ESTIMATION OF POTATO LATE BLIGHT INFECTION PRESSURE AS INFLUENCED BY CHANGING CLIMATE IN WEST BENGAL

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Abstract: Potato Late Blight (Phytophtora infestans, de Bary 1876) disease leads to severe potato yield collapses in the past. The epidemiology of blight disease of potato is very much dependent on climate. To study the effect of climatic parameters on occurrence, severity of potato blight disease, an attempt was made at Bidhan Chandra Krishi Viswavidyalaya (State Agricultural University), Kalyani, West Bengal, India (22057′E latitude, 88020′ E longitude, 7.8 meters altitude) during 2005-2006, 2006-2007 and 2007-2008. Results revealed that morning canopy humidity is closely related with percent disease index (PDI) of potato late blight ($R2$ = 0.7 to 0.8). Soil temperature (5 cm depth) is also directly and significantly correlated with disease severity of potato late blight ($R2$ = 0.72 to 0.82). The relation among the soil temperature and canopy humidity with the disease severity helps to develop disease forewarning system ($Y = -1.8075-0.70185*X1 +0.49546*X5$, where Y = PDI, X1 = Morning canopy humidity, X5 = Soil temperature at 5cm depth.). Agro meteorological indices were also closely related with percent disease index of potato late blight ($R2$ for GDD 0.82- 0.85, HTU 0.82-0.86 and Bright sunshine hour 0.79-0.86). Tuber yield varied with changing climatic scenario. It was analyzed that maximum tuber yield was obtained during 2007-2008 followed by 2006-2007 and 2005-2006. It was happened due to devastating blight infestation during 2005-2006 and 2006-2007. Under all climate change scenarios we noted marked change in infection pressure of evaluated disease and yield loss due to potato late blight outbreak.

Keywords: Canopy humidity, late blight, PDI, Soil Temperature.

Introduction: Potato is a starchy tuberous crop and whenever there has been a scarcity of food grains, potato has come to the rescue of the people. It can provide both food and nutritional security in the future as it is one of the most productive crops known to man. The crop is extremely sensitive to pest attack resulting in reduction in production. The incidence and severity of late blight of potato are mainly affected by weather condition and soil environment. Atmospheric humidity and soil temperature play an important role in onset and spread of the disease. The study is an attempt to find out the effect of soil temperature and humidity within the crop canopy and date of planting on infestation of potato late blight as well as on total yield.

Materials and Methods: To study the effect of climatic parameters on occurrence, severity of potato blight disease and the disease progress curve, an attempt was made at Bidhan Chandra Krishi Viswavidyalaya (State Agricultural University), Kalyani, West Bengal, India (22057′E latitude, 88020′ E longitude, altitude 7.8 meters) in split- plot design for consecutive three years starting from 2005-2006 with five dates of planting in seven days interval as D1 (11th November), along with sprayed and non sprayed treatment. PDI was estimated as Summation of Scores / Total No. of Observation x Maximum Scale.

Results and discussion: The date of disease initiation was predicted by backward extrapolation of disease progress curve to the point at which the curve intersect the X–axis (DAP). Days required for disease initiation was more in early DAP than the late DAP which are critically analyzed.

Canopy humidity and temperature within the canopy get modified by the crop canopy by building its own micro climate which may be congenial for late blight development and spread. Hence to study its relation with disease initiation and its subsequent damage to crop yield reading of canopy humidity and temperature was recorded above 5 cm from ground. Table 1-3 represented that a maximum of 67 % (59 DAP) and CV% ranged from as low as 0.74 (31DAP) to a high of 9.85 computed for 24 DAP. As canopy humidity is directly related to disease infection pressure, the relationship between the canopy humidity and PDI was (R^2 =0.7 to 0.8) significant.

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Table 1: Morning humidity (%) within the canopy for the season-2005-06											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	59.00	57.00	61.00	65.00	66.00	63.00	64.00	58.00	47.00	35.00	36.00
D2	60.00	58.00	60.00	63.00	63.00	65.00	65.00	57.00	48.00	38.00	37.00
D3	60.00	58.00	60.00	61.00	62.00	63.00	67.00	59.00	46.00	38.00	38.00
D4	58.00	60.00	60.00	62.00	63.00	61.00	62.00	59.00	48.00	38.00	39.00
D5	60.00	58.00	60.00	61.00	62.00	63.00	67.00	59.00	46.00	38.00	38.00
MEAN	59.40	58.20	60.20	62.40	64.00	63.00	65.00	58.40	47.00	37.40	37.60
SD±	0.89	1.10	0.45	1.67	2.35	1.41	2.12	0.89	1.00	1.34	1.14
CV %	1.51	1.88	0.74	2.68	3.66	2.24	3.26	1.53	2.13	3.59	3.03

