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Response of Potato (*Solanum tuberosum* L.) Cultivars to Different Levels of Nitrogen

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A B S T R A C T

Potato (*Solanum tuberosum* L.) requires abundant nitrogen to perform well and has low nitrogen use efficiency. Generally Indian soils have been reported to be low in nitrogen, so the exogenous supply found beneficial. A field experiment was conducted during *rabi* season at Vegetable Research Farm, Kalayanpur, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh under irrigated condition in factorial randomized block design with three replications to find the suitable nitrogen dose for different varieties. Four varieties namely Kufri Anand, Kufri Bahar, Kufri Khyati and Kufri Pukhraj and four doses of nitrogen *i.e.* 0 kg ha^{-1}, 60 kg ha^{-1}, 120 kg ha^{-1} and 180 kg ha^{-1}were taken into account to study. Different parameters studied were plant stand per plot, number of sprout per plant, height of plant, number of leaves per plant, different grade of tubers and total tuber yield. Kufri Pukhraj with nitrogen dose of 180 kg ha^{-1} was found best among all the treatments.

Introduction

Potato (*Solanum tuberosum* L.) belongs to family Solanaceae is one of the most important staple food in many developing countries. According to FAO in 2014 total world production of potatoes is 38.17 metric megatons from an area of 19.1 million hectares (FAOSTAT, 2015).India is one of the leading potato producing country in the world. Potato plays an important role both in human diet and processing industry (Zaheer and Akhtar, 2016). It is a major carbohydrate supplier in the diets of millions of people in the world. It also provides significant amount of proteins with essential amino acids, vitamin C, minerals and micronutrients which are vital for human nutrition (Mu *et al.*, 2017). It is a versatile food as it can be cooked in many ways, can be processed into a number of products each having its characteristic taste and can fit into any meal. Potatoes can be served in any course of a meal from salads, snacks and soups to the main course in which they can figure either as an accompanying side dish, or as the main dish itself.

Among the different essential plant nutrient, nitrogen application can play an important

role in crop growth and development resulting increased both size and number of tubers. It also plays a significant role in formation of protein and the enzymes in the plant and in the formation of nucleic acids and free amino acid and in the formation of (porphyries) groups. The potato plant is very responsive towards nitrogenous fertilizer levels (Harris 1992). With more nitrogen, there is an increase in the number of leaves (photosynthetically active) as well as in the rate of leaf per plant due to more branching, particularly at the upper portion of the plant (Oliveira, 2000). Vos and Biemond (1992) and Mustonen *et al.* (2010) showed that different nitrogen treatments resulted in plants that differed considerably in final dry weight and tuber yield. Generally Indian soil have been reported to be low in nitrogen, hence its supply through fertilizers may play an important role in crop production but indiscriminate use of them is hazardous to crop as well as for environment (Meena *et al.*, 2017). Therefore, it was considered necessary to study the effect of increasing doses of nitrogen on the growth and yield of commonly grown cultivars in Central Uttar Pradesh conditions to get the maximum net return with the minimum cost.

Materials and Methods

The field experiment was conducted during *rabi* season at Vegetable Research Farm, Kalayanpur, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh. The soil of experimental field was *Indo-gangetic* alluvial in origin. To determine the chemical and physical properties of soil, 15 samples were taken at random from a depth of 15 to 20 cm and collected a day before sowing. The factorial experiment is based on Randomized Block Design with three replications were carried out on four potato cultivars *viz*., Kufr i Anand, Kufri Bahar, Kufri Khyati and Kufri Pukhraj. The seed of potato tubers was obtained from Vegetable Research Farm, Kalyanpur, Kanpur, about 15 days before planting. The tubers were graded and planted after treating with 0.3% boric acid (for half an hour). Potato cultivars were planted in third week of October at a depth of 15 cm using one seed tuber per plot. The amounts of chemical fertilizers (except nitrogenous) were given based on soil fertility.

The basal dressing of 100 kg K_2O and 80 kg P_2O_5 per hectare was done at the bottom of the ridge uniformly in all treatments. The source of potassium and phosphorus were potassium sulphate and single superphosphate respectively. Nitrogen was applied in the form of urea. Half of the total nitrogen per treatment was applied at the time of planting whereas remaining half was applied after 35 days of planting. Different nitrogen doses are 0 kg ha^{-1}, 60 kg ha^{-1}, 120 kg ha^{-1} and 180 kg ha^{-1}. Cultural practices were same in each plot during experiment.

