Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(1): 918-921

Received: 04-11-2018
Accepted: 07-12-2018

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Study of effect of different regimes of nitrogen on late blight of potato

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Abstract
Late blight of potato caused by *Phytophthora infestans* (Mont.) de Bary is one of the most devastative diseases of agricultural crops. Measures for managing the disease is based on chemicals but these are hazards to environment, development of resistance in pathogen against fungicides increased needs integrated approach of managing disease. So along with chemical management practices other measures of disease management should be studied. In cultural management practices, fertilization plays an important role. Nitrogen being an essential constituent of protein and chlorophyll is important for growth and development of plants as well as yield. So in greed of more yield higher dose of nitrogen application is in practice. But nitrogen has both direct and indirect effect on plant making it susceptible to the pathogen. Direct effect is increased succulence of plant tissue so increased susceptibility. Indirect effects are bigger canopy which alters micro-climate of plant making it favourable for disease establishment and increases the spread of pathogen. So the optimum dose of nitrogen which can provide higher yield and should not make plant susceptible to the pathogen should be estimated. This study includes study of effect of different regimes of nitrogen on Late blight of potato. There were 6 doses of nitrogen ranging from 0 to 250 kg/ha out of which 150 kg/ha was found to be most suitable in terms of yield as well as less disease severity.

Keywords: Late blight, *Phytophthora infestans*, effect of nitrogen, cultural management

Introduction
Potato is a global crop. It is consumed as a staple food in Europe and a principal vegetable in developing countries. In developing countries, like India it is especially important for food and nutritional security. The tuber is known to supply carbohydrate, high quality protein, and substantial amounts of essential vitamins, minerals, and trace elements [7]. So it can solve the nutritional problems to a great extent for the lower income group. It plays a pivotal role in farm economy due to its great yield potential, so the area under this crop is increasing continuously and now being adopted as a cash crop by the farmers, but unfortunately the supposed yield is not being achievable due to crop loss caused by various biotic and abiotic factors. Among biotic factors Late blight disease is most destructive one. Potato late blight caused by the filamentous oomycete *Phytophthora infestans* (Mont.) de Bary, occurs in most potato-growing areas throughout the world, but it can be predominantly devastating in areas with warm and humid weather during the growing season [6]. Fungicides are commonly used to control LB, but developing-country farmers often cannot afford enough fungicides, and yield loss can be very high [11], development of fungicidal resistance in pathogen, environmental hazards due to fungicides make it important to evaluate other measures that can be taken to reduce LB, measures such as sanitation, shifting of the growing period out of the wet season [4], and the use of variety mixtures [5]. Another important variable in some disease systems is fertilization [10]. Nitrogen being an essential constituent of protein and chlorophyll is important for growth and development of plants as well as yield. So in greed of more yield higher dose of nitrogen application is in practice. But nitrogen has both direct and indirect effect on plant making it susceptible to the pathogen. Direct effect is increased succulence of plant tissue so increased susceptibility. Indirect effects are bigger canopy which alters micro-climate of plant making it favourable for disease establishment and distance-effect increases the spread of pathogen. So the optimum dose of nitrogen which can provide higher yield and should not make plant susceptible to the pathogen should be estimated.

Materials and Methods

The present investigation was carried out at the Instructional farm, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during the rabi season of 2016-2017. Study was conducted on Kufri Jyoti variety. Study was made to observe the effect of different regimes of nitrogen on late blight of potato. Each experimental unit was a field plot measuring 15 m^2 and consisted 6 rows with 32 plants each. Distance between rows was 45 cm, and spacing between plants was 15cm. A randomized block design was used for the statistical analysis, with 6 treatments and 3 replications.

Potato seed tuber was planted after treating with Streptomycin sulphate @ 5g/10 L water and Carbendazim + Mancozeb @20 g/10 L water and grown with the conventional agronomic practices adopted in this area. The 6 treatments were 6 different doses of nitrogen ranging from 0 to 250 kg/ha (Table 1). Nitrogen was applied in the form of Urea in 3 doses, half as basal and remaining half in two split doses at 30 DAP and 45 DAP along with earthing up operation in the field. P_2O_5 and K_2O were applied @ 100 kg/ha each in the form of SSP and MOP as basal dose. Mancozeb 75% WP was applied as protective fungicide before disease appearance. After disease appearance Curzate (Cymoxanil 8% + Mancozeb 64%) WP was sprayed as curative fungicide at 7 days interval.

