Effect of different levels of nitrogen and potassium on yieldand quality of potato

Abstract

The research experiment was carried out at Nalanda College of Horticulture, Noorsaraiduring 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, $N_5$and K_4 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 $N_5 \times K_4$ 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 $N_5 \times K_4$when applied with 160 kg/ha nitrogen and 120 kg/ha potassium.

***Keywords**: potato, nitrogen, solanum, chromosome*

Introduction

"Potato (*Solanumtuberosum* L.), having diploid chromosome number (2n=48), a member of the Solanaceae family, is the most important crop in the vegetable class. 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, totalnumber 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 3rd 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^+). 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 optimalN: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 NO_3^- translocation from root to shoot as counter ion and assimilate loading in the phloem" (Maathuis, 2007). "Cycling and recycling of K^+ increased with increasing shoot growth rate, which followed the suggested role of K^+ for the charge balance of 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.

Materials and method

Thepresentexperimentwascarriedoutduringthe Rabi seasonof2022-23attheVegetableResearchField,DepartmentofVegetable Science, Nalanda College of Horticulture, Noorsarai, Nalanda (Bihar).The experiment was laid out in a factorial randomized block design withtwentytreatmentsin threereplications.Potato cultivar Kufri Lima was taken asa testcrop.ThetreatmentsT_1- N_0:P_0:K_{0},T_2 - N_0:P_{80}:K_{80},T_3- N_0:P_{80}:K_{100},T_4-N_0:P_{80}:K_{120},T_5- N_{100}:P_{80}:K_0.,T_6-N_{100}:P_{80}:K_{80},T_7-N_{100}:P_{80}:K_{100},T_8-N_{100}:P_{80}:K_{120}, T_9-N_{120}:P_{80}:K_0,T_{10}-N_{120}:P_{80}:K_{80},T_{11}-N_{120}:P_{80}:K_{100},T_{12}-N_{120}:P_{80}:K_{120},T_{13}-N_{140}:P_{80}:K_0,T_{14}-N_{140}:P_{80}:K_{80},T_{15}-N_{140}:P_{80}:K_{100},T_{16}-N_{140}:P_{80}:K_{120},T_{17}-N_{160}:P_{80}:K_0,T_{18}-N_{160}:P_{80}:K_{80},T_{19}-N_{160}:P_{80}:K_{100},T_{20}-N_{160}:P_{80}:K_{120}.The crop was planted with a spacing of 50cm×20cm and a plot size of3.0m×3.0m. 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.

Results and discussion

Effect of N, K and N × K on growth and yield parameters of potato

The maximum number of tubers per plant (9.56) was recordedsignificantly with N_5(160 kg/ha and a minimum number of tubers (6.84) inthe absenceofnitrogenN_1. With the application K_4(120kg/ha), the maximum mean valueof the number of tubers per plant (8.92) was significantly observed. The minimum value ofnumberoftubersperplant(7.46)was shown inK_1(0Kkg/ha).The maximum number of tubers per plant (11.44) wasrecorded with the application of $N_5 \times K_4$(160×120 kg/ha). However, the minimumnumberoftubers perplant(6.74)wasnotedinthe $N_2 \times K_1$($N_{100} \times K_0$).

Table-1:Effectofdifferentlevelsofnitrogenandpotassiumonthe numberoftuber perplant

Treatment	K_1(C=0kg/ha)	K_2(80kg/ha)	K_3(100kg/ha)	K_4(120kg)	Mean
N_1(C=0kg/ha)	6.87	6.84	6.86	6.80	6.84
N_2(100kg/ha)	6.74	7.83	8.14	8.19	7.72
N_3(120kg/ha)	7.91	7.83	8.70	8.61	8.26
N_4(140kg/ha)	7.96	8.78	9.33	9.56	8.91
N_5(160kg/ha)	7.85	9.11	9.84	11.44	9.56
Mean	7.46	8.08	8.57	8.92	
	SEm(±)		CD		
N	0.20		0.57		
K	0.18		0.51		
N× K	0.40		1.15		

