Presly AH. 1977. Seed-borne infection and its relationship to the disease in the onion crop. Annual Report for 1977. National Vegetable Research station, Wellesboume, United Kingdom.

Meah MB, Khan AA. 1987. Check List of Fruit and Vegetable Diseases in Bangladesh. Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Meena L, Verma AK. 2017. Fungal diseases of onion and their biological management: a review. Int J Recent Sci Res 8(8):19441–19445.

Mohan K, Ebenezer EG, Seetharaman K. 2001. Management of leaf blight disease of onion caused by *Alternaria porri* by plant extracts, plant oils and biocontrol agents. News Letter Nat Hort Res Dev Found 21:1–14.

Mukhopadyay AN. 1994. Biocontrol of soil borne fungal plant pathogens: current status, future prospect and potential limitations. Indian Phytopath 47:119–126.

Rahman ML, Ahmed HU, Mian IH. 1988. Efficacy of fungicides in controlling purple leaf blotch of onion. Bangladesh J Plant Path 4:71–76.

Rahman MLA, Chiranjeevi CH, Reddy IP. 2003. Management of leaf blight disease of onion. Approaches for sustainable development of onion and garlic. National Horticultural Research and Development Foundation, Nashik :311–314.

Rashid MHO, Haque MM, Bakr MA, Islam MR. 2015. Effect of chemicals and environment friendly components on growth parameters and yield contributing character of onion (*Allium cepa*). J Agric Food Tech 5(2):8–14.

Schwartz HF, Mohan SK. 2008. Compendium of onion and garlic diseases, 2nd edn. American Phytopathological Society Press. St Paul Minnesota, USA.

Shahanaz E, Razdan VK, Raina PK. 2007. Survival, dispersal and management of foliar blight pathogen of onion. J Mycol Pl Pathol 37:213–214.

Sharma SR. 1986. Effect of fungicidal sprays on purple blotch and bulb yield of onion. Indian Phytopath 39:78–82.

Shumsun N, Ayub A, Sarker MA, Hamim I. 2014. Effect of sanitation on purple blotch for production of true seeds of onion. Bangladesh J Progress Sci Technol. 12(1):89–92.

Srivastava KJ, Qadri SMH, Tiwari BK, Bhonde SR. 2002. Chemical control of purple blotch of onion bulb crop in kharif season. Indian phytopath 44(2):251–252.

Steel RCD, Torrie JH. 1960. Principles and Procedures of Statistics. Mc Graw Brook Hall, New York, USA.

Suhag LS, Bhatia JN. 2006. *Stemphylium* blight of Onion- A review in Seed Technology and Seed Pathology. Pointer Publisher, Jaipur, Rajasthan, India.

Uddin MN, Islam MR, Akhtar N, Faruq AN. 2006. Evaluation of fungicides against purple blotch complex of onion (*Alternaria porri* and *Stemphylium botryosum*) for seed production. J Agril Edu Technol 9:83–86.

Wanggikar AA, Wagh SS, Kuldhar DP, Pawar DV. 2014. Effect of fungicides, botanicals and bioagents against purple blotch of onion caused by *Alternaria porri*. Int J Plant Protec 7:405–410. doi: 10.15740/HAS/IJPP/7.2/405-410.

Wheeler BE. 1969. An Introduction to Plant Diseases. John Wiley and Sons Ltd., London, UK.

Yadav PM, Rakholia KB, Pawar KB. 2013. Evaluation of bioagents for management of the onion purple blotch and bulb yield loss assessment under field conditions. The Bioscan 8:1295–1298.

Yadav RK, Singh A, Jain S, Dhatt AS. 2017. Management of purple blotch complex of onion in Indian Punjab. Int J Appl Sci Biotech 5:454–465. doi: 10.3126/ijasbt.v5i4.18632.

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