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Growth and yield of potato (*Solanum tuberosum* L.) cultivars under varying levels of nitrogen in central plain zone of Uttar Pradesh

Abstract

A field experiment was conducted on potato (*Solanum tuberosum* L.) at Vegetable Research Station, Kalyanpur, Kanpur (U.P.) during 2011-12, 2012-13 and 2013-14 in sandy loam soil. Treatments included combinations of two cultivars (Kufri Sadabahar and Kufri Surya) and five nitrogen levels (0, 75, 150, 225 and 300 kg/ha) replicated four times in factorial randomized block design. Based on pooled data over years, plant height (Kufri Sadabahar- 53.83 and Kufri Surya- 55.64 cm), number of shoots per plant (Kufri Sadabahar- 5.45 and Kufri Surya- 5.90) and tuber yield (Kufri Sadabahar- 32.58 t/ha and Kufri Surya- 35.85 t/ha) increased significantly upto 225 kg N/ha. Similar trend was also observed in case of net return and significantly highest of ₹ 164885 and 189774/ha was obtained under treatment of 225 kg N/ha in Kufri Sadabahar and Kufri Surya, respectively. Therefore, application of 225 kg N/ha may be recommended for these varieties in central plain zone of Uttar Pradesh.

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Keywords

Potato, Cultivars, Nitrogen, Growth, Yield, Economics

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important non-grain food crops of the world and is consumed by people across the globe both as food and as vegetable. It is contributing to world food basket just after rice, wheat and maize. Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time than cereals like rice and wheat. The dry matter, edible energy and edible protein content of potato makes it nutritionally superior vegetable as well as staple food. Potato is a highly nutritious, easily digestible, wholesome food containing carbohydrates, proteins, minerals, vitamins and high quality dietary fibre (Rajiv and Kawar, 2016). India is one of the important countries producing about 25 million tones of potato from an area of 1.34 million ha with an average productivity of 18.6 t/ha (Tyagi *et al*., 2012). Out of the total area under potato, 86% area is in Indo-Gangetic plains, 6% in the hills and remaining 8% in South-eastern, Central and Peninsular India (Pandey *et al*., 2012). The states of Uttar Pradesh, West Bengal and Bihar accounted for more than 70 percent share in total production with the rank of 1st, 2nd and 3rd, respectively, in relation to potato production (Anonymous, 2014).

Potato being a heavy feeder of nutrients, requires high amounts of nitrogen, phosphorus and potassium. Compared with cereal crops, potato produces much more dry matter per unit area and time. This high rate of dry matter production results in large amounts of nutrients removed per unit time, which generally most of the soils are not able to supply. A healthy crop of potato removes about 120-140 kg N, 25-30 kg P_2O_5 and 170-230 kg K_2O/ha (Dua, 2013). Potato crop is very sensitive crop to nitrogen, which improves vegetative growth and increases yield attributes. However, in the state of Uttar Pradesh, the application of unbalanced nitrogen is quite common at farmer's field. Low nitrogen application results in poor vegetative growth and low tuber yield due to premature senescence in the plants. On the other hand, excess nitrogen leads to prolong the vegetative phase and thus, interfere with the initiation of tuberization, decreasing yield and dry matter accumulation in the tubers (Jatav e*t al*., 2013). Therefore, there is a need to optimize nitrogen level for higher tuber yield under central plain zone of Uttar Pradesh. The demand for potato is expected to grow at 3.80% annual compounded growth rate. At this rate, total consumption of potato by the year 2030 would be 67.23 million tonnes considering 2007 data of FAO, *i.e.* 28.51 million tonnes as base. It indicates an excess production of 2.16 million tonnes by 2030 (Singh *et al*., 2011). Keeping all these points in view, the present study was undertaken to standardize the level of nitrogen of the newly released potato cultivars i.e. Kufri Sadabahar and Kufri Surya under central plain zone of Uttar Pradesh.

