J. Mycopathol, Res, **50(2)** : 211-216 (2012)

Effect of different levels of nitrogen and potassium on foliar disease severity of potato under different fertility levels

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Received : 11.11.2011 Accepted : 21.06.2012 Published : 29.10.2012

A study was undertaken to evaluate the effect of different combinations of three nitrogen levels, two potassium levels and a recommended dose of phosphorus on severity of three foliar diseases and yield of potato grown in soils with four fertility gradients. Nitrogen was applied @ 150, 200 and 250 kg ha^{-1}, potassium @ 100 and 125 kg ha^{-1} and phosphorus was applied @ 100 kg ha^{-1}. The fertility gradients were low (S_1) = 278.3:9.9:80.3, medium (S_2) = 90.1:22.9:97.0, moderate (S_3) = 296.0:26.6:213.5 and high (S_4) = 301.8:37.1:282.8 kg NPK ha^{-1}, respectively. The results showed that P @ 100 kg ha^{-1}, the effect of different level of N and K combinations N @ 150, 200 and 250, and K @ 100 and 125 kg ha^{-1} in different combinations were under different in different soil fertility gradients soil were effective to for reduction severity of late blight, early and leaf blotch diseases of potato severity and maximizing yield. The most effective combinations were as, the result concluded that for maximizing yield and minimum disease severity ,the N and K combinations requirements in different fertility gradient soil were N 150 kg ha^{-1} and K 125 kg ha^{-1} in case of low fertility gradient (S_1) (11.47 AUDPC; 18.13 t ha^{-1});, N 250 kg ha"[1] and K 125 kg ha"[1] in case of medium fertility gradient, (S_2) (6.98 AUDPC; 22.10 t ha^{-1}); N 150 kg ha^{-1} and K 125 kg ha^{-1} in moderate fertility gradient (S_3) (11.32 AUDPC; 18.08 t ha^{-1}), and N 250 kg ha^{-1} and K 125 kg ha^{-1} in high fertility gradient (S_4) (3.42 AUDPC; 21.73 t ha"l) soil condition.

Key words : Fertility gradients, nitrogen, potassium, foliar diseases, potato

INTRODUCTION

Nutrient requirement of potato is high because of its higher biological yield. Farmers judiciously applied fertilizer to increase its production without knowing the fertility level of soil. Increased use of fertilizers sometimes predisposed the cultivated crop to infection by various fungal diseases in low to severe (Mackenzie, 1981). The most commonly occurring destructive diseases of potato are late blight *(Phytophthora infestans),* early blight *(Alternaria solani)* and leaf blotch *(Cercospora concors).* The diseases may cause 25-100% crop loss depending on their severity (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 kinds and quantity of nutrients required by the pathogen are available there. 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 and potassium required among three N and two K levels under different fertility gradient soil to obtain higher yield of potato with less disease.

MATERIALS AND METHODS

The experiment was conducted at the Regional Research Station, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during 2006-07 and 2007-08. Soil was sandy clay loam and latitude 22° 93N and longitude 88° 33E.

Four fertility gradients in the experimental field were made by cultivation of maize during *Kharif* season. Four gradient areas of 500 m^2 covering the total area of 2000 m^2 were separated from each other by one meter irrigation channel. The fertility gradient strips were made by applying four different dozes (kg ha^{-1}) of NPK viz. low (S_1) - (0:0:0), me-

dium (S_2) (50:31:67), moderate (S_3) (100:62:134), high (S_4) (200:124:268). These NPK fertilizers were applied during maize cultivation. After harvesting of the maize, soil samples were collected from each gradient strips at a depth of 15 cm and analysed for pH, organic carbon (Nelson and Sommers 1982) and total NPK following standard methods (Jackson, 1973). The mean data of available NPK gradients in soils of maize crops were low (S_1) = 278.3:9.9:80.3, medium (S2) = 90.1:22.9:97.0, moderate (S_3) = 296.0:26.6:213.5 and high (S_4) = 301.8:37.1:282.8 kg ha^{-1}. The pH levels of the soils were 6.3, 6.2, 6.4 and 6.3, respectively. Every fertility gradient strips were divided into 4 m x 5 m sized 21 equal plots for 7 treatments including untreated control with 3 replications. The three different N doses combining with two K doses along with untreated control were regarded as treatments. The three different nitrogen doses used were 150 (N_1), 200 (N_2), 250 (N_3) kg ha^{-1}, where 50% N was used as basal and remaining 50% during earthing up at 35 days after sowing. Two different doses of K were 100 (K_1), 125 (K_2) kg ha^{-1} and recommended single dose of 100 kg P ha^{-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^{-1} and planted maintaining 60 cm row to row and 20 cm plant to plant distances. Irrigation was applied 5 times and insecticide was sprayed as and when required.

