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Survey for Incidence and Intensity of Potato Late Blight in Begusarai and Samastipur Districts under North Bihar

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Abstract Potato is the most important vegetable crop and cultivated mainly during *rabi* season in Bihar. Late blight, (*Phytophthora infestans*), the most devastating disease of potato, was found prevalent in all the surveyed fields of Begusarai district showing late blight incidence of 11.63% to 50.18% and 18.37% to 61.12% and late blight intensity 6.10% to 36.35% and 6.51% to 39.62% during the year 2013 and 2014 respectively, whereas late blight incidence of 15.33% to 56.20% and 22.73% to 68.77% and late blight intensity 9.56% to 44.57% and 10.30% to 46.21% were recorded during the year 2013 and 2014 respectively in Samastipur district. The late blight incidence was minimum (11.63% and 18.37%) at flowering stage and reached maximum (56.20% and 68.77%) at 15 days before dehaulming stage during both the year 2013 and 2014. The blight intensity was also recorded minimum (6.10% and 6.51%) at flowering stage and reached maximum (44.57% and 46.21%) at 15 days before dehaulming during both the years 2013 and 2014. The lesser blight incidence and intensity was recorded in 2013, compared to those in 2014. The fields of Samastipur district exhibited more disease incidence and intensity compared to the fields of Begusarai district at both the stages of flowering and 15 days before dehaulming during both the years of 2013 and 2014. The late blight incidence and intensity in both the districts of Begusarai and Samastipur increased with advancement in crop growth stage from flowering to dehaulming in both the surveyed years.

Keywords Potato, Late blight, Disease intensity, Disease incidence.

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Introduction

Potato (*Solanum tuberosum* L.) is one of the important and widely cultivated vegetable crop of India. India's total production of potato ranks fourth in the world although in cultivated area it ranks third [1, 2]. In India potato is cultivated in 20.32 lakh hectares producing 46.61 metric tonnes of tubers with productivity of 22.9 tonnes per hectares. Bihar ranks third after Uttar Pradesh and West Bengal is terms of area, production and productivity. In Bihar potato is cultivated in 31.8 lakh hectares producing 6.53 metric tonnes of tuber with productivity of 19.7 tonnes per hectare [3]. Late blight by the Oamycete *Phytophthora infestans* (Mont.) de-Bary, is the most limiting production factor for potato [4]. There are several constraints for low productivity of potato in Bihar and among these constraints, late blight of potato is one of the highly destructive disease and the most important constraint in the profitable cultivation of potato

(*Phytophthora infestans* (Mont.) de-Bary). The pathogen produces water soaked lesions with chlorotic borders that are small at first but expand very fastly under humid conditions, blightening the entire plant only within a few days with subsequent rotting of the developing tubes resulting in heavy yield losses under favorable conditions each year. Losses of upto 10 to 75% by the disease have been reported in India. In view of the dynamic nature of potatoes late blight and its negative impact on potato production, the current status of this disease in the districts Begusarai and Samastipur of North Bihar was informed by the need for effective and sustainable options for managing the disease in this area.

Materials and Methods

A systematic survey was conducted is major potato growing districts viz., Begusarai and Samastipur of North Bihar during 2013-14 and 2014-15 in *rabi* cropping season. In each district potato fields were sampled at block level, taking four blocks in each district and four villages in each block. At each village four fields were randomly selected for recording observations on late blight incidence and intensity. The package of practices adopted for raising the crop were also enquired from each grower for future interpretations and inferences.

Disease incidence

An area of 1m × 1.5m was randomly marked at 10 different places in the field for recording the total number of diseased and healthy plants at flowering stage and 15 days before dehaulming of the crop mathematically.

$$\text{Late blight incidence (\%)} = n/N \times 100$$

Where 'n' is the number of plants showing blight symptoms and 'N' is the total number of plants examined. An average of the ten assessments in the fields represented the average disease incidence of the field.

Disease intensity

An area of 1m × 1.5m was randomly marked at 10 different places in the field and the observation on the extent of the foliage blighted was recorded at flowering stage and 15 days before dehaulming using the disease rating scale given by Mohan and Thind (1999).

