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RESEARCH ARTICLE

EVALUATION OF THE EFFECTS OF SOME SOIL AMENDMENTS ON THE AGRONOMIC PERFORMANCE OF SNAKE TOMATO IN A NEWLY ESTABLISHED RUBBER PLANTATION IN IYANOMO

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ABSTRACT

A field study was conducted in 2018 and 2019 cropping season to determine the comparative effects of some soil amendments on the growth and fruit yield of snake tomato in a newly established rubber plantation in Iyanomo. The treatments involved a combination of sole and intercropped combination with NPK and rubber effluent application rates laid out in a randomized complete block design in three replications. Data were collected on vine length, vine girth, number of leaves, leaf area, fruit yield and its components. Results showed that soil amendment had significant effect on growth and fruit yield of snake tomato ($P<0.05$). Soil amendment significantly ($P<0.05$) improved snake tomato growth characters. The fertilized plants were higher in all the characters accessed than the unfertilized plants. Sole and intercropped snake tomato fruit yield with or without treatments had similar values. Unfertilized sole and intercropped snake tomato had the lowest fruit yield. The highest fruit yield were obtained from sole and intercropped snake tomato treated with NPK (STNPK and RSNPK).

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INTRODUCTION

Rubber (*Hevea brasiliensis* Wild ex A. de Juss. Muell.Arg.) belongs to the family Euphorbiceae, it is commercially grown in plantations for the white exudates (latex) which is commonly referred to as white gold. Rubber is very significant in world's industrialization as expressly emphasized in the production of Elastomers (materials that are made of polymers or rubber), the use of which is indispensable in land, space, and water technologies (Howstuffworks, 2013). Natural rubber production in Nigeria suffered serious reduction in production from mid 1970s to late 1990s, as a result of low prices of rubber in the international market and other agronomic challenges. Most serious among these agronomic challenges are, the long gestation period of rubber (5 to 7 years), that deprived farmers of a sustainable income (income is tied down for 5-7 years without returns) during the immature phase and the fallow land brought about by rubber spacing (NRAN, 2013). To be able to achieve this feat in Natural rubber production in Nigeria, efforts must be put in to encourage the smallholder's rubber farmers that contribute seventy-five percent of total rubber production (NRAN, 2013). Hence, there is the need for appropriate plantation management systems that can assist farmers to reduce the gestation period of rubber, reduce cost of production and ensure early returns on investment. One way to achieve these goals is the development of an agronomic system that will intercrop rubber with other arable crops.

The scarcity and untold price hike that occur annually as a result of the off season of the tomato plant and recent invasion by *Tuta absoluta* that ravaged the entire tomato farm directed research efforts to looking for an alternative to the regular tomato. Snake tomato is an orphan crop and its cultivation and use as an alternative to the regular tomato is attracting global interest. Cost of inorganic fertilizer, its availability, adulteration and its attendant effects on the world economy has been a source of concern, hence the need for an alternative. The disposal of rubber processing effluent has being a major challenge to factory owners and a source of pollution, but its use as soil nutrient amendment will go a long way to ameliorating the challenge. Hence, this study was undertaken to evaluate the comparative effects of some soil amendments on the agronomic performance of snake tomato in a newly established rubber plantation in Iyanomo.

MATERIALS AND METHODS

Experimental Site: This study was conducted in 2018 and 2019 cropping seasons at the Research farm of Rubber Research Institute of Nigeria (RRIN), Iyanomo near Benin City, Edo State, which lies within the Rain Forest zone of Nigeria. The study area falls between latitude 6^000 and $7^000'$N and longitude $5^000'$ and $6^000'$E. The rainfall pattern is bimodal with the peaks in the month of July and September but the highest in July and a short dry spell in August.

The soils of this humid forest belt are mainly ultisols and the site is classified locally as kulfo series with pH range between 4.0 and 5.5.

