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Effect of Graded Levels of Nitrogen and Potassium on Growth and Yield of Sweet Potato (*Lpomoea batatas* L.)

Pushpalatha, M. [1*], Vaidya, P. H. Sunil, B. H. and Adsul, P. B.

Department of Soil Science and Agriculture Chemistry, College of Agriculture, Latur

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani 431402 (M.S.) India

*Corresponding Author E-mail: pushpalatha.bscag@gamil.com

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ABSTRACT

A field Experiment was conducted in Kharif season during the year 2015-2016 on fine texture Vertisols at Horticulture Research Farm, College of Agriculture, Latur (Maharastra). This work aimed to investigate increasing growth and yield of sweet potato (Ipomoea batatas. L.) under the condition of semi-arid region. The experiment was laid in Factorial Randomized Block Design with three replications and twelve treatments. The experiment consist of 4 levels of nitrogen (0, 75, 100, & 125 kg ha^{-1}) and 3 levels of potassium (0, 75, & 100 kg ha^{-1}). The result of field experiment revealed that the all growth and yield of sweet potato were significantly increased with increased levels of nitrogen and potassium content in earlier growth stage of sweet potato and similar trend was observed in case of yield at harvest. Application of 125 kg N ha^{-1}recorded significantly higher leaf area index at end of harvest (1.26), leaf chlorophyll content like chlorophyll-a (0.65 mg/g Fresh weight) chlorophyll-b (1.48 mg/g Fresh weight) and total chlorophyll (2.13 mg/g Fresh weight) content at 120 DAP and yield of sweet potato (22. 39 ton/ha) was significantly recorded in same manner. Application of potassium @ 100 kg/ha was recorded significantly increases the leaf area index at harvest (1.30) and leaf chlorophyll like chlorophyll-a (0.41mg/g Fresh weight), chlorophyll-b (0.91 mg/g Fresh weight) and total chlorophyll (1.32 mg/g Fresh weight) at 120 DAP and yield of sweet potato (19. 59 ton/ha) significantly superior over rest of the treatments than control.

Key words: *Sweet potato, Nitrogen, Potassium, Chlorophyll.*

INTRODUCTION

Sweet potato (*Ipomoea batatas* L) is a dicotyledonous root crop and a member of the family *Convolvulaceae.* As well as, sweet potato is the seventh most important food crop in the worldwide, after wheat, rice, maize, potato, barley and cassava. The primary importance of sweet potato is in poor regions of the world. It is the fourth most important food crop in developing tropical countries and is grown in most of the tropical and subtropical regions of the earth. In India it is cultivated in almost all the states. Sweet potato is considered as a **'poor man's rich food'** in many parts of India.

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In India it covers 112 thousand ha area and production 1157 thousand MT and productivity is 12.10 MT/ha. In India sweet potato is largely grown in three states Orissa, Uttar Pradesh, and West Bengal. Sweet potato is a vegetatively propagated crop and it is rich in several essential macro and micronutrients. Considerable efforts have been made recently to promote sweet potato and to create awareness among the farming communities. Sweet potato production can be increased substantially through the proper use of fertilizer.

Nitrogen, phosphorus and potassium are essential macro elements. Nitrogen is most important major plant nutrient; it helps for growth and development of crop. Nitrogen is attributed to the role of one of the most important macronutrients in the formation of yield and quality of vegetables. Nitrogen has a great importance as a constituent of numerous organic molecules in plant such as proteins, nucleic acids and alkaloids, enzymes, chlorophyll-a, chlorophyll-b, certain acid of nucleus and certain hormones and its content is associated with the leaf relative chlorophyll content which affects photosynthesis. Nitrogen being "**The motor of plant growth"**. Unbalanced excess fertilizers in crops will decrease quality of crops particularly storage ability[5]. Nitrogen is an important factor in determining the yield and nutrient composition of root tubers, especially sweet potato[17].

