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Influence of graded levels of nitrogen and potassium on root rhizosphere soil properties and yield of sweet potato (*Ipomoea batatas*. L.) in vertisols of Maharashtra

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Abstract
This study evaluated the influence of graded levels of nitrogen and potassium fertilizer on soil properties of sweet potato (*Ipomoea batatas* L.). 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). The experiment was laid in factorial randomized block design with three replications and twelve treatments. The treatment consisted of 4 levels of nitrogen (0, 75, 100, & 125 kg ha^{-1}) and 3 levels of potassium (0, 75, & 100 kg ha^{-1}) were used. The application of N (125 kg ha^{-1}) and K (100 kg ha^{-1}) fertilizer significantly increased yield and soil properties like organic carbon content, $CaCO_3$ and available nitrogen, phosphorous, potassium and sulphur status and also micronutrient status in root rhizosphere of sweet potato were significantly increased with the treatments as compared to control, there is no significant difference in p^H and EC of soils of root rhizosphere of sweet potato.

Keywords: Sweet potato, nitrogen, potassium, root rhizosphere soil

Introduction

Sweet potato is an important starchy food crop in the world. It is dicotyledonous plant belongs to the family convolvulaceae crop grown in tropical and subtropical countries. In India it is cultivated in almost all the states and largely grown in three states Orissa, Uttar Pradesh, and West Bengal. One of the major constraints to sweet potato production in India is low soil fertility status. Sweet potato being a high nutrient mining crop it needs higher amount of N, P and K for its economic tuber production as well increases soil properties. In order to achieve high yield, Sweet potato requires semi arid weather, reasonable amount of nitrogen (N), phosphorus (P) and potassium (K) in the soil. Production in Maharashtra poor farming practices, lack of soil moisture content, pests and poor soil fertility since little has been done to determine the most appropriate combination rate for optimum sweet potato yield. This study is focused on soil fertility management using inorganic fertilizers. Nitrogen, phosphorus and potassium are essential macro elements. Chemical fertilizers are commonly used to improve soil fertility (FAO, 2000) [3]. However, the effect of chemical fertilizer on highly weathered, low organic matter and nutrient poor soil without any compensatory organic input sources has been reported to have limited residual effects (Okigbo, 2000) [6]. Nitrogen is most important major plant nutrient; it helps for growth and development of crop. It absorb in the form of ions (NH_4^+, NO^-_3) through the roots or leaves and incorporate it in organic matter throughout the whole growing season by transforming the mineral into an organic form. Exchangeable K plays an important role in soil plant availability. K from mica contributes a part of soil potassium. Because of low replenishment widespread deficiency of potassium has been reported in many of the intensively cultivated soils and hence K application through fertilizers has been responding satisfactorily (Asawalam and Onwudike 2011). Therefore we conducted this experiment with the objective of evaluating the response of nitrogen and potassium on yield and root rhizosphere soil properties of sweet potato.

Materials and Methods

The field experiment was conducted in College of Agriculture Latur farm during the *kharif* season 2015-2016. These experiment was laid out in factorial randomized block design with three replications and 12 treatments. Factors includes nitrogen fertilizer levels (0, 75, 100, 125 kg/ha) potassium fertilizer levels (0, 75, 100 kg/ha) with 3 replication of different combination of levels. Total number of plots are 36, size 3 x 2 m^2 with spacing 60 cm x 20 cm with local variety. Application of fertilizer at time of planting, full dose of potassium and RDF of phosphorous was given and half dose of nitrogen is given to time of planting and reaming was give at 30 DAP. Soil samples were taken before crop planting and after crop harvest to observe nutrient status in the soil. Collected soil samples were air dried and passed through 2 mm sieve and stored for analysis. Soil pH was measured in soil water paste ration of 1:2.5 and measured with combined glass electrode. Nitrogen was analyzed by Micro-Kjeldahl methods and available P_2O_5 by Bray P-1 method. Available K was extracted by 1N neutral ammonium acetate solution and detected through flame ignition.

