

# Early maturing late blight resistant potato for cereal based system of Indo-Gangetic Plains

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## Abstract

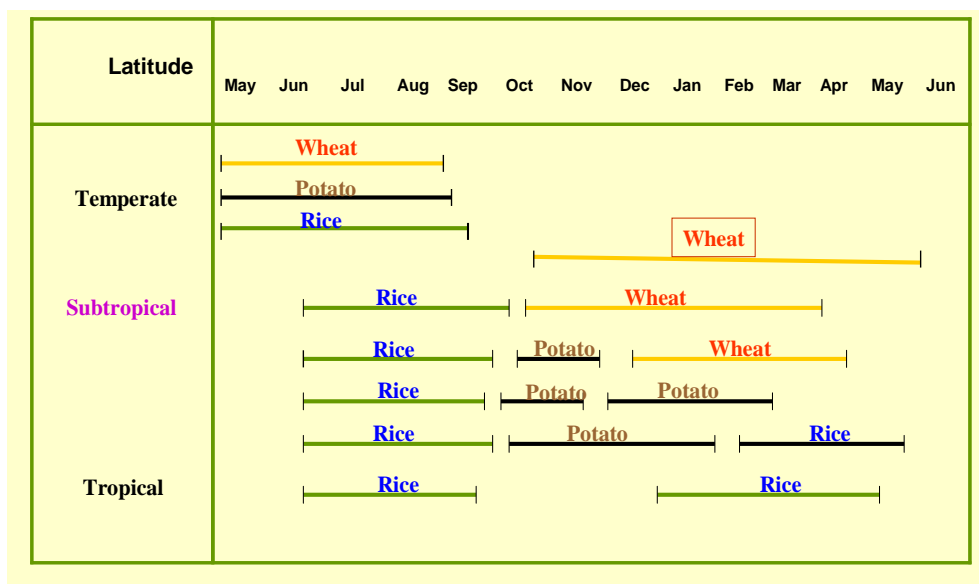
The lack of early bulking potato varieties and high late blight (LB) pressure due to mild temperatures and cool foggy weather limits potato production in the sub-tropical lowlands of Indo-Gangetic Plains (IGP). Potato's main niche is between two rice crops. The present study aimed to identify early maturing LB resistant potato varieties to plant after harvesting summer/fall rice and planting spring rice to enhance farm income. The field experiments were conducted in Bangladesh during 2007-08 and 2008-09 crop seasons at three locations. Visual observations of foliage infection with LB were recorded at weekly intervals starting from 27 days after planting (DAP). The crop was dehaulmed at 75 and 90 DAP to assess maturity periods. Late blight appeared early and spread fast in susceptible clones (391004.19, 391046.14, 396004.33, 3960.31.11) and the control variety Diamant. The susceptible clones and Diamant were devastated before senescence. Four clones (393077.15, 393085.5, 393371.58, 395011.2) out of 12 clone were found moderately resistant (MR) to LB. Average tuber yield of Diamant was recorded <9 t/ha compared to > 20t/ha of promising MR clones when harvested at 75 and 90 DAP. Two year field evaluation data concludes that two CIP clones:393371.58 and 395011.2 would be acceptable to farmers as they out-yielded most liked variety Diamant, have MR to LB and standard tuber characteristics and can fit effectively in cereal based systems in IGP enable farmers to generate greater income and enhance productivity of the systems.

**Keywords:** Early maturing, sub-tropical lowlands, late blight, clone.

## Introduction

The rice-wheat is the dominant cropping system in the sub-tropical IGP, but there are many other important cropping systems practiced by farmers for sustainable livelihoods. Fertile land and enhanced irrigation facilities have provided farmers with opportunities for crop diversification and intensification. The kharif (wet season) rice-potato-boro (summer season) rice is the emerging cropping system in Eastern IGP (Bangladesh and West Bengal, India). The role of potato and wheat in rice-based cropping systems by latitude is presented in Figure-1 (Graham et.al 2007). In Bangladesh, potato is the third largest food crop next to rice and wheat and is highly profitable compared to cereals. Nearly 9.2 million tons potatoes were produced from 0.5 million ha in Bangladesh in 2007-08 crop season (Hossain et.al 2008). The non-availability of 75 days late blight resistant varieties for rice based cropping system is major constraints to enhance productivity and profitability of cropping system. Late blight (*Phytophthora infestans*) is a most damaging disease for winter potatoes in IGP. The losses can go over 60% if crop is infected at early growth stage. The disease generally appears at the first week of January when the day temperature range 14-19<sup>o</sup> c and night temperature 9-14<sup>o</sup> c accompanied with foggy weather and heavy deposition of dew drops (Dey et.al 2008). The indiscriminate use of metalaxyl containing fungicides has developed metalaxyl resistant strain. The varieties Raja, Dheera and K.Jyoti having moderate resistant to late blight have also become susceptible. The Tuber Crops Research Center, Bangladesh and International Potato Center (CIP) have been working jointly in Bangladesh to test LB CIP advanced clones in sub-tropical lowlands under short day conditions and to identify promising 75 day clones to release varieties that can produce higher tuber yields than present varieties Cardinal and Diamant and fit in the existing rice-rice systems.

