Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.025

Full Length Research Article

EFFECTS OF MINERO-ORGANIC FERTILIZER AND WEED CONTROL METHODS ON THE PERFORMANCE OF SWEET POTATO (*IPOMOEA BATATAS*) VARIETIES

*Magaji, Y.T. and Sodangi, I.A.

Department of Crop Science, Faculty of Agriculture, Kaduna State University.

*Corresponding Author's Email Address: magaji.tagwai@kasu.edu.ng

ABSTRACT
A field trial was conducted during the wet seasons of 2019 and 2020 at the Research farm of the Faculty of Agriculture, Kaduna State University. The investigation was carried out in order to determine the effects of minero-organic fertilizer (MOF) and weed control methods on the growth, yield and yield components of two sweet potato (*Ipomoea batatas* L.) varieties. The treatments consisted of three levels of minero-organic fertilizer (0, 500 and 1000kg ha^{-1}), three weed control methods (Metolachlor 290g/l + Atrazine 370g/l at 1.5kg a.i ha $^{-1}$, manual weeding and a weedy check) and sweet potato varieties. The treatments were laid in a randomized complete block design and replicated three times. MOF at 1000kg ha^{-1}, Primextra at 1.5kg a.i ha^{-1} and UMUSPO 1 gave the highest yield; 36.60, 37.67 and 31.92t ha^{-1} respectively. Of the 28 weed species identified in 2019, broad leaf and grasses constituted 68.70 and 31.3 %, whereas in 2020, broad leaf was 62.0 and grasses 38.0% respectively. The findings in this trial revealed that the combination of MOF at 1000kg ha^{-1}, Primextra at 1.5kg a.i ha^{-1} and UMUSPO 1, could be used during the cultivation of sweet potato in this region.

Keywords: Sweet Potato, Minero-organic fertilizer, Primextra and Yield

INTRODUCTION
The sweet potato is a dicotyledonous plant that belongs to the bindweed or morning glory family, *Convolvulaceae* (Purseglove, 1968). Over 95 per cent of the global sweet potato is produced in developing countries where it is the fifth most important food crop in terms of fresh weight. It is an important staple food crop in most parts of tropical and subtropical regions of the world. (Laban *et al*., 2015).

World production figures stood at 142.6 million tonnes in 2,000. Production dropped to about 91.9 million tonnes in 2018, with China and Nigeria supplying about 94.5 and 3 % respectively of the world's production. (Anon. 2019). In Nigeria, sweet potato is the third most important of root and tuber crops, after cassava and yam (FAOSTAT, 2017). The crop has ceased to be "back yard crop or gap filler" as previously perceived. Surveys in Nigeria showed that production, marketing and utilization have expanded in the last decade beyond its traditional central and riverine areas (Agboola, 1979) to almost all ecological zones in the country (Tewe *et al*., 2001). Presently, Nigeria is the largest producer of sweet potato in Africa with annual output of 2.8 million metric tons (FAOSTAT, 2018).

The increasing potential of the crop in poverty alleviation and food security due to its high productivity per unit area and time makes sweet potato an important crop for the survival of the resource poor farmers in Nigeria (NRCRI 2003).

The crop serves as a starch staple food for human consumption. The tuber can be eaten roasted, fried or boiled (NRCRI, 1985). The foliage and smaller tubers serve as livestock feed (Ambe-Tumanteh, 1994). Its importance in starch, alcohol, pharmaceutical and textile industries are widely recognized (Woolfe, 1992). The orange-fleshed varieties with high ß-carotene content have become very important in combating vitamin A deficiency, especially in children (Woolfe, 1992). Sweet potato has a high nutritional value and serves as a good source of energy, calcium, iron, vitamins and some minerals (Woolfe, 1992). The leaves are rich in protein, with 34.5% crude protein (Nwinyi, 1987). Sweet potato roots can be reconstituted into fufu or blended with other carbohydrate flour sources such as wheat and used for baking bread and biscuits (Udoh *et al*., 2005). However, about 80% of the crop produced in Nigeria is used for human food (FAOSTAT, 2005).

In recent times, the production of sweet potato has been on the decrease despite its numerous economic and nutritional values. According to Fawole, (2007), yields of 4-7 tons of sweet potato per hectare are obtained by smallholder farmers, and this is just about 20-35 per cent of the crop's potential yield. The Federal Government of Nigeria released a plan in 2015 to improve the productivity of sweet potato in the country from 6 tonnes per hectare to 25 tonnes per hectare, and national production from two to six million tonnes per annum by 2016. There's great opportunity for sweet potato export in Nigeria (Ajetomobi, 2015).

Sweet potato is grown in diverse environments around the world, often by small scale farmers on marginal soils, using low inputs (Amare *et al*., 2014). In Nigeria, production is dependent primarily on seasonal rains. Optimum yields are obtained in areas with 750 to 1,000 mm rainfall, with at least 500 mm falling during the growing season (Tewe *et al.,* 2001). Sweet potato is grown on a variety of soils, but well-drained, light to medium-textured soils with a pH of 4.5-7.0 are more favourable for the crop. It can be grown on poor soils with little fertilizer. Low soil fertility is one of the constraints in production of sweet potato in Nigeria. Fertilizer application is an important option left to farmers for yield improvement in most soils. The potential of sweet potato as a cash crop has led to the requirements of fertilizer recommendations for commercial farmers to increase root yield.

Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.025

Weed competition has been identified as a major production constraint in sweet potato production in Nigeria. Yield losses caused by uncontrolled weed growth have been estimated at 42 - 65% in the country (Unamma, 1984). Chemical weed control has improved crop production and is cheaper in reducing the drudgery involved in manual weeding.

The objectives of the study are; to evaluate the performance of two sweet potato varieties as influenced by minero-organic fertilizer at Kafanchan and to evaluate some weed management practices on sweet potato under minero-organic fertilizer

MATERIALS AND METHODS

A field experiment was conducted during the wet seasons of 2019 and 2020 at the Research farm of the Faculty of Agriculture, Kaduna State University, Kafanchan Campus in the southern Guinea savannah; Nigeria. Soil samples were randomly collected at 0-30 cm soil depth using a soil auger from various points in the two years of study for the determination of physical and chemical properties. The samples for each year were bulked and the composite sample was air-dried, ground, sieved and analysed for their physico-chemical properties in each year. The treatments consisted of three neem based minero-organic compound fertilizer (7:7:7) (0, 500 and 1000 kg ha^{-1}, three weed control methods (Metolachlor 290g/l + Atrazine 370g/l-formulated as Primextra Gold at 1.5 kg a.i ha $^{-1}$, manual weeding and a weedy check) and two orange flesh sweet potato varieties (UMUSPO 1 and UMUSPO 11). The gross plot size was 4 ridges of 4 m long, spaced at 1 m, (4 x 4 =16.0 m^2). Each plot was separated by a border of 1 m across and 1 ridge along the ridges. The varieties used were UMUSPO 1 and UMUSPO 11, developed by the National Root Crops Research Institute (NRCRI) Umudike. Seed vines of the two varieties were sourced from NRCRI Nyanya sub-station, Nasarawa State. Ridges of about 0.25 m high and spaced at 1 m were made manually with hoe after ploughing and harrowing each year. Sweet potato vine cuttings of 25-30 cm long consisting of 2-3 nodes each were planted at the crest of ridges at a spacing of 1 m x 0.30 m (approximately 34,000 stands ha^{-1}) and depth of about10 cm. Planting was on 18 July and 15 June, 2019 and 2020 respectively. Fertilizer application was carried out in split doses; first dose was during planting and the second dose at four weeks after planting (4WAP) by side dressing in each case. The herbicide treatment was imposed using a CP15 Knapsack sprayer as per treatment; Primextra Gold at 1.5 kg a.i ha^{-1} applied as pre-emergence, and manual weeding at 4 WAP using hoe. Crop maturity was decided by yellowing of leaves, die back of vines and cracking of soil. Harvesting was by lifting root tubers with the aid of a hand hoe at the base of the plant.

Weed dry weight was obtained by collecting weed samples at random using 1 m^2 quadrant in each plot at 4, 8 and 12WAP. The samples were cleaned free of soil and oven dried at 70 ^{0}C to a constant weight. Observations on crop growth and yield related characters were taken at 4, 8 and 12WAP. The weights of the dried samples were determined using metler balance. All the data on yield and yield contributing characters were recorded.

Vine lengths in the net-plots were measured from base of stem to the shoot apex using a measuring tape and the means were computed and recorded in centimetres at 4, 8 and 12WAP in both years. The shoots of five randomly selected plants were harvested from the two outside rows at both locations at 4, 8 and 12WAP and oven dried at 75 ^{0}C to a constant weight. The average weight per plant was computed and recorded in both years. Leaf area was determined from the leaves of five randomly selected plants from outside rows at 4, 8 and 12WAP using Leaf Area Meter. The result was then divided by the area of land subtended by the five plants to obtain the LAI.

Leaf area index (LAI) is given by

LA/P

Where LA = leaf area (cm^2)

P = ground area covered/plant.

The total marketable tuber yield was obtained by the summation of weights of harvested tubers from each net plot before sorting the tubers into marketable tubers, and the result recorded as total tuber yield ha^{-1}. The marketable tuber yield was obtained from the total tuber weight of each net plot expressed as yield in tons per hectare. The data collected were subjected to analysis of variance using the F- test to determine significance of differences between the treatment means as described by Snedecor and Cochran (1967). The treatment means were compared using the Duncan Multiple Range Test (Duncan, 1955).

RESULTS

Results of the analysis for the physical and chemical properties for the period under consideration are presented in Table 1. According to the results, the soil texture in both years was sandy loam with low to moderate nutrient contents (0.51, 0.46% N, 12.96, 10.41 mg/kg P and 0.15, 0.18 mg/kg K) (Table 1).

