

EVALUATION OF ADVANCED CLONES OF POTATO FOR THEIR RESISTANCE TO *Phytophthora infestans* IN SHORT-DAY CONDITION OF NEPAL

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ABSTRACT

Late blight is the most important fungal disease of potatoes of Nepal causing significant yield losses both in the hills and Terai. Twenty-nine genotypes received from International Potato Center were tested from 1994/95 to 1997/98 in on-station and followed by on-farm experiments for late blight resistance. On the basis of the results obtained, five genotypes namely, 387146.48, 387199.33, 387115.8, 387224.11 and 388764.26 were found late blight resistant and high yielding and selected for both Central and Mid-western Terai condition of Nepal. However, genotypes 388764.6 and 387233.6 had also shown good performance in Mid-western Terai and 387199.28 and 387231.28 performed well in Central Terai, respectively.

Additional Key words: *Solanum tuberosum*, diseases, varieties, late blight

INTRODUCTION

Late blight (LB) caused by *Phytophthora infestans* (Mont.) de Bary is the most important foliage disease which limits potato production in Nepal. The amount of yield loss depends on how early and quickly the fungus destroys the foliage (Hide and Lapwood, 1992). The loss of yield vary with the time of appearance of the disease, its severity and the cultivars. Significant losses in yield are generally recorded every year in the hills and Terai (plains) of Nepal. However, in Terai LB appears in epidemic form at 2-3 years intervals whereas in the hills it occurs annually.

Depending on the time of appearance and severity of the disease the yield losses was reported from 11 to 74 % with the susceptible cultivars and up to 15% with the field resistant cultivars (Bhattacharya, 1990). During 1995/96 and 1997/98, the blight appeared in epidemic form causing yield loss of over 75% in winter potato and tomato crops of Terai (Shrestha et al., 1998). Most of the lines and introduced varieties during late 70's in Nepal are susceptible to LB. Some genotype like Desiree, Cardinal, Kufri Sindhuri were totally destroyed by late blight during winter of 1997/98. Even some resistant varieties in the past like Kufri Jyoti, Achirana Inta, NPI - 106 became more susceptible to late blight gradually.

Worldwide selection of resistant clones to cope with late blight is one of the most challenging tasks at present. Farmers need resistant varieties to replace traditional and old improved varieties that are susceptible to late blight (Qunbao et al., 1994). Therefore, International Potato Center (CIP) received major emphasis on breeding population which is the most advanced agronomically and is derived from population A (Landeo et al., 1997). Since 1990, Potato Research Program (PRP) receives several clones developed from the breeding population from CIP for testing these at different agro-climatic condition of Nepal. PRP under Nepal Agricultural Research council (NARC) is testing some clones developed by CIP with polygenetically controlled horizontal resistance against late blight.

MATERIALS AND METHODS

In 1994/95, twenty-nine genotypes received from CIP were tested at Regional Agricultural Research Station, Parwanipur, Bara. Five tubers per genotype were planted at 60 X 25 cm spacing on Oct. 31, 1994 and harvested on Feb. 20, 1995. Fertilizers were applied at the rate of 100:100:60 kg/ha NPK and 20 t/ha FYM. No fungicides were spread against LB disease during the trial. Five observations on late blight was recorded following CIP disease score scale (1-9). Yield record (kg/plot) was adjusted according to the number of plants harvested.

In 1995/96, out of 29 genotypes mentioned above only 25 were re-evaluated at same testing site, Parwanipur with 10 tubers per row at 60 x 25 cm spacing. As late blight was not occurred during cropping period only emergence percentage, uniformity, ground cover percentage, number of stems per plant and yield per plot were recorded.

During winter season of 1996/97, promising genotypes selected from previous year testing were multiplied in terai to acquire sufficient amount of seed to conduct on-farm participatory research trials.

