

CONTROL OF LATE BLIGHT DISEASE OF POTATO BY USING NEW FUNGICIDES

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ABSTRACT

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An investigation was carried at Tuber Crops Research Sub-Centre (TCRSC), Bogra during 2002 and 2003 crop season to find out suitable fungicide(s) to combat the late blight disease of potato. Altogether 13 fungicides viz. Amcozeb, Coromil Mz-72, Dithane M-45, Filthane M-45, Mancozeb, Metaril, Melody Duo, Oxivit, Ridomil gold, Secure, Unilax, Vitamy1 Mz-72 and Zhemetalax were tested against the disease in two consecutive seasons. All the fungicides significantly reduced the late blight incidence of potato over control. Among the fungicides, Filthane M-45, Secure, Melody Duo, Ridomil gold and Metaril are highly effective to minimize late blight and to increase yield of potato.

Key words: Late blight, fungicide. Potato

INTRODUCTION

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). 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°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 Tuber Crops Research Sub-Centre (TCRSC), BARI, Bogra during 2002 and 2003 cropping seasons. The experimental site of Bogra was high land and the soil was sandy loam in texture. The P^H 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 10 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. In both the seasons seeds of potato variety, Diamant were used. Seed tubers were collected from Breeders Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh. The experiments were 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. There were 12 treatments in both the crop seasons consisting of 11 fungicides and one control. In 2002, the treatments were: Amcozeb, Coromil Mz-72 WP, Dithane M-45, Filthane M-45, Mancozeb, Metaril, Melody Duo, Oxivit, Unilax, Vitamyl Mz-72, Zhemetalax and control. All the fungicides were used at 0.2% that means 2g of fungicides per 1000 ml of water. In 2003 crop season the treatments were: Amcozeb, Filthane M-45, Mancozeb, Metaril, Melody Duo, Oxivit 50 WP, Ridomil Gold, Secure, Unilax, Vitamyl Mz-72, Zhemetalax and control. All the fungicides except Secure were used at 0.2% while 0.1% used in case of Secure. In control treatment, equal amount of plain water was sprayed. Except Dithane M-45, all the fungicides were new ones, had been introduced in the country for registration. Fungicidal solutions were prepared by dissolving definite amount of the chemicals in definite quantity of plain water. Spray was initiated just after the detection of late blight symptoms in the experimental area and repeated thrice at an interval of 10 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 were taken on foliage infection, disease severity (1-9 scale), PDI (Percent Disease Index) and yield. After harvesting tuber yield per hectare was computed based on total tuber yield per plot. Disease severity (1-9 scale) was 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.

PDI was estimated as follows by selecting 25 plants randomly from each plot:

$$PDI = \frac{\text{Class frequency}}{\text{No. plants assessed} \times \text{Highest score of scale}} \times 100$$

The crops were harvested March 6, 2002 and February 25, 2003 for 2002 and 2003 crop season, respectively. Whenever necessary data were transformed following Arcsine transformation method. Means were compared following Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez, 1984.

RESULTS AND DISCUSSION

During 2002 season, all the fungicides significantly reduced the foliage infection, PDI and tuber infection and increased the yield over control. The foliage infection due to application of different treatment ranged from 1.59 to 97.48 where the lowest and the highest foliage infection were recorded from Filthane M-45 and control (where no fungicide was applied). Although Filthane gave the minimum foliage infection numerically among the treated fungicides but it showed statistically similar to Coromil, Dithane M-45, Mancozeb, Melody Duo and Unilax (Table 1). Dithane M-45 (1.71%) ranked next to Filthane M-45 in reducing foliage infection due to *P. infestans* which was followed by Melody Duo (1.82%), Unilax (2.20%), Coromil (2.23%), Mancozeb (2.28%), Zhemetalax (2.48%), Vitamyl (2.73%), Amcozeb (2.97%), Metaril (2.97%) and Oxivit (4.40%). The effectiveness of Amcozeb, Coromil, Mancozeb, Metaril, Vitamyl and Zhemetalax on reducing foliage infection due to late blight was statistically insignificant. Among the fungicides, although Oxivit appeared the lower one compared to other used fungicides but it reduced foliage infection more than 85.0% over control. Regarding PDI, all the fungicides significantly reduced PDI of late blight over control. In ascending order reduced PDI value the fungicides may be arranged as Filthane M-45, Dithane M-45, Melody Duo, Unilax, Mancozeb, Coromil, Zhemetalax, Vitamyl, Amcozeb, Metaril and Oxivit. The PDI value ranged under the trial from 17.03 to 89.92%. PDI decreased over control of 61.0, 63.5, 65.48, 65.95, 63.82, 60.97, 65.02, 58.59, 63.95, 61.87 and

