EFFECT OF PLANTING DATES AND FUNGICIDES ON POTATO LATE BLIGHT (*Phytophthora infestans* (Mont.) de Bary) DEVELOPMENT AND TUBER YIELD IN CHITWAN, NEPAL

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ABSTRACT Journal of Higher Education

A field experiment was conducted to find out the effects of different planting dates and fungicides in the control of potato late blight (*Phytophthora infestans* (Mont.) de Bary) on commercial TPS potato, variety HPS 7/67, at Rampur, Chitwan, during October 2011- March, 2012 under natural epidemiological conditions. The study consisted of four different planting dates, starting from 25th Oct. at ten days intervals and three fungicidal sprays (Acrobat, Dithane M-45, *Jeebatu*) and without spray as a check in split plot design with three replications. Planting dates were assigned to the main plots and fungicides to the sub-plots. The data revealed highly significant ($p<0.01$) difference between dates of planting for RAUDPC and tuber yield (t ha^{-1}). Potato planted on 25th Oct. showed minimum RAUDPC value (0.34) of late blight and maximum tuber yield (16.65 t ha^{-1}). Delaying in planting time, there was increased in RAUDPC value and decreasing tuber yield. Fungicides application was found highly significant ($P<0.01$) on RAUDPC and tuber yield (t ha^{-1}). Acrobat sprayed plot had minimum RAUDPC (0.2114), maximum tuber yield (11.86 t ha^{-1}). The increase in tuber yield over check was also highest in Acrobat-sprayed plots (67.63%), followed by Dithane M-45 (63.25%), and minimum in *Jeebatu* (5.98%). Considering disease development, tuber yield, efficacy and cost of fungicide application, Plantation of potato on 25th October and

Dithane M-45 spray just after initiation of disease resulted most effective management of late blight of potato.

Key words: Late blight, planting dates, fungicides, RAUDPC, efficacy.

1 INTRODUCTION

Globally, *Phytophthora infestans* (Mont.) de Bary remains a threat to the potato crops, causing significant losses annually (Guenther *et al*., 2001). Under favorable conditions, foliar late blight is the most common symptom and affecting the economic value of the potatoes.

The disease was first reported in Nepal between 1883 and 1897 (Shrestha, 1976) and has been appearing in epidemic proportions since mid 1990s. Subsequent outbreaks have been observed almost annually and cultivars previously known to resistant became susceptible to late blight. In the high hills losses have been encountered more than 75 percent and in terai losses have been reported 50-90 percent in some years (Shrestha, 2000). In Nepal, when yield loss due to late blight is estimated to a minimum level of 20 percent, the monitory loss reaches up to NRs.1.8 billion annually (Sharma and KC, 2004). Potato late blight occurs in most potato-growing areas around the world, but it can be particularly devastating in areas with warm and humid weather during the growing seasons (Hijmans *et al.*, 2000). Most of the potato growing farmers of Kathmandu valley use 10–15 times fungicides spray on Sept-Oct planting potato to control late blight (Sharma *et al*., 2007 and Dhital *et al.*, 2007).

In most parts of the developing world, the most widely grown potato genotypes are susceptible to late blight, and fungicides are necessity for crop protection. The fungicides most commonly used for control of late blight in the developing world are the low-cost dithiocarbamate-type contact fungicides, particularly mancozeb. Metalaxyl containing fungicides is also the commonly used fungicides for the controls of late blight disease in Nepal. Nowadays farmers are complaining about the poor efficacy of metalaxyl containing

fungicides. It may be due to either poor quality of product or prevalence of metalaxyl insensitive strain of *Phytophthora infestans.* Shrestha *et al*. (1998), Ghimire *et al*. (2002) and Shrestha (2005) reported prevalence of A1 and A2 mating types of *Phytophthora infestans* in Nepal. It may be one of the major reasons behind metalaxyl insensitive.

