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Original Research Article

Studies on status of Late Blight Disease (*Phytophthora infestans* (Mont) de Bary) of Potato in Kashmir Valley

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A B S T R A C T

Late blight, (*Phytophthora infestans*), the most devastating disease of potato, was found prevalent in all the potato growing areas of Kashmir valley with incidence 6.66 to 59.99% and 11.11 to 62.22 % in 2007 and 2008. During 2007 and 2008 prevalence of potato late blight in all the surveyed districts with the terminal blight incidence ranging between 39.25 to 49.62 per cent, and 36.29 to 43.45 per cent respectively with district Srinagar recording the maximum and district Budgam the minimum incidence. Similarly disease intensity ranging from 2.57 to 45.52 and 3.50 to 48.35 per cent during the year 2007 and 2008 was recorded. The terminal late blight intensity among districts oscillated in the range of 23.52 to 37.98 per cent, with Srinagar recording the maximum and Anantnag the lowest terminal blight intensity. Both the late blight incidence and intensity increased with advancement in crop growth stage from flowering to dehaulming in both the surveyed years.

Keywords

Late blight; (*Phytophthora infestans*; blight incidence; intensity.

Introduction

Potato (*Solanum tuberosum* L.) is the fourth most important food crop in the world (Marnique, 2000) after wheat, rice and corn (Rhodes, 1982). Potato is grown in various climatic conditions throughout the world (Haverkot, 1990; and Rhodes, 1982) in about 18.6 million hectares in 150 countries, and is an important part of global food supply (Anonymous, 2003). India is the third largest producer of potato in the world, producing about 24.4 million tonnes of fresh potato from about 1.15 million hectares (Kalloo *et al*, 2005).

The area under crop in the Jammu and Kashmir state is approximately 2500 hectares with production of 22589.20 tonnes (Anonymous, 2009). Among other constraints late blight disease of potato is one of the highly destructive disease (Chycoski and Punja, 1996; Fry and Goodwin, 1997; Song, *et al.*, 2003) and a major constraints 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 rapidly under humid conditions, blighting the entire plant in only a few days with subsequent rotting of the developing tubers resulting in heavy yield losses under favourable conditions each year (Flier, *et al.,* 2001) with reduction in global production by approximately 15 per cent (Anonymous, 1997). Losses of up to 10 to 75 per cent by the disease have been reported in India (Dutta, 1979).

Since establishing the status and the resultant yield losses of the disease are pre-requisite for deciding at the logical components of decision making in the adoption of integrated disease management. Therefore, The objective during the present investigation was achieved by undertaking surveys of major important potato growing districts of Kashmir valley

Materials and Methods

Survey

A systematic survey was conducted in major potato growing districts viz., Anantnag, Baramulla, Budgam, Pulwama, and Srinagar of Kashmir valley during 2007 and 2008 cropping seasons. In each district potato fields were sampled at block level, taking three villages in each block. At each village/ location, three 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 1 m x 1.5 m was randomly marked at 10 different places in the field for recording the total number of diseased and healthy plants at flowering stage and 10 days before dehaulming of the crop. Mathematically,

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

Where n is the number of plants showing blight symptoms and N 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 x 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 10 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

Disease Incidence

The data presented in Table-1 reveals prevalence of the disease in all the

Table.1 Incidence of late blight of potato at various locations of Kashmir during 2007-2008, cropping season