62.60% were estimated respectively by Amcozeb, Coromil, Dithane M-45, Filthane, Mancozeb, Metaril, Melody Duo, Oxivit, Unilax, Vitamyl and Zhemetalax. About 5.0% infected tuber was recorded in control which was significantly higher compared to rest treatments. Among the fungicides; Metaril and Unilax completely controlled late blight infection of tuber and they differed significantly with rest fungicides. Significant increase of yield was obtained with all the used fungicides over control. Significantly higher yield was recorded by Filthane (29.92 t/ha) which was statistically similar with rest fungicides over control except Zhemetalax. Melody Duo gave the second highest yield followed by Unilax, Oxivit, Mancozeb, Coromil, Amcozeb, Vitamyl, Dithane M-45, Metaril, Zhemetalax and control (22.33 t/ha). About 28.86, 28.21, 26.73, 33.99, 28.84, 25.03, 32.51, 30.85, 31.03, 27.72 and 14.24% yield per hectare increased over control respectively, by using Amcozeb, Coromil, Dithane M-45, Filthane, Mancozeb, Metaril, Melody Duo, Oxivit, Unilax, Vitamyl and Zhemetalax.

Results obtained from 2003 season, indicate that all the tested fungicides significantly reduced the foliage infection, PDI value and tuber infection against late blight disease and increased yield over control (Table 2). The foliage infection due to disease ranged 3.23-97.76% where the minimum and the maximum was recorded respectively, on Ridomil gold and control treatment. In order of ascending the effectiveness of fungicides may be arranged as: Ridomil gold, Secure, Unilax, Mancozeb, Filthane, Melody Duo, Metaril, Vitamyl, Zhemetalax, Amcozeb and Oxivit. The fungicides Ridomil gold, Secure and Unilax were equally effective in minimizing foliage infection and they were statistically similar and differed significantly with rest fungicides. In respect of PDI, the lowest PDI value was assessed on Ridomil gold (22.07%) followed by Secure (22.66%), Unilax (22.81%), Mancozeb (28.14%), Metaril (29.48%), Melody Duo (33.03%), Filthane (34.51%), Vitamyl (36.14%), Zhemetalax (39.55%), Amcozeb (41.77%), Oxivit (42.52%) and Control (90.37%). Statistical analysis revealed that there were no significant difference in maximum minimizing the PDI value by Ridomil gold, Secure and Unilax (Table 2) and they differed significantly with rest fungicides. The effectiveness between Mancozeb and Metaril was statistically insignificant in reducing PDI value. The fungicides Filthane, Melody Duo and Vitamyl were very close in reducing PDI value and they showed insignificant effect among them. Significantly the highest PDI value was estimated in control treatments, where no fungicide was applied about 44.06, 50.01, 55.47, 54.30, 51.23, 43.43, 61.07, 60.48, 60.35, 48.63 and 45.82% PDI decreased over control, respectively, by using Amcozeb, Filthane, Mancozeb, Metaril, Melody Duo, Oxivit, Ridomil gold, Secure, Unilax, Vitamyl and Zhemetalax. Tuber infection by *P. infestans* varied from 0.0 to 6.0% among the treatments. The three fungicides namely, Metaril, Melody Duo and Secure performed better to inhibit the *P. infestans* infection in tuber and they differed significantly with rest fungicides. About 0.5% tuber infection was recorded in Amcozeb treated crops and it differed significantly with rest fungicides and control. The performance of Filthane, Oxivit and Unilax were statistically identical in reducing tuber infection.

