Biological Control of Late Blight Caused By *Phytophthora Infestans* of Potato

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Abstract: An experiment was conducted in the field, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh to control the late blight of potato using biological agents. The experiment was carried out following factorial Randomized Complete Block Design (RCBD) with four replications for each treatment. Biofungicide treated seed tubers resulted lower late blight incidence and severity followed by Bavistin. Late blight incidence and severity was higher in control. The number of stem as well as highest plant height were recorded where potato tubers were treated with BAU-Biofungicide followed by Bavistin than untreated control. Moreover, BAU-Biofungicide followed by Bavistin treated potatoes resulted good effect on formation of the highest number and weight of tuber than untreated control. The highest tuber yield (5.30 t/ha) was recorded in BAU-Biofungicide in case of Diamant variety of Grade B in cut tuber that resulted 65.63% higher over control.
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1. Introduction

Potato (*Solanum tuberosum* L.*)* is an important food crop and one of the three leading staple food crops next rice and wheat of Bangladesh (Uddin, *et al.* 2010). It is native to central Andean area of South America (Keeps, 1979). It is of course the most important vegetable also. It contributes alone as much as 54% of the total annual vegetable production of Bangladesh (Anonymous, 2006). The crop extends substantial amount of high quality protein and essential vitamins, minerals and trace elements to the human diet (PAU, 2013). It produces more carbohydrate per unit area than either rice or wheat. In Bangladesh, potato is a crop of great economic significance. The potato covers an area of 402024.29 hectares and total production is 6648000 M. tons with an average yield of about 16.54 tons/ha (BBS, 2008) which is very low in comparison to that of other leading potato growing countries in the world like in Netherlands 44.80 tons/ha, in UK 49.88 tons/ha (Anonymous, 2006).

The major constrains in potato production in the country is incidence of diseases, as well as lack of distribution of disease free seeds. Out of 54 diseases, late blight (*Phytophthora infestans*) is important seed borne disease (BARI, 2008). Treatments of seeds (tubers) with chemicals are effective in reducing seed-borne infection, but uses of chemicals are hazardous, harmful for beneficial micro-organisms and costly. On the other hand, different types of beneficial micro-organisms are favored by biological control. *Trichoderma harzianum/viride* as a biocontrol agent has the potential to protect seed and seedlings against several diverse plant pathogenic fungi. It also provides effective colonization of the rhizoplane when added as seed treatment (Ahmad and Baker, 1987). Biological seed treatment not only reduces the diseases but also increases plant stand (Hossain and Naznin, 2005 and Bhuiyan, 2006). Reports on biological control of plant diseases by *Trichoderma* and *Trichoderma* based preparation are available in controlling soil borne as well as seed borne plant pathogenic fungi (Yeasmin *et al.,* 2009). A new product of *Trichoderma* has been developed in the name of BAU-Biofungicide which has been reported to control seed and soil borne diseases of different crops like vegetables, pulses and legumes (Bhuiyan, 2006, Yeasmin *et al.*, 2009). Considering the above facts, the present study was, therefore, under taken to manage the seed tuber from seed borne as well as soil borne pathogens.

2. Materials and Methods

The experiment was conducted in the Plant Pathology Field, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh during November, 2008 to March, 2009 under field condition and April, 2009 to July, 2009 under storage condition. The soil of the experimental plot was sandy loam in texture. The experimental area was under the sub-tropical climate which characterized by the comparatively high rainfall, humidity, temperature and relatively long day during April to September and scantly rainfall low humidity, low temperature and short day period during October 2008 to mid-March 2009. Apparently healthy, mature and disease free potato tubers of the cultivars Diamant and Asterix were collected from Bangladesh Agriculture Development Corporation (BADC), Jamalpur. Some potato tubers were cut into pieces so that each piece can contains at least two sprouted buds. The selected land was first opened on November, 2008 with a power tiller. The land was then harrowed, ploughed, cross ploughed for five times with a power tiller followed by laddering to obtain a good final land preparation. The experiment was laid out in factorial Randomized Complete Block Design (RCBD) having four replications for each treatment. The unit plot size was 1m×1m. The space between the plots and blocks were 1m.

Table 1. Disease severity (1-9 scale) as suggested by Henfling (1979) was used as follows.

