Relationship between Early Blight Disease Severity and Uptake of NPK by Potato Under Diverse Fertility Gradient of Soil

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ABSTRACT

Negative correlations were observed between the early blight disease severity (%) and uptake of Nitrogen, Phosphorus and Potassium by potato crop. The experiment was carried out by 13 treatments combination including untreated control ($S_0N_0P_0K_0$) with four different soil fertility gradient and Kufri jyoti was selected as test variety for the experiment. From this relationship, it clearly indicated that with increasing the disease severity there was Nitrogen uptake drastically reduced. Similarly, in case of Phosphorus and Potassium uptake by the plant extremely reduced with the increases of early blight disease severity. It due to less leaf area index (LAI), less root formation and less photosynthetic production were confirmed in the linear regression line and regression equations. The highest tuber yield (340.4 quintal ha^{-1}) was recorded in high fertility gradient of soil with higher NPK combinations ($S_4N_{250}P_{150}K_{125}$) followed by medium fertility gradient soil i.e. 339.4 quintal ha^{-1} ($S_3N_{200}P_{150}K_{125}$) and were found significantly superior to other treatments combination and in respect of untreated control under different fertility gradient of soil. From this observation, it could be noted that the high fertility gradient soil recorded the maximum yield and minimum yield obtained in low fertility gradient of soil. So it revealed that the nutrition factors as well as disease severity strongly interfere in the tuber yield.

Keywords: Early blight, disease severity, NPK, Soil fertility gradient, potato

Early blight of potato caused by Alternaria solani (Ell. and Martin) Jones and Grouts, is more common in West Bengal because the major potato growing belt in West Bengal is situated in the plains. Potato yield loss up to 40% was affected from year to year depending upon the weather conditions and artificially or naturally infected soil with Alternaria solani, serve a source of primary infection (De, 2004; Lakra, 1997). Studies on early blight in West Bengal are mainly restricted to the yearly occurrence of the disease. It depends on the effect of environmental conditions and management of the disease by spraying with fungicides. More over fertilizer and fertility level of the soil are known to affect the incidence of many diseases but such work has not yet been under taken in West Bengal.

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Timely and judicious application of fungicides is necessary for management of the disease.

The knowledge of plant nutrition with the relationship of plant disease provides a basis for modifying current agricultural practices to reduce disease severity in integrated crop production management. Farmers generally apply fertilizers without testing of the fertility status of the soil and also have little knowledge on the other aspects of the disease development (Huber and Graham, 1992). So, nutritional status of the soil is an important factor for disease severity for accurate prediction, such work has been made on this line.

Materials and Methods

The experiment was conducted at Regional Research Farm, Bidhan Chandra Krishi Viswavidyalya (B.C.K.V), Gayeshpur, Nadia,West Bengal during the rabi (dry) season of 2003-06. Study the effect of different NPK combinations on disease severity (%) of early blight of potato under diverse fertility gradient of soil. The research Farm is located at an elevation of 9.75 msl and the latitude and longitude are 23.5°N and 89.5°E respectively. The soil of the experimental field is sandy loam in texture, fine, mixed, and belongs to hyperthermia family of Aeric Haplaquept and with good water holding capacity. The main field consisted of four equal strips, gross plot area of the 4 (strips) fertility gradient soil were 2000 sq.m & each strip area was equal i.e. 500 sq.m and each of the plot was separated by one-meter irrigation channel. Before Potato sowing, soil samples collected from 15 cm. depths of soil from the 13 treatments plot under each strip were analyzed for pH, organic C, $KMnO_4$ method for N, Olsen method for P and $CH_3COO\ NH_4$ method for K and

Table 1: Available nutrients of soil, before potato sowing (Pooled data)

Strips (Key words)	pH	Organic C (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)
S_1	6.3	0.514	278.3	9.9	80.3
S_2	6.2	0.450	290.1	22.9	97.0
S_3	6.5	0.444	301.8	26.6	213.5
S_4	6.3	0.493	316.4	37.1	282.8

Plant samples were analyzed for N, P and K and their content and uptake by the method of Jackson (1973) and available mean nutrients of Initial soil of the three year data are presented in Table 1.

