

Effect of nitrogen levels and cultivars on growth and yield components of potato in foot hills of Arunachal Pradesh

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ABSTRACT

In order to determine the effect of nitrogen fertilizer levels and cultivars on growth and yield of potato, an experiment was conducted during 2009-10. The treatments included three nitrogen level (100, 125 and 150 kg nitrogen/ha) as the main plot and three potato cultivars (Kufri Khyati, Kufri Ashoka and Kufri Jyoti) as the sub-plot. Results indicated that different levels of nitrogen fertilizer on plant emergence, plant height, tuber yield (0-25 g), (25-50 g), (> 75), total tuber yield (t/ha), number of tuber (0-25 g), (25-50 g), (50-75 g) and total No. of tubers/ha were significant at $P < 0.05$. Cultivar had a significant effect on plant height, number of tubers (50-75 g) and total number of tubers/ha. The highest total tuber yield was obtained with 150 kg N/ha treatment by cultivar Kufri Ashoka (23.92 t/ha).

Keywords: Arunachal Pradesh, fertilizer, cultivar, potato, yield.

INTRODUCTION

Potato (*Solanum tuberosum*) is cultivated and consumed in more countries than some other crops (Jackson, 2). In terms of dry matter production per hectare; potatoes are among the most productive crops grown in the developing countries. Potato is a very important source of nutritious food for the different parts of India. However, in eastern foot hills part of Himalayas of India particularly in Arunachal Pradesh since soil is predominantly acidic, its great potential has not been adequately exploited. Research have indicated that potato could be one of the most important crop to be introduced in the area where the population experience heavy dependence on cereals crops and poor crop productivity. Plants require a variety of elements for growth and development of which N, P and K is the most important of the essential nutrients to plants because this is required in large quantity. The deficiency of N is manifested in the detrimental effects on the growth and development of plant (Tisdale *et al.*, 7). Furthermore, high mobility of N puts this plant nutrient on the priority list in the soil fertility management studies Kleinkopf *et al.* (4). The yield response of potato to increasing N rates varies with different environmental variables, including weather, soil type, residual fertility, soil moisture, seasons and cultivar. This study aimed to evaluate the effect of different nitrogen levels on the growth and productivity of three cultivars of potato, which can help to predict the optimal N fertilizer requirement and to improve the practice of potato production.

MATERIALS AND METHODS

The investigation was conducted during rabi 2009-10 at the experimental field of the Vegetable farm, College of Horticulture & Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh (28°06'N and 23°90'E, elevation 153 m). The soil of the experimental site was sandy loam with approximately 2.2 organic carbon and pH 6.7. The experimental design was split plot fitted to randomized complete block. The treatments included three nitrogen level ($F_1 = 100$ kg, $F_2 = 125$ kg and $F_3 = 150$ kg/ha) as the main plot and three potato cultivars (Kufri Khyati (V_1), Kufri Ashoka (V_2) and Kufri Jyoti (V_3) as the sub-plot. Before planting, phosphorus (P_2O_5) and potassium (K_2O) were applied at the rate of 120 and 100 kg/ha, respectively. Planting was done on the 2nd November, 2009. All recommended cultural practices were adopted uniformly according to standard crop requirements with irrigation. Nitrogen fertilizer was applied and in two split applications (50% basal dressing and 50% at the time of earthing up). The form of nitrogen used was urea (46% N). The basal dose of fertilizer was placed 5 cm below and covered with soil and followed by planting. Potato was harvested manually on 4th February, 2010. Statistical analysis of experimental data was conducted using the MSTATC software package.

RESULTS AND DISCUSSION

Nitrogen fertilizer application at all levels increased plant emergence by 0.83-2.92%. The highest level of nitrogen fertilizer (150 kg/ha) produced highest