Severity of early blight, late blight, leaf blotch and their mixed infections was assessed and was recorded based on a 1-9 scale developed by Malcolmsol (1970). Ten plants of each replication were selected randomly for data collection and per cent disease severity (PDI) was calculated as suggested by McKinney (1923). Per cent disease severity increase or decrease over control was calculated by using the formula-

$$\text{DI or PDI increase or decrease over control (\%)} = \frac{\text{Disease in control} - \text{Disease in treatment}}{\text{Disease in control plot}} \times 100$$

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

$AUDPC = \sum [(Y_1 + y_1) / 2 (X_{i+1}-X_i)]$; Y = Severity at 1st observation, X_i = Time (days) at first observation, N = Total number of observation

Potato tubers were harvested within 20-21 February in each year. Data on number and weight of tubers per plant were recorded from 5 randomly selected plants in each replication. The data were statistically analyzed (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

Disease severity

Nitrogen @150, 200 and 250 kg ha^{-1} and potassium @100 and 125 kg ha^{-1} in different combinations showed various degrees of severity (AUDPC) of late blight, early blight and leaf blotch and their mixed infection (Table 1).

In case of late blight, interaction between N and K levels showed no significant differences in disease severity though minimum disease severity was observed in treatment with 200 kg N ha^{-1} and 100 kg K ha^{-1} and higher with 200 kg N ha^{-1} and 125 kg K ha^{-1}. Therefore, maximum reduction in disease severity was noticed in 200 kg N ha^{-1} and 100 kg K ha^{-1} treated plot.

In case of early blight of potato, with the increase of K level there was a significant decrease in disease severity at all N levels except 200 kg ha^{-1} with 125 kg K ha^{-1} and the lowest disease severity was recorded at N 250 kg ha^{-1} with 125 kg K ha^{-1}. The maximum reduction of disease severity was also noticed at the same level of N and K combination.

Like early blight, almost similar trend was also observed in case of leaf blotch of potato, whereas in case of mixed infection, minimum disease severity of 4.63% was recorded at 250 kg N ha^{-1} with 100 kg K ha^{-1} application. Therefore, maximum reduction due to mixed infection (60.27%) was noticed at high level of N (250 kgha^{-1}) and K (125 kgha^{-1}) combination.

The effect of three levels of N and two levels of K on the reduction of three foliar diseases varied with the variation of fertility gradient soil condition.

In low fertility gradient soil (Si) condition, minimum late blight severity was recorded at 250 kg N ha^{-1} and 125 kg K ha^{-1} combination and highest at 200 kg N ha^{-1} and 125 kg K ha^{-1} combination. Per cent decrease in disease severity was noticed in 250 kg N ha^{-1} and 125 kg K ha^{-1} combination.

Table 1 : Effect of different combinations of nitrogen and potassium at a constant level phosphorus under different soil fertility gradients on severity (AUDPC) of late blight, early blight and leaf blotch diseases of potato

