Nigerian Journal of Ecology (2000) **2**:1-5

ISBN: 978-2169-01-3

Effect of Leaf Mulch on Inorganic Nitrogen Fertilizer Use in Plantain [*Musa* AAB cv Agbagba] production.

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ABSTRACT

In a field experiment in Ibadan, South-Western Nigeria, effects of *Gliricidia sepium* and *Tectona grandis* (Teak) leaf mulches on inorganic nitrogen fertilizer use and weed control was investigated in a split-plot experiment laid out in a randomized complete block design. Four rates of nitrogen fertilizer (0, 100, 200 and 300 g a.i.N/plant), the minor treatments, were randomly allocated to the sub-plots on the leaf mulch main plots. Plantain (*Musa* AAB) was used as test crop. The weed dry weight on unmulched plots was significantly (P=0.001) greater than the mulched plots. Eight months after transplanting, the mulch materials only slightly enhanced the growth of plantain, contributing 13.3%, 12.8% and 4.0% to pseudostem height, girth at 30-cm height and number of leaves respectively. The differences among the mulches were not significant. The response of plantain to fertilizer treatments on unmulched plots was more conspicuous than mulched plots. Growth was least on unmulched plots without nitrogen fertilizer. In unmulched plots, height and girth growth in plantains given zero nitrogen fertilizer were respectively 47% and 36% lesser than those given fertilizer, whereas in mulched plots they were respectively 14% and 10% less. This may indicate that with improvement in the crop environment by mulch, the nitrogen fertilizer requirement for plantain can be substantially reduced.

Keywords: Mulching, nitrogen fertilizer, plantain, vegetative growth, weed control.

INTRODUCTION

Fallow farming has been the most traditionally effective method of sustaining food production on fragile tropical soils (Agboola 1974). The fallow period alleviates the pressure of weeds and replenishes the soil organic matter and fertility (Ruthernberg 1976).

The shifting cultivation that provides for alternating fallow and cropping phases can no longer be practiced due to intense pressure on land for urbanization and industrialization, and restriction of access to fertile lands by governments' land tenure policies (Kotschi 1990). The collapse of the shifting cultivation has resulted in a steady decline in food production, despite the introduction of high yielding cultivars.

To meet the ever increasing food demand, intensive agriculture option with high input, especially nitrogen fertilizer was adopted. Productivity could not be sustained under this high input system probably due to further impoverishment of the soil resulting from the declining organic matter content (Wilson *et al.* 1985). This apart, the gradual withdrawal of subsidy on fertilizer by the government has made its cost too high for an average Nigerian farmer. Also, the excessive use of nitrogen fertilizer poses serious health hazard as it causes nitrate pollution of underground water (Allen and Allen 1981). This may cause methemoglobinema or nitrate cyanosis in infants and livestock (Egunjobi 1991).

In the quest to reduce the amount of nitrogen fertilizer used in the production system and evolve a safe, environment friendly and ecologically sound production alternative, organic farming was considered appropriate. The study reported herein investigated the potentials of leaf mulch in the reduction of nitrogen fertilizer input to food production, monitoring with the vegetative growth of plantain (*Musa* AAB).

Traditionally, plantain is produced in the homestead garden where it enjoys high supply of organic matter from the household refuse. Also in outlying fields, it is usually grown first among other food crops after the fallow period to ensure maximum benefit from organic matter resources and nutrients in the soils (Obiefuna 1980). In the outlying field productivity could only be sustained beyond the 'mother crop' through adequate supply of fertilizer, most especially, nitrogen fertilizer (Wilson *et al.* 1985).

MATERIALS AND METHODS

Study was conducted in Ibadan [7° 30'N, 3° 54'E; altitude 234m ASL] in South Western Nigeria. The rainfall is bimodal with peaks in June and September. The total rainfall, averaged over 5 years [1986-1990] was 1370.2mm distributed over 110 days. The total