In 1997/98, twelve selected genotypes were evaluated for resistance to late blight in two different sites representing short-day winter season of Terai, Ambhanjyang, Makwanpur in Central Region and Mainapokhar, Bardiya in Mid-western Region. The trials were planted on Nov. 27, 1997 and harvested on March 11, 1998 at Ambhanjyang. Similarly planting and harvesting date in Mainapokhar were Nov. 12, 1997 and March 16, 1998. The trials were conducted with RCBD and three replications following standard practice of cultivation recommended by the Potato Research Program. Fertilizers and FYM was applied as in earlier years. Farmers from respective locations were involved since beginning of trials for evaluation. Meteorological data were collected from the nearby Research Stations. Late blight disease was scored following CIP scale (1-9). Number of tubers (average of 5 plants) and yield was recorded for each genotype per plot. Based on these characteristics farmers made a selection of genotypes against late blight. Statistical analysis was done following ANOVA on tuber yield.

RESULTS AND DISCUSSION

Environmental Observations

Weather parameters prevailing over the experimental area for 1995 to 1997 are presented in Fig. 1 and 2. The mean monthly temperature at RARS Parwanipur ranged maximum 22.2 °C (Jan.) to 36.5 °C (May) and minimum 6.6 °C (Dec.) to 26.3 °C (Aug.), respectively. The highest rainfall during the year was recorded in July (345.4 mm) and lowest (no rainfall) in Nov. (Fig. 1). The relative humidity ranged from 63.7 % (May) to 89.7% (Jan.). Similarly, at RARS Nepalgunj one of the representative site from dry Terai, monthly mean maximum and minimum temperature during 1995 to 1997 ranged from 22.0 °C (Jan.) to 36.7 °C (June) and 7.5 °C (Jan.) to 27.5 °C (July), respectively. Maximum rainfall was recorded in July (329.3 mm) and minimum was in March (4.7 mm). Similarly, relative humidity was maximum in December (89 %) and minimum was in May (59.3 %).

Fig. 1. Monthly mean maximum and minimum temperature, rainfall and relative humidity (average of 1995-97) at Regional Agriculture Research Station, Parwanipur, Bara.