Treatment	Late blight (*Phytophthora infestans*)		Early blight (*Alternaria solani*)		*Leaf blotch* (*Cercospora concors*)		*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
N_1K_1	2.52	22.20	4.39	22.41	7.84	-32.08	14.83	-22.40
N_1K_2	2.26	-23.24	3.34	1.40	5.84	-52.03	11.44	-43.40
N_2Kj	1.76	-44.17	3.66	-4.30	4.97	-57.69	10.39	-49.37
N_2K_2	2.73	-16.17	3.89	1.44	6.01	-49.36	12.65	-38.24
N_3K_1	2.13	-17.64	3.33	-0.03	3.28	-72.03	4.63	-55.78
N_3K_2	2.20	-19.27	2.63	-37.77	3.08	-73.32	7.09	-60.27
SEM(±)	0.06	4.28	0.10	4.14	0.08	0.79	0.15	0.98
CD (5%)	0.17	12.14	0.28	11.74	0.21	2.24	0.42	2.78
$S_1N_1K_1$	4.55	1.90	5.67	-19.55	9.45	-27.27	19.76	-20.54
$S_1N_1K_2$	3.58	-19.56	2.68	-62.30	5.21	-59.30	11.47	-53.83
$S_1N_2K_1$	3.87	-13.73	5.24	-26.80	8.28	-36.36	17.39	-30.00
$S_1N_2K_2$	4.73	7.34	5.37	-24.84	8.83	-32.10	18.94	-23.69
$S_1N_3K_1$	3.93	-11.46	3.33	-54.04	3.23	-75.20	10.49	-57.83
$S_1N_3K_2$	3.30	-25.80	2.39	-66.70	4.19	-67.73	9.87	-60.36
$S_2N_1K_1$	2.50	-42.70	6.10	178.89	10.92	-18.95	19.1 1	-7.10
$S_2N_1K_2$	2.92	-31.74	5.77	171.89	1 1.02	-18.21	19.75	-3.32
$S_2N_2K_1$	1.58	-64.46	4.77	1 15.25	4.91	-63.62	11.26	-45.32
$S_2N_2K_2$	3.80	-12.22	5.02	130.57	8.97	-33.40	17.76	-13.33
$S_2N_3K_1$	2.32	-48.71	5.39	152.17	4.78	-64.92	12.44	-39.57
$S_2N_3K_2$	2.09	-52.34	2.08	-3.26	2.82	-79.18	6.98	-66.33
$S_3N_1K_1$	0.67	-75.37	3.34	-40.95	6.84	-42.94	10.95	-46.59
$S_3N_1K_2$	1.78	-32.77	4.09	-27.47	5.46	-54.61	11.33	-44.96
$S_3N_2K_1$	1.12	-58.29	3.37	-43.63	4.58	-61.87	8.99	-56.71
$S_3N_2K_2$	1.87	-29.68	3.40	-32.53	3.76	-69.53	9.64	-53.71
$S_3N_3K_1$	1.20	-54.64	2.65	-53.44	3.70	-69.24	7.13	-65.67
$S_3N_3K_2$	2.58	-1.57	4.87	-15.16	3.89	-67.48	11.43	-45.10
$S_4N_1K_1$	2.37	24.98	2.35	-28.76	4.16	-39.14	9.51	-15.37
$S_4N_1K_2$	0.69	-8.90	1.81	-76.54	1.69	-75.32	3.19	-71.48
$S_4N_2K_2$	0.47	-40.22	1.32	-62.91	2.13	-68.91	3.92	-65.67
$S_4N_2K_2$	0.54	-30.14	1.15	-67.43	2.57	-62.40	4.26	-62.26
$S_4N_3K_1$	1.09	44.25	1.94	-44.81	1.44	-78.77	4.46	-60.05
$S_4N_3K_2$	0.81	2.64	1.18	-65.98	1.44	-78.91	3.42	-69.39
SEM(±)	**0.11**	**5.57**	**0.21**	**8.27**	**0.16**	**1.57**	**0.31**	**1.95**
CD (5%)	**0.31**	**15.80**	**0.59**	**23.46**	**0.45**	**4.45**	**0.88**	**5.53**

N_1=150, N_2=200, N_3=250 kg N ha^{-1}

K_1 = 100& K_2=125 kg K ha^{-1}

The NPK gradients in soils low (S_1) = 278.3:9.9:80.3, medium (S_2) = 90.1:22.9:97.0, moderate (S_3) = 296.0:26.6:213.5 and high (S_4) = 301.8:37.1:282.8 kg ha^{-1}

In medium fertility gradient (S_2) soil, minimum late blight severity was recorded at 200 kg N ha^{-1} and 100 kg K ha^{-1} level. Whereas in moderate (S_3) and high (S_4) fertility gradient soil, minimum late blight severity was recorded at 150 kg N ha^{-1} and 100 kg K ha^{-1} combination and 200 kg N ha^{-1} with 100 kg K ha^{-1} combination, respectively. Therefore, maximum reduction in disease severity was noticed at 250

kg N ha^{-1} and 125 kg K ha^{-1} combination in case of low (S_1); 200 kg N ha^{-1} and 100 kg K ha^{-1} in case of medium (S_2); 150 kg N ha^{-1} and 100 kg K ha^{-1} combination in moderate (S_3), and N 200 kg N ha^{-1} and 100 kg K ha^{-1} combinations in high fertility gradient (S_4) soil condition. Their differences were significant.

