Direct RESEARCH JOURNALS

Responses of girth of two improved Rubber trees (*hevea brasiliensis*, muell argo) to tapping date, varieties, and soil locations in Akamkpa, Cross River state,Nigeria

Direct Research Journal of Agriculture and Food Science (DRJAFS) Vol.2 (8), pp. 113-118, September 2014
Available online at directresearchpublisher.org/drjafs
ISSN 2354-4147 ©2014 Direct Research Journals Publisher

Research Paper

Akpan, A. U.

Department of Agronomy College of Crop and Soil Sciences Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

*Corresponding Author E-mail: annahudo@yahoo.com; Tel: +2347064539635

Accepted 9 August 2014

This research was carried out in Cross River Estates limited (CREL) Akamkpa Cross River Stare, Nigeria. The research evaluated the responses of girth of two improved rubber trees (*Hevea brasiliensis,* Muell Argo) to tapping date, varieties, and soil locations in Akamkpa, Cross River State, Nigeria. Generally, the soil locations indicated high acidic situation (pH 4.40-4.69), high sand condition (73.7%-80%) including deficiencies in both micro and macro nutrients. The girths of the evaluated varieties (RRIM600 and PR107) were obviously increasing at a very slow proportion, due to poor soil locations as well as long and unregulated tapping dates, which invariably affected their girths, irrespective of the varieties. Although RRIM600 showed improved girth growth compared with PR107 at all the evaluated soil locations (Dukwe, Akamkpa and Uyanga), both varieties recorded higher cumulative mean girth of 121.6cm (RRIM600) and 119.2cm (PR107) at Akamkpa soil location, proving that Akamkpa soil location had improved fertility status compared with others (Dukwe and Uyanga). The significant influence of Akamkpa soil on the girths of the both varieties indicated that soil locations affect the growth of rubber trees, the variety notwithstanding. The improved girth performance by RRIM600 compared with PR107 at all the locations, suggested that RRIM600 was more adaptive and responsive to the agro-ecosystem than PR107. Improved and sustained girth increments of rubber trees will therefore require appropriate soil remediation practices, such as organic and inorganic fertilizers application. Cultivation of recommended varieties and adoption of proper tapping dates are recommended for vigorous girth development.

Key words: Girths, varieties, tapping dates, soil location, rubber trees.

INTRODUCTION

Rubbers (*Hevea brasiliensis*, Muell Argo) belongs to the family *Euphorbiaceae* and the *genus Hevea* (Anochili and Tindal, 1986). Rubber had been thought generally to perform best in climates of tropical low land, evergreen rainforest region, with annual rain of 2000-4000mm, evenly spread through the year, and with not more than one year of dry month (Onwueme and Sinha, 1999; Webster and Baulkwill, 1989). Many areas of the rain forest zone of Nigeria, are fairly well suited where mean annual rainfall exceeds 1750 mm and temperature falls between 22^{0}C and 28^{0}C.

Wycherley (1963), reported that soil constitutes the major aspects of the environment that greatly affect the growth and productivity of rubber trees. FELDA (1989) reported that poor plant growth might be brought about as a result of inappropriate choice of planting location. Wood (1986) reported that among the factors affecting rubber productivity, varieties has been the most, limiting factor.

Previous studies (Lundgren, 1978; Chijioke, 1980) have indicated that rubber soil suffers a considerable depletion of fertility as a result of monoculture of industrial and economic tree crop species. Benton-Jones (1985) stated that one of the major technological practices is the use of soil test and plant analysis to assist farmers identify and correct soil fertility problem.

Chijioke (1980), admitted that the extent and gravity of soil depletion depend largely on the growth rate of the species planted. The ultimate use and the biological, physical and chemical nature of soils under rubber trees in the warm, high rainfall areas of Nigeria is particularly due to the enormous nutrients removal in latex. Amalu (1992) reported that the immobilization of nutrients in the tree trunks and the use of little or no manures in rubber plantation are likely reasons for limited plantation of this species.