Themaximumvalueofsingletuberweight(91.54 g)wasnoticedsignificantlywithN_5(160 kg/ha) whereas theminimumsingle tuberweight(57.55 g)wasrecordedintheabsenceofnitrogen(N_1).With the application of K_4(120 kg/ha), the value of single tuberweight (91.07 g) was significantly observed. The minimum value of single tuber weight(55.27 g)was shown inK_1(0Kkg/ha).The maximum value of single tuber weight (110.19 g) wasrecorded with the application of $N_5 \times K_4$(160 × 120 kg/ha) which was at par with $N_4 \times K_4$and $N_5 \times K_2$. However, the minimum value of single tuber weight (46.60 g) was noted in the$N_1 \times K_1$($N_0 \times K_0$).

Table-2:Effect ofdifferent levelsofnitrogenandpotassiumon singletuberweight (g)

Treatment	K_1(C=0kg/ha)	K_2(80kg/ha)	K_3(100kg/ha)	K_4(120kg)	Mean
N_1(C=0kg/ha)	46.60	53.82	62.52	67.27	57.55
N_2(100kg/ha)	52.00	65.57	71.47	77.50	66.64

N_3(120kg/ha)	56.67	74.14	81.94	94.25	76.75
N_4(140kg/ha)	58.80	82.53	92.87	106.13	85.08
N_5(160kg/ha)	62.28	98.77	94.93	110.19	91.54
Mean	55.27	74.97	80.75	91.07	
	SEm(±)		**CD**		
N	2.01		5.74		
K	1.79		5.14		
N×K	4.01		11.48		

The maximum mean value of tuber weight per plant (811.18 g)was found significant with N_5(160 kg/ha). The minimum mean tuber weight per plant(382.38g)was noticedintheabsence ofnitrogen(N_1).With the application of K_4(120 kg/ha), the maximum meanvalue of tuber weight per plant (742.34 g) was significantly observed. The minimum meanvalue oftuberweightperplant(464.73g)was shown inK_1(0Kkg/ha).The maximum mean value of tuber weight per plant (962 g)was observed with the application of $N_5 \times K_4$(160 kg/ha × 120 kg/ha) and $N_5 \times K_2$. However,the minimum mean value of tuber weight per plant (280.95 g) was noted in the $N_1 \times K_1 (N_0 \times K_0)$.

Table-3:Effectofdifferentlevelsofnitrogenandpotassiumontuberweightperplant

Treatment	**K_1(C=0kg/ha)**	**K_2(80kg/ha)**	**K_3(100kg/ha)**	**K_4(120kg)**	**Mean**
N_1(C=0kg/ha)	280.95	354.91	420.20	473.45	382.38
N_2(100kg/ha)	327.51	488.61	634.88	642.89	523.47
N_3(120kg/ha)	422.20	678.41	691.22	798.29	647.53
N_4(140kg/ha)	636.87	697.54	802.76	835.06	743.06
N_5(160kg/ha)	656.11	769.13	857.46	962.00	811.18
Mean	464.73	597.72	681.30	742.34	
	SEm(±)		**CD**		
N	16.88		48.33		
K	15.10		43.23		
N ×K	33.76		NS		

The maximum mean value of tuber yield (339.35 q/ha) wasfoundsignificantly withN_5(160kg/ha)whichwasatparwithN_4(140kg/ha).Theminimummeantuberyield(178.55 q/ha)wasnoticedintheabsenceofnitrogen(N_1).Themaximummeantuberyield(323.02q/ha)wassignificantly observedin K_4(120 kg/ha). Theminimum mean tuberyield (227.03

q/ha)wasrecorded without application of potassium(K_1).The maximum mean value of tuber yield (372.36 q/ha) wasfound with the application of $N_4\times K_4$(140×120 kg/ha) which was at par with $N_5\times K_2$, $N_3\times K_4$, $N_5\times K_4$, $N_4\times K_3$ and $N_5\times K_3$. However, the minimum mean value of tuber yield(130.01q/ha)was recordedinthe $N_1\times K_1$(N0×K0).

