Effect of weed residues on growth, tuber yield and leaf nutrient content of yam in Southwest Nigeria

Ewulo, B.S*[1], Adeniyan, B.O[2], and Ojeniyi, S.O[1]

[1]*Department of Crop, Soil and Pest management, Federal University of Technology P.M.B 704, Akure, Ondo State. Nigeria*
[2] *Ondo state Agricultural Development Program, Oda Road, Akure, Ondo State. Nigeria*

ABSTRACT

Experiment was conducted to evaluate the effect of mulching with residues of Mexican sunflower (*Tithonia diversifolia*), Siam weed (*Chromolaena odorata*), Elephant grass (*Pennisetum purpureum*), and Guinea grass (*Panicum maximum* (Jacq)) on yam (*Discorea rotundata*) growth parameters, tubers yield, leaf nutrient content and soil physical properties at two locations in Southwest Nigeria. These mulch residues were applied at 10 t/ha making a total of five treatments with the control. The mulches increased vine length, number of branches and leaves tuber weight, leaf N, P, K, Ca and Mg contents significantly ($P<0.05$). Mexican sunflower and Siam had similar effect, likewise Guinea grass and Elephant grass. Soil moisture for plots treated with Mexican sunflower, Siam weed, Elephant grass, Guinea grass and control were 9.95, 9.1, 8.6, 7.7, 6.9% respectively,. Mexican sunflower most conserve soil temperature, followed by Siam weed, Elephant grass and Guinea grass. There were no significant differences in bulk density of soil treated with mulch at Akure, while Mexican sunflower had the least value of bulk density at both site

Keywords: mulching; mexican sunflower; siam weed; elephant grass; guinea grass; yam; growth parameters

*correspondence author; bsewulo@yahoo.co.uk

INTRODUCTION

Yam is a major staple of Sub-Saharan Africa (Gregory, 2000). Yam is essentially, a tropical crop that requires high soil fertility. It was reported that yam removed about 155, 18.2 176, 3.9 and 10.7 kg/ha N, P, K, Ca and Mg respectively (Obigbesan and Agboola, 1978). Therefore to sustain yam production requires external sources of nutrients especially N and K. However, farmers rarely apply chemical fertilizers in yam production due to its cost. Farmers are also of the opinion that chemical fertilizers adversely affect the storage and cooking quality of yams.

Findings by Adeniji *et. al.* (1978) indicated that application of N reduced the quality, while a combination of N, P, and K improved acceptability of yam tubers when pounded or fried. Obigbesan and Adeniyan (1981) found that increasing N application from 60 to 90 kg/ha have escalated nematode population in *Discorea rotundata,* these adverse effects of chemical fertilizers led to a caution for Nigerian farmers that application of incomplete nutrients has deleterious effect on yam quality.

To correct the defects of the use of chemical fertilizers in yam production, farmers use farmyard manure, plant residue, composts or green manures from pruning of tree legumes as source of nutrients to yam. The organic nutrient source also serves as mulch to control soil temperature and conserve moisture. However the effect of plant residues as sources of nutrients and in improving performance of yams has not received adequate research attention.

(Lawal *et. al.,* 2010) noted that the nutrition of root crops was hitherto a neglected field of study in Nigeria. Research into use of organic wastes for cultivation of tuber crops started in 1990 in Nigeria (Ano, 2000). Due to low mean yield of yam in Nigeria (6 t/ha) farmers were encouraged to produce organic fertilizer from crop residues in order to reduce cost of chemical fertilizers. This work therefore investigated the relative effect of Mexican sunflower, Siam weed, Elephant grass and Guinea grass mulches (residue) on growth, tuber yield, and nutrient content of yam (*Discorea rotundata*) in southwest Nigeria.