On the effect of tapping dates on girth (Wycherley, 1975) reported that numerous exploitation experiments, have shown adverse effect of tapping on girth increment and this effect is an important criterion in the choice of the most appropriate exploitation system. On girth and yield interaction (Sivakumaran, 1983) reported that there is a progressive increase in yield with increase in girth size, with the highest yields being obtained from trees of the biggest girth class. The effect of stimulation on girths of clones, as reported by (Gan. *et al*, 1991) was variable with girth size, clone type and stimulation concentration respectively. Akpan, *et al*. (2012), in an experiment on effect of clone types and soil fertility on stimulation and non-stimulation, reported that soil location with improved fertility indices gave higher mean girth. Apart from giving higher mean girth, locations with improved fertility indices was earlier reported to equally support higher latex yield (Akpan *et al*., 2007).

In an experiment on girths of selected cultivars (Gan *et al.,* 1991) reported, that opening at 40cm and 45cm girth brought rubber into tapping by 11 and 8 months earlier for clone GT.I, by 14 and 6 months for clone PB260; and by 13 months for clone RRIM600 respectively. Gan *et al.* (1991) submitted that initial yield per tree per tapping was lower at girth 50cm while cumulative yield was higher, because more trees per unit area could be opened at lower girth criterion. Wood and Edward (1987), acknowledged that growth and uniformity of stands determine the time of maturity and that tapping generally commences when 60% of the trees have a girth of 50cm at breast height and that if the stand is more vigorous and uniform, it could be tapped earlier. Watson (1989) stated equally that with optimum management of the soil medium, the girth of planting materials, such as; stump budding, could reach 10cm – 12cm for transplanting by about 15-18months after budding or 20-22months after nursery establishment, and that at immature stages, fertilizer is applied to promote vigorous tree growth so as to advance the time at which the trees may be large enough to be opened for tapping, at least by current standard of 50 cm girth at 150 cm above the point of budding union. Fertilizer deficiencies, particularly nitrogen, phosphorous and potassium (N.P.K) will cause slow growth rate, with reduced tree girth (Watson, 1989). With this background, the research evaluated the responses of girths of two improved rubber trees to tapping dates, varieties and the soil location in Akamkpa, Cross River State Nigeria.

MATERIALS AND METHODS

The study was conducted between June, 2008 and March 2009 in Cross River Estates Limited (CREL), Akamkpa, Cross River State. The state is located between latitudes 4^0.8' and 4.47'N and longitudes 8^0.17' and 8^0.22' E. The state has a bimodal pattern of rainfall with the first rainy season commencing from March – July and a dry period in August, followed by second rainy season in September – November. The mean annual rainfall is 266.4mm, temperature (27.1^{0}c) and relative humidity is 82.6%. The research was laid out with a split plot arrangement in a randomized complete block design. The main treatment was the two rubber varieties (RRIM600 and PR107), which were planted in the year 1990.

The sub-treatment was the three evaluated soil types: Dukwe; Akamkpa and Uyanga soils respectively, while the sub-sub-treatment was the evaluated months, June, July, August, September, October, November, December, and January, February, and March. Planting distant was 5m x 5m giving a population of 400 stands/ha, although wind damages and uncontrolled fire outbreaks were observed to reduce hectare size. Each experimental site comprised three replicates with 400 stands per replicate. At the commencement of this research, composite soil samples were collected randomly from these sites at 0 - 40 depth for particle size distribution and relevant chemical analysis, with the following parameters in focus: Soil pH by the glass electrode pH meter in 1:1 soil to water suspension, organic carbon by the dichromate wet oxidation method (Walkey-Black, 1934); total N. was determined by Kjeldahl digestion and distillation method as described by Udo and Ogunwale (1978). Available P. was determined by the Brays, P.I. method (Bray and Kurtz, 1945), while the exchangeable bases were extracted by the method described by Jackson (1964) using neutral ammonium acetate. The flame photometer was used to determine K, Na, and Ca, while Mg was read on the atomic absorption spectrophotometer.

Exchangeable acidity was determined by titration method while Cation Exchange Capacity (CEC) was determined as the sum of exchangeable bases and exchangeable acidity. Base saturation was obtained as a ratio of the total exchangeable bases to the effective Cation Exchange Capacity. The particle size distribution was determined by the Bouyoucos (1951) method.

Table 1. Rainfall (R) Temperature (T) Relative humidity (R/h) and Sunshine (S) of the research location for year 2008 and 2009.