Initial soil sample were collected and analyzed. Soil properties *viz.* clayey in texture, low in available nitrogen (275.98 kg ha^{-1}), medium in available phosphorus (15.75 kg ha^{-1}), very high in available potassium content (559.58 kg ha^{-1}) and neutral to alkaline in reaction having p^H (7.95) and EC (0.38 ds/m), $CaCO_3$ (85.42 g/kg) and very low in organic matter (3.80 g/kg) content in soil. Data recorded on yield and soil properties 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.

Result and Discussion

Yield

As regard the yield of sweet potato (Table-1) significantly highest in the graded level of nitrogen at 125 kg ha^{-1}. The tuber yield of sweet potato was recorded the highest (22.39 q ha^{-1}) in 125 kg /ha N_3 and it was on par with N_2 (100 kg/ha) and lowest tuber yield (11.41 q ha^{-1}) was recorded in N_0 level. This fertilizer effect might be due to application of higher dose of nitrogen would have helped in increases growth and higher supply of photosynthesis may increases tuber weight. Similar result was also observed by Sanjana *et al*. 2014 [7]. Different levels of potassium fertilizer application among this K_2 @ 100 kg/ha K_2O was recorded significantly heights sweet potato tuber yield (19.59 q ha^{-1}) and it was on par with K_1 @ 75 kg/ha and lowest tuber yield noted in control. This may be due to positive response shown by yield characters to K could be directly linked by well development of photosynthetic and increased physiological activities leading to more assimilates and improver the translocation accumulation of sugars in development of tubers.

The interaction effect of N and K was significant in the tuber yield of sweet potato. The N_3 x K_2 interaction shows significant effect on both tuber yield (23.26 q ha^{-1}) and par with N_3 x K_1, N_2 x K_2, N_2 x K_1 but significantly superior over rest of the interactions. Lowest yield observed in N_0 x K_0 this might 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. Potassium along with N plays a major role in growth and yield as it is involved in assimilation, transport and storage time of photosynthates reported by (Susan Johan *et al* 2013) was reported the effect of N: K interaction in cassava yield.

Table 1: Effect of graded levels of nitrogen and potassium on yield of sweet potato

Treatments (levels)	Weight of tuber plot (kg ha^{-1})	Yield (q ha^{-1})
Nitrogen levels		
N_0	6.85	11.411
N_1	9.91	16.518
N_2	12.89	21.496
N_3	13.44	22.398
SE±	0.24	4.07
CD @ 5%	0.72	11.93
Potassium levels		
K_0	9.27	15.447
K_1	11.30	18.825
K_2	11.76	19.597
SE±	0.21	3.52
CD@ 5%	0.62	10.33
Interaction (N x K)		
SE±	0.42	7.05
CD@ 5%	1.24	20.67

Effect of nitrogen and potassium on root rhizoshphere soil properties of sweet potato

Available nutrient status

Significant differences in soil chemical properties such as soil pH, organic matter, soil available nitrogen, available phosphorus, available sulphur and exchangeable calcium and magnesium were evident. Application of N @ 125 kg/ha and K @100 kg/ha increases soil organic matter content from 3.90 g/kg to 5.9 g/kg and 4.10 g/kg to 4.6 g/kg respectively due to residual effect of sweet potato crop. It is long duration and higher biomass production to increases the organic matter in soil. Application of mineral fertilizer did significantly increases the available nutrient status like N, P, K and S and also enhances the exchangeable Ca and Mg nutrient status. Available nutrients *viz,* N, P, K, S and exchangeable Ca and Mg were analyzed from representative soil samples collected from each plots after the harvest of sweet potato crop around the root rhizosphere. From the different graded levels of nitrogen application of 125 kg ha^{-1} (N_3) observed significantly higher content of available N (276.56 kg ha^{-1}), P (23.28 kg ha^{-1}) and K (544.78 kg ha^{-1}) than the rest of the treatments followed by the nitrogen level 100 kg ha^{-1} (N_2). The data further revealed that available N, P and K contains in soil was increase with increased levels of nitrogen. Poor fertility status was observed in control plot as compared to other treatments.

