Turrialba Vol. 30, Nº 3, 1980, pp. 268-271

Effect of inter-planting **Gmelina arborea** with food crops on soil condition*

S.O OJENIYI**, O. O AGBEDE***

COMPENDIO

Se investigó, en tres lugares de Nigeria del Sur, el efecto del plantío asociado de un árbol, Gmelina arborea *Roxbg con cultivos alimenticios, sobre la fertilidad del suelo. El cultivo asociado de* Gmelina *con plantas alimenticias como ñame, maíz y yuca no causó un cambio significativo en la fertilidad del suelo. Sin embargo, se observaron una ligera reducción en el carbono orgánico del suelo y aumentos en el N y P del suelo como resultado de la agri-silvicultura (producción simultánea de productos forestales y alimenticios en un terreno). No se observó un cambio definido en el pH. Esta investigación contribuye a apoyar la práctica de la agri-silvicultura como medio de incrementar la producción de alimentos en los trópicos.*

Introduction

AGRI-SILVICULTURE is simultaneous production of forest treep crop and agricultural crops on the same land Especially in the first two years of the forest crop, it is inter-cropped with single or multiple food crops. The background, biological and socio-economic aspects of this universally accepted system have been discussed (1). In Germany, agri-silviculture is called *waldfelbau,* in France *plantation sur cultures,* in Puerto Rico *parcelero* system, in Brazil *consorciação,* in Burma *Taungya* (3) and in India *Kumri*.

Various suggestions and assumptions have been made as to the effect of agri-silviculture on soil condition. Data on this aspect are rarely available (1), and *Gmelina arborea* as an agri-silvicultural crop supporting the pulp industry has not been dealt with by soil studies It was indicated (1) that there was great need for investigation of soil condition under agri-silviculture. King (1) concluded that it might be good policy to establish pulp plantations in the tropics with the use of cultivators (workers to crop the plantations), but also with the use of agricultural crops which are known to exercise no harmful effects upon the soil.

This paper briefly reports trials on the effect of agri-silviculture on soil fertility in different ecological zones of Southern Nigeria. Yam *(Dioscorea rotundata),* cassava *(Manihot utilissima)* and maize *(Zea mays)* are produced in young forest plantations in Nigeria.

Materials and method

Field Treatment

Five treatments, each treatment replicated 8 times, were established in three locations in Southern Nigeria. The agri-silvicultural treatments and the control were *Gmelina* alone (A), *Gmelina* + yam + cassava + maize (B), *Gmelina* + maize (C), *Gmelina* + yam (D), and *Gmelina* + cassava (E). The locations were Bende (5° 30'N, 7° 32'E), Sapoba (6° 47'E 4° 02'N) and Calabar (8° 21'E' 4° 58'N) The mean annual rainfall for the locations are about 1450, 2900 and 2200 mm. The analysis data of soil samples collected after bush clearing from 0 - 20 cm depth at the three sites in March 1975 are shown in Table 1. The sites had been under secondary forest 10 years before clearing

At each location, a randomized block design was utilized, with each treatment plot being 20 m x 20 m Stumps of Gmelina were planted staggered in June 1975 at a spacing of 2 m x 2 m. Cassava (matures in 1 year) cuttings collected from the International Institute of Tropical Agriculture at Ibadan were also planted in June, while maize (matures in 5 - 6 months) and yam (matures in about 1 year) had been planted at the onset of rain in March. All food crops were inter-planted, with yam on mounds, at 1.2 m x

* Received for publication November 23th, 1979

** Soil Scientist, Cocoa Research Institute of Nigeria, P.M.B. 5244, Ibadan, Nigeria

*** Research Officer, Forestry Research Institute of Nigeria, Ibadan, Nigeria.

1.2 m. Yam set and cassava cuttings (purchased from local farms) were not planted in the same row with *Gmelina,* but within the rows of *Gmelina* Maize was planted within and between the rows of *Gmelina.* Major cultural practises were thrice weeding (by hoe) and staking of the yam on mounds. Maize, yam and cassava were harvested 6, 12 and 15 months respectively after planting.

Soil Sampling

At about 30 months after planting (August 1977), soil samples were collected from each treatment plot Two samples were collected by hand trowel at 0 - 8 and 8 - 30 cm depths Therefore for each treatment, 48 soil samples were collected from the three experimental locations. On the whole 240 soil samples were analized from N (%), P (ppm), exchangeable K, Ca and Mg (m e/100 g soil), organic carbon (%), and pH in water and $CaCl_2$

Soil Analysis

Portions of 2mm- sieved air-dried soil samples were chemically analysed. Organic carbon was determined by the Walkey-Black (potassium permanganate) method (5). The available phosphorus was extracted with Bray and Kurtz solution Nº 1 and determined by the molybdenum blue method as modified by Yuen and Pollard (7). Total nitrogen was determined by the semi-micro Kjeldahl method according to Mackenzie and Wallace (2) The exchangeable cations Ca, Mg and K were determined on a 2N ammonium acetate leachate Exchangeable Ca and Mg were determined by titration with varsenate using Eriochrome Black T as indicator, Ca alone also by varsenate titration with calcein as indicator and Mg by difference. In both titrations, potassium cyanide, triethanolamine and hydroxylamine hydrochloride were used to mask interfering elements. Exchangeable K was determined by flame photometry. The pH of a 1 : 2.5 (4) soil-water and soil - $CaCl_2$ solution was measured by means of a glasselectrode assembly

