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Effect of planting time and fungicidal spray in controlling late blight of potato variety Raja

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Abstract: An experiment was conducted at breeder seed production centre, Bangladesh Agricultiural Research Institute, Debigonj, Panchagarh to find out the appropriate treatment combination against late blight of potato variety Raja during 2007-08 seasons under natural field condition. The two factor experiment comprised of planting date viz. 15th November (D_1) and 30th November (D_2) in main plot and seven different spray treatments in the sub plots viz. no spray (T_1), 1 time spray of Dithane M-45 (T_2), 2 times spray of Dithane M-45 (T_3), 1 time spray of Secure (T_4), 2 times spray of Secure (T_5), 1st spray with Dithane M-45+2nd spray with Secure (T_6), and 1st spray with Secure+2nd spray with Dithane M-45 (T_7). The higher yield (26.07 t ha^{-1}) was found from potato planted at 15th November which is increased by 34.29% than that of 30th November (20.28t ha^{-1}). Fungicidal spray showed about 2-5 & 3-8 fold less infection from control plot at 60 and 70 days after planting, respectively; while the increase in yield ranged from 2.94 to 8.32 t ha^{-1}. The interaction of the two planting time and spray treatments showed significant variations in disease severity and yield of potato. The highest yield of potato was obtained from the planting time 15th November 2 times spray of Dithane M-45 (30.68t ha^{-1}) which is statistically at per with 15th November 2 times spray of Secure (27.57 t ha^{-1}) while the lowest from 30th November no spray . The cost and return analysis revealed that 2 times spray of Dithane M-45 alone contributed the highest net return of Tk. 251850 $ha^{-1}$with benefit cost ratio 2.68 and the lowest by no spray of Tk. 132000 $ha^{-1}$with benefit cost ratio 1.91. Combination of 15th November 2 times spray of Dithane M-45 gave the highest net return of Tk.309900 ha^{-1} with benefit cost ratio 3.06 and 30th November no spray performed the lowest of Tk. 73200 ha^{-1} with benefit cost ratio 1.50. The combination of early planting and two times spray with fungicides is effective and economically viable for late blight management of potato variety Raja.
Key words: Control, Late blight, Potato, Disease.

Introduction

Potato (*Solanum tuberosum*) is the most important vegetable crop in Bangladesh. The country is 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. It has the potentiality for producing more calories and protein per unit land area with minimum time than most other major food crops (Upadhya, 1995). The area under this crop is increasing rapidly and the farmers are gradually adopting it as a cash crop. The national average yield of potato is only 14.76 t ha^{-1} in the country which is lower as compared to other potato growing countries of the world (Haque *et al.*, 2009). In the Ukraine and the Netherlands potato yield is 44.0 and 41.3 tha^{-1} respectively (Chadha, 1995; Swaminathan, 2000). One of the major constraints in potato production have been the incidence of wide range of pests and diseases. A total of 54 diseases (both biotic and abiotic) of potato have been recorded (Dey and Ali, 1994) in the country. Late blight of potato caused by *Phytophthora infestans* is a devastating disease. It causes severe yield loss in potato. 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%. Metalaxyl resistant strain of *P. infestans* has also been reported in the country (Dey and Ali, 1994). The chemical control of late blight of potato is widely adapted control measure. It was found that the early sown crops remain free from disease a longer period than the late sown crop. Normally in Bangladesh, the disease does not appear before the last week of December. Some limit of resistance against the disease was also observed earlier in some varieties. The effective control measure with the combination of cultural, biological and chemical means is of great importance in terms of economic production. Management of late blight of potato through Integrated Disease Management (IDM) procedure has extra importance because of the fact that curative treatments of fungal diseases is in most of the cases very hazardous. With a view to above background, the present piece of work was undertaken to find out the most effective integration but economically viable for late blight management.

