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Efficacy of fungicides in controlling late blight of potato

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Abstract

Potato cultivars grown in Bangladesh have low levels of general resistance to late blight. As such, most commercial potato farmers rely on fungicide applications for control of *Phytophthora infestans*, the causal agent of late blight. Management of late blight of potato requires an integrated approach that includes rotation with non-hosts, resistant cultivars, cultural practices, and fungicides. The study on efficacy of some new fungicides against late blight disease of potato was conducted at ARS, Alamnagar Rangpur during rabi season 2010-2011 to select suitable fungicides against late blight of potato. Thirteen different fungicides were tested and all the tested fungicides showed significantly better performance over control. Considering percentage disease incidence T_4,T_6 and T_{12} showed better performance than all other treatment. In case of T_4,T_6 and T_{12} treatment disease reduction was more than 80 % over control. Significantly the highest tuber yield 25.5 t $ha^{-1}$was obtained from T_3 which was statistically similar to the yield of T_2,T_5 , T_6, T_9, T_{10}, $T_{11}$and T_{12} treatment whereas the lowest tuber yield 14.5 t ha^{-1} was obtained from control treatment. Field experiment was conducted from 2010 to 2011 to investigate the comparative efficacy of the fungicides. In the field, applications of fungicide that preceded the largest incremental increase in disease incidence provided the best control of disease or increased yield.

Key words: Fungicides, late blight, potato

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Introduction

Potato is an important commercial crop in Bangladesh. Unfortunately, potato suffers from many destructive diseases, of which late blight, caused by *Phytophthora infestans* is the most important one. In Bangladesh, late blight causes serious yield loss in potato every year. Late blight was first reported in Bangladesh in 1922. In recent years more than 300 varieties, 2050 germplasm lines and 250 true potato seed (TPS) progenies were evaluated for resistance to major diseases under field conditions (Hossain *et al.*, 2008). Potato is the third important food crop in Bangladesh. It is truly a global crop. Bangladesh is an agro-based country. We are nearly at the door of self-sufficiency in cereals but deficient in minor crops in general, fruits and vegetables in particular. Millions of people are suffering from malnutrition. Potato can play an important role in supplying vegetable throughout the year and can solve the nutritional problems to a great extent for the lower income group. The area under this crop is increasing rapidly and the farmers are gradually adopting it as a cash crop. According to Bureau of Statistics (BBS, 2000) during 1999-2000, the production of potato was 2.93 million metric tons from 0.243 million hectare of land in Bangladesh. Tuber yield is only 12.06 t/ha in the country which is lower as compared to other potato growing countries of the world. In the Ukraine and the Netherlands potato yield is 44.0 and

41.3 t/ha respectively, (Chadha, 1995; Swaminathan, 2000).

Potato (*Solanum tuberosum* L.) has become an important staple and cash crop in Bangladesh. The use of protectant and systemic fungicides for managing late blight has perhaps been the most studied aspect of late blight management in temperate countries (Olanya *et al.*, 2001). In tropical, however, fungicide application intervals, frequency of application and timing, and fungicide dose response relationship have not been well investigated. Fontem and Aighew (1993) reported that fungicides applied for late blight management increased tuber yield by as much as 60%. While it is known that protectant fungicides need to be applied more frequently in wet weather (Schepers, 1996), it is precisely under these conditions that effective spraying is difficult. If rainfall continues for several days then the protection from a purely protectant product is rapidly lost and the crop cannot be sprayed again. Even when the rain stops the soil can be so saturated that it does not permit ease of movement in the field for efficient spraying. Preventive fungicides principally inhibit spore germination and penetration, but once the pathogen enters the leaves, these fungicides become ineffective. Under such conditions a product having some curative and systemic activity, such as metalaxyl is desirable (Schwinn and Margot, 1991). However, pathogens can easily develop resistance to systemic fungicides like metalaxyl because they have single site mode of action (Deahl et al., 1995). To reduce the risk of selecting strains of *P. infestans* resistant to systemic fungicides, farmers are usually advised to apply mixtures of a systemic and a broad spectrum protectant fungicide (Samoucha and Cohen, 1989) and/or reduce the number of sprays per season (Staub and Sozzi, 1984).

The other option is to apply a protectant until disease symptoms appear, and then make a curative treatment of a systemic fungicide. Little is known about the benefits of these alternative approaches. Dithane M-45 (Mancozeb 80% WP), a contact protectant fungicide and Ridomil MZ 63.5 (a systemic fungicide with a combination of metalaxyl and mancozeb) are the most commonly used fungicides in Bangladesh.