Experimental design and field layout: The treatments involved a combination of sole and intercropped combination with NPK and rubber effluent application rates laid out in a randomized complete block design in three replications. For snake tomato component in the intercrop, the treatments were:

RE1RS-Rubber Effluent at application rate of 50 Kg N ha^{-1} cropped with rubber and snake tomato (Intercrop)

RE1ST- Rubber Effluent at application rate of 50 Kg N ha^{-1} cropped with sole snake tomato

RE2RS- Rubber Effluent at application rate of 60 Kg N ha^{-1} cropped with rubber and Snake tomato (Intercrop)

RE2ST- Rubber Effluent at application rate of 60 Kg N ha^{-1} cropped with sole snake tomato

RE3RS- Rubber Effluent at application rate of 70 Kg N ha^{-1} cropped with rubber and snake tomato (Intercrop)

RE3ST- Rubber Effluent at application rate of 60 Kg N ha^{-1} cropped with sole snake tomato

RSC- Rubber and Snake Tomato intercrop control

STC- Sole Snake Tomato control

Prior to cropping with rubber and snake tomato, soil samples were randomly collected from the experimental site at a depth of 0 - 30 cm depth using auger and bulked together to form a composite sample. The composite soil sample was air-dried and sieved through a 2 mm mesh and analyzed for its physical and chemical properties using standard laboratory procedures. After harvest, soil samples were randomly collected from each plot separately and analyzed for its post-harvest chemical properties according to methods in Mylavarapus and Kennelley (2002).

Cultural practices and data collection: The snake tomato was sown in a polybag nursery filled with top soil at a depth of 3 cm on the 11th of June 2018 and 29th of May 2019 and watered twice daily (morning and evening). Seed emergence was observed on the 22nd of June 2018 and 10th of June 2019. The plot measuring 26 by 60 m was cleared of the existing vegetation manually with the aid of cutlasses and hoes, the debris were packed out of the plot, thereafter the field was marked out into plots measuring 3 by 7 m with a metre pathway. The rubber effluent was applied immediately to the designated plots as per treatment on the 6th day of June 2018. The Rubber saplings were transplanted to the field on the 20th of June 2018 (two weeks after application of effluent), The pulled budded stump (young rubber) was placed in the hole in such a way that the budded patch is just above the ground level at a spacing of 3 by 7 m which gave rise to 476 Rubber stand per hectare, each plot had four rubber stand. The snake tomatoes were transplanted on the 29th of June 2018 and 17th of June, 2019 at a spacing of 0.5 by 0.5 m which gave rise to a total of 40000 plants per hectare. The NPK fertilizer was applied to the designated plots as per treatment two weeks after transplanting of snake tomato seedlings. Trellis were erected on the plots immediately after sowing and the emerged plants were directed to climb through the twine. Weeding was carried out first at six weeks after transplanting and subsequently as at when due. Three plants within the middle row of each plot were randomly selected for Data collection on the growth (vine length, vine girth, number of leaves per plant and leaf area) of snake tomato at two weeks interval starting from 4, 6, 8 and 10 WAT. At harvesting of fruits of snake tomato, data were collected on fruit length, fruit diameter, number of fruits per plant, fruit weight, number of rotten fruits per plant and fruit yield. Vine length was measured using a tape rule from the base of the plant to the tip of the vine of all the sampled plants and average computed and calibrated in cm. Vine girth was measured with the aid of a vernier caliper and calibrated in cm. Number of leaves was obtained by counting all fully expanded leaves of all sampled plants and average computed to obtain the number of leaves per plant. Leaf area was obtained through the use of the leaf area meter. Number of days to flowering was determined by counting the number of days from the day of transplanting to the day of onset and 50 % flowering. Fruit diameter was determined by the use of a vernier caliper. Fruit length was determined by measuring fruits of sampled plants using tape rule calibrated in cm. Number of fruits per plant was obtained by counting all the harvested fruits of all sampled plants divided by three to arrive at the number of fruits per plant. Fruit weight per fruit was obtained through the summation of all the harvested fruits from the sampled plants divided by the number of fruits to obtained the fruit weight calibrated in kg. The number of rotten fruits per plant was estimated by counting the number of infested/aborted/withered/spoilt fruits of all the sampled plants divided by the number of sampled plants. From fruit weight, fruit yield was estimated thus:

$$\text{Fruit yield} = \frac{\textit{Fruit weight}}{\textit{Ground area}} \times \frac{10000}{1000}\ t\ ha^{-1}$$

