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RELATIVE EFFECT OF WEED MULCH TYPES ON SOIL PROPERTIES AND YIELD OF YAM IN SOUTHWEST NIGERIA

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ABSTRACT

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The experiment was conducted in the two locations namely Akure and Obaile in Southwest Nigeria during 2006 to study the relative effect of Mexican sunflower *(Tithonia diversifolia),* siam weed (*Chromolaena odorata),* elephant grass (*Pennisetum purpurem),* guinea grass (*Panicum maximum)* and no-mulch on soil physical and chemical properties and yam tuber yield. There was a control treatment and the mulches were applied at $10tha^{-1}$. Mexican sunflower and siam weed significantly influenced soil physical properties. Relative to the control, all mulches increased yam establishment and tuber weight significantly ($P>0.05$). Except for guinea grass mulch, the mulches also increased tuber length significantly. Mexican sunflower and siam weed increased tuber weight by 57%, while guinea grass and elephant grass mulch increased it by 29%. Considering all soil and plant parameters, Mexican sunflower and siam weed were most effective as mulch for yam.

Key words: Mulch, siam weed, mexican sunflower, yield of yam

INTRODUCTION

Yam (*Dioscorea* sp.) is an economically important tuber crop in tropical and subtropical regions of the world. Yam production is constrained by limited availability of planting material, high cost of farm operation, depletion of soil fertility and degradation of soil physical properties and inadequate use of fertilizers. In spite of increased demand for yam, its production and productivity declined. Tuber yield fall from 11t/ha in 1995 to 3.5 t/ha in 2007. This was adduced partly to decline soil fertility (Agbaje *et al.,* 2005).

Mulching is a traditional practice in yam cultivation aimed at controlling soil temperature and heat scorching. In addition mulching maintains a good soil physical condition by conserving soil moisture and enhancing water infiltration and stabilizing soil structure. Mulching improves biotic activity and adds nutrients to soil thereby improving soil fertility (Awodun and Ojeniyi, 1999; Ojeniyi and Adetoro, 1993). Hence mulching was found to increase yield of crops such as yam and cocoyam (Hulugalle *et al,* 1985, Igwillo, 2001), maize *(*Falade and Ojeniyi*;* 1997, and tomato (Agele *et al,* 1999a, 1999b). The type of residue mulching determines its impact on soil physical and chemical properties and crop yield (Awodun and Ojeniyi, 1999) and this is due to difference in biochemical quality of plant mulch material. Hence it is necessary to study the chemical composition of mulch materials and their effect on different crops. The role of mulch materials in soil fertility maintenance has received less research attention compared with its effect of soil physical properties. Also there is scarcity of studies on comparison of mulch materials as to their relative effects on soil properties, growth and tuber yield of yam. Awodun and Ojeniyi, (1999) investigated the relative effect of *Pennisetum purpurem, Aspilia africana, Panicum maximum, Chromolaena odorata,* and *Ageratum conyzoides* mulches on soil properties and maize. The mulches increased soil organic matter N, K, Mg, Ca, leaf N, Ca, Mg and K, maize grain yield and fresh matter significantly. Chromolaena residue gave highest yield, soil and leaf nutrients content. Mexican sunflower recently became a widespread aggressive weed in southern Nigeria suppressing the growth of other weeds and crops. It is known to be rich in N and P and has fertilizing and phytotoxic attributes (Taiwo and Makinde, 2005). However its fertilizing effect on soil and crops such as yam (*Dioscorea sp.)* has not received research attention especially in Nigeria. Some yam responds to some fertility and physical properties and because yam requires external source and nutrients especially N and K, (Obigbesan, 1981), There is need for studies on use of organic sources of nutrients in yam production. This is more so because the use of inorganic fertilizer in yam production is known to increase incidence of nematodes, reduce shelf life of tuber, increased yield, growth and carbon breakdown (Obigbesan, 1981, 1999). The objective of this work was to study the relative effect of Mexican sunflower *(Tithonia diversifolia),* siam weed (*Chromolaena odorata),* elephant grass (*Pennisetum purpurem),* guinea grass (*Panicum maximum)* and no-mulch on soil physical and chemical properties and yam tuber yield.

MATERIALS AND METHODS

Field experiment

Field trial was conducted at Akure and Oba-ile in rainforest zone of Southwest Nigeria. The Oba-ile site is 8km to Akure site. The soils are sandy loam (Alfisol) (USDA) or Luvisol (FAO). The plots were manually cleared and made into heaps. Four different mulch materials and no mulch were compared as to their effects on soil physical and chemical properties and yam performance. The vegetative mulch materials were derived from fresh residues of Mexican sunflower (*Tithonia diversifolia),* siam weed (*Chromolaena odorata*), elephant grass (*Pennisetum purpurem)* and guinea grass (*Panicum maximum*) applied at 10t/ha on heaps four weeks after planting of yam. The five treatments were replicated 3 times and allocated to plots using the randomized complete block design. Each of the 15 plots was $12m^2$ and heaps were spaced at 1 x 1 m.