Layout and Design of the Experiment

The experiment was carried out after creation of fertility gradients, for experimentation of potato early blight disease in a split plot design with three (3) replications. Four different fertility gradients of soil were made then each gradient of soil divided into 13 sub plots or treatment per replication, covering an area of sub plot was 12 sq. m. (4m x 3m), the fertilizers applied to potato under different strips in 12 NPK combinations treatment and 1 control (untreated) before the sowing of potato. Then potato tubers were planted on 20th -21st Nov. in the respective years and the spacing between row to row and plant to plant was 50cm x15cm.

(i) Treatments combination follows

$T_1(N_{150}P_{125}K_{125})$;$T_2(N_{150}P_{125}K_{150})$;$T_3(N_{150}P_{150}K_{125})$;$T_4(N_{150}P_{150}K_{150})$;$T_5(N_{200}P_{125}K_{125})$;

$T_6(N_{200}P_{125}K_{150})$;$T_7(N_{200}P_{150}K_{125})$;$T_8(N_{200}P_{150}K_{150})$;$T_9(N_{250}P_{125}K_{125})$; T_{10} $(N_{250}P_{125}K_{150})$;

T_{11} $(N_{250}P_{150}K_{125})$; T_{12} $(N_{250}P_{150}K_{150})$; T_{13} $(N_0P_0K_0)$.

All the experimental plots were uniformly fertilized. Half of N total P and k were application as basal dose during final land preparation and the rest half of nitrogen was top-dressed after the first ear thing up, 35 days after sowing. Then Fungicides mainly Metalaxyl 35% WS, was applied @ 2.5g per lit of water at 35DAS and 2 spray were done at 10 days interval , only 10 plant per plot and per replication selected to control the late blight and leaf blotch diseases for determining the forecasting system of early blight of potato. Insecticides viz. Imidachloprid 17.8% SL @ 1 ml/5 lit. of water sprayed to control the caterpillar as well as aphids in the experimental plot.

(ii) Assessment of disease severity

For early blight disease severity, 10 plants per replication per treatment plot were randomize selected by such standardized rating scale given by Mayee and Datar (1986) and then percent of disease index (PDI) or disease severity of this disease was calculated. The percent of disease index (PDI) was calculated by using the formula of the McKinney (1923).

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Total no. of leaflets observed x maximum ratings}} \times 100$$

The percentage of disease severity (%) of early blight disease increase or decrease over control was calculated by using the formula as below:

$$\text{Percentage of disease Severity increase or decrease on over control} = \frac{\text{Value of the treated plot- Untreated plot (Control)}}{\text{Untreated plot}} \times 100$$

(iii) Yield (tuber and biomass) of potato

The potato tubers were harvested on dated 22nd -23rd February in the first, second and third years respectively. The fresh weight of tubers and biomass per replication per plot were taken in kg ha^{-1} then converted to quintal ha^{-1} (except biomass wt.).

(iv) Statistical Analysis of Results

The experimental results were statistically interpreted through calculation of "Analysis of variance" by a standard method (Cox and Hinkely, 1979) and the significance of different treatments was tested by Error means square by Fisher and Snedicor's "F" test at probability level 0.05. The severity data are angular in parentheses transformed.

Results and Discussion

A. Early blight disease Severity (%):

Low fertility gradient soil (S_1): The table-2 clearly showed that the disease severity (%) varied 2.3%-6.2% respectively. It was also observed that highest disease was observed in untreated plot (Control-$N_0P_0K_0$) (Severity =8.8%). The reduction of Severity (%) of early blight disease of potato decrease with high doses of N, P and K combinations under every fertility gradient soil than the control plot. In this gradient of soil, out of 13 treatments only the treatments, T10 (Severity =2.3%), T11 (Severity =2.4%), T12 (Severity =3.2%), T9 (Severity =2.9%) and T5 (Severity =3.4%) respectively were given low disease severity than the other treatments. The T10 showed highest disease reduction (73.9% severity) on over control followed by T11 (72.7% severity) and T5 (61.4% Severity).