Weather	Rainfall (mm)		Tempt Max (^{0}C)		Tempt Min. (^{0}C)		R/humidity (%)		Sunshine (hrs)	
Months	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Jan.	68.0	8.0	33.7	32.0	23.1	23.8	80	81	6.5	5.7
Feb.	5.0	10.4	32.7	33.4	23.0	23.5	82	80	3.4	3.9
March	96.5	160.4	33.4	32.7	24.0	23.4	70	70	4.1	4.5
April	156.5	374.6	32.5	32.1	23.2	23.6	77	78	4.4	5.2
May	220.0	493.2	30.5	31.6	23.5	23.4	80	84	5.8	4.9
June	249.0	397.7	29.5	28.2	23.0	23.2	83	85	3.4	3.6
July	590.5	270.8	28.6	27.6	22.1	23.0	84	85	3.0	2.8
Aug.	395.1	460.1	29.0	28.4	22.7	22.8	90	90	2.0	2.4
Sept.	579.7	811.8	28.2	28.7	23.2	23.4	92	91	1.6	1.8
Oct.	230.7	383.1	30.5	29.4	22.6	23.0	87	86	3.0	4.8
Nov.	150.7	221.4	30.4	31.7	23.3	23.2	85	80	5.4	3.8
Dec.	55.4	4.8	32.6	32.0	24.0	24.3	78	84	6.5	6.4
Mean	233.1	299.6	30.9	30.7	23.1	23.2	82.3	82.8	4.09	4.15

Source: CREL (Nig) Ltd. Akamkpa.

Table 2. Girth measurement of rubber trees (cm) at 1.5m above ground level) as influenced by tapping date, soil locations and clone type.

Tapping date	Dukwe soil girth		Akamkpa soil girth		Uyanga soil girth	
	RRIM600	**PR107**	**RRIM 600**	**PR107**	**RRIM600**	**PR107**
June	92.72	89.13	119.80	117.58	115.90	110.13
July	93.30	87.84	120.05	117.95	116.20	110.86
Aug.	94.01	88.20	120.75	118.15	116.50	11.58
Sept.	94.59	88.50	121.03	118.50	116.98	112.93
Oct.	95.02	88.89	121.57	118.90	117.05	112.98
Nov.	95.69	89.08	121.95	119.46	117.88	113.58
Dec.	96.25	89.99	122.03	119.87	118.38	114.51
Jan.	96.88	90.23	122.68	120.23	118.68	115.20
Feb.	97.06	90.85	123.10	120.78	118.98	115.87
March	97.56	91.30	123.96	121.30	119.77	116.03
Means	95.31	89.40	121.69	119.27	117.63	113.37

LSD ($P< 0.05$), Varieties: 4.81,Dukwe:1.406,Akamkpa:3.403,Uyanga: ns,Tapping date: 1.99

Twenty rubber stands were sampled randomly per plot giving 60 stands per replicate for each variety in each location. Girths of the evaluated varieties were measured once per month for a period of 10 months. This methodology was adopted due to the observed slow girth increment associated with rubber trees placed on regular tapping as well as stimulation regimes. A well graduated measuring tape was used to measure rubber stems, at a position of 1.5m diameter at breast height (dbh) above the ground level. Data from the girth measurement and the soil analyses were subjected to Analysis of variance (ANOVA) method (Gomez and Gomez, 1984) while Fishers' Least Significant Difference (F-LSD) ($P<0.05$) was used to compare means.

In addition, data on the climatic situation of the research site (Table 1) were recorded during the research, from the meteorological unit of CREL (Nig) limited. Parameters of interest were: rainfall (mm), maximum and minimum temperatures (^{0}c) relative humidity (%) as well as sunshine (hrs).

RESULTS AND DISCUSSION

Girths of rubber trees as influenced by varieties, tapping dates and soil location

Both varieties and soil location greatly influenced the girths of rubber trees while tapping date exhibited a negative influence (Table 2) Although the girths of the evaluated varieties (RRIM600 and PR107) were generally low across the evaluated soil locations (Dukwe,

Table 3. Physico-chemical attributes of the evaluated soil locations in year 2008 – 2009.