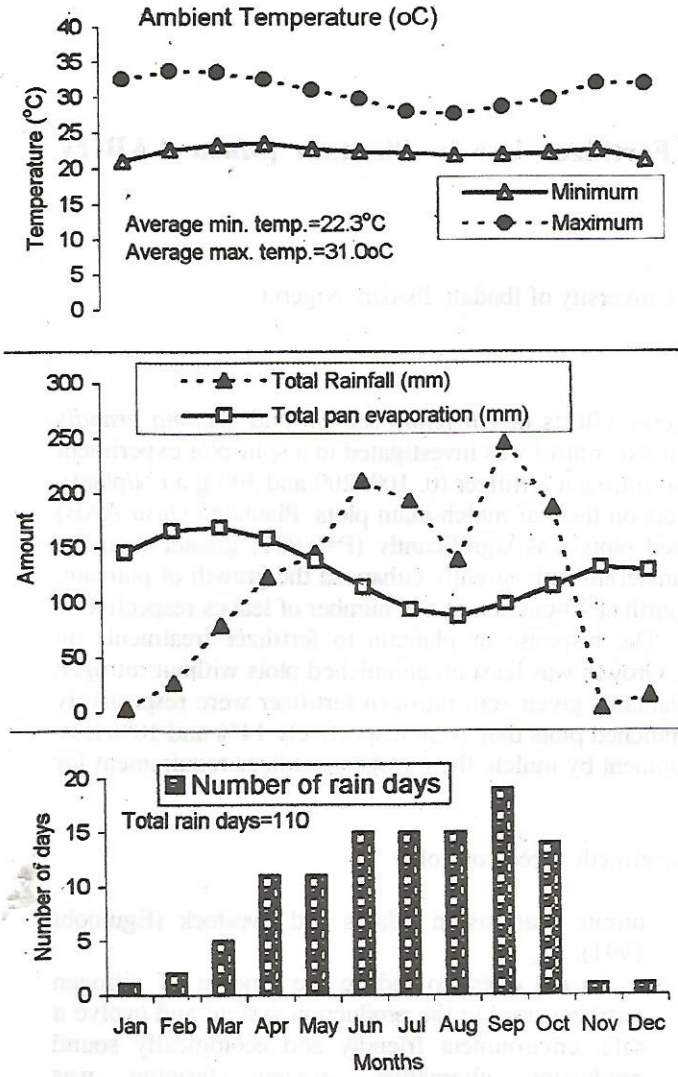

Figure 1: Five year [1986-1990] summary of total monthly rainfall (mm), total monthly pan evaporation (mm), number of rain days and mean monthly ambient temperature (°C) for Ibadan, Southwest Nigeria.
(Source: I.I.T.A., Central Station, Ibadan).

pan-evaporation over the period was 1370.2mm, and the average mean minimum and maximum temperature were 22.3°C and 31.0°C respectively (Figure 1). The soil of the experimental soil was loamy sand in texture, having low fertility status (Table 1).

The plantain suckers were transplanted at a density of 1600 stands per hectare in May when rainfall has stabilized. The design of the study was a split-plot experiment fitted into a randomized complete block design and replicated three times. The control [M0] and the two mulch materials [*Gliricidia* leaf (M1) and Teak leaf (M2)] were randomly allocated to the main plots while four nitrogen rates [0 (N0), 100 (N1), 200 (N2) and 300 (N3) g a.i.N/plant] made up the sub-plot treatments. There were 36 plants per plot and nine plants per subplot.

Table 1. Soil Characteristics of the Study Site.

pH (H_2O)		5.6
O.C. (%)		0.15
Total N(%)		0.01
Av. P (ppm.)		20.64
Sand (%)		79.4
Silt (%)		14.0
Clay (%)		7.6
Exchangeable Cations (meq./100g)	K	0.31
	Ca	1.05
	Mg	1.90
	Na	0.65

Mulch was laid within 60-cm radius of each stand to a thickness of 5cm at 2, 5, and 8 months after planting at the rate of 480 kg/ha for *Gliricidia* leaf and 640 kg/ha for Teak leaf. Control plots received no mulch. The plantain stands received a blanket application of 200g a.i.K as muriate of potash and 100g a.i.P as single superphosphate in a single dose as recommended (NIHORT 1987).The nitrogen was applied as calcium ammonium nitrate [CAN] at the rate of 200g a.i.N/plant/annum (NIHORT 1987). The nitrogen fertilizer was applied in three equal splits, commencing from two months after transplanting. Control plots received only basal dressings of potassium and phosphorus.

Two months after the second mulch application and weeding of the control plots, effect of mulch on weed growth was assessed. A 50cm x 50cm wooden quadrat was laid within the mulched area of ten randomly selected stands in each plot. All plants that rooted within the quadrat were clipped at soil level. The samples were oven-dried at 70°C to constant weight and used to estimate the mean weed biomass. After eight months of transplanting, response of plantain to the treatment combinations was assessed using pseudostem height, girth at 30-cm height and total number of leaves.

Analysis of Variance (ANOVA) and mean separation using Least Significant Difference[LSD] at 5% Level of Probability (Gomez and Gomez 1984) were performed on the data. Visual observation of root distribution in the top 5cm of the soil was made.

RESULTS

Gliricidia leaf mulch (M1) controlled weeds better than Teak leaf mulch (M2), though the two were not significantly different from each other (Table 2). The weed biomass on unmulched plots was significantly

(P=0.001) greater than that on mulched plots. The weed species encountered at the study site were *Chromolaena odorata, Commelina benghalensis, Cynodon dactylon, Euphorbia heterophylla, Panicum maximum, Spigelia anthelmia* and *Talinum triangulare.*

The mulch materials slightly increased the growth of plantains at eight months after planting. The differences in plantain growth among the mulch treatments were not significant (Table 3). Irrespective of leaf material, mulch contributed 13.3%, 12.8% and 4.0% to the pseudostem height, girth and number of leaves respectively compared to the unmulched control.

