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Yield and Yield Components of Potato (*Solanum tuberosum* L.) as Influenced by Different N and P Fertilization Levels

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Abstract

Soil fertility is one of the major limiting factors of crop production in the north western part of Ethiopia. Fertilizer trial on potato was conducted for two consecutive years (1992-1993) at two representative soil types of major potato growing areas of the region. The trial was conducted at Adet's red nitosols and Enjibara's light gray soil. The result indicated highly significant response ($P < 0.01$) to both N and P while their interaction effect is non-significant. It was also observed that there is highly significant variation in the available soil P over location. The highest marketable tuber yield of 293.86 q ha^{-1} was obtained from the application of 81/138 kg ha^{-1} N/P level. However, the economically feasible levels were found to be 81/0 followed by 81/69 kg ha^{-1} N/P with a marginal rate of return of 1418% and 1361%, respectively. The yield increase of these levels over the control (0,0) was 51.22% and 73.32%, respectively. Hence, though ranks second economically, the 81/69 kg ha^{-1} N/P level is recommended to be used since the soils at both locations show significant response and the plants exhibit deficiency symptoms of P indicating the insufficiency of P available in the soil.

Introduction

Potato (*Solanum tuberosum L.*) is one of the most important root crops grown intercropped with maize in almost all maize growing farmers fields of Yilmana Densa covering about 11.07% of the arable land (1). Besides, it is the third major food crop in the high land nitosols of Debre Tabor Awraja grown by about 72% of the farmers occupying close to 12% of the area under crop production (2). However, the poor soil

fertility status of the region together with the low yielding potential and susceptiblity to diseases of the local cultivar used by the growers contributed to the very low yields obtained by the farmers.

Fertilizer and manure experiments during the last decade in most potato growing areas indicated nutrient requirement of potato is very high. This is because of the fact that crops which build up large reserves of food in a short time requires N in large quantities (4). Potato crop yielding between 250 and 350 q/ha takes about 120 kg of N and 45 kg P from the soil (3). According to Sikka (1982) application of 80-120 kg/ha N and 100-200 kg/ha P was found to be economically feasible in the tropics.

Hailemichael (1977) recommended a fertilizer rate of 54 and 138 kg/ha N/P respectively. This was suggested for all varieties and soil types. However, the response to fertilizers vary under different environmental conditions depending on soil type, variety, crop rotation, moisture supply and management practices (6). Therefore, this experiment was conducted with the main objectives of determining the optimum level of N and P for potato.

Materials and Methods

Fertilizer experiments were carried out on potato in 1992 and 1993 at Adet and Enjibara with an objectives of determining the optimum level of N/P for potato. The experiment was laid out in RCB 4x4 NP in complete factorial combination. The N/P levels used were 0, 27, 54, 81 and 0, 69, 138, 207 kg/ha, respectively. The whole P source in the form of triple superphosphate was bottom placed below the seed tuber and covered slightly with soil at the time of planting while the N in the form of urea was splitly applied at planting about 3-4 weeks after planting and at flowering equally divided into three.

The plot size used was $9m^2$ (3m x 3m) with four rows per plot, at a spacing of 75cm x 30cm between rows and plants, respectively. The variety used in the trial was Sissay. Fungicide was sprayed 3 times to control the impact of late blight disease over the treatments. Other cultural practices were carried out as per recommendation. The crop was harvested after about four months at maturity. The central two rows were harvested for the analysis of results. A combined analysis of variances computed for tuber yield, marketable and total, number of tubers per hill average weight of a tuber in kg.

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Results and Discussion

Analysis of variance was carried out for total, marketable tuber yield, number of tuber per hill and average weight of a tuber (Table 1). Results of the trial showed that there was significant response both to N and P. However, the interaction between N and P was non-significant (Table 1). It was also observed that there is highly significant variation in the available soil P over location. Significant differences were also observed over locations for all parameters considered in the analysis of variance. The maximum marketable tuber yield of (29.4 t/ha) was obtained with the application of 81 kg N/ha and 138 kg P/ha (Table 1).

Table 1 Results of combined analysis of variance for total, marketable tuber yield, number of tubers per hill and average weight of a tuber in kg.

Source of variation	Total tuber yield	Marketable tuber yield	No. of tuber per hill	Average wt. of a tuber
Location (L)	P<0.001	P<0.001	P<0.001	P<0.05
Nitrogen (N)	P<0.001	P<0.001	P<0.001	P<0.001
L X N	NS	P<0.05	P<0.001	NS
Phosphorus (P)	P<0.001	P<0.001	P<0.001	NS
L X P	P<0.001	P<0.001	P<0.001	NS
N X P	NS	NS	NS	NS
L X N X P	P<0.05	NS	P<0.05	NS
CV %	12.33	14.51	12.06	24.75
Max. yield level 81/138N/Pkg/ha	330 q/ha	294 q/ha	65 g	0.065 kg

The partial budget analysis of the experiment is given in Table 2. Treatment 81/138 kg/ha (N/P combination) gave the highest net benefit followed by 81/69 kg/ha (N/P combination). Although the highest net benefit was obtained from 81/138 kg/ha (N/P combination) treatment, 81/0 kg/ha (N/P combination) was found to be the best as it

gave the maximum MRR followed by 81/69 kg/ha N/P. Hence, though ranks second economically, the 81/69 kg/ha N/P level is recommended for use by the farmers since the soil at both locations show significant response and the plants exhibited deficiency symptoms of P indicating the insufficiency of P available in the soil.

Table 2 Partial budget analysis for potato fertilizer trial

Treatments N/P levels	Marketable tuber yield q/ha	Gross benefit Birr/ha	Total variable cost	Net benefit Birr/ha	Marginal rate of return, %
(0,0)	157.86	6314.40	-	6314.40	-
(0,69)	169.92	6796.80	351.60	6445.20	37
(27,0)	191.28	7651.20	427.64	7178.56	606
(54,0)	209.17	8366.80	550.53	7816.27	819
(0,138)	180.42	7216.80	571.60	6645.20	D
(81,0)	238.72	9548.80	628.40	8920.40	1418
(27,69)	201.61	8064.40	692.65	7371.75	D
(54,69)	245.16	9806.40	770.54	9035.86	81
(0,207)	165.97	6638.80	791.61	5847.19	D
(81,69)	273.61	10944.40	848.41	10095.99	1361
(27,138)	215.22	8608.80	912.65	7696.15	D
(54,138)	254.28	10171.20	990.54	9180.66	D
(81,138)	293.86	11754.40	1068.41	10685.99	268
(27,207)	200.78	8031.20	1132.66	6898.54	D
(54,207)	260.92	10436.80	1210.55	9226.25	D
(81,207)	253.08	10123.20	1288.42	8834.78	D

40 Eth. birr/q of potato
132.68 birr/q of urea
146.65 birr/q of TSP
2.75 birr/man day wage rate
0.115 hr/m2 man day calculated for fertilizer application
*D indicates those dominated treatments

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