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Full Length Research Paper

Effect of phosphorus application on growth, yield and yield components of snake tomato (*Trichosanthes cucumerina* L.)

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The experiment was carried out on the teaching and research farm of the University of Agriculture, Abeokuta to determine the effect of phosphorus application rates on growth, yield and yield components of *Trichosanthes cucumerina* L. The experimental design was randomized complete block design with three replicates. The treatments were application of phosphorus at different levels (0, 15, 30, 45 and 60 kgha$^{-1)}$. Phosphorus significantly increased growth, yield and yield components (number of leaves, number of flowers length of main vine etc.) of snake tomato at 15kg/ha up to 30 kg P ha$^{-1,}$ beyond which there was a reduction.

Key words: Phosphorus, snake tomato, *Trichosanthes cucumerina,* yields.

INTRODUCTION

The Food and Agricultural Organization of the United Nations (FAO, 1998) reported that countries of West and Central Africa sub-regions have a large number of under-utilized indigenous edible plant species that are important to the livelihoods of local population. Numerous scientific studies have shown the importance of indigenous edible plants in the nutrition of the rural communities in Africa (Chweya, 1996; Abukutsa-Onyago, 2003; Adebooye, 1996; Adebooye et al., 2001). All over Africa, these traditional food plants have been major sources of nutrition for rural dwellers that cannot pay for milk and egg (Adebooye, 1996). One of such high premium indigenous food plants is *Trichosanthes cucumerina* L. commonly called snake tomato. It is a member of the Cucurbitaceae family, and utilized as a substitute to the Solanaceous tomato (*Lycopersicon lycopersicum* (Karst) due to its sweet taste, aromatic, and deep red endocarp pulp when fully ripe and that the fruit pulp does not go sour as quickly as paste of *L. lycopersicum.* These good qualities have made this plant a substitute to the Solanaceous tomato especially during the off-season when prices of Solanaceous tomato are very high. This suggests that consumption of the fruit may be related to income level. In Nigeria, the common tomato is largely cultivated in the northern parts of the country where environmental conditions and irrigation facilities for cultivation abound. Improved cultivars are cultivated on a large scale in the northern part of Nigeria, while unimproved cultivars of the crop are cultivated on a

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relatively smaller scale in the southern parts of the country (Denton and Swarup, 1983). Supply of fresh tomato fruits of improved cultivars in the southern part of Nigeria is fraught with irregularities and characterized by exorbitant prices. The importance of P as a yield limiting factor in many Nigerian soils is well established (Udo, 1981; Adetunji, 1994b; Adepetu, 1983). Fruits and vegetables of snake tomato are good sources of natural antioxidants for the human diet, containing many different antioxidant components which provide protection against harmful free radicals and have been strongly associated with reduced risk of chronic diseases, such as cardiovascular disease, cancer, diabetes, Alzheimer's disease, cataracts and age-related functional decline in addition to other health benefits (Cao et al., 1996; Knekt et al., 2002). These positive effects are believed to be attributable to the antioxidants, particularly the carotenoids, flavonoids, lycopene, phenolics and ß-carotene (Lavelli et al., 2000). The juice of the leaves and fruits are useful in decongesting of the liver and bilious headache .The fruit is also used as a laxative (Vashista, 1974). The fruit is considered to be anthelmintic, emetic and purgative. Information on cultivation of this substitute, snake tomato may encourage the cultivation on a large scale to reduce dependence on Solanaceous tomato .Cultivation of the common tomato is seasonal especially in the southern part of Nigeria and usually cultivated in the north particularly with irrigation. However, the cultivation of the snake tomato can be done in and out of rainy season in the southern part where the plant can be sustained by the soil moisture invariably throughout the year with little irrigation practice. Information is scanty in the literature on the agronomy of snake tomato, particularly, its nutritional requirements, it is therefore necessary to study the yield response of *T. cucumerina* to different levels of phosphorus fertilizer application.

The objective of this study was to evaluate the effect of rates of phosphorus application on the growth, yield and yield components of snake tomato (*T. cucumerina* L.).

MATERIALS AND METHODS

The experiment was carried out on the teaching and research farm of University of Agriculture Abeokuta, (7ØN, 3° 23'E), Nigeria. The soil type is sandy loam and the weather condition is 25°C. Pre-planting soil test was done to assess the nutrient status of the soil. The soil nutrient status was 0.021%P, 0.067%N and 0.879%K.

