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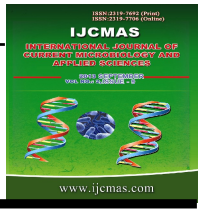

Original Research Article

Effect of irrigation frequency on Potato late blight (*Phytophthora infestans*)

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A B S T R A C T

Irrigation frequencies have marked effects on the incidence, intensity and yield of the potato crop. Higher disease incidence (83.99 and 87.77%) and intensity (46.11 and 65.04%) with higher AUDPC values of 120.42 and 144.07 and minimum tuber yield (115.34 and 122.38 qts/ha) were realized with more frequent irrigations. The disease can be greatly reduced if soil water status is maintained at relatively steady conditions. The least disease incidence (58.66 and 67.99%) disease intensity (30.50 and 48.02%), lower AUDPC values (91.64 and 115.42) and maximum yield were obtained in 21- days irrigation frequency, during 2007 and 2008 cropping season.

Keywords
Irrigation frequency; Potato late blight; *Phytophthora infestans*; Soil water.

Introduction

Potato late blight (*Phytophthora infestans*) is one of the most devastating plant disease worldwide (Mizubuti and Fry, 1998 and Namanda *et al.*, 2004) and is feared globally by farmers and industry reducing global potato production by 15 per cent annually (Anonymous, 1997). The control of the disease has been traditionally relied on foliar application of fungicides resulting in a very high input of pesticides in potato production. The pesticide cost is estimated to over 4 billion US dollars annually worldwide (Haverkot *et al.*, 2008). Besides the high cost of fungicides there is societal resistance today against using potentially harmful chemicals. Research on potato late blight management is not only of scientific interest but is important both from an economical and environmental perspectives as well. Several strategies for controlling the disease have been introduced over years but severe losses still occur, largely because the effectiveness of these approaches is variable and often short lived (Benhamou *et al.*, 1994).The current thinking about plant protection and environment suggests to develop such strategies that are effective, efficient and economical and that minimize the adverse effects on environment and human health. Identification and logical integration of strategies that would contribute towards suppression of the pathogen and/or enhancing the host resistance or undoing

the host predisposing factors, are likely, therefore, to be useful in managing the potato late blight.

Soil moisture levels and the soil temperature play important role in the incidence and spread of many plant diseases. Therefore, the frequencies of irrigation levels were assayed for their effects on late blight development.

Materials and Methods

Manipulation of irrigation frequency

Four different irrigation frequencies viz., no irrigation, and irrigations at 07, 14 and 21 days intervals, were evaluated for their effect on development of late blight of potato cv. kufri Jyoti in field trials at experimental farm of the Division of Plant Pathology, SKUAST-K, Shalimar during the cropping season 2007 and 2008 in silt loam soil having field capacity 27.5 per cent and bulk density of 1.48/cc. The plot size was 3mx2m maintaining a plant spacing of 20 x 45 cm. Measured quantity of irrigation water was applied to individual plots. A two metre wide buffer zone was maintained around each plot to isolate irrigation treatments and minimize inter plot interference. Soil moisture was determined before sowing. During 2007 cropping season, planting was done on 24th March, and the treatments commenced on 7th April. In 2008 planting was done on 28th March and treatment started on 15th April. All other recommended package of practices was followed for raising the crop (Anonymous, 2004). Moisture meter readings were recorded to determine moisture levels for scheduling irrigation levels. Check plots received no irrigation. The fields were inoculated in the first week of May each year to ensure the disease outbreak the blight incidence and intensity were monitored at 10 days interval as per the procedure given under

Disease incidence

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

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 and "A" Value

An area of 0.5 x 0.5m was randomly marked at 3 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

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

(AUDPC "A" value)was determined for each genotype as per the method given by Shanner and Finney (1997) using the formula. The AUDPC value was calculated with the following formula (Shanner and Finney, 1977).

$$AUDPC = \left[\frac{D_1 + D_2}{2} \times T + \frac{D_2 + D_3}{2} \times T + \frac{D_3 + D_4}{2} \times T + \right] \frac{}{(N-1)}$$

Where D = % Disease intensity at different dates ($D_1 + D_2$, $D_{2+} D_{3,} D_{3+} D_4$ … and so on)

T = Time interval between two observations
N = Total number of observations.