Research site	pH	EC ds/M	Org. M %	Total N%	AV.P (mg/kg	Ca	Mg	Na	K Cmol/kg	EA	ECEC	B.Sat.%	Sand%	Clay %	Silt %	Textual classes
Dukwe soil																
RRIM 600	5.30	0.06	0.14	0.006	6.80	1.30	0.40	0.02	0.03	1.60	3.48	60.72	78.8	30.5	5.6	SL
PR107	3.50	0.03	0.15	0.14	4.60	1.10	0.06	0.06	0.04	1.50	3.30	54.66	80.8	26.8	1.9	SL
Means	4.40	0.05	0.15	0.10	5.70	1.20	0.23	0.05	0.04	1.55	3.39	57.69	79.8	28.7	3.75	
Uyanga soil																
RRIM 600	4.70	0.05	0.28	0.08	7.75	2.30	0.40	0.07	0.12	1.60	4.10	50.50	70.8	70.8	30.5	SL
PR107	4.68	0.03	0.28	0.06	5.44	2.70	0.60	0.07	0.16	1.50	5.60	68.75	76.5	70.5	36.8	SL
Mean	4.69	0.04	0.28	0.07	6.50	2.50	0.50	0.07	0.14	1.55	4.85	59.63	73.7	70.7	33.7	
Akamkpa - soil																
RRIM 600	4.48	0.06	2.38	0.06	11.60	2.08	0.86	0.08	0.11	2.34	4.08	56.16	80.8	16.6	30.6	SL
PR107	4.40	0.05	1.86	0.06	12.30	2.30	6.68	0.08	0.13	1.81	4.89	50.64	80.8	16.6	30.6	SL
means	4.44	0.02	2.12	0.06	11.95	2.19	3.77	0.08	0.12	2.08	4.49	53.40	80.8	16.6	30.6	
LSD (P<0.05)																
Clone	0.08	NS	0.40	NS	2.30	0.50	NS	NS	NS	0.17	NS	4.50	4.8	4.2	NS	
Location	0.05	NS	0.05	0.01	0.33	NS	0.20	NS	NS	0.30	0.4	8.16	3.5	4.0	NS	

N/B: Values are means from the three replicates,SL=Sandy Loam,NS=Not significant

Akamkpa and Uyanga), RRIM600 recorded improved girths over PR107 at all the research sites, showing that RRIM600 was adaptive and responsive to soil locations, tapping date, and the prevailing climatic indices of the agro-ecosystem compared with PR107. Perhaps this explains why (Wood, 1986; and Opeke, 1987) reported that among the factors effecting rubber growth and productivity, varieties, has been the most limiting factor. Both varieties recorded higher cumulative mean girth of 121.6 cm (RRIM600) and 119.2cm (PR107) in Akamkpa soil, compared with the relatively low girths obtained at Dukwe and Uyanga soils respectively (Table 2). Thus, suggesting that Akamkpa soil, with improved fertility status supported sustained and vigorous girth development over Dukwe and Uyanga soils with relatively low fertility status. This is in line with an earlier assertion by (Wycherley, 1963) that soil constitutes the major aspects of the environment the greatly affect the growth and productivity of rubber trees, while FELDA (1989), reported that poor plant growth might be brought about as a result of inappropriate choice of planting location.

The generally low girths (Table 2) exhibited by both clones across the evaluated soils were attributed to low soil fertility and unregulated tapping dates frequencies. In the long run however, unmitigated poor soils and tapping dates and tapping frequencies would impact negatively on the girth of rubber trees. This finding confirms an earlier report by (Wycherley, 1975) that numerous exploitation experiments have shown pronounced adverse effect of tapping on girths increment and this effect is an important criterion in the choice of the most appropriate exploitation systems.

Soil fertility conditions and clone/soil interaction

The fertility situation of the evaluated soils (Dukwe, Uyanga and Akamkpa) (Table 3) greatly influenced the girths of the evaluated rubber varieties (RRIM600 and PR107) respectively. The higher cumulative mean girth performance of 121.6cm (RRIM600) and 119.2cm (PR107) at Akamkpa soil showed that Akamkpa soil possessed improved fertility indices over Dukwe and Uyanga soils, which recorded poor girth conditions (Table 2), because of poor fertility indices (Table 3), thus showing that fertile soils will always support vigorous girth increment irrespective of the variety. Among the evaluated soils, RRIM600 recorded higher girths of 95.3cm (Dukwe), 121.6cm (Akamkpa) and 117.6cm (Uyanga) over PR107 with girth of 89.2cm (Dukwe), 119.6cm (Akamkpa) and 113.4cm (Uyanga) respectively (Table 2), suggesting that girth growth of varieties vary with soils. The researcher observed that RRIM600 was more responsive and adaptive to the agro-ecosystem than PR107. This disparity between RRIM600 and PR107, was earlier reported by Wycherley (1971), that varieties vary greatly in response to soil fertility, some being almost sterile and some very prolific.

