The Effect of Irrigation Scheduling and Mucuna Pod Granule on Yield of Orange Fleshed Sweet Potato (Ipomoea Batata)

Tolubanwo, S.E.[1]; Okereke, N.A.A[2]; Oti, N.N[3]; Nwandikom, G.I[4], and Madubuike, C.N[5]

[1]*National Root Crops Research, Institute Umudike (NRCRI)*

[2,3,4,5]*Federal University of Technology Owerri (FUTO)*

Abstract: **The experiment was carried out during the 2017 and 2018 dry season to evaluate irrigation scheduling and mucuna pod granule fertilizer on the yield of orange-fleshed sweet potato (OFSP). The treatments are made up of four fertilizer rates (0, 200, 400 and 600kg/ha), one irrigation method (Furrow), three irrigation scheduling (once every two days (E2D), once every three days (E3D) and once every four days (E4D) and one OFSP variety (mother delight). The experiment's design was arranged in a Randomized Complete Block Design (RCBD) replicated three times. The size of the plot was 4m x 5.1m, and there are 36 plots with a one-meter alley within plots and two meters between reps. The average irrigation duration per plot was nine minutes. The mucuna pod was harvested, dried, ground and its chemical composition was determined. The actual volume of the mucuna pod required for the experiment was calculated, and the same applied to the plots. After harvest, the treatments of 600kg/ha rate (600M) and E3D for 2017 gave the highest average weight of Vine (12.46t ha-1 and 11.16t ha-1), total weight of roots (9.11t ha-1 and 9.44t ha-1) and marketable roots (8.89t ha-1 and 7.22t h-1). While in 2018, the treatments of 600kg/ha rate (600M) and E3D for 2018 gave the highest average weight of Vine (31.77t ha-1 and 27.03t ha-1), total weight of roots (20.78t ha-1 and 16.28t ha-1) and marketable roots (19.47t ha-1 and 15.23t ha-1). The 600M/E3D also gave the highest weight of Vine + leave, weight of root, root girth and root length per stand. The profits of the produce sold for both years from NPK and Mucuna wereN 238,139.5 and N 426,078.4 respectively. We can conclude from this study, that 600M/E3D gave the highest yield when compared to other treatments in the tables and should be recommended.**

***Keywords*: Irrigation scheduling, Fertilizer rate, mucuna pod fertilizer, orange-fleshed sweet potato, yield components.**

I. INTRODUCTION

Sweet potato [Ipomoea batatas (L.) Lam] is one of the most important crop found in sub-Saharan African (S.S.A.). This crop belongs to the Convolvulaceae family, as stated in Sheth et al. 2017 report. OFSP contains Carotenoid, which is a source of vitamin A used by most developing Countries to control vitamin A deficiency globally (Harvest Plus, 2009). It is grown for its large starchy, sweet-tasting tuberous roots (Nwankwo et al., 2014). The young leaves and shoots are also used as food condiments and for the preparation of local soups, plantain, rice, cocoyam, porridge yam, and beans (Bassey, 2017). The fresh root of sweet potato is rich in carbohydrates and contains appreciable amounts of βcarotene, ascorbic acid, and the amino acid, lysine, that is deficient in cereal-based diets like rice 4- 6. It also contains an appreciable amount of soluble fibre, which helps in reducing cholesterol levels and antioxidant nutrients, which can inhibit the development of coronary heart disease (Kays and Kays, 1997).