Moderate fertility gradient soil (S_2): Similarly in this gradient of soil, disease severity (%) varied 1.9%-5.4% respectively. The treatments mainly T10 (Severity =1.9%), T11 (Severity =1.9%), T9 (Severity =2.3%) and T5 (Severity =2.5%) respectively were given low disease severity than the other treatments but the percentage of disease reduction on over control only two treatment i.e. T10 (74.0% severity) and T11 (74.0% severity) were showed the maximum disease reduction followed by T5 treatment (65.8% severity) (Table-2).

Medium fertility gradient soil (S_3): In this gradient of soil, disease severity (%) varied 2.1%-5.7% respectively. The treatments mainly T10 (Severity =2.1%), T11 (Severity =2.1%), T9 (Severity =2.4%), and T5 (Severity =2.8%) respectively were given low disease severity than the other treatments but the percentage of disease reduction on over control only two treatment i.e. T10 (74.4% severity) & T11 (74.4% severity) were showed the maximum disease reduction followed by T5 treatment (65.9% severity) (Table-2).

Table 2. Interacting effect of different fertility gradient and different NPK combinations on disease severity (%) of early blight of potato (Pooled data).

Treatments	Disease severity (%)	% disease reduction on over control
$S_1N_{150}P_{125}K_{125}$	6.2 (14.4)*	29.6
$S_1N_{150}P_{125}K_{150}$	4.5 (12.2)	48.9
$S_1N_{150}P_{150}K_{125}$	4.5 (12.3)	48.9
$S_1N_{150}P_{150}K_{150}$	5.3 (13.3)	39.8
$S_1N_{200}P_{125}K_{125}$	3.4 (10.5)	61.4
$S_1N_{200}P_{125}K_{150}$	3.1 (10.1)	64.8
$S_1N_{200}P_{150}K_{125}$	3.3 (10.4)	62.5
$S_1N_{200}P_{150}K_{150}$	3.7 (11.1)	58.0
$S_1N_{250}P_{125}K_{125}$	2.9 (9.8)	67.1
$S_1N_{250}P_{125}K_{150}$	2.3 (8.7)	73.9
$S_1N_{250}P_{150}K_{125}$	2.4 (8.9)	72.7
$S_1N_{250}P_{150}K_{150}$	3.2 (10.3)	63.6
$S_1N_0P_0K_0$	8.8 (17.3)	---
$S_2N_{150}P_{125}K_{125}$	5.4 (13.4)	26.0
$S_2N_{150}P_{125}K_{150}$	3.7 (11.1)	49.3
$S_2N_{150}P_{150}K_{125}$	3.9 (11.4)	46.6
$S_2N_{150}P_{150}K_{150}$	4.5 (12.2)	38.4

