Original Research Article

Effect of planting and mulching materials on growth and yield of white yam (*Dioscorea rotundata*) in Ikorodu, Lagos State, Nigeria

ABSTRACT

The effect of planting and mulching materials on growth and yield of white yam was evaluated in Ikorodu. White yam head, bottom and seed yam were used as planting materials while cooking banana pseudostem, banana leaves and guinea grass (*Panicum maximum*) were used as mulching materials and control plot was left unmulched. The trial was arranged in a Randomized Complete Block Design with four replications. Data on days to 50% sprouting, vine lengths, and tuber yield were collected and subjected to statistical analysis. Planting and mulching materials had significant effect on days to sprouting, vine length and yield of white yam. Seed yam performed relatively better than head and bottom setts in growth and yield. Grass mulch significantly ($P < 0.05$) gave higher rate of emergence and had tuber yield greater than the banana pseudostem, leave mulch and the unmulched plots. Irrespective of mulching materials, it was found that mulching significantly ($P < 0.05$) increased tuber yield than the unmulched yam. Interaction between planting and mulching materials also had significant effect effects on days to sprouting, vine length and yield of yam. Obviously, the control (unmulched) plots performed least amongst the treatments. It could be suggested that banana pseudostem and leaves be chopped, fermented, dried and milled to serve better as mulching material and to improve the physical quality of the soil. It is therefore suggested that more work be conducted on the use of banana pseudostem as mulching material to determine the nutrient composition of the material and the appropriate level for its use.

Keywords: mulching materials; planting materials; pseudostem; white yam; yam sett.

INTRODUCTION

Yam *Dioscorea specie*is an annual crop widely grown in Nigeria and some other part of the world. It is a stem tuber crop with an underground reproductive and storage organ. The most important part (tubers) of the plant stores carbohydrates as food [1]. It has a higher nutritional value over cassava because it contains more protein. When wet, it contains 60 - 70% water, 4 - 8% protein and 30 - 40% carbohydrate (starch). It provides the staple foodstuff for millions of people in many tropical and sub-tropical countries [2]. The tubers are prepared for consumption in various forms. It is the foremost root crop in Nigeria with so many species. The southern-guinea savanna zone of Nigeria is the major yam producing area. The yams are the most important food crops in the zone [1].

There are approximately 200 different varieties of yam with flesh colour varying from white to ivory, yellow to purple. White yam *D. rotundata*, is the most important and most cultivated specie [3]. It has a cylindrical vine with leaves that are longer than they are broad. They are spined or spineless. They twine anti-clockwisely, the stem grows up to 12 metres high. The tubers are white and tuberise early. Tubers commonly weigh about 5kg and have thin skin. It is indigenous to West Africa. West Africa is the most important region for yam production in the world with about 96% of global production [4]. In the coastal West Africa, over 60 million people obtain dietary calories per day from yam [5]. The main producer is Nigeria which produces about 71% of world output with Ghana, Cote d'lovrie, Benin and Togo following in that order. It is Nigeria's leading crops both in terms of land under cultivation and preferred major staple food crops contributing immensely to rural and regional economies. It uses large area of land and utilizes huge quantity of soil nutrient. It normally follows a bush fallow. Recent studies in the zone have shown a high potential and suitability of the use of *D. rotundata* for minisetts in rapid seed yam multiplication [6,7]. Although, the minisett technique has been developed for the rapid production of seed yams, farmers prefer its use for the simultaneous production of seed and ware yams. Other popular ones are yellow yam *D. cayenensis*, lesser yam (*D. esculenta*), cush cush yam, India yam *D. trifida.* [8] stated that the average yield of yam is 5 - 20 tonnes per hectare. He further stated that several other factors like variety/cultivar/species. sizes of setts, disease and pest attack, quality of soil, adequacy or otherwise of moisture during the period of growth, degree and quality of insolation, low temperature during vegetative growth and tuber formation, and adequacy of cultural maintenance practices do affect the yield of yam.

