EVALUATION OF SOME CHEMICALS FOR SOIL DRENCHING IN CONTROLLING STEM CANKER AND BLACK SCURF OF POTATO

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ABSTRACT

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An experiment was conducted to find out the effectiveness of soil drenching with Amistar 250 SC (azoxystrobin) @ 0.05, 0.10 & 0.15%, Boric acid @ 2.0, 2.5 and 3.0%, Provax-200 (carboxin) @ 0.15, 0.20 & 0.25%, and Bavistin 50 WP (carbendazim) @ 0.05, 0.1 & 0.15% to control stem canker and black scurf disease of potato caused by *Rhizoctonia solani*. The experiment was conducted during 2008-09 cropping season at Tuber Crops Research Sub-Centre, of Bangladesh agricultural Research Institute (BARI), Bogra, Bangladesh The maximum of 41.24% stem canker incidence and 21.04 PDI were recorded from control plot where soil was drenched with plain water. The minimum incidence of 14.99 was obtained with soil drenching with Amistar 250 SC at 0.10% followed by Amistar 0.10% and Provax-200 at 02.0% and Amistar at 0.05%. The incidence was 14.99-18.74% under those treatments. The incidence was 19.99-23.74% under other treatments. All treatments with fungicides and Boric acid reduced disease severity (PDI) considerably over control. The lowest PDI was recorded from treatments with Amistar 250 SC at 0.15% followed by Amistar 250 SC at 0.05 and 0.10 and Bavistin 50 WP at 0.15% showing PDI of 5.62- 9.99. Soil drenching with all treatments with fungicides and boric acid reduced number and weight of russet, deformed and sclerotia infested tubers over control. Considerable reduction was achieved with three treatments with Amistar 250 SC. Number and weight of healthy tubers per plot, and tuber yield per hectare increased by 2.79-105.39, 42.49-165.57 and 4.54-36.78 over control, respectively. Boric acid was ineffective to control the disease and to increase yield. Among the fungicides, higher reduction in incidence and severity of stem canker and black scurf and increase in tuber yield were obtained with Amistar 250 SC. So, Amistar 250 SC was considered as the best fungicides to control the disease and to increase the yield of potato.

Key words: Stem canker, Black scurf, *Rhizoctonia solani*, Potato

INTRODUCTION

Potato (*Solanum tuberosum*) is an important vegetable crop of Bangladesh and it can play an important role for food security of the country (Hashem 1990) . The land area under the crop in 2008-09 potato season was 0.46 million hectares producing 6.89 million tons of potato with per hectare yield of 14.86 metric tons (Uddin *et al*. 2010). The yield is lower compares to other potato growing countries like Netherlands where potato yield is 41.3 t/ha (Waminathan 2000).

The major constraint of potato production in Bangladesh is the prevalence of epidemic diseases. In the country, a total of 39 diseases (both biotic and abiotic) of potato have been recorded (Ali and Khan 1990). The major soil and tuber-borne diseases are stem canker and black scurf and, bacterial wilt and common scab. Among the diseasesm stem canker and black scurf caused by *Rhizoctonia solani* (Kuhn) is the most common and occurs throughout the country (Ali and Dey 1994). The pathogen infects the underground stem and produces necrosis called stem canker while tuber infection produces symptoms on skin in the form of black sclerotia and it is called black scurf. The pathogen is also involved in the early dying syndrome of potato plant (Kotcon et *al*. 1985). It affects size, shape and appearance of potato tubers and reduces plant stand, yield, quality and market value of tubers (Weinhold and Bowman 1977).

Seed tubers treatment with Emisan-6 [2-methoxyethyl mercury chloride] and Bavistin (carbendazim) for 30 minutes was found effective for the control of *Rhizoctonia solani* (De and Sengupta 1992). Treatment of seed tubers by dipping in and spraying with aqueous suspension of Bavistin at 1%, Boric acid at 1.0, 2.0 and 3.0% have been proved to be

effective to control stem canker and black scurf disease of potato and to increase tuber yield (Somani 1988, Sing *et al*. 2001, Anon 2005). Soil drenching with fungicides to control the disease have also been reported by many researchers. Available reports reveal that soil drenching with Rovral and Vitavax-200 (Mian 2007), Avistin, Forastin, Goldazim, Vitavax and Zimgard (Anon. 2005), Borax and Cumulus (Himel *et al*. 2007) are effective in controlling stem canker and black scurf of potato under field conditions.