RESULTS

Soil physical and chemical properties prior to cropping with rubber and snake tomatoand the chemical composition of the rubber effluent: The soils were strongly acidic and low in organic C, total N, available P and exchangeable Ca (Table 1). The Ca/Mg ratios were moderate. The soils were texturally sandy loam. The chemical analysis of the rubber effluent used for the study showed that it was moderately acidic with total dissolved solids, chemical oxygen demand and biochemical oxygen demand (Table 2). It contained N, available P, organic C, K, Mg, Na and Ca in appreciable amount. However, the composition of the effluent varies with sources.

Vegetative characters: The effect of NPK and rubber effluent on vegetative characters and days to first and 50 % flowering of snake tomato in sole and intercropped with rubber grown on a newly established rubber plantation are presented in Table 3. In the first year trial both sole and intercrop snake tomato grown in plots treated with rubber effluent at application rate of 50 kg N ha^{-1} (RE1ST and RE1RS) had vines which were significantly shorter than other treatments. The longest vines were recorded in STNPK and RSNPK plants. In the second year trial, the shortest vines were recorded in RSC and STC plants. Snake tomato plants raised in STNPK and RSNPK plots had the longest vines. The thickest vines were observed in plants with STNPK but identical with RSNPK plants while RE1RS, RE1ST, RSC and STC plants had the thinnest vines in both experiments.

Plants in STNPK had the highest number of leaves which was comparable with the number of leaves observed in RSNPK, RE3RS and RE3ST plants. Sole snake tomato plant treated with rubber effluent applied at 50 kg N ha^{-1} (RE1ST) had the fewest number of leaves which was identical with the number of leaves recorded in RE1RS plants in the first experiment. In the second year experiment, RSC and STC plants had the fewest number per plant while plants in RSNPK and STNPK had the highest number of leaves per plant. The smallest leaf area was observed in RE1RS and RE1ST plants while the highest leaf area was observed in STNPK plants in the first year experiment. In the second year experiment, intercropped snake tomato grown on unfertilized plots (RSC) had the smallest leaf area which was similar with plants in STC, RE1R and RE1ST while the highest leaf area was recorded in RSNPK and STNPK plants. Sole and intercrop snake tomato grown on plots treated with NPK (STNPK and RSNPK) were earliest to flowering which was comparable with plants in STNPK in the first year experiment. Intercrop snake tomato plants grown on plots without fertilization (RSC) were latest to flowering in the first year experiment but not significantly later than STC plants. In the second year experiment, STNPK and RSNPK plants had identical days to flowering but significantly earlier than other treatments.

Table 1. Pre-cropping characterization of soils from the experimental site

Parameter	Site		Critical level	Fertility class
	New plantation	Existing plantation		
pH(H_2O) 1:1	5.40	5.40		SA
Organic carbon (g kg^{-1})	17.20	17.20	30.00 g kg^{-1} (Enwezor *et al*., 1989)	Low
Total nitrogen (g kg^{-1})	0.84	0.81	1.50 g kg^{-1} (Solulo and Osiname, 1981)	Low
C:N	20.48	21.23		
Available phosphorus (mg kg^{-1})	10.50	13.00	16.00 mg kg^{-1} (Adepetu *et al*., 1979)	Low
Exchangeable cation (cmol kg^{-1})				
Calcium	0.80	0.82	2.60 cmol kg^{-1} (Agboola and Corey, 1973)	Low
Magnesium	0.20	0.25		
Ca/Mg	4.00	3.40	3.00 (FDALAR, 1975)	Adequate
Potassium	0.16	0.17	0.16 - 0.20 (Hunter, 1975)	
Sodium	0.06	0.06		
Exchangeable acidity (cmol kg^{-1})				
Hydrogen	0.20	0.16		
Aluminium	0.10	0.11		
Particle size (gk g^{-1})				
Sand	886.00	886.00		NA
Silt	61.00	64.00		NA
Clay	55.00	50.00		NA
Textural class	Sandy loam	Sandy loam		NA

SA - Strongly acidic NA - Not applicable number of leaves per plant.