Table 2 : Effect of different levels of nitrogen and potassium applied in various combinations to control foliar diseases of potato on tuber yield under different fertility gradient soils

Treatment	Tuber per plant	Tuber wt. (g/plant)	Tuber yield (t/ha)	% increase over control
N_1K_1	6.83	398.75	17.30	266.03
N_1K_2	5.79	370.63	18.08	281.95
N_2K_1	6.00	484.58	18.18	283.65
N_2K_2	6.80	498.75	17.66	272.67
N_3K_1	5.79	433.13	18.63	292.31
N_3K_2	6.46	471.67	18.70	295.05
SEM(±)	**0.46**	**20.93**	**0.14**	**3.52**
CD (5%)	**1.30**	**59.38**	**0.38**	**9.98**
S N K	6.17	312.50	17.13	271.70
$S_1N_1K_2$	4.50	225.83	18.13	293.43
$S_1N_2K_1$	4.83	266.76	16.53	258.46
$S_1N_2K_2$	6.00	364.17	16.03	247.58
$S_1N_3K_1$	5.67	370.83	15.97	246.35
$S_1N_3K_2$	4.17	307.50	15.57	236.08
$S_2N_1K_1$	8.00	341.41	17.40	279.87
$S_2N_1K_2$	6.17	375.00	18.03	292.17
$S_2N_2K_1$	6.67	545.83	19.73	329.82
$S_2N_2K_2$	7.00	479.17	19.33	320.33
$S_2N_3K_1$	6.50	441.66	21.29	361.60
$S_2N_3K_2$	7.00	513.33	22.10	382.44
$S_3N_1K_1$	6.50	516.67	17.08	264.19
$S_3N_1K_2$	6.33	410.00	18.08	285.66
$S_3N_2K_1$	6.33	571.67	16.65	255.12
$S_3N_2K_2$	8.00	525.00	15.98	240.60
$S_3N_3K_1$	5.17	426.67	16.00	241.19
$S_3N_3K_2$	8.83	455.83	15.45	229.47
$S_4N K$	6.67	424.17	17.57	248.29
$S_4N^1K_2^1$	6.17	471.67	18.08	256.56
$S_4N_2^1K_2$	6.17	554.17	19.82	291.22
$S_4N_2K_1$	6.17	626.67	19.30	282.51
$S_4N_3K_1$	5.83	493.33	21.24	320.12
$S_4N_3K_2$	7.83	610.00	21.73	332.22
SEM(±)	**0.93**	**41.85**	**0.28**	**7.04**
CD (5%)	**2.64**	**118.72**	**0.77**	**19.97**

N_1=150, N_2=200, N_3=250 kg N ha^{-1}; K1=100 & K_2=125 kg K ha^{-1}
The NPK gradients in soils low (S_1) = 278.3:9.9:80.3, medium (S_2) = 90.1:22.9:97.0, moderate (S_3) = 296.0:26.6:213.5 and high (S_4^2) = 301.8:37.1:282.8 kg ha^{-1}

In case of early blight N 250 kg ha^{-1} mixed with K 125 kg ha^{-1} showed minimum disease severity of 2.39 as well as maximum disease reduction of 66.70% in the low fertility gradient soil, whereas in medium fertility gradient soil, minimum disease severity of 2.08 and maximum disease reduction of 3.26% were recorded in N 250 kg ha" and 125 kg K ha^{-1} combination. In moderate fertility gradient soil, minimum disease severity of 2.65 and maximum disease reduction of 53.44% were recorded in N 250 kg ha"^{1} and K 100 kg ha^{-1} combination. In high fertility gradient soil, minimum disease severity of 1.15 was recorded in N 200 kg ha"^{1} and high K 125 kg ha^{-1} combination, whereas maximum disease reduction of 76.54% was recorded at N 150 kg ha"' and K 125 kg ha"^{1} combination. Per cent reduction in disease severity over control showed no significant difference among N 250 kg ha"^{1} and K 125 kg ha^{-1} combinations (Table 1).