Under the above circumstances, the present investigation was undertaken to evaluate the effectiveness of soil drenching with three fungicides and Boric acids against stem canker and black scurf of potato caused by *Rhizoctonia solani*.

MATERIALS AND METHODS

Soil drenching was done with the aqueous suspensions of the selected fungicides Amistar 250 SC (azoxystrobin) and Bavistin 50 WP (carbendazim) at 0.05, 0.10, 0.15%, and Provax-200 (carboxin) @ 0.15, 0.20, and 0.25%. The Boric acid was tested at 2.0, 2.5 and 3.0% aqueous suspension. Each concentration of each fungicides or Boric acid represented a treatment. An additional treatment was maintained where soil was drenched with plain water.

The experiment was conducted during 2008-2009 cropping season at the Tuber Crops Research Sub-Centre (TCRC), Bangladesh Agricultural Research Institute (BARI), Bogra, Bangladesh. The seed tubers of a susceptible variety Daimant were collected from the Potato Breeder Seed Production Centre (BSPC) Debiganj, Panchagarh. The experiment was conducted in an experimental plot having soil naturally infested with *Rhizoctonia solani*. The design of the experiment was randomized complete block with four replications. The unit plot size was 3 m X 3 m. Block to block and plot to distances 100 cm and 50 cm respectively. Row to row and seed to seed distances were 60 cm and 25 cm respectively.

Recommended doses of fertilizer and manure were applied as suggested by tuber Crops Research Centre, BARI. Gazipur (Anon. 2007). Cowdung was incorporated in the soil during land preparation at the rate of 120 t/ha, Urea, Triple super phosphate (TSP), Marinate of potash (MOP), Gypsum. Zine sulphate and Boric acid were applied at the rate of 360, 220, 250, 14 and 6 kg per hectare, respectively. Half of urea and the entire other fertilizers were applied at final land preparation. Rest half of urea was applied at 30 days after planting. Seed tubers were planted on 30th November 2007. Weeding was done at 25 and 50 days after planting (DAP). Earthling up was done at 30 DAP. Irrigation was applied at 25 and 45 DAP. Dursban 50WP (Chloropyrifos) @ 0.5% and Admire (Imidacloprid) @ 0.1% were applied to control cutworn and aphid, respectively. Secure (Pyriminamine) @ 0.1% was sprayed at 10 days as preventive measures against late blight of potato (*Phytopthora infestans*). Data on seedling emergence in each unit plot was recorded at 10 DAP and expressed in percentage based on total number of seeds planted. At 70 DAP, number of healthy and canker infected stems per hill in every unit plot was recorded and incidence of the disease was expressed in percentage based on total number of stems.

Disease severity was indexed on a 0-6 scale (Bakr et al. 2010), where 0= no symptom on stolon. 1= minute brown lesion on stolon or root, 2= moderately brown lesion on stolon and curling tendency on center leaf, 3= stolon symptom discolored accompanied by brown discoloration on roots, 4= brown to black discoloration on underground parts, tissue discoloration and tissue squeezed curling of growing leaves, 5= profuse emergence of auxiliary leaves and leaf size reduced markedly with pale green margin, and 6= production of aerial tubers with colour. The plants were checked individually and categorized into different group according to the indexing scale. The number of stem canker infected plants under each grade was recorded and percent disease index (PDI) was calculated using the following formula:

$$\text{PDI} = \frac{\text{Class frequency}}{\text{Number of plants checked}} \times 100$$

The crop was harvested on 27th February 2008. Incidence of black scurf was recorded at harvest. The black scurf infected tubers were separated into three groups such as russet, deformed and sclerotic (Chand and Logan 1982). The number of tubers under each group was counted and the respective weight was recorded. Number and weight of healthy tubers of each plot was also recorded. Data on different parameters were analyzed using computer program MSTAT-C. Differences among the means were compared following Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The seedling emergence of 85.94% was recorded from the control (drenching with plain water). Soil drenching with suspensions of Amitstar, Provax-200 and Bavistin at all concentrations, and Boric acid at 2.5 and 3.0% increased the emergence within range of 86.98 to 93.83%. However, the emergence under all treatments including control was statistically similar (Table 1).