Weed dry weight (dwt)

The effects of minero organic fertilizer (MOF), weed control method and sweet potato varieties on weed dry weight in 2019 and 2020 wet seasons are presented in Table 2. Fertilizer rate did not show significant effect on weed dry weight throughout the sampling period. Likewise, Primextra consistently gave lower weed dry weight than all the other weed control treatments throughout the sampling period in both years. The weedy check however, resulted in higher weed dry weight throughout the sampling period in both years, except at 4WAP in both years where the parameter remained unchanged

Weed control methods significantly influenced weed dry weight throughout the sampling periods in both years. At all the sampling periods, Primextra Gold reduced weed dry weight over all the other weed control treatments.

Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.025

Table 1: Physico– chemical characteristics of soil samples at the experimental Sites during the 2016 and 2017 rainy seasons at Samaru and Kaduna.

Soil depth 0-30 cm		
Soil composition	2019	2020
Particle size		
Sand (g kg^{-1})	670	610
Silt (g kg^{-1})	240	220
Clay (g kg)$^{-1}$	98	110
Textural class	Sandy Loam	Sandy Loam
Chemical Characteristics		
pH in 0.01M $CaCl_2$	4.61	4.66
pH in H_20	6.20	6.18
Organic Carbon (g kg^{-1})	9.12	10.60
Total Nitrogen (g kg^{-1})	0.51	0.46
Available Phosphorus (mg kg^{-1})	12.96	10.41
K	0.15	0.18
Mg	0.56	0.55
Ca	2.21	3.82
Na	0.24	0.13
CEC	4.57	5.00

Source: Department of Agronomy, ABU Samaru, Zaria

Table 2: Weed dry weight (gm) at 4-12WAP as influenced by MOF, weed control methods and sweet potato varieties during the wet seasons of 2019 and 2020

	Weed dry weight (gm)					
Treatment	2019			2020		
Fertilizer(kg ha^{-1})	4WAP	8WAP	12WAP	4WAP	8WAP	12WAP
0	11.70	61.1	75.60	8.13	30.25	72.00
500	10.8	59.3	85.25	11	32.75	69.75
1000	12.3	57.7	83.63	10.6	35.25	72.25
SE±	0.12	1.38	2.90	11.87	15.75	23
Weed Control Method						
Primextra (1.5 kg a.i ha^{-1})	0.50b	43.60c	62.75c	0.25b	10.50c	58.40c
Hoe weeding	11.90a	50.50b	80.80b	10.40a	35.12b	72.50b
Weedy check	13.12a	182.30a	343.72a	8.62a	190.50a	328.25a
SE±	0.06	17	23	12.26	12.5	22
Varieties						
UMUSPO 1	10.62	43.5	63.87	8.37	33.37	79.37
UMUSPO 11	10.75	55.75	84.75	10.87	32.37	83
SE±	0.05	15.75	17.25	8.60	18.80	24.26
Interactions						
F*W	NS	NS	NS	NS	NS	NS
F*V	NS	NS	NS	NS	NS	NS
W*V	NS	NS	NS	NS	NS	NS
F*W*V	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 5 % level of probability using Duncan Multiple range Test (DMRT)

MOF = Minero organic fertilizer
WAP = Weeks after planting
F = Fertilizer
W = Weed control method
V = Variety
NS= Not significant

At 4WAP in both years, hoe weeded control resulted in similar weed dry weight with the weedy check.
The two varieties did not differ in weed dry weight in both years in this location.
The interactions of MOF, weed control treatments and crop variety were not significant throughout the sampling period.

There was no effect of fertilizer on weed characters as seen in Table 2. The non-effect of fertilizer on weed characters could be due to timing and method of fertilizer application.

Vine length
The effects of MOF, weed control treatments and crop variety on vine length of sweet potato in 2019 and 2020 wet seasons are presented in Table 3. Fertilizer treatments influenced vine length throughout the period of sampling in both seasons. At 4WAP in 2019, increase in fertilizer rates from 0-1000 kg ha^{-1} resulted in positive and significant increase in vine length with the application of MOF at 1000 kg ha^{-1} producing the highest vine length, followed by MOF at 500 kg ha^{-1}, then, the untreated control which produced the least. At 8 and 12WAP in 2019, MOF at 500 and 1000 kg ha^{-1} gave similar result which is higher than by the untreated control. At 4 and 8WAP in 2020, increase in fertilizer rate from 0-500 kg ha^{-1} resulted in significant difference. However, the parameter remained unchanged with increase in rate from 500-1000 kg ha^{-1}. At 12WAP in 2020, successive increase in fertilizer rates resulted in corresponding increase in vine length, with MOF at 1000 kg ha^{-1} producing the highest vine length, while the untreated control gave the least vine length.
At 4WAP, weed control treatment did not have significant influence on vine length. However, in both years, weed control treatments significantly influenced vine length at 8 and 12WAP. In each case, the weedy check plots resulted in shorter vines than the treated plots and all of which were similar except at 12WAP in 2020 where manual weeding gave the highest vine length which differed significantly with all other weed control treatments.
Crop variety significantly influenced vine length of sweet potato in both years. At each sampling period, UMUSPO 1 gave higher vines than UMUSPO 11 except in 2020
The interactions of fertilizer, weed control treatments and crop variety were not significant throughout the period under consideration.

Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.025

Table 3: Vine Length (cm) as influenced by MOF and weed control methods in sweet potato varieties during the wet seasons of 2019 and 2020

	Vine Length (cm)					
Treatment	2019			2020		
Fertilizer(kg ha-1)	4WAP	8WAP	12WAP	4WAP	8WAP	12WAP
0	9.60c	116.50b	125.93b	13.41b	118.30b	129.38c
500	15.90b	118.82a	131.10a	24.35a	135.14a	134.89b
1000	20.30a	119.43a	132.51a	21.53a	137.63a	146.08a
SE±	3.20	3.0147	4.34	0.65	5.97	4.94
Weed Control Method						
Primextra (1.5kg a.i ha^{-1})	12.30	132.62a	140.48a	12.79	133.82a	138.78b
Hoe weeding	12.84	135.60a	138.67a	13.65	129.61a	140.18a
Weedy check	11.19	97.70b	105.73b	12.79	98.60b	127.22c
SE±	0.87	3.34	4.37	0.75	6.32	7.36
Varieties						
UMUSPO 1	13.16a	179.21a	200.66a	13.04	184.62a	206.38a
UMUSPO 2	7.62b	61.74b	60.26b	12.54	66.29b	66.63b
SE±	0.61	2.36	3.05	0.53	4.47	5.22
Interactions						
F*W	NS	NS	NS	NS	NS	NS
F*V	NS	NS	NS	NS	NS	NS
W*V	NS	NS	NS	NS	NS	NS
F*W*V	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment are not significantly different at 5% level of probability using Duncan Multiple range Test (DMRT)
MOF = Minero organic fertilizer
WAP = Weeks after planting
F = Fertilizer
W = Weed control method
V = Variety
NS= Not significant

Shoot dry weight

The effects of MOF, weed control method and variety on shoot dry weight of sweet potato during the wet seasons of 2019 and 2020 are presented in Table 4**.** The data shows that fertilizer did not have significant effect on shoot dry weight at 4WAP in both years. However, at 8 and 12WAP in 2019 and 2020, shoot dry weight progressively increased with MOF from 0-1000 kg ha^{-1}. At 8WAP in 2019, MOF at 500 and 1000 kg ha^{-1} gave similar result which was higher than by the untreated control.

Table 4: Shoot dry weight (gm) as influenced by MOF, weed control method and sweet potato variety during the wet seasons of 2019 and 2020

	Shoot dry weight (gm)					
Treatment	2019			2020		
Fertilizer (kg ha^{-1})	4 WAP	8 WAP	12 WAP	4 WAP	8 WAP	12 WAP
0	25.70	98.61b	103.77c	16.50	87.29c	104.96c
500	28.47	164.32a	168.32b	16.0	141.53b	164.76b
1000	29.98	168.41a	184.73a	18.14	155.81a	184.51a
SE±	0.13	1.39	2.89	1.31	2.64	2.61
Weed Control Method						
Primextra (1.5 kg a.i ha^{-1})	28.60	158.70a	170.98a	17.51	151.81a	209.43a
Hoe weeding	26.08	161.77a	175.97a	17.26	148.48a	196.66a
Weedy check	29.10	57.83b	94.50b	15.00	68.96b	93.93b
SE±	0.06	13.81	6.78	0.69	1.69	1.41
Variety						
UMUSPO 1	28.35	81.27	148.42	17.89	163.29	187.98
UMUSPO 2	27.21	74.08	139.98	14.86	154.09	179.55
SE±	0.05	4.01	4.79	0.48	1.19	0.99
Interaction						
F*W	NS	**NS**	NS	NS	NS	NS
F*V	NS	**NS**	NS	NS	NS	NS
W*V	NS	**NS**	NS	NS	NS	NS
F*W*V	NS	**NS**	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 5 % level of probability using Duncan Multiple range Test (DMRT)
WAP = Weeks after planting
MOF = Minero organic fertilizer
F = Fertilizer
W = Weed control method
V = Variety
NS= Not significant

Thereafter, MOF at 1000 kg ha^{-1} consistently produced higher shoot dry weight than other fertilizer treatments.

Weed control method in both years did not have significant effect on shoot dry matter throughout the sampling periods, except at 8 and 12WAP in both years where Primextra at 1.5 kg a.i ha^{-1} and manual weeding consistently gave higher shoot dry weight than the weedy check. The data revealed the two varieties having similar shoot dry weight at 4-12WAP in both years. There was no significant interaction of MOF, weed control method and variety throughout the sampling period in both years.

