



# Effect of Different Levels of Nitrogen and Potassium on Yield and Quality of Potato

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The research experiment was carried out at Nalanda College of Horticulture, Noorsarai during 2021-22 to find out the effect of different levels of nitrogen and potassium on the growth and yield of potatoes. Findings of research showed that among the individual nitrogen and potassium levels, N<sub>5</sub> and K<sub>4</sub> performed better in respect of, the number of tubers per plant (7.85 and 6.80), average tuber weight (62.28 g and 67.27 g), tuber weight per plant (656.71 g and 473.45 g), tuber yield (270.95 q/ha and 216.73 q/ha), the diameter of tuber (5.21 cm and 3.98 cm), vitamin C content in tuber (14.15 mg/100gm and 11.89 mg/100gm), fresh weight (63.68 and 109.79), dry weight (12.89 and 22.12), moisture content of fresh tuber (76.09 and 91.07). In the case of interaction effect of N×K, the treatment of N<sub>5</sub>×K<sub>4</sub> pronounced significantly to the number of tubers per plant (11.44), single tuber weight (110.19 g), plant tuber weight (962.00 g), tuber yield (360 q/ha), diameter of tuber (8.10 cm), vitamin C content in tuber (18.50 mg/100 g), fresh weight (109.79 g), dry weight (22.12 g), moisture content of fresh tuber (91.07 g). Potato var. Kufri Lima yielded the maximum (360.76 q/ha) in the interaction of N<sub>5</sub>×K<sub>4</sub> when applied with 160 kg/ha nitrogen and 120 kg/ha potassium.

*Keywords: Potato; nitrogen; potassium; tuber yield; vitamin C.*

## 1. INTRODUCTION

“Potato (*Solanum tuberosum* L.), is an autotetraploid crop having chromosome number (2n=4X=48), a member of the Solanaceae family, is the most important crop among the vegetables. It is the most extensively grown tuber crop ranking fourth after rice, wheat and maize in the world. It is a vital source of nutrients for the human population and is taken almost daily by over a billion people, fresh or refined” (FAOSTAT, 2017). “It is believed to be used for global food security. About 40%, 35% and 25% of potatoes are grown in Europe, different developed countries and the rest of the world respectively” (Gull et al., 2011). “Being a starchy crop, it produces a high production of starch per unit area per unit time. The 100 gm of fresh tuber contains 70-80% water, 20.6% carbohydrates, 2.1% protein, 0.3% fat, 1.1% crude fibre and 0.9% ash. Potatoes are a rich source of carbohydrates, vitamin C, minerals and essential amino acids like leucine, tryptophan and isoleucine” (Bist and Sharma, 1997). “Potato is considered a highly nutritious food and it gives high productivity per unit area and time as compared to many food grains. The crop matures faster within 90 to 100 days and provides good tuber yield even in just 60 days. Overall, potato production is one of the most efficient means of converting plant, land, water and labour into a palatable and nutritious food” (Sahadevan, 2007). “Due to its uniqueness, the potato was declared a “Future food crop” by the Food and Agricultural Organization, Rome in the year 2008” (Hussain, 2016). “The potato tuber is an enlarged swollen underground stem with variable shapes and sizes. The swelling of the

tuber is due to the translocation and storage of photosynthates (carbohydrates), which retain their highest with the maturation of the aerial element of the plant. Hence, tuber boom and improvement of potatoes, in general, depend on the presence of ample foliage that produces the fundamental assimilates which directly depend on fertilization” (Hussain, 2016).

