J. Mycopathol, Res, **49(2)** : 273-278 (2011)

Effects of different levels of nitrogen against foliar diseases of potato under different fertility gradient soil on field condition

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Received : 25.02.2010 Accepted : 24.06.2011 Published : 24.10.2011

Three different doses of nitrogen against foliar diseases of potato under four fertility gradient soil on field condition for consecutive two years (2006-2008) showed that early blight (*Alternaria solani*), leaf blotch (*Cercospora concors*) and multiple disease complex were minimum in high fertility gradient soil (N 290.1 : P 26.3 : K 243.3 kgha^{-1}) as compare to other gradients and control except late blight of potato (*Phytophthora infestans*). Among the three nitrogen levels early blight, leaf blotch and multiple disease complex were decreased in high nitrogen dose (250 kgha^{-1}) except late blight. Interaction between four different soil gradients with three nitrogen doses showed minimum late blight severity in moderate fertility soil (N 275.4 : P 16.2 : K 163.3 kgha^{-1}) with low nitrogen dose (150 kgha^{-1}), minimum early blight severity in high fertility gradient soil with medium nitrogen dose (200 kgha^{-1}), and minimum leaf blotch in both high nitrogen and soil fertility gradient condition. Where as multiple disease was also minimum in both high nitrogen and fertility gradient soil on field condition. Yield (21.49 t/ha) also maximum in both high nitrogen (250 kgha^{-1}) and high fertility gradient soil condition.

Key words: Late blight, early blight, leaf blotch, potato, N level, fertility gradients

INTRODUCTION

The nutrient requirement of potato is high because of their higher biological yield. Farmers use fertilizer to increase its production without knowing the fertility level of soil. Increase use of fertilizers predisposes the cultivated crops towards infection by various fungal diseases in low to severe forms (Mackenzie, 1981). The most commonly occuring destructive diseases of potato are late blight (*Phytophthora infestans*), early blight (*Alternaria solani*) and leaf blotch (*Cercospora concors*) causing 25-100% crop loss according to the severity of this multiple disease complex (Lakra, 1996). Nutrition of a host may determine its resistance or susceptibility to disease as a pathogen grows in a particular host or its particular organ because availibility of specific nutrient on the site of infection. A disease can be eliminated or reduced by application of different nutrients in soil which ultimately determine the host nutrition. So knowledge of application of host nutrition in soil in relation to disease development in plant should be considered an important cultural weapon for controlling diseases in integrated crop production system. The experiment has been conducted to find out the actual doses of nitrogen rwquired among three N levels under different fertility gradient soil to harvest more yield with less disease.

MATERIALS AND METHODS

The experiment was conducted at the Regional Research Station, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during *rabi* season of 2006-07 and 2007-08. Soil was sandy clay loam. Four fertility gradient of soil were prepared by cultivation of maize during *kharif* season in the same field. Each gradient area was of 500 sq.m. covering total area of 2000 sq.m. and each of the gradient was separated by one meter irrigation channel. The four fertility gradient strips were fertilized in four different recommendations, namely, low (S_1) - 0:0:0 (N:P:K), medium (S_2) (50:31:67), moderate (S_3) (100:62:134), and high (S_4) (200:124:268). These NPK fertilizers were applied during maize cultivation. After harvesting of maize, soil samples were collected from 15 cm depth from each gradient strips and analysed for pH and available N,P,K. The mean data of available nutrients of different four fertility gradients of maize crops were as low (S_1)- pH, 6.3; N, 277.3; P, 9.5; K,

90.3 kgha^{-1}, in medium (S_2) - pH,6.2; N, 276.4; P, 12.6; K, 123.5 kgha-1, in moderate (S_3)- pH, 6.4; N, 275.4; P,16.2; K, 163.3 kgha^{-1}, and in high (S_4)- pH, 6.3; N, 290.1; P, 26.3; K, 243.3 kgha^{-1}. Every fertility gradient strips was divided into 12 equal plots for 4 treatments with 3 replications including untreated control and each plot measuring 5 mx7m. The three different N doses and untreated control were regarded as treatments. The three different doses of nitrogen used were – 150, 200, 250 kgha-1, of which 50%N was used as basal and remaining 50% during earthing up at 35 days after sowing. Normal doses of P and K (100, 10 kgha-1) were applied in each plot as basal at the time of sowing. The potato cultivar Kufri Jyoti was planted on 30th November in each year 2006-07 and 2007-08 during *rabi* season. The seed rate was 1500 kg/ha and cultivated with a 60 cm row and 20 cm plant to plant in furrows. Total 5 irrigations were given without any plant protection measures, except insecticide application, as and when required.

