International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 599-601

Received: 05-11-2019
Accepted: 08-12-2019

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Response of nitrogen levels on yield and growth attributes of potato (*Solanum tuberosum* L.)

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Abstract
The present investigation was carried out at Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.), during the year 2014-15 and 2015-16. The seven treatments were evaluated on cv. Kufri Khayti in Randomized Block Design with three replications. The study revealed that almost yield attributes are influenced by increasing different levels of nitrogen and found significantly higher by the increasing of the levels of nitrogen. The yield attributes viz., Number of tubers per plot (grade wise), Weight of A, B, C and D grade of tubers per plot (kg), Total number of tuber per plot, Total yield of tubers per plot (kg) and tuber yield per hectare recorded maximum with the application of treatment (T_5) 200 kg N/ha during both the years (2014-15 and 2015-16). The study further revealed that the treatment T_5 also had maximum net return and cost benefit ratio during both the years of investigation.

Keywords: potato, tuber yield, number of tubers grade wise and economics

Introduction
Potato (*Solanum tuberosum* L.) is whole some food and belongs to the family Solanaceae. It has originated in South America and now commercially grown in all over the world. Nutrients supply is one of the major part for enhancing tuber yield as well as proper growth and development of the plant. Among different plant nutrients nitrogen is the most important element for promoting growth, yield and quality of tubers in potato. Nitrogen is an essential constituent of protein and chlorophyll and is found in many other compounds of paramount physiological importance in plant metabolism such as nucleotides, phospitides, alkaloids enzymes, hormones, vitamins etc. Thus, nitrogen is the basic constituent of plant life. In plant nitrogen imparts dark green colour and promotes leaf, stem and other vegetative growth, it increases to a considerable extent in the utilization of potassium, phosphorus and other micro elements. As for the nitrogen deficiency is concerned it depresses both the rate and extent of protein synthesis. During early stage of plant, nitrogen deficiency is responsible for accumulation of carbohydrate. At later stage, flowering and fruit setting are adversely affected due to nitrogen deficiency.

Materials and methods
The experiment was conducted during the winter season of 2014-15 and 2015-2016 at Main Experiment Station Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.), Geographically, the experimental site falls under humid, sub-tropical climate and is located at 26.47º N latitude and 82.12º E longitudes on an elevation of about 113 meter above mean sea level in the Indo-Gangetic alluvial soil belt of eastern Uttar Pradesh. Faizabad region receives a mean annual precipitation of about 1200 mm. Maximum rainfall in this area is received from mid-June to end of September. However, occasional showers are very common in the month of January and February. The winter months are cold whereas, summer month are extremely hot, the western hot winds locally known as *Loo* starts from April and continued till the onset of monsoon in month of June. The experiment was conducted in Randomized Block Design (RBD) with four replications. The seven treatments were allocated randomly in to the plots in such a way that each and every treatment was received only once to each block. And every treatment was received only once to each block.

Details of treatments

Nitrogen levels: 7		
T_1	:	0 kg N/ha
T_2	:	50 kg N/ha
T_3	:	100 kg N/ha
T_4	:	150 kg N/ha
T_5	:	200 kg N/ha
T_6	:	250 kg N/ha
T_7	:	300 kg N/ha

Results and discussion

The nitrogen application markedly increased the number of A, B, C, D, grade tubers per plot. Maximum number of A, B, C, D, grade tubers per plot were recorded when plots were received 200 kg N/ha. It was probably due to physiological conditions conductive for tuber development. Increase levels of nitrogen resulted in increase of 'ware' size tubers reported by Kumar *et al.* (1992) [7] and Jamaati-E-somarin *et al.* (2010) [5].

Response of nitrogen (Table-1) on A, B, C and D grade tubers yield per plot was found to be favourable. The yield of A, B, C and D grade tubers per plot increased continuously up to 200 kg N/ha. Thus, the extent of increase in mean weight per tuber may be dependent on the effect of nitrogen on yield in different grades and their size increased significantly by nitrogen application. These findings are supported by Gupta and Pal (1989) [4], Gupta (1992) [3] and Kumar *et al.* (1992) [7]

Yield is the (Table-2) result of the vegetative growth of the plant. Increasing nitrogen levels increased the tuber yield to a great extent. The yield increased continuously up to 200 kg N/ha. However, highest nitrogen level (300 kg N/ha) produced at par higher tuber yield with 200, 250 kg/ha nitrogen. This increase in tuber yield was due to increase in photosynthetic activity of the plant which enhance with the supply of nitrogen. The manufactured photosynthesis help in increasing height of plants, number of leaves, number and weight of tubers per plot. Therefore, increasing nitrogen levels boosted the tuber yield tremendously. This is mainly due to more tuberization. Similar results have been reported by Castro (1988) [1], Lakshmi *et al.* (2010) [8] and Jing *et al.* (2012) [6]. Specific gravity of the tuber was influenced by the nitrogen application. It decreased with every successive increase in nitrogen level (Table-1). This decrease in specific gravity is due to increase in water content of the tuber, which was influenced by nitrogen levels because high levels of nitrogen leads to much more moisture uptake, which ultimately increases the water content in tubers. Decrease in specific gravity with increasing nitrogen level is also supported by White and Sanderson (1983) [10].