The major constraints in potato production have been the incidence of wide range of pests and diseases, difficulties in the production and distribution of disease free seeds, inadequacies of cold storage facilities resulting in rotting and sprouting and violent price fluctuations. Of them diseases play an important role for such low yield in the country. So far in Bangladesh a total of 54 diseases (both biotic and abiotic) of potato have been recorded (Dey and Ali, 1994). Among the diseases, late blight caused by *Phytophthora infestans* is serious one. Indiscriminate use of systemic fungicides especially metalaxyl (Ridomil) provides chance to develop resistant strain of the fungus has been reported from home and abroad (Ali and Dey, 1999; Gupta *et al.*, 1999; Singh, 2000). Comprehensive studies on late blight of potato are limited in Bangladesh (Ali and Dey 1999; Islam *et al.*, 2002). Some of the important findings showed that about 25.5 to 57.25% yield loss occurs due to late blight depending on degree of susceptibility of the cultivar, time of appearance and age of plant infection. Epidemiological studies indicated that the disease is devastating at 12-25^{0}C with relative humidity more than 85%. At present no resistant source of the potato is available in the country. Metalaxyl resistant strain of *P. infestans* has also been reported in the country (Dey and Ali, 1994). Moreover, new fungicides are introducing in the country every year against late blight whose efficacy needs to be ascertained. As no resistant cultivars is available at this moment so chemical control is indispensable for alternative approach to manage the disease. So, the present study was undertaken to find out suitable fungicide(s) to combat the disease.

Materials and Methods

The experiment was conducted at Agricultural Research Station, BARI Rangpur during 2010-2011 cropping seasons. The land was medium high and the soil was sandy loam in texture. The PH value of the soil was within the range of 5.5 to 6.2. The experimental plot was well ploughed. Recommended doses of fertilizers and manure suggested by TCRC (Tuber Crops Research Centre), BARI,Gazipur were used. Cowdung was incorporated in the soil during

land opening at the rate of 5 t/ha. Urea, Triple super phosphate (TSP), Muriate of potash (MP), Gypsum, Zinc sulphate and Boric acid were used respectively, at the rate of 325, 220, 250, 120 14 and 6 kg per hectare. Urea TSP, MP, Gypsum, Zinc sulphate and boric acid were the sources of N, P, K, Ca, Zn and B, respectively. Seeds of potato variety, Diamant were used. Seed tubers were collected from Breeders Seed Production Centre (BSPC), BARI, Debigonj, Panchagarh. The experiment was laid out in a Randomized complete Block Design (RCBD) with three replications. The unit plot size was 3.0 × 3.0 m. Spacing of row to row (within plot) and tuber to tuber (within row) was 60 cm and 25 cm, respectively. Each plot had five rows and in each row 12 seed tubers were sown. Two times weeding was done at an interval of 30 days. Earthing up was executed two times throughout the entire growing period, one at 30 days and another one at 60 days after planting. Irrigation was scheduled two times just after earthing up. Proper control measures were taken to control insect pest (cut worm and aphid). Dursban (0.5%) and Metasystox (0.1%) was applied respectively, to control cut worm and aphid.

Thirteen fungicides were included to determine their effectiveness against late blight disease. There were 14 treatments in seasons consisting of 13 fungicides and one control. The treatments were: Abmanoxil 72 WP (Mancozeb + Metalaxyl), M- cop 50 WP (copper oxychloride), Lagasus 60WG (pyraclostrobin metarum), Netcozeb 80WP (Mancozeb), T-cozeb 80WP (Mancozeb), Diamond 80WP (Mancozeb), Mayor 72WP, Doxycol 52WP (copper oxychloride), T- Mancocymocanil 72 WP (Manco + cymoxanil), T-Maxl-72 WP (Mancozeb+ Metalaxyl), Meta gold-72 WP (Mancozeb + Metalaxyl), Advance 72 WP (Mancozeb + Metalaxyl), Adhunik Gold 72 WP (Mancozeb + Metalaxyl) and control. All the fungicides were used at 0.2%. In control treatment, equal amount of plain water was sprayed. Spray was initiated just after the detection of late blight symptoms in the experimental area and repeated thrice at an interval of 7 days. Care was taken during spray both the upper and lower surface of leaves as well as stems was well covered by fungicidal solution. Spray tank was thoroughly washed before filling fungicidal solution materials. Data on yield of potato and percentage of disease incidence was taken and statistically analyzed following MSTAT software package (Gomez and Gomez, 1984).