Three important diseases of potato namely early blight, late blight, leaf blotch and their multiple disease complexes were assessed from each replication of each treatment. These disease severities were recorded using 1-6 scale (Ahmed, 2002). Ten plants of each replication were selected randomly and per cent disease severity was calculated as per McKinney (1923). Per cent disease severity increase or decrease over control was calculated by using the formula :

DI or PDI increase or decrease over control (%) =

$$\frac{\text{Disease in control} - \text{Disease in treatment}}{\text{Disease in control plot}} \times 100$$

The disease severity records were averaged over the three replication and disease progress curves were calculated as per formula of Willcoxon *et.al.* (1975) :.

AUPDC = $\sum [Y_{i+1} + y_i)/ 2(X_{i+1} - X_i)]$; Y_i = Severity at 1st observation; X_i = Time (days) at first observation; N = Total number of observation

Yield of potato tubers were harvested on dated 20-21 February in each year. The number of tubers and weight of tubers in per plant from each replication plot was obtained from randomly selected five plants. The results were statistically interpreted through calculation of Analysis of Variance by standard method (Cochran and Cox, 1957) and significant of different treatments were tested by Fisher and Snedicor's "F" test probability level 0.05.

RESULTS AND DISCUSSION

The different fertility status of the soil showed different disease reaction and yield attributes when different doses of N were used.

In case of late blight the disease severity were significantly decreased with increase in the fertility status. Though maximum disease severity decreased over control was observed in medium (42.03%) and moderate (42.05%) fertility status of soil. The maximum AUDPC was observed in low (3.99) and minimum (0.99) in high fertility status of soil (S_4) and their difference in disease severity was statistically significant (Table 1).

In case of early blight of potato the disease severity (AUDPC) was decreased with increase in fertility status of soil. Though low (S_1) and medium fertility status (S_2) soil showed no significant difference in disease severity. similar trend also observed in leaf blotch disease severity, were high fertility status (S_4) of soil showed minimum disease severity. Similar observation were also observed in multiple disease severity complexes (Table.1).

In three nitrogen levels the data showed different in disease severity and their differences were statistically significant. This situation was observed in all the three foliar diseases and also in multiple disease severity complex.

In case of late blight with increase in N level there was a significant decrease in disease severity where minimum AUDPC (2.16) was observed in the plots treated with 250 kgha^{-1} N and maximum (2.39) in the plots treated with 150 kgha^{-1} N. Maximum disease reduction (30.17%) was observed as comparison to untreated control in the plots treated with 200 kgha^{-1} N and minimum (0.52%) in 150 kgha^{-1} N treated plots.

In case of early blight infection maximum (18.90%) disease reduction over untreated control was recorded in 250 kgha^{-1} and minimum (1.43%) in 200 kgha^{-1} N treated plots.

Table 1 : Effect of different levels of nitrogen on disease severity (AUDPC) on foliar diseases of potato under different fertility gradients (Pooled of two years).

Treatment	Late blight		Early blight		Leaf blotch		Multiple disease complex	
	Disease severity (AUDPC)	% increase (+) or decrease (-) over control	Disease severity (AUDPC)	%increase (+) or decrease (-) over control	Disease severity (AUDPC)	% increase (+) or decrease (-) over control	Disease severity (AUDPC)	% increase (+) or decrease (-) over control
S_1	3.99	-10.22	4.12	-42.37	6.53	-49.77	14.65	-41.04
S_2	2.54	-42.03	4.85	124.25	7.22	-46.38	14.55	-29.15
S_3	1.53	-42.05	3.70	-35.53	4.69	-60.94	9.89	-52.12
S_4	0.99	28.77	1.45	-57.59	2.23	-67.24	4.79	-57.27
SEM (±)	0.12	14.94	0.22	22.26	0.24	1.89	0.59	4.53
CD (5%)	0.41	51.55	0.76	76.80	0.83	6.52	2.03	15.63
N_1	2.39	-0.52	3.86	11.90	6.84	-42.05	13.13	-32.9
N_2	2.25	-30.17	3.77	-1.43	5.49	-53.52	11.52	-43.76
N_3	2.16	-18.46	2.98	-18.9	3.18	-72.68	8.37	-58.02
SEM (±)	0.22	2.56	0.12	3.53	0.09	0.76	0.18	1.13
CD (5%)	0.06	7.65	0.36	10.55	0.27	2.37	0.54	3.38
S_1N_1	4.06	-8.83	4.22	-40.92	7.33	-43.63	15.61	-37.18
S_1N_2	4.30	-3.19	5.30	-25.82	8.56	-34.23	18.16	-26.48
S_1N_3	3.61	-18.63	2.86	-60.37	3.17	-71.46	10.18	-59.09
S_2N_1	2.74	-37.22	5.93	175.39	10.97	-18.58	19.43	-5.21
S_2N_2	2.69	-38.34	4.90	122.91	6.94	-48.51	14.51	-29.32
S_2N_3	2.21	-50.53	3.73	74.46	3.78	-72.05	9.71	-52.9
S_3N_1	2.23	-54.07	3.71	-34.21	6.15	-48.78	11.14	-45.77
S_3N_2	1.49	-43.99	3.65	-38.08	4.13	-65.7	9.31	-55.21
S_3N_3	1.89	-28.11	3.67	-34.3	3.8	-68.36	9.24	-55.38
S_4N_1	1.53	98.04	1.58	-52.65	2.98	-57.23	6.35	-43.42
S_4N_2	0.50	-35.18	1.34	-64.73	2.35	-65.66	4.09	-63.66
S_4N_3	0.95	23.44	1.65	-55.4	1.44	-78.84	3.94	-64.72
SEM (±)	0.05	5.31	0.24	7.06	0.18	1.52	0.35	2.25
CD (5%)	0.15	15.87	0.72	21.1	0.54	4.54	1.05	6.73