According to Selvakumar, 2014, the sweet potato is cultivated by using cutting from the flesh harvested Vine. The orange-fleshed sweet potato (OFSP) vine should be planted within four days of harvest on like the white-fleshed sweet potato (WFSP), which can survive after one week of harvest. OFSP is a short duration of three to four months' maturity; however, opportunity abounds for all-round year production through water irrigation. The irrigation schedule indicates how much irrigation water should be available to the crop and how often or when this water will be applied. Irrigation scheduling can be said to be the use of water management strategies to prevent over-application of water while at the same time minimizing yield loss due to water shortage or drought stress. Often water given depends on the amount of irrigation water needed for the crop as well as the temperature of the system. Therefore, irrigation scheduling is a critical management practice for crop production (F.A.O., 2017 and Joel et al., 2012). Iren. et al. 2016, stated that continuous farming on a particular land with improper use of inorganic fertilizer reduces the fertility of the soil, which is not good for crop growth. Poku et al. 2014 and Saravaiya et al. 2010 reported that Organic fertilizer increases the fertility and the health of the soil. Hence, in check for improvement of soil fertility and available water for increased yield of sweet potato, Mucuna Pruriens pod as well as irrigation schedule were used for the study.

II. MATERIALS AND METHODS

2.1 Description of the study area.

The study was conducted in 2017 and 2018 during the dry season using irrigation. The study was done at the National Root Crops Research Institute (NRCRI), Umudike Irrigation site with Latitude of $05^{o}29'$N, Longitude 07^{o}E at an Altitude of 122m above sea level. The minimum temperature ranges from 190C to 240C, and the maximum ranges from 280C to 340C. The experimental site soil was sandy clay loam with low nutrient reserve as a result of its strong acidic nature

(Lucas et al., 2012), and as such classified as Ultisol (Soil Survey, 2014). The Institute dam was used as a source of water.

2.2 Experimental Design

The experimental design was 1x1x3x4 treatments (one OFSP variety, one irrigation method, three irrigation scheduling and four fertilizer rates) were laid in a randomized c complete block design (RBCD) with three replications. The plot size was 4m x 5.1m. There was 1m alley in between plots and a 2m alley between reps. Below are the details of the treatments:

One variety of OFSP used was mother delight.

One irrigation method used was furrow.

Three irrigation scheduling used are

Once every two days (E2D)

Once every three days (E3D)

Once every four days (E4D)

Four fertilizer rates 0kg/ha (control), 200kg/ha, 400kg/ha and 600kg/ha

2.3 Mucuna pod granule preparation

The mucuna pods collected from IITA, Ibadan was dried under room temperature to preserve the effect of excessive temperature on nitrogen content as well for easy grinding with a hammer mill. The ground mucuna pod helps in the fast released of the nutrients to the soil for the crops to absorbed them. The mucuna dried pod and the mucuna pod granule are shown in plate 2.1 and 2.2. The ground mucuna pod analyzed following standard procedures (Udo et al., 2009). The physic-chemical composition of the Mucuna pod is as shown in Table 3.1. The specific weight of manure or fertilizer applied per nitrogen rate calculated based on the nitrogen content of the material using N.P.K. rate, as shown in Tables 2.1

Plate 2.1: Dried Mucuna Pod

Plate 2.2: Dried Mucuna Pod Granule

Table 2.1: Treatments and Quantity per Hectare

Control	no N
Mucuna pod manure at 200kg/ha	1,588.24
Mucuna pod manure at 400kg/ha	3,186.28
Mucuna pod manure at 600kg/ha	4,764.71

2.4 Physical and chemical properties of ground mucuna pod

Table 3.1 present the physical and chemical properties of the ground mucuna pod.

From the laboratory result, the quality of the ground mucuna pod showed that the pH was 6.13, which was alkaline in nature and suitable for the growth of OFSP. It also contained nitrogen 2.05%, organic matter 72.34%, potassium 0.6%, and phosphorous 0.4%, and the other essential elements which the OFSP needed for sustaining its performance. The high organic matter level in the mucuna pod is important in the water holding capacity of the soil, which the crop needed in the dry season.