Materials and Methods

The experiment was conducted at Breeder Seed Production Centre (BSPC), Debigonj, Panchagarh of Bangladesh Agricultural Research Institute (BARI) during Rabi season of 2007-08 to find out the most effective integration of time planting and spray for management of late blight of potato using the variety Raja as planting Materials. According to the soil test report, doses of manures and fertilizers viz. Cow dung 10 t ha^{-1}, Urea 350 kg ha^{-1}, TSP 250 kg ha^{-1}, MP 275 kg ha^{-1}, Gypsum 120 kg ha^{-1}, Magnesium sulphate, Zinc sulphate 10 kg $ha^{-1}$and boric acid 5 kg ha^{-1}were applied in the field. Cow dung, half of the dose of Urea, TSP, MOP, Gypsum, Magnesium sulphate, Zinc sulphate and Boric acid were used as basal. The remaining half of the dose of Urea was applied during earthing up. Irrigation and other intercultural operations were done as and when necessary. The experiment was laid out in split plot design with three replications. The unit plot size was 3m 3m, maintaining 60cm25cm spacing between two rows and from tuber to tuber. Well sprouted whole tubers were used as planting material of grade 'A'. There were two planting time (D_1 =15th November, D_2 =30th November) in the main plot and in the sub plots there were seven treatments viz. T_1 = No spray, T_2 = 1 time spray of Dithane M-45, T_3 = 2 times spray of Dithane M-45, T_4 = 1 time spray of Secure, T_5 = 2 times

spray of Secure, T_6 = 1st spray with Dithane M-45+ 2nd spray with Secure, T_7 = 1st spray with Secure+ 2nd spray with Dithane M-45. In case of two sprays the 2nd spray was applied 10 days after 1st spray. Dithane M-45 at 0.2% and Secure 80 wp were used at 0.1%. In control treatment, equal amount of plain water was sprayed. 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. Severity of the disease caused by *Phytophthora infestans* was recorded at 60, 70 and 80 days after planting following 1-9 rating scale (Henfling, 1979) by selecting 10 plants randomly from each unit plot. The crops were harvested after 90 DAP. Yield data was taken from the whole plot. Sprays were done at 10 days interval. Spraying was started at 40 Days after planting. 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

Effect of planting time: All the parameters tested were significantly influenced by the effect of planting time except percent leaf area infected at 80 DAP (Table 1). The performance of the two changed planting time under the study differed significantly in terms of percent leaf area infected at 60, 70 days after planting and yield of potato. Potato planted at 15th November showed very low percentage of leaf area infection (2.95, 16.86) compared to 30th November (20, 37.14) at 60 and 70 days after planting respectively. The higher yield (26.07 t ha^{-1}) was found from potato planted at 15th November while 28.55% lower yield was performed by 30th November (20.28 t ha^{-1}). Nooruddin and Mehta (1995) reported that delayed planting beyond 30 November gave lower weight of tubers per plant and fresh tuber yield. Similarly, 3rd week of November was found to be the optimum planting time for getting high yield, quality and optimum size of potato tubers followed by 1st and 3rd week of December in Anand area of Gujarat. The present findings showed that early planting of potato reduces the chance of late blight disease attributing higher tuber yield and this results is supported by the findings of Rashid and Ali (1992) who observed November 10-20 to be the best time of planting for the production of seed potatoes in Bangladesh, whereas for table potato production planting could be delayed up to 1st December but the total yields were affected when planted after 1st December.

Table 1. Effect of planting time on late blight severity and yield of potato

Date of planting	% Leaf area infected at 60 DAP	% Leaf area infected at 70 DAP	% Leaf area infected at 80 DAP	Yield (t ha^{-1})
D_1 (15th November)	2.95	16.86	95.19	26.07
D_2 (30th November)	20	37.14	95.71	20.28

Table 2. Effect of fungicidal spray on late blight severity and yield of potato

Treatments	% Leaf area infected at 60 DAP	% Leaf area infected at 70 DAP	% Leaf area infected at 80 DAP	Yield (t ha^{-1})
$T_{1(\text{No spray})}$	35.0 a	84.17 a	100.0 a	18.49 c
$T_{2(\text{1 spray of Dithane M-45})}$	10.33 c	24.17 c	95.83 b	22.66 abc
$T_{3(\text{2 spray of Dithane M-45})}$	5.0 d	15.17 d	95.0 b	26.81 a
$T_{4(\text{1 spray of Secure})}$	15.0 b	30.0 b	95.00 b	21.43 bc
$T_{5(\text{2 sprayof Secure})}$	5.0 d	13.50 de	95.00 b	23.66 ab
$T_{(\text{1st spray with Dithane M-45 +2nd spray with Secure})}$	5.0 d	11.0 e	94.83 b	24.63 ab
$T_{7(\text{1st spray with Secure+ 2nd spray with Dithane M-45})}$	5.0 d	11.0 e	92.50 c	24.55 ab
Lsd $_{(0.05)}$	2.536	2.570	2.137	3.971
Cv $_{(\%)}$	13.17	5.67	1.33	10.21

Means bearing same letter within same column do not differ significantly at 5% level by Lsd