Alteration in time of planting with application of the effective fungicides tends to slow down the epidemics leading to longer periods of vegetative growth of *P. infestans*. Also, the dynamics of potato foliar blight is highly influenced by environmental conditions. The objectives of this study were to identify the suitable time of planting seedling tuber of TPS potato in chitwan and evaluate efficacy of fungicides to control the late blight of potato in field.

2 MATERIAL AND METHODS

Field experiment was conducted in the research field of Plant Pathology at Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal during October 2011 to March 2012 by planting seedling tubers of TPS potato, variety HPS 7/67 on four different dates starting from 25th October in ten days intervals with different fungicides i.e. Acrobat 50% WP (Dimethomorph), DithaneM-45 75% WP (Mancozeb), *Jeebatu* (combination of Micro-organism) and Check (without treatment) in split plot experimental design. Individual plot size was 2.5 m × 2.8 m and area of the whole field was 565.95 m^2 (38.5 m ×14.7m). There were 4 rows/plot 70 cm apart. Plant to plant distance was 25 cm. Each plot consisted of 4 rows in which each rows consisted of 10 plants. Manual cultural practices were followed as and when necessary.

Sprouted potato seed tubers were planted on four different dates i.e. October 25, November 4, 14 and 24, 2011 in rows. Plant nutrients in the form of N, P_2O_5 and K_2O @ 100:100:60 kg/ha, respectively, through urea, di-ammonium phosphate and muriate of potash,

were applied on the line demarcated just prior to planting. Farm yard manure @ 20 ton/ha was also applied on plot before planting at the time of field preparation. Sprouted tubers of approximately similar physiological age were planted at 5-6 cm depth in ridges. Two flood irrigations at 30 and 45 days after planting were given.

Chemical fungicides were sprayed for 36 days, starting as soon as the first symptoms appeared. Acrobat was sprayed at 12 days interval @ 1g/ltr, Dithane M-45 at 7 days interval @ 3.5 g/ltr, whereas *Jeebatu* at 4 days interval @ 50ml/ltr of water by the sprayer.

Disease scoring was started in the field just after the appearance of the late blight symptoms in the plot. Disease assessments ended when the non-sprayed treatment reached 100% severity.

Data analysis

The relative area under disease progress curve for the entire season was estimated using the following formula (Baker *et al*., 2000).

$$RAUDPC = \frac{\sum 0.5\,(Y_{i+1} + Y_i)\,(T_{i+1} - T_i)}{T_{total} \times 100}$$

Where,

Y_i = late blight disease severity % on the i^{th} date

T_i = date on which the disease was scored,

n = numbers of dates on which disease was scored, T_{total} was the period in days from the first to the last evaluation. Values of the RAUDPC range from 0 to 1.

The data recorded during the study were processed to fit into R-software for analysis, Microsoft excel program was used for data tabulation, and Duncan's Multiple Range Test (DMRT) was carried out at 5 % level of significance. The data entry was done to develop ANOVA table. DMRT, a mean separation technique was applied to identify most effective

treatment. Correlation and regression analysis were done for group comparison and to test the main and interaction effects (Gomez and Gomez, 1984).

3 RESULTS AND DISCUSSION

3.1 Late blight disease development

3.1.1 Relative area under disease progress curve (RAUDPC)

3.1.1.1 Effect of planting dates on RAUDPC

Analysis of variance (ANOVA) revealed highly significant ($p<0.01$) differences between date of planting for RAUDPC. Minimum RAUDPC value (0.34) was recorded in Potato planted on 25th Oct. Delay in planting time, there is increased in RAUDPC value as compared to early planted crop. RAUDPC value was found in increasing with the delay in planting time up to 4th Nov., then the RAUDPC value was found to slightly decline on 14th Nov. and again increased on 24th Nov. Potato planted on 24th November showed maximum RAUDPC (0.42) (Table 1).

Potato planted on 25th October showed minimum RAUDPC could be due to late appearance of symptoms (40 DAP) as compared to other (Table 1). This might be because of low inoculums pressure in the earlier days of planting where as in late planted potato high spore load built in the environment in the vicinity of the experimental plot.