Results and Discussion

The results obtained during 2007 cropping season (Table-1) revealed maximum late blight development at higher irrigation frequency compared to that at lower frequencies and check (no irrigation) with concomitant decrease in tuber yields. The disease incidence was more (69.33-83.99%) in plots receiving irrigation at 7-14 days interval compared to the plots receiving either no irrigation or irrigation at 21 days interval (53.33-58.66%). The disease intensity was maximum (46.11%) in treatments receiving irrigation at 7 days interval; irrigation at 14 and 21 days interval, however, did not show any significant decrease in disease intensity compared to no irrigation application (check) exhibiting disease intensity of 27.44-31.08 per cent. The area under disease progress curve (A value) calculated on periodical observations on late blight intensity revealed maximum 'A' valve for 7 days irrigation intervals (120.42) followed by that for 14-21 days irrigation intervals (91.64-94.92), whereas the plots receiving no irrigation exhibited minimum A value (80.12) for the disease. Maximum tuber yield (145.22-164.26 q/ha) with better percentage of grade A (24.51-25.86%) and B (50.00-55.48) tubers were however, obtained in treatments receiving irrigation at 14-21 days intervals. The plots receiving irrigation at 7 days interval yielded statistically check plots receiving no irrigation. The results obtained during 2008 cropping season (Table-2) again indicated maximum blight development at higher irrigation frequency compared to lower frequencies and un-irrigated check.

The late blight incidence was maximum (87.66%) in plots receiving irrigation at 7 days interval compared to those receiving irrigation at 14-21 days interval or receiving no irrigation at all (66.77-67.99%). The disease intensity followed the same pattern with the most frequent irrigation at 7 days interval exhibiting the maximum intensity (65.04%) compared to other treatments and un-irrigated check (35.80-46.04%). The 'A' value obtained was maximum (144.07-131.39) for the plots receiving more frequent irrigation at 7-14 days interval; un-irrigated plots, however, exhibited least 95.27 A value for the disease. The tuber yield were, however, maximum 164.26 q/ha in plots receiving least frequent irrigation at 21 days interval followed by those receiving irrigation at 7-14 days interval (122.38-143.10 q/ha). The un-irrigated plots exhibiting minimum tuber yield (112.90 q/ha). The A grade tubers were maximum (25.61%) in plots receiving 21 day irrigation followed by (23.00-19.12%) those of receiving irrigation at 7 and 14 days interval. An insight into data obtained during 2007 (Fig. 1) reveals maximum late blight intensity at maximum soil moisture levels, obtained after providing most frequent irrigation at 7 days interval, the intensity decreases as the soil moisture level decreases with lesser frequent

Table.1 Effect of different irrigation frequencies on late blight of potato cv. Kufri jyoti during 2007

Irrigation interval (days)	Disease Incidence (%)	*Disease intensity (%)	"A" Value	Yield (qtls/ha.)	**Tuber grade (%)		
					Grade A	Grade B	Grade C
7	83.99 (68.87)	46.11 (42.70)	120.42	115.34	21.32	49.88	28.78
14	69.33 (59.42)	31.68 (34.19)	94.92	145.22	25.86	50	24.12
21	58.66 (50.08)	30.50 (33.35)	91.64	164.26	24.51	55.48	20%
Check	53.33 (46.98)	27.44 (31.58)	80.12	122.74	19.40	50.04	30.60
CD (0.05%)	9.78	7.31	10.44	21.98	1.41	2.03	2.11