District	Block	Village	Late blight Disease incidence (%)					
			2007		2008		Mean 2007-08	
			I	II	I	II	I	II
Anantnag	Kulgam	Damhal/Hanjipora	15.55	26.66	22.22	37.77	18.88	32.22
		Devsar	13.33	26.66	17.77	44.44	15.55	35.55
		Kulgam	13.33	26.66	17.77	31.11	15.55	28.88
		Mean	14.07	26.66	19.25	37.77	16.66	32.22
	Phalgam	Ashimuqam	9.99	33.33	17.77	37.77	13.88	35.55
		Mattan	19.99	46.66	17.77	51.11	18.88	48.88
		Pahalgam	17.77	39.99	17.77	44.44	17.77	42.22
		Mean	15.91	39.99	17.77	44.44	16.84	42.22
	Varinag	Duroo	15.55	43.33	22.22	51.11	18.88	47.22
		Kukarnag	19.99	56.66	22.22	57.77	21.11	57.22
		Verinag	19.99	53.33	24.44	55.55	22.22	54.44
		Mean	18.51	51.11	22.96	54.81	20.73	52.96
	Mean		**16.16**	**39.25**	**19.99**	**45.66**	**18.07**	**42.46**
Baramulla	Rohama	Bosian	19.99	44.44	22.22	48.88	21.10	46.66
		Rafiabad	13.33	39.99	17.77	44.44	15.55	42.22
		Dangiwacha	11.11	39.99	17.77	42.22	14.44	41.10
		Mean	14.81	41.47	19.25	45.18	17.03	43.32
	Sopore	Botangoo	11.11	44.44	15.55	37.77	13.33	41.10
		Sopore	19.99	55.55	22.22	39.99	21.10	47.77
		Sangrama	13.33	35.55	17.77	37.77	15.55	36.66
		Mean	14.81	45.18	18.51	38.51	16.66	41.84
	Tangmarg	Gulmarg	17.77	33.33	15.55	42.22	16.66	37.77
		Narbal	24.44	53.33	24.44	57.77	24.44	55.55
		Yarikha	17.77	35.55	17.77	42.22	17.77	38.88
		Mean	19.99	40.73	19.25	47.40	19.62	44.06
	Mean		**16.53**	**42.46**	**19.00**	**43.69**	**17.77**	**43.08**
Budgam	Chadoora	Badipura	13.33	35.55	22.22	39.99	17.77	37.77
		Bugam	13.33	39.99	17.77	44.44	15.55	42.22
		Gurwat	13.33	35.55	17.77	37.77	15.55	36.66
		Mean	13.33	37.03	19.25	40.73	16.29	38.88
	Khansahib	Arizal	15.55	46.66	22.22	39.99	18.88	43.33
		Khansahib	19.99	39.99	24.44	51.11	22.22	45.55
		Parinoo	19.99	57.77	24.44	48.88	22.22	53.32
		Mean	18.51	48.14	23.71	46.66	21.11	47.40
	Soibugh	Khag	15.55	43.33	17.77	51.11	16.66	47.22
		Sholipora	13.33	40.00	17.77	39.99	15.55	39.99
		Soibugh	15.55	46.66	22.22	57.77	18.88	52.22
		Mean	14.81	43.33	19.25	49.62	17.03	46.47
	Mean		**15.55**	**42.83**	**20.73**	**45.66**	**18.14**	**44.25**