The mean pH values of 4.40, 4.69 and 4.44 for Dukwe, Uyanga and Akamkpa soils, indicated that soils wore generally acidic and therefore capable of hindering the availability of macro-nutrients to the rubber trees. The particle size analysis revealed that Akamkpa soil was higher in sand fraction (80.8%), followed by Dukwe soil (79.8%) as well as Uyanga soil (73.7%) (Table 3). Apart from total N. which was higher in Dukwe soil, organic matter, available Phosphorus (AV.P.), Mg, Na were generally higher in Akamkpa soil. High sand endownment could be remedied by the planting some varieties of creeping legumes, including *pueraria phaseoloides, Colopogonium muocunoides*, and *Centrosema Pubescens*, for the eventual production of organic matter that will provide effective aggregation and binding effects on the soil.

The general fertility condition of these soils was low, which explains the negligible girths increment observed. The sand fractions were higher than the recommended range of (50-70%) texture for rubber growth (RRIM, 1977). High sand proportion will facilitate reduced water-holding capacity while nutrients will be leached beyond the reach of roots of the trees. The total N. and AV.P values were below the critical limits of 1% (Pushparajah *et al.,* 1983) and 11.0mg/kg (Chan *et al.*, 1984). The evaluated soils could not therefore support vigorous girth growth of the evaluated clones. The research showed that, where fertility was relatively better (Akamkpa) girth growth was higher (Tables 2 and 3).Research has indicated that where K, Ca, Mg. values were below 0.2,5 and 1 cmol/kg, the rubber growth was equally very low (Tinker 1967; Taylor and Pholen, 1970; Enwenzor *et al.,* 1988; Amalu, 1992). It is therefore extremely crucial, that proper soil remediation practices; through liming, organic and inorganic fertilizers application must be taken seriously. RRIM600 performed better than PR107 in all the evaluated soil, proofing that the former is adaptive and responsive to the agro-ecosystem.

CONCLUSION

Sustained increments in girths of rubber trees, irrespective of the variety, vary with variety, tapping date, as well as soil location. The girth disparities exhibited by both RRIM600 and PR107 is attributable to the higher genetic, adaptive and responsive potential possessed by RRIM600 for the agro-ecosystem over PR107. The evaluated soils (Dukwe, Akamkpa and Uyanga) however require efficient soil remediation practices, such as application of inorganic and organic fertilizers, the cultivation improved rubber variety and adoption of proper tapping date to facilitate sustained girth increments of rubber trees. RRIM600 was however recommended for the agro-ecosystem.

ACKNOWLEDGEMENT

I am very grateful to the management and the entire field staff of CREL (Ltd) Akamkpa, Cross River State, for their esteemed support.

REFERENCES

Akpan AU, Edem SO, Ndaeyo NU (2012). Latex yield of rubber (Hevea brasiliensis, Muell Argo) as influence by clone planted and locations with varying fertility status. Journal of Agriculture and Social Sciences. 3(1):29-30.

Akpan AU., Edem SO, Ndaeyo NU (2007). Effect of clone type and soil fertility on stimulation and non-stimulation of rubber trees (Hevea brasiliensis, Muell Argo) in Cross River State, Nigeria. Journal of Applied Agricultural Research. 4(2):131-138.

Amalu UC (1992). Survey of properties and constraints of the acid sands of mid-west Nigeria to higher yields of rubber (Hevea brasiliences, Muell Argo) trees. Nigerian Journal of Agric. Sci. 6:34-40.

Anochili BC, Tindall AD (1986). Cash Crops. Macmillan Publishers, London.

Benton-Jones J(1985). A specialized laboratory for soil testing and plant analysis. World Crops, 37:28-29.

Bouyoucos GH (1951). A recalibration of the hydrometer method for making mechanical analysis of soils. Agronomy Journal 43: 434-438.