MATERIALS AND METHODS

Field Experiment

Field trial was conducted at the Teaching and Research Farm of the Federal University of Technology, (FUT) and the Federal College of Agriculture Akure (FCA), Akure, in the rainforest zone of southwest Nigeria (7 30 N, 3 52 E). The soils are skeletal, clayey kaolinitic, Oxic Tropudalf (Ewulo *et. al*., 2002), textural class of soil at both site is sandy loam. Soils were shown to be slightly acidic, low in N and available P and exchangeable Ca (Table 1).

Table 1: Pre-planting soil properties (0-15cm bulked sample) at the site of the experiment

Parameters	Location	
	Akure	Obaile
Sand (%)	68.12	62.48
Silt	17.25	23.11
Clay	14.63	14.40
Textural triangle	Sandy loam	Sandy loam
PH (H20)	5.35	5.88
Bulk density g cm-3	1.40	1.30
Organic matter (%)	2.51	2.75
Nitrogen (%)	0.09	0.10
Available P mg Kg-1	12.61	14.35
Exchangeable K cmol/kg	0.32	0.38
Exchangeable Ca	2.70	2.59
Exchangeable Mg	1.10	1.21

Sites were manually cleared and plots heaped. Five mulch treatments were applied for yam cultivation: no mulch, Mexican sunflower flower (*Tithonia diversifolia*), Siam weed (*Chromolaena odorata*), Elephant grass (*Pennisetum purpurem*) and Guinea grass (*Panicum maximum*). The residues were applied at 10 t/ha on heaps Four weeks after planting. The five treatments were replicated three times and allocated to plots using

randomised complete block design. Each of the blocks was subdivided into five plots of 3 X 4 m^2 dimension. There were twelve manually made heaps spaced at 1 X 1 m^2 in each plot. Yam sets (*Discorea rotundata*) weighing about 0.5 kg each was planted per heap. Sprouted plants were staked to 3m heights. Five weeding were manually done at 4, 8, 12, 16 and 20 weeks after planting.

Soil analysis

Composite sample of the site soil were analyzed before commencement of the experiment. Soil samples were collected at 0-15cm depths below the mulch layer in each plot at both site at harvest for chemical analysis, they were air dried and passed through 2mm-sieve. Soil pH was measured by glass electrode in a 1:2 soil water suspension (Carter, 1993). Total soil N was determined by micro-kjeldahl method (Bremner and Mulvancy, 1982) and organic matter by Walkley-Black wet dichromate method (Nelson and Sommers, 1982). Exchangeable K, Ca, Mg, were extracted with neutral 1M ammonium acetate and K was determined with a flame photometer (AOAC, 1970), Ca and Mg were determined by versenate (EDTA) titration method (Jackson, 1970). Available P was determined by colorimetry after Bray-1 extraction (Bray and Kurtz, 1945). Soil samples were collected below mulch layer using core sampler and bulk density determined. Core samples were placed in oven for 24 hours at 105^{o}C and gravimetric moisture content determined. Soil temperature at 15.00h was also determined by placing thermometer *in situ* to 0.10m depth.

Leaf analysis

At 180 days after planting, leaf samples were collected from 6 random plants per plots, Leaf samples were oven-dried at 90^{0}C for 48 hrs (IITA, 1979), ground and digested using nitric –pechloric acid mixture. Leaf N was determined using micro-kjedahl method, P was determined by vanadomolybdate colorimetry, K by flame photometer and Ca and Mg by EDTA titration

Crop data

Six plants were selected per plot. Data on vine length, number of branches and leaves were taken at two weeks interval from six months after planting and five months after treatment application (20, 22, 24, 26, 28 and 30 week after application (WAA)). At harvest (10 months after planting) tuber weight was taken. Data were subjected to

analysis of variance and mean compared using least significant difference ($p>0.05$)

RESULT AND DISCUSSION

Analysis of yam growth parameters mean data collected at 20, 22, 24, 26, 28 and 30 WAA (Table 2), showed that all treatment had increased vine length of Yam. Vine length values were least for the control which was followed by Elephant and Guinea grass respectively. Siam weed and Mexican sunflower had similar values at Akure and Oba-ile locations. Relative to control, the mulches increased mean vine length significantly ($p>0.05$)

Numbers of branches were increase by Siam weed and Mexican Sunflower, whereas the control, Guinea grass and Elephant grass had similar values. Also vine length increased in the order of control, Guinea grass, Elephant grass, Mexican sunflower and Siam weed. The mean values for the latter two mulches were similar and significantly ($P>0.05$) higher than values for the control.