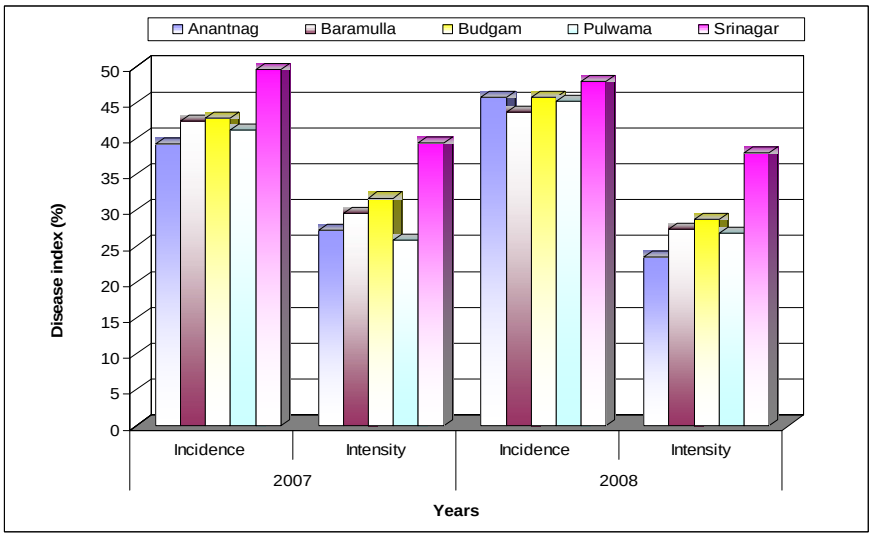
Table-1 Contd…

		Abham	6.66	33.33	15.55	37.77	11.10	35.55
	Keller	Achgosh	19.99	51.11	17.77	37.77	18.88	44.44
		Keller	17.77	35.55	15.55	37.77	16.66	36.66
		Mean	14.80	39.99	16.2	37.77	15.54	38.88
		Muran	13.33	37.77	22.22	42.22	17.77	39.99
Pulwama	Rajpora	Rajpura	17.77	42.22	22.22	46.66	19.99	44.44
		Shadimarg	11.11	37.77	15.55	37.77	13.33	37.77
		Mean	14.07	39.25	19.99	42.22	17.03	40.73
		Hurpura	17.77	46.66	17.77	51.11	17.77	48.88
	Shopian	Zainpura	19.99	44.44	22.22	57.77	21.10	51.10
		Khansahib	13.33	42.22	22.22	57.77	17.77	49.99
		Mean	17.03	44.44	20.73	55.55	18.88	49.99
	Mean		**15.30**	**41.22**	**18.99**	**45.17**	**17.15**	**43.20**
		Ganderbal	22.22	53.33	17.77	48.88	19.99	51.10
	Ganderbal	Lar	13.33	37.77	11.11	31.11	12.22	34.44
		Tulmullah	15.55	42.22	22.22	51.11	18.88	46.66
		Mean	17.03	44.44	17.03	43.70	17.03	44.06
		Gunbugh	15.55	59.99	22.22	62.22	18.88	61.10
Srinagar	Srinagar	Maloora	19.99	59.99	24.44	62.22	22.21	61.10
		Palpora	19.99	55.55	24.44	57.77	22.21	56.66
		Mean	18.51	58.51	23.70	60.73	21.10	59.62
		Fraw	15.55	42.22	17.77	37.77	16.66	39.99
	Kagan	Kangan	19.99	53.33	15.55	37.77	17.77	45.55
		Kullun	15.55	42.22	17.77	42.22	16.66	42.22
		Mean	17.03	45.92	17.03	39.25	17.03	42.58
	Mean		**17.52**	**49.62**	**19.25**	**47.89**	**18.42**	**48.75**

Data presented as average of 27 observation across the village; data recorded at flowering (1) and 10 days before dehaulming (11) during the cropping season

locations surveyed with varying degrees of incidence. Fields in district Srinagar exhibited the maximum blight incidence (46.52%) followed by those in Budgam (42.03%), whereas Baramulla, Pulwama and Anantnag fields displayed lesser late blight incidence (40.23 to 40.96%) at dehaulming. Among blocks at the same crop stage, Srinagar fields recorded the maximum late blight incidence (57.36%) followed by Verinag fields (50.73%), whereas Kulgam fields exhibited the least incidence (29. 99%) of the disease. The villages where more than 50 per cent late blight incidence was recorded were Maloora, Gungbugh and Palpora in block Srinagar, Narbal in block Tangmarg, Kokernag and Verinag in block Verinag and Parinoo in block Khansahib, where as a blight incidence of less than 30 per cent was recorded in villages Kulgam and Damhal/Hanjipora of block Kulgam at the same crop stage. The data recorded during 2007 season revealed the prevalence of potato late blight in all the surveyed districts with the terminal blight incidence ranging between 39.25 to 49.62 per cent, district Srinagar recording the maximum and district.