Fertilizer is one of the most important inputs of increasing the productivity of crops Potassium is a part of many important regulatory roles in the plant. It is essential in nearly all processes needed to sustain plant growth and reproduction i.e. photosynthesis translocation of photosynthates, protein synthesis, control of ionic balance, regulation of plant stomata, turgor maintenance, stress tolerance and water use, activation of plant enzymes and many other processes. Potassium uptake also depends on plant factors, including genetics and developmental stage. All plants require potassium, especially crops high in carbohydrates, such as potatoes. Studies have shown that adequate K nutrition has also been associated with increased yields of both agriculture filed crops and horticulture crops and improves the self-life of fruits and vegetables.

MATERIEL AND METHODS

The field experiment was conducted in College of Agriculture, Latur farm during the *kharif* season 2015-2016. This experiment was laid out in factorial randomized block design with 3 replications and 12 treatments. Experimental factors includes nitrogen fertilizer levels (0, 75, 100, 125 kg/ha) potassium fertilizer levels (0, 75, 100) with 3 replications of different combination of levels. Total numbers of plots are 12, size 3 x 2 sq. m with spacing 60 cm x 20 cm with local variety. Graded levels of potassium and nitrogen was applied at the time planting and recommended dose of phosphorous was applied in the same time but graded levels of N was split in to half at time of planting and reaming half at the 30 days after planting.

Random Selection of five plants per plots for recorded Leaf area index was measured by leaf area meter at different growth stage (DAP) of sweet potato plants for randomly selected and calculated based on ground area basis. The plant pigment like chlorophyll a, b and total chlorophyll content in leaves were determined by using DMSO (Dimethyl sulfoxide) method at different growth level as per procedure described by Hiscox and Israelstan[7] Yield of tuber recorded at the time of harvesting.

$$\text{LAI} = \frac{\text{Leaf area /plant (cm)}^2}{\text{land area occupied by plant(cm)}^2}$$

Data recorded on yield and quality parameter was subjected to analysis of variance (ANOVA, $p \leq 0.05$) and means comparisons were done at $P \leq 0.05$. Percentages were computed using the least square means from respective ANOVA and tables and figures were drawn using MS excel 2010 program.

RESULTS AND DISCUSSION

Effect of Nitrogen on LAI

Among the different graded levels of nitrogen, nitrogen at N_3 level (125 kg N ha^{-1}) was found

significant higher for leaf area index per plant at 60 DAP (1.03), 90 DAP (1.58), 120 DAP (2.14) and at end of harvest (1.30), over rest of the treatments and it was at par with N_2 level (100 kg N ha^{-1}) of 60 DAP (0.96), 90 DAP (1.49), 120 DAP (2.09) and at end of harvest (1.26), While, the effect of nitrogen at N_3 level (125 kg N ha^{-1}) was found non-significant at 30 DAS for leaf area index per plant in sweet potato and minimum LAI was found in the treatment N_0 (control).

Increases in leaf area index of sweet potato significantly more in the early growth stages and middle growth stages were observed with increased application of nitrogen fertilizer levels, this might be due to the nitrogen fertilizer increased the vegetative growth of plants and increases the number of leaf and leaf area under the different levels of nitrogen application. Similar findings were also reported by Ismail and Abu[6] in potato crop. Sandhu *et al.*[11] inferred that the sufficient use of nitrogen fertilizer in the beginning growth stage coursed the extension of leaf surface and increases the photosynthesis capacity of leaves similar with the finding of Bourke[4] in sweet potato and Mojtaba *et al.*[8] in potato crop.

Effect of potassium on LAI

Among the different graded levels of potassium, the K_2 level (100 kg K_2O ha^{-1}) was found significantly more at 60 DAP (0.94), 90 DAP (1.52), 120 DAP (1.90) and at end of harvest (1.17), over rest of the treatments and However, found at par in 60 DAP (0.86), 90 DAP (1.44) 120 DAP (1.87) and at end of harvest (1.15) with K_1 level (75 kg K_2O ha^{-1}) for the character leaf area per plant. While, the effect of potassium at K_2 level (75 kg K_2O ha^{-1}) was found non- significant at 30 DAP for leaf area index per plant in sweet potato and lower LAI were obtained in K_0.