The highest number of stems per hill was 4.40 recorded from all three treatments with Amistar and the second highest number of 4.38 stems per hill was recorded from the treatment with Boric acid at only 2.5%. Effectiveness of those four treatments was statistically but significantly higher compared to control. The number of stems under other treatments including control ranged 3.33-4.10 per hill but their differences were not significant (Table 1).

The lowest plant height of 49.05 cm was observed under control. All treatments with fungicides and Boric acids increased the plant height within the range of 50.10-60.10 cm. Significant increase was achieved with only Amistar at all concentrations and Provax-200 at 0.25% (Table 1).

The highest incidence of 41.24% stem canker was recorded from control. All treatments with three fungicides and Boric acids reduced the disease incidence compared to control within the range of 14.99 to 28.74%. The reduction was significant compared to control. The lowest disease incidence was recorded from Amistar at 0.25% followed by Amistar 0.15%, Provax-200 at 0.25% and Amistar 0.05% (Table 1).

Table 1. Effect of chemicals at different doses for soil drenching on the germination, growth parameters, incidence and severity of stem canker of potato

Treatments	Germination (%)	Stem number per hill	Plant height (cm)	Disease Incidence (%)	Severity (PDI)
Amistar (0.05%)	91.30 a	4.40 a	56.75 abc	18.74 de	7.71 ef
Amistar (0.10%)	93.83 a	4.40 a	58.72 ab	17.49 de	6.67 f
Amistar (0.15%)	92.26 a	4.40 a	61.10 a	14.99 e	5.62 f
Boric acid (2.0%)	84.38 a	3.65 ab	50.10 cd	28.74 b	15.21 b
Boric acid (2.5%)	86.98 a	3.33 b	52.08 bcd	26.24 b	14.79 b
Boric acid (3.0%)	87.50 a	3.40 b	56.67 abc	25.00 bc	12.48 bcd
Provax (0.15%)	90.70 a	3.98 ab	51.97 bcd	24.58 bc	13.75 bc
Provax (0.20%)	91.29 a	4.38 a	55.58 abcd	21.24 cd	12.49 bcd
Provax (0.25%)	92.26 a	4.10 ab	60.78 a	17.49 de	11.12 cd
Bavistin (0.05%)	88.10 a	3.70 ab	53.10 bcd	23.74 bc	13.12 bc
Bavistin (0.10%)	90.62 a	4.00 ab	55.05 abcd	21.66 cd	10.20 de
Bavistin (0.15%)	91.15 a	3.93 ab	56.17 abcd	19.99 cd	9.99 de
Control (Plain water)	85.94 a	3.45 b	49.05 d	41.24 a	21.04 a

Means within the same column with a common letter(s) do not differ significantly (P=0.05).

The maximum disease severity in term of percent disease index (PDI) of 21.04 was recorded from control. Like disease incidence, the PDI was also significantly reduced due to soil drenching with three fungicides and Boric acid at all concentrations. The lowest PDI was recorded from Amistar at 0.15 followed by 0.10 and 0.05%. Their differences were not significant (Table 1).

The maximum disease severity in term of percent disease index (PDI) of 21.04 was recorded from control. Like disease incidence, the PDI was also significantly reduced due to soil drenching with three fungicides and Boric acid at all concentrations. The lowest PDI was recorded from Amistar at 0.15 followed by 0.10 and 0.05%. Their differences were not significant (Table 1).

Rhizoctonia solani produced three types of symptoms and sign viz. russet, deformed and sclerotia infested tubers. The number of tubers under those three categories was 17.00, 15.00 and 62.25, respectively under control. Soil drenching with three fungicides and Boric acid at different concentrations reduced number of russet, deformed and sclerotia infested tubers to the ranges of 5.00-9.25, 3.05-14.00, and 4.00-49.00. The reduction in number of russet and sclerotia infested tubers was significant under all treatments compared to control. Except the treatments with 2.0% Boric acid and 0.15% Provax, all other treatments with fungicides and Boric acid significantly reduced the number of deformed tubers over control. Among the treatments, soil drenching with Amistar at 0.05, 0.10 and 0.15% gave the higher reduction compared to other treatments. Its effectiveness was corroborated with its concentration (Table 2).