Shrestha (1989) also mentioned that the late blight disease intensity on potato could be minimized by adjusting the planting time. He had concluded that 2nd or 3rd week of October showed complete escape or minimum late blight severity of potato in case of Chitwan.

From the beginning of 3rd December 2011 to 29 January 2012, the maximum day temperature was in between 18.57 to 22.21^{0}C and the minimum night temperature was in between 4.55 to 8.65^{0}c and the relative humidity was in between 91.52 to 94%. Besides the climatic conditions there was sufficient dew and morning till 11 a.m. All the conditions are favorable for the development of disease in epidemic form.

3.1.1.2 Effect of fungicides on RAUDPC

The application of a fungicide significantly ($P < 0.01$) reduced the RAUDPC. Relative area under disease progress curve was minimum (0.21) in Acrobat sprayed plots followed by Dithane M-45 treated plot (0.26). RAUDPC was significantly highest (0.57) in untreated plots than all the fungicides treated plots.

Sharma *et al.* (2011) also obtained that RAUDPC was minimum (0.028) in Sectin sprayed plots followed by Acrobat (0.047), and Agrifos-400 (0.083) as compared to unsprayed control plots (0.459) (Table 1). According to his finding, among the high efficacious fungicides, Sectin and Acrobat were at par in controlling the disease. There was no significant difference between *Jeebatu* sprayed and unsprayed check plots.

Shrestha (1989) reported that fungicide Dithane M-45 was found highly effective in reducing the severity of late blight disease on potato. The maximum disease was controlled in all the varieties of potato when Dithane M-45 was applied at the rate of 0.5% at 4 days interval. But under most favorable climatic conditions and high inoculums pressure it failed to protect the crop from the attack of disease.

Table 1. Effect of planting dates and fungicides on days to first symptoms appearances, RAUDPC, vine mass and tuber yield (t ha^{-1}) of potato at Rampur, Chitwan during 2011/012

Treatments	Days to first symptoms appearances (DAP)	RAUDPC	Vine mass (t ha^{-1})	Tuber Yield (t ha^{-1})
Date of planting				
25th October	40.33[a]	0.340[d]	6.77[a]	16.65[a]
4th November	30.00[b]	0.417[b]	4.28[b]	9.171[b]
14th November	26.33[c]	0.371[c]	3.01[c]	6.695[c]
24th November	24.92[d]	0.426[a]	2.66[d]	5.457[d]
F-test	**	**	**	**
SEm (±)	0.2308	0.00029	0.0052	0.2193
$LSD_{0.05}$	0.7985	0.001	0.148	0.7588
Fungicides				
Acrobat 50%WP	30.42	0.211[d]	6.042[a]	11.86[a]
Dithane M-45: 75% WP	30.33	0.267[c]	5.845[b]	11.55[a]
Jeebatu (5%V/V)	29.92	0.498[b]	2.625[c]	7.498[b]
Check (untreated)	30.92	0.578[a]	2.214[d]	7.075[b]
F-test	NS	**	**	**
SEm (±)		0.0056	0.0605	0.3126
$LSD_{0.05}$		0.00084	0.1767	0.9126
CV (%)	3.66	4.98	5.01	11.41

DAP: Days after planting, RAUDPC: relative area under disease progress curve, CV: Coefficient of variation, LSD: Least significant difference, SEm: Standard error of mean, *: significant at 0.05 level of significance, **: Significant at 0.01 level of significance. Value with the same letters in a column is not significantly different at 5% by DMRT

3.2 Tuber yield

3.2.1 Effect of planting dates and fungicides on potato tuber yield

Analysis of variance (ANOVA) revealed highly significant ($p<0.01$) effect on date of planting and fungicides treatments tuber yields. The average tuber yields for the four dates of planting potato varied between 5.457 and 16.65 t ha^{-1} (Table 1). Varying levels of late blight severity was due to change in date of planting and varying environmental conditions were reflected in tuber yields. The data revealed that maximum tuber yield (16.65 t ha^{-1}) was obtained from early planted (25th October) followed by potato planted on 4th November (9.16 t ha^{-1}) and 14th November (6.69 t ha^{-1}). The minimum tuber yield (5.45 t ha^{-1}) was obtained from 24th November planted plot (Table 1).