More than 0.15 million ha area can be brought under rice-potato-rice system by providing promising LB resistant 75 day potato to resource poor farmers.



**Figure 1. Agro-ecological description of the role of potato in wheat/rice based cropping system by latitude**

## Material and methods

Ten and twelve CIP advanced clones were evaluated at three locations (Bogra, Munshigonj and Jamalpur) conducive to LB in sub-tropical tropical lowlands in winter season under short day conditions in 2007-08 and 2008-09, respectively. For comparison, the dominant variety Diamant was planted. The uniform size of tubers of each clone/variety was planted in replicated (3 replication) plots of 2.4x3m size at 60x25 cm spacing in RCBD. The crop was planted in last week of November and dehaulmed at 75 and 90 days after planting (DAP) to evaluate for maturity. Recommended doses of fertilizers and intercultural operations were applied. No fungicide was applied at any stage to protect crop from LB. The percentage of leaf infection recorded at 10 days interval from 50 days after planting in 2007-08 and at weekly intervals after 27 days after planting in 2008-9 crop seasons. The tuber yield, average tuber weight and tuber characteristics were recorded at harvesting time. The data were analyzed statistically.

## Results and discussion

The percentage infection of late blight recorded in 2007-08 and 2008-09 crop seasons is presented in Table 1 and 2. No CIP clone or Diamant exhibited complete resistance to late blight. Some clones found resistant in first year showed late blight infection in second year. The late blight appeared first at Bogra site during both years indicating that environmental condition of this location is more congenial to late blight spread than Munshigonj and Jamalapur. Second year (2008-09), the late blight appeared early and spread fast in susceptible clones (391004.19, 391046.14, 396004.33, 3960.31.11) and in variety Diamant (Table-2). Five CIP clones and Diamant were completely devastated at 63 days after planting before natural senescence. Four clones (393077.15, 393085.5, 393371.58, 395011.2) were found moderately resistant (MR) to LB.

The CIP clones performed better than variety Diamant for tuber yield (Table-3). Average tuber yield of Diamant was recorded <9 t/ha compared to > 20t/ha of promising moderately resistant clones when harvested at 75 and 90 DAP. The Diamant and some clones infected severely at early stage and therefore could not produce good yield. The mean tuber yield of two CIP clones:393371.58 and 395011.2 was recorded 21.7 and 21.0 t/ha, respectively, greater than other clones and Diamant when harvested at 75 days after planting (Table-3). CIP

clone 393085.5 gave maximum tuber weight (50g) followed by 393077.15 (47g), 393371.58 (42g) and 395011.2 and 396244.12 (41 g each) when harvested at 75 DAP (Table-4). The tuber weight of clones and variety Diamant infected by late blight at early stage was recorded significantly lower than moderately LB resistant clones. The clones giving maximum average tuber weight and yield at 75 DAP are only to be selected for further testing at farmer fields.

The tuber skin colour, tuber shape, eye depth and flesh colour of CIP clones and variety Diamant recorded at harvest are given in Table-5. The tuber characters play a vital role in selecting a variety because of consumers' liking. The oblong, oval or round yellow skin tubers having fleet eyes are most liked in Bangladesh. The pure red tubers are also acceptable. Two year field evaluation data concludes that two CIP clones (393371.58 and 395011.2) will be commercially acceptable as they out-yielded dominant variety Diamant, have MR to LB and standard tuber characteristics and can fit successfully in rice based systems in Indo-Gangetic Plains to generate greater income and enhance food security.

