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INFLUENCE OF PLANT PRUNINGS ON SOIL PROPERTIES AND YIELD OF YAM MINISETT

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ABSTRACT

The importance of the application of agroforestry prunings on improvement of the soil organic matter cannot be overemphasized. The study focused on the influence of plant prunings on soil properties and yield of yam minisett. There is no doubt that effective production of seed yam through minisett technique requires adequate plant nutrient to be available in the soil. The study revealed that application of agroforestry prunings improved soil exchangeable K. The study showed that the plant prunings of Gliricidia sepium seem to be the best of the prunings used in this study in terms of total yield (t/ha), nitrogen, phosphorous and potassium addition to the soil. The resulting effect of this is improvement in the yield of yam minisett.

Key words: plant prunings, soil properties, yield of yam minisett

INTRODUCTION

Application of agroforestry prunings improved the soil organic matter. The various agroforestry prunings are high in dry matter. The dry matter content of plant prunings used in the study ranged from 31.8% to 47.6%. The dry matter decomposes and releases organic matter into the soil. The decomposition process is progressive, that is why organic matter improved with time for plots that received agroforestry prunings. Better effect of the agroforestry prunings on organic matter was obtained with *Gliricidia sepium, Pentaclethra macrophylla, Spondias mombin* than *Dactyladenia barteri*. This could be attributed to higher N content of these agroforestry prunings compared to *Dactyladania barteri*. In the same vein, Application of agroforestry prunings improved soil pH. Improvement of soil pH on application of green manure has been reported by Hue and Amien (1989) and was attributed to the release of organic chelates as decomposition products of green manure which then forms complexes with $Al(OH)_3$

METHODOLOGY

The experiment was concluded on the experimental research farm of the National Root Crops Research Institute (NRCRI) Umudike, Umuahia which is located on latitude 05^0 29^1N and longitude 07^0 33^1E in the rain-forest ecological zone of Southeastern Nigeria. The site lies at an altitude of 122 metres (400ft) above sea level. The Research Institute can be conveniently reached from all parts of the country. Geographically, South-eastern Nigeria refers to the area bounded within latitudes 4^0 20^1 and 7^0 25^1 north of the equator and longitudes 5^0 25^1 and 8^0 51^1 east of the Greenwish meridian, occupying a land area of about 109,524sq km or about 11.9% of the total land area of Nigeria (Odurukwe et al; 1995). It is bounded on the West by River Niger and Delta State, on the East by the Republic of Camcroon, on the North by Benue State and on the South by the Bight of Benin (Odurukwe et al; 1995). With a population of 19.36 million or 22% of the population of Nigeria, it is once of the most densely populated zones of the Country.

The climate of Umudike is typical of the humid tropics, with fairly even and uniform temperatures throughout the two seasons (dry and rainy) each year. The rainy season which usually starts from early March and ends in October is characterized by clouds driven by light winds from the ocean, relatively constant temperature, frequent rains and high humidity. From May to October, rainfall is quite high with peaks in July and September.

From November, when the dry season starts, the weather clears rapidly as the wind shifts to become the dusty “Hamattan” bringing the drier air from the Sahara. The season, notably dry with very little rainfall, hotter days, cooler nights, and lower humidity, ends in February. The mean annual maximum temperature ranges from 30^0C to 33^0C and mean annual minimum temperature ranges from 21^0C to 29^0C (Enwezor et al 1990). The rainfall distribution pattern of the area is bimodal with a total annual mean of 1830mm in the Delta region (Odurukwe et al; 1995). A meteorological station is maintained and observations are made on rainfall, air, temperature, relative humidity, sunshine, wind velocity, and evaporation. Table one(1) gives weather characteristics for Umudike in respect of rainfall, air, temperature and relative humidity for a 40 year period (1928 – 67) wind velocity, sunshine and day length for a 10 year period (1956-65).

The soils in Umudike (study area) are classified as Ultisol, Alfisols, and Oxisols (USDA Classification) or Acrisols, Luvisols and Nitosols (FAO/UNESCO Classification). (Jungerius, 1964; FAO/UNESCO, 1977; FPDD, 1989). The soil of the study area is classified as Ultisol. (USDA Classification). The soils of Umudike were derived from semi consolidated sand and sandy clay deposits with occasional intercalation of shale and sandstone fragments at varying depths. Soil type distribution tends to grade into a toposequence following the occurrence of a natural ridge running across the station in a west easterly direction with the land sloping towards Northern and Southern boundaries. Towards the Western half, the ridge is dissected by the Qua Ibo stream into whose narrow basin the ridge tends to phase out. The vegetation of the experimental area is typical of tropical rainforest vegetation. The secondary bush which dominates the area are the remnant of the typical tropical rainforests which are fast disappearing in the area. Some of the forest species found in the area especially in the alley crop portion includes: *Dactyladenia barteri, Magnifera indica, Pentaclethra macrophylla, Gliricidia sepium, Irvengia gabonensis and Treculia africana*. Grasses and broadleaf weeds that dominate the entire area include *Panicium maximum, Pennisetum purperium, Cyperus spp, Axonopus compressus, Elusine indica. The broadleaf weeds are Chromolaena odoratum, Centrosema pubescen, Calapagonium, mucunoides, Mucuna spp, Aspillia africana etc*. The major tuber and root crops mostly grown on ridges and mounds in the area include Cassava (*Manihot esculanta*), Yam (*Dioscorea spp*), Sweet potato (*Ipomoea batatas*) and Cocoyam (*Xanthosomonas sagittifolium*). Maize (*Zea mays L*), Melon (*Citrullus vulgaris*), Tomato *(Lycopersicium esculantum*), Pepper (*Capsicium spp*) and Vegetables such as Okra (*Hibiscus esculentus*) and fluted pumpkin (*Telferia spp*) are also grown as intercrops. Yields are however, low due to the inherent low soil fertility.

