



Influence of Rubber Effluent and NPK Application on the Growth of Rubber (*Hevea brasiliensis* Wild ex A. de Juss. Muell.Arg.) Plant in Rubber/Snake Tomato Intercrop

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ABSTRACT

The smallholder rubber farmers are the major producer of rubber worldwide. In Nigeria, in late 1970s and early 1990s, there was withdrawal of these farmers owing mainly to the long gestation of rubber plant before it can be tapped for latex production among other factors. A field study was conducted in 2018 and 2019 cropping season to determine influence of rubber effluent and NPK fertilizer on the growth of rubber in a rubber /snake tomato intercrop in Iyanomo. The treatments combination include sole snake tomato and rubber and their intercrop combinations treated with rubber effluent (0,50,60 and 70kgNha⁻¹) and NPK fertilizer application (applied at 60kgNha⁻¹) fitted into a randomized complete block design with three replications. Data collected were on growth characters (plant height, collar girth, number of leaves per plant and leaf area). Results showed that NPK and rubber effluent had significant effect on all the growth characters measured, however NPK was superior to rubber effluent applied at the highest level and that intercropping snake tomato with rubber was not detrimental to the growth of the rubber plant.

INTRODUCTION

Rubber (*Hevea brasiliensis* Wild ex A. de Juss. Muell.Arg.) belongs to the family Euphorbiaceae, a dicotyledonous perennial plant, commercially grown in plantation for its white (milky) exudates called latex. This latex is used in the production of auto tyres, tubes and plastics, which are indispensable in land and space technologies (Howstuffworks, 2013). The small holder rubber farmers are the highest contributor to the total rubber production in the world (they contribute about 75% of total rubber production) compared to estate owned (production from estate) (NRAN, 2013). The withdrawal of these small holder rubber farmers from production caused a drastic set back in rubber production in Nigeria. This withdrawal was mainly due to low prices of rubber in the international market and other agronomic challenges (Ogbebor, 2013). Most serious among these 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) and low soil fertility status among others. To be able to return these small holder rubber farmers back to production in order to achieve a feat in rubber production, there is the need to develop rubber/arable crop intercrop that can help reduce the gestation period of rubber, reduce cost of production and guarantee security.

The problem of low soil fertility status can be resolved through the application of fertilizer. inorganic fertilizer usage is associated with high cost of procurement, adulteration, unpleasant residual effect, energy crisis, acidity and unavailability has directed research attention to looking for an alternative that can cushion the effect. Rubber factory effluent is waste from rubber processing factories and its disposal has constituted a nuisance to the environment. Its use as soil amendments will go a long way in the reduction of the cost of rubber production, improving soil fertility for the benefit of the crop and also taking care of issues of water pollution raised by environmentalist and the problem of disposal posed to rubber processing factories. Hence, this study was undertaken to evaluate the influence of rubber effluent and NPK fertilizer on the growth of rubber (*Hevea brasiliensis*) in rubber/snake tomato intercrop 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°00' and

7°00'N and longitude 5°00' and 6°00'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 rubber and snake tomato and their intercropped combination with NPK (applied at 60kgNha⁻¹) and rubber effluent application rates (0,50,60 and 70kgNha⁻¹) laid out in a randomized complete block design in three replications. For rubber 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)
 RE1SR- Rubber Effluent at application rate of 50 Kg N ha⁻¹ cropped with sole rubber
 RE2RS- Rubber Effluent at application rate of 60 Kg N ha⁻¹ cropped with rubber and Snake tomato (Intercrop)
 RE2SR- Rubber Effluent at application rate of 60 Kg N ha⁻¹ cropped with sole rubber
 RE3RS- Rubber Effluent at application rate of 70 Kg N ha⁻¹ cropped with rubber and snake tomato (Intercrop)
 RE3SR- Rubber Effluent at application rate of 70 Kg N ha⁻¹ cropped with sole rubber
 RSC- Rubber and snake tomato intercrop control
 RSNPK- 60 Kg NPK applied to rubber and snake tomato intercrop
 SRC- Sole Rubber Control
 SRNPK- 60 Kg NPK applied to sole rubber