“The most important nutrient in fertilizer is nitrogen which is a growth stimulant for plants. Nitrogen is an essential constituent of various metabolically active compounds like amino acids, proteins, nucleic acids, pyrimidines, flavines, purines, nucleoproteins, enzymes, proteins, protoplasm and chlorophyll” (Panda, 2006). “So, its availability is important to plant growth and yield. Nitrogen applications can increase dry matter and protein content of tuber, quality, bulking rate, haulm growth and total tuber yield” (Belanger et al., 2002). “There is a positive impact of N on photosynthetic rate, leaf expansion, total number of leaves, canopy growth and shoot dry matter. The higher nitrogen content can be attributed to increased root proliferation due to the effect of nitrogen on cellular activities and the translocation of some growth-stimulating compounds to roots, resulting in improved tuber growth and nutrient absorption” (Sharma and Sood, 2002).

“Potassium (K) is the 3<sup>rd</sup> essential nutrient element for plant growth and is taken up from the soil solution by the plant roots in the form of potassium ion (K<sup>+</sup>). Potassium is very mobile within the plant and its deficiency symptoms in plants appear first in the older leaves” (Tisdale et al., 1993). “Potassium is directly involved in

enzyme activation, maintenance of water status, energy relations, and translocation of assimilates and protein synthesis. K regulates cellular turgid pressure to avoid wilting, which in turn controls the stomata opening and hence greatly enhances drought tolerance” (McCarty, 2005). The response of crops to potassium increases significantly in the presence of nitrogen (Sharma, 1989). “Potatoes require high amounts of potassium fertilizer for optimum growth, production and tuber quality. Potassium promotes leaf development, especially in the early stages of growth and for longer periods during tuber bulking. The nutrients management plans including their economic cost and return were pondered to obtain optimum yield and maximum profit. Potassium affects tuber quality characteristics such as ascorbic acid, total soluble solids, specific gravity, and tuber bulking rate, in addition to enhancing resistance to pests and diseases, which results in a better market price for the produce. Potato plants require much more potassium than many other vegetable crops; therefore, it is also regarded as an indicator crop for K availability” (Al-Moshileh, 2004).

“Positive effects of N and K interaction in terms of crop productivity and economics, but the balance of N and K application is not appropriately practiced in many parts of the world. Inadequate application of potassium (K) combined with over-application of nitrogen (N) is a serious problem in modern intensive agricultural production systems. Higher yields and crop quality can be obtained at optimal N:K nutritional ratios. Optimal N and K application is essential for best nutrient management in agriculture. Application of K facilitates the uptake and transport of nitrate towards aerial parts of the plant, which in turn enhances the activities of nitrate assimilating enzymes (K cycling and recycling play an important part in  $\text{NO}_3^-$  translocation from root to shoot as counter ion and assimilate loading in the phloem” (Maathuis, 2007). “Cycling and recycling of  $\text{K}^+$  increased with increasing shoot growth rate, which followed the suggested role of  $\text{K}^+$  for the charge balance of  $\text{NO}_3^-$  in the xylem and organic acids in the phloem” (Engels and Kirkby, 2001). The present research was undertaken to study the effect of combined and individual effects of nitrogen and potassium on the growth and yield of potatoes and also to determine the optimum levels of nitrogen and potassium individual or in combination, which would be best for the growth of potatoes.