The plant stand was recorded after 50 days of planting. The total numbers of sprouts of sample plants were counted after 50 days of planting and number of sprouts per plant were calculated at each stage. The heights of main shoot of tagged plants were measured in centimeters from the upper portion of ridge to the apex of fully opened leaf. Number of leaves per plant was calculated after 50 days of planting. After digging, the tubers were separated in different grades as per their weight (A-less than 25 g, B-25-50 g, C-50-75 g and D-more than 75 g). Yield of different grade of tubers were recorded in kg per plot and calculated in q/ha with the help of following formula.

$$\text{Tuber yield}\left(\frac{\text{q}}{\text{ha}}\right) = \frac{tuber\ weight(kg\ per\ plot) \times 10{,}000}{net\ plot\ size\ \times 100}$$

Obtained data were analyzed statistically following the standard procedure at 5% level of significance.

Results and Discussion

In term of plant stand there is no significance difference found among treatments, although the highest plant stand found at nitrogen dose of 180 kg ha^{-1} in Kufri Anand (97.91) as presented in figure 1. Number of sprout per plant differs significantly among verities and nitrogen levels. With an increase in applied nitrogen from 0 to 180 kg ha^{-1} sprouts per plants also increases, among the varieties Kufri Khyati shows best response toward increased nitrogen levels (from 5.40 to 7.00 per plant) (Fig. 2).

There were significant differences among the varieties, nitrogen levels and interaction between the treatments with respect to height of main shoot and number of leaves per plant. Maximum height found in Kufri Pukhraj at 180 kg ha^{-1} Nitrogen dose whereas, minimum in Kufri Khyati at the same level of nitrogen. It was also seen that all the variety positively responded towards increased nitrogen doses except Kufri Pukhraj where after 120 kg ha^{-1} Nitrogen there was a sudden decrease in plant height seen. Reports of Khan *et al.,* (2010) in capsicum and Bobadi and Damme (2003) support the same. Number of leaves per plant is very important vegetative parameter which directly influence tuber yield. Kufri Pukhraj (78.50) followed by Kufri Anand (78.40) at 180 kg ha^{-1} Nitrogen shows most leaves per plant. In every cultivars trend was directly proportional between number of leaves and nitrogen doses. Similar results were also reported by Zelalem *et al.,* (2009).

Out of different tuber grades namely A, B, C and D; Kufri Bahar yields significantly higher amount of A grade and B grade tubers *i.e.* 2.71 and 8.36 tonnes ha^{-1} respectively whereas, C grade tubers yields highest in Kufri Anand (13.01 tonnes ha^{-1}) and D grade tubers were found highest in Kufri Pukhraj (23.24 tonnes ha^{-1}). These differences in yield among four varieties was genetically and shows that Kufri Pukhraj followed by Kufri Anand have better market potential as produce better size tubers among the varieties under consideration. With no exception according to observation recorded at nitrogen dose of 180 kg ha^{-1} yield of every grade of tubers were maximum which found at par with the nitrogen dose of 120 kg ha^{-1} except in B grade tubers. Interaction between varieties and nitrogen doses shows significant differences with each other (Fig. 3; Table 1).

Fig.1 Effect of Varieties and different doses of nitrogen on plant stand per plot

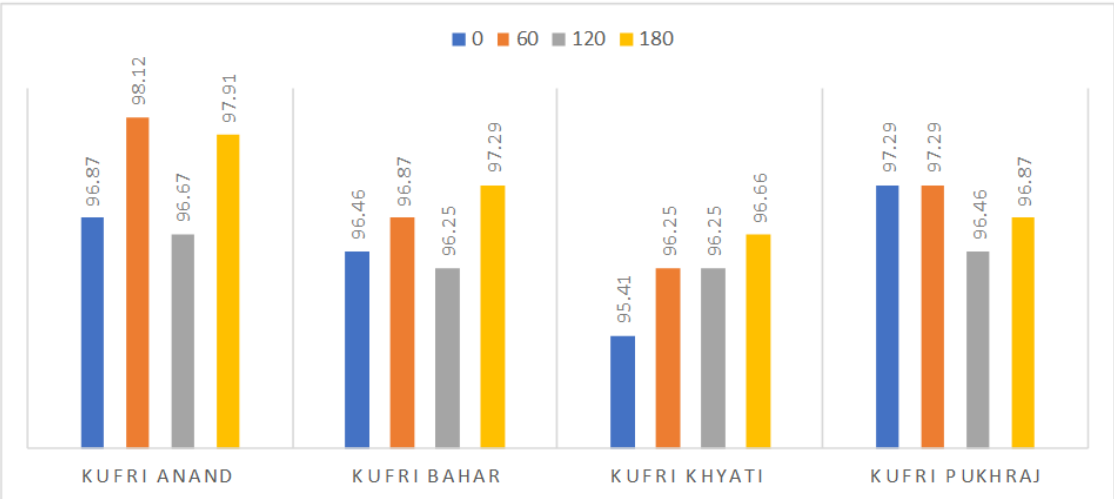

Fig.2 Effect of varieties and different doses of nitrogen on number of sprout per plant