Disease score	Score description in terms of foliage infected (%)
0	No visible symptoms
1	1-10
2	11-25
3	26-50
4	51-75
5	> 75

The disease intensity was calculated by using the following formula.

$$\text{Late blight intensity (\%)} = \frac{\text{Summation of numerical rating}}{\text{No. of plants examined} \times \text{maximum disease score}} \times 100$$

Results and Discussion

The data presented in Table 1 reveal that the prevalence of the disease in Begusarai district at all the locations surveyed with varying degrees of incidence. Fields of Naokothi block exhibited maximum blight incidence (47.36%) followed by those in Khodawandpur (45.85%) Bakhri (46.75%) and Cheriabariarpur (41.72%) respectively at 15 days before dehaulming during the year, 2014 where as the fields of Khodawandpur recorded highest late blight incidence (39.52%) followed by Bakhri (38.70%), Naokothi (35.70%) and Cheriabariarpur (31.44%) respectively at the same crop stage during the year 2013. The fields of Naokothi block showed maximum blight incidence (26.48%), followed by Khodawandpur (26.46%), Bakhari (23.95%) and Cheriabariarpur (22.61%) respectively at flowering stage during the surveyed year 2014 where as the fields of Khodawandpur block were recorded with maximum blight incidence (19.48%) followed by Bakhri (18.18%), Naokothi (17.92%) and Cheriabariarpur (16.81%) respectively at the same crop stage during the surveyed year 2013. The data recorded during the year 2013 revealed that the prevalence of potato late blight incidence in the fields of different four blocks of Begusarai districts

Table 1. Incidence of late blight of potato at various locations in Begusarai and Samastipur districts of North Bihar during 2013-2014 cropping season.

			Late blight disease incidence (%)					
			2013		2014		Mean (2013-14)	
District	Block	Village	I	II	I	II	I	II
Begusarai	Cheriabariarpur	Korjana	15.66	28.27	20.95	39.52	18.30	33.89
		Arjun Tol	20.51	39.82	27.48	51.88	29.99	45.85
		Makashpur	17.99	30.56	23.66	40.23	20.82	35.39
		Vikrampur	13.08	27.11	18.36	35.28	18.37	31.18
		Mean	16.81	31.44	22.61	41.72	20.37	36.58
	Khodawandpur	Mushahari	18.95	38.34	26.94	44.15	22.94	41.24
		Khodawandpur	24.46	47.70	28.51	48.94	26.48	48.32
		Matihani	20.97	43.98	23.66	54.16	23.31	49.07
		Malmalla	13.54	28.07	26.72	36.15	20.13	32.11
		Mean	19.48	39.52	26.46	45.85	23,21	42.68
	Naokothi	Sakarpura	11.63	26.21	22.25	37.65	16.44	31.93
		Gangraha	17.42	31.28	26.55	44.21	21.98	37.74
		Simri	17.88	35.16	26.48	46.49	22.18	40.72
		Koelamohan	24.76	50.18	30.66	61.12	27.71	55.65
		Mean	17.92	35.70	26.48	47.36	22.07	41.51
	Bakhri	Naokothi	14.87	28.87	24.15	40.67	19.51	34.77
		Pahsara	18.15	40.33	24.05	50.00	21.10	45.17
		Mahisbara	18.96	42.45	25.78	52.84	22.37	47.64
		Bagar	20.77	43.18	21.82	53.45	21.29	48.31
		Mean	18.18	38.70	23.95	46.75	21.06	43.97
		Mean	18.09	36.34	24.87	45.42	21.51	41.18
Samastipur	Bivutipur	Patelia	16.77	36.87	22.73	44.08	19.75	40.51
		Sankhmohan	19.50	34.85	24.00	42.93	21.75	30.89
		Narhan	18.51	34.99	24.44	48.88	21.47	44.43
		Karrakh	19.99	48.14	28.75	57.77	24.37	52.45
		Mean	18.69	39.16	24.98	48.41	21.83	42.07
	Hashanpur	Hashanpur	19.88	40.55	30.67	50.18	25.27	45.36
		Sakarpura	17.94	36.47	23.35	57.26	20.64	46.86
		Rampur	23.87	56.20	35.42	61.25	39.64	58.72
		Nayanagar	21.08	55.33	33.22	68.77	27.15	62.05
		Mean	20.94	47.88	30.66	61.11	25.67	54.49
	Rosera	Bhirha	15.33	29.42	25.72	40.94	20.52	35.18
		Dharhi	17.81	34.83	28.16	46.69	22.98	40.76
		Kapan	21.78	37.47	30.13	53.55	25.45	45.51
		Kalhua	20.44	37.80	28.12	57.78	24.28	47.79
		Mean	18.84	34.80	28.03	49.74	23.31	42.62
	Dalsinghsarai	Rampur	16.81	29.37	28.54	33.74	22.67	31.55
		Pagra	18.09	35.52	28.13	59.56	23.11	43.54
		Kanaila	20.51	36.18	28.78	55.53	24.64	45.85
		Kyota	16.43	28.15	24.98	39.81	20.70	33.98
		Mean	17.96	32.30	27.10	47.66	22.78	38.73
		Mean	19.10	38.73	27.11	53.73	23.39	45.47