*Repeated at 10 days interval, data are mean of five replications.
**Figures in parenthesis are per cent tuber grade
Recording of data started on May 20th, 2007
Figures in parenthesis are arc sine transformed values

Table.2 Effect of different irrigation frequencies on late blight of potato cv. Kufri jyoti during 2008

Irrigatio.n interval (days)	Disease Incidence (%)	*Disease intensity (%)	"A" Value	Yield (qtls/ha.)	**Tuber grade (%)		
					Grade A	Grade B	Grade C
7	87.66 (74.18)	65.04 (54.27)	144.07	122.38	19.12	58.66	22.20
14	75.99 (61.10)	46.04 (42.69)	131.39	143.10	23.00	55.81	21.17
21	67.99 (56.07)	48.02 (43.69)	115.42	159.60	25.61	60.35	14.00
No irrigation	66.67 (54.81)	35.80 (36.62)	95.27	112.90	18.48	51.57	29.93
CD (0.05%)	11.28	10. 15	25.08	2.01	3.12	2.98	1.99

*Repeated at 10 days interval, data are mean of five replications.
** Figures in parenthesis are per cent tuber grade
Recording of data started on May 19th, 2008
Figures in parenthesis are arc sin transformed values

Fig.1 Effect of moisture levels on the development of late blight of potato during cropping season-2007