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). On laboratory analysis, the soil had a pH of 5.40, organic carbon 17.20gkg⁻¹, total nitrogen 0.84g kg⁻¹, available phosphorus 10.00mg kg⁻¹, exchangeable Ca, Mg, K, Na, and acidity were 0.80, 0.20, 0.16, 0.06 and 0.30Cmol kg⁻¹. The soil was also texturally sandy loam. Rubber effluent had a pH of 6.20 with organic carbon of 29.60gkg⁻¹, total nitrogen of 1.10%, phosphorus 2.30%, magnesium 0.38%, calcium 0.49%, sodium 0.04%, zinc 0.05%, copper 0.02%, manganese 0.08%, iron 0.10%, chemical oxygen demand, biochemical oxygen demand and total dissolved solids were 410.00, 250.00 and 760.00 mol⁻¹.

Cultural practices, data collection and Analysis

The snake tomato seeds were raised into seedlings in a polybag nursery filled with a mixture of top soil and poultry manure in ratio 3:1 for two weeks.

An experimental field 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 site, thereafter the field was marked out into plots measuring 3 by 7m with a metre pathway. The rubber effluent was applied immediately to the designated plots as per treatment two weeks prior to transplanting of rubber saplings. 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. The snake tomato seedlings were transplanted to designated plots at a spacing of 0.5 by 0.5 m, a week after the planting out of the rubber saplings. The NPK fertilizer was applied to the designated plots as per treatment two weeks after transplanting of snake tomato seedlings.

Trellises were erected on the plots immediately after planting out the snake tomato seedlings and directed to climb through the twines. Weeding was carried out first at six weeks after transplanting and subsequently as at when due.

Two rubber plants in each plot were randomly selected and tagged for data collection on growth characters (plant height, stem girth, number of leaves per plant and leaf area). Data collected were analyzed with GENSTAT programme, using analysis of variance and significant differences among treatments means were separated using the LSD procedure at 0.05 level of probability

RESULTS

Growth characters

Height of rubber plant in sole and intercropped with snake tomato as influenced by NPK and rubber effluent is presented in Table 1. Generally, NPK and rubber effluent soil amendment affected plant height throughout the sampling periods. At one month after transplanting (MAT), intercropped rubber plants treated with NPK (RSNPK) had sprouted and credited with the tallest plants. At 2 MAT, plant height varied between

9.33 and 17.67 cm for unfertilized sole rubber (SRC) and intercropped rubber treated with rubber effluent at 50 kg N ha⁻¹(RE1RS), respectively. However, plants in RE1RS were identical with other treatments except SRC, RE2SR and RSC plants.

At 3 MAT, plant height ranged from 28.83 and 41.00 cm for RSC and SRNPK, respectively. However, plants in RSNPK were statistically comparable with plants grown in SRNPK. At 4 MAT, the unfertilized rubber plants (RSC and SRC) had similar plant height which was the shortest and identical with the plant height recorded with RE1RS plants. The tallest rubber plants were recorded in RSNPK and were comparable with the plant height observed with plants in SRNPK.

At 13 MAT, there was increased in plant height with increasing effluent application rate up to 70 kg N ha⁻¹. But the height of RE3RS and RE3SR plants were below the height of plants in RSNPK and SRNPK. The sole and intercropped rubber with snake tomato without fertilization had similar heights and was shortest. Plants in RSNPK and SRNPK had similar plant height which was the tallest. This distribution trend in plant at 13 MAT was repeated at 14 and 16 MAT. At 15 MAT, the shortest plants were observed in RSC and SRC while the tallest plants were recorded in RSNPK and SRNPK plant. All fertilized plants had higher height than unfertilized plants.

Stem girth of rubber plant as influenced by NPK and rubber effluent and intercrop combination in a newly established plantation is presented in Table 2. At 1 MAT, the thickest plants were observed in RSNPK and STNPK but were comparable with plants in RE3RS and RE3SR. At 2 MAT However, the thinnest stems were observed with plants in RSC and SRC which were comparable with RE1RS, RE1SR, RE2RS and RE2SR plants. The thickest stems were found on SRNPK and RSNPK plants but at par with RE3SR and RE3RS plants.