## 2. MATERIALS AND METHODS

The present experiment was carried out during the Rabi season of 2022-23 at the Vegetable Research Field, Department of Vegetable Science, Nalanda College of Horticulture, Noorsarai, Nalanda (Bihar). The experiment was laid out in a factorial randomized block design with twenty treatments in three replications. Potato cultivar Kufri Lima was taken as a test crop. The treatments  $T_1$ -  $\text{N}_0$ : $\text{P}_0$ : $\text{K}_0$ ,  $T_2$  -  $\text{N}_0$ : $\text{P}_{80}$ : $\text{K}_{80}$ ,  $T_3$ -  $\text{N}_0$ : $\text{P}_{80}$ : $\text{K}_{100}$ ,  $T_4$ -  $\text{N}_0$ : $\text{P}_{80}$ : $\text{K}_{120}$ ,  $T_5$ -  $\text{N}_{100}$ : $\text{P}_{80}$ : $\text{K}_0$ ,  $T_6$ -  $\text{N}_{100}$ : $\text{P}_{80}$ : $\text{K}_{80}$ ,  $T_7$ - $\text{N}_{100}$ : $\text{P}_{80}$ : $\text{K}_{100}$ ,  $T_8$ - $\text{N}_{100}$ : $\text{P}_{80}$ : $\text{K}_{120}$ ,  $T_9$ -  $\text{N}_{120}$ : $\text{P}_{80}$ : $\text{K}_0$ ,  $T_{10}$ - $\text{N}_{120}$ : $\text{P}_{80}$ : $\text{K}_{80}$ ,  $T_{11}$ - $\text{N}_{120}$ : $\text{P}_{80}$ : $\text{K}_{100}$ ,  $T_{12}$ -  $\text{N}_{120}$ : $\text{P}_{80}$ : $\text{K}_{120}$ ,  $T_{13}$ - $\text{N}_{140}$ : $\text{P}_{80}$ : $\text{K}_0$ ,  $T_{14}$ - $\text{N}_{140}$ : $\text{P}_{80}$ : $\text{K}_{80}$ ,  $T_{15}$ -  $\text{N}_{140}$ : $\text{P}_{80}$ : $\text{K}_{100}$ ,  $T_{16}$ - $\text{N}_{140}$ : $\text{P}_{80}$ : $\text{K}_{120}$ ,  $T_{17}$ - $\text{N}_{160}$ : $\text{P}_{80}$ : $\text{K}_0$ ,  $T_{18}$ - $\text{N}_{160}$ : $\text{P}_{80}$ : $\text{K}_{80}$ ,  $T_{19}$ - $\text{N}_{160}$ : $\text{P}_{80}$ : $\text{K}_{100}$ ,  $T_{20}$ - $\text{N}_{160}$ : $\text{P}_{80}$ : $\text{K}_{120}$ . The crop was planted with a spacing of 50cm x 20cm and a plot size of 3.0 m x 3.0 m. Uniform cultural practices recommended for broccoli were followed. The recorded data of the trial were subjected to statistical analysis and the results were documented, analysed and presented in tabular form.

## 3. RESULTS AND DISCUSSION

**Effect of N, K and N x K on growth and yield parameters of potato:** The maximum number of tubers per plant (9.56) was recorded significantly with  $\text{N}_5$  (160 kg/ha and a minimum number of tubers (6.84) in the absence of nitrogen  $\text{N}_1$ . With the application  $\text{K}_4$  (120 kg/ha), the maximum mean value of the number of tubers per plant (8.92) was significantly observed. The minimum value of number of tubers per plant (7.46) was shown in  $\text{K}_1$  (0 Kkg/ha). The maximum number of tubers per plant (11.44) was recorded with the application of  $\text{N}_5 \times \text{K}_4$  (160 x 120 kg/ha). However, the minimum number of tubers per plant (6.74) was noted in the  $\text{N}_2 \times \text{K}_1$  ( $\text{N}_{100} \times \text{K}_0$ ).

The maximum value of single tuber weight (91.54 g) was noticed significantly with  $\text{N}_5$  (160 kg/ha) whereas the minimum single tuber weight (57.55 g) was recorded in the absence of nitrogen ( $\text{N}_1$ ). With the application of  $\text{K}_4$  (120 kg/ha), the value of single tuber weight (91.07 g) was significantly observed. The minimum value of single tuber weight (55.27 g) was shown in  $\text{K}_1$  (0 K kg/ha). The maximum value of single tuber weight (110.19 g) was recorded with the application of  $\text{N}_5 \times \text{K}_4$  (160 x 120 kg/ha) which was at par with  $\text{N}_4 \times \text{K}_4$  and  $\text{N}_5 \times \text{K}_2$ . However, the minimum value of single tuber weight (46.60 g) was noted in the  $\text{N}_1 \times \text{K}_1$  ( $\text{N}_0 \times \text{K}_0$ ).

