GROWTH AND YIELD OF SWEET POTATO AS INFLUENCED BY DIFFERENT POTASSIUM LEVELS IN THREE SOIL TYPES

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ABSTRACT

Both silt loam and sandy loam media were significantly superior than clay loam in enhancing the length of vines and increasing the number of nodes and branches produced on the primary vines of sweet potato plant. Plants grown in silt loam produced the highest average weight of marketable tubers at 0.499 kg/pot, while those in clay loam had the lowest (0.453 kg/pot). In general, there was an increased response of sweet potato as the potassium levels in the soil were increased. This was manifested by longer vines, more nodes produced on the primary vines, and more secondary branches. The highest weight of marketable tubers (0.5688 kg/pot) was obtained at 600 ppm K, while the lowest (0.3606 kg/pot) in the control. Interaction effects of soil types and potassium levels were significant on the growth and yield of sweet potato. Interactions between silt loam and sandy loam media with the 4 potassium levels were found to be significantly better than the interaction effects of clay loam and the 4 potassium levels.

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KEY WORDS: Sweet potato. Soil type. Sandy loam. Clay loam. Silt loam. Soil fertility. Potassium level. Growth and yield.

INTRODUCTION

The growth and yield of sweet potato depend on the kind of nutrients present in the soil. Among the different nutrient elements present in the soil, potassium is greatly needed since it is important in the development of tuberous roots. Fujise and Tsuno (1967) noted that potassium greatly affects the dry matter production of sweet potato. Epstein (1972) also cited that potassium indirectly affects the translocation of photosynthates from the leaves. Some researches further revealed that potassium is somewhat responsible for the closing and opening of the stomata in the leaves.

Although sweet potato is adaptable under both dry and rainy season, its growth and yield vary under different types of soil. Soils differ in their physical and chemical properties such as tilth and nutrient supplying capacity. Thus, for good growth of sweet potato, the soil must possess physical characteristics that would allow rapid root extension and tuber enlargement. In addition, it must contain sufficient amounts of nutrient elements, especially potassium.

This study was conducted to investigate the effects of soil types on the yield of sweet potato, determine the K level (inherent in and applied to the soil) required for optimum yield of sweet potato, and study the interaction effects of soil types and K levels on the growth and yield of sweet potato.

MATERIALS AND METHODS

Soil Types. — The 3 soil types used were procured from 3 different locations in ViSCA. A composite soil sample was taken from each of these lots for analysis before the crop was planted. Samples were analyzed at the PRCRTC Soil Laboratory and at the Bureau of Soils at Tacloban City for nitrogen, phosphorus, potassium, pH, and organic matter content (Table 1).

Preparation of the Soil Media for Potting. — The 3 different soils were collected by digging a layer of soil at least 6 in. deep. The soil media were placed in polyethelene bag (18 x 18 x 0.006 in.) previously perforated at the side to allow drainage. Each bag contained 10 kg air-dried soil.

Table 1. Some important chemical properties of the three soil types used in the experiment.

Soil Type	OM (%)	Mineralizable N (ppm)	Exchangeable K (ppm)	Available P (ppm)	pH	Crop previously grown
Sandy loam	1.5	1500	240	43	6.5	tomato & eggplant
Silt loam	2.0	2000	410	45	6.0	sweet potato
Clay loam	2.5	2500	227	31	4.7	rice

Experimental Design Lay-Out. — A 4 x 3 factorial in a completely randomized design replicated 10 times was used. A total of 120 polybags were placed in an open area at a distance of 100 cm between bags following the square method. An alleyway of 1 m in each side of the experimental area was provided. Thus, the experimental site had a total land area of 210 sq m.