The mulches increased number of leaves relative to the controls at Akure and Oba-ile (Table 1). The increases were significant ($p>0.05$) for all treatment applications at Akure, and for Siam weed as well as sunflower at Oba-ile. Mexican sunflower and Siam weed had highest mean numbers of leaves, while Elephant and Guinea grasses had similar but lower values relative to the former. The mulches significantly increased tuber weight relative to control (Table 2).

Research on nutrition of yam production indicated that supplying of N is essential since N is necessary for vine and leaf development (Obigbesan, 1981). According to Obigbesan (1981), yam also has high consumptive power for K, which is indispensable for synthesis and translocation of assimilates to storage tuber. The yield increases observed for the four mulches can therefore be adduced to improved availability of nutrients such as N, P, K, Ca and Mg on decomposition of the mulches followed by mineralization of organic nutrients. The increases in growth parameters such as vine length, number of branches and leaves would have enhanced photosynthesis and starch formation leading to resultant translocation of sugar to the storage and tuber, especially due to K.

Analysis of the manorial properties of organic source had shown Mexican

sunflower compared favourably with N, P, K and Ca (Togun and Akanbi, 2002 ; Hsieh and Hsieh, 1990) and favoured with low C:N ratio (8:1) compared with Guinea grass and Siam weed with 30:1 and 12:1 CN ratio respectively (Olabode *et. al,* 2007)

The tuber weight for Mexican sunflower, Siam weed, Elephant grass, Guinea grass and no mulch were 2.2, 2.2, 1.75, 1.8, 1.35 kg respectively (Table 2). The Mexican sunflower or Siam weed mulch increased tuber weight by 36% relative to no mulch, whereas Elephant grass or Guinea grass increased tuber weight by 29%.

Sunflower and Siam weed had high and similar tuber weight while Elephant and Guinea grass had low but similar tuber weight. Because sunflower and Siam weed significantly increased tuber yield than Elephant and Guinea grass, the use of the two mulches is recommended.

At Akure and Oba-ile, yam leaf N, P, K, Ca and Mg contents were increased by the four mulches relative to the control (table 3), the increases were significant in the case of leaf N and K at Oba-ile. There were no significant difference ($p>0.05$) in Mexican sunflower and Siam mulch N, P, K, Ca and Mg value at Akure and Obaile. Elephant grass and Guinea grass had similar values for nutrients at Oba-ile with similar values of leaf N, P and K in Akure. Mexican sunflower and Siam weed gave similar leaf N and K and similar tuber yield

Also similar leaf N and K given by Elephant and Guinea grasses account for the similar tuber yield, this is because N and K are the most critical nutrient elements for yam production.

Table 2: Effect of mulch materials on Yam growth parameters

Mulch treatment	Vine length	No of branches per plant	No of leaves per plant	Tuber length (cm)	Tuber girth (cm)	Tuber weigth (kg)
			Akure			
Mexican Sunflower	389	33	1804	41.1	23.0	2.1
Siam Weed	393	34	1787	41.3	22.0	2.2
Elephant grass	336	31	1482	33.2	18.1	1.7
Guinea grass	342	30	1513	34.5	18.9	1.7
No mulch	325	29	1362	29.9	17.4	1.3
Lsd	10.1	2.1	81.1	5.8	Ns	0.3
			Oba ile			
Mexican Sunflower	390	34	1870	43.4	34.5	2.3
Siam Weed	390	34	1903	41.3	33.2	2.2
Elephant grass	332	32	1542	33.9	29.9	1.8
Guinea grass	341	31	1511	31.2	22.5	1.9
No mulch	315	31	144.2	28.8	22.0	1.4
Lsd	14.5	1.9	170.2	5.9	5.1	0.2