**Table 1. Effect of different levels of nitrogen and potassium on the number of tuber per plant**

Treatment	K <sub>1</sub> (C=0 kg/ha)	K <sub>2</sub> (80 kg/ha)	K <sub>3</sub> (100 kg/ha)	K <sub>4</sub> (120 kg)	Mean
N <sub>1</sub> (C=0 kg/ha)	6.87	6.84	6.86	6.80	6.84
N <sub>2</sub> (100 kg/ha)	6.74	7.83	8.14	8.19	7.72
N <sub>3</sub> (120 kg/ha)	7.91	7.83	8.70	8.61	8.26
N <sub>4</sub> (140 kg/ha)	7.96	8.78	9.33	9.56	8.91
N <sub>5</sub> (160 kg/ha)	7.85	9.11	9.84	11.44	9.56
Mean	7.46	8.08	8.57	8.92	
	<b>SEm(±)</b>		<b>CD</b>		
N	0.20		0.57		
K	0.18		0.51		
N × K	0.40		1.15		

**Table 2. Effect of different levels of nitrogen and potassium on single tuber weight (g)**

Treatment	K <sub>1</sub> (C=0 kg/ha)	K <sub>2</sub> (80 kg/ha)	K <sub>3</sub> (100 kg/ha)	K <sub>4</sub> (120 kg)	Mean
N <sub>1</sub> (C=0 kg/ha)	46.60	53.82	62.52	67.27	57.55
N <sub>2</sub> (100 kg/ha)	52.00	65.57	71.47	77.50	66.64
N <sub>3</sub> (120 kg/ha)	56.67	74.14	81.94	94.25	76.75
N <sub>4</sub> (140 kg/ha)	58.80	82.53	92.87	106.13	85.08
N <sub>5</sub> (160 kg/ha)	62.28	98.77	94.93	110.19	91.54
Mean	55.27	74.97	80.75	91.07	
	<b>SEm(±)</b>		<b>CD</b>		
N	2.01		5.74		
K	1.79		5.14		
N × K	4.01		11.48		

**Table 3. Effect of different levels of nitrogen and potassium on tuber weight per plant**

Treatment	K <sub>1</sub> (C=0kg/ha)	K <sub>2</sub> (80kg/ha)	K <sub>3</sub> (100kg/ha)	K <sub>4</sub> (120kg)	Mean
N <sub>1</sub> (C=0kg/ha)	280.95	354.91	420.20	473.45	382.38
N <sub>2</sub> (100 kg/ha)	327.51	488.61	634.88	642.89	523.47
N <sub>3</sub> (120 kg/ha)	422.20	678.41	691.22	798.29	647.53
N <sub>4</sub> (140 kg/ha)	636.87	697.54	802.76	835.06	743.06
N <sub>5</sub> (160 kg/ha)	656.11	769.13	857.46	962.00	811.18
Mean	464.73	597.72	681.30	742.34	
	<b>SEm(±)</b>		<b>CD</b>		
N	16.88		48.33		
K	15.10		43.23		
N × K	33.76		NS		

**Table 4. Effect of different levels of nitrogen and potassium on tuber weight (q/ha)**

Treatment	K <sub>1</sub> (0 kg/ha)	K <sub>2</sub> (80 kg/ha)	K <sub>3</sub> (100 kg/ha)	K <sub>4</sub> (120 kg)	Mean
N <sub>1</sub> (0 kg/ha)	130.01	167.98	199.49	216.73	178.55
N <sub>2</sub> (100 kg/ha)	239.37	251.54	284.34	297.53	268.20
N <sub>3</sub> (120 kg/ha)	242.27	274.86	308.38	367.70	298.31
N <sub>4</sub> (140 kg/ha)	252.55	303.21	358.40	372.36	321.63
N <sub>5</sub> (160 kg/ha)	270.95	369.85	355.85	360.76	339.35
Mean	227.03	273.49	301.29	323.02	
	<b>SEm(±)</b>		<b>CD</b>		
N	6.71		19.22		
K	6.00		17.19		
N × K	13.43		38.44		