Table 2: Effect of graded levels of nitrogen and potassium on root rhizosphere soil properties of sweet potato

Treatments (levels)	p^H	EC (dSm^{-1})	$CaCO_3$ (g /kg)	OC (g /kg)
Nitrogen				
N_0	7.70	0.30	79.0	3.90
N_1	7.82	0.33	89.8	4.10
N_2	7.84	0.35	92.20	4.30
N_3	7.83	0.36	95.42	5.9
SE±	0.031	0.02	2.20	0.14
CD @ 5%	NS	NS	S	S
Potassium				
K_0	7.79	0.33	86.7	4.10
K_1	7.79	0.34	93.2	4.30
K_2	7.83	0.32	95.80	4.6
SE±	0.027	0.018	1.80	0.13
CD@ 5%	NS	NS	S	S
Interaction NxK				
SE±	0.053	0.035	3.80	0.25
CD@ 5%	NS	NS	NS	NS
Initial soil status	7.95	0.38	85.42	3.80

As compared with initial soil sample of N, P & K which were significantly increases after harvesting of crop due to residual effect of nutrients and crop residues. Among the different graded levels of fertilizers the treatment K_2 (100 kg ha^{-1}) recorded significantly higher values for available N (231.83 kg ha^{-1}), P (21.86 kg ha^{-1}), and K (471.17 kg ha^{-1}) followed by the treatment K_1 (75 kg ha^{-1}).

Application of essential nutrients in adequate amount through fertilizer to the crop helps in growing crops but also there is enhancement in the availability of nutrients in soil. Generally the availability of nutrients in soil was increased with increase fertilizer levels to crop attributed to NPK alone, might be due to decomposition of organic matter and mineralization of nutrients. Similar results were also noted by Agbede (2010) [2] in sweet potato. Laxminarayana *et al.* (2011) [4] confirmed that addition of nitrogenous fertilizer tends to increases the availability N status of the soil by 22 %, 39 %, & 56 % in respect of 50 %, 100 % & 150 % NPK over control.

Potassium is a mobile nutrient and does not remain in the soil for long after released from the reverse. Higher rate of application K has higher chance of fixation than application of little, Sachneider (1997). Increases in the available phosphorous content of the soil attributed by decomposition of organic manure which could have enhanced the liable in the soil by complexing Ca, Mg and Al, Subramanian and Kumaraswamy (1989) [4].

Table 3: Effect of graded levels of nitrogen and potassium on available nutrient status of root rhizosphere soil of sweet potato

Treatments (levels)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Available S (mg/kg)	Exchangeable Ca (meq/100 g)	Exchangeable Mg (meq/100 g)
Nitrogen						
N_0	133.60	19.37	397.20	10.60	20.80	10.41
N_1	202.67	20.54	405.33	12.53	21.30	10.65
N_2	259.09	21.95	513.74	13.26	21.93	10.97
N_3	276.56	23.28	544.78	13.43	22.82	11.41
SE±	5.779	0.34	10.546	0.29	0.22	0.11
CD @ 5%	S	S	S	S	S	S
Potassium						
K_0	199.52	20.39	396.95	12.84	21.37	10.68
K_1	222.59	21.60	452.67	12.01	21.41	10.71
K_2	231.83	21.86	471.17	13.77	22.36	11.19
SE±	5.00	0.29	9.133	0.26	0.19	0.095
CD@ 5%	S	S	S	S	S	S
Interaction NxK						
SE±	10.01	0.59	18.27	0.52	0.37	0.19
CD@ 5%	NS	NS	NS	NS	NS	NS
Initial soil status	275.98	15.75	559.58	12.30	20.10	10.48

It was also evident that application of phosphorus in conjunction with nitrogen improved the available nitrogen status of the soil as compared to the application of N alone. Among the inorganic fertilizer, continuous application of N and P had depressive effect on the available K content of the soil which may be due to nutrient imbalance in soil, Ismail and Abu (2009) [5].