LAI

The effects of MOF, weed control method and variety on LAI of sweet potato during the wet seasons of 2019 and 2020 are presented in Table 5**.** The data shows that fertilizer did not have significant effect on LAI at 4WAP in both years. However, at 8 and 12WAP in 2019 and at 12WAP in 2020, LAI progressively and significantly increased with MOF from 0-1000 kg ha^{-1}. MOF at 1000 kg ha^{-1} gave higher LAI than MOF at 500 kg ha^{-1} and the untreated control except at 8 WAP in 2020 where the result is at par. Weed control method in both years did not have significant effect on LAI at 4WAP. Similarly, the parameter remain unchanged at 8 and 12WAP in both years, except the weedy check which gave the least LAI and differed significantly with all other weed control treatments. The data revealed that UMUSPO 1 consistently produced higher LAI than UMUSPO 11 throughout the trial period except at 4WAP in both years.
There were no significant interactions between fertilizer, weed control method and variety

Total marketable tuber yield (t/ha^{-1})

Data on total marketable tuber yield of sweet potato per hectare as influenced by MOF, weed control method and variety during 2019 and 2020 wet seasons are presented in Table 6. Fertilizer rate had significant effect on total marketable tuber yield in both years and the combined means. Total tuber yield increased with MOF from 0-1000 kg ha^{-1}, with MOF at ha^{-1} producing the highest tuber yield per hectare, followed by MOF at 500 kg ha^{-1}, then, the untreated control
Similarly, weed control method influenced total marketable yield in both years and the combined means. All the imposed treatments resulted in higher tuber yield and each was higher than the weedy check. In 2019 and 2020, Primextra at 1.5 kg a.i ha^{-1} produced the highest total marketable tuber weight than all the other weed control treatments.
Also, crop variety significantly influenced this parameter, with UMUSPO 1 giving more total marketable tuber yield than UMUSPO 11.

Table 5: Leaf area index as influenced by MOF, weed control method and sweet potato variety during the wet seasons of 2019 and 2020

	Leaf area index					
	2019			2020		
Fertilizer(kg ha^{-1})	4WAP	8WAP	12WAP	4WAP	8WAP	12WAP
0	0.38	2.08c	2.07c	0.25	1.42b	2.04c
500	0.54	4.2b	6.08b	0.36	3.00a	5.83b
1000	0.58	5.44a	7.30a	0.44	3.40a	6.58a
SE±	0.14	0.06	0.20	0.05	0.10	0.17
Weed Control Method						
Primextra (1.5 kg a.i ha^{-1})	0.48	3.64a	5.95a	0.60	5.04a	6.19a
Hoe weeding	0.27	3.38a	5.45a	0.48	4.96a	6.10a
Weedy check	0.24	1.08b	1.47c	0.48	1.12b	1.00b
SE±	0.05	0.17	0.28	0.13	0.12	0.15
Variety						
UMUSPO 1	0.24	3.38a	5.45a	0.48	5.52a	6.54a
UMUSPO 2	0.24	2.99b	3.96b	0.50	4.32b	5.59b
SE±	0.04	0.12	0.20	0.10	0.11	0.01
Interaction						
F*W	NS	NS	NS	NS	NS	NS
F*V	NS	NS	NS	NS	NS	NS
W*V	NS	NS	NS	NS	NS	NS
F*W*V	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 5 % level of probability using Duncan Multiple range Test (DMRT)
WAP = Weeks after planting
MOF = Minero organic fertilizer
F = Fertilizer
W = Weed control method
V = Variety
NS= Not significant

Table 6: Total marketable tuber yield (t/ha) as influenced by MOF and weed control methods in sweet potato variety during the wet seasons of 2019 and 2020

	Total marketable tuber yield (t/ha)		
Treatment	2019	2020	Combined
Fertilizer (kg ha^{-1})			
0	12.84c	10.15c	11.49c
500	30.35b	29.76b	30.10b
1000	37.39a	35.81a	36.60a
SE±	1.35	1.34	1.35
Weed Control Method			
Primextra (1.5 kg a.i ha^{-1})	37.77a	37.58a	37.67a
Hoe weeding	29.95b	24.30b	27.12b
Weedy check	7.16c	3.36c	5.26c
SE±	0.94	1.18	1.06
Variety			
UMUSPO 1	33.38a	30.45a	31.92a
UMUSPO 2	24.82b	22.68b	23.75b
SE±	0.67	0.84	0.75
Interaction			
F*W	**	**	**
F*V	NS	NS	NS
W*V	NS	NS	NS
F*W*V	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability using Duncan Multiple range Test (DMRT)
WAP = Weeks after planting
MOF = Minero organic fertilizer
** Significant at 1% level of probability using DMRT
F = Fertilizer
W = Weed control method
V = Variety
NS= Not significant

The interaction of fertilizer and weed control method on total marketable tuber yield of potato was significant in both years of study and the combined means. In 2019, Primextra and hoe weeding produced similar result at each increase in fertilizer rate up to 1000 kg ha^{-1}, A similar trend was observed in 2020, except that the combination of Primetra and MOF at 1000 kg ha^{-1} gave the highest yield and differed significantly with other weed control treatments. In both years, the weedy check in combination with all fertilizer rates produced the least tuber yield per hectare.

Table 7: Interaction of weed control method and variety on total marketable tuber yield ha^{-1} of sweet potato at 12 WAP in 2019 and 2020.