The highest weight of russet, deformed and sclerotia infested tubers were recorded from control where soil was drenched with plain water. All treatments with three fungicides and Boric acid at different concentrations reduced the weight of tubers having different symptoms compared to control. However, significant reduction in weight of three categories of diseased tubers was obtained with Amistar 0.05, 0.10 and 0.15% and Bavistin at 0.15%. Provax and Bavistin at their two higher concentrations also produced significantly lower weight of sclerotia infested tubers compared to control (Table 2).

Table 2. Effect of soil drenching with fungicides and Boric acid at different concentration on the number of black scurf infected and healthy tubers

Treatment	Number of infected tubers/plot			Weight of infected tuber/plot (g)		
	Russet	Deformed	Sclerotia infested	Russet	Deformed	Sclerotia infested
Amistar (0.05%)	7.26 ghi	5.25 fg	8.00 g	550 cd	450 cd	580 de
Amistar (0.10%)	6.26 hi	4.00 gh	6.25 g	550 cd	400 d	330 e
Amistar (0.15%)	5.00 i	3.05 h	4.00 g	500 d	380 d	200 e
Boric acid (2.0%)	14.25 b	13.25 ab	49.00 b	950 a	810 a	3500 ab
Boric acid (2.5%)	13.00 bc	12.00 bc	39.25 c	850 ab	750 ab	2800 abc
Boric acid (3.0%)	12.00 bcd	10.00 cd	33.00 d	810 abc	710 abc	2500 a-d
Provax (0.15%)	13.00 bc	14.00 ab	32.50 d	960 a	780 ab	2430 a-d
Provax (0.20%)	11.25 cde	12.00 bc	25.25 e	900 ab+	630 a-d	1830 b-e
Provax (0.25%)	10.00 def	10.75 c	23.50 ef	880 ab	500 bcd	1700 b-e
Bavistin (0.05%)	11.00 cde	10.25 cd	31.25 d	850 ab	730 abc	2350 a-d
Bavistin (0.10%)	9.25 efg	8.25 de	22.00 ef	780 a-d	550 a-d	1600 b-e
Bavistin (0.15%)	8.00 fgh	7.00 ef	19.50 f	650 bcd	450 cd	1430 cde
Control	17.00 a	15.00 a	62.25 a	1020 a	830 a	4150 a

Means within the same column with a common letter(s) do not differ significantly (P=0.05).

Number of healthy tubers was 98.25 per plot under control, which was statistically similar to the treatments with Boric acid at all concentrations, Provax at 0.15% and Bavistin at 0.05%. All other treatments increased the parameter significantly over control. The weight of healthy tubers was 5460 g per plot under control. Soil drenching with three fungicides at all concentration and Boric acid at the highest concentration significantly increased the parameter over control within the range of 7760-14500 g/plot. The maximum increase in both number and weight of healthy tubers were achieved with Amistar at 0.15% followed by Amistar 0.10% and 0.05%. Yield of potato tuber was 15.87 mt/ha under control, which statistically similar to the treatments with Boric acid at all concentrations and Provax 0.15%. The highest yield of tubers was obtained with Amistar 0.15% followed by Amistar 0.01%, Bavistin 0.15% and Provax 0.25%. The yield of these four treatments ranged 19.68-21.70 mt/ha which were statistically similar and significantly higher compared to control. Soil drenching with Amistar 0.05%, Provax 0.20% and Bavistin 0.10% increased the tuber yield to 19.09, 18.50 and 18.54 mt/ha, respectively, which statistically similar and significantly higher compared control (Table 3).