Table 2. Chemical composition of rubber effluent

Parameter	Odia	Okomu	Michellin
pH (H_2O)	6.20	6.20	6.40
Organic carbon (%)	29.60	25.80	15.96
Total nitrogen (%)	1.10	0.40	0.80
Phosphorus (%)	2.03	3.25	5.00
Potassium (%)	0.22	0.24	0.43
Magnesium (%)	0.38	0.38	0.40
Calcium (%)	0.49	0.50	0.57
Sodium (%)	0.04	0.05	0.06
zinc (%)	0.05	0.05	0.07
Copper (%)	0.02	0.02	0.03
Manganese (%)	0.08	0.08	0.09
Iron (%)	0.10	0.11	0.14
Chemical oxygen demand (mg l^{-1})	410.00	230.00	550.00
Biochemical oxygen demand (mg l^{-1})	250.00	270.00	870.00
Total dissolved solids (mg l^{-1})	760.00	160.00	330.00

Table 3. Effect of soil amendment on vegetative characters and days to first and 50 % flowering of snake tomato cropped in newly established rubber plantation

Treatment	Plant height (cm)		Stem girth (cm)		Number of leaves		Leaf area (cm^2)		Days to 1st flowering		Days to 50 % flowering	
	1st	2nd year	1st	2nd year	1st	2nd year	1st	2nd year	1st	2nd year	1st	2nd year
REIRS	153.00	220.00	0.53	0.27	17.00	16.00	663.30	431.00	44.33	61.00	58.67	75.67
RE1ST	149.30	221.30	0.60	0.27	16.00	16.00	620.30	357.00	43.33	61.67	58.00	74.00
RE2RS	199.70	246.00	0.67	0.40	19.33	16.67	824.70	422.00	42.00	60.67	57.67	71.00
RE2ST	193.30	245.30	0.70	0.37	20.17	16.67	920.80	429.00	42.00	61.67	56.67	71.33
RE3RS	252.30	255.30	0.83	0.57	21.67	20.67	1090.70	635.00	42.00	60.33	55.67	68.00
RE3ST	243.70	254.70	0.87	0.57	21.67	20.67	1090.00	661.00	41.33	60.67	56.33	66.67
RSC	227.30	680.00	0.57	0.27	18.83	12.67	760.00	257.00	45.67	61.33	59.67	74.33
RSNPK	296.00	312.00	0.90	0.63	22.00	26.00	1490.00	1335.00	40.00	51.67	45.67	62.67
STC	221.30	67.00	0.53	0.27	18.17	12.33	753.30	264.00	44.67	61.00	59.67	74.67
STNPK	289.70	310.00	0.97	0.67	22.67	25.00	1643.30	1302.00	40.33	51.00	46.00	61.33
$LSD_{(0.05)}$	18.520	2.720	0.090	0.100	1.49	2.670	93.520	133.100	1.18	2.080	1.970	4.510

Foot note

RE1RS - Rubber effluent at application rate of 50 kg N ha-1 cropped with rubber and snake tomato (Intercrop)
RE1ST - Rubber effluent at application rate of 50 kg N ha-1 snake tomato (Sole)
RE2RS - Rubber effluent at application rate of 60 kg N ha-1 cropped with rubber and snake tomato (Intercrop)
RE2ST - Rubber effluent at application rate of 60 kg N ha-1 snake tomato (Sole)
RE3RS - Rubber effluent at application rate of 70 kg N ha-1 cropped with rubber and snake tomato (Intercrop)
RE3ST - Rubber effluent at application rate of 70 kg N ha-1 snake tomato (Sole)
RSC - Rubber-snake tomato intercrop without NPK/rubber effluent treatment (control)
STC - Sole snake tomato (control)
STNPK - Sole snake tomato treated with 60 kg N ha-1 of NPK 15:15:15
RSNPK - Rubber-snake tomato treated with 60 kg N ha-1 of NPK 15:15:15

All other treatments had comparable number of days to flowering. Plants in RSNPK and STNPK plants had identical days to 50 % flowering which were earliest in the both experiments. The unfertilized plants (RSC and STC) were not significantly different from RE1RS and RE1ST plants in the first year experiment. Plants in STC had the longest days to 50 % flowering but identical with plants in RSC, RE1RS, RE1ST and RE2ST in the second year experiment.

