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EFFECT OF DIFFERENT WEED MANAGEMENT TECHNIQUES ON GROWTH, SUSCEPTIBILITY TO WIND DAMAGE AND BUNCH YIELD OF A PLANTAIN LANDRACE (*MUSA* SP. AAB CV. AGBAGBA) IN A DERIVED SAVANNA ECOSYSTEM OF NIGERIA.

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ABSTRACT

A field study was conducted at the University of Nigeria, Nsukka in the derived savanna ecosystem to evaluate the influence of five weed management techniques and a weed-free control on the pre-flowering growth, susceptibility to wind damage, sucker production, and fruit yield of a plantain landrace (*Musa spp.* AAB cv. Agbagba). The weed management techniques included slashing at 8-weekly intervals, mulching alone, glyphosate + slashing, glyphosate + mulching, glyphosate alone and a weed-free control. Glyphosate + mulching proved to have the greatest positive influence on plant height, plant girth, leaf area and number of leaves throughout the duration of the experiment. Similarly, glyphosate + mulching treated plants produced bunch yield that was significantly ($P < 0.05$) higher than the other weed managements. Mulching and weed-free control produced the highest number of suckers. Generally, the plants that were mulched were the least susceptible to wind damage, for example, mulched plots had zero percent lodging in contrast to the weed-free (control plots) that lost more than 50% of the total plant population to wind damage. Results from this study suggested that glyphosate + mulching was the most effective weed management system in plantain plantation in the study area.

KEY WORDS: Weed Management; Plantain; Growth; Wind damage; Yield.

INTRODUCTION

Plantains are starchy bananas which make up one-quarter of the total world production of bananas (*Musa spp.*), and unlike the sweet dessert bananas, plantains are a staple food which is fried, baked, boiled (and sometimes pounded) or roasted and consumed alone or together with other food (Swennen, 1990). It is estimated that about 70 million people in West and Central Africa derive more than one quarter of their food energy requirements from plantain, making it one of the most important sources of food energy throughout the African lowland humid forest zone (Swennen, 1990). Besides, plantains are important sources of rural income particularly in some locations where small holders produce them in some compound or home gardens (Chandler, 1995).

Among the numerous problems that hamper plantain production are drought and organic matter status of the soil (Awodoyin, 2003), pests and diseases, labour shortage, poor agronomic practices and postharvest constraints (Robinson, 1996) and weed menace, which happens to be the most detrimental and its control cost highly prohibitive. Weed control is the single most important cost component accounting for 30 – 40 per cent of the overall cost of plantain production (Ndubizu and Obiefuna, 1979), and because plantain is a shallow rooting crop it is highly susceptible to weed competition and wind damage (Ndubizu and Manufor, 1988).

Weed control techniques in plantain plantation include mulching, use of herbicides and or manually by slashing. Mulching is the most efficient means because a mulch layer can impede or prevent weed growth (Swennen, 1990). Anderson (1996) reported that mulching completely excludes light from the growing weed plant, thereby preventing photosynthesis and further growth. According to Anderson (1996), hey, manure, grass clipping, straw, sawdust, woodchips, rice hulls, paper and plastic film can all be effectively used as mulching materials. Chemical weed control is expensive and in some instances also dangerous. Manual weeding is not recommended (although the weeds are thereby effectively controlled) because slashing or hoe weeding inevitably damages the plantain root system. However, sometimes manual weeding or slashing is the only available option.

Considering the numerous positive and negative effects of the various methods available for weed control and the failure of any one single weed control method to effectively suppress weed growth in crop production, the adoption of integrated weed management techniques became imperative. Komolafe (1973) recommended integration of manual, mechanical and chemical methods wherever possible as the solution to Nigeria's weed problems in tree crop farming.

In this study, the effects of six different weed management techniques were evaluated on growth, susceptibility to wind damage and yield of a plantain landrace.