$S_2N_{200}P_{125}K_{125}$	2.5 (9.1)	65.8
$S_2N_{200}P_{125}K_{150}$	2.2 (8.6)	69.9
$S_2N_{200}P_{150}K_{125}$	2.5 (9.1)	65.8
$S_2N_{200}P_{150}K_{150}$	3.0 (10.0)	58.9
$S_2N_{250}P_{125}K_{125}$	2.3 (8.7)	68.5
$S_2N_{250}P_{125}K_{150}$	1.9 (7.8)	74.0
$S_2N_{250}P_{150}K_{125}$	1.9 (7.9)	74.0
$S_2N_{250}P_{150}K_{150}$	2.4 (8.9)	67.1
$S_2N_0P_0K_0$	7.3 (15.7)	---
$S_3N_{150}P_{125}K_{125}$	5.7 (13.8)	30.5
$S_3N_{150}P_{125}K_{150}$	4.0 (11.6)	51.2
$S_3N_{150}P_{150}K_{125}$	4.4 (12.1)	46.3
$S_3N_{150}P_{150}K_{150}$	4.9 (12.7)	40.2
$S_3N_{200}P_{125}K_{125}$	2.8 (9.5)	65.9
$S_3N_{200}P_{125}K_{150}$	2.4 (9.0)	70.7
$S_3N_{200}P_{150}K_{125}$	2.7 (9.4)	67.1
$S_3N_{200}P_{150}K_{150}$	3.3 (10.4)	59.8
$S_3N_{250}P_{125}K_{125}$	2.4 (8.9)	70.7
$S_3N_{250}P_{125}K_{150}$	2.1 (8.3)	74.4
$S_3N_{250}P_{150}K_{125}$	2.1 (8.4)	74.4
$S_3N_{250}P_{150}K_{150}$	2.6 (9.3)	68.3
$S_3N_0P_0K_0$	8.2 (16.7)	---
$S_4N_{150}P_{125}K_{125}$	4.9 (12.8)	26.9
$S_4N_{150}P_{125}K_{150}$	3.4 (10.6)	49.3
$S_4N_{150}P_{150}K_{125}$	3.5 (10.8)	47.8
$S_4N_{150}P_{150}K_{150}$	4.1 (11.7)	38.8
$S_4N_{200}P_{125}K_{125}$	2.3 (8.7)	65.7
$S_4N_{200}P_{125}K_{150}$	2.1 (8.3)	68.7
$S_4N_{200}P_{150}K_{125}$	2.3 (8.6)	65.7
$S_4N_{200}P_{150}K_{150}$	2.7 (9.5)	59.7
$S_4N_{250}P_{125}K_{125}$	1.9 (7.8)	71.6
$S_4N_{250}P_{125}K_{150}$	1.6 (7.4)	76.1
$S_4N_{250}P_{150}K_{125}$	1.5 (7.1)	77.6
$S_4N_{250}P_{150}K_{150}$	2.0 (8.1)	70.2
$S_4N_0P_0K_0$	6.7 (14.9)	---
S.Em ±	0.016(0.029)	---
CD (P=0.05)	0.044(0.080)	---

*Data in parentheses are angular transformed values
$S_{1=}$Low fertility gradient soil, $S_{2=}$ Moderate fertility gradient soil, $S_{3=}$ Medium fertility gradient soil and $S_{4=}$ High fertility gradient soil

High fertility gradient soil (S4): In this gradient of soil, disease severity (%) varied between 2.1%-5.7% respectively. The treatments mainly T10 (Severity =1.6%), T11 (Severity =1.5%), T9 (Severity =1.9%), And T5 (Severity =2.3%) respectively were given low disease severity than the other treatments but the percentage of disease reduction on over control only two treatment i.e. T10 (76.1% severity) & T11 (77.6% severity) were showed the maximum disease reduction followed by T5 treatment (65.7% severity) (Table-2).

Different NPK interactions on different fertility gradient soil, it was clearly emphasized that the increases in fertility gradient there was a significant decrease of disease severity (%) here high fertility gradient soil (S4) indicate the lowest percentage of the disease severity (%) and low fertility gradient soil (S1) indicate the maximum disease severity (%) while moderate (S2) and medium (S3) fertile soil showed the similar scenario of the severity of early blight disease. Similar result was also observed by Sohi (1985) in another solanaceous vegetables caused by Alternaria sp. Our result also confirmed by the Mondal *et al.,* (1989) that higher doses of Phosphorus (triple super phosphate) and with normal doses of potash reduced the incidence of purple blotch of onion caused by Alternaria porri. Similar observation was also obtain by Mackenzie (1981) that increased the nitrogen application reduced the apparent infection rate of potato early blight caused by Alternaria solani and final amount of disease incidence and severity also reduced.

B. Relationship between disease severity and uptake of NPK by Potato crop.

(1) Nitrogen Uptake and disease severity:

During the Cropping period (2003-06), Table no.3 revealed that there was a negative correlation between disease severity and uptake of nitrogen by potato confirmed by negative values of correlation coefficient(r) in different fertility gradient of soil. The highest correlation coefficient(r) and Coefficient determination (R^2) values were 'r' = -0.909, -0.924 and -0.907 and 'R^2' = 0.8612, 0.8791 and 0.8514 and the corresponding regression equations were obtained $\hat{Y}$ = 96.035-3.2613x, $\hat{Y}$ = 54.903-1.8821x and $\hat{Y}$ = 61.456-1.9863x in moderate fertility gradient (S_2) of soil during the three consecutive years. From these equations it was also observed that the attainable uptake of nitrogen 96.035, 54.903 and 61.456 Kg ha^{-1} but drop off 3.2613, 1.8821 and 1.9863 Kg ha^{-1} in moderate fertility gradient of soil it was statistically highly significant. But Coefficient determination (R^2) values in low fertility, medium fertility and high fertility gradient of soil showed low to medium significant. So far this relationship indicates that with increasing the disease severity there was N uptake by potato drastically reduced

Table 3. Correlation between disease severity (%) and uptake of N by Potato in different fertility gradient of soil (Pooled data).