Population and increased demands on land for non-agricultural purposes have made soil fertility maintenance through prolonged fallows an untenable proposition, leaving maintenance of soil fertility through fertilizer usage the only viable alternative. Lal [9] however postulated that when crop residue mulch and animal wastes are used efficiently its substantially reduce chemical fertilizer requirements. Since yam requires high amount of potassium for good yield, there is the need to try other sources of potassium ion to improve or cater for the high potassium requirement in yam. Returning crop residue as mulch may also have synergistic effects with fertilizer use. Plantain leaves, pseudostem, fruit stalks and peels, after chopping, fermentation and drying have been reported to yield a meal somewhat more nutritious than alfalfa presscake. These waste materials have been considered for use as organic fertilizer in Somalia [10]. The study is designed to investigate the effect of banana pseudostem and banana leave mulch on growth and yield of white yam *D. rotundata*.

MATERIALS AND METHODS

The experiment was carried out on the teaching and research plot of the Department of Crop Protection, Lagos State University of Science and Technology, Ikorodu which lies between latitude 5^{o} 7′-5^{o}10′ North and longitude 3^{o}16′-3^{o}18′ East of the Greenwich meridian. Soil type is Alagba series. The site has been left unused for one year and the type of vegetation found there was a mixture of both broad leaved weeds and grasses. The gross plot size was 17m by 13m and the net plot 15 m by 11 m. The experimental materials are banana pseudostem, banana leaves and dry grasses as mulching materials, yam setts (top and bottom) and seed yam as planting material.

Seed yam and yam setts (tops and bottoms) each of about 50g were cut smoothly using a sharp knife and were left under shade for about 8hours for the surface to dry and were treated with aldrin dust mixed with wood ash in the ratio of 1:2 respectively. Mulch was applied immediately after planting as described by Igwilo [11]. The banana pseudostem mulch was gotten from matured cooking banana pseudostem 15cm long, sliced vertically into 4 halves. The pseudostem cuttings were placed on mounds 3-4 pieces depending on the pseudostem girth. Dry grasses of about 3cm thick and dry banana leaves were used on some mounds and heap of soil was packed over it to serve as weight over them. Others were left unmulched (control). The experimental design used was a 3 x 4 factorial in a Randomized Complete Block Design (RCBD) replicated four times. Each replicate contained 12 stands of yam comprising of 4 seed yam, 4 top setts and 4 bottom setts. A complete block had four different treatments comprising of a pseudostem mulched plot, dry grass mulched, dry banana leaf mulched and an unmulched plot. Each block is replicated 3 times.

Data collection

The chemical components of the mulching materials (banana pseudostem and dry banana leaf and dry grasses) determined at the Agronomy laboratory, University of Ibadan, Ibadan, Nigeria. Data were collected on days to 50% sprouting, vine lengths at 8 and 14 weeks after planting (WAP), and tuber yield in tons per hectare. All data collected were analyzed using Statistical Analysis System (SAS) analytical tools and analysis of variance. All significantly different means were separated using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Initial soil properties

The pre-planting soil analysis is as shown in Table 1. The pH of the soil was strongly acidic. The analysis of the soil showed that the nutrient status of the soil was low in major macronutrients. the available phosphorus and nitrogen were relatively low, and the exchangeable K, Ca, and Mg was moderate. The organic matter was adequate. There was a high quantity of sand, with a relatively low quantity of silt and clay in the soil, therefore, the textural class sandy loam.

The low fertility status of the soil could be as a result of inherent or continuous cropping on the same piece of land over a period of time without amending the soil with either organic manure or inorganic fertilizer.

Effects of planting and mulching materials on number of days to 50% sprouting

The result in Table 2 shows the effects of planting and mulching materials on number of days to 50% sprouting, vine length at 8 and 14 weeks after sprouting (WAS) and yield of white yam. Statistical analysis showed that planting material significantly affected ($p<0.05$) the rate of sprouting of white yam. The earliest planting material to sprout was seed yam which sprouted 59 days after planting (DAP) while the latest planting materials to sprout was yam bottom setts that sprouted 81 DAP. The findings that seed yam sprouted before the head and bottom setts is supported by Beatrice *et al*. [12] who reported that sprouts from the whole seed emerged from the soil and reached their peak faster than those from the minisetts, and they had a higher final percentage of crop establishment. They further reported that sprouts from the whole seeds started emerging from the soil less than 10 days after planting (DAP), reached 50% emergence at 37 and 35 days, respectively, and peaked at 56 days. Minisetts of the same sizes had their peak emergence at 77 DAP. So also, findings that head setts sprouted before the bottom setts is supported by Orkwor [13] who noted that when yam tubers are cut and planted, setts from the head portion sprout and emerge earliest, followed by those from the tail portion and lastly setts from the middle. The difference in time to emergence may be attributable to the differential age of tuber tissues, where the head portion is oldest and contains the shoot primordium that is apically dominant; the tail has the youngest tissues that regenerate easily.