Figure.1 Status of potato late blight at various locations in Kashmir during 2007 and 2008 cropping seasons



Budgam the minimum incidence. Among blocks, the maximum terminal blight incidence was recorded in block Srinagar of district Srinagar (58.51%) followed by that in block Verinag of district Anantnag (51.11%), whereas the block Kulgam of district Anantnag exhibited the minimum terminal blight incidence (26.66 %). The villages which exhibited terminal blight incidence of more than 50 per cent are Kangan in block Kangan, Ganderbal in block Ganderbal, Palpora Maloora and Ganbugh in block Srinagar, Sopore in block Sopore Narbal in block Tangmarg, Achgosh in block Keller, Verinag and Kokernag in block Verinag, and Parinoo in block Khanshaib. However, all the surveyed villages viz., Damhal/Hanjipora, Kulgam and Devsar in block Kulgam, exhibited the lowest terminal blight incidence of 26.66 per cent only. Similar trend of late blight incidence in potato fields located in different districts and blocks in Kashmir was observed during 2008 cropping season. The blight incidence increased with advancement in crop growth stage from flowering to dehaulming. The terminal late blight incidence among districts oscillated in the range of 36.29 to 43.45 per cent, with Srinagar recording the maximum and Budgam the lowest terminal blight incidence. Among blocks, the maximum terminal blight incidence was recorded in block Srinagar of district Srinagar (56.29 %) followed by that in block Verinag of district Anantnag (50.36%), whereas the block Kulgam of district Anantnag and block Keller of district Pulwama exhibited the minimum terminal blight incidence (26.66%). The villages which exhibited terminal blight incidence of more than 50 per cent are Palpora, Maloora and Gangbugh in block Srinagar, Narbal in block Tangmarg, Zainpura and Khansahib in block Shopian, Kalnag and Kakernag in block Verinag and Soibugh and Sholipora in block Soibugh. However, all the surveyed villages viz., Damhal/Hanjipora, Devsar, Kulgam in block Kulgam exhibited the lowest terminal blight incidence of 26.66 per cent only.

Table.2 Intensity of late blight of potato at various locations of Kashmir during 2007 and 2008 cropping seasons

District	Block	Village	Late blight Disease intensity (%)					
			2007		2008		Mean 2007-08	
			I	II	I	II	I	II
Anantnag	Kulgam	Devsar	6.5	25.39	3.50	21.50	5.07	23.71
		Kulgam	7.5	19.59	8.50	17.40	8.05	18.67
		Mean	7.97	22.16	7.56	19.44	7.82	20.76
	Phalgam	Ashimuqam	8.33	30.90	9.8	24.58	9.05	27.74
		Mattan	11.71	34.96	10.7	28.27	11.27	31.61
		Pahalgam	8.94	30.56	9.9	23.56	9.45	27.00
		Mean	9.66	32.14	10.13	25.47	9.92	28.78
	Varinag	Duroo	7.75	27.50	10.30	25.54	9.02	26.52
		Kukarnag	9.72	30.40	10.50	23.12	10.11	26.75
		Verinag	11.82	24.50	8.51	28.33	10.16	26.41
		Mean	9.76	27.46	9.77	25.66	9.76	26.56
	Mean		**9.13**	**27.25**	**9.15**	**23.52**	**9.16**	**25.36**
Baramulla	Rafiabad	Bosian	11.07	38.03	10.71	33.92	10.89	35.97
		Dangiwacha	7.10	32.71	9.72	25.12	8.41	28.91
		Rohama	9.08	34.60	11.07	25.94	10.07	30.27
		Mean	9.08	35.11	10.50	28.32	29.37	31.71
	Sopore	Botangoo	6.61	21.91	5.71	25.71	6.61	23.80
		Sangrama	10.70	20.01	9.90	15.43	10.32	17.72
		Sopore	8.70	20.07	8.71	26.75	8.70	23.41
		Mean	8.67	20.66	8.10	22.63	8.54	24.64
	Tangmarg	Gulmarg	9.21	28.07	11.40	24.93	10.30	27.50
		Narbal	14.61	43.71	17.30	46.75	15.95	45.23
		Yarikha	8.05	27.16	6.50	22.24	7.27	24.70
		Mean	10.62	32.98	11.73	31.30	11.17	32.14
	Mean		**9.45**	**29.58**	**10.11**	**27.41**	**16.48**	**28.46**
Budgam	Chadoora	Badipura	13.70	33.45	18.50	24.50	16.13	28.97
		Bugam	14.00	42.35	19.11	36.50	16.55	39.42
		Gurwat	11.10	35.44	17.03	38.90	14.65	38.67
		Mean	12.93	38.08	18.21	33.30	15.77	35.68
	Khansahib	Arizal	9.70	24.39	14.40	26.55	12.05	25.47
		Khansahib	13.50	35.58	13.20	27.91	13.35	31.74
		Parinoo	15.30	38.55	14.30	36.51	14.84	37.53
		Mean	12.83	32.84	13.96	30.32	13.41	31.58
	Soibugh	Khag	10.70	28.50	11.40	30.03	11.05	29.26
		Sholipora	8.70	20.50	9.50	15.50	9.15	18.00
		Soibugh	11.70	23.58	11.50	34.50	11.66	29.04
		Mean	10.36	24.19	10.80	26.76	10.62	25.43
	Mean		**12.04**	**31.70**	**14.32**	**28.79**	**16.26**	**30.89**