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**Table 1: Performance of CIP clones and Diamant variety to late blight resistant in Bangladesh during 2007-08**

CIP clones/varieties	Percentage of leaf infection at different duration														
	50DAP			60 DAP			70 DAP			80 DAP			90 DAP		
	Locations			Locations			Locations			Locations			Locations		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
LB1 (391004.19)	10	0	0	22	0	0	50	6	0	72	57	8	78	95	18
LB2 (391046.14)	4	0	0	35	0	0	82	10	0	92	53	5	95	99	13
LB3 (391058.18)	1	0	0	2	0	0	4	0	0	8	2	0	13	20	7
LB4 (393077.15)	3	0	0	5	0	0	6	2	0	8	7	0	12	38	0
LB 5 (393085.5)	2	0	0	4	0	0	5	0	0	4	2	0	8	12	0
LB6 (393280.64)	-	0	0	-	0	0	-	0	0	-	3	0	-	38	0
LB7 (393371.58)	1	0	0	1	0	0	2	0	0	4	2	0	5	12	0
LB 8 (395011.2)	1	0	0	2	0	0	3	1	0	4	8	0	5	38	0
LB11 (396031.11)	-	0	-	-	0	-	-	1	-	-	7	-	-	42	-
LB12 (396031.119)	8	0	-	25	0	-	68	5	-	78	32	-	82	87	-
LB14 (396244.12)	4	0	0	7	0	0	12	2	0	17	12	0	28	43	0
Diamant	10	0	0	53	0	0	83	16	0	96	72	0	96	83	4
LSD <sub>0.05</sub>	3	0	0	5	0	0	9	3	0	5	13	3	4	19	3

DAP- Days After Planting, Locations: a- Bogra, b-Jamalpur, c-Munshigonj. LB are TCRC number

**Table 2. Performance of CIP clones to late blight resistant at three locations in Bangladesh during 2008-09**

CIP clones/varieties	% Infection of foliage by late blight																										
	27 DAP			34 DAP			41 DAP			49 DAP			56 DAP			63 DAP			70 DAP			77 DAP					
	Locations			Locations			Locations			Locations			Locations			Locations			Locations			Locations					
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
LB1 (391004.19)	10	0	0	22	0	0	50	6	0	72	57	8	78	95	18	83	100	21	97	100	25	100	100	25			
LB2 (391046.14)	4	0	0	35	0	0	82	10	0	92	53	5	95	99	13	99	100	16	100	100	20	100	100	20			
LB3 (391058.18)	1	0	0	2	0	0	4	0	0	8	2	0	13	20	7	20	83	17	90	100	23	100	100	27			
LB4 (393077.15)	3	0	0	5	0	0	6	2	0	8	7	0	12	38	0	13	63	0	30	91	4	32	98	5			
LB 5 (393085.5)	2	0	0	4	0	0	5	0	0	4	2	0	8	12	0	9	56	0	30	85	0	34	95	0			
LB6 (393280.64)	-	0	0	-	0	0	-	0	0	-	3	0	-	38	0	-	70	0	-	92	0	-	97	0			
LB7 (393371.58)	1	0	0	1	0	0	2	0	0	4	2	0	5	12	0	6	53	0	32	85	2	38	96	2			
LB 8 (395011.2)	1	0	0	2	0	0	3	1	0	4	8	0	5	38	0	6	63	1	37	87	5	38	97	5			
LB9 (396004.33)	7	0	0	18	0	0	53	16	0	70	60	7	73	98	15	73	100	22	98	100	28	100	100	28			
LB11 (396031.11)	-	0	-	-	0	-	-	1	-	-	7	-	-	42	-	-	73	-	-	98	-	-	100	-			
LB12 (396031.11)	8	0	-	25	0	-	68	5	-	78	32	-	82	87	-	82	100	-	97	100	-	100	100	-			
LB14 (396244.12)	4	0	0	7	0	0	12	2	0	17	12	0	28	43	0	30	100	5	76	93	12	94	100	12			
Diamant	10	0	0	53	0	0	83	16	0	96	72	0	96	83	4	99	100	13	100	100	18	100	100	18			
LSD <sub>0.05</sub>	3	0	0	5	0	0	9	3	0	5	13	3	4	19	3	6	10	4	5	8	7	4	2	6			

DAP- Days After Planting, Locations: a- Bogra, b-Jamalpur, c-Munshigonj. LB are TCRC number