The result also showed that mulching materials significantly ($p<0.05$) affects sprouting in yam. The unmulched control plot was earliest to sprout, followed by plots treated with banana pseudostem and grass mulch which not significantly ($p<0.05$) different from each other. Yam mulched with banana leaves was latest to sprout at 76.5 DAP. Research has showed that yam planted under mulched materials was significantly higher in emergence and growth rate than unmulched control plot. Arnoud [14] had also reported that the time taken for planting yam setts to sprout was significantly ($p<0.05$) shortened by approximately 20% using *Gliricidia sepium* leaf mulch on Wateryam (*D. alata*).

Generally, interaction between planting and mulching materials revealed that seed yam and different mulching materials produced sprouts earlier than other planting and mulching materials. In the same way, interaction of the head setts with various mulching materials performed significantly better than interaction between bottom setts and mulching materials. The earliest and significantly different sprout was recorded for seed yam with grass mulch. Interaction between head setts and mulching materials was next to interaction between seed yam and mulching materials. The latest sprout was observed on plots with interaction of bottom setts and pseudostem.

Effects of planting and mulching materials on vine length at 8 WAS

There was significant difference in vine length produced by different mulching materials. Statistical analysis for vine length of yam planted with different planting and mulching materials (Table 2) revealed that seed yam produced the longest vines not significantly different from head setts at 8 WAP, while bottom setts recorded the shortest vines. Banana pseudostem mulch resulted in longest vine (1.01m) which is not significantly different from grass mulch (0.98m). The control unmulched plot recorded the shortest vine length (0.61m) which is not significantly different from the banana leave mulched yam (0.62m). There was significant interference ($p>0.05$) of planting and mulching materials on vine length at 8 WAP. Yam planted with seed yam and mulched with grasses gave the longest vine (1.52m) whereas the shortest was observed in yam planted with yam bottom with no mulching material (Table 2). The result of the study also indicated that blocking do not significantly influence ($p>0.05$) the vine length of yam at 8 WAP. Mulching materials significantly ($p<0.05$) influenced days to 50% sprouting. This is supported by work of' Arnoud [14] which postulated that the time taken for the yam setts to sprout was found to be shortened by approximately 20% using *Gliricidia sepium* leaf mulch on water yam (*D. alata*).

Effects of planting and mulching materials on vine length at 14 WAS

The result in Table 2 revealed that planting materials also significantly affected ($p<0.05$) the vine length at 14 WAP. Yam planted with seed yam have the longest vine length (2.76), followed by head setts (2.25m) while the shortest vine length was observed in yam planted with bottom (1.65m). Mulching materials was best with banana pseudostem (2.65m). While the shortest length was observed from plots mulched with banana leaves (1.84m). Statistical analysis for vine length at 14 DAP as shown in the table revealed that there was significant interference ($p>0.05$) between planting and mulching materials. The longest vine at 14WAP was observed in yam planted with seed yam and mulched with banana pseudostem (3.36m) while the shortest was observed in yam planted with yam bottom setts with banana leave (1.53m) and no mulching material (1.29m). Yam planted with seed yam significantly reduced days to sprouting and induced vine length at both 8 and 14 WAP. The yam planted with seed yam also had better growth rate than those planted with head and bottom. The better growth rate of seed yam might he due to relatively short dormancy period observed in seed yam.

Grass mulch had been reported to significantly ($P < 0.05$) lowered maximum soil temperature by 1-2℃ at 15cm depth during the thermal critical period (January - March). Generally, the yam planted under mulched plot were significantly higher in emergence rate, vine length, number of stem branches and number of leaves than for un-mulched plot. Irrespective of mulching materials, it was found that mulching significantly ($P< 0.05$) increased emergence rate and tuber yield of yam than the unmulched [15]. This finding is also in agreement with previous report that the emergence and growth rate of yam seedling were observed to be significantly higher in mulched plots than the un-mulched plot by [16,17]. Increased emergence and more rapid development of setts in mulched yams could be attributed to an increase in soil moisture content and the consequent modification of soil temperature under mulched plot [16,18-20].