Table 2: Morning humidity (%) within the canopy for the season-2006-07											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D_1	38.00	39.00	39.00	42.00	36.50	42.00	34.00	52.00	51.00	49.00	48.00
D_2	40.00	45.00	40.00	45.00	39.00	48.00	38.00	53.00	51.00	51.00	49.00
D_3	41.00	48.00	42.00	48.00	38.00	51.00	39.00	52.00	50.00	50.00	49.00
D_4	45.00	51.00	45.00	47.00	40.00	52.00	40.00	52.00	49.00	51.00	49.00
D_5	41.00	48.00	42.00	48.00	38.00	51.00	39.00	52.00	50.00	50.00	49.00
MEAN	41.00	46.20	41.60	46.00	38.30	48.80	38.00	52.20	50.20	50.20	48.80
SD±	2.55	4.55	2.30	2.55	1.30	4.09	2.35	0.45	0.84	0.84	0.45
CV %	6.22	9.85	5.53	5.54	3.40	8.37	6.17	0.86	1.67	1.67	0.92

Table 3: Morning humidity (%) within the canopy for the season-2007-08											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D_1	59.00	57.00	61.00	65.00	66.00	63.00	64.00	58.00	47.00	35.00	36.00
D_2	60.00	58.00	60.00	63.00	67.00	65.00	65.00	57.00	48.00	38.00	37.00
D_3	60.00	58.00	60.00	61.00	62.00	63.00	67.00	59.00	46.00	38.00	38.00
D_4	58.00	60.00	60.00	62.00	63.00	61.00	62.00	59.00	48.00	38.00	39.00
D_5	60.00	58.00	60.00	61.00	62.00	63.00	67.00	59.00	46.00	38.00	38.00
MEAN	59.40	58.20	60.20	62.40	64.00	63.00	65.00	58.40	47.00	37.40	37.60
SD±	0.89	1.10	0.45	1.67	2.35	1.41	2.12	0.89	1.00	1.34	1.14
CV %	1.51	1.88	0.74	2.68	3.66	2.24	3.26	1.53	2.13	3.59	3.03

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Table 4: Morning soil temperature at 5 cm depth for the season-2005-06											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	18.00	17.50	17.50	17.50	18.00	18.50	17.50	18.50	23.00	24.00	25.00
D2	18.00	18.00	17.50	18.00	18.00	19.00	18.00	19.00	22.50	24.50	25.00
D3	18.50	17.50	18.00	17.50	17.00	18.50	17.50	17.50	21.50	23.50	25.50
D4	17.50	17.00	17.50	17.00	18.00	18.00	17.50	18.50	22.50	23.50	24.50
D5	17.50	17.00	17.00	17.00	17.50	19.00	17.00	17.00	23.00	23.50	25.00
MEAN	17.90	17.40	17.50	17.40	17.70	18.60	17.50	18.10	22.50	23.80	25.00
SD±	0.42	0.42	0.35	0.42	0.45	0.42	0.35	0.82	0.61	0.45	0.35
CV %	2.34	2.40	2.02	2.40	2.53	2.25	2.02	4.54	2.72	1.88	1.41

Table 5: Morning soil temperature at 5 cm depth for the season-2006-07											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	21.00	20.00	22.00	21.00	21.00	22.00	19.50	21.00	25.50	27.00	27.50
D2	21.50	20.50	22.00	21.50	21.00	22.50	20.00	21.50	25.00	26.50	28.00
D3	21.50	20.00	22.50	22.00	22.00	21.50	19.00	20.00	25.00	26.00	28.50
D4	20.00	20.00	21.50	22.00	21.50	21.50	18.50	19.50	16.50	27.50	28.00
D5	21.50	21.00	21.50	22.00	21.50	23.00	19.00	19.50	26.00	26.50	28.00
MEAN	21.10	20.30	21.90	21.70	21.40	22.10	19.20	20.30	23.60	26.70	28.00
SD±	0.65	0.45	0.42	0.45	0.42	0.65	0.57	0.91	0.99	0.57	0.35
CV %	3.09	2.20	1.91	2.06	1.95	2.95	2.97	4.47	4.52	2.14	1.26