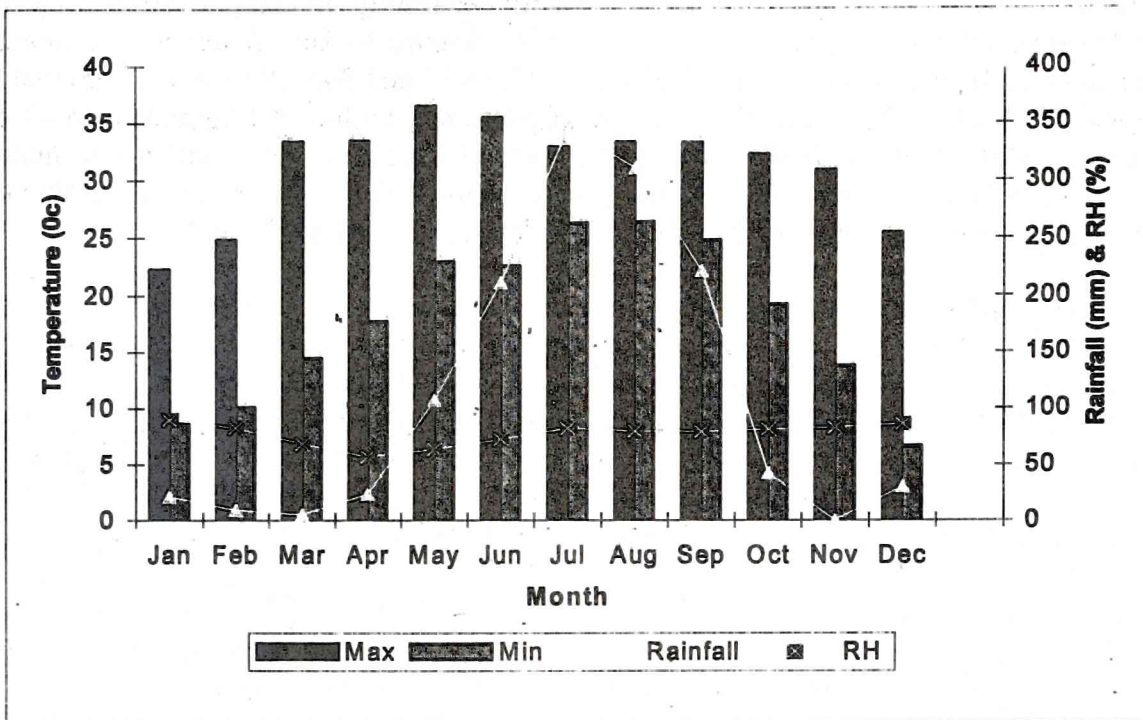
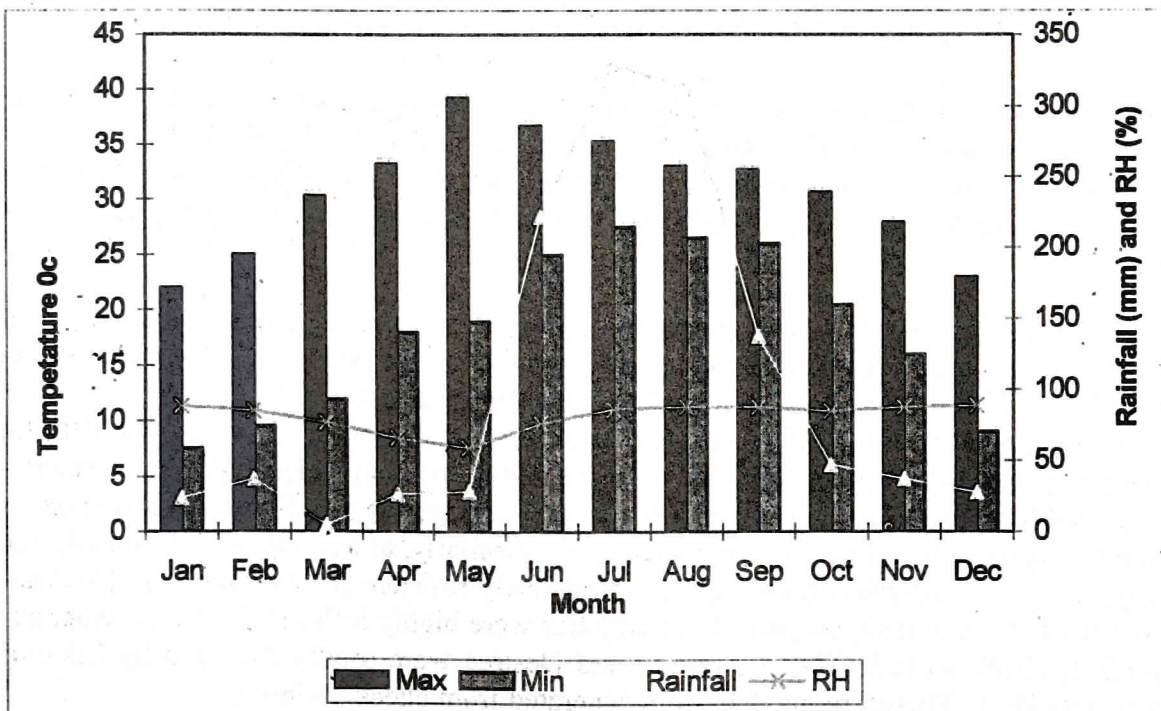


Fig. 2. Monthly mean maximum and minimum temperature, rainfall and relative humidity (average of 1995-97) at Regional Agriculture Research Station, Nepalgunj, Banke.



Phase 1. On station observation

1994/95: The genotypes were evaluated based on late blight scoring. Late blight pressure was very low during this season in Terai. Genotypes 387191.16, 387224.19, 387233.3 and 388790.24 with disease rating 3 and above were rejected for further testing. In comparison to early check variety Desiree, all other tested clones were found medium to late in maturity. Among the selected clones 381397.25, 387199.1, 387224.33, 387234.22 and 800979 were medium maturing type. Yield of check variety Kufri Sindhuri was significantly higher (2.4 kg/plot) than all other tested clones. Only clone 387146.48 had better yield (1.8 kg/plot) than another late maturing variety CIP 720088. In comparison to variety Desiree, only seven clones had better yield (Table 1). However, for further evaluation, 25 different genotypes were selected this year.