The effect of different planting materials and mulches on yield of white yam

The yield of yam planted with different planting and mulching materials is as shown in Table 1. The highest yield was recorded from seed-yam (2.28t/ha) followed by 2.15t/ha from head setts. Statistical analysis revealed that grass mulch was best giving a yield of 2.45t/ha closely followed by banana leaf that gave 2.36t/ha. Yam planted with seed yam significantly reduced days to sprouting and better growth rate than those planted with head and bottom. The induced vine length observed in seed at both 8 and 14 WAP which translates into a better yield might be due to relatively short dormancy period which aids photosynthesis and greater accumulation of dry matter and more time is allowed for tuberisation due to early leaf emergence. This is in conformity with Law-Ogbomo and Remison [21] statement that “changes in leaf number are bound to affect the overall performance of yams as the leaves serves as the photosynthetic organ of the plant and that increased leaf number leads to a greater dry matter accumulation per unit of land area, because of better utilization of solar radiation. Although Opara [22] reported that average yield of yam is influenced by the planting material, result from this work shows there was no significant difference ($p>0.05$) from the planting materials.

Statistical analysis also revealed that mulches do significantly influenced the yield of yam. Grass mulch recorded the highest yield of 2.45t/ha. The least was from banana pseudostem not significantly different from the control. Grass mulch have been reported to significantly improved the growth, development and yield of yam than other mulch and the unmulched plots. This is in consonant with Maduakor *et al*. [23] who stated that mulching significantly increased yam tuber yield as much as 20%.The beneficial effects of grass mulch on yam growth could be attributed to the nutrients released by decomposing mulch [16,18], and its physical effect on the possible reduction of nutrient losses by surface erosion and leaching. It has also been placed on record that irrespective of the variety of white yam planted, mulching significantly increased tuber length, tuber diameter, tuber weight and yield of yam than for un-mulched plot. These findings also agreed with previous report that the yield and yield components of yam were significantly higher in mulched plots than the un-mulched plot by [16,17,24]. The observed increase in growth and tuber yield of yams was possibly by reducing nutrient losses through control of water and nutrient runoff and leaching in the raining season. Since fertilizer was not used in the study, the yield recorded in the grass mulch was also attributed partly to the possible influence of an early decomposed mulch material on increase in soil nutrient status and availability since the grass mulch is known to contain some element of Nitrogen, magnesium, calcium, phosphorus and potassium [24], and these nutrients, particularly N, P and K are important in the growth and bulking of yam tubers, and consequently in the tuber yield [25].

The result also showed that there was significant interaction ($p>0.05$) between the planting materials and mulches on yield. The highest yield was observed in yam planted with seed yam and mulched with grasses which produced a yield of 3.10 t/ha while the lowest yield was observed in yam planted with seed yam and pseudostem mulched.

CONCLUSIONS AND RECOMMENDATIONS

From this study, it is obvious that planting and mulching materials significantly aided the emergence and development of yam setts and increased tuber yield. The physical effect of the mulch through reducing nutrient losses by runoff, erosion and leaching and decreasing maximum soil temperature and conserving moisture, increased growth and tuber yield as compared to un-mulch. Further, the type of mulching material influenced emergence, development, and yield of yam. All mulches have the physical effect of reduction of nutrient losses by surface erosion and leaching and also checks weed growth. However, the grass mulch may have significantly lower soil temperature and produced higher yield through its chemical effect and the release of nutrients, particularly phosphorous from its earlier decomposition. Yam head sett could be substituted for seed yam as planting material. Also, with the result obtained from the different mulching materials, it could be suggested that banana pseudostem and leaves be chopped, fermented, dried and milled to serve better as mulching material and to improve the physical quality of the soil. It is therefore suggested that more work be conducted on the use of banana pseudostem as mulching material to determine the nutrient composition of the material and the appropriate level for its use.