Table 6: Morning soil temperature at 5 cm depth for the season-2007-08											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	18.00	17.90	16.00	18.80	21.60	18.00	18.00	17.90	22.80	17.60	22.80
D2	17.90	18.20	18.40	18.50	21.60	18.20	18.20	18.00	22.50	17.80	22.50
D3	17.90	17.40	18.80	18.40	22.00	18.00	18.00	17.90	22.10	17.70	22.10
D4	18.20	17.90	19.00	18.50	22.10	18.20	18.20	17.60	21.80	17.60	21.80
D5	18.00	17.40	18.10	18.60	21.90	18.00	18.00	17.90	21.40	17.00	21.80
MEAN	18.00	17.76	18.06	18.56	21.84	18.08	18.08	17.86	22.12	17.54	22.20
SD±	0.12	0.35	1.20	0.15	0.23	0.11	0.11	0.15	0.55	0.31	0.44
CV %	0.68	1.97	6.66	0.82	1.05	0.61	0.61	0.85	2.50	1.78	1.99

Table 7: Percent disease index for lower tier of potato leaves for late blight during 2005-2006											
DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	0.5	0.5	5.55	8.33	33.33	55.55	61.11	77.77	88.88	88.88	100
D2	0.5	0.5	0.5	5.55	16.66	30.55	55.55	55.55	61.1	88.88	100
D3	0.5	0.5	0.5	2.77	16.66	30.55	55.55	61.11	77.77	88.88	100
D4	0.5	0.5	0.5	0.5	8.33	33.33	55.55	61.11	77.77	88.88	100
D5	0.5	0.5	0.5	0.5	8.33	33.33	55.55	61.11	77.77	88.88	100

Soil temperature was measured at a number of positions in a north – south running furrow. Generally the west facing slope was warmer than the east facing slope because of better illuminations by sun's rays.
Hence table 4-6 presents the soil temperature recorded at 5 cm depth varied from 17.0 ^{O} C recorded at 24-38

DAP to a high of 27.5^{O} C at 80 DAP .Coefficient of variation (CV%) ranged from 0.61 attained at 52-59 DAP to a high of 4.54 at 66 DAP. It was analyzed that percent disease index (PDI) was directly correlated with the soil temperature at 5 cm depth (R^2 = 0.72 to 0.82)

Table 8: Percent disease index for lower tier of potato leaves for late blight during 2006-2007

DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	0.5	0.5	5.55	11.11	33.33	55.55	61.10	77.77	88.88	100	100
D2	0.5	0.5	5.55	11.11	16.66	30.55	61.10	77.77	88.88	100	100
D3	0.5	0.5	0.5	5.55	11.11	30.55	55.55	61.10	77.77	88.88	100
D4	0.5	0.5	0.5	0.5	5.55	33.33	55.55	61.10	77.77	88.88	100
D5	0.5	0.5	0.5	0.5	8.33	33.33	55.55	61.10	77.77	88.88	100

Table 9: Percent disease index for lower tier of potato leaves for late blight during 2007-2008

DOP	DAYS AFTER PLANTING										
	17	24	31	38	45	52	59	66	73	80	87
D1	0.5	0.5	0.5	5.55	8.33	16.10	33.33	55.55	61.10	88.88	100
D2	0.5	0.5	0.5	2.77	8.33	11.11	16.10	33.33	55.55	88.88	100
D3	0.5	0.5	0.5	0.5	5.55	16.10	30.55	55.55	61.10	77.77	88.88
D4	0.5	0.5	0.5	0.5	2.77	11.11	33.33	55.55	61.10	77.77	88.88
D5	0.5	0.5	0.5	0.5	2.77	8.33	33.33	55.55	61.10	77.77	88.88

Photo 1. Recording of Canopy temperature by Infrared thermometer

Fig. 1(a-c) Relationships among PDI and agrometeorological indices

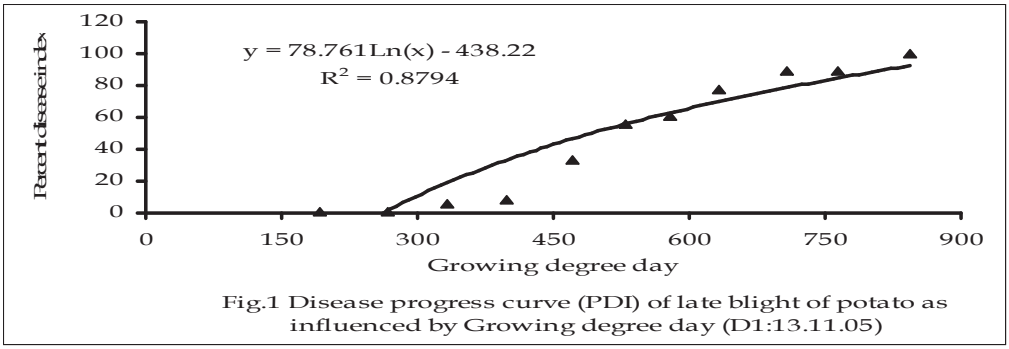

Fig.1 Disease progress curve (PDI) of late blight of potato as influenced by Growing degree day (D1:13.11.05)