The growth of plantains given nitrogen fertilizer (N1, N2 and N3) were not significantly different, but significantly better than those that did not receive nitrogen fertilizer(N0) (Tables 3 & 4). Irrespective of mulch treatments, N1 (100g a.i.N/plant) treatment resulted in better growth than the other two nitrogen rates.

Table 2. Effect of leaf mulch on weed dry weight.

Mulch	Weed dry weight (tonne/ha.)
M0 (Control)	1.34
M1 (*Gliricidia*)	0.06
M2 (Teak)	0.12
LSD (0.05)	0.3
CV(%)	26.8

Whereas plantain showed little response to rates of nitrogen fertilizer in mulched plots, the response was very conspicuous in unmulched plots. On mulched plots, height and girth of plantain that received no nitrogen fertilizer were respectively 14% and 10% lesser than those that received the fertilizer, but on unmulched plots they were 47% and 36% less.

On mulched plots the root mass of plantain was confined to the top 5 cm of the soil while few roots were found within this zone in unmulched plots.

Table 3. Vegetative growth of plantain (*Musa* AAB) as affected by leaf mulch and inorganic nitrogen fertilizer at 8 months after planting.

	Pseudostem height (cm/plant)	Pseudostem Girth (cm/plant)	Number of leaves/plant
		Mulch Types	
M0 (No Mulch)	156.31	35.69	26.75
M1 (Gliricidia)	183.19	41.50	27.63
M2 (Teak)	177.38	40.34	28.09
LSD (0.05)	ns	ns	ns
		Nitrogen Fertilizer	
N0 (0g a.i.N/plant)	141.06	33.58	25.39
N1 (100g a.i.N/plant)	197.89	44.06	28.64
N2 (200g a.i.N/plant)	173.83	39.25	27.92
N3 (300g a.i.N/plant)	176.37	39.81	28.00
LSD (0.05)	25.09	6.03	1.60

ns – not significant

Table 4. Mean square of the effect of leaf mulch and nitrogen fertilizer on vegetative growth of plantain (*Musa* AAB) 8 months after planting.

Sources of Variation	df	MEAN SQUARE		
		Height	Girth	No. of leaves
Replication	2	19249.72 ***	1329.06 *	77.76 *
Mulch Types (A)	2	2400.63 ns	113.46	5.51 ns
Error (a)	4	1122.99	123.04.	5.06
Nitrogen fertilizer (B)	3	4950.07 **	166.47 *	18.53 **
A x B	6	522.76 ns	31.57 ns	1.84 ns
Error (b)	18	636.54	36.89	2.60
CV (a) %	-	6.48	9.44	2.73
CV (b) %	-	4.88	5.17	1.96

ns - not significant *; **; *** - significant at 5%, 1% and 0.1% level of probability respectively.

DISCUSSION

Mulch effectively controls weed by cutting off light from reaching the soil surface thus preventing germination of weed seeds (weed-break) in the soil seed bank. It also provides mechanical hindrance to smother weed seedlings. Hume (1982) reported that mulches generated from fallow growth contribute to the ability of fallow in serving as weed break.

It is clear from the study that pseudostem height and girth of plantain may be more effective in monitoring the soil environment modification by mulching than number of leaves. Satyanarayana (1990) reported that mulching plus green manuring and mulching alone resulted in tall plants with increased girth in plantain. Mulching increases water-use efficiency and nutrient-use efficiency of plants by stimulating better root development and by controlling weed development (Daisley *et al.* 1983), thus enhancing crop growth and development.

The marginal difference between the growth of plantains given fertilizer and those unfertilized on mulched plots may indicate that not only nitrogen but improvement in other soil properties and crop environment with mulch that combine to enhance better growth in crops. The result is in agreement with those of Palada *et al.* (1992) on *Amaranthus cruentus, Celosia argentia, Abelmoschus esculentus* and *Lycopersicon esculentum.*

The concentration of roots of plantains at the top 5cm of the soil on mulched plots may be a result of less moisture depletion at the soil surface. Battacharyya and Madhava Rao (1992) reported that Robusta banana (AAA) developed shallow and non-extensive root system under soil covers and low moisture depletion. This may pose a serious problem to plantain production in the dry season, especially, if the soil is sandy and well drained because of severe moisture shortage in the upper layer. Considering the enormous 'stem' of plantain and its high moisture demand, the stress could readily result in severe 'fall-back'.

CONCLUSION

In view of the need to conserve the fragile tropical soils and prevent ground water pollution by reducing nitrogen fertilizer input into food production, mulching may provide a sustainable and low-external input alternative. *In-situ* mulch sourcing techniques will alleviate the drawback of high labour requirement that may make *ex-situ* sourcing less attractive.

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