Table 1: Physical and chemical analysis of mulching materials and soil before planting and soil after treatment

Properties	Mulches			Pre-plant Soil	Post-plant soil		
	Pseudostem	Leaf	Grass		Pseudostem	Leaf	Grass
pH (KCl)	-	-	5.10	4.35	5.80	5.60	5.30
pH (H_2O)	-	-	5.70	4.92	6.90	6.70	6.90
Org. C.	-	-	2.12	9.01	1.79	1.69	2.12
Total N. (%)	11.40	15.60	0.74	0.09	0.43	0.41	0.52
Av. P. (ppm)	81.06	61.99	42.50	29.24	42.37	38.29	37.78
Ca (Me/100g)	1.20	1.24	1.61	6.41	1.36	1.50	1.74
Mg (Me/100g)	0.72	0.74	0.81	5.09	0.70	0.79	0.81
Na (Me/100g)	0.14	0.15	0.08	0.92	0.80	0.10	0.10
K (Me/100g)	0.50	0.52	0.10	1.16	0.15	0.17	0.18
Ex. Ac. (Me/100g)	-	-	-	0.10	0.20	0.40	0.20
CEC (Me/100g)	-	-	-	13.58	2.49	2.97	3.02
B. Sat. (%)	-	-	-	97.00.00	92.28	86.53	93.38
Mn. (ppm)	73.90	77.4	124.50	93.26	99.40	108.30	116.70
Fe. (ppm)	108.70	110.80	141.30	138.41	154.30	159.40	172.20
Cu. (ppm)	98.00	103.00	16.50	-	9.10	10.30	11.70
Zn. (ppm)	293.00	351.00	73.80	-	48.60	52.20	55.10
Sand (%)	-	-	-	71.00	81.80	81.80	79.80
Clay (%)	-	-	-	9.00	12.80	10.80	14.80
Silt (%)	-	-	-	20.00	5.40	7.40	5.40

Table 2: Effects of planting and mulching materials on days to 50% sprouting, vine length and yield of whiteyam (*Dioscorea rotundata*) in Ikorodu area of Lagos State, Nigeria

Treatments	Days to 50% sprouting	Vine length (m) Weeks after sprouting		Yield (t/ha)
		8	14	
Planting materials				
Bottom	81.80a	0.21b	1.65c	2.11a
Head	67.56b	1.05a	2.25b	2.15a
Seedyam	59.10c	1.11a	2.76a	2.28a
Mulching materials				
Grass	67.58b	0.98a	2.31a	2.45a
Banana leaves	76.50a	0.62b	1.84b	2.36ab
Banana pseudostem	68.58b	1.01a	2.63a	1.96b
Control	63.55c	0.61b	2.20b	1.94b
Interactions				
Bottom x Grass	71.00d	0.46cd	1.98abc	1.74bc
Bottom x Leaves	85.50b	0.12d	1.53bc	2.35ab
Bottom x Pseudostem	91.25a	0.19d	1.78bc	2.55ab
Bottom x Control	78.25c	1.10d	1.29c	1.88abc
Head x Grass	65.00e	1.31ab	2.00abc	2.50ab
Head x Leaves	78.25c	0.85bc	1.94abc	2.36ab
Head x Pseudostem	58.00fg	1.31ab	2.74abc	2.32abc
Head x Control	69.00de	0.71bcd	2.33abc	1.94abc
Seed yam x Grass	54.75g	1.17a	2.95ab	3.10a
Seed yam x Leaves	65.75e	0.89abc	2.06abc	2.37ab
Seed yam x Pseudostem	56.50fg	1.52a	3.36a	1.00c
Seed yam x Control	59.25f	0.84bc	2.68abc	1.97abc

Means with the same letters within a column are not significantly different ($p<0.05$)