Results and discussion

Soil analysis data from inter-cropped *Gmelina* plots were quite close, and therefore the mean for the plots were compared with that of the plot with *Gmelina* alone. This was to achieve clearity and brevity. The only aim of this paper is to investigate whether intercropping of *Gmelina* had deleferious effect on soil fertility. For example the soil organic carbon content (%) for plots B, C, D and E at Sapoba were 1.73, 1.72, 1.68 and 1.88 respectively The equivalent values for soil N were 0.24, 0.20, 0.26 and 0.22 per cent respectively The values for pH at Bende were 5.7, 5.6, 5.9 and 5.7

Agri-silviculture only caused insignificant reduction in soil content of base elements (K + Ca + Mg) in two out of the three ecological locations (Table 2). The only exception was at Sapoba, and this could be due to the initial lowest content of base elements in its soil (Table 1). Increased cultivation due to agri-silviculture might have increased organic matter decomposition (6) and release of base elements. Nye and Greenland (3) also concluded that no large decreases in soil exchangeable cations were likely occur after a single cropping period of one to three years after bush clearing in the tropics.

Also in two out of three sites, agri-silviculture caused increase in the soil content of N and P. Comparison of Tables 1 and 2 show that there were

Table 1.—Characteristics of soil samples from experimental sites before planting.*

Site	N(%)	P(ppm)	K (m e /100g)	Ca (m e /100g)	Mg (m e /100g)	C(%)
Bende	0.16	4.44	1.58	38.30	14.15	4.00
Mechanical analysis (%)			33.7 CS	31.0 FS	10.1 S	25.2 C
Calabar	0.12	6.35	0.58	2.40	1.75	1.39
Mechanical analysis (%)			46.5 CS	30.3 FS	6.5 S	16.7 C
Sapoba	0.05	2.52	0.15	0.63	0.90	1.35
Mechanical analysis (%)			54 OCS	18.8 FS	11.2 S	16.0 C

* Each value is mean for 5 samples collected at 0 - 20 cm depth CS, FS, S and C represent Coarse sand, Fine sand, Silth and Clay respectively

Table 2—Effect of inter-cropping Gmelina with food crops on soil major and secondary nutrients.

Site	Treatment	N %	P ppm	K m e/100g	Ca	Mg Soil
Bende	Gmelina	0 19	8 6	1 14	9 80	3.75
	Gmelina + Crop	0 21	11 2	1 08	4 83	3 78
Sapoba	Gmelina	0 11	5 5	0 14	1 09	1.59
	Gmelina + Crop	0 23	8 9	0 20	1 23	2 39
Calabar	Gmelina	0 09	4 4	0 29	3 69	1 68
	Gmelina + Crop	0 09	3 5	0 25	3 59	1 13

increases in soil N and P as a result of cropping after bush clearing. Observed reduction in organic carbon content (Table 3) as a result of agri-silviculture could have caused increased availability of N and P in the soil (3). It is shown that at those sites where increased N and P were observed (Bende and Sapoba), there was also reduction in soil organic carbon content as a result of agri-silviculture.

Table 3—Effect of inter-cropping Gmelina with food crops on soil organic carbon

Site	Treatment	C(%)	Organic matter (%)
Bende	Gmelina	2 83	4 90
	Gmelina + Crop	2 58	4 46
Sapoba	Gmelina	1 75	3 03
	Gmelina + Crop	1 48	2 56
Calabar	Gmelina	2 00	3.46
	Gmelina + Crop	1 64	2.84

Slight change in soil fertility as a result of agri-silviculture expectedly did not reflect in considerable differences in pH values as shown by Table 4.

Although some degree of consistency was observed in the data, no significant difference in the values of any soil chemical factor was observed as a result of agri-silviculture. Table 5 shows the F values to treatment and site. In most cases, soil chemical parameters significantly varied from one site to the other, which indicates that the trials were adequately spread. The insignificant effect of agri-silviculture on soil fertility could be the main biological justification for agri-silviculture. King (1) suggested that agri-silviculture which only involves cropping for a relatively short period might not cause noticeable deterioration

Table 4—Effect of inter-cropping Gmelina with food crops on pH

Site	Treatment	pH (water)	pH ($CaCl_2$)
Bende	Gmelina	6 1	5 1
	Gmelina + Crop	5 7	4 7
Sapoba	Gmelina	4 9	3 2
	Gmelina + Crop	5 1	4 4
Calabar	Gmelina	4 9	4 2
	Gmelina + Crop	5 1	4 7

in soil fertility. He indicated that after clearing of forest and felling of trees for afforestation soils of the humid and sub-humid tropics possess qualities necessary for raising food crops.

Table 5—Statistical analysis of the effect of site and agri-silviculture on soil chemical parameters.