Effect of fungicidal spray treatments: The reaction of different spray treatments on late blight severity and yield of potato is presented in the Table 2. Control treatment (T_1) showed the highest percentages of leaf area infection (35.0 , 84.17 and 100.0). The lowest percentage of leaf area infection (5.0, 11.0, and 92.50) was performed by T_7 which is statistically similar than that of T_5 T_6 and T_3 at 60, 70 and 80 days after planting. Considering yield, significant variation was observed among the spray treatments. The increased yield over control treatment (T_1) ranged from 2.94 to 6.22 t/ha. Regarding yield, spray treatments may be arranged in order to descending as; T_3 = 2 times spray of Dithane M-45 (26.81 t ha^{-1}), T_6 = 1st spray with Dithane M-45 + 2nd spray with Secure (24.63 t ha^{-1}), T_7 = 1st spray with Secure + 2nd spray with Dithane M-45 (24.55 t ha^{-1}), T_5 = 2 times spray of Secure (23.66 t ha^{-1}), T_2 = 1 time spray of Dithane M-45 (22.66 t ha^{-1}), T_4 = 1 time spray of Secure (21.43 t ha^{-1}) and T_1 = no spray (18.49 t ha^{-1}). The result of the study revealed that spraying fungicides reduces the infection of *Phytophthora infestans*. Fry (1977) observed that the use of protective fungicides could complement cultivar resistance to reduce

foliar potato late blight. Being the pathogen least adaptable to Mancozeb (Sing *et al*., 1988) could contribute the yield variation.

Table 3. Interaction of planting time and fungicidal spray on late blight severity and yield of potato

Interaction (Date of planting x spray)	% Leaf area infected at			Yield (t ha^{-1})
	60 DAP	70 DAP	80 DAP	
D_1 x T_1	20.0 c	68.33 b	100.0 a	22.41 cdef
D_1x T_2	0.67 e	18.33 f	96.67 b	25.20 bcd
D_1x T_3	0 e	5.333 g	95.0 b	30.68 a
D_1x T_4	0 e	20.0 f	95.0 b	24.83 bcd
D_1x T_5	0 e	2.0 h	95.0 b	26.16 bc
D_1x T_6	0 e	2.0 h	94.67 b	25.61 bcd
D_1x T_7	0 e	2.0 h	90.0 c	27.57 ab
D_2 x T_1	50.0 a	100.0 a	100.0 a	14.57 g
D_2x T_2	20.0 c	30.0 d	95.0 b	20.11 ef
D_2x T_3	10.0 d	25.0 e	95.0 b	22.94 cde
D_2x T_4	30.0 b	40.0 c	95.0 b	18.02 fg
D_2x T_5	10.0 d	25.0 e	95.0 b	21.16 def
D_2x T_6	10.0 d	20.0 f	95.0 b	23.66 bcde
D_2x T_7	10.0 d	20.0 f	95.0 b	21.53 def
Lsd $_{(0.05)}$	2.536	2.570	2.137	3.971
Cv $_{(\%)}$	13.17	5.67	1.33	10.21

Means bearing same letter within same column do not differ significantly at 5% level by DMRT, T_1 = No spray, T_2 = 1spray of Dithane M-45, T_3 = 2 spray of Dithane M-45, T_4 = 1 spray of Secure, T_5 = 2 spray of Secure, T_6 = 1st spray with Dithane M-45+ 2nd spray with Secure, T_7 = 1st spray with Secure +2nd spray with Dithane M-45

Table 4. Economic potential of fungicidal spray on potato for late blight management

Treatments	Fungicides (kg ha^{-1})	Cost of Spray (Tk.ha^{-1})	Yield (t ha^{-1})	Gross Return (Tk. ha^{-1})	Total Cost of Prodn. (Tk.ha^{-1})	Net Return (Tk. ha^{-1})	Benefit Cost Ratio
T_1	0	0	18.49	277350	145350	132000	1.91
T_2	1.5 (Dithane)	2475	22.66	339900	147825	192075	2.30
T_3	3 (Dithane)	4950	26.81	402150	150300	251850	2.68
T_4	0.75 (Secure)	2400	21.43	321450	147650	173800	2.18
T_5	1.5 (Secure)	4800	23.66	354900	150150	204750	2.36
T_6	1.50 (Dithane) + 0.75 (Secure)	4875	24.63	369450	150225	219225	2.46
T_7	0.75 (Secure) + 1.50 (Dithane)	4875	24.55	368250	150225	218025	2.45