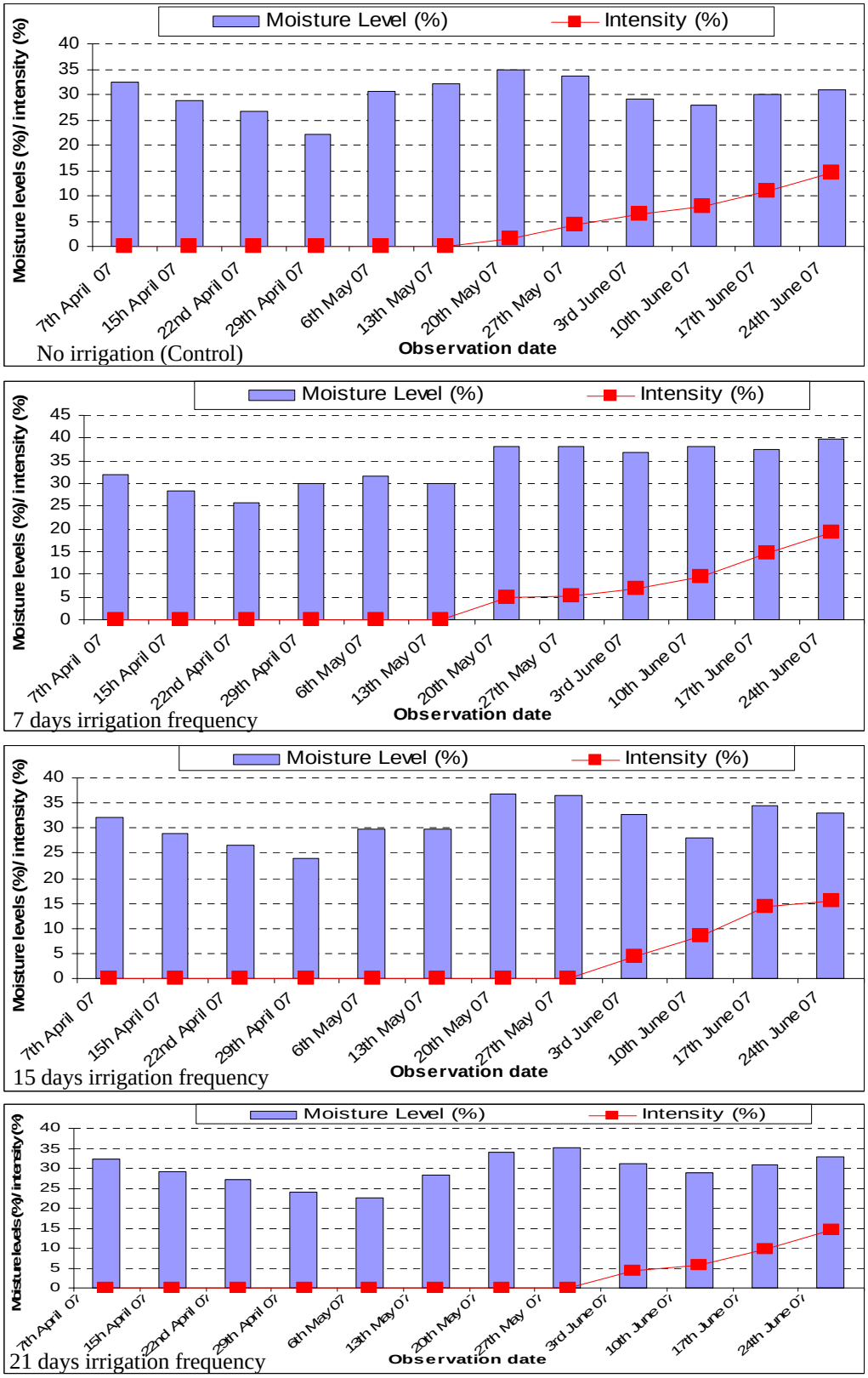
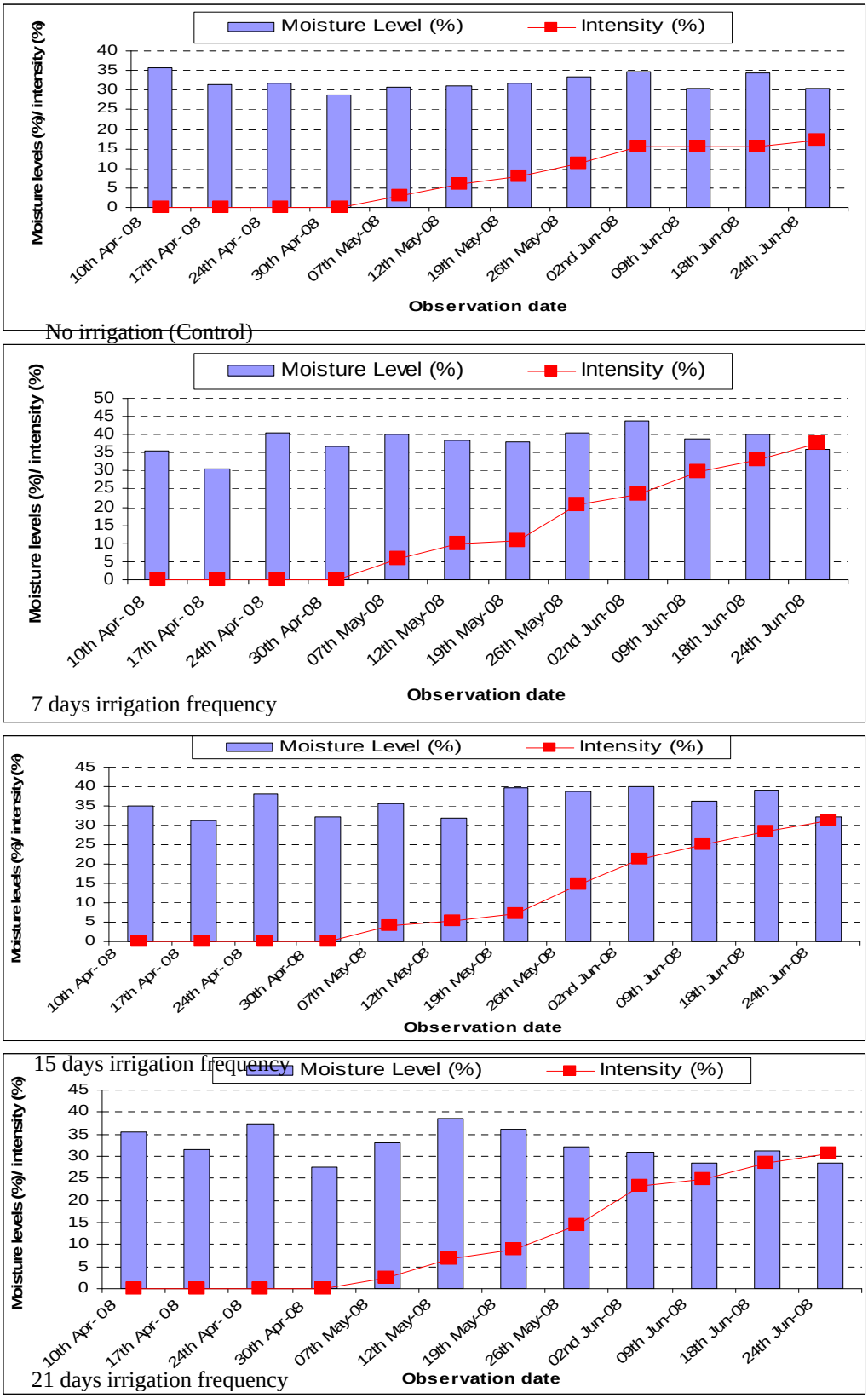