The experimental design was laid out in a randomized complete block design (RCBD) with three replicates. The plot size was 6 by 4 m. Each plot separated with a pathway of 0.5 and 1.0 m separated the replicates. The treatments were application of phosphorus at five levels (0, 15, 30, 45 and 60 kg P_20_5/ha), using single super phosphate (18% P_20_5). At 21 days after transplanting, single superphosphate fertilizer was applied according to the treatment as a single dose application. Seedlings of *T. cucumerina L.* were raised in polythene sleeves filled with top soils. At 24 days after sowing (4 to 5 leaf stage), the seedlings were transplanted to a clean manually weeded field at a spacing of 2 by 2 m and 4 plants per row, making up 12 plants per plot. At eighteen days after transplanting (DAT), pole staking were imposed in which a bamboo was put firmly beside each seedling to project 1.6 m above the ground level and vines were trained to climb round the pole. The fertilizer was applied by ring method by scooping a ring 15 cm radius round each stand at a depth of 7 cm. Then the weighed fertilizer was applied at the rate of 0, 15, 30, 45 and 60 kg. Basal application was also done at the rate of 20 kg N/ha in form of urea and muriate of potash. Weeding was done manually at two week interval, commencing from 2 weeks after transplanting (WAT).

Data was collected on growth, yield and yield component commencing from 5 WAT which include dry matter production, number of flowers per plant, number of leaves per plant vine length and number of fruit and fruit yield, fruit diameter and fruit length. The shoots of two plants per plot from the border rows were cut at the ground level and put in a sampling bag for fresh weight measurement. This was then dried in the oven at 70°C to constant weight. Sampling for dry matter production commenced at 5 WAT and continued to 9 WAT at two week interval.

Data collected were subjected to Analysis of Variance (ANOVA) and the treatment means separated using the least significant difference (LSD).Where F values were significant ($p<0.05$).

RESULTS

Table 1 shows the effect of phosphorus on the number of leaves per plant at various weeks after transplanting. At 5 weeks after transplanting (WAT), the *T. cucumerina* given 30 kg/ha of phosphorus fertilizer had higher value than those with higher rates and no P_2O_5 (control). Furthermore, plant with P_2O_5 at 15 and 45 kg/ha had similar number of leaves at 5 and 7 WAT which were significantly more than those of plants treated with 60 kg/haP_2O_5. At 9 WAT, plots with 15 and 30 kg/haP_2O_5 had higher values than those with the other P_2O_5 treatments, while those with 60 kg/ha and no P_2O_5 were similar and lower than those with 45 kgP_2O_5/ha.

In Table 2, effect of phosphorus on vine length at various weeks after planting; the vines of plots treated with 30 kgP_2O_5 kg/ha at 5 to 9WAT were significantly longer ($p\leq0.05$) than those of plots with higher P_2O_5 and those without P_2O_5. At 7WAT vines of the plots having 30 kg/ha of P_2O_5 were also significantly longer than those of the plots given 15 kgP_2O_5/ha. Vine length at 5, 7, and 9WAT decreased significantly with P_2O_5 beyond 30 kg/ha to 60 kg/ha while it increased from 0 to 30 kgP_2O_5/ha at

Table 1. Effect of phosphorus on number of leaves of snake tomato at various weeks after transplanting.

Treatment	Number of leaves/plant (WAT)		
	5	7	9
Phosphorus level($kgP_2O_5ha^{-1}$) 0	8.7	15.7	23.3
15	24.7	42.7	101.0
30	28.3	55.3	117.3
45	21.0	41.3	68.7
60	11.3	23.0	38.3
LSD	5.73	13.22	22.95
CV (%)	16.21	19.72	17.48

WAT – Weeks after transplanting.

Table 2. Effect of phosphorus on vine length of snake tomato at various weeks after transplanting.

Treatment	Vine length (cm) (WAT)		
	5	7	9
Phosphorus level ($kgP_2O_5ha^{-1}$) 0	33.8	54.1	104.6
15	75.1	113.7	288.2
30	95.8	162.0	352.0
45	72.6	113.9	250.8
60	51.2	100.3	133.6
LSD	18.67	37.70	61.64
CV (%)	15.10	18.40	14.50

WAT – Weeks after transplanting.

7WAT.

In all cases, plots without P_2O_5 had significantly shorter vines than those with 15 and 45 kgP_2O_5/ha.