In case of leaf blotch disease, maximum of 75.20% reduction in disease severity was recorded at N 250 kgha^{-1} and K kgha^{-1} under low fertility gradient soil. In medium fertility gradient soil at N 250 kg ha^{-1} and K 125 kgha^{-1} the maximum reduction 79.18%. In moderate fertility gradient soil. N 200 kg ha^{-1} and high K 125 kg ha^{-1} combination showed maximum disease reduction of 69.53%. However, the reduction in disease severity over control was not significantly different among different N and K combination under this fertility gradient soil condition. Combination of 250 kg N ha^{-1} and 125 kg K ha^{-1} also showed maximum PDI of 78.91 under high fertility gradient soil condition.

Mixed infection of above three foliar diseases showed that all the three N and two K combinations decreased the disease severity over untreated control under all the fertility gradient soil conditions. The differences in disease severity and per cent reduction over control in different treatment combinations were significant among themselves under different fertility gradient soil condition (Table 1).

In low fertility gradient soil, maximum disease reduction was 60.36% in case of mixed disease infection at N 250 kg ha^{-1} and K 125 kg ha^{-1}. Similar observation was also noticed in medium fertility gradient soil where N 250 kg ha^{-1} and K 125 kg ha^{-1} caused maximum disease 66.23% reduction. In moderate fertility gradient soil, maximum of 65.67% disease reduction was noticed at N 250 kg

ha^{-1} and K 100 $kgha^{-1}$. Whereas in high fertility gradient soil, maximum disease reduction was 71.48% at N 150 kg ha^{-1} and K 125 kg ha^{-1}, though N 250 kg ha^{-1} and K 125 kg ha^{-1} combination showed statistically similar results in terms of diseases severity.

In case of late blight of potato the result confirmed the results of Phukan (1993), who found that fertilizer treatment with higher concentration of N and K in potato increased susceptibility to leaf infection by *P. infestans.* Reduction in severity of early blight of potato at increased level of K and N fertilizers also reported by Huang *et al.* (1999). Kimberly and Woltz (1981) and Arora (1989) reported a positive correlation between degree of nitrogenous fertilization and resistance of sugar beet against *Cercospora biticola.* They also found that higher application of N (300 kg ha^{-1}) at the time of planting reduced the leaf spot of potato caused by *Cercospora concors.* Similar result was also reported by Tanaka *et al.* (1993) who worked with *Cercospora* leaf spot of soybean.

Tuber Yield

The effect of different levels of nitrogen and potassium applied in different combinations to control foliar diseases of potato grown under different fertility gradient soil condition on the yield of potato tuber is shown in Table 2.

Number of tubers

The maximum number of tuber per plant was observed at low N (150 $kgha^{-1}$) and high K (125 $kgha^{-1}$) combination and minimum at high N (250 $kgha^{-1}$) and low K (100 $kgha^{-1}$) combination. However, the differences in the parameter under three N and two K combinations were not significant. Number of tuber production per plant showed no significant differences among three N and two K combinations though different N and K combinations in different soil fertility gradient also produced different number of tubers per plant. In case of low fertility gradient soil, the maximum number of tubers per plant was produced at low N and K combination and the minimum was produced at high N and high K combination. Almost similar observations were also observed in medium fertility gradient soil. Whereas in moderate fertility gradient soil, the maximum number of tuber per plant was found at medium N and high K combination. Maximum number of tubers per plant was noticed at high N (250 $kgha^{-1}$) and high K (125 $kgha^{-1}$) fertilization under high fertility gradient soil condition (Table 2).