Treatment		**Fertilizer (kg ha^{-1})**		
Weed control method		0	500	1000
			2019	
Primextra (1.5 kg a.i ha^{-1})		12.39c	30.30b	37.53a
Hoe weeding		11.30c	27.12b	34.60a
Weedy Check		2.72e	5.53d	6.27d
SE±	1.073			
			2020	
Primextra (1.5 kg a.i ha^{-1})		11.83d	26.10c	35.71a
Hoe weeding		12.00d	24.42c	30.00b
Weedy Check		2.50f	3.90f	4.58e
SE±	0.827			
		Combined		
Primextra (1.5 kg a.i ha-1)		12.11c	28.20a	36.62a
Hoe weeding		11.65c	16.32b	32.3b
Weedy Check		2.61d	4.71d	5.42c
SE±	0.95			

Means followed by the same letter(s) are not significantly different at 5 % level of probability using (DMRT)

DISCUSSION

Effect of Fertilizers on Weed Parameters

Fertilizer did not seem to have significant effect on weed characters in both years and locations. This is probably due to the fact that the crop would have been more vigorous at the initial growth stage due to available nutrients, thereby, smothering the weeds at this stage. This result conformed to the finding of Anon. (2019) who reported that sweet potato cultivars with a vigorous, shoot growth habit, greater branching, and a denser canopy early in the growing season may be less susceptible to weed interference.

Effect of Fertilizers on growth parameters

The effects of MOF on the growth character of sweet potato were observed at 4, 8 and 12WAP. At 4WAP, MOF positively influenced vine length significantly. This is expected because the fertilizer was applied during planting. This initial dose was able to improve the nutrient status of the native soil which was effectively utilized by the crop for increase in growth. Similar effect was reported by Anon (2010) where it was stated that in the U.S, research has revealed that fertilizing sweet potato at two weeks after planting is generally a good idea. Fertilizer will provide sweet potato the nutrients it needs to expand vines and root system and produce high tuber yield.

Most of the growth characters increased linearly with increased in levels of MOF. An observation of the shoot dry weight data revealed that the increase was steady up to 12 WAP (Table 4). The increase in weight is likely due to the fact that gains from photosynthetic activity of the crop were more than losses due to transpiration. The result is similar with that of vine length. This is because, the dry weight is a product of both length of stem and other growth parameters such number of leaves per plant. The maximum LAI at 12 WAP in 2019 and 2020 was 7.30 and 6.58 respectively (Table 5). Similar result was obtained by Enyi, (1977) and Bourke, (1985) who reported that, 'nitrogen application increased leaf area index (LAI).'

Effect of Fertilizers on yield and yield components

Fertilizer, positively and significantly influenced tuber yield in both years. Total marketable tuber yields increased even with the combined. Increased with the highest dose of MOF (1000 kg ha^{-1}), produced the highest marketable tuber yield, 36.60 t ha^{-1} based on the combined means, representing 68.6 % increase above the untreated control based on the combined data (Table 6).

The ability of MOF to significantly influence tuber yield could be attributed to its positive effects on vegetative growth, and the presence of potassium which plays significant role in root and tuber development, for which sweet potato has a high requirement of as it utilizes more of it than nitrogen. These findings revealed that soil fertility has great influence on the yield of sweet potato and is in conformity with Stanley (2010) who reported that application of 3 t ha^{-1} cow dung improved soil organic matter.

The significant yield decline in the two varieties when no fertilizer was applied might be due to poor soil nutrients as occurred in traditional farming systems. This finding is in consonance with the observation of Udo *et al*., (2005) who reported that 'the farmers who allowed sweet potato to respond to native fertility of the soil always recorded poor yields'. Furthermore, the researchers stated that nutrient availability significantly accounted for good yield of crops. They stated that two varieties of sweet potato, TIS 87/0087 and NRSP 05/022 though adaptable to Akwa-Ibom soils, could be profitably cultivated only with well-planned fertilization programme. This implies that UMOSPO 1 and UMOSPO 11 could be profitably cultivated only with well-planned fertilization programme

Effect of weed control methods on weed Parameters

Weed control methods had significant effects on weed characters such as they all supported low weed population compared with the weedy check (Table 2). Primextra at 1.5 kg a.i ha^{-1} appeared to have been more effective in reducing weed infestation compared to all other weed control treatments. This supports finding by Akobundu (1987) who reported that sweet potato is one of the crops in which chemical weed control was promising.

Effect of weed control methods on sweet potato growth and yield characters

Weed competition has been identified as a major production constraint in Sweet potato production in Nigeria (Unamma, 1984). Vine length and shoot dry weight appeared not to have been affected by weed control methods throughout the period under consideration. Akobundu, (1987) reported similar finding in which he said 'Under some conditions, root crops and weeds can grow together for a certain period of the growing season without significant harmful effect on crop yield.

Yield and yield components were greatly affected in both years. This study discovered that the yield parameters varied among weed control methods with Primextra at 1.5 kg a.i ha^{-1} producing the highest yield of 37.67 t ha^{-1}corresponding to 86.0% more than the weedy check based, on the combined data of 2019 and 2020 (Table 6). The use of herbicide and manual weeding would have greatly reduced competitiveness of weeds in the crop which enabled it harness available nutrient for the production of plant assimilates. This is in line with Awassa (1991) report which stated that a yield loss of 87 to 98.9 % was recorded if sweet potato is left un-weeded; even early or late weeding reduced the yield.