Score	% foliage affected	Description
1	0	None or very few lesions on the leaflets
2	3	More than 0% but less than 10%
3	10	More than 10% but less than 25%
4	25	More than 25% but less than 50%
5	50	Half of the foliage destroyed
6	75	More than 50% but less than 75%
7	90	More than 75% but less than 90%
8	97	Only very few green areas leaf (much less 10%)
9	100	Foliage completely destroyed

3. Results

The disease incidence of late blight was range from 2.23 – 100 % during the observation period. At 60 DAP the highest incidence (100%) was found in control and the lowest (58.86%) was found in BAU-Biofungicide (Table 2).

The disease severity of late blight was range from 2 – 9 (1-9 scale) during the observation period. The highest severity of late blight at 40 DAP and 50 DAP were found in control and the lowest was found in BAU-Biofungicide. Late blight severity at 60 DAP ranged from 5 to 9. The highest (9) late blight severity was recorded in control in case of using Asterix variety, tuber Grade A of both cut tuber and whole tuber. The lowest (5) late blight severity was recorded where the potato tubers were treated with BAU-Biofungicide in case of using Diamant variety in cut tuber of Grade B (Table 3).

The highest number of stem/hill (4.13), plant height (31.31 cm), number of tubers/hill (4.81), weight of tubers/hill (82.18g) was recorded in BAU-Biofungicide and the lowest was recorded in control (Table 4).

The highest yield of tubers (5.30 t/ha) was recorded where BAU-Biofungicide was used as tuber treatment in case of Diamant variety of Grade B in cut tuber that resulted 65.63% increase over control and the lowest yield of tubers (1.51 t/ha) was recorded in control plot in case of Asterix variety of Grade B in cut tuber (Table 5). The relatively higher incidence (%) of dry rotted tubers (57.14%) were recorded in control where Diamant variety of tuber Grade B in cut tuber were used and relatively lower incidence (%) of dry rotted tubers (0.00 %) were recorded where Bavistin was used as variety of tuber Grade B in whole tuber. Under storage condition, the incidence of storage diseases of potato were less (Table-6).

There were three treatments viz.T_0= Control, T_1= BAU-Biofungicide (2% solution) and T_2= Bavistin (0.4% solution). Three factors:- 1. Varieties (Diamant and Asterix), 2. Grades of tuber (Grade A and Grade B) and 3. Size of tuber (cut tuber and whole tuber). Potato tubers were treated with BAU-Biofungicide and Bavistin by dipping the potato tubers (2% BAU-Biofungicide and 0.4% Bavistin solution). Control plot was planted with untreated tubers. The potato tubers were planted in rows at the spacing of plant to plant 40 cm and row to row 50 cm at the depth of 6 cm. After planting, fine soil mixture was used for covering the tubers. Earthing up was executed two times throughout the entire growing period, one at 30 days and another one at 40 days after planting. The plots were irrigated twice at 35 DAP and 45 DAP.

The following data were collected: disease severity, disease incidence, number of stem, plant height, number of tubers, weight of tubers and yield of tuber. Statistical analysis were done using MSTAT-C and Duncans Multiple Range test (DMRT) was used followed by Gomes and Gomes (1984).

Table 2. Effect of BAU-Biofungicide and Bavistin on late blight incidence of potato

Variety	Grade	Cut/Whole Tuber	Treatment	Disease Incidence (%)		
				40 DAP	50 DAP	60 DAP
Diamant	Grade A	Cut Tuber	Control	5.64	56.36	92.76
			BAU-Biofungicide	4.20	40.39	68.82
			Bavistin	4.75	47.05	70.68
		Whole Tuber	Control	5.16	22.40	85.00
			BAU-Biofungicide	2.23	10.86	64.42
			Bavistin	4.78	14.84	67.55
	Grade B	Cut Tuber	Control	9.88	46.52	85.55
			BAU-Biofungicide	4.30	25.00	58.86
			Bavistin	6.48	28.52	63.71
		Whole Tuber	Control	14.71	48.25	73.82
			BAU-Biofungicide	12.02	29.42	63.71
			Bavistin	10.46	23.43	58.95
Asterix	Grade A	Cut Tuber	Control	25.72	69.91	95.07
			BAU-Biofungicide	15.84	58.14	75.15
			Bavistin	15.96	62.88	76.67
		Whole Tuber	Control	23.66	64.35	96.76
			BAU-Biofungicide	21.00	57.97	76.10
			Bavistin	19.30	57.17	86.25
	Grade B	Cut Tuber	Control	27.62	87.54	100.00
			BAU-Biofungicide	19.26	69.27	85.59
			Bavistin	21.31	7311	82.00
		Whole Tuber	Control	29.14	77.53	100.00
			BAU-Biofungicide	20.33	61.48	78.59
			Bavistin	20.33	62.19	85.72