Fig.2 Effect of moisture levels on the development of late blight of potato during cropping season-2008



irrigation. Similar trend was observed during 2008, perusal of the data, (Fig.2) reveals maximum late blight intensity at maximum soil moisture levels, obtained after providing most frequent irrigation at 7 days interval, the intensity decreases as the soil moisture level decreases with lesser frequent irrigation.

Soil moisture levels and the soil temperature play important role in the incidence and spread of many plant diseases. Therefore, the frequencies of irrigation levels were assayed for their effects on late blight development. More frequent irrigation at 7-14 days intervals were found to exhibit maximum (69.33-83.99) blight incidence compared to less frequent irrigation at 21 days intervals or no irrigation (53.33-58.66). Similarly the disease intensity was maximum (46.11%) in treatment receiving irrigation at 7 days intervals compared to irrigation at 21 days interval (30.50%). The result obtained during 2008 cropping season again indicate maximum blight development at higher irrigation frequencies than check. The late blight incidence was maximum (87.66%) plots receiving irrigation at 7 days interval compared to those receiving irrigation at 21 days interval for receiving no irrigation at all (66.67). The disease followed same pattern with the most frequent irrigation exhibiting maximum intensity (65.04%) compared to no irrigation 35.80 per cent. The obtained results are in accordance with those Bowers and Mitchell (1990), Bowers *et al.* (1990) and Ristaniso (1991). The occurrence and spread of crown rot (*Phytophthora capsici*) disease of pepper was found to depend on irrigation intervals (Cafe-Filho and Duniway, 1995). The frequency of furrow irrigation and flooding duration was also found to have a direct effect on *Phytophthora* diseases (Bowers and Mitchell, 1990). Higher disease incidence and mortality of pepper plants occurred with more frequent irrigations and longer duration of flooding (Bowers and Mitchell, 1990; Cafe-Filho and Duniway, 1995) which is in consonance with the present findings where frequent irrigations create flooding and water-stagnation-like conditions in the fields predisposing potato crop to infection. Conditions of wet and dry cycles in soil requiring maintaining the life cycle of most *Phytophthora* spp. (Gisi *at al*., 1980) also confirms our observations. In practice, rainfall and periodic furrow irrigations usually provide a wet–dry cycle in soil, favoring sporangia formation during the dry period and zoospore release during the flooding (Bowers and Mitchell, 1990). Thus the frequent irrigations at 7-14 days intervals create soil condition suitable for pathogen spread and proliferation and seem to predispose the host to infection by *P. infestans*.

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