Fallow practices as in other parts of the tropics are the traditional shifting cultivation and its related bush fallow system. The dynamics and characteristics of these systems in the humid and sub-humid regions of West Africa and some parts of South America have been described by Nye and Greenland (1960), Ahn (1970), Hopkins (1974) and Ruthenberg (1980). Following the fallow period, the secondary forest regrowth or grass is cut with cutlass or slasher and the biomass and plants residues are burnt in-situ after drying. The land is then cropped for short period after which it is again allowed to fallow and the cycle is repeated. This type of clearing is not exhaustive, leaving both appreciable cover on the soil, and the root system which gives the tropical structural stability for one or two years (Aina et al; 1991). The experimental site had been cropped continuously for four years with mechanical clearing done in February/ March followed by planting in April/ May. During these years, cassava had been inter-planted with other crops like maize, melon, pepper, fluted pumpkin and sometimes yam. Inorganic fertilizers and organic manure were used sparingly. When these were available, weeding was done manually using hoes, cutlasses and trowels.

Four mulching materials (prunings) were used at the rate 4t/ha and an unmulched control (control plot). The prunings from different agroforestry species were: *Dactyladenia barieri (Syn. Acioa barteri); Gliricidia sepium; Pentaclethra macrophlla and Spondias mombin.*

Experimental Design

The experimental design that was used is Randomized Complete Block Design (RCBD) and this was replicated three (3) times. The experiment was conducted during the 2000 cropping season and repeated in the 2001 cropping season. Fresh plant pruning from 4 multipurpose tree species- *Dactyladenia barteri, Gliricidia sepium, Pentaclethra macrophylla, and spondias mombin* were applied and two yam minisetts sixes (25g and 45g), were laid out in field plots of 5m x 4m in a randomized complete block design (R.C.B.D) and replicated three (3) times. Some samples were taken per plot at the beginning of the experiment and subsequently monthly for four (4) months after application of green mulch for analysis. Samples of each green mulch were taken by the time of application for nutrient content determination. The green mulch was applied two (2) weeks after planting yam minisetts at 4t /ha and was incorporated into the soil at first weeding. Yam minisetts (Cultivar Obiaoturugo) was planted in the month of June at 40,000 stands ha^{-1} and harvested in December. At harvest, the total seed yam yield was measured.

Soil samples were taken at 0 – 20cm soil depth per plot at the beginning of the experiment and subsequently for four (4) months after application of green mulch. The samples were analyzed for pH, organic matter, total N, available P, exchangeable K, Ca, Mg and Na. Samples of green mulch were also taken at the time of application. The samples were dried, milled and analyzed for N, P, K, Ca, Mg and Na. all soil and plant analyses were carried out as outlined by Udo and Ogunwale (1978). Physical property of soil that was measured is:- bulk density.

Determination Of Chemical Properties Of Soil & Plant Samples

Soil pH was determined by direct reading electrode pH meter method (Baked, 1954). Total nitrogen was determined by the semi-micro Kjeldahl method (Bremner, 1965). Exchangeable cations were extracted with 1 N neutral ammonium acetate solution and determined photometrically using flame photometer (Blaker, 1965). Available P was determined by Bary No. 2 method (Bray and Kurtz, 1945).

Data Analysis

Analysis of variance (ANOVA) was used to analyze data according to Gomez and Gomez (1984) and mean difference was determined using the least significant difference (LSD) test. The experiment was conducted during the 2000 cropping season and repeated in the 2001 cropping season. Fresh plant pruning from 4 multipurpose tree species – *Dactyladenia barteri*, *Gliricidia sepium*, *Pentaclethra macrophylla*, and *Spodias mombin* were applied and two yam minisett sizes (25g and 45g), were laid out in field plots of 5m x 4m in a randomized complete block design (R. C. B. D) and replicated three (3) times.

Soil samples were taken per plot at the beginning of the experiment, and subsequently monthly for four (4) months after application of green mulch for analysis. Samples of each green mulch were taken by the time of application for nutrient content determination. The green mulch was applied two (2) weeks after planting yam minisett at 4t/ha and was incorporated into the soil at first weeding.