DAP= Days After Planting

Table 3. Effect of BAU-Biofungicide and Bavistin on late blight severity of potato

Variety	Grade	Cut Tuber/ Whole Tuber	Treatment	Disease severity (1-9)		
				40 DAP	50 DAP	60 DAP
Diamant	Grade A	Cut Tuber	Control	2	6	8
			BAU-Biofungicide	2	4	6
			Bavistin	2	5	6
		Whole Tuber	Control	2	3	7
			BAU-Biofungicide	2	2	6
			Bavistin	2	3	6
	Grade B	Cut Tuber	Control	2	4	7
			BAU-Biofungicide	2	3	5
			Bavistin	2	4	6
		Whole Tuber	Control	3	5	7
			BAU-Biofungicide	3	4	6
			Bavistin	3	3	6
Asterix	Grade A	Cut Tuber	Control	3	6	8
			BAU-Biofungicide	3	6	6
			Bavistin	3	6	7
		Whole Tuber	Control	3	6	8
			BAU-Biofungicide	3	6	7
			Bavistin	3	6	7
	Grade B	Cut Tuber	Control	4	7	9
			BAU-Biofungicide	3	6	7
			Bavistin	3	6	7
		Whole Tuber	Control	3	7	9
			BAU-Biofungicide	2	6	7
			Bavistin	3	6	7

Table 4. Effect of BAU-Biofungicide and Bavistin on number of stem, plant height, number of tubers and weight of tubers

Treatment	No. of stem/hill	Plant height (cm)	No. of tubers/hill	Weight of tubers (g)/hill
Control	2.84	25.33	3.25	60.71
BAU-Biofungicide	4.13	31.31	4.81	82.18
Bavistin	3.78	28.62	4.31	70.74
LSD (P≥0.01)	0.62	1.64	0.67	6.79

Data in column having common letter (s) do not differ significantly.

Table 5. Effect of BAU-Biofungicide and Bavistin on yield of tubers

Variety	Grade	Cut/Whole Tuber	Treatment	Tubers yield (t/ha)
Diamant	Grade A	Cut Tuber	Control	1.90
			BAU-Biofungicide	2.55
			Bavistin	2.30
		Whole Tuber	Control	2.10
			BAU-Biofungicide	2.40
			Bavistin	2.30
	Grade B	Cut Tuber	Control	3.20
			BAU-Biofungicide	5.30
			Bavistin	3.25
		Whole Tuber	Control	3.80
			BAU-Biofungicide	5.15
			Bavistin	4.75
Asterix	Grade A	Cut Tuber	Control	1.83
			BAU-Biofungicide	2.50
			Bavistin	2.36
		Whole Tuber	Control	2.20
			BAU-Biofungicide	2.51
			Bavistin	2.30
	Grade B	Cut Tuber	Control	1.51
			BAU-Biofungicide	2.52
			Bavistin	2.28
		Whole Tuber	Control	2.38
			BAU-Biofungicide	3.36
			Bavistin	3.08

Data in parenthesis indicates % increase (+) over control

Table 6. Effect of BAU-Biofungicide and Bavistin on incidence under storage condition

Variety	Grade	Cut/Whole Tuber	Treatment	Dry rot (%)	Soft rot (%)
Diamant	Grade A	Cut Tuber	Control	0.00	0.00
			BAU-Biofungicide	0.00	0.00
			Bavistin	0.00	0.00
		Whole Tuber	Control	14.28	4.76
			BAU-Biofungicide	7.14	0.00
			Bavistin	7.69	7.69
	Grade B	Cut Tuber	Control	57.14	0.00
			BAU-Biofungicide	5.55	0.00
			Bavistin	0.00	0.00
		Whole Tuber	Control	0.00	0.00
			BAU-Biofungicide	0.00	0.00
			Bavistin	0.00	0.00
Asterix	Grade A	Cut Tuber	Control	7.14	0.00
			BAU-Biofungicide	6.25	0.00
			Bavistin	0.00	0.00
		Whole Tuber	Control	11.11	0.00
			BAU-Biofungicide	0.00	0.00
			Bavistin	6.66	0.00
	Grade B	Cut Tuber	Control	50.00	0.00
			BAU-Biofungicide	0.00	0.00
			Bavistin	0.00	0.00
		Whole Tuber	Control	8.69	0.00
			BAU-Biofungicide	0.00	0.00
			Bavistin	5.00	0.00