Primextra was able to control weeds at the initial stage of the crop life cycle; therefore, the initial low weed infestation at 4WAP in the Primextra treated plots is expected. Before harvest, the crop would have developed good canopy which was able to smother the growth of weeds with time. This suggests that Primextra is a residual, pre-emergence herbicide for the control of many important annual grasses and broadleaf weeds in many arable crops without the problem of carryover of herbicides affecting succeeding crops. This confirmed the finding of Anon (2016) who reported that Metolachlor when mixed with Atrazine and applied as pre-emergence gives good control of annual grasses and broad leaf weeds.

The early application of fertilizer would have enabled the crop to be more vigorous at the initial growth stage due to available nutrients, thereby, smothering the weeds at this stage. This result conformed to the finding of Anon. (2016) who reported that sweet potato cultivars with a vigorous shoot growth habit; greater branching and a denser canopy early in the growing season may be less susceptible to weed interference.

The low yield in the weedy check might have been as a result of weeds competing with the crop for available nutrient. Weeds and crops require similar growth resources from the soil and atmosphere, since they grow on the same piece of land at the same time. They both respond similarly to the environmental factors involved in plant growth, such as water, light, air and nutrients. This creates competition and results in weeds sharing of available growth resources, thereby causing deficiencies and reduction in crop yield. This is in conformity with report by Unamma, (1984) who said 'Weed competition has been identified as a major production constraint in Sweet potato production in Nigeria.

Varietal Response

The influence of weed characters on UMUSPO 11 suggest that the crop had less plant canopy and so, was unable to smother the weeds. The high LAI of UMUSPO1 would have been responsible for high crop canopy which in turn might have resulted in suppressing the growth of weeds. This confirmed earlier work by Tenaw *et al*., (2011) who reported that 'the low weed infestation in Tis 2498 (sweet potato variety) could be attributed to its canopy structure and leaf area, which might contribute to better competition for light, moisture, and nutrient". The researchers also reported that 'low weed population at higher plant densities indicated weed suppression as plant density increased probably due to less light interception due to less space for weed growth'.

Influence of crop variety on sweet potato growth characters

The influences of the two varieties on crop growth characters were significant, with UMUSPO 1 supporting higher vine length, shoot dry weight and LAI compared to UMUSPO 11. The differences among the varieties might have been due to varietal differences controlled by genes and it is consistent with earlier report by Zhang *et al*., (1998) who reported that 'varietal performances are genetically controlled. Genes control the inheritance of characteristics in sweet potato such as leaf margin, tuber formation, skin and colour of tubers.'

Influence of crop variety on yield and yield components

UMUSPO 1 exerted superiority over UMUSPO 11 by producing total marketable tuber yield of 31.92 t ha^{-1}, which is 25.6 % higher than UMUSPO 11 according to the combined means (Table 6). The higher yield by UMUSPO 1 can be attributed to the fact that it supported higher vegetative growth in terms of vine length, plant dry matter and LAI compared to UMUSPO 11. Its high LAI enabled the crop to intercept more light, thereby, leading to high assimilate production from the source to the sink, this in turn led to significantly higher number of harvestable and marketable tubers per plant. The variations observed among variety of sweet potato have also been reported by Peter *et al*., (1988), Kamalam, (1996) and Teshome *et al*., (2003)

Interaction

Fertilizer and weed control methods on marketable yield

The interaction between fertilizer and weed control methods on marketable tuber yield is presented in Table 7. Based on the interaction table, MOF at 1000 kg ha^{-1}in combination with Primextra at 1.5 kg a.i ha^{-1} gave higher number of marketable tubers ha^{-1} compared to all other combinations. The result is in line with report by Tanaka *et al*., (1976). According to his report, sweet potato is a crop that requires nitrogen, phosphorus and potassium for optimum root growth and tuber yield. Therefore, any average soil will grow a reasonable crop of sweet potato, but as with all vegetables, sweet potato responds well to the right nutrients application. Similarly, Anon. (2016) also reported that Metolachlor when mixed with Atrazine and applied as pre-emergence gives good control of annual grasses and broad leaf weeds.

Acknowledgements

This work was supported by Tertiary Education Trust Fund (Tetfund) of Nigeria, under Institutional based Research Grant 2018 through the Kaduna State University, we are indebted to all. We also are thankful to our colleagues, especially A.L. Banta and M.S. Yahaya for their tremendous support during the work

REFERENCES

Ajetomobi, (2015) Daily Independent Newspaper. There's great opportunity for potato export in Nigeria

Akobundu, I.O. (1987). Weed Science in the tropics; Principles and Practices. A Wiley- Inter science Publications. pp. 71-105 and 364-367.

Amare, B., Abay, F. and Tsehaye,Y. (2014). Evaluation of sweet potato (*Ipomoea batata* L.) variety for total storage root yield in south and south east zones of Tigray, Ethiopia. Am. J. Trade Policy, 1: 74-78.

Ambe-Tumanteh, I., 1994. History and importance of sweet potato in Cameroun. In: *Proceedings of the International Potato Centre Workshop* in Douala, Cameroun, 27-29 July, 1992, p. 35-46.