The maximum mean value of tuber weight per plant (811.18 g) was found significant with N<sub>5</sub> (160 kg/ha). The minimum mean tuber weight per plant (382.38g) was noticed in the absence of nitrogen (N<sub>1</sub>). With the application of K<sub>4</sub> (120 kg/ha), the maximum mean value of tuber weight per plant (742.34 g) was significantly observed. The minimum mean value of tuber weight per plant (464.73g) was shown in K<sub>1</sub> (0 K kg/ha). The maximum mean value of tuber weight per plant (962 g) was observed with the application of N<sub>5</sub> × K<sub>4</sub> (160 kg/ha × 120 kg/ha) and N<sub>5</sub> × K<sub>2</sub>. However, the minimum mean value of tuber weight per plant (280.95 g) was noted in the N<sub>1</sub> × K<sub>1</sub> (N<sub>0</sub> × K<sub>0</sub>).

The maximum mean value of tuber yield (339.35 q/ha) was found significantly with N<sub>5</sub> (160 kg/ha) which was at par with N<sub>4</sub> (140 kg/ha). The minimum mean tuber yield (178.55 q/ha) was noticed in the absence of nitrogen (N<sub>1</sub>). The maximum mean tuber yield (323.02q/ha) was significantly observed in K<sub>4</sub> (120 kg/ha). The minimum mean tuber yield (227.03 q/ha) was recorded without application of potassium (K<sub>1</sub>). The maximum mean value of tuber yield (372.36 q/ha) was found with the application of N<sub>4</sub> × K<sub>4</sub> (140 × 120 kg/ha) which was at par with N<sub>5</sub> × K<sub>2</sub>, N<sub>3</sub> × K<sub>4</sub>, N<sub>5</sub> × K<sub>4</sub>, N<sub>4</sub> × K<sub>3</sub> and N<sub>5</sub> × K<sub>3</sub>. However, the minimum mean value of tuber yield (130.01q/ha) was recorded in the N<sub>1</sub> × K<sub>1</sub> (N<sub>0</sub> × K<sub>0</sub>).

It is found that the application of N and K fertilizers significantly increased growth and yield of the tuber. Increased application of different levels of N and K was found significant effect on the growth and yield of tuber in potatoes. The interaction effect of N × K was also found to be significant in growth and yield of the tuber. Similar findings are supported by Sezek et al., (2018). Plant height is an indicator of vegetative growth. The addition of nutrients enhances the soil fertility and productivity levels which results in healthy crops. The minimum plant height might be due to the result of unavailability of nitrogen and other nutrients required by the plants for their normal growth and development. It was observed that an increase in nitrogen levels positively affected the plant height character which might be due to the role of nitrogen in cell division, cell enlargement and protein synthesis. Potassium nutrient in metabolism and many processes needed to promote plant vegetative growth and development. A positive response was

registered by Ali et al. (2003) and Hossain et al. (2009) who found that increasing potassium fertilization increased shoot height, number of leaves per plant and shoot fresh weight. Application of K increases plant height, crop vigour and imparts resistance against drought, frost and diseases. Potassium increases leaf expansion, particularly at early stages of growth and extends leaf area duration by delaying leaf shedding near maturity. It increases both the rate and duration of tuber bulking. Its application activates several enzymes involved in photosynthesis, carbohydrate and protein metabolism, and assists in the translocation of carbohydrates from leaves to tubers. Potassium increases the size but not the total number of tubers (Trehan et al., 2001). Potassium application thus increases yield by the formation of larger-sized tubers. Zhao-Hui et al. (2008) found that K increased the yields of tomatoes at most N rates. Nevertheless, the N<sub>0</sub>K<sub>0</sub> treatment produced the lowest yields. The interaction between N and K showed that with higher rates of N application, the effect of K became more significant with increasing application rate. This clearly indicated that as soon as a higher yield potential through better N supply was implemented, there was a rapid depletion of soil K. According to Mullins et al. (1991) and Cassman et al. (1992), the relationship between N and K determines the balance between vegetative growth, fruit quality and reproductive processes. Increased N and K forced higher yield which is also supported by Taya et al. (1994) who found that 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 (100 kg N/ha). Higher fertilizer response may be linked to the increase in total leaf area which in turn increased the amount of solar radiation intercepted and more photo-assimilates might have been produced and assimilated to the tubers.