At 3 MAT, the thickest stem was recorded in RE3SR but comparable with RE2RS, RE3RS, RSNPK and SRNPK. The thinnest stems were recorded in SRC and RSC plants but identical with plants in RE1RS and RE1SR. Stem girth increased with increasing rubber effluent application rate and climaxed at 70 kg N ha⁻¹ which was similar with RSNPK and SRNPK. This distribution trend was repeated at 4 MAT. However, RE2RS was significantly lower than RE3RS.

Table 1: Effect of NPK and rubber effluent on height (cm) of rubber sapling cropped with snake tomato in a newly established rubber plantation (2018 and 2019 combined).

Treatment	2018				2019			
	Months after transplanting				Months after transplanting			
	1	2	3	4	13	14	15	16
RE1RS	0.00	17.67	33.00	33.67	83.67	92.67	95	103.67
RE1SR	0.00	15.00	33.00	35.33	83.00	92.00	95.33	105.00
RE2RS	0.00	15.00	34.33	34.33	91.33	101.67	108.33	135.33
RE2SR	0.00	14.33	34.33	35.00	91.00	102.67	106.33	134.00
RE3RS	0.00	16.00	36.33	41.33	93.33	104.00	110.00	139.00
RE3SR	0.00	15.33	36.00	41.00	91.67	104.33	109.67	140.00
RSC	0.00	14.33	28.83	31.33	82.33	91.33	91.00	102.67
RSNPK	14.30	15.00	40.83	46.67	110.00	130.67	140.33	196.33
SRC	0.00	9.33	29.67	31.33	82.00	90.33	91.67	103.33
SRNPK	14.83	16.00	41.00	44.00	110.00	128.67	139.33	107.67
LSD _(0.05)	0.381	3.213	3.213	2.756	4.165	2.401	1.765	6.646

Foot noteRE1RS - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber (Sole)RE1SR - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)RE2RS - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber (Sole)RE2SR - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)RE3RS - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber (Sole)RE3SR - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber and snake tomato (Intercrop)

RSC - Sole Rubber without NPK/rubber effluent treatment (control)

SRC - Rubber-snake tomato intercrop without soil amendment (control)

RSNPK - Sole rubber treated with 60 kg N ha⁻¹ of NPK 15:15:15SRNPK - Rubber-snake tomato intercrop treated with 60 kg N ha⁻¹ of NPK 15:15:15

Table 2: Effect of NPK and rubber effluent on stem girth (cm) of rubber sappling cropped with snake tomato in a newly established rubber plantation (2018 and 2019 combined)

Treatment	2018 Months after transplanting				2019 Months after transplanting			
	1	2	3	4	13	14	15	16
RE1RS	0.00	0.63	1.83	1.90	2.10	2.17	2.27	2.27
RE1SR	0.00	0.67	1.87	1.90	2.07	2.13	2.27	2.27
RE2RS	0.00	0.67	2.03	1.97	2.23	2.33	2.47	2.47
RE2SR	0.00	0.73	1.97	1.93	2.27	2.33	2.43	2.43
RE3RS	0.00	0.83	2.07	2.10	2.57	2.70	2.83	2.83
RE3SR	0.00	0.87	2.13	2.07	2.53	2.63	2.87	2.87
RSC	0.00	0.57	1.80	1.80	2.03	2.13	2.20	2.20
RSNPK	0.31	0.97	2.07	2.17	2.83	3.00	3.20	3.20
SRC	0.00	0.57	1.80	1.80	2.03	2.13	2.20	2.20
SRNPK	0.32	0.97	2.03	2.07	2.87	3.00	3.13	3.13
LSD _(0.05)	0.114	0.180	0.114	0.129	0.131	0.131	0.131	0.131

Foot note

RE1RS - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber (Sole)

RE1SR - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)

RE2RS - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber (Sole)

RE2SR - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)

RE3RS - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber (Sole)

RE3SR - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber and snake tomato (Intercrop)

RSC - Sole Rubber without NPK/rubber effluent treatment (control)

SRC - Rubber-snake tomato intercrop without soil amendment (control)

RSNPK - Sole rubber treated with 60 kg N ha⁻¹ of NPK 15:15:15

SRNPK - Rubber-snake tomato intercrop treated with 60 kg N ha⁻¹ of NPK 15:15:15

At 13 – 16 MAT, stem girth was similar with RSNPK and SRNPK plants which had the thickest stems. Rubber effluent application of 50 kg ha⁻¹ for both sole and intercrop (RE1SR and RE1RS) were comparable with control (RSC and SRC) which had the thinnest stems. Stem girth increased with increasing rubber effluent application rate (RE3RS and RE3SR) were significantly lower than RSNPK and SRNPK.