MATERIALS AND METHODS

The experiment was conducted at Nsukka (6^{o} 51^{o}N, 7^{o} 29^{o}E) in the derived savanna ecosystem of Nigeria. The field was established on a gentle slopping terrain in mid June 2005. Prior to establishing the experiment, the land was under fallow for three years and the predominant weed flora was a mixture of broad and narrow leaved weeds of *Aspilia africana* (Pers) (haemorrhage plant), *Cyperus sp.* (sedges), *Anthephora ampullaceal* stapt and C.E. Hubbard, and *Panicum maximum* Jacq (Akobundu and Agyakwu, 1996). The soil is a sandy loam Oxisol of Nkpologu series (Ndubizu, 1981). The experimental area covered was 50 x 45 m (0.225 ha) and consisted of a total population of 360 plants.

The experimental layout was a randomised complete block design (RCBD) with six treatments replicated four times. Each experimental unit had a dimension of 10 x 7.5 m with fifteen stands planted at a spacing of 2.5 m between and 2.0 m within the rows.

The treatments included a weed-free (control), slashing at eight-weekly interval, mulching with 15 kg sawdust (at 50 cm radius around each stand and 5 cm thickness), mulching with sawdust + glyphosate applied (6 l/ha), glyphosate + intermittent slashing, and glyphosate alone (6

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l/ha). Glyphosate, N-(phosphonomethyl) glycine is a non-selective, broad-spectrum, foliar-applied systemic herbicide used to control annual and perennial weeds (Anderson, 1996).

A compound fertilizer (NPK 20: 10: 10) was applied at the rate of 300 kg/ha to augment the decomposed poultry manure which was applied four weeks after emergence at the rate of 2 kg per stand. The decomposed poultry manure was mixed with isazophos (a nematicide) at the rate of 2.5 g per plant.

Suckers were collected from a healthy vigorously growing 4-year old plantain plantation at Ajassor, Etum LGA of Cross River State, Nigeria. The planting materials were maiden suckers cut back to 30 cm and the corms were parred with a machete.

Data were collected on plant height (cm), measured from ground level to the junction of the last two fully expanded leaves, plant girth measured at 30 cm above ground level, number of the photosynthetically active leaves and leaf area of the last three uppermost leaves at 4, 8, 12, 16 and 20 weeks after treatment application. Also recorded were number of lodged stands and total number of suckers produced. The fruit yield measured as bunch weight per plant and per hectare was determined at harvest.

All data were subjected to analysis of variance test, and significance of treatment means were determined by least significance difference (LSD) test at 5% probability level.

RESULTS

There was no significant treatment effect on plant height at the initial (4-12 weeks) period of treatment application (Table 1), however, plant height differed significantly at 16 and 20 weeks after treatment application (WAT). The results showed that, except for slashing at 8-weekly intervals, all the other treatments were statistically similar. Plant girth was similar across weed management at 4 and 8 weeks, but between the 12^{th} and 20^{th} week of treatment application there were significant weed management effects (Table 1). Plants grown under slashing at 8-weekly intervals and use of glyphosate alone had smaller girth than all other treatments. At 20 WAT, glyphosate + mulching treated plots had significantly ($P < 0.05$) bigger girth than the other treatments.

Table 1. Effect of different weed management techniques on [a] plant height (cm) and [b] plant girth (cm) at 4, 8, 12, 16, and 20 weeks after treatment (WAT) application.

Weed Management Technique	Weeks after treatment application				
	4	8	12	16	20
[A]					
Weed-free (by hoeing)	83.7	111.4	127.7	131.4	134.1
Slashing 8-weekly	79.8	100.9	110.6	111.8	113.0
Mulching alone	86.8	111.1	120.5	122.5	124.4
Glyphosate + slashing	83.0	103.8	116.0	119.9	118.1
Glyphosate + mulching	90.3	115.7	133.0	142.8	145.6
Glyphosate alone	81.0	101.8	112.2	117.0	113.5
$LSD_{(0.05)}$	NS	NS	NS	27.1	24.5
[B]					
Weed-free (by hoeing)	22.3	29.9	33.5	34.2	33.4
Slashing 8-weekly	21.3	26.9	28.1	28.5	27.8
Mulching alone	23.7	30.5	32.8	33.4	32.9
Glyphosate + slashing	21.9	27.8	30.3	30.5	30.3
Glyphosate + mulching	24.0	32.0	36.4	38.6	38.6
Glyphosate alone	22.5	27.3	29.4	30.1	29.5
LSD(0.05)	NS	NS	6.5	6.5	5.8