Table 2.2: Physio-Chemical Properties of Grounded Mucuna Pod

Elements	Percentage (%)
pH	6.13
Organic content (Org. C)	31.09
Organic matter (Org. C)	72.34
Nitrogen	2.05
Zinc	0.003
Phosphorous	0.40
Iron	0.02
Potassium	0.60
Calcium	1.02
Magnesium	0.41
Sodium	3.52
EC	2.41

Source: Tolubanwo PhD Thesis

2.5 Crop Management

i. Land Preparation: The experimental field was prepared with the use of a tractor and it's accessories to slashed, ploughed, harrowed and ridged. The ridges were than manually prepared into plots with the used of spades, field tape and rope. However, a total of 36 plots were laid out of 5.1 x 4m per plot, with a one-meter alley between plots and two meters' alley between reps.

ii. Soil Sampling: The soil sample of the experimental field was analyzed using the sampling techniques of soil auger at a depth of 0-15cm and 15cm-30cm. In the pre-soil analysis, as shown in Table 3.2, sample points were taken from each experimental block; these soil samples from the different points were mixed together to make a composite sample before the commencement of the analysis in the soil laboratory. The essence of the analysis was to know the present status of the soil.

iii. Planting and Fertilizer application: The mucuna pod fertilizer was incorporated into the soil two weeks before the OFSP vine was planted so that the nutrients will be made available at the right time when the crops are in need of it. Four nodes of the Vine were used as the vine length during dry season planting.

iv. Irrigation Application and Agronomy Practise

The irrigation was scheduled as E2D, E3D and E4D. This will enable one to know which of the schedules will have better yield. The same volume of water, 0.18m^3per plot, was applied at each irrigation time across the board. Each average irrigation duration per plot was nine minutes. The agronomy practise was carried out effectively; that is; herbicide was applied one week before the vines were planted. Manual weeding was done six weeks after planting. Pesticide was used to prevent pests from destroying the leaves of the OFSP.

2.6. Data collection and analysis

The crop growth parameters (vine lengths were collected at 4, 8. 12WAP and at harvest with the number of leaves) and yield data (root length, root girth, numbers of root, marketable non-marketable roots and weight of roots per stand and per hectare) collected were based on the analysis of variance (ANOVA) using the R statistical computing platform version 3.4.4

The growth parameters collected, such as vine length at 4WAP, 8WAP, 12WAP, at harvest, as well as the number of leaves per Vine, were significantly influenced with the application of irrigation scheduling and mucuna pod at different rates. These parameters are presented in Tables 3.1 and 3.2. Under the irrigation scheduling at 4,8,12 WAP and at harvest, the maximum vine length for 2017 (138.82cm, 1334.67cm, 2318.93cm and 3954.82cm, respectively) was recorded with every three days (E3D) irrigation. The once every two (E2D) was next with 110.73cm, 1171.94cm, 2013.61cm and 3157.36cm at 4, 8, 12WAP and at harvest, respectively. The once every four days (E4D) had the least vine length. The number of leaves at harvest also showed the same trend of E3D having the highest leaves of 1608, followed by E2D of 1077 and E4D had the least of 878. The trend in the vine yield under irrigation scheduling revealed that OFSP does not need excessive or under irrigation. That was why the E3D gave the best vine yield throughout the trend. Also, in table 3.1, under fertilizer rate, control at 4WAP had the lowest length of 6.75cm/plant while mucuna at M600 had the highest length of 221cm/plant. At 8WAP, the fertilizer rate application was highly significant ($P<0.001$). From the trend of the fertilizer rate, the control had the lowest length of 563.11cm/plant, while the highest length was found with mucuna at M600, which gave 1,682.22cm/plant. At 12WAP length, the fertilizer rates were highly significant ($P<0.001$). The control had 1,031cm/plant, Mucuna at M600 application had the highest length of 3,239.17cm/plant. At harvest, it also revealed that the control treatment had the lowest length of 1,605.64cm/plant while the application of mucuna at M600 gave the highest length of 4,972.17cm/plant. This increase in the length is a result of the available nutrients in the mucuna pod granule. The above result is in line with Hirich et al. (2014) and Nedunchezhiyan et al. (2012), who indicated that a higher level of organic amendment of soil increased yield with proper irrigation frequency.