Table-2 Contd…

		Abhama	2.57	25.52	5.70	24.53	4.13	25.05
	Keller	Achgosh	7.14	21.74	10.60	23.31	0.87	22.52
		Keller	8.80	23.72	5.80	24.54	7.32	24.13
		Mean	6.17	23.66	7.36	24.12	4.10	23.90
		Muran	7.48	26.92	7.90	24.53	7.53	25.72
Pulwama	Rajpora	Rajpura	8.89	27.31	11.71	28.33	10.25	27.82
		Shadimarg	4.39	23.31	7.30	28.32	5.82	25.81
		Mean	6.92	25.84	8.97	27.06	7.86	26.45
		Hurpura	9.07	27.73	11.50	25.06	10.28	26.39
	Shopian	Imamsahib	9.72	30.71	13.61	33.75	11.66	32.23
		Zainpura	10.71	31.74	8.20	28.95	9.45	30.34
		Mean	9.83	30.06	11.10	29.25	10.46	29.65
	Mean		**7.64**	**25.84**	**9.14**	**26.81**	**7.47**	**26.66**
		Ganderbal	15.07	38.90	12.30	38.51	13.68	38.70
	Ganderbal	Lar	6.06	27.08	8.40	25.50	7.23	26.29
		Tulmullah	11.22	40.30	10.20	43.53	10.71	41.91
		Mean	10.78	35.42	10.30	35.84	10.54	35.63
		Gunbugh	12.36	42.76	14.71	48.35	13.53	45.55
Srinagar	Srinagar	Maloora	15.03	38.70	14.90	43.70	13.68	41.20
		Palpora	14.30	45.52	15.31	43.30	14.82	44.41
		Mean	13.89	42.72	14.97	45.11	14.01	43.72
		Fraw	08.90	30.11	9.31	33.51	9.01	31.31
	Kagan	Kangan	12.03	34.91	9.31	33.07	10.67	34.49
		Kullun	10.75	36.60	11.03	32.41	10.89	34.50
		Mean	10.58	33.87	9.88	32.99	10.19	33.43
	Mean		**11.78**	**37.33**	**11.65**	**37.98**	**11.58**	**37.59**

Data presented as average of 27 observation across the village; data recorded at flowering (1) and 10 days before dehaulming (11) during the cropping season