The response of nitrogen application on dry matter was found non-significant during both the years of experimentation quality parameters was decreased with every successive levels of nitrogen. Nitrogen fertilization reduced the dry matter percentage of the tubers. Perhaps by encouraging the production of protoplasm, this is largely composed of water. The dry matter and starch percentage of tuber was reduced to nitrogen application as reported by Chaurasia and Singh (1993) [2] and Tajner-Czope *et al.* (2005) [9]. Example, and replaces it with oil. Therefore, low dry matter/high water tubers tend to absorb more oil, which is typically the most expensive component of fries, and become more soggy and or oily.

The production of potato influenced by various agronomical factors and among the factors nitrogen plays an important role on different levels of nitrogen while, no information regarding the requirement of major nutrients are available on latest develop varieties of potato Kufri Khyati under Eastern U.P., particularly Faizabad conditions.

The benefit cost ratio (Table-3) is maximum cost of cultivation Rs. 82214 and 86490 and 161278 and 210876 during both the years (2014-15 and 2015-16) respectively in treatment T7(300 kg N/ha).Whereas maximum net return □169335 and 218048 and B:C ratio 2.07 and 2.5 during 2014-15 and 2015-16 respectively from T5 (200 kg N/ha).

Table 1: Effect of different nitrogen levels on yield attributes

Treatments	Number of tubers per plot (grade wise)								Weight of A,B,C and D grade of tubers per plot (kg)							
	2014-15				2015-16				2014-15				2015-16			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
T1: 0 kg N/ha	129.20	349.02	167.49	334.88	121.00	250.00	269.00	336.00	9.90	12.11	3.04	2.80	9.10	14.60	4.50	3.60
T2: 50 kg N/ha	137.93	279.11	274.06	349.94	129.00	260.00	275.00	351.00	9.180	13.47	6.56	2.75	9.40	15.00	9.00	3.75
T3: 100 kg N/ha	147.72	312.54	353.73	413.14	159.00	313.00	335.00	415,00	11.01	16.46	8.96	3.64	11.40	18.24	10.81	4.60
T4: 150 kg N/ha	120.69	417.07	337.98	423.58	162.00	318.00	339.00	425.00	11.48	16.61	9.95	3.99	11.55	18.45	11.60	4.65
T5: 200 kg N/ha	156.89	319.68	349.91	427.35	168.00	320.00	351.00	428.00	11.73	17.28	10.98	4.22	11.85	18.80	11.80	4.75
T6: 250 kg N/ha	175.75	218.76	348.00	426.28	166.85	319.00	350.00	427.00	11.44	17.20	10.58	4.2I	11.60	18.20	11.70	4.31
T7: 300 kg N/ha	164.28	318.00	347.50	425.90	166.00	318.10	349.10	426.20	11.20	17.23	10.48	4.18	11.48	18.00	11.60	4.20
S. Em. ±	2.99	2.49	2.27	3.57	2.59	2.49	2.76	2.57	4.99	3.25	4.97	4.87	2.68	3.89	2.58	0.23
C.D. (p=0.05)	15.14	29.72	31.65	57.26	13.69	29.67	34.87	39.88	1.69	2.06	1.89	0.92	1.99	2.79	1.98	0.63

Table 2: Effect of different nitrogen levels on yield of tubers

Treatments	Total number of tuber per plot		Total yield of tubers per plot (kg)		Total yield of tubers per hectare (q)		Dry matter (%)		Specific gravity	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T1: 0 kg N/ha	870.61	776.00	28.85	29.17	150.05	155.01	15.63	16.11	1.01	1.00
T2: 50 kg N/ha	914.72	1025.00	33.67	34.19	175.25	177.62	17.11	17.18	1.01	1.02
T3: 100 kg N/ha	420.03	1222.00	35.20	36.44	183.50	191.64	17.93	18.93	1.01	10.4
T4: 150 kg N/ha	1545.22	1247.00	46.17	44.52	240.25	231.80	18.67	19.24	1.02	1.01
T5: 200 kg N/ha	1222.00	1264.00	48.02	48.48	250.8	253.05	19.00	19.36	1.04	1.04
T6: 250 kg N/ha	1261.00	1262.50	47.78	48.28	248.52	252.13	19.29	19.31	1.03	1.03
T7: 300 kg N/ha	1259.80	1261.90	47.59	48.42	247.50	251.82	19.12	19.17	1.03	1.03
S. Em. ±	2.74	2.55	1.07	1.59	0.79	0.507	1.69	1.92	0.95	6.86
C.D. (p=0.05)	129.39	109.89	1.94	3.57	7.49	6.92	NS	NS	NS	NS

Table 3: Economics and net return per hectare as influenced by various nitrogen levels in potato during 2014-15 and 2015-16

Treatments	Tuber yield(q/ha)		Cost of cultivation (Rs/ha)		Gross income (Rs/ha)		Net return (Rs/ha)		Benefit cost ratio	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T1: 0 kg N/ha	140.05	165.01	79992	83882	150050	186012	70108	703835	0.71	0.64
T2: 50 kg N/ha	165.25	197.62	80698	84314	175258	213145	94925	128838	1.151	1.52
T3: 100 kg N/ha	133.50	141.64	80698	84796	191684	229968	110951	445225	1.47	1.71
T4: 150kg N/ha	220.25	231.80	81083	85186	240250	278166	159165	192980	1.76	2.27
T5: 200 kg N/ha	250.80	253.05	81461	85618	250800	303666	169335	218048	2.07	2.5
T6: 250 kg N/ha	248.52	252.13	81839	86050	248520	302556	166681	16506	2.03	2.52
T7: 300 kg N/ha	247.50	251.82	82214	86490	247500	302184	165286	215694	2.60	2.48

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