There was significant differences in the number of leaves per plant among soil amendment at 1, 4, 13 – 16 MAT (Table 3). The highest number of leaves per plant was recorded in sole rubber plant treated with NPK (SRNPK). Number of leaves per plant was significantly higher with plant in SRNPK at 1 MAT. At 4 MAT, the fewest number of leaves was recorded in SRC plants which were identical with plants in RSC, RE1RS, RE1SR, RE2RS, RE2SR and RE3SR while the highest number of leaves was recorded in SRNPK plants. At 13 MAT, intercrop rubber plants treated with

NPK (RSNPK) produced the highest number of leaves which were identical with sole rubber plant treated with NPK (SRNPK). Intercropped rubber plants without fertilization (SRC) had the fewest number of leaves per plant which were identical with RSC and RE1SR.

At 14 MAT, plants grown in the different treatments ranged from 23.00 and 37.33 leaves per plant for SRC and RSNPK plants, respectively. Plants in SRC were comparable with RSC, RE1RS and RE1SR while RSNPK was comparable with SRNPK and higher than the highest rubber effluent application rate. This distribution trend was repeated at 15 MAT. At 16 MAT, the highest number of leaves per plant was observed in RE3RS which was similar to other treatments except SRC, RSC, RE1RS, RE1SR and RE2RS which had the fewest number of leaves per plant.

Table 3: Effect of NPK and rubber effluent on number of leaves per plant of rubber sapling cropped with snake tomato in a newly established rubber plantation (2018 and 2019 combined)

Treatment	2018 Months after transplanting				2019 Months after transplanting			
	1	2	3	4	13	14	15	16
RE1RS	0.00	5.33	5.33	1067	18.00	24.33	30.33	76.67
RE1SR	0.00	5.67	5.33	11.00	16.00	25.33	30.67	77.67
RE2RS	0.00	5.67	5.67	10.67	19.33	26.00	32.33	78.83
RE2SR	0.00	5.67	5.33	10.67	19.33	25.67	32.67	79.67
RE3RS	0.00	5.67	5.33	12.33	27.67	33.33	40.00	86.33
RE3SR	0.00	5.67	6.00	10.33	26.67	33.00	38.67	84.67
RSC	0.00	5.33	5.33	10.67	14.33	24.00	30.00	74.33
RSNPK	3.33	5.67	5.67	13.33	31.00	37.33	44.67	81.67
SRC	0.00	5.33	5.33	10.00	14.00	23.00	29.33	75.67
SRNPK	4.00	5.67	5.67	14.67	32.00	36.33	43.00	81.33
LSD _(0.05)	0.313	ns	ns	1.012	2.387	2.348	1.524	7.103

RE1RS - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber (Sole)

RE1SR - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)

RE2RS - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber (Sole)

RE2SR - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)

RE3RS - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber (Sole)

RE3SR - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber and snake tomato (Intercrop)

RSC - Sole Rubber without NPK/rubber effluent treatment (control)

SRC - Rubber-snake tomato intercrop without soil amendment (control)

RSNPK - Sole rubber treated with 60 kg N ha⁻¹ of NPK 15:15:15

SRNPK - Rubber-snake tomato intercrop treated with 60 kg N ha⁻¹ of NPK 15:15:15

The results in Table 4 showed the effect of NPK and rubber effluent on the leaf area of rubber intercrop with snake tomato. At 1 MAT, intercropped rubber plants treated with NPK (RSNPK) had the largest leaf area while all other treatments except SRNPK had zero leaf area. At 2 MAT, SRNPK had the largest leaf area which was identical with RSNPK, RE2RS, RE2SR, RE1RS, RE3RS and RE3SR. Rubber plants in RSC had the smallest leaf area which was identical with SRC and RE1ST. Leaf area was similar among treatment at 3 MAT. At 4 MAT, SRNPK and RSNPK had the largest leaf area. The smallest leaf area was recorded in SRC which was identical with RSC, RE2SR and RE1RS.