Application of Fertilizer. — The different nutrients needed by the plants like N, P, K, Ca, Cl, and S elements were supplied to the soil by adding the following fertilizers:

	Elements					
Fertilizer	N	P	K	Ca	S	Cl
Urea	46	—	—	—	—	—
Solophos	—	7.7	—	23.7	12.6	—
Muriate of potash	—	—	52.7	—	—	47.3

The estimated concentrations of nitrogen, phosphorus, and potassium in the soil media were put in the same levels with the application of commercial fertilizers. The rate of K application was based on the analysis of the least fertile soil type used. The different K levels used were designated as:

Level I - without added K
Level II - 450 ppm
Level III - 525 ppm, and
Level IV - 600 ppm K.

The amounts of nitrogen and phosphorus elements were kept constant in all treatment combinations by adding the appropriate amount and kind of commercial fertilizers before planting. Table 2 shows the estimated amounts of NPK inherent in the soil and the added amounts while the estimated elemental concentrations in the various soil types before and after applications are shown in Table 3.

RESULTS AND DISCUSSION

Vegetative Growth in Relation to Soil Fertility

Length of Vine (cm).

Plants grown in silt loam were significantly taller than those grown in sandy loam and clay loam, while those grown in sandy loam produced longer vines than those developed under clay loam (Table 4). The production of shorter vines by plants grown under clay loam could perhaps be partly attributed to the very low amount of native potassium in the soil.

Among the 4 levels of potassium, soils with 600 ppm K produced significantly longer vines than the rest. Plants grown in soils with 450, 525, and 600 ppm K were significantly superior than the control (with only the inherent K present in the soil). These results strongly indicate that application of potassium fertilizers accelerate the growth of sweet potato vine.

Of the 12 treatment combinations, clay loam with no K added

Table 2. Estimated amount of some nutrients present in and added to the soil.

Nutrient level/ Soil Type	Nutrient elements		
	Mineralizable N (ppm)	Available P (ppm)	Exchangeable K (ppm)
		Amount inherent in soil	
Level I			
Sandy loam	1500	43	240
Silt loam	2000	45	410
Clay loam	2500	31	227
		Amount added to soil	
Level II			
Sandy loam	1300	12	210
Silt loam	800	10	40
Clay loam	300	24	223
Level III			
Sandy loam	1300	12	285
Silt loam	800	10	115
Clay loam	300	24	298
Level IV			
Sandy loam	1300	12	260
Silt loam	800	10	190
Clay loam	300	24	273

supported plants with the shortest vine while silt loam with 600 ppm K produced the longest vine (Table 5). It may be noted that plants grown in silt loam and applied with different levels of K consistently produced longer vines than those grown in the other 2 soil types. This could be due to chemical properties of the silt loam which was comparatively better than that of the other 2 soil types. Sandy loam had lower organic matter content and lesser amount of available phosphorus, while clay loam had very low pH aside from its inherently low phosphorus.

Number of Nodes.

The highest average number of nodes was noted in sandy loam, which significantly differed from silt loam and clay loam medium at 1% and 5% level of significance, respectively (Table 4). Apparently, the production of fewer nodes on the primary vines by plants grown under clay loam could be attributed to its poor soil condition. It may be noted that plants grown in sandy loam had more nodès than those in silt loam, but the vines of the plants grown in the former were shorter than those from the latter. Thus, it may be

Table 3. Estimated elemental concentrations in the soil types before and after fertilization.

Soil Type	Nutrient elements: Mineralizable N (ppm)	Available P (ppm)	Exchangeable K (ppm)
		Before Fertilization	
Level I			
Sandy loam	1500	43	240
Silt loam	2000	45	410
Clay loam	2500	31	226
		After Fertilization	
Level II			
Sandy loam	2800	55	450
Silt loam	2800	55	450
Clay loam	2800	55	450
Level III			
Sandy loam	2800	55	525
Silt loam	2800	55	525
Clay loam	2800	55	525
Level IV			
Sandy loam	2800	55	600
Silt loam	2800	55	600
Clay loam	2800	55	600

inferred that vines of sweet potato tend to have longer internodes when planted in silt loam soil.