Fig.1.a

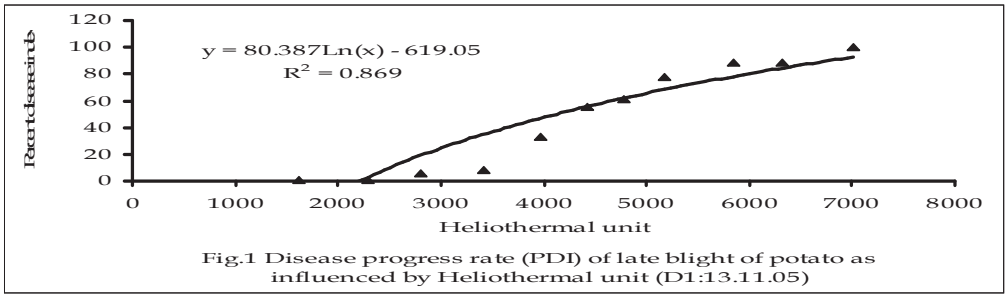

Fig.1 Disease progress rate (PDI) of late blight of potato as influenced by Heliothermal unit (D1:13.11.05)

Fig.1.b

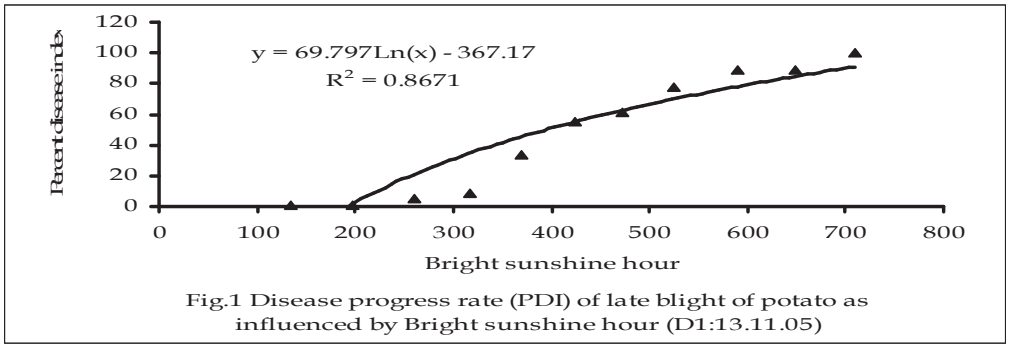

Fig.1 Disease progress rate (PDI) of late blight of potato as influenced by Bright sunshine hour (D1:13.11.05)

Fig.1.c

The logarithmic disease progress curve was plotted against GDD, HTU and BSS to get any possible association of these parameters with disease progress. The graphs shows that in all cases the logarithmic relation holds good as evident from reasonable higher values of Regression co-efficient ((R² for GDD 0.82 - 0.85, HTU 0.82-0.86 and Bright sunshine hour 0.79-0.86).This implies that Growing degree days(GDD) model can be used for predicting disease initiation of late blight of potato.

Fig. 2 & 3 Potato tuber yield for different dates of planting in three different seasons

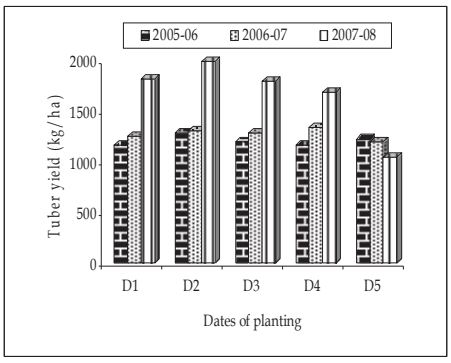

Fig.2 Sprayed

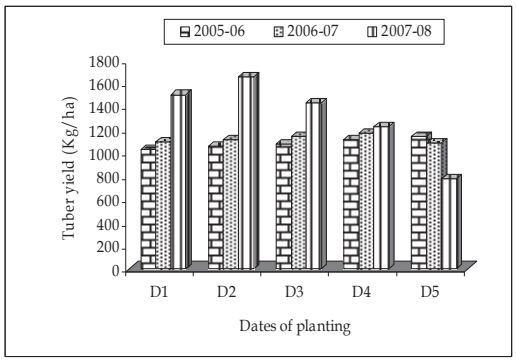

Fig.3 Non sprayed

The yield loss of potato due to late blight was estimated by getting the difference between yield from sprayed and non sprayed plots. Though the yield level was higher in earlier dates of planting like D1 and D2 but the yield difference was maximum in D4. On the other hand the minimum yield difference was recorded from last date of planting. It may be assumed that when the planting is delayed much, the late blight affects less.

Photo 2.Recording of Soil temperature by digital soil thermometer

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