Different fertility gradient Soil	Correlation regression equation	r	R^2
Year 2003-04			
S_1	$\hat{Y}$ = 81.426-2.07x	-0.681	0.5792
S_2	$\hat{Y}$ = 96.035-3.2613x	-0.909	0.8612
S_3	$\hat{Y}$ = 101.26-2.8545x	-0.864	0.7468
S_4	$\hat{Y}$ = 128.62-4.5308x	-0.796	0.7114
Year 2004-05			
S_1	$\hat{Y}$ = 46.691-1.015x	-0.434	0.2746
S_2	$\hat{Y}$ = 54.903-1.8821x	-0.924	0.8791
S_3	$\hat{Y}$ = 60.089-1.4776x	-0.427	0.2556
S_4	$\hat{Y}$ = 53.26-1.447x	-0.482	0.3083
Year 2005-06			
S_1	$\hat{Y}$ = 51.714-1.0589x	-0.411	0.2631
S_2	$\hat{Y}$ = 61.456-1.9863x	-0.907	0.8514
S_3	$\hat{Y}$ = 64.941-1.6006x	-0.453	0.2790
S_4	$\hat{Y}$ = 60.607-1.7815x	-0.539	0.3619

$S_{1=}$ Low fertility gradient soil, $S_{2=}$ Moderate fertility gradient soil, $S_{3=}$ Medium fertility gradient soil and $S_{4=}$ High fertility gradient soil

$\hat{Y}$ = Nitrogen (N) uptake (Kg ha^{-1})

r = Correlation coefficient

R^2 = Coefficient determination

x= Disease Severity (%)

due to less leaf area index (LAI) for photosyntheses (Reddy and Reddi, 2000).

(2) Phosphorus Uptake and disease severity:

Similarly a negative correlation was also observed between the uptake of Phosphorus by potato and early blight disease severity (Table 4). The highest correlation coefficient (r) and Coefficient determination (R^2) values were 'r' = -0.829, -0.686 and -0.691 and 'R^2' = 0.7416, 0.5372 and 0.5488 respectively. The correlation regression equations were obtained $\hat{Y}$ = 17.835-0.6933x, $\hat{Y}$ = 10.192-0.2944x and $\hat{Y}$ = 10.607-0.3136x in moderate fertility gradient (S_2), Medium fertility gradient (S_3), and High fertility gradient (S_4) of soil during the three different years. From these equations, $\hat{Y}$ indicates the uptake of P loss from different gradient of soil by potato and x = indicates the disease severity, so, above equations were stated that the attainable uptake of P 17.835, 10.192 and 10.607 Kg ha^{-1} but drop off 0.6933, 0.2944 and 0.3136 Kg ha^{-1} respectively where R^2 value was confirmed the limit of significant level for prediction equations (Table 4). From this relationship, it was clearly reveal that higher level of disease severity Phosphorus uptake by potato extremely reduced due to less growing root formation.

Table 4. Correlation between disease severity (%) and uptake of P by Potato in different fertility gradient of soil (Pooled data).