Results and Discussion

Thirteen different fungicides were tested all fungicides showed significantly better performance over control. Considering percentage of disease incidence T_4 = Netcozeb 80WP (Mancozeb), T_6 = Diamond 80WP (Mancozeb)and T_{12} = Advance 72 WP (Mancozeb + Metalaxyl) showed better performance than other treatment. T_4, T_6 and T_{12} treatment reduced disease incidence more than 80 % over control. Significantly the highest tuber yield 25.5 t $ha^{-1}$was obtained from T_3 = Lagasus 60WG (pyraclostrobin metarum) treatment which was statistically similar to T2,T5 , T_6, T_9, T_{10}, T_{11} and T_{12} whereas the lowest tuber yield 14.5 t ha^{-1} was obtained from control treatment.

Results of the percent investigation indicate that all the fungicidal treatments significantly reduced disease severity and increased yield over control. This is in accordance with the findings of Samucha and Cohen (1986) who claimed better effect of the systemic and contact fungicides to control late blight of potato. For commercial production of potato Kankwasta *et al*., (2002*)* suggested that mancozeb application reduced the late blight severity more than 50% and increased yield more than 30%. De and Mohasin (1999) stated that Mancozeb gave the lowest disease incidence and highest yield and greatest net benefit against late blight. As preventive spray with Mancozeb is the best to control late blight but less effective as curative measures (Viswanathappa *et al.* 1988, Singh *et al.* 1994). Kankwasta *et al.* (2003) achieved the highest marginal benefit by applying Ridomil once and Dithane M-45 subsequently at intervals of 14 and 21 days. All these findings are in agreement with the present findings of present study. Considering findings of the present investigation it may be concluded that to avoid risk of fungicidal resistance of *P. infestans*, alternate of spray of systemic and contact fungicides can be used to control late blight of potato.

Table 1. Effect of fungicides on the yield of potato at ARS, Rangpur during rabi season 2010-2011

Treatment	Yield t/ha^{-1}
T_1=Abmanoxil 72 WP (Mancozeb+ Metalaxyl),	18.6d
T_2=M- cop 50 WP (copper oxychloride)	22.6abc
T_3=Lagasus 60WG (pyraclostrobin metarum)	25.5a
T_4=Netcozeb 80WP (Mancozeb)	24.2ab
T_5=T-cozeb 80WP (Mancozeb)	21.2bcd
T_6=Diamond 80WP (Mancozeb)	22.6abc
T_7=Mayor 72WP	21.6bcd
T_8=Doxycol 52WP (copper oxychloride)	20.6cd
T_9=T- Mancocymocanil 72 WP (Manco+ cymoxanil)	25.3a
T_{10}=T-Maxl-72 WP (Mancozeb+ Metalaxyl)	22.1abc
T_{11}=Meta gold-72 WP (Mancozeb+ Metalaxyl)	24.2ab
T_{12}=Advance 72 WP (Mancozeb+ Metalaxyl)	24.2ab
T_{13}=Adhunik Gold 72 WP (Mancozeb+ Metalaxyl)	22.1bc
T_{14}=Control	14.5e
CV (%)	6.55

Table 2. Percentage of disease incidence and disease reduction over control of late blight of potato at ARS, BARI, Rangpur during the rabi season 2010-2011

Treatment	Percentage of disease incidence	Disease reduction over control(%)
T_1=Abmanoxil 72 WP (Mancozeb+ Metalaxyl),	66.6	33.4
T_2=M- cop 50 WP (copper oxychloride)	96.6	3.4
T_3=Lagasus 60WG (pyraclostrobin metarum)	50.0	50
T_4=Netcozeb 80WP (Mancozeb)	17.3	82.7
T_5=T-cozeb 80WP (Mancozeb)	43.3	56.7
T_6=Diamond 80WP (Mancozeb)	20.0	80.0
T_7=Mayor 72WP	45.0	55.0
T_8=Doxycol 52WP (copper oxychloride)	86.6	13.4
T_9=T- Mancocymocanil 72 WP (Manco+ cymoxanil)	56.0	44.0
T_{10}=T-Maxl-72 WP (Mancozeb+ Metalaxyl)	60.0	40.0
T_{11}=Meta gold-72 WP (Mancozeb+ Metalaxyl)	63.3	36.7
T_{12}=Advance 72 WP (Mancozeb+ Metalaxyl)	16.0	84.0
T_{13}=Adhunik Gold 72 WP (Mancozeb+ Metalaxyl)	50.0	50.0
T_{14}=Control	100.0	0

Conclusion

From the trial, it was observed that the fungicides Lagasus 60WG, Diamond 80WP and Advance 72 WP were more effective for controlling late blight disease of potato.

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