1995/96: During 1995/96-winter season, incidence of late blight disease was low and no symptoms were observed in the trial plots. Genotypes were evaluated based on only plant characteristics and yield (Table 2). Emergence counted at 30 days after planting (DAP) varied 80 to 100 %. Except 387224.33 and 387234.22, most of the genotypes had good to very good uniformity on canopy development. Ground cover varied from 35 to 90% depending on upon genotypes. Similarly, average number of main stems per plant also varied significantly ranging from 2.3 to 6.9. Highest number of main stems per plant was recorded with clone 388791.20 and lowest in Desiree.

The genotypes 387234.22, 800979, 381406.25 and 381397.25 had low tuber yields than the check variety Desiree (12.0 t/ha). In comparison to Kufri Sindhuri, genotypes 388764.26, 387224.11, 387199.33, 387199.28, 387146.48 and 387115.8 were gave higher yields exceeding 22 t. The highest tuber yield was obtained from 387199.33 (38.7 t/ha) and lowest from 387234.22 (7.3 t/ha). Based on the plant and yield characteristics, eleven clones were selected for further testing (Table 2).

Phase 2. On-farm Observation

During winter season of 1997/98, late blight resistant clones were evaluated in the farmer's field from Central and Mid-western Region and results are presented below:

Emergence: Plant emergence at both the experimental sites exceeded 83% of all tested clones at 30 DAP. However there were differences among clones on emergence (Table 3 and 4). Clone 387224.11 had 100 % emergence in both experiments. In Parwanipur, check varieties; Cardinal and Kufri Sindhuri had less emergence (75 and 74 % respectively) compared to the all introduced lines.

Late Blight scoring: In terai, the epidemic of LB is occasional depending upon weather conditions during potato growing period. In Ambhanjyang, LB scoring was started from Feb. 19, 1997 whereas, it was quite earlier in another site Mainapokhar from Dec. 28.

The materials (lines) tested at both the experimental sites were received from CIP, Lima and selected by the CIP scientists for horizontal resistance to LB (Landeo, 1997). However, LB scoring at Ambhanjyang (Table 3) shows that out of twelve genotypes, 3 are susceptible (scoring 9), 4 moderately resistant (5-6) and 5 resistant (3-4). Similarly, at Mainapokhar (Table 4) out of 12 genotypes, 2 are susceptible (scoring 8), 1 moderately resistant (6), two resistant (3-4) and 7 highly resistant. At Ambhanjyang the check varieties were highly infected scoring 9, whereas, at Mainapokhar, check varieties Kufri Sindhuri and Desiree were totally damaged by LB during first scoring 45 DAP. Therefore, no data were generated from check varieties.

Table 1. Yield and other characteristics of Initial Stage International Late Blight Trial at Parwanipur, 1994-95.

S. No.	Clones	Emergence (%) 30 DAP	Late blight score (Reading)				Plant Harvested (#)	Maturity	Yield (kg/plot)	Remarks
			I	II	III	IV				
1	381397.25	100	1	1	1	1	5	Medium	0.6	Selected
2	381406.25	100	1	1	1	1	4	Late	0.9	Selected
3	386201.3	80	1	1	1	1	4	Late	1.0	Selected
4	386219.7	100	1	1	1	1	5	Late	0.8	Selected
5	387115.8	80	1	1	1	1	4	Late	0.9	Selected
6	387121.4	100	1	1	1	1	5	Late	1.1	Selected
7	387146.48	80	1	1	1	1	4	Late	1.8	Selected
8	387191.16	60	1	1	1	4	3	Late	0.5	Rejected
9	387199.1	100	1	1	1	1	5	Medium	0.5	Selected
10	387199.28	80	1	1	1	1	4	Late	0.8	Selected
11	387199.33	100	1	1	1	1	5	Late	1.0	Selected
12	387224.11	80	1	1	1	1	4	Late	1.5	Selected
13	387224.19	100	1	1	1	3	5	Medium	0.4	Rejected
14	387224.33	100	1	1	1	1	5	Medium	0.6	Selected
15	387231.28	100	1	1	1	1	5	Late	1.0	Selected
16	387233.12	100	1	1	1	2	5	Late	1.0	Selected
17	387233.3	80	1	1	2	4	4	Late	1.5	Rejected
18	387233.5	80	1	1	1	1	4	Late	0.7	Selected
19	387233.6	100	1	1	1	1	5	Late	1.1	Selected
20	387234.22	100	1	1	1	1	5	Medium	1.5	Selected
21	388764.26	80	1	1	1	1	4	Late	1.6	Selected
22	388764.6	100	1	1	1	1	5	Late	1.5	Selected
23	388790.24	100	1	1	1	3	5	Late	1.0	Rejected
24	388791.20	100	1	1	1	1	5	Late	1.3	Selected
25	390254.31	100	1	1	1	1	5	Late	1.5	Selected
26	390254.36	100	1	1	1	1	5	Late	1.3	Selected
27	390310.33	100	1	1	1	2	5	Late	1.0	Selected
28	380389.1	80	1	1	1	1	4	Late	0.9	Selected
29	800979	100	1	1	1	1	5	Medium	0.5	Selected
30	720088 (ch)	100	1	1	1	1	5	Late	1.6	-
31	K. Sindhuri (ch)	100	1	1	2	4	5	Late	2.4	-
32	Desiree (ch)	100	1	1	1	1	5	Early	1.1	-