Table: 1 Effect of graded levels of nitrogen and potassium on sweet potato leaf area index (LAI)

Treatments (levels)	30 DAP	60 DAP	90 DAP	120 DAP	AT harvest
Nitrogen levels					
N_0	0.45	0.50	1.01	1.34	0.69
N_1	0.48	0.88	1.39	1.83	1.08
N_2	0.52	0.96	1.49	2.09	1.26
N_3	0.54	1.03	1.58	2.14	1.30
SE ±	0.023	0.033	0.032	0.071	0.048
CD@ 5%	NS	0.096	0.094	0.207	0.14
Potassium levels					
K_0	0.48	0.72	1.39	1.53	0.93
K_1	0.49	0.86	1.44	1.87	1.15
K_2	0.52	0.94	1.52	1.90	1.17
SE±	0.020	0.028	0.028	0.061	0.042
CD @ 5%	NS	0.083	0.082	0.18	0.12
Interaction (N x K)					
SE±	0.039	0.056	0.056	0.12	0.083
CD@ 5%	NS	NS	NS	NS	NS

NS=non-significance, S=significance

Potassium plays a crucial role in maintenance of tissue water relation aids to photosynthesis and enhances protein synthesis resulting in better foliage growth similar results was also reported by Singh & Lal[14] in sweet potato crop. Trehan *et al*[16] observed that potassium increases crop vigour, leaf expansion particularly at early growth stage and extended leaf area duration. Increases LAI significantly in the early and middle growth stages nevertheless it declined LAI in the late growth stages, this may be due to potassium fertilizer in the late growth stage reduces the translocation of dry matter from functional leaves to storage part of the plant in sweet potato crop. The interaction effect of nitrogen and potassium were found non- significant for leaf area index per plant.

Effect of nitrogen on chlorophyll-a, chlorophyll-b, and total chlorophyll content of sweet potato leaves

Among the different graded levels of nitrogen at N_3 level (125 kg N ha^{-1}) significantly highest for total chlorophyll (a+b) content at 30 DAP (1.29 mg/g), 60 DAP (1.69 mg/g), 90 DAP (2.43 mg/g) and 120 DPA (2.13 mg/g), over rest of the treatments and it was found at par with N_2 level (100 kg N ha^{-1}) of

30 DAP (1.21 mg/g), 60 DAP (1.55 mg/g), 90 DAP (2.35 mg/g), 120 DAP (1.93 mg/g) followed by rest of the treatments. The lowest total chlorophyll was recorded in control.

Total chlorophyll content of leaf was increase with increased nitrogen fertilizer rate in the early growth stage, which in turn increases the plant vigorous growth and plant chlorophyll pigments significantly, this might be due to nitrogen-containing chlorophyll in the presence of solar energy which fixes atmospheric CO_2 as carbohydrates, result was obtained by Singh & Lal[14] in potato, similarly Ismail and Abu[9] reported the same result and showed that the increased nitrogen significantly increases the chlorophyll pigments.

The total chlorophyll content in leaves was declined at the time of different plant growth stages this might be due to the availability of nitrogen in plant was highest in early growth stages which increases the age of the plant thus decreases the availability of nitrogen. The leaf nitrogen decreases with time was also observed by workers Seadh *et al.*[15] Abd *et al*[2].

Effect of potassium on chlorophyll-a, chlorophyll -b and total chlorophyll content of sweet potato leaves

Among the different graded levels of potassium. Potassium K_2 level (100 kg K_2O ha^{-1}) was found significantly superior on total chlorophyll (a+b) content at 30 DAP (1.10 mg/g), 60 DAP (1.46 mg/g), 90 DAP (2.17 mg/g), and 120 DAP (1.68 mg/g) over rest of the treatments and it was at par in 30 DAP (1.00 mg/g), 60 DAP (1.33 mg/g), 90 DAP (1.97 mg/g) and 120 DAP (1.52 mg/g) followed by rest of applications in sweet potato. The lowest total chlorophyll was observed in control.