Secondary nutrients *viz*, Ca, Mg, and sulphur were also analyzed from representative soil samples collected from each plots after the harvest of sweet potato crop around the root rhizosphere and their analytical results are presented in table (3) and depicted in the data. Secondary plant nutrient status revealed that the nitrogen and potassium graded levels significantly affected and exchangeable Ca, Mg and available sulphur in root rhizosphere soil.

Among the different graded levels of nitrogen application of nitrogen 125 kg ha^{-1} (N_3) observed significantly higher content of available S (13.43 mg kg^{-1}), exchangeable Ca (22.82 meq100^{-1} g) and exchangeable Mg (11.41 meq 100^{-1}g) than the rest of the treatments and it was followed by the nitrogen level 100 kg ha^{-1} (N_2), The data further revealed that available S, exchangeable Ca and exchangeable Mg contains in soil was increase with increased levels of nitrogen. Poor fertility status was observed in controlled plot as compared to other treatments. More over application of N & K increases the exchangeable Ca and Mg content in soil than initial status of soil.

Among the fertilizer levels the treatment K_2 (100 kg ha^{-1}) recorded significantly higher values for available S (13.77 mg kg^{-1}), exchangeable Ca (22.36 meq 100^{-1}g), and exchangeable Mg (11.19 meq 100^{-1}g) followed by the treatment K_1 (75 kg ha^{-1}), Very low available S, exchangeable Ca and Mg was observed in K_0 (control) plots. This may be due to the residual effect of sweet potato crop and fertilizer effect in the soil. Similar result was reported by Agbede (2010) [2] in sweet potato the application of N, P & K increases the Ca & Mg content in the soil but it will decreases the soil p^H.

Effect of nitrogen and potassium levels on available micronutrients in root rhozosphere

Soil available micronutrients status *viz.*, Fe (5.53 ppm), Zn (0.83 ppm), Cu (1.06 ppm) and Mn (4.40 ppm) were recorded in application of 125 kg N /ha significantly higher micronutrient availability followed by 100 kg N /ha than control, micronutrient content in root rhizosphere soil was increased with increased levels of nitrogen. In potassium application @ 100 kg/ha were significant higher available status of Fe (4.80 ppm), Zn (0.77 ppm), Cu (0.96 ppm) and Mn (4.09 ppm) followed by application of 75 g//ha potassium over control. This might be due to the residual effect of sweet potato crop and fertilizer after harvesting of crop and positive interaction with macro and micronutrients in the soil. Due to neutral pH of soil, there might be a favorable micronutrient activity resulting in release of organic acids to increase the availability of micronutrients. The result are in conformity with Yogananda *et al.* (2004) [10], Similar result also fund by Abd *et al*. (2011) [1] in potato.

Table 4: Effect of graded levels of nitrogen and potassium on micronutrient status in root rhizosphere soil of sweet potato

Treatments (levels)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Nitrogen				
N_0	3.83	0.63	0.79	3.64
N_1	4.27	0.71	0.91	3.89
N_2	4.68	0.78	0.94	4.02
N_3	5.53	0.83	1.06	4.40
SE±	0.080	0.013	0.019	0.058
CD@ 5%	S	S	S	S
Potassium				
K_0	4.39	0.70	0.88	3.89
K_1	4.55	0.74	0.93	3.99
K_2	4.80	0.77	0.96	4.09
SE±	0.070	0.012	0.016	0.05
CD@ 5%	S	S	S	S
Interaction (NxK)				
SE±	0.14	0.023	0.032	0.10
CD@ 5%	NS	NS	NS	NS
Initial status	4.21	0.65	0.90	4.13

NS – non significant, S - significant

Conclusion

Application of inorganic fertilizer in improving soil chemical properties of root rhizosphere soil of sweet potato crop should be fertilized with 125 Kg N $ha^{-1}$and 100 Kg K_2O ha^{-1} were improves the soil fertility status of soils and also yield of sweet potato.

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