Table 3.2 also revealed that in 2018, vine length at 12 W.A.P., harvest and number of leaves vine at harvest were highly significant ($P<0.001$). The E3D had the highest values of vine length from 8, 12 W.A.P. at harvest for both Vine and leaves of 1,709.42cm, 3,004.50cm, 3,366.01cm and 1,063.96 numbers of leaves, respectively.

III. RESULTS AND DISCUSSIONS

3.1. Effects of irrigation scheduling, fertilizer (mucuna pod) rates on OFSP growth Parameters

Table 3.1: Effects of irrigation scheduling, fertilizer (mucuna pod) rates on OFSP growth parameters for 2017

Treatment	Growth Parameters				
Irrigation scheduling	Vine Length (cm)				No of leaves vine at harvest
	4WAP	8WAP	12WAP	Harvest	
E2D	110.73b	1171.94b	2013.61b	3157.36b	1077.36b
E3D	138.82a	1334.67a	2318.93a	3954.82a	1607.50a
E4D	93,39c	1021.37c	1862.35b	2722.05c	878.38c

LSD	13.806	62.9410	227.3615	391.2757	127.1248
Fertilizer rate					
M0	6.75e	563.11f	1031.00e	1605.64f	507.00f
M200	95.89c	1065.94d	1933.17c	2822.56de	934.44d
M400	171.17b	1446.00c	2470.44b	4162.28b	1570.22b
M600	221.00a	1682.22a	3239.17a	4972.17a	1862.44a
LSD	21.0868	96 .1439	347.3004	597.6748	194.1864

Table 3.2: Effects of irrigation scheduling, fertilizer (mucuna pod) rates on OFSP growth parameters for 2018

Treatment	Growth Parameters				
Irrigation scheduling	Vine Length (cm)				No of leaves vine at harvest
	4WAP	8WAP	12WAP	Harvest	
E2D	42.44a	1327.42a	2460.25b	2289.92b	687.69b
E3D	42.30a	1709.42a	3004.50a	3366.01a	1063.96a
E4D	37.25a	1093.57a	2109.50c	1817.64c	533.29b
LSD	NS	NS	213.61	374.1436	173.9268
Fertilizer rate					
M0	26.53d	700.08c	1394.20d	954.68d	283.4c
M200	40.22c	974.37b	1906.25c	1782.66c	579.02b
M400	51.33b	1589.76a	2872.65b	3183.36b	956.46c
M600	62.56a	1978.05a	3581.69a	3761.88a	1170.66a
LSD	6.6798	350.1239	319.7153	576.0986	269.2352

In 2018 as presented in table 3.2, the fertilizer rate was highly significant (P<0.001) throughout 4,8 and 12 W.A.P. as well as harvest for both vine length and number of leaves at harvest. In the fertilizer rate application, M600 gave the highest yield parameter of 62.56cm, 1,978.05cm, 3,581.69cm, 3,761.88cm vine length and 1,170.66 numbers of leaves for 4,8 and 12 W.A.P. as well as harvest for both vine length and number of leaves at harvest. The result is also in agreement with researchers Iren et al. (2016) and Maobe et al. (2011) that organic manures are generally superior in improving the soil availability of soil minerals for plant growth.As presented in tables 3.3 and 3.4 for 2017 and 2018, the significant influence of irrigation scheduling on weight of vine leaves (t/ha), number of root per stand, weight of root per stand, root length per stand, root girth per stand, total root yield (t/ha) and marketable roots yield (t/ha) was explained by every three days' irrigation (E3D) which had the highest values in all the data collected.