ranged from 15.66% to 20.51%, 13.54% to 24.46%, 11.63% to 24.76% and 14.87% to 20.77% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri blocks at flowering stage where as the late blight incidence ranging from 27.11% to 39.82%, 28.07% to 47.70%, 26.21% to 50.18% and 28.87% to 43.18% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri block at 15 days before dehaulming during the same surveyed year 2013.

The late blight incidence in the different four blocks of Begusarai district oscillated in the range of

18.37% to 27.48%, 23.66% to 28.51%, 22.25% to 30.66% and 21.82% to 25.78% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri blocks at flowering stage during the year 2011 where as the late blights incidence ranging from 39.52% to 51.88%, 36.15% to 54.16%, 37.65% to 61.12% and 40.67% to 53.45% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri block at 15 days before the dehaulming stage during the same surveyed year 2014.

The average of late blight incidence of both the years at flowering stage was recorded highest (23.21%) with the fields of Khodawandpur block and followed by the fields of Naokothi (22.07%), Bakhri (21.06%) and Cheriabariarpur (20.37%) of Begusarai district. The similar trend for average of late blight incidence was recorded at 15 days before dehaulming. In Samastipur district, the highest average of late blight incidence of both the years at flowering stage was recorded from the fields of Hashanpur block (25.67%) and followed by Rosera (23.31%), Dalsingsarai (22.78%) and Bivutipur (21.83%), respectively though the fields of Hashanpur block showed maximum average of late blight incidence (54.49%) followed by Rosera (42.67%), Bivutipur (42.07%) and Dalsingsarai (38.73%) respectively at 15 days before dehaulming.

The data in Table 1 also indicate that the fields of Hashanpur block recorded maximum percentage of blight incidence (61.11%) and followed by Rosera (49.74%), Bivutipur block (48.11%) and Dalsingsarai (47.66%) at 15 days before dehaulming stage during the year 2014 where as at flowering stage the maximum late blight incidence (30.66%) was recorded from the fields of Hashanpur block and followed by Rosera (28.12%), Dalsingsarai (27.10%) and Bivutipur (24.98%) during the same surveyed year 2014. The highest late blight incidence (47.58%) was recorded in the fields of Hashanpur block followed by Bivutipur (39.96%), Rosera (34.80%) and Dalsingsarai (32.30%) at 15 days before dehaulming during the year 2013 where as at flowering stage during the same year the maximum late blight incidence (20.94%) was recorded from the fields of Hashanpur block and followed by Rosera (18.84%), Bivutipur (18.69%) and Dalsingsarai (17.46%). The data recorded during the year 2013 season revealed that the prevalence of potato late blight incidence in four blocks of Samastipur district ranged from 16.77% to 19.99%, 17.94% to 23.87%, 15.33% to 21.78% and 16.81% to 20.51% respectively from Bivutipur, Hashanpur, Rosera and Dalsingsarai at flowering stage where as ranging from 34.85% to 48.14%, 36.47% to 56.20%, 29.42% to 37.80% and 28.15% to 36.18% respectively recorded from Bivutipur, Hashanpur, Rosera and Dalsingsarai during the same surveyed year at 15 days before dehaulming. The potato late blight incidence in the four blocks of Samastipur district oscillated in the range of 22.73% to 28.75%, 23.35 to 35.42%, 25.72% to 30.13% and 24.98% to 28.78% respectively in Bivutipur, Hashanpur, Rosera and Dalsingsarai blocks respectively at flowering stage and 42.93% to 57.77%, 50.18% to 68.77%, 40.94% to 57.78 and 33.74% to 59.56% respectively in Bivutipur, Hashanpur, Rosera and Dalsingsarai at 15 days before dehaulming during the year 2014. The fields of Samastipur exhibited more average of late blight incidence (53.73%) at 15 days before dehaulming and 27.11% at flowering stage in compared to Begusarai where late blight incidence (45.42%) at 15 days before dehaulming stage and 24.87% at flowering stage were recorded during the course of surveyed year 2014. The average of late blight incidence at 15 days before dehaulming stage (38.73%) and at flowering stage (19.10%) in the fields Samastipur district were also found more in compared to late blight incidence (36.34%) at 15 days before dehaulming and (18.09%) at flowering stage during the surveyed year 2013 in Begusarai district.