Regarding yield, significantly higher yield was harvested in Mancozeb (21.26 t/ha) and it showed statistically similar to Amcozeb, Filthane, Metaril, Melody Duo, Oxivit, Ridomil gold, Unilax and Vitamyl. The lowest yield was obtained in control (15.29 t/ha) but it showed statistically insignificant with only Zhemetalax. Percentages of yield increased due to fungicidal application over control in order of descending were: Mancozeb (39.04%), Filthane (34.46%), Vitamyl (30.80%), Ridomil gold (28.84%), Melody Duo (26.42%), Unilax (25.96%), Metaril (24.72%), Oxivit (24.19%), Secure (19.35%) and Zhemetalax (6.54%).

Results on the investigation of effectiveness of fungicides to minimize the disease incidence of late blight under two years field trial 2002 and 2003 indicated that all the fungicides significantly reduced the disease incidence and increased yield over control. More or less both the systemic and contact fungicides were equally effective against late blight. Among the used contact fungicides Mancozeb and Filthane M-45 showed better performance reducing disease parameters and increasing yield compared to other contact fungicides. This was in very close agreement with Khanna (1989), Singh *et al.* (1994), and Singh and Shekhawat (1999). For commercial production of potato, Kankwatsa *et al.* (2002) suggested that integration of host resistance and Mancozeb application reduced the late blight severity by more than 50% and resulted in yield gains of more than 30% which clearly supports the present investigation. De and Mohasin (1999) stated that Mancozeb gave the lowest disease incidence, highest yield and greatest net benefit against late blight. As preventive spray Mancozeb is the best late blight that has been reported by Viswanathappa *et al.* (1988). Although Oxivit (copper fungicide) showed good performance in reducing disease incidence but less effective compared to Mancozeb and Filthane M-45. The effectiveness of copper fungicides in controlling late blight of potato has been documented by Bhattacharyya *et al.* (1987). All the test systemic fungicides (Coromil, Metaril, Melody Duo, Unilax, Vitamyl, Secure, Ridomil Gold and Zhemetalax) significantly reduced the late blight incidence over control under the present investigation. Of them Coromil, Metaril, Unilax, Vitamyl, Ridomil gold and Zhemetalax contain

metalaxyl and mancozeb belong to Phenylamides; Melody Duo belongs to propineb and Secure belongs to Imidazolinones. The performance of metalaxyl in controlling late blight under present investigation has been supported by many researchers throughout the world (Singh and Shekhawat, 1999; Singh *et al.*, 2001; Islam *et al.*, 2002; Tsakiris *et al.*, 2002). According to Bradshaw (1992) metalaxyl + Mancozeb delayed disease progress more efficiently than mancozeb alone. Thind *et al.* (1989) claimed that only Ridomil controlled *P. infestans* when applied after infection. Indiscriminate use of Ridomil induce the development of *P. infestans* resistant strain of late blight throughout the world. In Bangladesh the resistant strain of *P. infestans* has also been identified (Dey and Ali, 1994). So, Ridomil Mz-72 has been withdrawn from the country and new formulation of metalaxyl like Ridomil gold, Metaril, Coromil, Vitamyl, Unilax and Zhemetalax are under process for introductions in the country whose resistant strain of *P. infestans* not yet developed in abroad. For overcoming this alarming situation mixture or alternate use of metalaxyl and mancozeb has been suggested in many countries (Gerasimova *et al.*, 1994; Singh *et al.*, 1994). Under the study Melody Duo (Propined) was effective in reducing late blight incidence and increased yield. This is in accordance with Samoucha and Cohen (1986). Apaydin *et al.* (1999) suggested to use of propineb to control late blight of potato effectively by reducing disease incidence and increased yield. Secure proved to be highly effective in managing the late blight disease and increased yield.