**Effect of N, K and of N × K on quality parameters of potato tuber:** The maximum mean value of the diameter of tuber (6.63 cm) was found significant with N<sub>5</sub> (160 kg/ha). The minimum mean diameter of the tuber (3.88 cm) was noticed in the absence of nitrogen (N<sub>1</sub>). The maximum mean value of the diameter of tuber (6.13 cm) was significantly observed in K<sub>4</sub> (120kg/ha) which was significantly superior to all potassium levels. The minimum mean diameter of tuber (4.53 cm) was shown in 0 K kg/ha (K<sub>1</sub>). The maximum mean value of the diameter of tuber (8.10 cm) was found with the application of

N<sub>5</sub> × K<sub>4</sub> (160 × 120 kg/ha) which was significantly superior to all N × K interactions. However, the minimum mean value of the diameter of tuber (3.73cm) was recorded in the N<sub>1</sub> × K<sub>1</sub> (N<sub>0</sub> × K<sub>0</sub>).

The maximum mean value of vitamin C content (15.97 mg/100 g) was observed significantly with N<sub>5</sub> (160 kg/ha). The minimum mean vitamin C content (11.17mg/100 g) was noticed in the absence of nitrogen (N<sub>1</sub>). The maximum mean value of vitamin C content (14.09 mg/100g) was

significantly noticed in K<sub>4</sub> (120 kg/ha) which was at par with K<sub>3</sub> (100kg/ha). The minimum mean vitamin C content (12.68 mg/100 g) was noted in K<sub>1</sub> (0 K kg/ha). The maximum mean value of vitamin C content (18.50 mg/100 g) was found with the application of N<sub>5</sub> × K<sub>4</sub> (160 × 120 kg/ha) which was significantly superior to all N × K interactions. However, the minimum mean value of vitamin C content (10.46 mg/100 g) was recorded in the N<sub>1</sub> × K<sub>1</sub> (N<sub>0</sub> × K<sub>0</sub>).

**Table 5. Effect of different levels of nitrogen and potassium on the diameter of tuber (cm)**

Treatment	K <sub>1</sub> (C=0kg/ha)	K <sub>2</sub> (80kg/ha)	K <sub>3</sub> (100kg/ha)	K <sub>4</sub> (120kg)	Mean
N <sub>1</sub> (C=0kg/ha)	3.73	3.84	3.96	3.98	3.88
N <sub>2</sub> (100 kg/ha)	3.82	4.77	5.12	5.51	4.81
N <sub>3</sub> (120 kg/ha)	4.80	4.91	5.66	6.19	5.39
N <sub>4</sub> (140 kg/ha)	5.07	5.81	6.33	6.88	6.02
N <sub>5</sub> (160 kg/ha)	5.21	6.29	6.94	8.10	6.63
Mean	4.53	5.12	5.60	6.13	
	SEm (±)		CD		
N	0.14		0.40		
K	0.13		0.36		
N×K	0.28		0.81		