Table 4. Effect of NPK and rubber effluent on fruit yield and its components of snake tomato cropped in newly established rubber plantation

Treatment	Fruit length (cm)			Fruit diameter (cm)			Number of fruits per plant			Fruit weight (kg $fruit^{-1}$)			Number of rotten fruits			Fruit yield (t ha^{-1})		
	1st	2nd year	Combined	1st	2nd year	Combined	1st	2nd year	Combined	1st	2nd year	Combined	1st	2nd year	Combined	1st	2nd year	Combined
RE1RS	47.00	39.00	43.00	4.77	3.90	4.33	9.00	8.67	8.83	0.80	0.70	0.75	3.00	3.33	3.17	28.60	23.10	25.90
RE1ST	48.00	38.33	43.17	4.60	3.63	4.12	8.00	10.00	9.00	0.93	0.73	0.83	2.67	3.67	3.17	28.30	27.90	28.10
RE2RS	55.00	42.33	48.67	5.70	4.70	5.20	16.00	12.67	14.33	0.87	0.77	0.82	2.33	3.33	2.83	52.20	36.70	44.50
RE2ST	56.33	41.33	48.83	5.70	4.73	5.22	15.67	13.67	14.67	0.83	0.73	0.78	2.33	4.00	3.17	50.20	37.90	44.00
RE3RS	57.67	43.67	50.67	5.70	4.87	5.28	20.33	14.00	17.17	1.20	0.77	0.98	1.33	4.00	2.67	86.40	40.80	63.60
RE3ST	57.17	43.33	50.25	6.20	5.20	5.70	20.33	14.33	17.33	0.93	0.83	0.88	1.00	4.67	2.83	71.40	45.50	58.40
RSC	44.40	38.00	41.20	5.03	3.23	4.13	7.00	8.33	7.67	0.63	0.67	0.65	3.67	3.00	3.33	17.00	21.10	19.10
RSNPK	60.33	56.67	58.50	6.23	5.17	5.70	25.33	19.33	22.33	1.40	0.90	1.15	1.00	4.67	2.83	135.20	66.10	100.70
STC	43.33	37.33	40.33	5.40	3.17	4.28	6.67	7.07	7.17	1.07	0.70	0.88	3.67	3.00	3.33	27.50	20.30	23.90
STNPK	61.33	57.33	59.33	6.47	5.17	5.82	26.67	18.00	22.33	1.67	0.93	1.30	1.00	4.33	2.67	169.20	63.60	116.40
Mean	53.06	43.73	48.39	5.58	4.37	4.98	15.50	12.67	14.08	1.03	0.77	0.90	2..20	3.80	3.00	66.60	38.30	52.40
$LSD_{(0.05)}$	4.170	3.73	2.654	0.48	0.88	0.573	1.77	2.92	1.719	0.24	0.12	0.133	1.01	1.34	ns	20.230	9.820	10.550
$LSD_{(0.05)}$ year		1.190			0.26			0.77			0.06			0.36			4.720	

Foot note
RE1RS - Rubber effluent at application rate of 50 kg N ha-1 cropped with rubber and snake tomato (Intercrop)
RE1ST - Rubber effluent at application rate of 50 kg N ha-1 snake tomato (Sole)
RE2RS - Rubber effluent at application rate of 60 kg N ha-1 cropped with rubber and snake tomato (Intercrop)
RE2ST - Rubber effluent at application rate of 60 kg N ha-1 snake tomato (Sole)
RE3RS - Rubber effluent at application rate of 70 kg N ha-1 cropped with rubber and snake tomato (Intercrop)
RE3ST - Rubber effluent at application rate of 70 kg N ha-1 snake tomato (Sole)
RSC - Rubber-snake tomato intercrop without NPK/rubber effluent treatment (control)
STC - Sole snake tomato (control)
STNPK - Sole snake tomato treated with 60 kg N ha-1 of NPK 15:15:15
RSNPK - Rubber-snake tomato treated with 60 kg N ha-1 of NPK 15:15:15