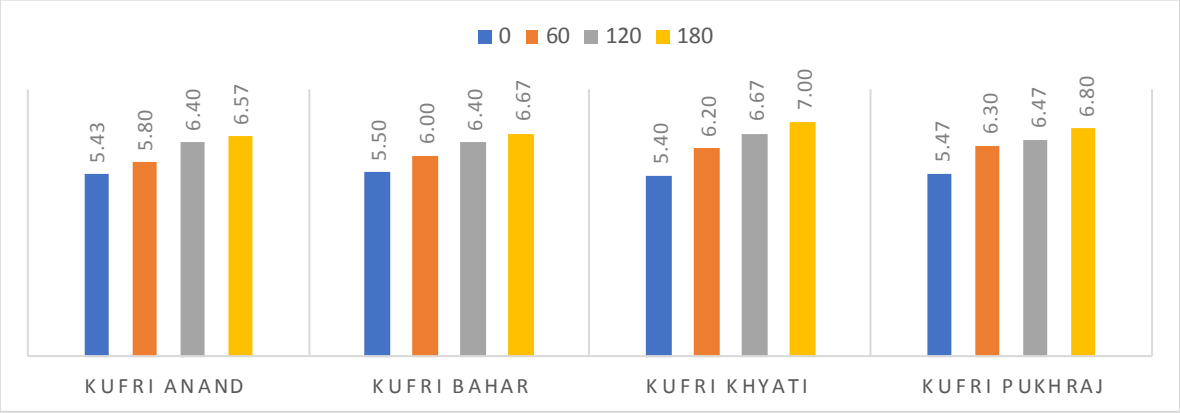

Fig.3 Effect of varieties and different doses of nitrogen on yield of different grades of potato tubers