Similar disease reduction was also observed in leaf blotch disease severity where maximum disease reduction (72.68%) was noticed in 250 $kgha^{-1}N$ and minimum (32.90%) in 150 $kgha^{-1}N$ treated plots as compare to untreated control.

In case of multiple disease severity complex similar trend was also observed where maximum disease reduction was observed in high N level and minimum in low N level and their differences were statistically significant (Table1). Three different levels of N when applied in four fertility status of soil the three foliar disease severity showed difference in their reaction and their differences were statistically significant.

In late blight of potato with increase in N level there is a significant decrease in disease severity. This was observed in both low (S_1) and medium (S_2) fertility status of soil. The per cent reduction of disease severity over control was increased with increasing level of N. In moderate fertility status (S_3) of soil the reverse results were noticed where with increase in N there was significant increase in late blight of potato. The per cent reduction of disease severity over control showed with decrease in N level there was a significant increase in per cent reduction of disease.

In high fertility status (S_4) of soil, with increase in N doses there was a significant decrease in disease severity. Though maximum reduction in disease severity over control was noticed in the plots treated with 200 $kgha^{-1}N$.

Early blight disease severity showed minimum (2.86) in high N level (250 kgha^{-1}) and maximum (15.30%) in medium N level (200 kgha^{-1}) in low fertility status soil (S_1) and maximum disease reduction (60.37%) was also noticed in similar high N level. In medium fertility status soil (S_2) the disease severity was decreased with increase in N. In moderate fertility status (S_3) soil the disease reduction over control showed no significant difference among N levels. Similarly high fertility status soil N dose showed no significant difference in disease reduction.

Leaf blotch disease severity with high N doses (250 kgha^{-1}) caused maximum disease reduction in all four fertility status of soil (78.84% in high, 72.05% in medium and 71.46% in low).

The multiple disease complex of the three foliar diseases showed with increase in N doses there was a significant decrease in disease severity and it was noticed in all the four fertility status of soil their differences in disease severity were statistically significant among themselves. Maximum disease reduction were noticed as 59.09% in low, 52.90% in medium, 55.38% in moderate, 64.72% in high fertility status of soil where high N dose (250 kgha^{-1}) were used. In all fertility status of soil with increase in N level in soil there was a significant decrease in disease severity.

In case of late blight of potato the disease severity was very low in natural condition. This result confirmed the result of Jaurez *et al.* (2000) that N had no effect on disease when severity was very low. Sawicka (1992) also stated that higher doses of N do not affect disease appearance but increase infection. The disease severity was less due to decrease in sporulation in excessive fertilized soil as reported by Rotem *et al.* (1983).

In case of early blight this result confirmed the result of Dasgupta *et.al.* (1991) in case of musturd that higher application of nitrogen fertilizer reduced the incidence of Alternaria blight of musturd. Similarly Barkley *et al.* (1972) reported that high N level reduced the incidence of *Alternaria solani* in potato as increase in N levels increase the disease resistance in plants through extended the period of meristematic activity with enable the plant to allow infection. This result also confirmed by Machenzie (1981) as increased N application reduced the apparent infection rate of potato early blight.