Number of leaves per plant was similar across treatment only at 4 WAT, but at all other growth stages glyphosate + mulching supported more green leaves per plant (Table 2). It was interesting to note that this treatment enhanced retention of about seven green leaves at 20 WAT (coinciding with January, 2006) during a very low soil moisture recharge and low relative humidity. During the same period glyphosate + slashing treated plants retained only three green leaves, mulching alone plots retained about six while the weed free (control) plots retained approximately four green leaves per plant. The area of the last three leaves was similar across weed managements during the first 8 WAT; however, there was a significant ($P < 0.05$) variability thereafter. Application of glyphosate + mulching consistently supported the largest leave area per plant.

Table 2: Effect of different weed management techniques on [a] number of leaves per plant and [b] leaf area (cm^2) of the last three uppermost leaves at 4, 8, 16 and 20 weeks after treatment application.

Weed Management Technique	Weeks after treatment application				
	4	8	12	16	20
[A]					
Weed-free (by hoeing)	12.9	13.3	9.4	4.6	3.5
Slashing 8-weekly	12.2	12.3	7.9	3.7	3.5
Mulching alone	13.3	13.2	8.8	6.7	5.8
Glyphosate + slashing	13.0	12.5	9.0	4.3	3.1
Glyphosate + mulching	13.0	14.3	11.1	8.4	6.7
Glyphosate alone	13.2	11.8	9.0	5.0	3.7
LSD(0.05)	NS	1.65	0.9	1.4	1.2
[B]					
Weed-free (by hoeing)	9055.87	13607.6	14848.6	14837.8	13081.7
Slashing 8-weekly	9284.27	11613.1	12155.0	11357.3	10639.7
Mulching alone	9938.57	13766.1	14027.5	14184.1	14142.9
Glyphosate + slashing	9555.20	12342.0	13312.4	12,906.1	10652.2
Glyphosate + mulching	10445.36	14457.5	16397.0	17449.9	16871.4
Glyphosate alone	9297.27	11632.7	12388.1	12557.9	11497.7
$LSD_{(0.05)}$	NS	NS	3997.7	4066.1	3595.7

The treatment effect became significant on sucker growth only at 20 WAT (Table 3). Application of glyphosate alone induced the lowest number of sucker formation whereas mulching alone supported the highest number of suckers per plant.

There was no plant lodging in any of the plots treated with mulching alone and those treated with glyphosate + mulching. The highest number of lodged plants (8.8 out of 15 initial stands) was recorded in the weed-free plot, followed by slashing 8-weekly plots which recorded about six lodged plants (Table 4). Glyphosate alone and Glyphosate + slashing treatments recorded about six and five lodged plants, respectively.

Table 3. Effect of different weed management practices on the number of lodged stands due to wind effect at 20 WAT, out of initial 15 plants per plot.

Weed management technique	Number of lodged stands	
	Original data	Transformed data
Weed-free (by hoeing)	8.8	3.0
Slashing 8-weekly	6.2	2.4
Mulching alone	0.0	0.7
Glyphosate + slashing	5.2	2.1
Glyphosate + mulching	0.0	0.7
Glyphosate alone	5.7	2.1
$LSD_{(0.05)}$	5.6	1.3

Table 4: Effect of weed management practices on the number of new suckers at 8, 12, 16 and 20 weeks after treatment application.

Weed management technique	Weeks after treatment application			
	8	12	16	20
Weed-free (by hoeing)	1.9	2.4	2.7	3.2
Slashing 8-weekly	1.7	2.0	1.9	2.1
Mulching alone	2.5	3.0	2.9	3.2
Glyphosate + slashing	1.4	1.7	2.0	2.2
Glyphosate + mulching	1.6	1.8	2.3	2.4
Glyphosate alone	1.3	1.5	1.3	1.1
$LSD_{(0.05)}$	NS	NS	NS	1.7

Weed management techniques had significant effect ($P < 0.05$) on bunch yield (Table 5). The highest mean bunch weight of 6.05 kg per plant (i.e. 12.1 t/ha) was obtained from glyphosate + mulching plots. The yield obtained from this treatment was significantly better than those obtained from the other treatments including the weed-free control plot. The lowest fruit yield of 1.07 kg per plant (i.e. 2.14 t/ha) was obtained from the plot managed by slashing eight-weekly intervals.