Weight of tubers

Maximum weight of tubers per plant was noticed at 200 kg N ha^{-1} and 125 kg K ha^{-1} combination, whereas the minimum weight of tubers per plant was recorded at N 150 kg ha^{-1} and K 125 kg ha^{-1} combination. Different N and K combinations in different fertility gradient soils showed different weight of tubers per plant and their differences were significant. In low fertility gradient soil, maximum weight of tubers per plant was recorded at N 250 kg ha^{-1} and K 100 combination and minimum at N 150 kg ha^{-1} and K 125 kg ha^{-1} combinations. N 200 kg ha^{-1} and K 100 kg ha^{-1} combination yielded maximum weight of tuber per plant in medium fertility gradient soil and minimum at N 150 kg ha^{-1} and K 100 kg ha^{-1}. Effect of the treatments on tuber weight per plant was significant. In moderate fertility gradient soil, maximum weight of tuber per plant was noticed at N 200 kg ha^{-1} and K 100 kg ha^{-1} combination. Whereas in high fertility gradient soil, maximum weight of tuber per plant was noticed at N 200 kg ha^{-1} and K 125 kg ha^{-1} combination. On the other hand, the minimum weight of tuber per plant was found at N 150 kg ha^{-1} and K 100 kg ha^{-1} combination. Their differences were significant (Table 2).

Yield of tubers

Tuber yield per hectare (t ha^{-1}) under natural infection of three foliar diseases along with their mixed infection at different N and K combination applied in four different fertility gradient soils are shown in the Table 2. Among the treatments, N 250 kg ha^{-1} and K 125 kg ha^{-1} combination gave thee maximum tuber yield of 18.70 t ha^{-1} followed by N 250 kg ha^{-1} and K 100 kg ha^{-1} and their differences were not significant. The treatment N 200 kg ha^{-1} and K 125 kg ha^{-1} combination and N 150 kg ha^{-1} and K 100 kg ha^{-1} combination produced minimum tuber yield, and their difference was also not significant. The maximum increase of 295.05% in tuber yield was recorded from the treatment with N 250 kg ha^{-1} and K 125 kg ha^{-1} combination and the minimum of 266.03 % yield increase was found at N 100 kg ha^{-1} and K 100 kg ha^{-1}.

In low fertility gradient soil, tuber yield ranged 15.57 t ha^{-1}-18.13 t ha^{-1}. The maximum was recorded from N 150 kg ha^{-1} and K 125 kg ha^{-1} and minimum at N 250 kg ha^{-1} and K 125 kg ha^{-1} combinations. In medium fertility gradient soil , the maximum tuber yield of 22.10 t ha^{-1} was recorded from the treatment with N 250 kg ha^{-1} and K 125 kg ha^{-1} combination followed by N 250 kg ha^{-1} and K 100 kg ha^{-1} and the minimum of 17.40 t ha^{-1} was obtained at 150 kg ha^{-1} and K 100 kg ha^{-1} combinations and their differences were significant. In case of moderate fertility gradient soil, The maximum tuber yield of 18.08 t ha^{-1} was recorded at N 150 kg ha^{-1} and K 125 kg ha^{-1} combination. N 250 kg ha^{-1} and K 125 kg ha^{-1} and N 250 kg ha^{-1} and K 100 kg ha^{-1} combinations produced significantly higher tuber yield compared to other treatments in high fertility gradient soil and minimum at N 150 kg ha^{-1} and K 100 kg ha^{-1} combinations.

The findings of the present investigation suggest that P @ 100 kg ha^{-1}, N @ 150, 200 and 250, and K @ 100 and 125 kg ha^{-1} in different combinations under different soil fertility gradients are effective to reduce severity of late blight, early and leaf blotch diseases of potato and maximizing yield. The most effective combinations were N 150 kg ha^{-1} and K 125 kg ha^{-1} in low fertility gradient, N 250 kg ha^{-1} and K 125 kg ha^{-1} in medium fertility gradient, N 150 kg ha^{-1} and K 125 kg ha^{-1} in moderate fertility gradient, and N 250 kg ha^{-1} and K 125 kg ha^{-1} in high fertility gradient soil condition. The results confirms the findings of Seasick and Skalski (1992) who found that increase in N doses increase the yield of potato. This was observed in high and medium fertility gradient soil. But it contradicts with low and moderate fertility gradient soil, where optimum N 150 kg ha^{-1} increase the tuber yield and N 250 kg ha^{-1} significantly reduce the tuber yield. Jaurez *et al.* (2000) reported that optimum N 160 kg ha^{-1} increase the yield of tuber but doubling the dose 220 kg ha^{-1} did not increase yield in absence of late blight. Similar result was also observed by Ciceko *et al.* (1993) that tuber yield of potato was greatest with 100-150 kg ha^{-1} N application.

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