In Samastipur district, the highest average of late blight incidence of both the years at flowering stage was recorded from the fields of Hashanpur block (25.67%), and followed by Rosera (23.31%) Dalsingsarai (22.78%), and Bivutipur (21.83%) respectively where as maximum average incidence of blight at 15 days before dehaulming was recorded from the fields of Hashanpur (54.49%), followed by Rosera (42.62%), Bivutipur (42.07%) and Dalsingsarai (38.73%). The average of late blight incidence of both the year at flowering (23.39%) at 15 days brfore dehaulming (45.47%) in Samastipur district were also found more in compared to Begusarai district where average of late blights incidence of both the years at

Table 2. Intensity of late blight of potato at various locations in Begusarai and Samastipur districts of North Bihar during 2013-2014 cropping season.

			Late blight disease intensity (%)					
			2013		2014		Mean (2013-14)	
District	Block	Village	I	II	I	II	I	II
Begusarai	Cheriabariarpur	Korjana	8.30	27.80	8.41	32.40	8.35	30.10
		Arjun Tol	6.10	18.91	8.50	21.05	7.30	19.98
		Makashpur	9.08	25.15	9.80	27.82	9.44	26.50
		Vikrampur	7.50	19.58	8.65	25.94	7.85	22.76
		Mean	7.74	22.86	8.84	26.81	8.23	24.83
	Khodawandpur	Mushahari	8.94	30.10	10.70	30.88	9.82	30.49
		Khodawandpur	9.50	28.05	9.90	32.40	9.70	30.22
		Matihani	7.35	21.16	9.72	25.72	8.53	23.44
		Malmalla	9.70	22.14	12.40	24.93	11.05	23.53
		Mean	8.87	25.36	10.68	28.48	9.77	26.92
	Naokothi	Sakarpura	11.62	32.44	13.16	34.42	12.39	33.43
		Gangraha	7.10	20.94	9.90	23.91	8.50	22.42
		Simri	9.51	27.85	8.46	26.12	8.98	26.98
		Koelamohan	6.60	21.91	6.51	18.97	6.55	20.44
		Mean	8.70	25.78	9.50	25.85	9.10	25.81
	Bakhri	Naokothi	8.67	20.05	9.85	24.85	9.26	22.45
		Pahsara	14.65	36.35	15.11	39.62	14.88	37.98
		Mahisbara	8.70	20.50	12.56	24.81	10.63	22.65
		Bagar	11.36	23.15	11.75	27.52	11.55	25.33
		Mean	10.84	20.01	12.31	29.20	11.58	27.10
		Mean	9.03	23.52	10.33	27.58	9.67	26.16
Samastipur	Bivutipur	Patelia	12.93	31.75	18.40	34.30	15.66	33.02
		Sankhmohan	13.70	32.15	20.75	36.50	17.22	34.32
		Narhan	11.10	32.44	17.08	33.26	14.09	32.85
		Karak	9.56	24.39	15.40	24.55	12.48	24.47
		Mean	11.82	30.18	17.90	32.15	14.86	31.16
	Hashanpur	Hashanpur	10.62	28.50	11.50	30.08	11.06	29.29
		Sakarpura	11.56	34.74	11.48	34.52	11.52	34.63
		Rampur	10.36	28.50	10.76	30.18	10.56	29.34
		Nayanagar	12.83	30.92	20.41	35.47	16.62	33.19
		Mean	11.34	30.66	13.53	32.56	12.44	31.61
	Rosera	Bhirha	10.75	30.94	10.30	32.84	10.52	31.89
		Dharhi	12.34	42.46	14.70	43.75	13.52	43.10
		Kapun	15.10	38.25	15.35	45.81	15.22	42.03
		Kalhua	14.20	44.57	14.90	44.95	14.55	44.76
		Mean	13.09	39.05	13.81	41.83	13.45	40.44
	Dalsinghsarai	Rampur	12.08	32.90	12.45	36.42	12.26	34.66
		Pagra	10.70	36.57	11.85	38.96	11.27	37.73
		Kanaila	10.54	32.43	11.34	39.98	10.94	36.20
		Kyota	13.89	42.72	14.97	46.21	14.43	44.46
		Mean	11.80	36.14	12.65	40.39	12.22	38.26
		Mean	12.01	34.00	14.47	36.70	13.24	40.3