The greatest average number of nodes was produced at 600 ppm K. Analysis of variance showed highly significant differences among potassium levels, suggesting that the production of nodes was influenced by the amount of potassium in the soil. However, an amount of 450 ppm K in the soil appeared to be already optimum for node production.

Results of the interaction effects between soil type and potassium levels indicate that regardless of soil types, the number of nodes produced on the primary vines significantly increased with potassium levels except in clay loam with 525 ppm K (Table 6). However, the general trend seem to indicate that the amount of 450 ppm potassium was already sufficient to effect production of an optimum number of nodes in clay loam and sandy loam media. An amount of 525 ppm K, however, appeared to be maximum for silt loam.

Table 4. Effect of soil type and potassium level on the yield component and other agronomic characters of sweet potato (BNAS-51).

Treatment	Length of Vine (cm)	Number of Nodes	Number of Branches	Marketable Tubers		Non-marketable tubers		Fresh Weight of vines (kg/pot)
				Number	Wt. (kg/pot)	Number	Wt. (kg/pot)	
Soil Type								
Clay loam	311.44 c	50.4 c	11.44 b	1.85	0.453 c	1.70	0.0186	2.770
Sandy loam	332.10 b	62.1 a	13.05 a	1.95	0.461 b	1.75	0.0187	2.800
Silt loam	357.53 a	59.1 b	13.47 a	1.80	0.499 a	1.70	0.0191	2.795
Potassium Level (ppm)								
I - (inherent)	294.23 d	52.6 c	10.97 b	1.77	0.361 d	1.73	0.0190	2.810
II - (450)	340.33 b	57.2 b	13.83 a	1.79	0.465 c	1.77	0.0187	2.896
III - (525)	338.37 c	58.7 a	13.63 a	1.83	0.490 b	1.67	0.0186	2.720
IV - (600)	361.83 a	60.2 a	13.20 a	1.97	0.568 a	1.70	0.0189	2.740
HSD								
Soil type								
.05	17.22	2.72	1.42	ns	0.012	ns	ns	ns
Potassium level								
.05	20.68	3.27	1.70	ns	0.014	ns	ns	ns
Interaction Effect								
.05	25.25	3.99	2.08	0.536	0.018	0.185	0.008	0.255

Note: All values having the same letters are not statistically significant at 5% level using DMRT.

Number of Branches.

Both silt loam and sandy loam media significantly produced more branches than the clay loam (Tables 4 and 7). This result strongly suggests that the production of branches in sweet potato is influenced by soil type. This finding confirmed the report of Cadiz and Gabucan (1964) that sweet potato grows best in silt loam that is well drained, mellow, loose, and rich in organic matter. The poor growth of plants grown in clay loam could partially be attributed to the relatively low native fertility level, low pH and poor soil structure of the medium. Clay loam was observed to be more compact than the other two growth media. Compact soils tend to inhibit root elongation, thereby limiting plant growth.

As to the effect of potassium, a level of 450 K caused the development of the highest average number of branches. This result indicates that the response of sweet potato to potassium established its peak at 450 ppm with respect to the production of branches.

In general, results indicate that regardless of soil type, potassium application enhances the production of branches in sweet potato.

Yield Components as Affected by Soil Types, Potassium Levels and Interaction Effects

Weight of Marketable Tubers (kg/pot).

Plants grown in silt loam had the highest average weight of marketable tubers (Table 4). This result clearly manifested that the formation of marketable tubers in sweet potato is considerably influenced by soil type. The production of more tubers under silt loam could be attributed to the high initial potas-

Table 5. Average increase in length of vine (cm) as affected by soil type and potassium level.

Soil Type	Potassium Level				
	I	II	III	IV	Mean
Clay loam	251.40g	340.30bcd	312.90ef	341.15bcd	311.44
Sandy loam	294.75f	334.25de	337.55cde	361.85abc	332.10
Silt loam	336.55de	346.43bcd	364.65ab	382.50a	357.53
Mean	294.23	340.33	338.37	361.83	

		Soil Type	Potassium Level	Interaction
HSD	0.05	17.22	20.68	25.25
	0.01	22.79	25.89	30.05

Note: All values having the same letters are not statistically significant at 5% level using DMRT.