Table 3.4: Effects of irrigation scheduling, fertilizer (mucuna pod) rates on OFSP root yieldparameters at harvest for 2017

Treatment	Yield Parameters						
Irrigation Scheduling	Wt. of vine leave (vl) (t/ha)	No of root /stand	Wt.of root/ stand(kg)	Root length/ Stand(cm)	Root girth/ Stand (cm)	Total root yield (t/ha	Marketable rootyield (t/ha)
E2D	21.04	2.73b	2.19b	68.28a	29.13b	13.86b	12.92b
E3D	27.03	3.08a	2.51a	72.68a	32.63a	16.28a	15.23a
E4D	17.63	2.37c	2.01c	58.10a	21.51c	11.12c	10.28c
LSD	3.064	0.7187	0.1421	6.9487	3.2174	2.4172	1.6132
Fertilizer rate							
0M	10.58	2.54ab	0.76d	52.03b	13.68d	6.88d	6.07d
200M	16.22	2.98ab	2.06c	68.98ab	24.21c	11.27c	10.48c
400M	25.71	3.04a	2.75b	73.09ab	34.84b	16.78b	15.76b
600M	31.77	3.48a	3.21a	95.75a	42.62a	20.78a	19.47a
LSD	9.6285	NS	0.2171	NS	4.9148	6.5721	5.5162

According to Nedunchezhiyan et al. (2012) that proper irrigation scheduling and application result in higher root yield and vine production. The E3D did not significantly increase the number of roots in table 3.3 of 2017, while others were significantly increased. In table 3.4 of 2018, E3D significantly increase weight of vine leaves (t/ha), number of root per stand, weight of root per stand, root length per stand, root girth per stand, total root yield (t/ha) and marketable roots yield (t/ha). When E2D, E3D and E4D are compared, E3D gave higher values, followed by E2D and E4D gave the lest value. Nevertheless, this might be due to the fact that over and under irrigation is not ideal if we need a good increase in yield. Mucuna fertilizer rates had a significant effect weight of vine leaves (t/ha), number of root per stand, weight of root per stand, root length per stand, root girth per stand, total root yield (t/ha) and marketable roots yield (t/ha) as presented in tables 3.3 and 3.4. This showed that mucuna fertilizer application increases the yield of sweet potato as the mucuna rate increases but not the number of roots per stand. The mucuna fertilizer rates were highly significant ($P<0.001$), as shown by yield components. These could be due to the beneficial effect of the various components present in the mucuna pod. The result agrees with the reports by Jari et al. (2015) and Yeng et al. (2012) that nitrogen and other components promotes cell division, growth and increases the yield of sweet potato through the formation of large-sized tuber roots. From the figures in the tables, it can be reported that sweet potato yield increased with an increase in the rate of mucuna fertilizer from M200 to M600 kg/ha. According to this finding, the greatest sweet potato yield was obtained with M600 kg/ha. In this study, however, all yield components of M0 were far below the yield of M200/ha, suggesting that the M200 kg/ha is not adequate for sweet potato yield in the study area. However, the nutrient of the soil could become limiting due to continuous cultivation. Also, it was observed that the treatment with the highest mucuna rate of M600/ha growth produced the highest yield, indicating a positive influence of mucuna fertilizer on sweet potato yield. The total cost of production (input) for both NPK and Mucuna for 2017 and 2018 was N200,760.5 and N210,921.6 respectively. The produces (vine and roots) which is the output sold was N444,900 and N637,000 for NPK and Mucuna. Profit margin is N238,139.5 for NPK and N426,078.4 Mucuna. This is in agreement with the above researchers.

IV. CONCLUSIONS AND RECOMMENDATIONS

The study revealed that E3D (Irrigation once every three days) gave the greatest growth and yield and that the application of mucuna fertilizer has the potential of increasing the growth and yield of sweet potato in which the greatest growth and yield were obtained with M600/ha. A combination of E3D and M600/ha will give maximum sweet potato production, which can be recommended for farmers during dry season farming. Farmers can also be encouraged to use the mucuna pod as organic fertilizer during the on season farming.

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