At 13 MAT, the smallest leaf area values were recorded in plant in SRC, RSC and RE1SR while the

largest leaf area was observed in plants in SRNPK and was identical with the leaf area of plants in RSNPK. At 14 MAT, the smallest leaf area was recorded in SRC plants which were comparable with the leaf area of plants in RSC, RE1RS, RE1ST, RE2RS and RE2SR. Leaf area of plants in SRNPK and RSNPK were identical and was also the largest. At 15 MAT, the smallest leaf area was observed in RSC, which was not significantly different from SRC, RE1SR and RE1RS. The largest leaf area was recorded in plants in SRNPK and RSNPK. This distribution trend was repeated at 16 MAT. However, at 16 MAT, leaf area of plants recorded in RE1RS was significantly higher than SRC and RSC plants.

Table 4: Effect of NPK and rubber effluent on leaf area (cm²) of rubber sapling intercropped with snake tomato in a newly established rubber plantation (2018 and 2019 combined)

Treatment	2018 Months after transplanting				2019 Months after transplanting			
	1	2	3	4	13	14	15	16
RE1RS	0.00	364.30	405.30	701.30	1194.00	1655.00	2305.00	2759.00
RE1SR	0.00	343.30	410.70	781.00	1071.00	1725.00	2361.00	2770.00
RE2RS	0.00	390.70	446.30	739.30	1340.00	1829.00	2549.00	3022.00
RE2SR	0.00	372.00	425.00	718.00	1303.00	1780.00	2601.00	2975.00
RE3RS	0.00	405.30	461.00	896.00	2010.00	2435.00	3448.00	3797.00
RE3SR	0.00	397.00	508.00	764.30	1911.00	2387.00	3269.00	3582.00
RSC	0.00	326.20	380.00	692.70	942.00	1608.00	2210.00	2485.00
RSNPK	168.00	417.00	462.30	1004.70	2335.00	2687.00	3648.00	4137.00
SRC	0.00	330.00	381.00	663.30	940.00	1541.00	2217.00	2449.00
SRNPK	141.30	429.00	461.00	1112.30	2452.00	2859.00	3496.00	3986.00
LSD _(0.05)	17.850	67.460	Ns	73.650	175.600	305.700	188.900	256.300

RE1RS - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber (Sole)

RE1SR - Rubber effluent at application rate of 50 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)

RE2RS - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber (Sole)

RE2SR - Rubber effluent at application rate of 60 kg N ha⁻¹ on rubber cropped with snake tomato (Intercrop)

RE3RS - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with rubber (Sole)

RE3SR - Rubber effluent at application rate of 70 kg N ha⁻¹ cropped with sole rubber)

SRC - Sole Rubber without NPK/rubber effluent treatment (control)

RSC - Rubber-snake tomato intercrop without soil amendment (control)

SRNPK - Sole rubber treated with 60 kg N ha⁻¹ of NPK 15:15:15

RSNPK - Rubber-snake tomato intercrop treated with 60 kg N ha⁻¹ of NPK 15:15:15

DISCUSSION

This study has showed that rubber can be successfully intercropped with arable crop (Snake tomato) for the first two years of establishment. The sole and intercropped rubber plants exhibited similar height, stem girth, number of leaves and leaf area indicating that intercropping rubber and snake tomato had no adverse effect on growth of rubber. Idoko, *et al.* (2012) reported similar stem girth for sole and intercropped rubber, Esekade, *et al.* (2013) contradict it by stating that intercropped rubber plant had thicker stem girth compared to sole rubber plant. The rubber plants, sole or intercropped grew well especially in plots that were treated with NPK and rubber effluent. This present observation implied that intercropped rubber plant had similar girth with the sole rubber plants.