Bray RH, Kurtz LT (1945). Determination of total organic and available form of phosphorus in soils. Soil Science 59.39-45.

Chan HY, Yew FK, Pushparajah EH (1984). A soil suitability, technical grouping system for Hevea. Third ASEAN soil conference. Kuala Lumpur, Malaysia. Pp. 9-11.

Chijioke EO (1980). Impact of mono culture of *Gmelina arborea* and *pinus caribea* on soils of lowland humid tropics, Report of Adre Major Researcher Fellowship, FAO, Rome. P.82.

Enwenzor WO, Udo WJ, Usoro NJ, Ayotode KA, Adepetu JA, Chude VO, Degbe C (1988). Fertilizer use sand management of food crops in South Easter Nigeria. In: Fertilizer use and management practices for crops in Nigeria. Series no FPDD. P. 64

FELDA (1989). Federal Land Development Authority, Annual Report, Kuala Lumpur, FELDA.

Gan LT Chew JS, Chew OK, Ho CY (1991).Early opening of trees to improve productivity and profitability. In: Proceedings of Rubber Research Institute of Malaysia (RRIM). Rubber growers' Conference. Poh, Perak. PP. 147-154.

Gomez KA, Gomez AA (1984). Statistical Procedure for Agriculture Research. John Wiley and Sons. New York.

Jackson ML (1964). Soil Chemical Analysis: Advance course, 2nd Edition. Department of Soil Science. Wisconsin. Pp. 12-15.

Lundgren E (1978).Soil conditions and nutrient cycling under natural and plantation forests in Tanzania highlands. Reports on forest ecology and forest soils. 31 Department of Forest Soils, Swedish University of Agricultural Science. Uppsala, Sweden Pp. 5-8.

Onwueme IC, Sinha TO (1999). Field Crops production in Tropical Africa. C.T.A. Wageningen. Netherlands. Pp. 35-40.
Opeke LK (1987). Tropical Tree Crops. Spectrum Book Ltd, Ibadan. Pp. 85-103.
Pushparajah EH, Chan Y, Sivanadyan K (1983): Recent development for reduced fertilizer applications in Hevea. In: proceedings of the Rubber Research Institute of Malaysia. Planters' Conference. Kuala Lumpur Pp. 313-327.
RRIM (Rubber Research Institute of Malaysia) (1977). A soil suitability technical grouping system for Hevea. Planters' Bulletin of the Rubber Research Institute of Malaysia. PP. 135-146.
Sivakumaran S (1983). Ethephon stimulation, Inter-relationship between concentration, dosages and frequency of application. Planters' Bulletin of the Rubber Research Institute of Malaysia. 179:59-64.
Taylor HN, Pholen IJ (1970).Soil Survey Methods Department of Sciences and Industrial Research. Lower Hatt. New Zealand. Soils Bureaux Bulletin 25:101.
Tinker PBH (1967).Soil chemistry and fertility. In: Proceedings of the International Society of Soil Science. Aberdeen pp. 223- 231.
Udo EJ, Ogunwale SA (1978). Laboratory manual for the analysis of Soils, Plants and water samples. University Press, Ibadan, Nigeria.
Walkey A, Black IA (1934). An examination of the Degtjareff method of determination of soil organic matter Soil Science 37:29-38.
Watson GA (1989). Climate and Soil. In: Rubber. C. C. Webster and W. J. Baulkwill (Editors): Longman Group. United Kingdom. Pp. 244-308.
Webster CC, Baulkwill WJ (1989). Rubber. Longman group. United Kingdom. Pp. 107-109.
Wood BJ (1986).A brief guide to Oil Palm Science. The Incorporated Society of planters. Malaysia. Pp. 66-70.
Wood BJ, Edward NC (1987). The Role of Research and Development in plantation profitability. Planter Kuala Lumpur 63:236.
Wycherley PR (1963). Variation in performance of Hevea in Malaysia. Journal of Tropical Geography. 17:143-145.
Wycherley PR (1971). Hevea Seeds (i) (ii) (iii): Planter. Kuala Lumpur. 47:291-298; 47:345-350; 47:405-410.
Wycherley PR (1975). Hevea: long flow, adverse partition and storm losses. Planter, Kuala Lumpur. 51:6-13.