Different fertility gradient Soil	Correlation regression equation	r	R^2
Year 2003-04			
S_1	$\hat{Y}$ = 14.18-0.3551x	-0.510	0.3724
S_2	$\hat{Y}$ = 17.835-0.6933x	-0.829	0.7416
S_3	$\hat{Y}$ = 19.318-0.4966x	-0.686	0.4701
S_4	$\hat{Y}$ = 17.427-0.3816x	-0.525	0.3698
Year 2004-05			
S_1	$\hat{Y}$ = 6.8919-0.1571x	-0.419	0.2649
S_2	$\hat{Y}$ = 7.098-0.2272x	-0.594	0.4144
S_3	$\hat{Y}$ = 10.192-0.2944x	-0.686	0.5372

S_4	$\hat{Y}$ = 8.9703-0.2617x	-0.595	0.4312
Year 2005-06			
S_1	$\hat{Y}$ = 9.052-0.1987x	-0.419	0.2638
S_2	$\hat{Y}$ = 7.004-0.1973x	-0.621	0.4641
S_3	$\hat{Y}$ = 11.32-0.3018x	-0.637	0.4891
S_4	$\hat{Y}$ = 10.607-0.3136x	-0.691	0.5488

S_1= Low fertility gradient soil, S_2= Moderate fertility gradient soil,

S_3 = Medium fertility gradient soil and S_4 = High fertility gradient soil

$\hat{Y}$ = Phosphorus (P) uptake (Kg ha^{-1})

r = Correlation coefficient

R^2 = Coefficient determination

x= Disease Severity (%)

Potassium Uptake and disease severity

Likewise Table no. 5 also showed a negative correlation between disease severity (%) and uptake of Potassium by potato which confirmed by correlation coefficient (r) in different fertility gradient of soil. The highest correlation coefficient(r) and Coefficient determination (R^2) values were 'r' = -0.935, -0.865 and -0.856 and where, 'R^2' = 0.8746, 0.7918 and 0.7773 respectively and the regression equations were obtained $\hat{Y}$ = 100.69-3.0371x, $\hat{Y}$ = 81.349-2.5101x and $\hat{Y}$ = 84.802-2.5729 x in Medium fertility gradient soil (S_3) (2003-04) and next two year (2004-2006) in moderate fertility gradient (S_2) of soil during the said investigation periods. From these equations attainable uptake of Potassium 100.69, 81.349 and 84.802 Kg ha^{-1} but drop off 3.0371, 2.5101 and 2.5729 Kg ha^{-1} were observed in these fertility gradients of soil it was statistically highly significant. But Coefficient determination (R^2) was confirmed the limit of significant level for prediction equations in diverse fertility gradient of the soil (Table 4.). So far this relationship indicates that with increasing the disease severity there was K uptake by potato drastically reduced due to less leaf area index (LAI) and less Photosynthesis production (Reddy and Reddi, 2000).

Table 5. Correlation between disease severity (%) and uptake of K by Potato in different fertility gradient of soil (Pooled data).

Different fertility gradient Soil	Correlation regression equation	r	R^2
Year 2003-04			
S_1	$\hat{Y}$ = 71.413-1.853x	-0.700	0.5981
S_2	$\hat{Y}$ = 92.223-3.2649x	-0.828	0.7483
S_3	$\hat{Y}$ = 100.69-3.0371x	-0.935	0.8746
S_4	$\hat{Y}$ = 91.285-1.6923x	-0.585	0.4271
Year 2004-05			
S_1	$\hat{Y}$ = 77.581-1.8987x	-0.732	0.6198
S_2	$\hat{Y}$ = 81.349-2.5101x	-0.865	0.7918
S_3	$\hat{Y}$ = 99.117-2.6561x	-0.680	0.5511
S_4	$\hat{Y}$ = 83.845-2.3883x	-0.507	0.3289
Year 2005-06			
S_1	$\hat{Y}$ = 91.076-2.2993x	-0.769	0.6671
S_2	$\hat{Y}$ = 84.802-2.5729x	-0.856	0.7773
S_3	$\hat{Y}$ = 102.58-2.6782x	-0.701	0.5765
S_4	$\hat{Y}$ = 89.658-2.3529x	-0.500	0.3346

S_1 = Low fertility gradient soil,

S_2 = Moderate fertility gradient soil,

S_3 = Medium fertility gradient soil and

S_4 = High fertility gradient soil

$\hat{Y}$ = Potassium (K) uptake (Kg ha^{-1})

r = Correlation coefficient

R^2 = Coefficient determination

x= Disease Severity (%)