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plant emergence (94.00%). However, no significant differences were found between two treatments: 100 and 125 kg N/ha (Table 3). The effect of cultivar on plant emergence (%) was not statistically significant, but the interaction between nitrogen level \times cultivar was significant at 5% level. The maximum plant emergence was observed at 150 kg N/ha in cultivar Kufri Jyoti (94.7%). Similar results have been reported in investigations conducted by Kanziwera *et al.* (3) and Sharma and Arora (6). The effect of nitrogen fertilizer level on plant height was significant at the 5% level. The lowest plant height (36.88 cm) was obtained at 100 kg N/ha and the highest plant height (42.58 cm) at 150 kg N/ha. The effect of cultivar on plant height was statistically significant. Interaction of nitrogen level \times cultivar was significant at the 5% level. Maximum plant height (44.25 cm) was shown by cultivar Kufri Jyoti at 150 kg/ha. Although this result agrees with the findings of Getu (1) that studies different to ours climatic conditions, growth season, cultivar and local situation. Plant height increases in response to the fertilizer may be attributed to stem elongation. Although there was differential response among varieties, N fertilization increased plant height. By increasing the nitrogen fertilizer level the number of shoots/plant increased but the difference between 100, 125 and 150 kg N/ha treatment was not statistically significant. The highest number of shoots/plant was obtained at 150 kg N/ha application, while the lowest number of shoots/plant was obtained at 100 kg N/ha (Table 3). There was non-significant difference among cultivars Kufri Jyoti, Kufri Ashoka and Kufri Khyati. Further, the interaction between nitrogen fertilizer level and cultivar on number of shoots/plant was non-significant at $P = 0.05$ and highest number of shoots/plant was in cultivar Kufri Jyoti in the third treatment (150 kg N/ha) and lowest in Kufri Khyati at 100 kg N/ha. Similar results have been reported in investigations conducted by Maryam and Naser (5). Though number of shoots/plant is one of the most important yield components in potato, it was not significantly influenced by nitrogen fertilization. This could be due to the fact that the trait is much influenced by the inheritance of the same; it is also influenced by other factors such as storage condition of tubers, number of viable sprouts at planting, sprout damage at the time of planting and growing conditions, physiological age of the seed tuber and tuber size.

Nitrogen fertilizer levels have no significant effect on number of leaves/plant but the highest number of leaves was related to first treatment (100 kg N/ha). Sharma *et al.* (6) also reported non-significant effect of nitrogen on leaves. The effect of cultivar,

also the interaction of cultivar \times nitrogen level did not affect number of leaves/plant significantly in all three cultivars. Nitrogen fertilizer level significantly affected yield of (0-25 g) and the highest yield of (0-25 g) was related to first treatment (100 kg N/ha), while the lowest was related to third fertilizer level (150 kg N/ha). Yield decreases at the highest nitrogen dose might be due to increase in higher tuber weight. The effects of cultivar, and interaction cultivar \times fertilizer application were non-significant. The effect of nitrogen fertilizer level on tuber yield (25-50 g) t/ha was significant at $p = 0.05$. The highest yield was related to the third treatment (i.e. 150 kg N/ha). There were significant difference among cultivars Kufri Khyati, Kufri Ashoka and Kufri Jyoti and being highest in Kufri Ashoka. Also, the interaction between nitrogen fertilizer level and cultivar was significant and highest tuber yield in the third treatment (150 kg N/ha) and cultivar Kufri Ashoka, while the lowest tuber yield was obtained in Kufri Khyati at 125 kg N/ha. Similar findings were also reported by Zelalem *et al.* (8). The effect of nitrogen fertilizer level on yield of tuber (50-75 g) t/ha was non-significant. The effect of cultivar, also the interaction cultivar \times nitrogen fertilizer did not affect yield of tuber (50-75 g) t/ha significantly. The effect of nitrogen fertilizer level on tuber yield (>75 g) t/ha was significant at $P = 0.05$. The highest tuber yield (>75 g) t/ha was related to the third treatment (i.e. 150 kg N/ha) and the lowest tuber yield was related to the first treatment (i.e. 100 kg N/ha). The effect of cultivar did not affect tuber yield significantly. However, interaction of cultivar \times fertilizer level (N) affect tuber yield (> 75 g) t/ha significantly. The investigation is in conformity of Zelalem *et al.* (8). The effect of nitrogen fertilizer level on total tubers yield (t/ha) was significant. The highest total tuber yield (23.16 t/ha) was related to the third treatment (i.e. 150 kg N/ha) and lowest total yield was related to first treatment (i.e. 100 kg N/ha). The effect of cultivar did not affect significantly. However, interaction of cultivar \times fertilizer level affect tuber yield significantly. Highest tuber yield (23.92 t/ha) was recorded at nitrogen fertilizer level (i.e. 150 kg N/ha) in cultivar Kufri Ashoka. These results are consistent with those reported by Zelalem *et al.* (8) and Shahzad *et al.* (8). The effect of nitrogen fertilizer level on number of tubers (0-25 g) /ha was also significant at $P=0.05$. The highest number was related to the treatment 100 kg N/ha and lowest number was related to the third treatment (i.e. 150 kg N/ha). The cultivar affect was significant to the number of tubers (0-25 g/ha). Maximum number of tubers was obtained in cultivar Kufri Ashoka. However, interaction of cultivar \times nitrogen level for number of tubers (0-25

Table 1. Average monthly temperature, relative humidity and precipitation during growing season (2009-10).