Table 1: Different doses of Nitrogen as Treatments

Sl. No	Treatment	Nitrogen dose (Kg/ha)
1	N0	0
2	N50	50
3	N100	100
4	N150	150
5	N200	200
6	N250	250

Before appearance of disease, 15 plants in each plot were selected randomly. The severity of disease was assessed according to symptom observed on foliage and plants affected and subsequently its corresponding rating value on 0-9 scale given by CIP, 1985 (Table 2). Percent disease index was calculated by formula given by Wheeler (1969) [14] and Area under disease progress curve was calculated by formula given by Wilcoxson *et al.*, (1975) [16].

$$PDI = \frac{\Sigma \text{ of individual ratings}}{\text{No of leaves assesed}} X \frac{100}{\text{Maximum disease grade}}$$

$$AUDPC = \sum_{I-1}^{n} 1/2\ (S_i - S_{i-1})\ d$$

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AUDPC = Area under disease progress curve
Si = Disease severity at the end of time i
k = Number of successive evaluation of blight severity
d = Interval between two observations

Table 2: Key for assessing severity of late blight under field conditions (0-9 scale given by CIP)

CIP scale value	Blight (%)		Symptoms
	Mean	Limits	
1	0		No late blight observable
2	2.5	Traces- < 5	Late blight present. Maximum 10 lesions per plant.
3	10	5- < 15	Plants look healthy, but lesions are easily seen at closer distance. Maximum foliage area affected by lesions or destroyed corresponds to no more than 20 leaflets.
4	25	15- < 35	Late blight easily seen on most plants. About 25% of foliage is covered with lesions or destroyed.
5	50	35- < 65	Plot looks green; however, all plants are affected. Lower leaves are dead. About half the foliage area is destroyed.
6	75	65- < 85	Plot looks green with brown flecks. About 75% of each plant is affected. Leaves of the lower half of plants are destroyed.
7	90	85- < 95	Plot neither predominantly green nor brown. Only top leaves are green. Many stems have large lesions
8	97.5	95- < 100	Plot is brown- colored. A few top leaves still have some green areas. Most stems have lesions or are dead.
9	100		All leaves and stems dead.

Statistical Analysis

Data were analysed using SPSS statistical package.

Results and Discussion

A significant variation of disease progress at different doses of nitrogen applied in field was observed which is evidenced in table 1. Among the different plots of Potato with different doses of nitrogen a very less disease progress was found with the application of Nitrogen @ 150 Kg per hectare followed by application of 200Kg and 100 kg of Nitrogen per hectare. Figure 1 clearly indicates lowest disease progress with the application of 150 Kg of Nitrogen per hectare, whereas highest disease progress was found in the plots without application of Nitrogen as well as with application of 250 kg Nitrogen per hectare. Highest yield was recorded with application of 250 kg Nitrogen per hectare (26.39 t/ha) which was at par with application of 150 kg Nitrogen per hectare (26.27 t/ha). Lowest yield was recorded in treatment without application of Nitrogen (7.73 t/ha). Inspite of high AUDPC value of treatment N250, yield of the corresponding treatment was also high. The probable reason behind this may be, as in the treatment with higher dose of nitrogen disease incidence

increased in the later stage of plant growth and by that time tuber bulking was already over due to increased bulking rate with higher dose of nitrogen application.

Table 3: Late blight disease severity at different Nitrogen doses

Nitrogen doses	AUDPC	Yield (kg/4 m^2)	Estimated yield (t/ha)
N0	661.11^{A}	3.09^{C}	7.73
N50	643.52^{A}	8.83^{B}	22.07
N100	587.04^{BC}	9.82^{AB}	24.55
N150	557.41^{C}	10.51^{A}	26.27
N200	581.48^{BC}	9.46^{AB}	23.64
N250	600.93^{B}	10.55^{A}	26.39
SEM ±	10.23	0.39	
CD	32.22	1.22	