C. Potato tuber yield:

Interactions of different NPK combinations under different fertility gradient soil on yield attributes of potato were given in Table No. 6. The pooled data of the three years (2003-06) clearly revealed that tuber yield and biomass fresh weight were increased in every treatment combinations under different fertility gradient of soil as compared to untreated plot ($S_0N_0P_0K_0$). It was observed that highest tuber yield of potato 292.3q ha^{-1}($S_1N_{250}P_{150}K_{150}$) followed by 273.5 q ha^{-1}($S_1N_{250}P_{150}K_{125}$) and biomass fresh weight also higher than the untreated (control) plot(tuber yield=58.1 q ha^{-1}; biomass= 86.2 Kg ha^{-1}) under low fertility gradient (S_1) of soil. In moderate fertility gradient (S_2) of soil highest tuber yield and biomass fresh weight were observed in $S_2N_{200}P_{125}K_{150}$ (tuber yield=305.2 q ha^{-1}; biomass= 354.5 Kg ha^{-1}) followed by $S_2N_{250}P_{150}K_{125}$ (tuber yield=301.8 q ha^{-1}; biomass = 365.4 Kg ha^{-1}) on over the control plot. In case of medium fertility gradient of soil (S_3) highest tuber yield and biomass fresh weight were observed in $S_3N_{200}P_{150}K_{125}$ (tuber yield=339.4 q ha^{-1} ; biomass= 363.6 Kg ha^{-1}) followed by $S_3N_{250}P_{150}K_{150}$ (tuber yield=336.8 q ha^{-1}; biomass = 317.8 Kg ha^{-1}) and $S_3N_{200}P_{150}K_{150}$ (tuber yield=336.0 q ha^{-1}; biomass= 462.1 Kg ha^{-1}) both the combinations statistically at par on over the control plot. In high fertility gradient (S_4) soil, the maximum yield and biomass obtained from $S_4N_{250}P_{150}K_{125}$ (tuber yield=340.4 q ha^{-1}; biomass= 701.2 Kg ha^{-1}) followed by $S_4N_{250}P_{125}K_{150}$ (tuber yield=337.9 q ha^{-1}; biomass= 771.8 Kg ha^{-1}), $S_4N_{250}P_{150}K_{150}$ (tuber yield=335.9 q ha^{-1}; biomass= 617.2 Kg ha^{-1}).The maximum yield percent increased and biomass fresh weight were also increased with the increases of NPK doses on over control under all fertility gradient soil. From this observation, it could be noted that the high fertility gradient soil recorded the maximum yield and minimum yield obtained in low fertility gradient of soil. So it revealed that the nutrition factors as well as disease severity strongly interfere in the tuber yield (Table-6). Similar observation has been reported for other diseases including groundnut rust (Das and Raj, 1993) and rice blast (Nagarajan, 1989).

Table 6. Interacting effect of different fertility gradient and different NPK combinations on yield attributes of potato under field conditions (Pooled data in the three year i.e. 2003-06).

Treatments	Yield attributes of Potato			
	Tuber yield (q/ha)	% Tuber yield increase on over control	Biomass fresh wt.(Kg/ha)	%Biomass fresh wt.(Kg/ha) increase on over control
$S_1N_{150}P_{125}K_{125}$	199.7	243.7	282.1	227.3
$S_1N_{150}P_{125}K_{150}$	243.8	319.6	316.3	266.9
$S_1N_{150}P_{150}K_{125}$	253.8	336.8	324.7	276.7
$S_1N_{150}P_{150}K_{150}$	237.7	309.1	310.9	260.7
$S_1N_{200}P_{125}K_{125}$	228.2	292.8	252.3	192.7
$S_1N_{200}P_{125}K_{150}$	226.2	289.3	296.0	243.4
$S_1N_{200}P_{150}K_{125}$	237.6	308.9	344.9	300.1
$S_1N_{200}P_{150}K_{150}$	256.9	342.1	349.6	305.6
$S_1N_{250}P_{125}K_{125}$	270.3	365.2	399.8	363.8
$S_1N_{250}P_{125}K_{150}$	232.4	300.0	266.8	209.5
$S_1N_{250}P_{150}K_{125}$	273.5	370.7	325.0	277.0
$S_1N_{250}P_{150}K_{150}$	292.3	403.1	413.6	379.8
$S_1N_0P_0K_0$	58.1	---	86.2	---
$S_2N_{150}P_{125}K_{125}$	234.3	203.6	243.4	151.7
$S_2N_{150}P_{125}K_{150}$	260.0	236.8	271.0	180.3
$S_2N_{150}P_{150}K_{125}$	260.4	237.5	357.8	270.0
$S_2N_{150}P_{150}K_{150}$	235.0	204.5	325.8	236.9