In case of leaf blotch caused by *Cercospora concors* the data showed high N reduced the disease and it was confirmed by Arora (1989) that application of N 300 kgha^{-1} at the time of planting reduced the build up of leaf blotch pathogen. Garza and Cruz, (1991) reported that Cercospora leaf spot of soyabean can be controlled by application of high doses of N.

Yield attributes

The effect of three N levels on four fertility status of soil and occurence of disease severity had ultimately reflected on the yield attributes of potato. The yield attributes, particularly, number of tubers per plant, weight of tubers per plant and ultimately total yield of tubers were recorded and discussed.

Number of tubers per plant

Different fertility status of soil showed different number of tubers per plant. Maximum (6.89) was noticed on medium fertility staus of soil (S_2) and minimum (5.22) in low (S_1) irrespective of different N doses. The three different levels of N showed no significant effect on number of tubers per plant. Interaction between fertility status of soil showed no significant differences in number of tuber per plant though poor number was observed in low fertility status (S_1) of soil (Table.2).

Weight of tubers per plant

Weight of tubers per plant (g plant^{-1}) was significantly influenced by different levels of fertility status of soil and maximum tuber weight per plant was observed in high (S_4) fertility status of soil (530 g plant^{-1}) and minimum in low (S_1) fertility status of soil (307.92 g plant^{-1}) and their differences are statistically significant.

Similarly three different levels of N also influenced the tuber weight per plant and maximum (491.67 g plant^{-1}) were observed in 200 kgha^{-1}N and minimum in 150 kgha^{-1} N applied plots (384.69 g plant^{-1}).

Three different levels of N in four different fertility stutus of soil showed that with increase in N there was a significant increase in tuber weight per plant in all fertility status of soil. Where the three levels of N had no significant effect on tuber yield per plant.

Table 2 : Effect of different levels of nitrogen on yield attributes of potato under different fertility gradients (Pooled of two years).

Treatment	No.of tuber/ plant	% increase (+) or decrease (-) over control	Wt. of tuber/plant (g)	% increase (+) or decrease (-) over control	Yield/t ha-1	% increase (+) or decrease (-) over control
S_1	5.22	74.78	307.92	256.59	16.55	258.95
S_2	6.89	65.27	449.44	272.59	19.65	327.77
S_3	6.53	79.19	484.31	335.10	16.54	252.77
S_4	6.47	23.56	530.00	133.62	19.62	288.48
SEM (±)	0:34	32.85	15.96	26.31	0.08	37.20
CD (5%)	1.17	113.34	55.07	90.78	0.28	128.35
N_1	6.31	59.73	384.69	204.25	17.69	273.99
N_2	6.40	66.33	491.67	286.38	17.92	278.20
N_3	6.13	56.05	452.40	257.80	18.67	293.68
SEM (±)	0.25	37.73	10.19	10.00	0.07	3.27
CD (5%)	2.14	112.78	30.46	29.89	0.21	9.77
S_1N_1	5.33	74.52	269.17	207.89	17.63	282.61
S_1N_2	5.42	80.50	315.42	264.60	16.28	253.02
S_1N_3	4.92	69.32	339.17	297.28	15.73	241.22
S_2N_1	7.08	72.30	358.33	196.09	17.71	286.02
S_2N_2	6.83	66.13	512.50	325.52	19.53	325.07
S_2N_3	6.75	57.38	477.50	296.16	21.70	372.02
S_3N_1	6.42	70.11	463.33	315.91	17.58	274.92
S_3N_2	7.17	100.64	548.33	395.43	16.32	247.86
S_3N_3	6.00	66.82	441.25	293.97	15.73	235.33
S_4N_1	6.42	21.99	447.92	97.13	17.82	252.42
S_4N_2	6.17	18.02	590.42	159.96	19.56	286.86
S_4N_3	6.83	30.67	551.67	143.79	21.49	326.17
SEM (±)	0.51	15.46	20.39	21.01	0.14	6.54
CD (5%)	1.52	46.21	60.95	59.81	0.42	19.55

Maximum tuber weight per plant (590.42 g plant^{-1}) was noticed in 200 kgha^{-1}N applied plots in high fertility status of soil and minimum (269.17g plant^{-1}) in 150 kgha^{-1} N applied plots in low fertility status of soil.

The experiment showed that N@ 200 kgha^{-1} increase the weight (in gm) of tubers per plant in medium (512.52), moderate (548.33) and high (590.42) status of soil and their differences were statistically significant (Table 2).

