EFFECTS OF DIFFERENT N:K RATIOS AND NPK LEVELS ON SWEET POTATO

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ABSTRACT

Generally, plants that received NPK fertilizer had better stand than those that did not receive either N or K. However, nitrogen had greater influence than potassium on the vegetative growth of the plant. Root formation and yield were significantly improved as the amount of potassium was increased up to 90 kg/ha with nitrogen at 30 kg/ha. In this treatment where the N:K ratio is 1:3, the highest root yield of 6.52 t/ha was obtained. Altering the N:K ratio from 1:1 to 3:2 led to maximum leaf development and vine elongation while reducing the ratio from 3:2 to 1:3 favored storage root formation.

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KEY WORDS: Sweet Potato. N:K ratio. NPK fertilizer. Herbage yield. Root yield.

INTRODUCTION

Fertilizer application is necessary when sweet potato is continuously grown because of the expected decline in the inherent fertility of the soil. In Japan, Tsuno (1976) reported that sweet potato is a heavy feeder of nutrients especially nitrogen and potassium and that deficiency of these elements alters its growth and development. He also noted that an N:K ratio of 1:3 produced the highest yield of sweet potato. His results showed the importance of K in nitrogen metabolism, in protein synthesis, and in the correction of the detrimental effects of very high rates of P fertilizers. Similarly, Capuno (1977) observed that nitrogen and potassium significantly affected root production.

Due to their increasing cost and scarcity in the local market as a result of importation problems, fertilizers should be properly and wisely used to obtain maximum profit. This study thus aimed to determine the optimal N:K ratio and

NPK level for maximum sweet potato production under local soil conditions.

MATERIALS AND METHODS

An area (fine, mixed, isohyperthermic, aquic Eutropepts) of 784 m^2 was plowed three times. Each plowing operation was followed by harrowing at 1-week interval to hasten decomposition of weeds. A randomized complete block design (RCBD) with four replications per treatment was used. The experimental area was divided into four blocks and each block was further subdivided into eight plots with an area of 20 m^2 each. A 1.5 m alleyway was provided between blocks to facilitate farm operations and management.

The following ιreatments were used:

Treatment	N:K Ratio	Fertilizer Rate (kg NPK/ha)
T_1	1:1 (low)	30-60-30
T_2	1:1 (high)	60-60-60
T_3	1:2	30-60-60
T_4	1:3	30-60-90
T_5	2:3	60-60-90
T_6	3:2	90-60-60
T_7	$Check_1$	00-60-60
T_8	$Check_2$	60-60-00

Healthy tip cuttings of sweet potato (cv. BNAS-51) were planted using the ridge method at a distance of 100 cm between rows and 25 cm between hills with one cutting per hill. Ammonium sulfate (21-0-0), ordinary superphosphate (0-20-0), and muriate of potash (0-0-60) were applied following the rates in the different treatments. The entire amounts of phosphorus and potassium fertilizers were incorporated in the soil during planting. One half of nitrogen was applied at planting and the other half, 1 month later.

A fungicide (Benlate) and insecticides (Furadan and Thiodan) were applied following the manufacturer's recommended rate. Spraying was done at 2-week intervals, starting from the second week after planting up to maturity. Handweeding and cultivation with the use of garden tools were done whenever necessary. Hilling up was performed 1 month after planting, immediately following the last nitrogen fertilizer application.

Leaf area index at harvest was determined using two 1-m^2 quadrats per plot. All fully-opened leaves within the quadrat were measured. The area of each leaf was determined using the formula: leaf area (LA) = width x length x 0.797 (established correction factor for cv. BNAS-51). The leaf area index was computed using the formula:

$$LAI = \frac{\text{Total leaf area}}{\text{Ground area}}$$

All plants in the four middle rows of a six-row plot, excluding border plants in every row, were harvested 127 days after planting. The roots were dug out after cutting the vines at the base, washed, air dried, and classified as marketable or non-marketable depending on size regardless of weevil infestation. Roots classified as marketable were those which were at least 2.5 cm in diameter and 6.5 cm in length. The roots which did not satisfy this size requirement were considered non-marketable.

RESULTS AND DISCUSSION

Agronomic Characters

Leaf Area Index (LAI). An increase in the rate of N and K fertilizer application tended to increase the leaf area indices (Table 1). However, it appears that N had a greater influence on LAI values than K. In the absence of N, LAI was only 3.62 even when P and K were applied at 60 kg each/ha while it was 4.23 when N and P were applied at the same rate in the absence of K. This could be due to the fact that nitrogen is an essential constituent of proteins and its high concentration tends to encourage the production of more and bigger leaf cells leading to an overall improvement in leaf production (Devlin, 1975). The above results suggest that LAI could be improved by increasing the proportion of either N or K in the fertilizer formulation.

Length of Main Vines (m). Sweet potato vines became longer as the N and K levels were increased (Table 1). However, it is apparent that N alone can more effectively enhance vine growth than K alone. Slightly longer vines were produced at 90 kg N/ha than at 90 kg K/ha.

Vine length significantly varied at the different N:K ratios (Table 1). A marked increase was noted when the ratio was increased from 1:1 to 3:2 while a slight decrease was noted with a decreased ratio (3:2 to 2:3).

Fresh Herbage Weight (t/ha). The effect of N and K fertilizers on this agronomic character is the same as on LAI and vine length. This is shown by the significantly higher yield (18.0 t/ha) without K than without N (12.54 t/ha) and by the higher herbage yields with increased N than with increased K. Highest herbage yield (30.56 t/ha) was obtained when 90 kg N/ha was applied while the lowest (12.54 t/ha) was obtained with no N application.