Sprouted plants were staked to 3m height. Five weedings were carried out manually at 4, 8, 12, 16 and 20 weeks after planting.

Soil sampling and analysis

Surface 0 – 15cm soil samples were collected prior to land preparation. Fifteen core samples were collected over each site and bulked. At harvest, (12 months after planting –MAP), 15 composite samples were collected at each site under mulch layer. Samples were air-dried crushed to pass through 2mm sieve and analyzed as described by Carter (1993). The pH was determined using glass electrode in 1:2 soil-water medium. Organic matter was determined using Walkley-Black potassium dichromate oxidation. Total N was determined using microkjeldahl method, and available P by molybdenum blue colorimetry. Exchangeable K, Ca and Mg were extracted using ammonium acetate, Ca and Mg were determined using EDTA titration, and K using flame photometer.

Soil physical properties

Mechanical analysis was done using hydrometer method. Moisture content by gravimetric method was done using core samples at 6 months after application of mulch, and bulk density was determined using oven-dried core samples. Samples were put in oven set at 100^0C for 24 hours for moisture content and bulk density determinations.

Crop data

Sprouted plants were counted five months after planting for determination of establishment percentage. At harvest (10 months after planting) data on tuber length, girth and weight were taken.

Statistical analysis

Data were subjected to analysis of variance and means compared using least significant difference at 95% level.

RESULTS AND DISCUSSION

Data of soil properties at experimental sites at Akure and Oba-ile are shown in Table 1. Critical total N given for yam is 0.10 – 0.14, available P 3.9 – 4.5 mg/kg, and exchangeable K 0.15 cmol/kg (Okereke *et al*, 1987). The values of 0.35 – 1.10 cmol.kg Ca and 0.25-0.43 cmol/kg were recorded for soils in major yam growing areas of Nigeria (Ohiri, 1995). The sandy loam experimental soils are considered marginal in N, but adequate in organic matter, P. K. Ca and Mg. The pH is marginal and adequate since often pH 5.5 is associated with acidity. The soils required organic source of nutrients which was were also expected to improve the soils physically.

Since the soils have high bulk density for yam (1.30 and 1.40 g/cm^3). Fergusen and Gumbs (1976) observed that tuber yield of yam was reduced by increased soil bulk density above $1.1g/cm^3$.

Table 1. Physico-chemical properties of soils at experimental sites prior to yam cropping

Property	Akure	Obaile
Sand %	68.1	62.5
Silt %	17.3	23.1
Clay %	14.6	14.4
pH (H_20)	5.3	5.9
Bulk density g/cm^3	1.40	1.30
Organic matter %	2.51	2.75
N%	0.09	0.10
Available Pmg/kg	12.6	14.4
Exchangeable K cmol/kg	0.32	0.38
Exchangeable Ca "	2.70	2.59
Exchangeable Mg "	1.0	1.21

The mulch materials were effective in improving soil physical properties (Table 2) by reducing soil bulk density and temperature and increasing moisture content at Akure and Oba-Ile sites. Relative to the control, the materials reduced bulk density significantly (P>0.05) at Akure and Mexican sunflower and siam weed had the same effect at Obaile. The materials significantly reduced soil temperature at both sites. At Akure sunflower and siam weed were effective in increasing soil moisture content significantly. Mexican sunflower and siam weed respectively were most effective in improving moisture content, reducing temperature and soil bulk density. The presence of mulch should have reduced evaporative wastes loss thereby conserving moisture and reducing temperature (Agele *et al.*, 1999a, 199b). These effects should have enhanced biotic activity and led to enhancement of soil porosity and reduction of soil density. Also the mulch by protecting the soil should have stabilized the soil structure against raindrop impact.