Fruit yield and components of snake tomato: The fruit yield indices of snake tomato in sole and intercrop with rubber as influenced by NPK and rubber effluent cropped in a newly established rubber plantation is presented in Table 4. Sole snake tomato in STNPK had the longest fruits in the first and second year experiments. Sole snake tomato plants in STC had the shortest fruits but similar with fruits produced from RSC plot in the first year experiment. In the second year experiment, unfertilized sole snake tomato plant (STC) had the shortest fruits but identical with plants in RSC, RE1RS and RE1ST. Snake tomato plants in RSNPK produced the thickest fruits in the first year experiment while the thinnest fruits were produced by plants in RE1ST which were comparable with plants in RE1RS and RSC. Plants in RE3ST produced the thickest fruits but identical with plants in RSNPK, RE3RS, RE2ST and RE2RS in the second year experiment. The thinnest fruits in the second year experiment was produced from RSC, STC, RE1RS and RE1ST plants. The thickest fruits were recorded in STNPK plants but not significantly different from RSNPK, RE3ST and RE3RS. The highest number of fruits per plant was recorded in RSNPK and STNPK plants in both experiments. The fewest number of fruits was produced from STC plot which was identical with RE1ST plants in the first year experiment. This was almost repeated in the second year experiment. However, in the second year experiment, plants in RE1RS had identical number of fruits per plant with STC plants.

Heaviest fruits were produced by plants in STNPK in both experiments. However, in the second year experiment, the weight of fruit produced by plants in STNPK was comparable with the weight of fruit recorded in RSNPK and RE3ST plants. Fruits of snake tomato intercropped with rubber grown in unfertilized (RSC) plots were the lightest in both experiments. However, RSC plants was not significantly different from RE1RS, RE2RS, RE3Rs and STC. The least number of rotten fruits was recorded in RE3ST, RSNPK and STNPK plants but identical with RE3R in first year experiment. The highest number of rotten fruits was observed in plants in RSC and STC. In the second year experiment, the least number of rotten fruits was observed in STC and RSC plants but identical with RE1RS and RE2RS plants. The highest number of rotten fruits was observed in plants in RSNPK and RE3ST. Snake tomato plant intercropped with rubber without fertilization (RSC) had the lowest fruit yield in the first ear experiment. In the second year experiment, unfertilized sole snake tomato produced the lowest fruit yield which was comparable with the fruit yield in RE1RS, RE1ST and RSC plants. The highest fruit yield was observed in STNPK plants in the first year experiment. In the second year experiment, the highest fruit yield was recorded in RSNPK plants which was identical with the fruit yield recorded in STNPK plants.

DISCUSSION

The study has showed that during the first two years of rubber cultivation, snake tomato can be cropped successfully between rubber plants spaces thereby contributing positively to national food security and ensuring land sustainability. This study has emphasized the need to save this crop from extinction. Snake tomato was not detrimental to the growth of rubber plant since the growth and yield of the sole and intercropped snake tomato were similar. This evidenced from the fact that vine length, vine girth and number of leaves exhibited similar values between intercrop and sole snake tomato. However, the higher leaf area accrued to the sole snake tomato plant did not translate to higher fruit yield. The first year cropping in the newly established rubber plantation, when the fruit yield of snake tomato plants were higher in STNPK than plants in RSNPK but in the other year their yields were comparable. This observation is in line with Esekhade *et al*. (1996) who reported that both food and horticultural crops can be intercropped with rubber during the immature period as they had no adverse effect on rubber. The competition for space, light, water and nutrients was not intense in the young rubber plantation since rubber plant requirement at this stage is minimal but will gradually increase as the plant aged. This may have accounted for the gradual reduction in growth and economic yield of snake tomato as the rubber plant aged. The soils of the experimental site were strongly acidic with values lower than critical level for some essential nutrients. This implied that the soil has low fertility status. Law-Ogbomo and Osaigbovo (2018) reported that most Nigerian soils are of low in native fertility owing to the highly weathered soils coupled with leaching and continuous cropping. Soil fertility is a very important factor in soil productivity in relation to nutrient and yield (Erhabor, 2005). Plants need supply of appropriate proportionate essential nutrients from the soil for optimum growth, development and yield. Low soil fertility status without adequate soil nutrient supplementation will result in growth and yield depression due to nutrient deficiencies (Law-Ogbomo *et al*., 2020).