It may be concluded that among the new fungicides, Filthane M-45, Secure, Melody Duo, Ridomil gold and Metaril are highly effective to minimize late blight and to increase yield of potato. So, these may be recommended to control late blight disease of potato in the country.

Table 1. Effectiveness of some fungicides in controlling late blight of potato during 2002

Treatments	Foliage infection (%)	PDI	Tuber infection (%)	Yield (t/ha)
Amcozeb	2.97 c (9.92)	21.92 c (27.91)	1.0 e (5.74)	28.33 a
Coromil MZ-72wp	2.23 cdef (8.60)	19.40 def (26.13)	1.33 d (6.65)	28.63 a
Dithane M-45	1.71 f (7.52)	17.47 f (24.71)	2.5 b (9.10)	28.22 a
Filthane M-45	1.59 f (7.24)	17.03 f (24.37)	2.0 c (8.13)	29.92 a
Mancozeb	2.28 cdef (8.68)	19.55 def (25.90)	2.5 b (9.10)	28.77 a
Metaril	2.97 c (9.92)	21.92 c (27.94)	0.0 f (0.0)	27.92 a
Melody Duo	1.82 ef (7.74)	17.92 ef (25.04)	1.0 e (5.74)	29.59 a
Oxivit 50 WP	4.4 b (12.10)	24.44 b (29.64)	2.0 c (8.13)	29.22 a
Unilax	2.20 def (8.35)	18.96 def (25.80)	0.0 f (0.0)	29.26 a
Vitamyl MZ-72	2.73 cd (9.49)	21.03 cd (27.29)	1.0 e (5.74)	28.52 a
Zhemetalax	2.48 cde (9.06)	20.29 cde (26.77)	1.0 e (5.74)	25.51 b
Control	97.48 a (81.01)	89.92 a (71.58)	5.0 a (12.92)	22.33 c
Sx̄	0.442	0.557	0.246	0.803

- Means followed by the same letter within same column do not differ significantly at 5% level of DMRT

- Figures in parenthesis indicate transformed values

Table 2. Effectiveness of some fungicides in controlling late blight of potato during 2003

Fungicides	Foliage infection (%)	PDI	Tuber infection (%)	Yield (t/ha)
Amcozeb	21.4 b (27.52)	41.77 b (40.24)	0.5 e (4.05)	18.66 abc
Filthane M-45	7.64 ef (15.96)	34.51 c (35.96)	1.0 d (5.74)	20.56 ab
Mancozeb	5.89 f (14.03)	28.14 d (32.03)	1.5 c (7.04)	21.26 a
Metaril	14.96 cd (20.26)	29.48 d (32.87)	0.0 g (0.0)	19.07 ab
Melody Duo	9.92 de (18.35)	33.03 c (35.08)	0.0 g (0.0)	19.33 ab
Oxivit-50 WP	22.67 b (28.37)	42.52 b (40.69)	1.0 d (5.74)	18.99 ab
Ridomil gold	3.23 g (10.26)	22.07 e (28.0)	0.2 f (2.56)	19.70 ab
Secure	3.39 g (10.55)	22.66 e (28.43)	0.0 g (0.0)	18.25 bc
Unilax	3.37 g (10.57)	22.81 e (28.52)	1.0 d (5.74)	19.26 ab
Vitamyl MZ-72	14.01 c (21.82)	36.14 c (36.95)	2.0 b (8.13)	20.00 ab
Zhemetalax	18.35 b (25.35)	39.55 b (38.97)	1.0 d (5.74)	16.29 cd
Control	97.76 a (81.41)	90.37 a (71.93)	6.0 a (14.18)	15.29 de
Sx̄	0.9942	0.6235	0.2131	0.8089

- Means followed by the same letter within same column do not differ significantly at 5% level of DMRT

- Figures in parenthesis indicate transformed values

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