Month	Temp. (0°C)		R.H. (%)		Precipitation (mm)
	Min.	Max.	Min.	Max.	
October	21.3	30.8	74.2	86.0	177.6
November	16.7	26.2	72.3	85.1	143.1
December	14.4	24.0	72.7	85.7	22.4
January	12.0	25.1	64.3	82.4	0.3
February	14.8	24.1	69.9	82.1	39.3

Table 2. Change in soil fertility and nutrient balance.

Treatment	Soil fertility status after experiment					Nutrient balance (Nutrient applied-nutrient removed)		
	OC* (g/kg)	pH	Av. N	Av. P	Av. K	Av. N	Av. P	Av. K
V ₁ F ₁	1.85	6.7	355.0	50.4	120.0	-17.0	10.75	-65.92
V ₂ F ₁	1.95	6.7	352.0	50.0	121.0	-20.0	10.35	-64.00
V ₃ F ₁	1.80	6.7	351.0	50.0	120.0	-20.5	10.40	-65.92
V ₁ F ₂	1.75	6.7	350.0	51.0	119.5	-21.0	12.0	-66.42
V ₂ F ₂	1.85	6.7	355.0	51.0	120.0	-17.0	12.0	-65.92
V ₃ F ₂	1.85	6.7	354.0	50.4	121.0	-18.0	10.75	-64.92
V ₁ F ₃	1.80	6.7	352.0	50.4	119.5	-20.0	11.4	-66.42
V ₂ F ₃	1.80	6.7	354.0	50.0	119.0	-18.0	10.35	-66.00
V ₃ F ₃	1.85	6.7	352.0	51.0	119.5	-20.0	11.35	-66.00
Mean initial value of plot	2.12	6.71	371.8	39.4	185.7	-	-	-

V₁ = Kufri Khyati, V₂ = Kufri Ashoka and V₃ = Kufri Jyoti, F₁ = 100 kg N, F₂ = 125 kg N, F₃ = 150 kg N

g/ha) was significant. Highest number of tubers was recorded in Kufri Ashoka (199.63'000) at 100 kg N/ha, while lowest number of tubers (0-25 g/ha) was obtained in Kufri Khyati (131.56'000) at 150 kg N/ha. Nitrogen fertilization improved total tuber yield. The observed higher fertilization response may be linked to the increase in total leaf area which in turn increased the amount of solar radiation intercepted and more photo-assimilate might have been produced and assimilated to the tubers. Similar results were also reported by Sharma *et al.* (6). The effect of nitrogen fertilizer level on number of tubers (25-50 g)/ha was statistically non-significant. Cultivar had significant effect on number of tubers (25-50 g)/ha. However, interaction of cultivar × nitrogen fertilizer level was significant and maximum number of (25-50 g)/ha was recorded in Kufri Khyati at 125 kg N/ha, while lowest number was obtained in Kufri Ashoka at 150 kg N/ha. The effect of nitrogen fertilizer level on number of tubers (50-75 g)/ha was significant, but cultivar Kufri Khyati had significant effect on number

of tubers. However, interaction of cultivar × nitrogen fertilizer level had significant effect on number of tubers (50-75 g)/ha. Maximum number of tubers (90.86'000) was obtained in cultivar Kufri Ashoka at 150 kg N/ha. Similar findings were also reported by Kanziwere *et al.* (3), and Sah *et al.* (6). The effect of nitrogen fertilizer level and cultivar on number of tubers (>75 g)/ha were statistically non significant. However, interaction of cultivar × nitrogen fertilizer level was significant at P = 0.05. Maximum number of tubers (>75 g) was obtained in cultivar Kufri Khyati at 100 kg N/ha. The finding is in agreement with Maryam and Naser (5). The effect of nitrogen fertilizer level on total number of tubers/ha was statistically significant at P = 0.05. However, effect of cultivar on total number of tubers/ha was statistically non-significant. Though, interaction of cultivar × nitrogen fertilizer level was significant. Maximum total number of tubers/ha was obtained in Kufri Khyati at 100 kg N/ha while lowest number of tubers/ha was obtained in Kufri Jyoti at 125 kg N/ha. Similar results were observed by Sharma

Table 3. Effect of different fertilizer treatments on plant emergence, plant height, number of shoots/plant and number of leaves/plant in potato.