Application of 30kgP_2O_5/ha resulted in significantly higher snake tomato fresh shoot weight than P_2O_5 at 60 kgP_2O_5kg/ha and no P_2O_5 at 5, 7 and 9 WAT, as shown in Table 3,(effect of phosphorus on shoot fresh weight at various weeks after planting) as well as 15 and 45 kgP_2O_5/ha at 7 and 9 WAT.

Table 4 represents effect of phosphorus on shoot dry weight of snake tomato at various weeks after transplanting. Shoot dry weight was significantly affected by P_2O_5 rate at 5, 7 and 9WAT. Dry shoot weight of plots treated with 30 kgP_2O_5/ha was significantly higher than those of the plots with P_2O_5 at 45 and 60kg/ha and no P_2O_5 as well as those given 15 kgP_2O_5/ha at 7 and 9 WAT. At harvest, (Table 5, effect of phosphorus on yield of snake tomato) fruit weight of plots treated with 15 and 30 kgP_2O_5/ha were significantly higher than those of the plots with other P_2O_5 treatments. Plots treated with 30 kgP_2O_5/ha however had significantly higher fruit weight compared to those given 15 kgP_2O_5/ha. Fruit weight significantly decreased with P_2O_5 levels up to 60 kg/ha from 15 and 30 kgP_2O_5/ha. Application of 15 to 45 kg/ha however resulted in significantly higher fruit weight compared to no P_2O_5 (control).

The regression analysis of snake tomato yield against phosphorus rates indicated quadratic and the equation thus

$$Y = 2.40 + 0.220x - 0.004x^2$$

Where Y refers to expected yield at a given phosphorus rate x.

When computed the optimum yield was 6.2 t/ha with optimum application rate of 27.5 (kgP_2O_5 ha^{-1}) and this shown in Figure 1.

DISCUSSION

Longer leaves were recorded in this study compared with those reported by Oloyede and Adebooye (2005) and Okelana and Okeleye (1994). Similar to the observation on number of leaves, P_2O_5 application in excess of 30 kg/ha (45 and 60 kg P_2O_5/ha) resulted in decline in leaf length for the same reason given earlier. In this study, the number of leaves and shoot dry matter production obtained for all levels of P_2O_5 were lower than those reported for the same rates by Okelana and Okeleye (1994). Leaf number and length, vine length and shoot fresh weight increased with P_2O_5 from 0 to 30 kg/ha and declined with further increase to 45 and 60 kg P_2O_5/ha.

Table 3. Effect of phosphorus on shoot fresh weight of snake tomato at various weeks after transplanting.

Treatment	Shoot fresh weight/plant (g)		
	5WAT	7WAT	9WAT
Phosphorus level(kgP_2O_5ha-^{1}) 0	3.2	24.4	69.9
15	44.0	92.9	270.3
30	48.3	169.5	539.8
45	41.3	57.0	121.8
60	9.8	34.0	81.8
LSD	5.99	79.05	197.3
CV (%)	11.33	55.57	47.61

WAT – Weeks after transplanting.

Table 4. Effect of phosphorus on shoot dry weight of snake tomato at various weeks after transplanting.

Treatment	Shoot dry weight/plant (g) (WAT)		
	5	7	9
Phosphorus level(kgP_2O_5ha-^{1}) 0	0.7	2.9	12.3
15	6.3	9.0	30.2
30	7.1	19.5	72.2
45	4.2	6.5	13.6
60	1.1	3.6	8.5
LSD	1.56	9.74	20.25
CV (%)	21.37	62.28	39.26

WAT – Weeks after transplanting.

Table 5. Effect of phosphorus on yield of snake tomato (*Trichosanthes cucumerina* L.).