REFERENCES

1. Onwueme, I. C. (1977). Field comparison of West African planting and tuber yield in *Dioscorea rotundata*. *Journal of Agricultural Science*, 84:503-506.
2. (Coursey, 1967)
3. Ike, P. C and Inoni O. U. (2006).Determinants of yam production and economic efficiency among small-holder farmers in southeastern Nigeria. *Journal of Central European Agriculture*, 7:2.
4. (FAO, 2002)
5. Nweke, F. I., Okorji, L. C., Njoku, 1. F. and King, D. J. (1992). Elasticities of demand of major food items in a root and tuber-based food system: Emphasis on yam and cassava in southeastern Nigeria. RCMD, *Research Monograph*No. II, lITA, Ibadan, Nigeria. 2lpp.
6. Kalu and Erhabor, 1992
7. Kalu and Ortese, 1993
8. Opeke, K.L. (2006). Essentials of Crop Farming. Spectrum Books Limited, Spectrum House, Ring Road, Ibadan. Obiokoro, O.G. 2005. Agrometeorology. Onitsha: Dunkwu Publishers. pp. 24-30.
9. Lal, R. (1995). Sustainable management of soil resources in the humid tropics. Proceeding of. International Symposium on Soil Processes and Management Systems: Greenhouse Gas Emissions and Carbon Sequestration, 5- 9 April 1993
10. Morton (1987)
11. Igwilo, N.O. (2003). Effects of mulching, staking and tillage on weed growth in yam plots during the dry season. *Global Journal of Agricultural Sciences*, 1:119-128.

12. Beatrice Aighewi, Norbert Maroya, Robert Asiedu, Daniel Aihebhoria, Morufat Balogun and Djana Mignouna (2020): Seed yam production from whole tubers versus minisetts. *Journal of Crop Improvement*, 34(6).

13. Orkwor, G.C. 1998. "Seed Yam Production Technology. The Yam Minisett Technique." In *2010. Yam Nutrition: Nutrient Disorders and Soil Fertility Management. ACIAR Monograph No. 144*, edited by J. N. O'Sullivan. Canberra: Australian Centre for International Agricultural Research.

14. Arnoud, B. (2004).Effect of the application of the leaf mulch of *Gliricidia sepium* on early development, leaf nutrient contents and tuber yields of water yam (*Dioscorea alata*). *Agroforestry Systems,* Volume 8, Number 3: 243-256.

15. Eruola, A.O., Bello, N.J., Ufoegbune, G.C. and Makinde, A.A. (2012): Effect of Mulching on Soil Temperature and Moisture Regime on Emergence, Growth and Yield of White Yam in a Tropical Wet-and-Dry Climate. *International Journal of Agriculture and Forestry*, 2(1):93-100

16. International Institute of Tropical Agriculture (IITA). (1995). Yam research at IITA: 1971-1993. IITA Ibadan, Nigeria. 38pp.

17. Lai, R. (1975). Role of mulching techniques in tropical soil and water management. Technical Bulletin, International Institute of Tropical Agriculture, Ibadan, Nigeria. 38pp

18. Fageria, N.K. 1980. Deficiencia hidrica em arroz de cerrado e resposta ao fosforo. Pesqui. *Agropec. Bras*, 15:259-265.

19. Kutugi, A.D. (2002). Comparative analysis between indigenous and modern tiilage practices in the production of *Dioscorea rotundata* and *Dioscorea cayenensis* in the middle belt of Nigeria. *Journal of Aagriculture and Environment*, 2(1):53-66.

20. Okoh, C.A. (2004). The effect of mulching on soil physico-chemical properties and the yield of White Yam. *Tropical Journal of Root Tuber Crops*, 4(2):24-31.

21. Law-Ogbomo, K.L. and Remison, S.U. (2007). The response of *Dioscorea rotundata* to NPK fertilizer application in Edo state, Nigeria. *Research Journal of Agriculture and Biological Science*, 3(6):917 923.

22. Opara (2004)

23. Maduakor, K.O., Lal, R. and Opara-Nadi, O.A. (1984). Effects of methods of seedbed preparation and mulching on the growth and yield of white yam (*Dioscorea rotundata*) on an ultisol in south-east Nigeria. *Field Crops Research*, 9(2):119 - 130.

24. Odjugo, P.A.O. (2008). The effect of tillage systems and mulching on soil microclimate, growth and yield of yellow yam (*Dioscorea cayenensis)* in Midwestern Nigeria. *African Journal of Biochemistry*, 7(24):4500-4507.

25. Hahn, S.K., Osiru, D.S.O., Akoroda, M.O. and Otoo, J.A. (1987). Yam product and its future prospects. *Outlook on Agriculture*, 16(3):105-110.