Tuber yield

The tuber yield of potato showed maximum tuber yield (t ha^{-1}) in medium (19.65 t ha^{-1}) and high (19.62 t ha^{-1}) among the four fertility status of soil in irrespective of three different N levels. Maximum increase in tuber yield (327.70%) was also observed in medium fertility status of soil.

Tuber yield (t ha^{-1}) increased with increase in N level and maximum (18.67 t ha^{-1}) was recorded in 250 kgha^{-1} N applied plots and minimum (17.69t ha^{-1}) yield in 150 kgha^{-1} N applied plots. Interaction between three N levels and four fertility status soil showed that N level had a positive significant role with increase in tuber yield (21.70 t ha^{-1}). High N doses (250 kgha^{-1}) in medium fertility status of soil followed by high N doses with high fertility status of soil (21.49 t ha^{-1}) produced maximum yield and they were statistically at par. In low and moderate fertility status of soil high N doses recorded minimum tuber yield (15.73 t ha^{-1}) as compare to other treatment combinations.

In case of per cent increase in tuber yield (t ha^{-1}) the similar observations were recorded as above total tuber yield (t ha^{-1}). The result confirm the result of this experiment as per Sharma and Sodhi (1983)

that high N level produced higher yield of healthy fruits of tomato. This result also confirmed the result of Jaurez *et al.* (2000), that more N led to more foliage develoment and highre yield of potato in the absence of late blight disease.

The above results therefore suggested that fertility levels of soil should be considered before application of N for maximize tuber yield of potato and to reduce the important foliar diseases. Among the four fertility status of soil with increased in N (150, 200, 250 $kgha^{-1}$) there was a significant decrease in early blight, leaf blotch and multiple disease complex with a few exceptions in late blight of potato. In high(S_4) and medium (S_2) fertility status of soil, high N dose (250 $kgha^{-1}$) increase the yield attributes, tuber yield and also reduced the early blight, leaf blotch and multiple disease complex. In low (S_1) and moderate (S_3) fertility status soil maximum yield was recorded in low N level (150 $kgha^{-1}$) though maximum disease reduction was observed in high N levels.

REFERENCES

Ahmed Zubair 2002. *Reaction of different Macro-nutrient levels on the severity of foliar diseases of potato (Solanum tuberosum. Linn).* M.Sc. (Ag.) thesis. Bidhan Chandra Krishi Viswavidyalaya, Nadia, Mohanpur. P - 95.

Arora K 1989 Some observations on leaf spot diseases of potato in Shimla Hills. *Ind J Pl Pathol.* **7:** 6-14

Barklay GM, Murphy HJ, Manzer FE and Hutchinson FE 1972. Effect of differential rates of nitrogen and phosphorus on early blight of potaoes. *Am Pot J* **50:** 42-48.

Cochran WG and Cox GN 1957. *Experimental Designs,* 2d ed., John Wiley & Sons, New York.

Cwalina B, Czajka W. and Fabisiewicz M 2000. Infestation of milo potato cultivar by some pathogens during the growing season in relation to different fertilizer treatments. *Biuletyn In Hodowi.* **214** : 239-244.

Dasgupta B, Ghosh RK and Chatterjee BN 1991. Effect of different doses and levels of nitrogen fertilizers on Alternaria blight disease and productivity of Indian mustard. *Env and Eco* **9:** 118-123.

Garza JG and Cruz M 1991. Effect of fertilizers and chemical control of diseases on yield and quality of soybean in Las Hastecas, *Tamaulipas Rev Mexicana.* **9:** 134-143.

Jaurez JS, Amaro JR, Rivera MD and Parraga A 2000. The effect of nitrogen fertilization on potato late blight in the field. Progress report 69-76

Lakra BS 1997. Prevalence of diseases of potato crop in Haryana. *Crop Res Hisar* **14** : 357-360.

Mackenzie DR. 1981. Association of potash, early blight, nitrogen fertilizer rate and potato yield. *Plant Dis* **65:** 575 - 577.

Rotem J and Sari A 1983. Fertilization and age conditioned predisposition of potatoes to sporulation of and infection of *Phytophthora infestans. Pflanzensehutz* **90:** 83-88.

Sawicka B and Skalski J 1992. The influence of protection against blight and of nitrogen fertilization of potatoes on yield and its structure. *Roc Nan Roln* **109:** 153-161.

Wilcoxon RD, skovm R and Atif AA 1975. Evaluation of wheat cultivars for the ability to retard development of stem rust. *Ann App Bio,* **80** : 275-87.