$S_2N_{200}P_{125}K_{125}$	277.6	259.6	295.6	205.7
$S_2N_{200}P_{125}K_{150}$	305.2	295.5	354.5	266.6
$S_2N_{200}P_{150}K_{125}$	260.6	237.6	337.9	249.4
$S_2N_{200}P_{150}K_{150}$	270.7	250.7	269.1	178.3
$S_2N_{250}P_{125}K_{125}$	259.1	235.7	354.1	266.2
$S_2N_{250}P_{125}K_{150}$	256.1	231.8	400.8	314.5
$S_2N_{250}P_{150}K_{125}$	301.8	291.1	365.4	277.9
$S_2N_{250}P_{150}K_{150}$	288.5	273.8	292.9	202.9
$S_2N_0P_0K_0$	77.2	---	96.7	---
$S_3N_{150}P_{125}K_{125}$	245.3	204.3	269.2	114.7
$S_3N_{150}P_{125}K_{150}$	311.3	286.2	282.9	125.6
$S_3N_{150}P_{150}K_{125}$	278.2	245.2	575.3	358.8
$S_3N_{150}P_{150}K_{150}$	316.2	292.3	561.0	347.4
$S_3N_{200}P_{125}K_{125}$	285.6	254.4	409.0	226.2
$S_3N_{200}P_{125}K_{150}$	277.8	244.7	299.4	138.8
$S_3N_{200}P_{150}K_{125}$	339.4	321.1	363.6	190.0
$S_3N_{200}P_{150}K_{150}$	336.0	316.9	462.1	268.5
$S_3N_{250}P_{125}K_{125}$	285.4	254.1	597.7	376.6
$S_3N_{250}P_{125}K_{150}$	289.2	258.9	444.6	254.6
$S_3N_{250}P_{150}K_{125}$	312.9	288.3	510.7	307.3
$S_3N_{250}P_{150}K_{150}$	336.8	317.8	609.1	385.7
$S_3N_0P_0K_0$	80.6	---	125.4	---
$S_4N_{150}P_{125}K_{125}$	313.9	195.5	487.5	158.1
$S_4N_{150}P_{125}K_{150}$	298.7	181.1	494.3	161.7
$S_4N_{150}P_{150}K_{125}$	289.4	172.4	622.3	229.4
$S_4N_{150}P_{150}K_{150}$	267.9	152.2	554.4	193.5
$S_4N_{200}P_{125}K_{125}$	308.8	190.6	557.1	194.9
$S_4N_{200}P_{125}K_{150}$	315.5	197.0	730.8	286.9
$S_4N_{200}P_{150}K_{125}$	303.5	185.6	616.6	226.4
$S_4N_{200}P_{150}K_{150}$	298.9	181.3	688.6	264.5
$S_4N_{250}P_{125}K_{125}$	271.9	155.9	730.5	286.7
$S_4N_{250}P_{125}K_{150}$	337.9	218.1	771.8	308.6
$S_4N_{250}P_{150}K_{125}$	340.4	220.4	701.2	271.2
$S_4N_{250}P_{150}K_{150}$	335.9	216.1	617.2	226.7
$S_4N_0P_0K_0$	106.2	---	188.9	---
S.Em ±	4.577	---	1.391	---
CD (P=0.05)	12.816	---	5.962	---

$S_{1=}$Low fertility gradient soil, $S_{2=}$ Moderate fertility gradient soil,
$S_{3=}$ Medium fertility gradient soil and $S_{4=}$ High fertility gradient soil

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