Potato planted on 25th October showed maximum tuber yield could be due to late outbreak of disease (40 DAP) with high vine mass at harvest and minimum RAUDPC value as compared to other whereas late planting (24th November) showed significantly lower tuber yield due to less growth of the foliage and early attack of plants by late blight (25 DAP) resulting greater RAUDPC value.

In case of fungicides application, the yields recorded in sprayed plots were significantly higher than those in unsprayed plots. Data revealed that maximum tuber yield was obtained from Acrobat-sprayed plots (11.86 t ha^{-1}) followed by Dithane M-45 (11.15 t ha^{-1}). Tuber yield was significantly lowest (7.08 t ha^{-1}) in untreated plots than all the fungicides treated plots. The tuber yield increase was highest in Acrobat-sprayed plots (67.63%) followed by Dithane M-45 (63.25%) and *Jeebatu* (5.98%) over the yield of untreated plots.

Singh and Pundhir (2012) also reported that early planted (20th Oct) susceptible potato cultivars showed highest potato yield even though it shows maximum disease severity followed by medium planted (30th Oct.) and late planted (10th Nov.)

Sharma *et al*. (2011) reported that the tuber yield increase was highest in Sectin-sprayed plots (131.9%) followed by Acrobat (127.8%), Agrifos (97.1%) and Fluazinam (84.9%) over the yield of untreated plots.

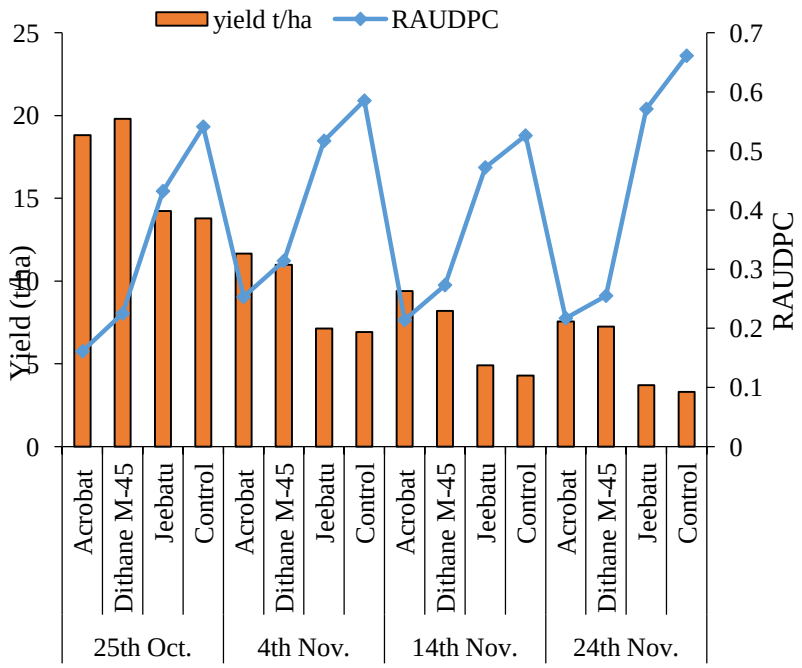

Figure 1. Effect of date of planting and fungicides spray on RAUDPC and tuber yield of potato at Rampur, Chitwan during 2011/012

3.3 Correlation between RAUDPC and tuber yield (t ha^{-1})

There was highly significant negative correlation between RAUDPC and tuber yield. Contribution of RAUDPC for reduction in tuber yield was 32% (Figure 2).