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

Treatment	**K_1 (0 kg/ha)**	**K_2 (80 kg/ha)**	**K_3 (100 kg/ha)**	**K_4 (120 kg)**	**Mean**
N_1 (0 kg/ha)	130.01	167.98	199.49	216.73	178.55
N_2 (100 kg/ha)	239.37	251.54	284.34	297.53	268.20
N_3 (120 kg/ha)	242.27	274.86	308.38	367.70	298.31
N_4 (140 kg/ha)	252.55	303.21	358.40	372.36	321.63
N_5 (160 kg/ha)	270.95	369.85	355.85	360.76	339.35
Mean	227.03	273.49	301.29	323.02	
	SEm(±)		**CD**		
N	6.71		19.22		
K	6.00		17.19		
N × K	13.43		38.44		

It is found that the applicationof 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_0K_0 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) wasfound significant with N_5(160 kg/ha). The minimum mean diameter of the tuber (3.88 cm)wasnoticedintheabsenceofnitrogen(N_1). The maximum mean value of the diameter of tuber (6.13 cm)wassignificantlyobservedinK_4(120kg/ha)whichwassignificantlysuperiortoallpotassium levels.Theminimum mean diameter of tuber(4.53 cm)was shown in 0Kkg/ha (K_1). The maximum mean value of the diameter of tuber (8.10 cm)was found with the application of N_5× K_4(160 × 120 kg/ha) which was significantlysuperior to all N × K interactions. However, the minimum mean value of the diameter of tuber(3.73cm)wasrecordedinthe N_1×K_1(N_0×K_0).

Table-5: Effect ofdifferentlevelsofnitrogen andpotassiumon the diameteroftuber (cm)

Treatment	K_1(C=0kg/ha)	K_2(80kg/ha)	K_3(100kg/ha)	K_4(120kg)	Mean
N_1(C=0kg/ha)	3.73	3.84	3.96	3.98	3.88
N_2(100 kg/ha)	3.82	4.77	5.12	5.51	4.81
N_3(120 kg/ha)	4.80	4.91	5.66	6.19	5.39
N_4(140 kg/ha)	5.07	5.81	6.33	6.88	6.02
N_5(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		

The maximum mean value of vitamin C content(15.97 mg/100 g)was observed significantly with N_5(160 kg/ha). The minimum mean vitamin C content(11.17mg/100 g)was noticedinthe absenceofnitrogen(N_1). The maximum mean value of vitamin C content (14.09 mg/100g)wassignificantlynoticedinK_4(120kg/ha)whichwas atparwithK_3(100kg/ha).TheminimummeanvitaminCcontent(12.68 mg/100 g)wasnotedinK_1(0Kkg/ha).The maximum mean value of vitamin C content (18.50 mg/100 g) was found with the application of N_5× K_4(160 × 120 kg/ha) which was significantlysuperior to all N × K interactions. However, the minimum mean value of vitamin C content (10.46 mg/100 g)wasrecordedinthe N_1×K_1(N_0×K_0).

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

Treatment	K_1 (0 kg/ha)	K_2 (80 kg/ha)	K_3 (100 kg/ha)	K_4 (120 kg)	Mean

N_1 (0 kg/ha)	10.46	10.97	11.36	11.89	11.17
N_2 (100 kg/ha)	11.22	12.05	12.34	12.98	12.15
N_3 (120 kg/ha)	13.44	13.54	13.87	11.83	13.17
N_4 (140 kg/ha)	14.12	14.42	14.94	15.26	14.68
N_5 (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		

The maximum mean value of the fresh weight of tuber (91.43 g)was observed significantly with N_5(160 kg/ha). The minimum mean fresh weight of tuber(57.78g)was noticedintheabsence ofnitrogen(N_1). The maximum mean value of fresh weight of tuber (91.01 g)was significantly noticed in K_4(120 kg/ha). The minimum mean fresh weight of tuber(55.51g)was notedinK_1(0Kkg/ha). The maximum mean value of fresh weight of tuber (109.79g) was found significantly with the application of $N_5 \times K_4$(160×120 kg/ha which is at parwith $N_4 \times K_4$. However, the minimum mean value of the fresh weight of tuber (45.94 g) wasshown inthe$N_1 \times K_1$($N_0 \times K_0$).