Materials and Methods

The field experiment was conducted during 2011-12, 2012-13 and 2013-14 at Vegetable Research Station, Kalyanpur of C.S. Azad University of Agriculture and Technology, Kanpur under All India Coordinated Research Project on Potato. The soil was sandy loam with organic carbon 0.39%, available N 159.0 kg/ha, phosphorus 14.8 kg/ha and potassium 190 kg/ha at initiation of experiment. Soil pH was 7.8, which showed slightly alkaline reaction. Treatments included combinations of two cultivars (Kufri Sadabahar and Kufri Surya) and five nitrogen levels (0, 75, 150, 225 and 300 kg/ha) replicated four times in factorial randomized block design.

Planting of sprouted seed tubers was done in between 26 and 29 October while digging of tubers was done at full maturity between 20 and 24 February during different years. Potato seed tubers were taken out from the cold store 10-13 days before planting and were kept in plastic creates in the shade having diffused light to allow the emergence of sprouts. Planting of seed tubers was done on ridges at 60x20 cm spacing. A uniform dose of 80 kg P_2O_5 and 120 kg K_2O/ha was applied through single super phosphate and muriate of potash, respectively at the time planting, whereas half of the nitrogen was applied as basal and remaining half at 30 days after planting through urea as per treatment. Crop was raised with recommended package of practices except treatments. Haulms cutting of potato were done during first week of February in different years. The yield data were recorded on five randomly selected plants in each treatment and replication and recorded data were analyzed by using statistical techniques. On the basis of total variable cost and gross return, net return and B:C ratio were calculated as per methods suggested by Devasenapathy *et al*. (2008).

Results and Discussion

Growth parameters: A result of the experiment on growth parameters reveals that the treatment effect was found significant on plant height and number of shoots per plant (Table-1). Increasing trend in terms of plant height and number of shoots per plant was recorded with increase in dose of nitrogen in both the cultivars. The maximum plant height recorded at 50 DAP was 54.99 and 56.38 cm under 300 kg N/ha followed by 53.83 and 55.64 cm with 225 kg N/ha in Kufri Sadabahar and Kufri Surya, respectively. However, these both treatments were found statistically at par in terms of plant height. Hence, plant height increased significantly upto 225 kg N/ha only. Similar trend was also observed in case of number of shoots per plant. Improvement in plant height and number of shoots with increase in dose of nitrogen may be due to the reason of that higher nitrogen concentration enhanced vegetative growth of the plant through high cell division and more formation of tissues. Present findings are in agreement with the findings of Banjare *et al*. (2014) and Anabousi *et al*. (1997).

Crop Productivity: Cultivars and different levels of nitrogen influenced potato tuber yield significantly (Table 2). Cultivar Kufri Surya produced the highest tuber yield at all the levels of nitrogen as compared to Kufri Sadabahar. It might be attributed to the yield potential and ability of response to nitrogen and bulking rate. Sharifi *et al.* (2007) have also reported that different cultivars behave differently in terms of applied nitrogen, bulking rate and yield. Results of experiment indicated that the tuber yield of both cultivars is increasing as the dose of nitrogen application increased. Although, maximum tuber was recorded with nitrogen application of 300 kg/ha but significantly increment in tuber yield was found only upto nitrogen level of 225 kg/ha in both the cultivars (Kufri Sadabahar- 32.58 t/ha and Kufri Surya- 35.85 t/ha). Tuber yield response of both cultivars to nitrogen fertilization was highest at the level of 75 kg/ha and reduced remarkably as the dose of nitrogen application increased. These results corroborate with the findings of Jatav *et al.* (2013) and Banjare *et al*. (2014). When nitrogen doses increased from 75 to 150 kg/ha and 150 to 225 kg/ha tuber yield increase was maximum in Kufri Surya as compared to Kufri Sadabahar. The

Table- 1: Effect of nitrogen levels on growth parameters of potato (Pooled over three years)