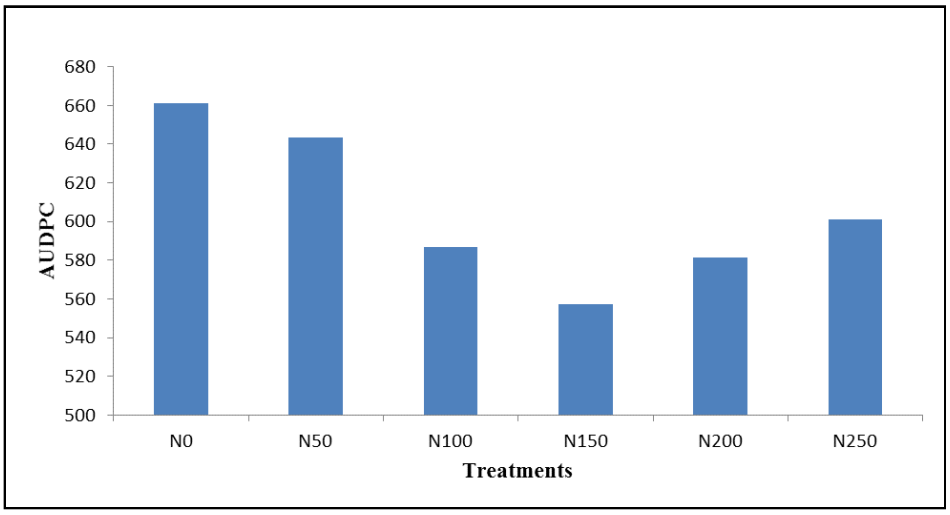

Fig 1: Comparison of AUDPC of treatments with different N doses

Initially among various treatments, disease progress was more in N0 and N50, lowest in N250 and N200 and intermediary in N100 and N150. But in the later stage of plant growth highest disease progress was recorded in treatment with the application of 250 Kg of Nitrogen per hectare followed by treatment with the application of 200 Kg of Nitrogen per hectare which was at par with treatment N0. Lowest disease was shown by treatment with 150 Kg Nitrogen/ha, which is evident from Fig. 2.

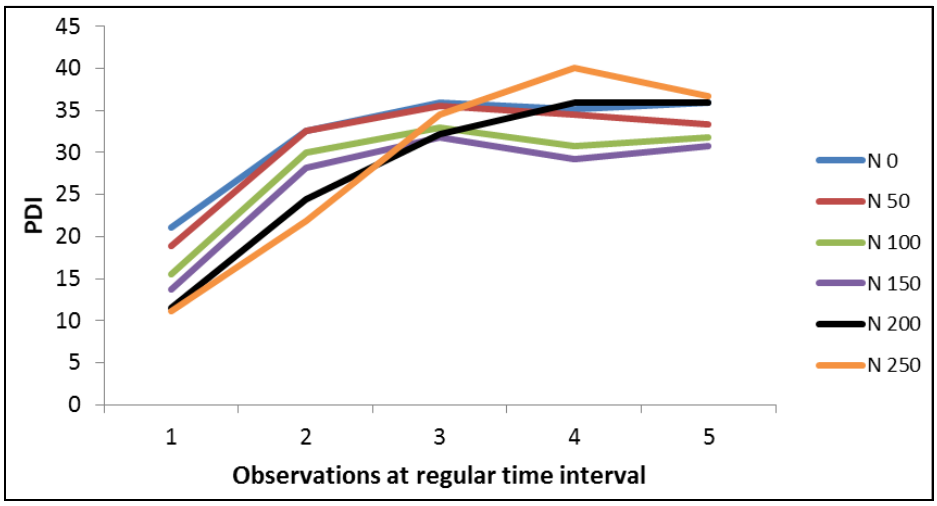

Fig 2: Comparison of PDI of disease in different nitrogen doses

Various studies made on effect of nitrogen doses show contrasting results. Sawicka (1993) [12] reported higher infection with increased nitrogen fertilization, in contrast Wierzejska-Bujakowska (1994) [15] found that rate of disease increase was reduced with increased nitrogen fertilization. But in our study a clear effect of different N dose was observed on Potato late blight. The disease increased with high nitrogen dose (250 kg ha^{-1}) and minimum late blight severity was found with low nitrogen dose (150 kg ha^{-1}). This result is corroborated with the findings of Mahapatra *et al.* (2011) [9]. They reported that where early blight, leaf blotch and multiple disease complex decreases in high nitrogen dose, late blight

disease severity increases and minimum late blight severity was observed in moderate fertility soil. Juarez *et al*. (2000) [8] reported that N had no effect on the disease when severity was very low or high but at intermediate levels of disease severity, increased N led to increase disease. Carnegie *et al*. (1983) [1] concluded that increasing rate of Phosphorus or Potash did not significantly affect the development of blight lesions but a linear increase in lesion size was associated with increasing application rates of nitrogen. At low doses of nitrogen due to poor nutrition plant may became susceptible resulting in high disease incidence. Whereas, at high dose of N vegetative growth is more, plants become more succulent and canopy size is more which makes plants susceptible to disease. Bigger canopy not only invite the pathogen but also helps in its establishment and spread. Changes in canopy size may affect micro-climate and hence LB because *P. infestans* is sensitive to temperature and humidity, especially humidity [3].

Conclusion

As late blight of potato is most destructive disease of potato and the disease causing pathogen, *Phytophthora infestans*, is of variable nature, so management of this disease needs more concern. Though the disease can be best managed with chemicals, we can't solely depend upon chemical control measures. An integrated approach of disease management should be practised. Among cultural management fertilization plays an important role in plant growth and development, yield as well as disease resistance. Our study on the effect of different regimes of nitrogen on Late blight of potato reveals that both less and high dose of nitrogen application invites more disease. So optimum nitrogen dose of 150 Kg/ha should be applied which gives high yield with low disease severity.

Abbreviations

AUDPC	-	Area under disease progress curve
PDI	-	Percent Disease Index
SPSS	-	Statistical Package for the Social Sciences
DAP	-	Diammonium phosphate
SSP	-	Single superphosphate
MOP	-	Muriate of potash

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