**Table 3. Performance of CIP clones and variety for tuber yield during 2007-08 and 2008- 09**

CIP clones/variety	Tuber yield (t/ha)											
	75 DAP (2008-09)				90 DAP (200708, 2008-09)							
	I	II	III	Mean	I		II		III		Mean	
				a	b	a	b	a	b	a	b	
LB1 (391004.19)	9.3	5.1	18.7	11.0	38.2	10.9	11.9	5.2	16.3	22.6	22.1	12.9
LB2 (391046.14)	6.5	2.3	14.4	7.7	37.0	9.8	12.3	3.5	25.9	17.2	25.1	10.2
LB3 (391058.18)	20.1	14.2	16.9	17.1	33.1	20.4	7.6	15.2	-	21.7	20.4	19.1
LB4 (393077.15)	17.9	13.1	22.7	17.9	34.0	22.9	24.1	16.8	22.9	31.4	27.0	23.7
LB 5 (393085.5)	25.6	18.2	13.8	19.2	-	33.7	18.2	22.3	-	18.1	18.2	24.7
LB6 (393280.64)	16.6	-	16.6	16.6	34.2	22.8	20.8	-	25.5	23.0	26.8	23.8
LB7 (393371.58)	24.7	17.7	22.7	21.7	49.7	33.5	22.2	18.7	-	28.7	36.0	27.0
LB8 (395011.2)	25.5	21.4	16.1	21.0	40.8	33.6	22.2	25.7	31.9	21.4	31.6	26.9
LB9 (396004.33)	10.8	3.9	9.6	8.1	-	29.0	-	4.2	-	12.8	-	15.8
LB11 (396031.11)	16.4	-	-	16.4	28.6	19.8	16.8	-	-	-	22.7	19.8
LB12 (396031.11)	10.9	3.5	-	7.2	32.9	12.9	15.4	5.3	-	-	24.2	12.9
LB14 (396244.12)	20.5	12.0	18.8	17.1	43.1	22.7	18.8	13.5	39.4	26.9	33.8	22.7
Diamant	5.5	3.2	14.0	7.6	38.3	8.1	11.7	5.6	16.3	17.8	22.1	8.1
LSD <sub>0.05</sub>	5.4	3.3	4.6	-	3.9	5.8	4.0	3.9	2.3	5.9	-	-

CIP numbers in parentheses; LB are TCRC number; DAP-days after planting; I-Jamalpur; II-Bogra; III-Munshigonj;a=2007-08; b= 2008-09

**Table 4. Performance of CIP clones and variety for average tuber weight during 2007-08 and 2008- 09**

CIP clones/variety	Average tuber weight (g)												
	75 DAP (2008-09)				90 DAP (200708, 2008-09)								
	I	II	III	Mean	I		II		III		Mean		
				a	b	a	b	a	b	a	b	a	b
LB1 (391004.19)	14	12	31	19	102	17	32	13	34	37	56	22	
LB2 (391046.14)	13	5	28	15	81	18	27	7	52	40	53	22	
LB3 (391058.18)	35	31	52	39	92	41	23	34	-	63	58	46	
LB4 (393077.15)	41	43	56	47	54	46	38	56	51	75	48	59	
LB 5 (393085.5)	56	50	46	50	-	66	38	55	-	53	38	58	
LB6 (393280.64)	32	-	26	29	61	37	38	-	47	36	49	41	
LB7 (393371.58)	47	44	34	42	89	60	42	49	-	43	66	51	
LB 8 (395011.2)	40	48	37	41	63	45	38	51	62	47	54	36	
LB9 (396004.33)	28	16	36	27	-	65	-	17	-	42	56	43	
LB11 (396031.11)	27	-	-	27	70	32	41	-	-	-	41	45	
LB12 (396031.11)	17	19	-	18	66	20	31	22	-	-	46	29	
LB14 (396244.12)	40	40	43	41	98	45	45	43	88	60	77	45	
Diamant	13	14	40	23	79	16	30	22	42	45	50	28	
LSD <sub>0.05</sub>	9	12	11	-	18	18	10	13	10	11	-	-	

CIP numbers in parentheses; LB are TCRC number; DAP-days after planting; I-Jamalpur; II-Bogra; III-Munshigonj;a=2007-08; b= 2008-09

**Table 5. Tuber characters of CIP clones and Diamant evaluated for late blight resistance**

CIP clones/variety	Tuber characters			
	Skin Colour	Tuber shape	Eye Depth	Flesh Colour
LB1 (391004.19)	Yellow	Oblong	Shallow	Yellow
LB2 (391046.14)	Yellow	Oblong	Shallow	Yellow
LB3 (391058.18)	Yellow	Oblong-round	Shallow	Yellow
LB4 (393077.15)	Yellow, picked eyes	Round	Medium	Light Yellow
LB 5 (393085.5)	Dull brown, russetting	Oval to flat	Shallow	Yellow
LB6 (393280.64)	Red	Round	Medium	Yellow
LB7 (393371.58)	Yellow, picked eyes	Round	Shallow	Light Yellow
LB 8 (395011.2)	Yellow	Oval	Shallow	Yellow
LB9 (396004.33)	Yellow	Round	Shallow	Yellow
LB11 (396031.11)	Yellow	Round	Shallow	Yellow
LB12 (396031.11)	Yellow	Oval	Shallow	Yellow
LB14 (396244.12)	Yellow	Oval to oblong	Shallow	Yellow
Diamant	Yellow	Oblong	Shallow	Yellow