4. Discussion

The highest incidence of late blight at 40 DAP and 50 DAP were found in control and the lowest was found in BAU-Biofungicide. Even at 60 DAP the highest incidence (100%) of late blight was found in control and the lowest (58.86%) was found in BAU-Biofungicide. The highest severity of late blight at 40 DAP and 50 DAP were found in control and the lowest was found in BAU-Biofungicide. Late blight severity at 60 DAP ranged from 5 to 9. The highest (9) late blight severity was recorded in control plot in case of using Asterix variety, tuber Grade A of both cut tuber and whole tuber. The lowest (5) late blight severity was recorded where the potato tubers were treated with BAU-Biofungicide in case of using Diamant variety in cut tuber of Grade B. These findings has also been supported by other researchers. Arora (2000) studied the biological control of late blight of potato by using the antagonist, *Trichoderma*. The antagonist either prevented the germination of sporangia or inhibits the development of late blight. However, the disease control in the field was less effective compared to the laboratory and greenhouse tests. This findings is also accordance with the findings of Gupta (2004). Basu *et al.* (2001) also reported good effect of *Trichoderma* in controlling late blight of potato by treating seed tuber and soil application. Ferrari *et al* (2007) used the formulated product of *Trichoderma harzianum* T_{39} for controlling late blight of potato under artificially inoculated condition with *Phytophthora infestans* under growth chamber and greenhouse conditions. They recorded significant control of the disease. Under the present study Bavistin has been found to show good effect to a certain extent to keep the plant with relatively low late blight. This findings has been supported by Nasker *et al.* (2006). They applied Bavistin in the field of potato for controlling late blight disease in West Bengal in India. They recorded significant reduction of the disease by spraying Bavistin. The highest number of stem/hill (4.13), plant height (31.31 cm), number of tubers/hill (4.81), and weight of tubers/hill (82.18g) was recorded in BAU-Biofungicide and the lowest was recorded in control. Similar findings have been documented by many researchers which clearly supports the present investigation. Inbar *et al.* (1994) reported that *Trichoderma harzianum* increased 23.8% seedlings height, 96.1% leaf area and 24.7% plant weight of cucumber compared to untreated control plants. Attaullah *et al.* (2005) reported that the highest number of stems per plant, plant height, fresh shoot weight, root weight, number of medium-sized tubers, weight of medium-sized tubers, total tuber yield and the lowest disease severity was obtained with 40g wheat bran + *T. harzianum.* Basu *et al.* (2001) reported that seed tuber treatment and soil application of *T. viride* recorded the average germination (95%), crop yield (265.7 q/ha), average plant weight (375g), average number of tuber per plant (15), average yield per plant (525g) and lowest disease incidence (22.06). Hossain and Naznin (2005), Bhuiyan *et al.* (2006) found that seed treating with *Trichoderma* based BAU-Biofungicide as an antagonist increased shoot length, root length, shoot weight, root weight, vigor index of the seedlings of different vegetables. The highest yield of tubers (5.30 t/ha) was recorded where BAU-Biofungicide was used as tuber treatment in case of Diamant variety of Grade B in cut tuber that resulted 65.63% increase over control and the lowest yield of tubers (1.51 t/ha) was recorded in control plot in case of Asterix variety of Grade B in cut tuber. These results have been supported by Attaullah et al. (2005), Basu (2000) and Chaudhari et al (2003). The relatively higher incidence (%) of dry rotted tubers (57.14%) were recorded in control where Diamant variety of tuber Grade B in cut tuber were used and relatively lower incidence of dry rotted tubers (0.00 %) were recorded where Bavistin was used as variety of tuber Grade B in whole tuber. Under storage condition, the incidence of storage diseases of potato was less.

The present experiment was conducted for one year. Therefore, it would be difficult to make concrete suggestion and recommendation for controlling late blight of potato with BAU-Biofungicide. But the findings of the present study revealed that BAU-Biofungicide has strong potentiality for treating potato tubers in controlling late blight diseases of potato. The findings of the present study need to be applied under field condition for its potentiality in the farmer's plots. Moreover further research need to be carried out for its conformity under field condition in other ecological zones of Bangladesh. In addition, it is highly essential to emphasis foliar spray of BAU-Biofungicide for controlling late blight of potato as the disease is profoundly considered as foliar disease.

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