Anonymous, (2010) Importance of root crops in Africa – FAO www.fao.org › 3

Anonymous, (2016) https://en.wikipedia.org/wiki/Sweet_potato (Accessed 05- 06-2016) check download

Awassa, (1991). *Research Progress reports* (1988- 90).Awassa, Ethiopia.

Bourke, R.M. (1985). Sweet Potato in Papua New Guinea. In Villareal, R.L and T.D Griggs (Eds). Sweet potatoes, pp45-57 *Proceedings of the first International Symposium,* Asian Vegetable Research and Development Centre ,Shanhua, Tiana, Taiwan, China.

Duncan, P.B. (1955) Multiple range and multiple F-tests. Biometrics 11:1-42.

Enyi, B.A.C (1977). *The effects of spacing on growth, development and yield of single And multi-shoot plants of cassava (Manihot esculenta Crantz)*. Physiological Factors. East African Agricultural and Forestry Journal 38:27-34

FAOSTAT, 2005. (Food and Agricultural Organization). Annual Report Accessed 16- 11-2019

FAOSTAT, (2017). Food and Agricultural Organization of the United Nations Statistics data. http//faostat.fao.org. Accessed 2- 11-2019

FAOSTAT,(2018) http://www.fao.org/faostat/en/#data/QC/visualize

Fawole, O.P. (2007) Constraints to Production, Processing and Marketing of sweet potato. www.krepublishers.com/.../JHE-22-1-023-07-1500-Fawole-O-P-Tt.pdf Accessed 26- 2-2020

Kamalan, P. (1996). Improvement of sweet potato for high starch and early maturity Through poly cross method. In: Tropical Tuber Crop Problems, Prospect and Future Strategies. Pp 127-132.

Laban, T.F., Peace, K. M. Robert, K., Hellen M. andMuhumuza, J. (2015). *Participatory agronomic performance and sensory evaluation of selected orange-fleshed sweet potato variety in south western Uganda.* Global J. Sci. Frontier Res., 15: 25-30.

NRCRI, 1985. Briefs on other root crops. National Root Crops Research Institute, Umudike, Nigeria Annual Report. p.16.

NRCRI, 2003. (National Root Crops Research Institute), Umudike, Nigeria Annual Report.

Nwinyi, S.C.O., 1987. *Sweet potato: A potential industrial and staple food crop of Nigeria*. Outlook on Agriculture, 16 (1): 178-181.

Purseglove, John Williams (1968). Tropical crops: Dicotyledons. Longman Scientific and Technical. New York: John Wiley and Sons. ISBN 978-0-582-46666-1.

Peter, G. I. Masaru and D. Hartein (1988).Sweet potato in food system of eastern and Southern Africa. In: Ofor, F and Hahn S.K. (Eds). Tropical root crop in Developing Economy.*Proceeding 9th symposium International Society forTropical Root Crops,* Accra Ghana 20-26th Oct 1988. Pp 405-513.

Snedecor, G.W. and Cochran, W.G. (1967).Statistical Methods Iowa University press.Iowa USA pp339-377.

Tanaka, J. S., and T. T. Sekioka.(1976). Sweet potato production in Hawaii. 150-151. In: *Proceedings of the fourth symposium of the Int. Soc. for Tropical Root Crops*. CIAT, Cali, Colombia, 1-7 Aug. 1976.

Tenaw W, Waga M, Legesse H (2011). Growth habit, plant density and weed control on weed and root yield of sweet potato, Areka, southern Ethiopia. *Journal of Horticulture and Forestry,* 3: 251-258.

Tewe, O.O., Abu, O.A., Ojeniyi, E.F., Nwokocha, N.H. (2001). Sweet potato Production, Utilization, and Marketing in Nigeria. In: Akoroda, M.O. and J.M. Ngeve, eds. Root Crops in the Twenty-first Century. *Proceedings of the Seventh Triennial Symposium of the International Society for Tropical Root Crops* - Africa Branch, Cotonou, Benin. October 11-17, 1998.

Tenaw W, Beyenesh Z, Waga M (2011). Effect of variety, seed rate and weeding frequency on weed infestation and grain yield of haricot bean, pp.61-69. In: Fassil Reda and Tanner, D.G. (eds.).

Teshome, A.D., Veeragarathm, and Kannan, M. (2003). Growth Analysis of fifteenSweet potato clones under sub-tropical and semi-arid climate of TN. In:Hanafi, A (ed). Sixth *Proceedings Triennial Congress of the African PotatoAssociation APA Congress,* 5- 10th April. 2003 Agadir, Morocco.Pp159-165.

Unamma, C.P.A., Enyinnia, J. and Emezie J.E. (1984). Critical Period of Weed Interference in Co- coyam/Maize/Sweet potato. Trop. Pest Management 31:21-23

Udo, D.J., Ndon B.A., Asuquo, P.E., Ndaeyo, N.U. (2005). Crop Production techniques for the tropics. Lagos, Nigeria, Concept production limited

Woolfe, J.A. (1992). Sweet potato to an Untapped Food Resources.Pub.Collaboration with CIP-Peru.Cambridge University press