Treatment	Plant emergence (%)				Plant height (cm)				No. of shoots/plant				No. of leaves/plant			
	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean
F ₁	91.38	90.88	91.78	91.34	35.75	37.25	37.63	36.88	3.50	4.00	4.00	3.83	46.25	51.00	50.25	49.17
F ₂	91.88	92.88	91.75	92.17	38.00	40.65	40.75	39.80	3.75	4.25	4.00	4.00	47.50	46.00	47.75	47.08
F ₃	93.63	93.66	94.70	94.00	41.25	42.25	44.25	42.58	4.75	3.75	4.75	4.42	46.50	48.00	46.75	47.08
Mean	92.29	92.47	92.74	92.50	38.33	40.05	40.88	39.75	4.00	4.00	4.25	4.80	46.75	48.33	48.25	47.78
CD at 5%																
Fertilizer (F)				0.65				1.19							2.19	
Variety (V)				1.13				2.10							3.80	
F × V =				0.83				3.55							5.44	

Table 4. Effect of different fertilizer treatments on yield yield of different grades of tuber (t/ha) and total yield (t/ha).

Treatment	Yield of 0-25g tuber				Yield of 25-50g tuber				Yield of 50-75g tuber				Yield of >75g tuber				Total yield (t/ha)			
	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean
F ₁	3.02	2.77	2.94	2.91	2.51	2.66	2.10	2.42	4.61	4.88	5.14	4.88	11.19	12.06	12.64	11.96	21.34	22.37	22.83	22.18
F ₂	2.50	2.23	2.32	2.35	2.05	2.26	2.51	2.27	4.73	5.07	5.24	5.01	12.06	12.40	12.35	12.27	21.34	21.96	22.41	21.90
F ₃	2.38	2.62	1.83	2.28	2.84	3.15	2.89	2.96	4.76	4.73	4.15	4.54	13.90	13.41	12.83	13.38	23.87	23.92	21.71	23.16
Mean	2.63	2.54	2.36	2.51	2.46	2.69	2.50	2.55	4.70	4.89	4.84	4.81	12.38	12.62	12.61	12.54	22.18	22.75	22.32	22.42
CD at 5%																				
Fertilizer (F)				0.32				0.21				0.50				0.48			0.74	
Variety (V)				0.56				0.37				0.87				0.83			1.28	
F × V =				15.22				9.91				12.35				4.53			3.90	

Table 5. Treatment, Number of different grades of tubers (in '000) and total number of tubers (in '000)/ha.

Treatment	No. of tubers/ha (>25g)				No. of tubers/ha (25-50 g)				No. of tubers/ha (50-75 g)				No. of tubers/ha (>75 g)				Total No. of tubers/ha			
	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean	V ₁	V ₂	V ₃	Mean
F ₁	188.66	199.63	181.13	189.86	86.61	86.80	87.19	86.87	89.70	71.37	78.13	79.73	75.23	71.18	72.92	73.11	440.20	429.01	419.37	429.53
F ₂	167.44	177.66	143.90	163.00	90.86	82.95	84.49	86.10	79.48	87.19	87.58	84.75	71.57	72.53	74.65	72.92	409.34	420.33	309.63	406.76
F ₃	131.56	133.49	135.22	133.42	80.83	71.57	72.34	74.91	87.78	90.86	75.62	84.75	74.65	75.04	73.30	74.33	374.81	370.95	356.48	367.41
Mean	162.56	170.27	153.42	162.08	86.10	80.44	81.34	82.63	85.65	83.14	80.44	83.08	73.82	72.92	73.62	73.45	408.12	406.76	356.48	401.24
CD at 5%																				
Fertilizer (F)				3642.05				2923.19				3559.87				1797.55			6459.23	
Variety (V)				6308.215				5063.12				6165.87				3113.45			11187.71	
F × V =				2.67				4.20				5.09				2.90			1.91	

and Arora (6), and Zalalem *et al.* (8). Maximum net return of Rs. 1,69,450.00/ha was obtained in cultivar Kufri Ashoka at 150 kg N/ha fertilizer level, while minimum return was obtained in Kufri Jyoti (Rs. 1,43,410.00) at 150 kg N/ha. This study indicates that yield and yield components of potato can be improved with application of nitrogen fertilizers in foot hills of Eastern Himalayas of Arunachal Pradesh.

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