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

Treatment	**K_1(C=0kg/ha)**	**K_2(80kg/ha)**	**K_3(100kg/ha)**	**K_4(120kg)**	**Mean**
N_1(C=0kg/ha)	45.94	54.23	62.66	68.29	57.78
N_2(100kg/ha)	51.56	65.70	71.64	78.46	66.84
N_3(120kg/ha)	56.75	74.45	81.96	93.83	76.75
N_4(140kg/ha)	59.61	82.71	92.20	104.69	84.80
N_5(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		

The maximum mean value of dry weight of tuber (18.61g) was found significant with N_5(160 kg/ha). The minimum mean dry weight oftuber(12.08g)wasrecordedintheabsence ofnitrogen(N_1). The maximum mean value of dry weight of tuber(18.13g)wassignificantlynoticedinK_4(120kg/ha).Theminimummeandryweight of the tuber(10.91g)was with K_1(0Kkg/ha). The maximum mean value of dry weight of tuber(22.12 g) was found significantly with the application of $N_5\times K_4$(160 × 120 kg/ha) which is atpar with $N_4\times K_4$. However, the minimum mean value of the dry weight of tuber (9.08g) wasshown inthe$N_1\times K_1$($N_0\times K_0$).

Table-8: Effect of different levels of nitrogen and potassium on dry weight oftuber (g).

Treatment	**K_1(C=0kg/ha)**	**K_2(80kg/ha)**	**K_3(100kg/ha)**	**K_4(120kg)**	**Mean**
N_1(C=0kg/ha)	9.08	11.07	13.10	15.05	12.08
N_2(100kg/ha)	9.65	13.01	15.06	17.49	13.80
N_3(120kg/ha)	10.78	15.02	17.65	16.28	14.93
N_4(140kg/ha)	12.16	16.15	17.13	19.69	16.28
N_5(160kg/ha)	12.89	20.04	19.37	22.12	18.61
Mean	10.91	15.06	16.46	18.13	
	SEm(±)		**CD**		
N	0.36		1.03		
K	0.32		0.93		
N ×K	0.72		2.07		

The maximum mean value of moisture mattercontentin tuber(82.71 %) was found significantly with N_1(0 kg/ha) which was at par with N_2(79.49 %),N_3(78.31 %) and N_5(78.31%). The minimum mean moisture mattercontentin the tuber (74.30%) wasrecordedinthe(N_4).The maximum mean value of moisture mattercontentin tuber(81.98%) was significantly noticed in K_1(0 kg/ha). The minimum mean moisture mattercontentin tuber (78.86%)was120 kg/ha(K_4).The maximum mean value of moisture mattercontentin tuber(93.03%) was found significant with the application of $N_1\times K_1$. The minimum meanvalue of moisture mattercontentin tuber (70.87 %) was recorded in the $N_4\times K_3$ ($N_{140}\times K_{100}$kg/ha).

Table-9: Effect of different levels of nitrogen and potassium on moisture contentinthe tuber.

Treatment	K_1(C=0kg/ha)	K_2(80kg/ha)	K_3(100kg/ha)	K_4(120kg)	Mean
N_1(C=0kg/ha)	93.03	81.14	77.00	79.69	82.71
N_2(100kg/ha)	83.10	78.45	79.35	77.05	79.49
N_3(120kg/ha)	79.15	76.25	75.51	74.88	76.45
N_4(140kg/ha)	78.52	76.19	70.87	71.60	74.30
N_5(160kg/ha)	76.09	74.83	71.26	91.07	78.31
Mean	81.98	77.37	74.80	78.86	
	SEm(±)		**CD**		
N	1.76		5.05		
K	1.58		4.52		
N×K	3.53		10.10		

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).

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.

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