flowering stage and 15 days before dehaulming were recorded 21.51% and 41.18% respectively.

The data (Table 2) reveal that prevalence of the disease in Begusarai at all the locations surveyed with varying degrees of intensity. Fields in block Bakhri showed maximum late blighting intensity (29.20%) followed by Khodawandpur (28.48%) Cheriabariarpur (26.81%) and Naokothi (25.85%) respectively at 15 days before dehaulming during the surveyed year 2014 where as the fields of Naokothi exhibited maximum late blights intensity (25.78%) followed by Khodawandpur (25.36%), Cheriabariarpur (22.86%) and Bakhari (20.01%) at the same crop stage during

the surveyed year 2013. The fields of Bakhri block recorded maximum late blight intensity (12.31%) followed by Khodawandpur (10.68%), Naokothi (9.50%) and Cheriabariarpur (8.84%) at flowering stage during the surveyed year 2014 where as maximum blight intensity of 10.84% was recorded from the fields of Bakhari and followed by Khodawandpur (8.87%), Naokothi (8.70%) and Cheriabariarpur (7.74%) at the same crop stage during the surveyed year 2013. The data recorded during the year 2013 reveal that the prevalence of potato late blight intensity in the fields of four blocks of Begusarai district oscillated from 6.10% to 9.08%, 7.35% to 9.50%, 6.60% to 11.62% and 8.67% to 14 .65% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri block at the flowering stage where as during the surveyed year 2014 at the same crop stage, the late blight intensity ranged from 8.41% to 9.80%, 9.72% to 12.40%, 6.51% to 13.16% and 9.85% to 15.11% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri block. The potato blight intensity ranged from 18.91% to 27.80%, 21.16% to 30.10%, 20.94% to 32.44% and 20.05% to 36.35% respectively in the fields of Cheriabariarpur, Khodawandpur, Naokothi and Bakhri blocks at 15 days before dehaulming stage during the year 2013 though during the year 2014 at the same crop stage the late blight intensity ranged from 21.05% to 32.40%, 24.93% to 32.40%, 18.97% to 34.42% and 24.81% to 39.62% respectively in Cheriabariarpur, Khodawandpur, Naokothi and Bakhri block.