**Table 6. Effect of different levels of nitrogen and potassium on vitamin C content (mg per 100 gm) in tuber**

Treatment	K <sub>1</sub> (0kg/ha)	K <sub>2</sub> (80 kg/ha)	K <sub>3</sub> (100 kg/ha)	K <sub>4</sub> (120 kg)	Mean
N <sub>1</sub> (0 kg/ha)	10.46	10.97	11.36	11.89	11.17
N <sub>2</sub> (100 kg/ha)	11.22	12.05	12.34	12.98	12.15
N <sub>3</sub> (120 kg/ha)	13.44	13.54	13.87	11.83	13.17
N <sub>4</sub> (140 kg/ha)	14.12	14.42	14.94	15.26	14.68
N <sub>5</sub> (160 kg/ha)	14.15	15.57	15.67	18.50	15.97
Mean	12.68	13.31	13.64	14.09	
	SEm (±)		CD		
N	0.32		0.92		
K	0.29		0.83		
N × K	0.64		1.84		
N × K	3.46		9.91		

**Table 7. Effect of different levels of nitrogen and potassium on fresh weight of tuber**

Treatment	K <sub>1</sub> (C=0kg/ha)	K <sub>2</sub> (80kg/ha)	K <sub>3</sub> (100kg/ha)	K <sub>4</sub> (120kg)	Mean
N <sub>1</sub> (C=0kg/ha)	45.94	54.23	62.66	68.29	57.78
N <sub>2</sub> (100kg/ha)	51.56	65.70	71.64	78.46	66.84
N <sub>3</sub> (120kg/ha)	56.75	74.45	81.96	93.83	76.75
N <sub>4</sub> (140kg/ha)	59.61	82.71	92.20	104.69	84.80
N <sub>5</sub> (160kg/ha)	63.68	96.99	95.25	109.79	91.43
Mean	55.51	74.82	80.74	91.01	
	SEm(±)		CD		
N	1.73		4.96		
K	1.55		4.43		
N×K	3.46		9.91		

**Table 8. Effect of different levels of nitrogen and potassium on dry weight of tuber (g)**

Treatment	K <sub>1</sub> (C=0kg/ha)	K <sub>2</sub> (80kg/ha)	K <sub>3</sub> (100kg/ha)	K <sub>4</sub> (120kg)	Mean
N <sub>1</sub> (C=0kg/ha)	9.08	11.07	13.10	15.05	12.08
N <sub>2</sub> (100kg/ha)	9.65	13.01	15.06	17.49	13.80
N <sub>3</sub> (120kg/ha)	10.78	15.02	17.65	16.28	14.93
N <sub>4</sub> (140kg/ha)	12.16	16.15	17.13	19.69	16.28
N <sub>5</sub> (160kg/ha)	12.89	20.04	19.37	22.12	18.61
Mean	10.91	15.06	16.46	18.13	
	<b>SEm(±)</b>		<b>CD</b>		
N	0.36		1.03		
K	0.32		0.93		
N ×K	0.72		2.07		

**Table 9. Effect of different levels of nitrogen and potassium on moisture content in the tuber**

Treatment	K <sub>1</sub> (C=0kg/ha)	K <sub>2</sub> (80kg/ha)	K <sub>3</sub> (100kg/ha)	K <sub>4</sub> (120kg)	Mean
N <sub>1</sub> (C=0kg/ha)	93.03	81.14	77.00	79.69	82.71
N <sub>2</sub> (100kg/ha)	83.10	78.45	79.35	77.05	79.49
N <sub>3</sub> (120kg/ha)	79.15	76.25	75.51	74.88	76.45
N <sub>4</sub> (140kg/ha)	78.52	76.19	70.87	71.60	74.30
N <sub>5</sub> (160kg/ha)	76.09	74.83	71.26	91.07	78.31
Mean	81.98	77.37	74.80	78.86	
	<b>SEm(±)</b>		<b>CD</b>		
N	1.76		5.05		
K	1.58		4.52		
N×K	3.53		10.10		