Mulch treatment is found to conserve soil moisture (table 4), the mean soil moisture for Mexican sunflower, Siam weed, Elephant grass, Guinea grass and no mulch were 9.95, 9.1, 8.6, 7.7, 6.9, respectively. Linnel *et. al.,* (2000) and Smolikowiski *et. al.,* (2001) reported an increase in soil water content between 6 – 7% on fine sandy loam due to mulching. Aina (1979) also reported 6% differences in soil moisture content between mulched and unmulched plot. All the treatment significantly increases soil moisture compared with the control at the two locations with the exception of Guinea grass (table 4), Mexican sunflower most conserve soil moisture at Akure and Oba-ile site. Guinea grass mulch had the least influence on soil moisture.

Mulch treatments significantly lower soil temperature at the two sites when compared with the control (Table 4). This is consistent with the observation of Aina (1979). Guinea grass grain was also reported to significantly reduce soil temperature within the top 20cm of soil (Cadavid *et. al.,* 1998) whereas soil temperature was also found reduced below supra optimal level by application of 2 tons/ha grass mulch (Mbagwu, 1991). Siam weed most conserve soil temperature at the two locations while Guinea grass mulch has the least influence.

Mulch lower soil bulk density when compared with control (table 4), the bulk density of soil treated with Mexican sunflower and Siam weed mulch significantly ($p>005$) differ from the control at Oba-ile site. Mexican sunflower most reduces bulk density at both sites.

Table 3: Effect of mulch materials on yam leaf nutrient

Mulch treatment	Nutrient N	P	K	Ca	Mg
			Akure		
Mexican Sunflower	2.98	0.31	2.63	1.57	0.82
Siam Weed	2.94	0.28	2.59	1.66	0.79
Elephant grass	2.23	0.26	2.13	1.63	0.69
Guinea grass	2.04	0.25	1.96	0.99	0.80
No mulch	1.94	0.23	1.83	0.88	0.63
Lsd	0.78	0.05	0.17	0.15	0.10
			Oba-ile		
Mexican Sunflower	2.82	0.23	2.11	1.33	0.74
Siam Weed	2.75	0.18	2.20	1.32	0.74
Elephant grass	2.12	0.21	1.98	1.28	0.68
Guinea grass	1.98	0.24	1.89	1.26	0.72
No mulch	1.96	0.19	1.77	1.21	0.61
Lsd	0.57	NS	0.16	NS	NS

Table 4: Effect of Mulch treatment on soil physical properties at Akure and Oba-ile

Mulch treatment	Moisture content (%)		Temperature °C		Bulk Density g/cm^3	
	Akure	Obaile	Akure	Obaile	Akure	Obaile
Mexican Sunflower	9.8	10.1	30.5	29.2	1.08	1.07
Siam Weed	9.0	9.2	31.0	29.8	1.14	1.14
Elephant grass	7.6	9.6	35.3	33.5	1.21	1.21
Guinea grass	7.4	8.0	34.5	32.3	1.20	1.21
No mulch	6.9	6.9	38.8	37.5	1.38	1.27
Lsd	0.89	1.2	2.1	1.5	Ns	0.07

CONCLUSION

This study confirmed that the weed residues are effective sources of N, P, K, Ca and Mg for yam plants. Nutrients released by the decomposed residues led to enhanced growth and yield of yam. The effects of the weed residues (Mexican sunflower, Siam weed, Elephant grass, Guinea grass) were significant. The Mexican sunflower and Siam weed were more effective than Elephant and Guinea grass mulches in improving yam growth and leaf nutrient and in conserving soil properties.

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