Table 3. Effect of chemicals at different doses for soil drenching on the weight of black scurf infected, healthy tubers and yield

Treatment	Number of healthy tubers per plot	Weight of healthy tubers (g/plot)	Yield (mt/ha)
Amistar (0.05%)	174.80 ab	12180 bc	19.09 bc
Amistar (0.10%)	185.50 ab	13450 ab	20.45 ab
Amistar (0.15%)	201.80 a	14500 a	21.70 a
Boric acid (2.0%)	83.00 g	5350 h	14.16 e
Boric acid (2.5%)	92.00 g	6530 gh	14.58 de
Boric acid (3.0%)	103.30 efg	7780 fg	15.80 de
Provax (0.15%)	101.80 efg	7760 fg	16.59 cde
Provax (0.20%)	130.30 cde	9980 de	18.50 bc
Provax (0.25%)	158.30 bc	11310 cd	19.68 ab
Bavistin (0.05%)	125.00 def	8600 ef	17.01 cd
Bavistin (0.10%)	136.50 cd	10430 cd	18.54 bc
Bavistin (0.15%)	168.80 b	11900 bc	20.03 ab
Control	98.25 fg	5460 h	15.87de

Means within the same column with a common letter(s) do not differ significantly (P=0.05).

Under the above study four chemicals, each with three doses were tested used as soil drench to control stem canker and black scurf of potato. Results revealed that all the chemicals with the increase of doses

significantly reduced the disease infection as compared to the control. There were significant differences among the doses of an individual chemical except Amistar. Among them Amistar at all doses performed better against the disease followed by Provax, Bavistin and Boric acid. The fungitoxicity of Amistar to control *R. solani* has been suggested by Wharton *et al.* (2007*)*; Djelbali and Bathassel (2010) which is in close agreement with the findings of the study.

Some of the chemicals significantly reduced the incidence of the disease and increased yield. Of them Amistar (Azoxystrobin) and Provax 200 WP (Carboxin) showed better performance as compared to others. This was in agreement with the findings of a good number of researchers (Wenham *et al*. 1976; Bolkan 1976; Anon. 2005; Djelbali and Bathassel (2010). Djelbali and Bathassel (2010) agreed that seed tuber treatment and in furrow application of Amistar gave effective control of stem canker and black scurf of potato. Wenham *et al*. (1976) reported that Carboxin at 1 kg per 100 kg seed tubers gave effective control of stem canker both *in vitro* and *in vivo.* In contrast Bavistin appeared equally effective like Amistar and Provax 200 WP. Similar observations have been documented by De and Sengupta (1992), Khanna and sharma (1996), Akhilash *et al.* (1996), Anon. (2005) and Himel *et al.* (2007).

Boric acid for seed tuber treatment was effective to reduce the infection of stem canker and black scurf of potato. Similar results were reported by many researchers (Somani, 1988; Khanna and Sharma 1996, Singh *et al.* 2001, Anon. 2005, Naz 2006). According to Himel *et al.* (2007), Borax is effective in controlling *R. solani*, the causal organisam of stem canker and black scurf of potato. Naz (2006) reported that seed tuber treatment with Boric acid (3%) gave significant protection to eyes and sprouts against soil-borne inoculum of *R.solani.* Jalali and Mehta (1994) advocated that application of Boric acid on the seed tubers after harvest prevented the spread of the disease in the storage. They also reported that post harvest application gave better germination (87.73%) and higher yield as compared to pre-harvest application.

The present investigation proved the potentiality of Provax regardless of doses as soil drench against stem canker. The findings of Diomande and Beute (1977), Bartaria *et al.* (1982), Cother (1983), Cayley *et al.* (1983), Gurking and Jenkins (1985), Singh and Gaudhi (1991), Srikanta *et al.* (1995), Mian (2007), Anon. (2005) strongly supported the result of the study. Srikanta *et al*. (1995) stated that Carboxin as soil drench at 5 kg/ha at 70 and 100 days gave excellent control of root rot of Sugarbeet caused by *R. solaini*. From the present investigation, Bavistin appeared moderately effective against stem canker which was also supported by the observations of Lal and Nagarajan (1983), Avila–de (1991), Datar *et al*. (1992) and Srikanta *et al.* (1995). Bavistin was effective *in vitro* and *in vivo* against *R. solani* of potato (Himel *et al.* 2007).

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