Table 2: Effect of graded levels of nitrogen and potassium on chlorophyll content of sweet potato leaves at different growth stages

Treatments (levels)	30 DAP (mg/g F W)			60DAP (mg/g F W)			90 DAP (mg/g F W)			120 DAP (mg/g F W)		
Nitrogen levels	Chloro phyll – a	Chloro phyll – b	Total Chloro phyll	Chloro phyll – a	Chloro phyll – b	Total Chloro phyll	Chloro phyll – a	Chloro phyll – b	Total Chloro phyll -	Chloro phyll – a	Chloro phyll - b	Total Chloro phyll
N_0	0.35	0.29	0.65	0.47	0.41	0.89	0.60	0.73	1.33	0.18	0.63	0.81
N_1	0.47	0.37	0.84	0.57	0.53	1.10	0.71	0.89	1.58	0.35	0.78	1.13
N_2	0.59	0.62	1.21	0.65	0.89	1.55	0.80	1.55	2.35	0.63	1.30	1.93
N_3	0.65	0.68	1.29	0.73	0.96	1.69	0.86	1.58	2.43	0.65	1.48	2.13
SE±	0.015	0.008	0.014	0.013	0.013	0.016	0.015	0.022	0.025	0.009	0.016	0.018
CD@ 5%	0.043	0.022	0.041	0.37	0.039	0.047	0.045	0.066	0.073	0.026	0.046	0.054
Potassium levels												
K_0	0.46	0.44	0.91	0.56	0.58	1.14	0.68	0.95	1.63	0.41	0.91	1.32
K_1	0.52	0.48	1.0	0.61	0.72	1.33	0.74	1.23	1.97	0.46	1.06	1.51
K_2	0.57	0.53	1.10	0.66	0.80	1.46	0.81	1.38	2.17	0.49	1.19	1.68
SE±	0.013	0.007	0.012	0.011	0.011	0.014	0.013	0.019	0.022	0.008	0.014	0.016
CD@ 5%	0.037	0.019	0.036	0.032	0.034	0.041	0.045	0.057	0.064	0.023	0.040	0.047
Interaction (NxK)												
SE±	0.025	0.013	0.024	0.022	0.023	0.028	0.027	0.039	0.043	0.016	0.027	0.032
CD@ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=non-significance, S=significance

Potassium increases the chlorophyll content of functional leaves significantly during the early and middle growth stage of plant, this might be due to potassium plays a crucial role in maintenance of tissue water relation aids to photosynthesis and enhances protein synthesis resulting in better foliage growth. Similar results were also reported by Singh & Lal[14] in sweet potato crop, and Seadh *et al.*[15] in sweet potato.

Increased total chlorophyll content was significantly more at early and middle growth stage of plant nevertheless declined in the late growth stage this may be due to decreased potassium availability in late growth stage of the plant as reported by Hongjvan *et al.*[6] in sweet potato. The interaction effect of nitrogen and potassium was found non- significant for leaf total chlorophyll (a+b) content in sweet potato leaves.

Effect of nitrogen on tuber yield

Among the different graded levels of nitrogen at nitrogen level N_3 (125 kg N ha^{-1}) was found significantly more for producing maximum tuber yield (22398 kg ha^{-1}) over rest of the treatments and at par with N_2 level (100 kg N ha^{-1}). Minimum weight of tuber (11411 kg ha^{-1}) was found in N_0 level (control).

The increased tuber weight in response to the fertilizer supply increase could be attributed to more luxuriant growth, more foliage and leaf area and higher supply of photosynthates, which may have induced formation of bigger tubers there by resulting in higher yield were also reported by Patricia and Bansal[10].

The significantly higher total yield of tubers were obtained with application of higher dose of nitrogen would have helped in increasing tuber size, number of tubers and development of tubers resulted in higher production of tuber. Similar results were also observed by Sanjana *et al.*[13] in potato Alfred *et al.*[1] in sweet potato. Satapathy *et al.*[12] recorded the highest tuber yield of (15.91 t ha^{-1}) in the application of 100 kg N ha^{-1} in sweet potato.

Effect of Potassium on tuber yield

Among the effect of potassium, potassium K_2 level (100 kg K_2O ha^{-1}) produce significantly more tuber weight at end of harvest (19597 kg ha^{-1}), over rest of the treatments and it was par (18825 kg ha^{-1}) with K_1 level (75 kg K_2O ha^{-1}) for producing weight of tuber per hectare. Minimum weight of tuber (16834 kg ha^{-1}) noted in K_0 level.