Table 6. Average increase in the number of nodes on the primary vines as affected by soil type and potassium level.

Soil Type	Potassium Level				
	I	II	III	IV	Mean
Clay loam	44.8g	52.1ef	50.1f	54.7de	50.425
Sandy loam	58.7bc	63.3a	63.8a	62.6ab	62.100
Silt loam	54.4de	56.3cd	62.2ab	63.4a	59.075
Mean	52.63	57.23	58.70	60.23	

		Soil Type	Potassium Level	Interaction
HSE	0.05	2.72	3.27	3.99
	0.01	3.60	4.50	4.75

Note: All values having the same letters are not statistically significant at 5% level using DMRT.

sium level in silt loam that could sufficiently supply an adequate amount of potassium to the crop for optimum tuber production.

The highest weight of marketable tubers was obtained with application of 600 ppm potassium while the lowest was obtained in the inherent level. These findings indicated that the weight of marketable tubers was substantially increased as the amount of potassium was increased up to maximum level. These results clearly emphasized that greater amount of potassium is needed for tuber formation, than for vegetative growth in sweet potato.

Interaction effects also significantly influenced the yield of marketable tubers (Table 8). Increasing tuber yield at increasing levels were observed under both sandy and clay loam media. In silt loam, however, the result obtained was different from those of the other two soil types, which could be attributed to its inherently high potassium content.

The above results implied that the response of sweet potato to potassium fertilization varies with soil type in terms of tuber weight. It may be inferred that application of potassium fertilizers in sweet potato may not be necessary if the soil (especially silt loam) contains an inherently large amount of exchangeable potassium.

Weight of Non-Marketable Tubers (kg/pot).

Statistical analysis revealed that soil type and potassium level did not significantly affect the growth and yield of sweet potato tubers (Table 4).

Number of Marketable and Non-Marketable Tubers.

Both soil type and fertilization failed to show any significant effect on the number of marketable and non-marketable sweet potato tubers (Table 4). This suggested that the effects of the 3 soil types and 4 potassium levels were manifested greatly on size and weight of tubers rather than on number. A similar observation was reported in cassava by Ngongi, *et al.* (1977) wherein potassium fertilization did not have any significant effect on the number of storage roots per plant.

Fresh Weight of Vines (kg/pot).

Statistical analysis confirmed that soil type and potassium level

Table 7. Average number of branches produced per plant as affected by soil type and potassium level.

Soil Type	Potassium Level I	II	III	IV	Mean
Clay loam	9.3g	13.1bcd	11.0efg	12.1cdef	11.40
Sandy loam	10.7fg	13.8abcd	15.8a	11.9def	13.05
Silt loam	12.9bcde	14.6ab	14.1abc	12.5cdef	13.47
Mean	10.97	13.83	13.63	12.20	

	Soil Type	Potassium Level	Interaction
HSD 0.05	1.42	1.70	2.08
0.01	1.88	2.13	2.48

Note: All values having the same letters are not statistically significant at 5% level using DMRT

Table 8. Average weight of marketable tubers as affected by soil type and potassium level (kg/pot).

Soil Type	Potassium Level				
	I	II	III	IV	Mean
Clay Loam	0.234j	0.313h	0.834b	0.424f	0.453
Sandy loam	0.123k	0.467c	0.348q	0.912a	0.461
Silt loam	0.725c	0.621d	0.288i	0.365q	0.499
Mean	0.361	0.465	0.490	0.568	

		Soil Type	Potassium Level	Interaction
HSD	0.05	0.012	0.014	0.018
	0.01	0.016	0.018	0.021

Note: All values having the same letters are not statistically significant at 5% level using DMRT.

did not significantly affect the production of vines as in the other yield parameters measured (Table 4).

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