Yam minisett (Cultivar Obiaoturugo) was planted in the month of June at 40,000 stands ha[1] and harvested in December. At harvest, the total seed yam yield was measured.

RESULTS AND DISCUSSION

Effect of applied agroforestry prunings on the dynamics of soil factors

Organic Matter

Application of agroforestry prunings improved the soil organic matter. The various agroforestry prunings are high in dry matter (Table 1). The dry matter content of plant prunings used in the study ranged from 31.8% to 47.6%. The dry matter decomposes and releases organic matter into the soil. The decomposition process is progressive, that is why organic matter improved with time for plots that received agroforestry prunings. Better effect of the agroforestry prunings on organic matter was obtained with *Gliricidia sepium, Pentaclethra macrophylla, Spondias mombin* than *Dactyladenia barteri*. This could be attributed to higher N content of these agroforestry prunings compared to *Dactyladania barteri*.

Table 1: Nutrient content of agroforestry prunings (mulches).

	Nutrient content (g per 100g dray mulch)						
Plant prunings	**Dry matter**	**N**	**P**	**K**	**Ca**	**Mg**	**Na**
D. barteri	47.6	1.54	0.21	0.30	0.50	0.79	0.01
G. sepium	34.5	3.85	0.35	1.00	0.50	0.67	0.01
P. macrophylla	46.3	3.08	0.25	0.70	0.70	1.16	0.01
S. mombin	31.8	2.38	0.30	0.88	1.10	0.85	0.01

Soil pH

Application of agroforestry prunings improved soil pH. Improvement of soil pH on application of green manure has been reported by Hue and Amien (1989) and was attributed to the release of organic chelates as decomposition products of green manure which then forms complexes with Al $(OH)_3$ as shown below:

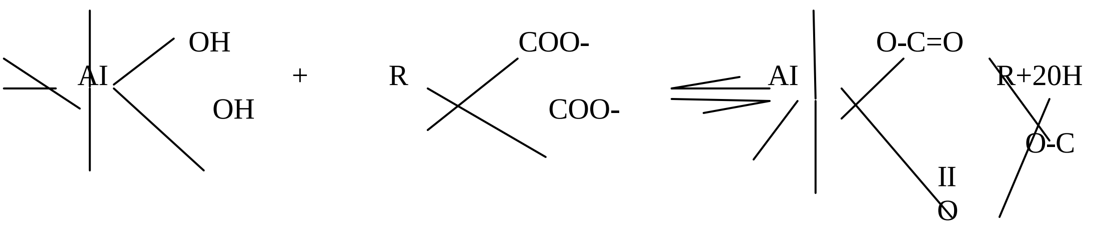

Table 2: Effect of plant pruning on soil organic matter for 2000 and 2001 planting seasons.

	Mean Organic Matter (%) Months after mulch application			
Plant Pruning	**1**	**2**	**3**	**4**
D. barteri	1.80	2.00	2.16	2.50
G. sepium	2.50	3.60	4.20	2.10
P. macrophylla	2.50	2.50	2.80	3.60
S mombin	2.15	2.80	2.60	3.20
No pruning	1.20	1.20	0.60	0.30
LSD (P=0.05)	0.60	0.40	0.40	0.20

Table 3: Effect of Plant Pruning on Soil pH.

	Months after mulch application			
Plant Pruning	**1**	**2**	**3**	**4**
D. barteri	5.1	5.1	5.1	5.2
G. sepium	5.2	5.4	5.4	5.4
P. macrophylla	5.1	5.4	5.4	5.4
S mombin	5.3	5.5	5.5	5.6
No pruning	5.0	5.0	4.5	5.0
LSD (P=0.05)	N.S*	0.2	0.2	0.3

*NS = Not significant at P=0.05

Exchangeable K

Application of agroforestry prunings also improved soil exchangeable K. The greatest effects was obtained with Gliricidia sepium (Tabel 1). These agroforestry prunings contain various levels of K. When the mulches decompose their K content is released into the soil system.

Table 4: Effect of Plant Pruning on Exchangeable K

	Exchangeable K (me/100g) Months after mulch application			
Plant Pruning	**1**	**2**	**3**	**4**
D. barteri	0.10	0.18	0.25	0.22
G. sepium	0.20	0.30	0.36	0.30
P. macrophylla	0.16	0.20	0.25	0.30
S mombin	0.22	0.08	0.05	0.05
No pruning	0.12	0.06	0.03	0.03
LSD (P=0.05)	0.04	0.06	0.09	0.07

CONCLUSION AND RECOMMENDATIONS

Effective production of seed yam through minisett technique requires adequate plant nutrient to be available in the soil. The study revealed that application of agroforestry prunings improved soil exchangeable K. The study showed that the plant prunings of *Gliricidia sepium* seem to be the best of the prunings used in this study in terms of total yield (t/ha), nitrogen, phosphorous and potassium addition to the soil.

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