There was a slight and insignificant increase in herbage yield when the N:K ratio was varied from 1:1 to 1:3 or from 1:3 to 2:3. However, herbage yield became significantly higher when the ratio was increased to 3:2. These results suggest that N and K can promote the growth of sweet potato. However, it appears that N has greater effect than K on vine production and consequently on herbage yield. Chang and Tseng as cited by Wang (1975) had the same observation, i.e., vine yield responds significantly to N but minimally to P and K application.

Yield and Yield Components

Number of Marketable Storage Roots Per Hectare. In contrast to herbage yield, storage root production appeared to be less influenced by N fertilization. In fact, the

Table 1. Agronomic characters, yield and yield components of sweet potato as affected by different N:K ratios and fertilizer rates.[1]

Treatment		Leaf Area	Vine	Herbage	Number of Roots/ha x 1000		Weight of Roots (t/ha)	
N:K Ratio	Fertilizer Rate (kg NPK/ha)	Index at Harvest	Length (m)	Weight (t/ha)	Market-able	Non-Marketable	Market-able	Non-Marketable
1:1 (low)	30-60-30	4.18d	3.43de	16.60de	48.83d	63.50e	2.94de	1.81c
1:1 (high)	60-60-60	4.50c	3.51cde	19.17cd	50.17c	67.00de	3.87cd	1.67c
1:2	30-60-60	4.57c	3.82cd	19.73cd	50.83c	74.83cd	4.23bc	1.72c
1:3	30-60-90	4.98b	3.96bcd	20.53bcd	72.50a	103.50a	6.52a	2.68a
2:3	60-60-90	5.18a	4.50ab	25.77b	62.50b	95.00b	4.63b	2.23b
3:2	90-60-60	5.31a	4.78a	30.56a	51.83c	81.83cd	4.33bc	2.43b
$Check_1$	00-60-60	3.62e	3.02e	12.54e	41.00d	60.00e	2.67de	1.79c
$Check_2$	60-60-00	4.23d	3.45de	18.00d	37.50d	51.33f	2.52e	1.79c
C.V. (%)		2.30	9.99	17.84	6.84	6.50	14.77	10.90

[1] Treatment means within a column followed by a common letter are not significantly different at 5% level, DMRT.

number of marketable roots considerably increased at 30 kg N/ha with only a slight increase beyond this level. However, the values obtained became higher as K level was increased up to 90 kg/ha.

The marketable storage roots did not markedly differ in number at N:K ratios of 1:1 and 1:2. Decreasing the ratio from 1:2 to 1:3, i.e. using higher K level, resulted in the production of more roots. Increasing the N:K ratio from 2:3 to 3:2 significantly lowered the number of marketable roots. These observations indicate that the number of marketable storage roots can be increased by keeping N at a minimum (30 kg/ha) and K at a maximum (90 kg/ha), or by using the 1:3 N:K ratio. The results obtained confirm the findings of Capuno (1977) that excessive amounts of N increased top:root ratio and decreased storage root yields.

Potassium is important in the storage root development of sweet potato and other root crops. Obigbesan et al. (1976) reported that potassium application appreciably improved the marketable tuber yield of yams. Ferguson (1970) claimed that potassium markedly affected the yield of yams in his study due to longer bulking duration.

Number of Non-Marketable Storage Roots Per Hectare. The number of non-marketable storage roots significantly increased with increasing K level and reached 103 x 10^3/ha at 90 kg K/ha. The least number of non-marketable storage roots (51 x 10^3/ha) was obtained when K was not applied. The data indicate that K is important in the initiation and development of roots. Potassium induced the development of more storage roots but the proportion of marketable to non-marketable roots was also maintained. This is due to the greater number of physiologic sinks (roots) which compete for the photosynthates manufactured in the leaves.

Weight of Marketable and Non-marketable Storage Roots (t/ha). Highest yield of marketable storage roots (6.52 t/ha) was obtained when 90 kg K and 30 kg N were applied per hectare. When the N:K ratio was decreased from 1:1 to 1:3, the weight of marketable storage roots significantly increased from 3.87 t/ha to 6.52 t/ha. In contrast, root yield was considerably reduced when the N:K ratio was raised from 2:3 to 3:2.

These results show that the N:K ratios that favored the development of vines did not necessarily cause high production of storage roots. Therefore, formulation of fertilizers for sweet potato production should depend upon the purpose of growing sweet potato. If the intention is to produce high storage root yields, more K should be applied with moderate amount of N. A similar finding was obtained by Tsuno (1976) who showed that sweet potato yield was greatly improved by K application. He concluded that sweet potato is a heavy feeder of K and that this element expedites swelling of tuberous roots and improves translocation of photosynthates. Ngongi et al. (1976) also reported that application of K fertilizer in cassava markedly improved the yield of the crop.

LIMITATIONS OF THE STUDY

The area used for this study had clayey soil texture such that water did not easily drain after a heavy rain. As a result, some parts of the experimental area became waterlogged particularly following heavy rains in early August and late September. This factor might have affected the general development of the plants and consequently reduced yields. Moreover, early harvesting of the sweet potato roots at 127 days after planting might have contributed to low yields.

An N:K ratio of 1:3 which appeared optimum for maximum sweet potato production in this study may be specific to areas with similar properties as that of the experimental area used. The said ratio may not be optimum in areas of different native soil fertility and other environmental factors like climate.

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