



Effect of Planting and Mulching Materials on Growth and Yield of White Yam (*Dioscorea rotundata*) in Ikorodu, Lagos State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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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. 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 sets 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

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planting and mulching materials also had a significant effect on days to sprouting, vine length and yield of yam. 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.

1. INTRODUCTION

Yam (*Dioscorea species*) an annual crop widely grown in Nigeria and other parts 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, yam 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. The tubers are prepared for consumption in various forms. Yam is the foremost root crop in Nigeria with many species. The southern-Guinea savanna zone of Nigeria is the major yam producing area. Yams are the most important food crop in this 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 [2]. 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 5 kg and have thin skin and is indigenous to West Africa. West Africa is the most important region for yam production in the world with about 96% of the global production [3]. In the coastal West Africa, over 60 million people obtain dietary calories per day from yam [4]. Nigeria produces about 71% of world output with Ghana, Cote d'Ivoire, 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. Yams use 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 minisett in rapid seed yam multiplication. 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 yams include yellow yam (*D. cayenensis*), lesser yam (*D. esculenta*), cush cush yam (*Dioscorea trifida*), and India yam (*D. trifida*). Lal stated that the average yield of yam is 5 - 20 tonnes per hectare [5]. He further stated that several other factors such as variety/cultivar/species, size of setts, disease and pest, quality of soil, adequacy of moisture during the period of growth, degree and quality of insolation, temperatures during vegetative growth and tuber formation, and adequacy of cultural maintenance practices 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 [6] however postulated that if crop residue mulch and animal wastes are used efficiently chemical fertilizer requirements are substantially reduced. 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 on 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. The study is designed to investigate the effect of banana pseudostem and banana leave mulch on growth and yield of white yam. *D. rotundata*.

2. MATERIALS AND METHODS

The experiment was carried out at the teaching and research plot of the Department of Crop Protection, Lagos State University of Science and Technology, Ikorodu (5° 7'-5°10' N, 3°16'-3°18' E). 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 broadleaf weeds and grasses. The gross plot size was 17m by 13m and the net plot 15 m by 11 m. The experimental materials were banana pseudostem, banana leaves and dry grasses as mulching materials and 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 and left under shade for about 8 hours for the surface to dry then 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 [7]. The banana pseudostem mulch was obtained from matured cooked banana pseudostem 15 cm long, sliced vertically into 4 halves. Three to four pseudostem cuttings were placed on mounds depending on the pseudostem girth. Dry grasses approximately 3 cm thick and dry banana leaves were used on some mounds and 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.

2.1 Data Collection

The chemical components of the mulching materials (banana pseudostem and dry banana leaf and dry grasses) were 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 at $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Initial Soil Properties

The soil analysis is shown in Table 1. The pH of the soil was strongly acidic. Nutrient content 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.

3.2 Effects of Planting and Mulching Materials on Number of Days to 50% Sprouting

Planting material significantly affected the rate of sprouting of white yam (Table 2). The earliest planting material to sprout was seed yam which sprouted 59 days after planting (DAP) while the latest planting material to sprout was yam bottom setts that sprouted 81 DAP. These findings are supported by Beatrice et al. 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 [8]. They also reported that sprouts from the whole seeds started emerging from the soil less than 10 DAP, reached 50% emergence at 37 and 35 days, respectively, and peaked at 56 DAP. Minisetts of the same sizes had their peak emergence at 77 DAP. Also, findings that head setts sprouted before the bottom setts is supported by Orkwor [9] who noted that after 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. The head portion is oldest and contains the shoot primordium that is apically dominant while the tail has the youngest tissues that regenerate easily.

Mulching materials also affected yam sprouting. The unmulched control plot was sprouted the earliest, followed by plots treated with banana pseudostem and grass mulch.. Yam mulched with banana leaves sprouted last 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 [10] had also reported that the time taken for planting yam setts to sprout was shortened by approximately 20% using

Gliricidia sepium leaf mulch on water yam (*D. alata*).

The 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, the interaction of the head setts with various mulching materials performed better than the interaction between bottom setts and mulching materials. The earliest sprout was observed with seed yam using grass mulch. The latest to sprout was the interaction of bottom setts and pseudostem.

3.3 Effects of Planting and Mulching Materials on Vine Length 8 Weeks after Sprouting (WAS)

There was significant differences in vine length produced by different planting materials (Table 2). Seed yam and the head setts produced the longest vines while bottom setts recorded the shortest vines 8 WAS.

When comparing mulching materials, banana pseudostem and grass mulch resulted in longest vine length while the unmulched control and banana leaves recorded the shortest vine length. (Table 2).

There was interaction of planting and mulching materials on vine length 8 WAP. Yam planted with seed yam and mulched with grasses gave the longest vine (1.52 m) 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 influenced days to 50% sprouting. This is supported by work of Arnoud [10] who 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*).

3.4 Effects of Planting and Mulching Materials on Vine Length 14 WAS

Planting materials also affected the vine length 14 WAS (Table 2). 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).

When evaluating mulching materials, the best growth occurred when using banana pseudostem and grass. The shortest length was observed from plots mulched with banana leaves (1.84 m). There was a significant interaction between planting and mulching materials at 14 WAS. The longest vine was observed in yam planted with seed yam and mulched with banana pseudostem (3.36 m) while the shortest was observed in yam planted with yam bottom setts with banana leaf (1.53 m) and no mulching material (1.29 m). 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 be due to relatively short dormancy period observed in seed yam.

Grass mulch had been reported to lower maximum soil temperature by 1 to 2°C at 15 cm depth during the thermal critical period (January - March). Generally, the yam planted under mulched plot were 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 increased emergence rate and tuber yield of yam than the unmulched [11]. This finding is also in agreement with previous reports that the emergence and growth rate of yam seedling were observed to be higher in mulched plots than the un-mulched plot by. 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 [12-15].

3.5 The Effect of Different Planting Materials and Mulches on Yield of White Yam

When comparing planting material, there were no yield differences (Table 2). highest yield was recorded from seedyam (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 [16] 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 reported that average yield of yam is influenced by the planting material, result from this work shows there was no difference from the planting materials.

Mulches did influence yam yield (Table 2). Grass mulch and banana leaves recorded the highest yield with banana pseudostem and the control produced the least. Grass mulch have been reported to improved the growth, development and yield of yam over other mulches and the unmulched plots. Maduakor et al. [17] 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 [12], 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 [17]. 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 [17], and these nutrients, particularly N, P and K are important in the growth and bulking of yam tubers, and consequently in the tuber yield [18-20].

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 ₂ O)	-	-	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)		Yield (t/ha)
		Weeks after sprouting		
		8	14	
Planting materials				
Bottom	81.80a	0.21b	1.65c	2.11a
Head	67.56b	1.05a	2.25b	2.15a
Seed yam	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	1.90c
Seed yam x Control	59.25f	0.84bc	2.68abc	1.97abc

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

4. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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