The analysis of the rubber effluent showed variability depending on location. They were moderately acidic and contain N, P, K and Ca in appreciable quantity. The effluent has high concentration of organic carbon, COD and BOD at safe level. This finding is in agreement with Orhue *et al*. (2007) who reported highly significant amount of total suspended and dissolved solids, phosphate and total N in rubber effluent. Orhue and Osaigbovo, (2013) reported that rubber effluent had great potential as organic fertilizer and could be beneficial to arable crops without additional cost as effluent are waste product of rubber processing factories and its disposal has been a major concern to factory owners. This is an indication that rubber effluent which ought to be waste and pollutant to the environment can be made to be an avenue for wealth creation through its conversion to organic fertilizer. Days to first and fifty percent flowering were earlier in NPK and rubber effluent at higher application level treated plants. However, NPK treated plants were earliness to first and fifty percent flowering than rubber effluent and untreated plants. The fertilized plants were earlier to flowering probably due to the enhancement of their vegetative phase through the stimulating effect of the readily available nutrients on photosynthetic processes leading to early flower initiation. The early flowering was advantageous to plants fertilized with NPK and rubber effluent applied at higher rate as it resulted in higher yield. The high snake tomato yield with low rotten, longer and heavier and higher number of fruits per plants accrued to plants treated with soil amendment is clear evidence that rubber effluent and NPK enhanced yield positively. This observation is in agreement with Mbonu and Arifalo (2016) who reported that, the use of readily available fertilizer enhances the yield of the plant. However, yield was most enhanced with NPK. Snake tomato plant treated with rubber effluent applied at 50 Kg N ha^{-1} had similar yield with plants without fertilizer treatment. This implies that rubber effluent application only enhanced fruit yield at higher application rate. The reduction in fruit yield of snake tomato observed in plants grown on unfertilized plots could have arisen from insufficient nutrient uptake as the plant have to rely on nutrients from the soil which have been found to be less than the critical level in some essential plant nutrients. Apart from the nutrient being low, there could be a problem of availability of phosphorus, calcium and magnesium to the plant since pH was less than 5.50 indicating strong acidity. Plants grown on plots without fertilizer application had shorter and thinner vines with lower number of leaves and leaf area leading to reduction in fruit yield and components. Lower field yield could be due to inadequate production of assimilates owing to low nutrients availability to plants. This is an indication that growth and yield of snake tomato depends on residual soil nutrients. The higher yield obtained from plants treated with NPK and higher rate of rubber effluent is a reflection of the application of fertilizer to the soil through improved supply of nutrients to plants leading to better utilization of carbon and consequent synthesis of assimilates. Adequate nutrient availability has been indicated to be useful to the growth and yield of snake tomato. This clearly demonstrated the benefit of the application of soil amendments. The application of soil amendment boosted the enhancement of vine length, vine girth, number of leaves and leaf area leading to the production of abundant assimilates which resulted in higher fruit yield.

CONCLUSION AND RECOMMENDATION

The study shows that intercropping rubber plant with snake tomato was desirable as the inter-plant competition was not intense. It ensures that farmers start reaping fruits from the enterprise from the first year. Fertilizer application increased the growth and fruit yield of snake tomato. Nutrient content and uptake by snake tomato were enhanced through fertilizer application. Based on the findings from this study, snake tomato intercropping with rubber should be supplemented with fertilizer application to improve the fertility of the soil to sustain soil and higher growth of rubber and yield of snake tomato. There were growth and yield disparity between NPK and rubber effluent treated plants, however, the application of rubber effluent at 70 kg N ha^{-1} showed promising. NPK should be applied at 60 Kg N ha^{-1} (400 Kg NPK ha^{-1}) to increase fruit yield of snake tomato and growth of rubber.

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