In Samastipur district the maximum late blight intensity (41.83%) was recorded from the fields of Rosera block followed by Dalsingsarai (40.39%), Hashanpur (32.56%) and Bivutipur block (32.15%) respectively at 15 days before dehaulming during the year 2014 where as during the year 2013 the maximum late blight intensity (39.05%) was recorded from Rosera block and followed by Dalsingsarai (36.14%), Hashanpur (30.66%) and Bivutipur (30.18%) respectively at the same crop stage. The fields of Bivutipur block showed maximum late blight intensity (17.90%) and followed by Rosera (13.81%) Hashanpur (13.53%) and Dalsingsarai (12.65%) respectively during the year 2014 at flowering stage where as fields of Rosera block showed maximum blight intensity (13.09%) and followed by Bivutipur (11.82%) Dalsingsarai (11.80%) and Hashanpur (11.34%) during the year 2013 at the same crop stage. The data (Table 2) reveal that the late blight intensity ranged from 24.55% to 36.50%, 30.08% to 35.47%, 32.84% to 45.81% and 36.42% to 46.21% respectively in Bivutipur, Hashanpur, Rosera and Dalsingsarai during the year 2014 at 15 days before dehaulming stage where as late blight intensity ranged from 24.39% to 32.44%, 28.50% to 34.74%, 30.94% to 44.57% and 32.43% to 42.72% respectively in Bivutipur, Hashanpur, Rosera and Dalsingsarai at the same crop stage during the year 2013. The late blight intensity ranged from 15.40% to 20.75%, 10.76% to 20.41%, 10.30% to 15.35% and 11.34% to 14.97% were recorded respectively from the fields of Bivutipur, Hashanpur, Rosera and Dalsingsarai at the flowering stage during the year 2014 where as during the year 2013 at the same crop stage the late blight intensity ranged from 9.56% to 13.70%, 10.36% to 12.83%, 10.75% to 15.10% and 10.54% to 13.89% were respectively recorded from Bivutipur, Hashanpur, Rosera and Dalsingsarai block.

The disease was prevalent in all the surveyed fields of Begusarai district showing late blight incidence of 11.63% to 50.18% and 18.37% to 61.12% (Table 1) and late blight intensity 6.10% to 36.35 and 6.51% to 39.62% (Table 2) during the year 2013 and 2014 respectively whereas late blight incidence of 15.33% to 56.20% and 22.73% to 68.77% (Table 1) and late blight intensity 9.56% to 44.57% and 10.30% to 46.21% (Table 2) were recorded during the year 2013 and 2014 respectively in Samastipur district. The late blight incidence was minimum (11.63% and 18.37%) at flowering stage and reached maximum (56.20 and 68.77%) at 15 days before dehaulming stage during both the year 2013 and 2014. The late blight intensity was also recorded minimum (6.10% and 6.51%) at flowering stage and reached maximum (44.57% and 46.21%) at 15 days before dehaulming during both the year 2013 and 2014. The lesser blight incidence and intensity was recorded in 2013 compared to those in 2014, seems to be owing to the predisposing environment conditions, which prevailed during 2014 and led to increased disease development and spread. The role of environmental factors such as temperature and high relative humidity in the development of late blights epidemic has been well documented [5]. In general the fields in Samastipur district exhibited more disease incidence and inten-

sity in compared to the fields of Begusarai district at both the stages flowering and 15 days before dehaulming during both the years 2013 and 2014. The cultivation of potato over large continuous areas with delayed sowing of tuber from last week of November to first week of December along with the application of tuber as seed from infected and poor quality of old seed stocks seem to have led to more increased disease incidence and intensity in surveyed fields of Samastipur district during both the years. The increased disease incidence affecting the potato yield. Late blight (*Phytophthora infestans*), was found prevalent in all the potato growing villages with incidence of 9.99 to 53.33% and 14.76 to 57.77% and intensity 6.61 to 38.90% and 5.71 to 46.75% in 2011 and 2012 respectively in Jammu and Kashmir [6].

The adoption of different cropping patterns and the use of different undescriptive varieties in the fields also account for differences in incidence and intensity for different locations surveyed in both the districts during both the years. The increased disease incidence and intensity effecting the potato yield. The yield losses during the year 2014 have been reported up to 40.55% in Bihar. Potato yield may be reduced by 50.70% based on severity of disease late blight [7]. The losses due to disease seem to vary from location to location and district to district depending on the prevailing environment condition, vulnerability of crop variety, sowing time and quality of tuber used as seed and adoption of different cropping patterns. All these factors need, therefore to be taken into account while deciding at adoption of management components for the disease late blight of potato.

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