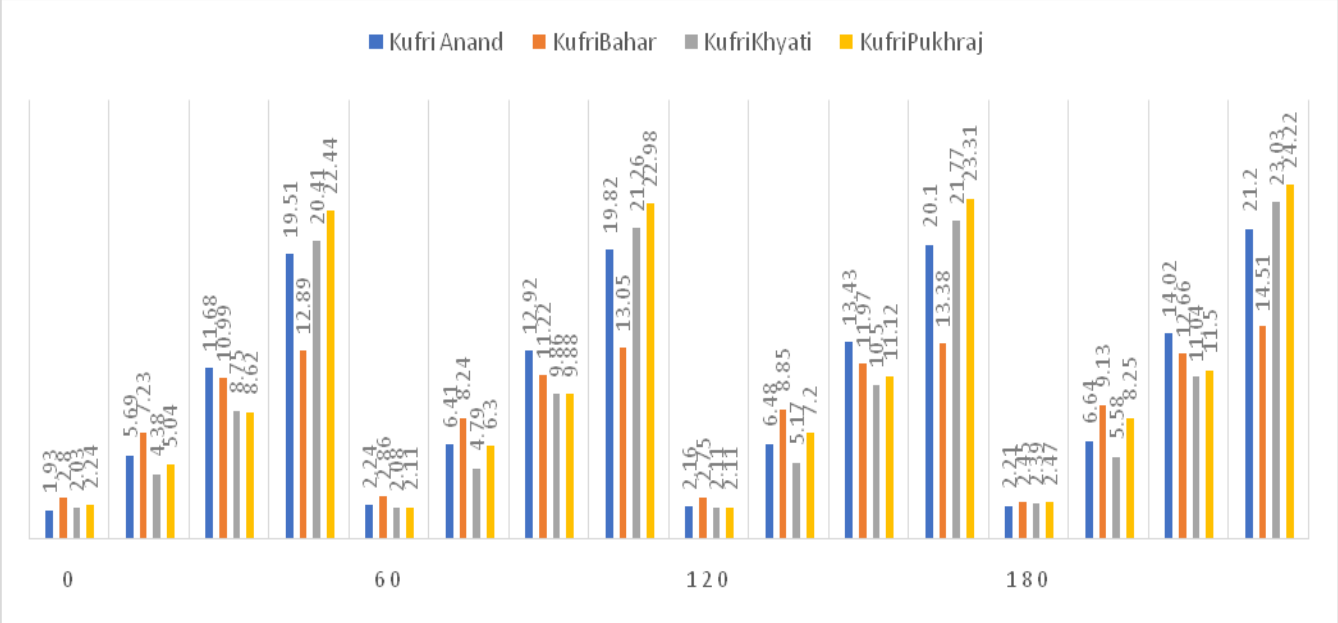

Table.1 Effect of varieties and different doses of nitrogen on height of main shoot (cm) and Number of leaves per plant

Varieties	Height of main shoot (cm)					Number of leaves per plant				
	Nitrogen kg ha^{-1}					Nitrogen kg ha^{-1}				
	0	60	120	180	Mean	0	60	120	180	Mean
Kufr iAnand	52.43	53.13	53.43	54.30	53.33	73.27	74.70	77.23	78.40	75.90
Kufri Bahar	52.00	52.60	53.20	53.50	52.83	69.40	70.73	74.20	76.47	72.70
Kufri Khyati	52.57	52.43	53.50	51.57	52.27	62.77	65.93	69.63	75.13	68.37
Kufri Pukhraj	53.53	55.40	54.47	55.80	54.80	72.63	75.67	76.63	78.50	75.86
Mean	52.38	53.39	53.65	53.79	-	69.52	71.76	74.42	77.13	-
CD at 5%	V= 0.28, N= 0.28, V×N= 0.56					V= 0.31, N= 0.31, V× N = 0.62				

Table.2 Effect of Varieties and different doses of nitrogen on total yield of potato tubers

Varieties	Total yield of tuber (tonnes ha^{-1})				
	Nitrogen kg ha^{-1}				
	0	60	120	180	Mean
Kufr iAnand	38.81	41.38	42.18	44.08	41.61
Kufri Bahar	33.92	35.36	36.95	38.75	36.24
Kufri Khyati	35.56	37.98	39.55	42.05	38.79
Kufri Pukhraj	38.35	41.28	43.75	46.44	42.25
Mean	36.66	39.00	40.61	42.83	-
CD at 5%	V=0.69	N= 0.69		V × N = 1.38	

Kufri Pukhraj with a nitrogen dose of 180 kg ha^{-1} yields highest D grade tubers (24.22 tonnes ha^{-1}) whereas, in Kufri Anand with a nitrogen dose of 180 kg ha^{-1} yields highest C grade tubers (14.02 tonnes ha^{-1}). Oparka (1987) and Gibson (2004) suggest that high nitrogen levels can reduce translocation leaf carbon to tubers, and increases nitrogen flow to new leaves rather than driving tuber production.

Kufri Pukhraj (42.25 tonnes ha^{-1}) yields highest tubers among varieties and nitrogen dose of 180 kg ha^{-1} gives highest yield *i.e.* 42.83 tonnes ha^{-1}. The best response of interaction between varieties and nitrogen doses found in variety Kufri Pukhraj at a nitrogen dose of 180 kg ha^{-1} (Table 2). According to increase in nitrogen dose, the yield of tubers also increases but the rate of difference in yield per dose increases with less pace as nitrogen dose advances. Same pattern was also observed by Fontes *et al.*, (2016). Plant metabolic factors for nitrogen use efficiency maximization differ at high and low nitrogen availability, indicating great potential for nitrogen use efficiency improvement (Xu *et al.*, 2012). It follows that precision-application of nitrogen promotes improved physiological characteristics and nitrogen indexes, and thus improves photosynthetic activity, favouring an increase in tuber yield ha^{-1} as tubers accumulate carbon in the form of starch and sugars (Jain *et al.*, 2017).

Presented results depict a clear cut idea about the better potato cultivation scenario in the *Indo-gangatic* alluvial region of Uttar Pradesh. Based on the observation recorded potato variety Kufri Pukhraj provided with nitrogen dose 180 kg ha^{-1} was found highly remunerative as having the highest C and D grade tubers which were having better market potential and also having the highest total tuber yield. In the *Indo-gangatic* alluvial region of Uttar Pradesh this combination of Kufri Pukhraj with nitrogen dose 180 kg ha^{-1} can be recommended after some extensive field trials.

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