Phosphorus level(kgP_2O_5ha^1)	Fruit weight (kg/plant)	Fruit yield (tons/ha)
0	0.91	2.21
15	4.90	4.90
30	5.22	6.22
45	2.79	2.80
60	1.12	1.42
LSD	0.57	1.15
CV (%)	19.31	

This was probably because *T. cucumerina* could not tolerate P_2O_5 level in excess of 30 kg/ha. Among the information required for the successful cultivation of the crop are nutrient requirements, particularly those that promote good growth. Phosphorus (P) as phospholipids is a constituent of cell membrane require by plant. It is usually concentrated in the fast growing parts of the plants particularly in the root tips. P speeds up the maturation of crops and is found in large quantities in seeds and fruits. It also stimulates good root development. Plant absorbs P largely in the form of phosphates as primary orthophosphates ion (HPO_4^{2-}). Phosphorus does not occur abundantly in soils as nitrogen (N) and potassium (K).This was probably because *T. cucumerina* could not tolerate P_2O_5 level in excess of 30 kg/ha. The increase in those parameters with P_2O_5 up to 30 kg/ha was in line with the report of Okelana and Okeleye (1994) and this therefore implies that phosphorus deficiency in snake tomato can be corrected easily by the application of P fertilizers since the crop is grown on sandy soils with low contents of clay soils in which P fixation is not a common problem. Soil P levels required for tomato are often lower than those required for other crops (Cope et al., 1984). Earlier

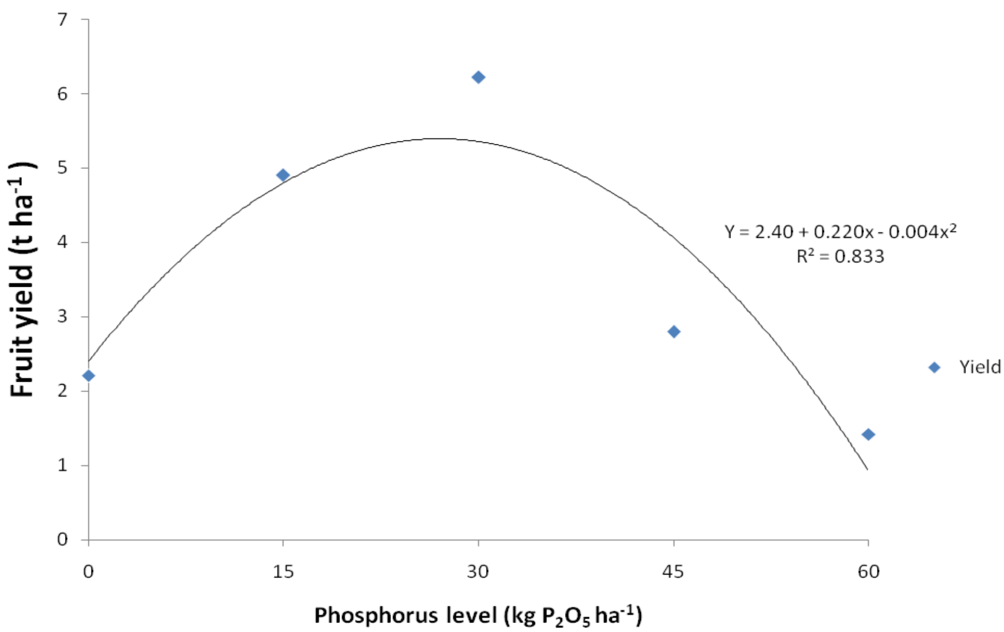

Figure 1. Polynomial response of snake tomato yield to phosphorus application.

studies by Soladoye and Adebisi (2004) and Adebooye and Oloyede (2005) documented that there was little information in the literature on the agronomic practices for *T. cucumerina.* The fruit yield recorded was higher than those reported by Okelana and Okeleye (1994) for all the three levels of fertilizer applied and at the three periods at which data were collected. The highest fresh shoot weight (539.8 g) obtained in this study also concurs with work of Adebooye et al. (2006) who reported that the fruit weight ranged from 438.1-651.4 g; fresh pulp weight from 20.4 to 37.6 g; seed weight/fruit from 21.8-39.5 g; number of seed per fruit from 54 to 70; and 100-seed weight from 39.2 to 64.1 g. The changes (increases and decreases) in the value of parameter compared to researchers cited above may be attributed to weather and environmental conditions of the study area. The quadratic response recorded of effects of phosphorus levels on yield of snake tomato indicate that the optimum P_2O_5 required for the crop was reached and as such the additional P_2O_5 added lead to a decrease in yield.

CONCLUSION

It can be concluded that phosphorus application was effective for the parameters considered in this study but treatment of 27.5 kgP_2O_5 /ha was optimum for *T. cucumerina* growth and productivity.

RECOMMENDATION

It is hereby recommended that dry season trials should be carried out to know the extent to which the crop can thrive in the season and phosphorus application of 27.5 kgP_2O_5/ha should be used according to the finding of this study.

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