The similarity in plant height exhibited by rubber in sole and intercrop indicates that intra specific competition between plants was not intense. Ehigiator and Otaru, (2011) reported shorter plant height for intercropped than sole rubber and attributed this to the reaction of the intercrop to the modified environment resulting in inter-specific competition of the component crops. Rubber plants without NPK and rubber effluent

treatments were shorter than those of the fertilized plants as they have to rely on the nutrient from the native soil which was low in fertility. The higher plant height accrued to the fertilized plants is a reflection of the effect of supplementary nutrients from applied soil amendments on the soil. The higher plant height is an indication of efficient interception of radiation as the leaves will be well distributed on the plant instead of being crowded and thus leading to higher photosynthetic activity which resulted in higher production of assimilates. This contributed to stem enlargement which is indicated by increased in stem girth. However, NPK fertilized plants (RSNPK and SRNPK) were markedly different from all other fertilizer levels throughout the experimental periods as plots treated with NPK differ from all rubber effluent levels. This may likely be due to readily release of nutrient from NPK compared to rubber effluent which will have to undergo mineralization and equilibration before being release. White and Brown,. (2010) reported that inorganic fertilizers release nutrients faster for plant utilization compared to organic fertilizers.

The stem girth of rubber plants increased with increase in rubber effluent and peaked at 70 Kg N ha⁻¹. Hoque, *et al.* (2004) reported higher stem girth with

increase in fertilizer application. The similar stem girth recorded for NPK and rubber effluent at 70 Kg N ha⁻¹ treated plants was in line with the observation of Dinesh, *et al.* (2000) and Lee, (2010) that increased in fertilizer (organic and inorganic) application also resulted in increase in the growth of rubber. The thicker stems associated with plants treated with NPK and rubber effluent implied greater retention of assimilates in the stem for higher leaf production (Law-Ogbomo, *et al.*, 2016). This could be responsible for higher number of leaves on rubber plants grown fertilized plots. Stem girth responded more favourably to fertilizer application in the second season than the first season. This could be adduced to the residual effect of the fertilizers and the crop residues of the snake tomato after harvest in the 2018 cropping season. The crop residues could have acted as mulched and equilibrated with the soil with increased in microbial population, organic content and essential plant nutrients available to the rubber plant. This finding conformed to the report of Dunsin, *et al.* (2015) who reported that fertilizer application (organic and inorganic) resulted in increase in rubber growth parameters.

Number of leaves of rubber plant increased with increase in NPK and rubber effluent application. This could be as a result of availability and utilization of plant nutrients made available by the soil amendment. This agreed with findings by Ogundare, *et al.* (2012) reported that soil amendment has the ability to make rubber plant grow better and attain tappable girth much earlier. The highest number of leaves was recorded in soils treated with NPK fertilizer which could likely be due to higher rate of release of nutrient by inorganic fertilizer compared to rubber effluent.

Higher number of leaves favours photosynthetic activity. Higher number of leaves led to higher leaf area due to additional number and larger leaves. Higher leaf area associated with fertilized plants over unfertilized plants is an indication of higher interception of solar which favour photosynthetic capacity leading to greater production of assimilates (Law-Ogbomo and Remison, 2007). Therefore, possession of higher number of leaves is a precursor to the production of assimilates which could lead to rapid stem thickening, thereby making the plant to reach the tappable girth much earlier.

This study showed that rubber growth was increased through the application of NPK and rubber effluent. The efficiency of these fertilizers in enhancing the growth of rubber was evidenced in the increase in height, number of leaves, stem girth and leaf area of fertilized plants. Anushka, *et al.* (2017) reported positive impact of rubber effluent and NPK on growth components of rubber plant. The better plant growth exhibited by NPK treated plants over rubber effluent treated plants may be attributed to the readily availability of nutrient and uptake by the plant. Thihthanakul, *et al.* (2017) reported positive response of rubber agronomic parameters to fertilizer application and that fertilized immature rubber reached tappable girth faster compared to the unfertilized.

CONCLUSION AND RECOMMENDATION

The study shows that rubber effluent contained appreciable amount of plant essential nutrients. The rubber plant did not suffer any adverse effect from the intercropping system as their growth character values were similar. Based on the findings from this study, there is the need to intercrop rubber with snake tomato and supplement soil nutrient with fertilizer application (NPK at 60kgNha⁻¹ or rubber effluent at 70kgNha⁻¹) to improve the fertility of the soil, sustain the soil and enhance the growth of rubber.

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