Table 2. Yield and other characteristics of late blight resistant clone at Parwanipur, 1995-96.

S.No	Clones Tested	Emergence	Uniformity	Ground	Stems/	Yield		Remarks
		(%) 30 DAP	(1 - 5 scale)	Cover (%)	Plant #	(kg/plot)	(t/ha)	
1	381397.25	100	4	55	6.2	1.3	8.7	Rejected
2	381406.25	100	5	65	2.9	1.4	9.3	Rejected
3	386201.3	100	5	85	5.8	2.5	16.7	Rejected
4	386219.7	100	5	85	3.9	2.6	17.3	Rejected
5	387115.8	100	5	80	4.8	3.3	22.0	Selected
6	387121.4	100	5	70	4.7	2.0	13.3	Rejected
7	387146.48	100	5	80	4.0	5.3	35.3	Selected
8	387199.1	100	5	65	3.6	2.1	14.0	Rejected
9	387199.28	100	5	80	3.8	3.5	23.3	Selected
10	387199.33	100	5	90	6.7	5.8	38.7	Selected
11	387224.11	100	4	70	4.7	4.7	31.3	Selected
12	387224.33	100	3	45	3.8	1.9	12.7	Rejected
13	387231.28	80	4	40	3.0	3.1	20.7	Selected
14	387233.12	90	4	45	3.7	1.8	12.0	Rejected
15	380389.1	90	5	60	4.3	2.0	13.3	Rejected
16	387233.5	100	5	75	6.4	2.3	15.3	Rejected
17	387233.6	100	5	70	3.7	3.1	20.7	Selected
18	387234.22	90	3	35	2.4	1.1	7.3	Rejected
19	388764.26	90	5	40	4.5	4.1	27.3	Selected
20	388764.6	90	5	60	2.7	3.1	20.7	Selected
21	388791.20	100	5	70	7.8	2.9	19.3	Selected
22	390254.31	100	5	60	4.0	2.4	16.0	Rejected
23	390254.36	90	4	70	2.8	2.8	18.7	Rejected
24	390310.33	100	5	80	6.6	3.4	22.7	Selected
25	800979	100	4	40	2.4	1.6	10.7	Rejected
26	Desiree (ch)	100	4	60	2.3	1.8	12.0	-
27	Kufri Sindhuri (ch)	100	5	65	4.6	3.1	20.7	-

Table 3. Plant and yield characteristics of late blight resistant lines in the farmers' field, Ambhanjyang, Makwanpur, 1997-98