Table 2. Effect of mulch treatments on soil physical properties at Akure and Oba-ile Akure

Mulch	Moisture %	Temperature ^0C	Bulk density g/cm^3
Akure			
Mexican sunflower	9.82	30.5	1.08
Siam weed	9.01	31.0	1.14
Elephant grass	7.63	35.3	1.21
Guinea grass	7.42	34.5	1.20
No mulch	6.89	38.8	1.38
LSD (0.05)	0.87	2.14	0.09
Oba-ile			
Mexican sunflower	10.07	29.2	1.07
Siam weed	9.16	29.8	1.14
Elephant grass	7.61	33.5	1.21
Guinea grass	8.01	32.3	1.21
No mulch	6.93	37.5	1.27
LSD (0.05)	1.17	1.53	0.07

The mulches did not increase soil pH, OM, N, P, Ca and Mg significantly (P>0.05) (Table 3). However Mexican sunflower and siam weed slightly increased soil N and P at both sites of study. Elephant and guinea grasses also increased soil P slightly at Obaile. However mulches significantly increased exchangeable soil K at both sites relative to the control. At Akure all mulches gave significant increases in soil K, whereas at Obaile only Mexican sunflower and siam weed had significant effect. At both sites the latter treatments mostly enhanced soil K status and siam weed had highest values. This finding is noted since yam has high requirement for K (Obigbesan, 1981, 1999). Hence the relatively high tuber weights (Table 4) recorded for sunflower and siam weed can be adduced partly to higher K status of their soils.

Table 3. Effect of mulch treatments on soil chemical properties at Akure and Oba-ile

Mulch	pH	OM %	N %	P (mg/kg)	K (Cmol/kg)	Ca (Cmol/kg)	Mg (Cmol/kg)
Akure							
Mexican sunflower	6.1	2.61	0.11	13.5	0.48	3.8	1.37
Siam weed	5.5	2.63	0.11	17.9	0.52	3.9	1.53
Elephant grass	5.9	2.30	0.08	12.7	0.40	4.2	1.40
Guinea grass	5.6	1.96	0.09	12.01	0.39	3.0	1.37
No mulch	6.1	1.91	0.09	12.3	0.31	4.0	1.53
LSD (0.05)	NS	NS	NS	NS	0.06	NS	NS
Oba-ile							
Mexican sunflower	6.8	2.90	0.13	14.7	0.62	4.2	1.27
Siam weed	6.6	2.98	0.12	18.7	0.75	3.7	1.37
Elephant grass	6.6	2.65	0.13	17.6	0.43	4.1	1.33
Guinea grass	7.0	2.80	0.10	14.7	0.47	2.8	1.47
No mulch	6.9	2.15	0.11	14.1	0.49	3.0	1.27
LSD (0.05)	NS	NS	NS	NS	0.18	NS	NS

Table 4 shows that all mulches increased yam establishment and tuber weight significantly. Except guinea grass, mulches also increased tuber girth significantly at Obaile. Only Mexican sunflower and siam weed increased tuber length significantly at both sites. Therefore all mulches increased tuber weight significantly and the Mexican flower and siam weed gave higher performance of yam. They had similar effect. Increased performance of yam due to mulches can be adduced to improved availability of K in soil especially in case of Mexican sunflower and siam weed, reduced soil temperature also in case of the latter treatments, reduced soil bulk density and enhanced soil moisture content especially in case of Mexican sunflower and siam weed with mean soil moisture content close to 10%. Variation in soil moisture content between 10 to 32% is suitable for yam (Ohiri, 1995). Also soil temperature between 25 to 30^0C was found suitable for yam growth (Ohiri, 1995). Yam tuber yield and growth are known to reduce with increase in soil bulk density as from 1.1g/cm^3 (Fergusen and Gumbs, 1976) and increased soil density has been found to reduce uptake of N, P, K, Ca and Mg by yam (Agbede and Ojeniyi, 2003).

Table 4. Effect of mulch treatments on yam tuber growth and yield at Akure and Oba-ile

Mulch	Establishment %	Tuber Length (cm)	Tuber girth (cm)	Tuber weight (kg)
Akure				
Mexican sunflower	94.4	41.1	11.5	2.1
Siam weed	88.9	41.3	11.0	2.2
Elephant grass	77.8	33.2	9.0	1.7
Guinea grass	77.8	34.5	9.0	1.7
No mulch	63.9	29.9	8.7	1.3
LSD (0.05)	9.1	5.8	NS	0.3
Obaile				
Mexican sunflower	97.2	43.4	17.2	2.3
Siam weed	97.2	41.3	16.6	2.2
Elephant grass	86.1	33.9	15.0	1.8
Guinea grass	83.3	31.2	11.2	1.9
No mulch	66.7	28.8	11.0	1.4
LSD (0.05)	7..6	5.9	2.6	0.2

CONCLUSION

Considering the mean tuber weight for the two sites, it was found that both Mexican flower and siam weed increased tuber weight by 57%, while guinea grass and elephant grass increased it by 29%. Therefore Mexican sunflower and siam weed had similar effect on yam performance and are more suitable as mulch material for yam than elephant and guinea grasses. The mulches significantly increased soil moisture content, reduced soil temperature and bulk density and increased soil K. These attributes led to enhanced growth and tuber yield of yam.

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