Nitrogens levels	Plant height (cm) at 50 DAP*		No. of shoots/plant at 50 DAP*	
	K. Sadabahar	K. Surya	K. Sadabahar	K. Surya
0 kg/ha	43.35	44.86	4.61	4.83
75 kg/ha	47.90	49.09	4.96	5.10
150 kg/ha	51.60	53.38	5.17	5.35
225 kg/ha	53.83	55.64	5.45	5.90
300 kg/ha	54.99	56.38	5.75	6.34
CD(P=0.05)	Cultivars	4.30	Cultivars	0.27
	N levels	4.33	N levels	0.48
	C x N	4.41	C x N	0.32

* DAP- Days after planting

Table- 2: Effect of nitrogen levels on tuber yield of potato (Pooled over three years)

Nitrogen levels	Tuber yield (t/ha)		Increase in yield over control			
	K. Sadabahar	K. Surya	K. Sadabahar		K. Surya	
			t/ha	%	t/ha	%
0 kg/ha	20.30	22.30	-	-	-	-
75 kg/ha	25.01	27.10	4.71	23.20	4.80	21.52
150 kg/ha	29.46	31.64	9.16	45.12	9.34	41.88
225 kg/ha	32.58	35.85	12.28	60.49	13.55	60.76
300 kg/ha	34.02	37.05	13.72	67.58	14.75	66.14
CD(P=0.05)	Cultivars	2.86	-	-	-	-
	N levels	2.93	-	-	-	-
	C x N	2.53	-	-	-	-

Table- 3: Effect of nitrogen levels on economic parameters of potato (Pooled over three years)

Nitrogen levels	Net return (/ha)		B:C ratio	
	K. Sadabahar	K. Surya	K. Sadabahar	K. Surya
0 kg/ha	80881	95122	2.13	2.33
75 kg/ha	111477	128490	2.55	2.78
150 kg/ha	141844	160136	2.95	3.19
225 kg/ha	164885	189775	3.23	3.56
300 kg/ha	174621	197280	3.32	3.62
CD(P=0.05)	Cultivars	17275	Cultivars	0.27
	N levels	20523	N levels	0.28
	C x N	16997	C x N	0.23

interaction between cultivars and nitrogen levels was found significantly.

As compared to treatment of zero nitrogen level, potato yield increased remarkably upto 225 kg N/ha but margin of increase varied in different treatments. In increasing order of nitrogen dose of application, the margin was remarkable highest of 12.28 t/ha or 60.49 % and 13.55 t/ha or 60.76 % in Kufri Sadabahar and Kufri Surya, respectively, under the nitrogen level of 225 kg/ha and further increase in dose of nitrogen (300 kg/ha) the margin of increase was minimum as compared to nitrogen level of 225 kg N/ ha. It might be attributed to the surplus availability of nitrogen nutrient for crop use.

Economics: Net return increased with increase in nitrogen levels (Table 3) and was obtained significantly highest of 164885 and 189774/ha under treatment 225 kg N/ha in Kufri Sadabahar and Kufri Surya, respectively. Treatment 0 kg N/ha earned lowest net return, while 75 kg N/ha increased net return significantly and 150 kg N/ha over 75 kg N/ha further increased the net return significantly but 300 kg N/ha over 225 kg N/ha further not increased the net return significantly in both the cultivars. Net return is the resultant of gross income and cost of cultivation where gross income dominated over cultivation cost in present study. B:C ratio followed the same pattern of net return under different treatments (Table-3). It might be due to higher increase in gross income in comparison to increase in cultivation cost under respective treatments.

The results of the experiment may be concluded that both potato cultivars i.e. Kufri Sadabahar and Kufri Surya are the high yielder and nitrogen efficient. Tuber yield and net return of the both cultivars increased with increase in nitrogen levels. However, significantly improvement was observed only upto the nitrogen level of 225 kg/ha under central plain zone of Uttar Pradesh. Increase in dose of 300 kg N/ha over 225 kg N/ha further not increased the tuber yield and net return significantly in both the cultivars.

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