Table 5: Effect of weed management practices on bunch weight per plant and yield per hectare.

Weed management technique	Bunch weight (kg/plant)	Yield (t/ha)
Weed-free (by hoeing)	3.67	7.34
Slashing 8-weekly	1.07	2.14
Mulching alone	3.55	7.10
Glyphosate + slashing	3.75	7.50
Glyphosate + mulching	6.05	12.10
Glyphosate alone	2.31	4.62
$LSD_{(0.05)}$	1.07	2.14

DISCUSSION

Plantains are shallow-rooting with about 50% of the total root volume located within the top 30 cm of the soil. Therefore, any factor that influences the soil environment constitutes a major determinant of growth and yields of *Musa* plants. Earlier report by Baiyeri *et al*. (2004) revealed that significant cropping system effects on growth and yield of 36 *Musa* genotypes was essentially due to the effect of the cropping systems on the soil environment.

Besides the direct effect of the weed management on weed-crop interaction, the different techniques probably influenced the soil environment. Thus, it was appropriate that plant performances varied significantly due to weed management. The poor growth of plant in 8-weekly slashed plot might probably be attributed to the increased root density of the slashed weeds which subsequently reduced water infiltration thereby affecting the circulation of air and mineral nutrients in the soil. Besides, it could probably be due to competition for water and nutrient before the weeds were slashed. However, the more vigorous growth obtained in glyphosate + mulching plot might be attributed to the relatively higher moisture level in the soil accentuated by the sawdust-mulch and the effective weed control by the glyphosate. Relative to their individual effects, the combination of glyphosate and mulching had complimentary effect on plantain growth especially on photosynthetic apparatus of the plants. Higher number of green leaves coupled with larger leaf area portend higher photosynthetic capacity, this probably supported larger quantity of photo-assimilate which invariably could translate to better yield (Baiyeri and Tenkouano, 2007).

The best performance of vegetative growth recorded in the mulching alone and glyphosate + mulching plots agrees with an earlier report of Baiyeri *et al.* (1994), which showed that the use of siam weed (*Chromolena odorata*) mulch enhanced more vigorous plant growth and induced more sucker formation. Similarly, the effect of sawdust mulch on suckering as observed in this experiment is supported by Obiefuna (1986) who reported the superiority of sawdust mulched plants over un-mulched ones in sucker production. The reduced mean number of suckers observed in this experiment on the glyphosate + mulching plots could be attributed to phytotoxicity induced by the glyphosate applied and this could be true because of the production of the least number of suckers observed in the treatment where glyphosate was applied alone.

The high resistance to wind damage by the plantain stands in the mulch treated plots may be attributed to the effective weed suppression by the mulch, as well as the reduction of moisture evaporation from such treated plots which subsequently lead to better root establishment and enhanced vegetative growth. This result is supported by Robinson, (1996) who reported that mulches help to retain ground moisture, add nutrients to the soil and form a layer over the soil which inhibits weed growth in banana and plantain orchards.

The significantly better fruit yield of plantain in the glyphosate + mulching plots could be attributed to the effective weed control, increased moisture holding capacity of the soil and enhanced water use efficiency of the plantain created by the management system. This result is in agreement with De *et al* (1983) who reported decreased soil moisture depletion and thus increased water use efficiency of rice straw mulch which led to increased yield of grain sorghum. The result also agrees with the findings of Obiefuna (1988) who reported heaviest bunches with the highest number of hands and marketable fingers with sawdust mulch.

We conclude that since glyphosate + mulching supported the best plant growth without any lodging and enhanced the highest fruit yield, it is recommended as a weed control management strategy for plantain plantation in the derived savannah agro-ecology.

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