Disease intensity

The data (Table-2) reveals varying degrees of blight intensity throughout the valley. Fields in district Srinagar exhibited the maximum blight intensity (37.59%) followed by those in Budgam (30.89%), whereas Baramulla, Pulwama, and Anantnag fields displayed late blight intensity in the range of 25.36 to 28.46 per cent only at the dehaulming. Among blocks at the same crop stage Srinagar fields recorded the maximum late blight intensity (43.72%) followed by Chadoora fields (35.68%), whereas Kulgam fields exhibited the least intensity (20.76%) of the disease. The villages where more than 40 per cent late blight intensity was recorded were Tulmullah in block Ganderbal, Maloora, Gangbugh and Palpora in block Srinagar, and Parinoo in block Khanshaib, whereas a blight intensity of less than 20 per cent was recorded in villages Kulgam of block Kulgam and Sopore in block Sopore at the same crop stage. The data recorded during 2007 season revealed the prevalence of potato late blight in all the surveyed

districts with the terminal blight intensity ranging between 25.84 to 37.33 per cent, district Srinagar recording the maximum and district Pulwama the minimum intensity. Among blocks, the maximum terminal blight intensity was recorded in block Srinagar of district Srinagar (42.72%) followed by that in block Chadoora of district Budgam (38.08 %), whereas the block Sopore of district Baramulla exhibited the minimum terminal blight intensity (20.66%). The villages which exhibited terminal blight intensity of more than 40 per cent are Tulmullah in block Ganderbal, Palpora and Gangbugh in block Srinagar, Narbal in block Tangmarg, and Bugam in Chadoora. However, in all the surveyed villages Kulgam in block Kulgam exhibited the lowest terminal blight intensity of 19.59 per cent only.

Similar trend of late blight intensity in potato fields located in different districts and blocks in Kashmir was observed during 2008 cropping seasons. The blight intensity increased with advancement in crop growth stage from flowering to dehaulming. The terminal late blight intensity among districts oscillated in the range of 23.52 to 37.98 per cent, with Srinagar recording the maximum and Anantnag the lowest terminal blight intensity.

Insight into the data (Fig. 1) revealed that comparatively more disease incidence in 2008 compared to that in 2007 all the surveyed location. The disease intensity during both the years was almost similar with district Srinagar exhibiting more disease intensity followed by district Budgam.

The disease was prevalent in all the surveyed fields showing blight incidence of 6.66 to 59.99 and 11.11 to 62.22(Table-1) and intensity 2.57 to 45.52 and 3.50 to 48.35 (Table-2) during 2007 and 2008, respectively. The incidence was minimum (6.60 and 11.11 %) at flowering stage and reached maximum (59.99 and 62.22%) at dehaulming stage during both the cropping seasons, respectively. The lesser blight incidence and intensity was recorded in 2007 compared to those in 2008, seems to be owing to the pre-disposing environmental conditions which prevailed during 2008 and led to increased disease development and spread. The role of environmental factors such as temperature, topographical features and high relative humidity in the development of late blight epidemic has been well documented (Harrison, 1992; Fahim *et al.*, 2002). In general, the fields in district Srinagar exhibited the maximum disease incidence (48.75%) followed by those in district Budgam (44.25 %) at dehaulming stage. Monoculture of potato over large contiguous areas and the prevalence of high humid conditions in district Srinagar during the cropping season seem to have led to much increased disease intensity. The yield losses during the 2007 have been reported up to 50-70% (Haq *et al*., 2008). Kumar *et al.* (2003) reported 25-85% yield losses due to late blight depending mainly on the degree of susceptibility of the host plant. The varying levels of disease intensity and the inflicting losses recorded at different places in the valley seem largely due to the topographical differences between locations which reflect in the form of different environmental factors. The adoption of different cropping patterns and the use of different undescriptive varieties in the field also account for such differences. Thus the losses due to the disease seem to vary from region to region and location to location depending on the

prevailing environmental conditions and the vulnerability of the crop variety under plantation. The stage of the crop at the time of first disease appearance also contribute to the extent of disease development and spread. All these factors need, therefore, to be taken into account while deciding at adoption of management components for the disease (Mohan and Thind, 1999).

Late blight of potato [*Phytophthora infestans* (Mont) De-Bery] is prevalent in almost every potato field of Kashmir with varied incidence and intensity from place to place. The blight incidence was minimum at flowering stage and reached maximum at dehaulming stage during both the cropping seasons at all the surveyed locations

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