Parameter	Source of variation	df	F	
pH (water)	Treatment	1	0 18	NS
	Site	2	9 82	*
Soil Mg	Treatment	1	0 10	NS
	Site	2	15 25	**
Soil K	Treatment	1	2 00	NS
	Site	2	106 00	*
Soil C	Treatment	1	2 00	NS
	Site	2	13 00	*

* F Significant at 0 1 level, NS is non-significant F

Summary

The effect on soil fertility of inter-planting a forest crop, *Gmelina arborea* Roxbg. with food crop was investigated in three locations in Southern Nigeria Inter-cropping of *Gmelina* with food crops such as yam, maize and cassava caused no significant change in soil fertility However slight reduction in soil organic carbon and increases in soil N and P as a result of agri-silviculture (simultaneous production of forest and food crops on a land) were observed No definite change in pH was observed. The investigation therefore further supports the practise of agri-silviculture as a means of increasing food production in the tropics.

Literature cited

1 KING, K F S. Agri-silviculture (The Taungya System) University of Ibadan, Nigeria. Bulletin Nº 1, Dept Forestry, 1967/68, pp 25-44

2. MACKENZIE, H A. and WALLACE, H S. The Kjeldahl determination of nitrogen. A critical study of digestion conditions - temperature, catalyst and oxidizing agents. Australian Journal of Chemistry 7:55-69 1952.

3 NYE, P H and GREENLAND, D. J. The soil under shifting cultivation Harpenden, Commonwealth Agricultural Bureaux Technical Communication Nº 51 1960. pp 98-137

4 NEPTUNE, A M, MURAOKA, T and STEWART, J W. Efficiency of fertilizer phosphorus utilization by common bean *(Phaseolus vulgaris* L.) CV 'Carioca' under different methods of applying phosphatic fertilizer Turrialba 29: 29-34 1979.

5. ORPHANOS, P I. On the determination of soil carbon Plant and Soil 39: 706-708. 1973

6 SOANE, B D and PIDGEON, D J Tillage requirement in relation to soil physical properties Soil Science 119-376-384. 1975.

7. YUEN, S H and FOLLARD, A G. Denige method for the determination of phosphorus with special reference to soil extracts. Journal of the Science of food and Agriculture 6: 223-225. 1955.

Notas y Comentarios

Publicaciones

Revista AIBDA Con fecha enero-junio de 1980 ha aparecido la *Revista AIBDA,* órgano de la Asociación Interamericana de Bibliotecarios y Documentalistas Agrícolas (AIBDA) Por algún tiempo anunciada y esperada en el ambiente de la documentación, el primer número constituye una promesa de que esta nueva publicación cumplirá a cabalidad su propósito de servir de instrumento de mejoramiento profesional y educación permanente de los que en este hemisferio están involucrados en la información científica agrícola Contendrá contribuciones originales de investigación, comunicaciones técnicas y revisiones de literatura El primer número tiene artículos sobre la construcción de vocabularios controlados (D Leatherdale y María José Galrao); sobre los suelos en los sistemas de clasificación bibliográfica universales (Milton Nocetti), y de enfermedades y plagas de plantas en la clasificación Dewey (María Días Bicalho) Tiene notas técnicas, una bibliografía sobre tesaurus, un glosario de siglas y abreviaturas usados en la especialidad, y cuatro reseñas de libros De periodicidad trimestral, la editora es Ana María Erickson, la infatigable Secretaria Ejecutiva de AIBDA La dirección es: AIBDA, c/o IICA-CIDIA, Turrialba, Costa Rica.

Publicaciones

Nueva Agricultura Tropical Deberíamos haber saludado hace algún tiempo la reparación de la antigua revista, fundada en 1945, *Agricultura Tropical,* órgano de la Asociación Colombiana de Ingenieros Agrónomos (SIAC), la que desapareció hace unos años a raíz de una crisis institucional pero no lo hicimos antes por no haber recibido un ejemplar hasta ahora Se trata del Volumen 33, número 6, correspondiente a junio de 1980, y lleva el título de *Nueva Agricultura Tropical.* Hay una brecha de cuatro años, pues debería estar en el volumen 36 si hubiera seguido apareciendo sin interrupción Debemos agradecer por esto a los ingenieros agrónomos colombianos que, para fortalecer su unión, comenzaron a formar asociaciones regionales (ASIAVA, SIAS, etc.) las que a su vez fundaron la Federación de Ingenieros Agrónomos de Colombia (FIAC), el nombre que en breve adoptará la SIAC. Con esta estructura, la FIAC adquirirá solidez y poder para desempeñar su papel de órgano representativo de los profesionales colombianos del agro Entre sus múltiples tareas del futuro está la de mantener el nivel de esta prestigiosa revista agrícola latinoamericana

El número que hemos recibido contiene artículos de opinión y crítica sobre el plan de integración nacional en su parte correspondiente al sector agropecuario y el sistema de alimentos, así como también sobre el suelo ante los otros factores de producción agrícola El presidente de la SIAC-FIAC es Ernesto Muñoz Orozco, el director ejecutivo es Carlos Augusto Villarruizar Quesada, y el director de la revista, Darío Restrepo Ramírez. La dirección es: Apartado Aéreo 18282, Bogotá.