Dithane M-45 = Tk 650 kg^{-1}, Secure 80 wp = Tk 1200 kg^{-1}, Potato (2007-08) = Tk 15 kg^{-1}, Spray cost for 1 time = Tk 1500 ha^{-1}, Total cost of production of potato excluding spray cost = Tk 145350 ha^{-1}

Interaction effect: The effect of spray of two fungicides once, twice and alternatively in combination of two planting time against late blight of potato are shown in Table 3. From the table it is clear that combined effect of fungicidal treatments and planting time significantly reduced disease severity and increased yield against control. The highest interaction yield of potato was obtained from 15th November × 2 times spray of Dithane M-45 (30.68 t ha^{-1}) which is statistically at per with 15th November × 1st spray with Secure + 2nd spray with Dithane M-45 (27.57 t ha^{-1}) and the lowest from 30th November × no spray (14.57 t ha^{-1}). As preventive spray Mancozeb is the best to control late blight that has been reported by Viswanathappa *et al.* (1988). The results of the study revealed that potato planted before 15th November with minimum one spray of fungicides could attribute less infection of *P. infestans* and higher yield but two times spray with fungicides is highly effective.

Economic performance: The cost and return analysis of different treatments and treatment combinations for late blight disease management of potato are presented in Table 4 & 5. The net return (NR) and benefit cost ratio (BCR) varied due to variations in yield and cost of production. In case of main effect of spray, the highest net return (Tk. 251850 ha^{-1}) and benefit cost ratio (2.68) was obtained from T_3, which was very close to T_6 (Tk. 219225 ha^{-1}) and T_7 (Tk. 218025 ha^{-1}) with 2.46, 2.45 benefit cost ratio respectively. The lowest benefit cost ratio was performed by the control treatment T_1 (1.91) with net return (Tk. 132000 ha^{-1}). Table 5 showed that early planting and spray with fungicides attributed higher net return and benefit cost ratio. De and Mohasin (1999) stated that Mancozeb gave the lowest disease incidence and highest yield and greatest net benefit against late blight. Kankwasta *et al.,* (2003) achieved the highest marginal benefit by applying Ridomil once and Dithane M-45 subsequently. All these findings are also in consistence with the present findings.

The overall results of the study revealed that potato planted before 15th November with minimum use of fungicides could attribute less infection of *P. infestans* and higher yield of potato variety Raja. The combination of early planting and two times spray with fungicides

(Dithane M-45 and/ or Secure) is effective and economically viable for late blight management.

Table 5. Economic potential of combination of planting time and spray on potato for late blight management

Treatments	Fungicides (kg ha^{-1})	Cost of Spray (Tk. ha^{-1})	Yield (t ha^{-1})	Gross Return (Tk. ha^{-1})	Total Cost of Prodn. (Tk. ha^{-1})	Net Return (Tk. ha^{-1})	Benefit Cost Ratio
D_1 x T_1	0	0	22.41	336150	145350	190800	2.31
D_1x T_2	1.5(Dithane)	2475	25.2	378000	147825	230175	2.56
D_1x T_3	3 (Dithane)	4950	30.68	460200	150300	309900	3.06
D_1x T_4	0.75(Secure)	2400	24.83	372450	147750	224700	2.52
D_1x T_5	1.5(Secure)	4800	26.16	392400	150150	242250	2.61
D_1x T_6	1.50(Dithane) + 0.75(Secure)	4875	25.61	384150	150225	233925	2.56
D_1x T_7	0.75(Secure) + 1.50(Dithane)	4875	27.57	413550	150225	263325	2.75
D_2 x T_1	0	0	14.57	218550	145350	73200	1.50
D_2x T_2	1.5(Dithane)	2475	20.11	301650	147825	153825	2.04
D_2x T_3	3 (Dithane)	4950	22.94	344100	150300	193800	2.29
D_2x T_4	0.75(Secure)	2400	18.02	270300	147750	122550	1.83
D_2x T_5	1.5(Secure)	4800	21.16	317400	150150	167250	2.11
D_2x T_6	1.50(Dithane) + 0.75(Secure)	4875	23.66	354900	150225	204675	2.36
D_2x T_7	0.75(Secure) + 1.50(Dithane)	4875	21.53	322950	150225	172725	2.15

Dithane M-45 = Tk 650 kg^{-1}, Secure 80 wp = Tk 1200 kg^{-1}, Potato (2007-08) = Tk 15 kg^{-1}, Spray cost for 1 time = Tk 1500 ha^{-1}, Total cost of production of potato excluding spray cost = Tk 145350 ha^{-1}

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