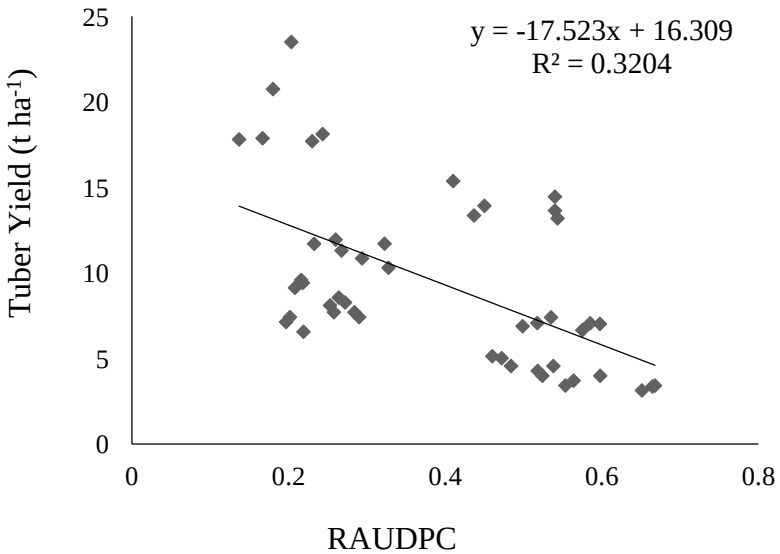

Figure 2. Correlation between RAUDPC and Tuber yield of potato at Rampur, Chitwan during 2011/012

3.4 Benefit-cost analysis of fungicide applications

Benefit per treatment was the highest (NRs. 60960) in Dithane M-45 sprayed plots, followed by Acrobat (NRs. 59040). Regarding with the benefit-cost ratio, the highest benefit-cost ratio (3.12) was obtained from Dithane M-45 sprayed followed by Acrobat sprayed plot (2.18) (Table 2).

The benefit-cost analysis demonstrated that the greatest return on investment was not necessarily from the treatment that gave the greatest disease control. Treatments with Acrobat generally had low cost-benefit ratio even though it had highest disease control due to the high cost of products.

Though Acrobat is highly effective there is possibility of developing *P. infestans* resistance to it (Stein and Kirk, 2004).

Table 2. Benefit-cost analysis of fungicides on control of potato late blight at Rampur, Chitwan during 2011/012

Treatments	Cost of fungicides application/trt/ha (Rs)	Tuber yield (ton/ha)	Yield increase due to treatment (ton)	Value of increased yield (Rs)	Benefit/treatment (Rs)	B:C ratio
Acrobat: 50%WP	27000	11.86	4.78	86040	59040	2.18
Dithane M-45:75% WP	19500	11.55	4.47	80460	60960	3.12
Jeebatu (5% V/V)	32500	7.49	0.423	7614	-24886	-0.76
Check (untreated)	0	7.07	0	0	0	

Acrobat @ NRs. 7500/kg, Dithane M-45 @ NRs. 500/ Kg, Jeebatu @ NRs. 100/ltr, Labour cost NRs. 250/head/day. 6 labours/ha/spray (NRs 1500/spray/ha), Potato selling price @ NRs 18/kg.

4 CONCLUSION

Thus, based on the present research, it can be concluded that early planted potato (25th Oct) showed minimum RAUDPC and highest potato yield. Acrobats as well as Dithane M-45 were the effective fungicides that significantly reduced late blight intensity and consequently increased tuber yield. Dithane M-45 was quite cheap and had high benefit-cost ratio as compared to Acrobat. So, plantation of potato during or before 4th week of October coupled with Dithane M-45 spray just after initiation of disease gives the good result in management of late blight resulting higher yield in susceptible potato cultivars. However, further research is to be carried out taking even before 25th October planting date at weekly intervals. Microbial product *Jeebatu* being ineffective in controlling late blight disease, its use for disease control cannot be recommended without making its further improvement.

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