The maximum mean value of the fresh weight of tuber (91.43 g) was observed significantly with N<sub>5</sub> (160 kg/ha). The minimum mean fresh weight of tuber (57.78g) was noticed in the absence of nitrogen (N<sub>1</sub>). The maximum mean value of fresh weight of tuber (91.01 g) was significantly noticed in K<sub>4</sub> (120 kg/ha). The minimum mean fresh weight of tuber (55.51g) was noted in K<sub>1</sub> (0 K kg/ha). The maximum mean value of fresh weight of tuber (109.79g) was found significantly with the application of N<sub>5</sub> × K<sub>4</sub> (160 × 120 kg/ha which is at par with N<sub>4</sub> × K<sub>4</sub>). However, the minimum mean value of the fresh weight of tuber (45.94 g) was shown in the N<sub>1</sub> × K<sub>1</sub> (N<sub>0</sub> × K<sub>0</sub>).

The maximum mean value of dry weight of tuber (18.61g) was found significant with N<sub>5</sub> (160 kg/ha). The minimum mean dry weight of tuber (12.08g) was recorded in the absence of nitrogen (N<sub>1</sub>). The maximum mean value of dry weight of tuber (18.13g) was significantly noticed in K<sub>4</sub> (120 kg/ha). The minimum mean dry weight of the tuber (10.91g) was with K<sub>1</sub> (0 K kg/ha). The maximum mean value of dry weight of tuber (22.12 g) was found significantly with the application of N<sub>5</sub> × K<sub>4</sub> (160 × 120 kg/ha) which is

at par with N<sub>4</sub> × K<sub>4</sub>. However, the minimum mean value of the dry weight of tuber (9.08g) was shown in the N<sub>1</sub> × K<sub>1</sub> (N<sub>0</sub> × K<sub>0</sub>).

The maximum mean value of moisture matter content in tuber (82.71 %) was found significantly with N<sub>1</sub> (0 kg/ha) which was at par with N<sub>2</sub> (79.49 %), N<sub>3</sub> (78.31 %) and N<sub>5</sub> (78.31%). The minimum mean moisture matter content in the tuber (74.30%) was recorded in the (N<sub>4</sub>). The maximum mean value of moisture matter content in tuber (81.98%) was significantly noticed in K<sub>1</sub> (0 kg/ha). The minimum mean moisture matter content in tuber (78.86%) was 120 kg/ha (K<sub>4</sub>). The maximum mean value of moisture matter content in tuber (93.03%) was found significant with the application of N<sub>1</sub> × K<sub>1</sub>. The minimum mean value of moisture matter content in tuber (70.87 %) was recorded in the N<sub>4</sub> × K<sub>3</sub> (N<sub>140</sub> × K<sub>100</sub> kg/ha).

It is quite clear that the individual effects of N and K responded significantly to ascorbic acid, fresh weight, dry weight and moisture content of tuber. This might be due to an increase in the uptake of nutrients nitrogen and potassium

which promoted ascorbic acid content supported by Tomar and Singhal (2007). The positive influence of potassium was due to the close relationship between carbohydrate metabolism and the formation of ascorbic acid. Awaad et al. (2016) found that applications of N and K at higher levels significantly increased the fresh and dry weights of the lettuce plants. These results are in agreement with the findings of Gülser (2005) who indicate that the yield of spinach was increased by increasing the rates of N fertilizer. Nurzyńska-Wierdak (2009) indicated that the increase in the amounts of N and K application generally contributed to an increase in fresh leaf weight and yield. Abdel-Motagally and Osman (2010) found that increasing N and K fertilizer rates resulted in a significant increase in yield compared to the other treatments. The application of K has a direct influence on tuber quality (Trehan et al., 2001).

#### 4. CONCLUSION

Positive effects of N and K interaction in terms of crop productivity and economics, but the balance of N and K application is not appropriately practiced in many parts of the world. Inadequate application of potassium (K) combined with over-application of nitrogen (N) is a serious problem in modern intensive agricultural production systems. Higher yields and crop quality can be obtained at optimal N:K nutritional ratios.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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