S.N	Clones	Emergence (%) 30 DAP	Late Blight Scoring (reading)				Plant Harvested (#)	# Tubers/plant (avg of 5)	Yield		Farmers rating *	Remarks
			I	II	III	IV			(kg/plot)	t/ha)		
1	386219.7	97	8	8	9	9	23	15	5.7	15.7	1	Very short dormancy
2	387146.48	83	3	3	3	4	20	12	12.1	33.5	4	
3	387233.6	83	5	5	6	6	20	12	10.0	27.9	3	Long stolen
4	376199.28	92	2	3	5	5	23	13	10.9	39.3	5	
5	387199.33	97	2	2	3	4	23	18	10.06	29.5	5	Tuber cracking
6	387231.28	97	4	4	6	6	22	9	9.9	27.4	3	
7	387115.8	93	2	2	4	5	23	11	12.4	34.5	4	
8	388764.6	83	2	2	3	3	23	13	9.8	27.2	5	
9	390310.33	93	9	9	9	9	23	8	6.6	18.4	1	
10	387224.11	100	1	2	3	4	24	14	11.6	32.2	5	
11	388764.26	95	2	2	2	4	24	17	14.2	39.4	5	
12	388791.2	93	8	8	9	9	23	17	9.2	25.6	2	
13	Cardinal (ch.)	75	9	9	9	9	21	9	3.5	9.8	1	
14	Khfri Sindhuri (ch)	74	6	7	9	9	22	11	5.8	16	3	

* 5 = Best and 1 = Worst

Table 4. Plant and yield characteristic of LB resistant lines in the farmer's field, Mainapokhar, Bardiya, 1997-98

S.N.	Clones	Emergence (%) 30 DAP	Late blight scoring (reading) (Date/Month)					Tubers/Plant (avg. of 5)	Yield		Remarks
			I	II	III	IV	V		(kg/plot)	(t/ha)	
1	386219.7	98	1	2	7	8	8	15	5.9	16.3	
2	387146.48	87	1	1	1	1	2	15	13.0	36.1	
3	387233.6	87	1	1	1	1	2	14	12.1	33.7	
4	387199.28	94	1	1	1	2	3	17	9.7	27.4	
5	387199.33	98	1	1	1	1	1	21	15.2	42.3	
6	387231.28	92	1	1	1	2	4	12	9.3	25.9	
7	387115.8	90	1	1	1	1	1	12	13.3	36.9	
8	388764.6	87	1	1	1	1	1	19	13.1	36.3	Long stolen
9	390310.33	94	1	2	5	6	6	11	6.9	19.1	
10	387224.11	100	1	1	1	1	2	13	11.3	31.4	
11	388764.26	92	1	1	1	1	1	21	15.1	41.9	Long stolen, weak steams
12	388791.2	97	1	2	7	8	8	14	5.3	14.3	
	CV (%)									10.8	
	LSD (0.05)									**	
										5.5	

Results obtained from experimental sites shows that incidence of LB was higher in Ambhanjyang than in Mainapokhar. However, in both experimental sites, genotypes 386219.7, 390310.33 and 388791.2 were found highly susceptible and had highest score against LB.

Tuber yield: Number of tubers per plant also varied from 11-21 in Mainapokhar and 8-18 in Ambhanjyang respectively. Depending upon the individual genotype, highest numbers of tubers were obtained from clones 387199.33 (21 and 18) at both experimental sites and this genotype was found highly resistant in both sites.

The yield per plot differed significantly in both sites (Table 3 and 4). In Ambhanjyang all tested clones had better yield than check varieties except 386219.7 which had only 5.7 kg/plot. The highest yields in both sites ranged 30-42 t/ha. Clone 387199.33 had highest yield (42.0 t/ha) at Mainapokhar but 29.5 t/ha at Ambhanjyang. The genotype 388764.26 was found highest yielder in both sites (41.9 and 39.4 t/ha).

CONCLUSIONS AND RECOMMENDATION

Based on emergence percentage, late blight tolerance and yield data, clones 387146.48, 387199.33, 388764.6, 387224.11 and 388764.26 were found suitable for both Terai belt of Nepal. Beside these, other genotypes; 387233.6, 376199.28, 387231.28 and 387155.8 had also good performance in the Western Terai: but these genotypes need to reevaluation before recommendation can be made to the farmers. It needs more evidence from on-farm trials at least one more year. It is, thus, recommended that such type of study on genotype evaluation against late blight should be included in regular screening program of Potato Research Program in future.

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