The increment in tuber yield due to fertilizing the sweet potato plant with a rate of 100 kg/ha may be due to attributed to increase in vegetative growth characteristics i. e, number of leaves and leaf area, subsequently enhancing photosynthesis and improving the translocation and accumulation of carbohydrates in the tubers, Similar results were also observed by El- Sawy[3] in sweet potato. The interaction effects of nitrogen and potassium levels are able to gain the level of significance. This may be due the positive interaction between nitrogen and potassium in soil. Potassium influence on the crop yield can also be indirect as a result of its positive interaction with other nutrients especially N[18].

Table: 3 Interaction effects of graded levels of nitrogen and potassium on tuber yield of sweet potato

Levels	K_0	K_1	K_2	Mean
N_0	6944	12977	14311	11411
N_1	13983	17277	18294	16518
N_2	20044	21922	22522	21496
N_3	20811	23122	23261	22398
Mean	15445	18825	19597	
	SE±	C.D. @ 5 %		
N	407	1193		
K	352	1034		
Interaction (NxK)	705	2067		

Fig. 1: Effect of graded levels of nitrogen and potassium on sweet potato yield (kg ha^{-1})

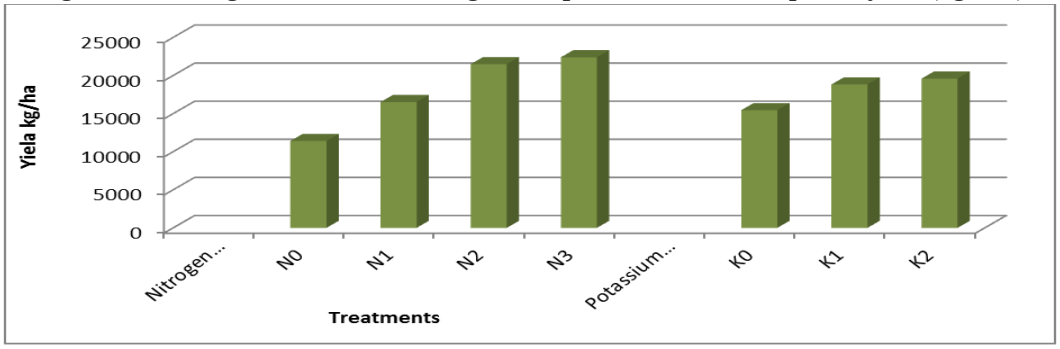
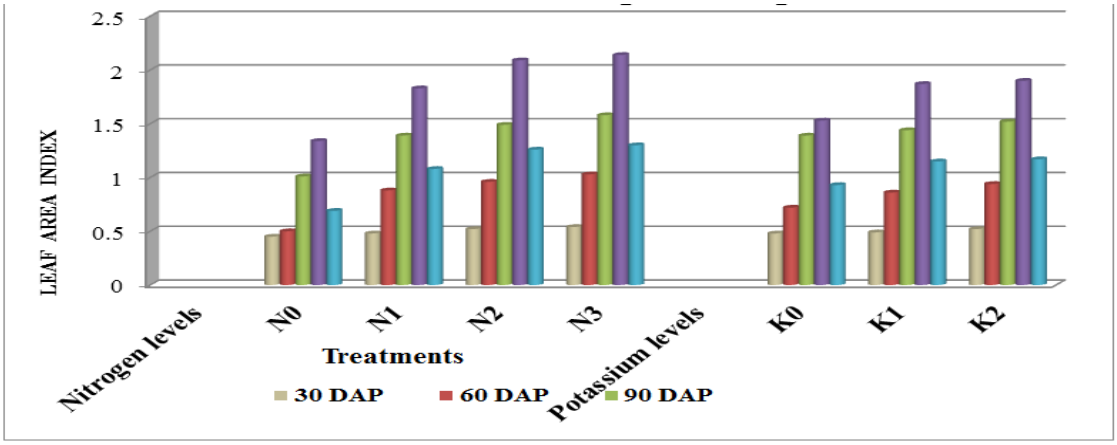


Fig. 2: Leaf area index of sweet potato as infuenced by N and K levels at different growth stages



CONCLUSION

The obtained results under the present condition recommended that applying the 125 kg N ha^{-1}along with 100 kg K_2O ha^{-1} recorded significantly higher leaf area index and leaf chlorophyll content in earlier growth stage of sweet potato. Similar trend was observed in case of yield of sweet potato.

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