

YIELD RESPONSES OF WATERMELON (*CITRULLUS LUNATUS* (THUMB) IN A COASTAL PLAIN SOIL UNDER VARIABLE FERTILIZER RATES AND IRRIGATION REGIME IN A DRY SEASON PRODUCTION CYCLE



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ABSTRACT

Field experiments were conducted during 2017 and 2018 cropping seasons at Illah, Delta North ecological zone of Nigeria to investigate the appropriate rates of NPK fertilizer and irrigation intervals in relation to yield response of water melon (*Citrullus lunatus*). The site had sandy loam texture, low in organic carbon (0.38%), low in total nitrogen (0.064%), available phosphorus (6.83 mgkg⁻¹) and cation exchange capacity (6.74 cmolkg⁻¹). The fertilizer rates were (0:0:0), (50:25:25), (80:40:40), and (120:60:60) KgN, P₂O₅ and K₂O/ha and irrigation regimes of 6:12:18 days. It was a factorial experiment laid out in a Randomized Complete Block Design with three replicates. Results indicated that increase in fertilizer rates from 0:0:0 to 80:40:40 kg/ha significantly increased growth and fruit yield. Further increase to 120:60:60 kg/ha depressed yield. Increase irrigation intervals from 6 -12 days also influenced significantly growth and fruit yield and further increase to 18 days intervals affected negatively the parameters. Interaction effects between fertilizer x irrigation intervals were not significant. Correlation analysis showed that the growth and yield characters were significant and positively correlated with fruit yield. Results indicated that fertilizer rates and 12 days irrigation interval were adequate and recommended for increased production of watermelon in the study area.

1. INTRODUCTION

Watermelon (*Citrullus lunatus* var. *Lunatus* (Thumb) is a tropical fruit that belongs to the family cucurbitaceae and consists of nearly 100 genera and over 750 species (Enujeke;2014; Toth et al., 2007). The crop is believed to originate in the deserts of Kalahari in South Africa from where it got spread to other parts of the world including Nigeria (Shagufta, 2011). The rinds of watermelon are characteristically light green or pale green in colour and the fruit is relished for its delicate flavour and thirst quenching properties (Kim, 2008). Watermelon has been nutritionally and medically evaluated to be a very rich source of carotenoids which was said to have antioxidant activity due to free radical scavenging property (Arora et al., 2011; Kim, 2008). It is also known to be very rich in lycopene, a known antioxidant that gives the crop its characteristics colour. The fruit crop is considered to be free of fat, and contains about 92% water and 8% sugar (Mangila et al. 2007). The seeds have been identified to be a source

of protein which is about 35% rich in protein. 50% oil and 5% dietary fibre and also rich in macro and micronutrients of magnesium, calcium, potassium, iron, phosphorus and zinc (Kim, 2008). It grows favourably in alluvial soils and does not require excessive soil moisture (Ndubizu, 2008, Aquaah, 2006). Thus, in Nigeria the largest production of the crop is the drier northern parts of the country where it is usually cultivated at the onset of the rains and towards the end of the rains in the much humid southern part of the country (De Lannoy, 2011; Toth et al., 2007).

In the tropics, watermelon grows and matures within 75-80 days of planting from seed to mature fruit and the aggressive vines can attain up to 50-60cm in length in a well spaced environment. It also needs approximately 3 months of steady hot sunny weather to grow and ripen (IITA, 2013). Before this time in Nigeria, watermelon was generally perceived to grow and do very in the drier parts of the country with less moisture concentration. Recent trials by Oluloye et al. (2015). Nduka and Ike (2017) in the rainforest zone of Nigeria showed that the crop can thrive well in the environment but the production will be well-timed towards the end of rainy season with guided fertilizer application and efficient irrigation intervals to sustain moisture requirement. In Nigeria, the people are becoming aware of the importance of irrigated agriculture in boosting farmers income and reduction in dry season redundancy (Ndubizu, 2008). A good fertilizer use and irrigation intervals in crop production during the drier periods would enhance yield, improve crop quality and provide better soil moisture environment for crop yield (IITA, 2013). Because of the increasing involvement of youths in watermelon cultivation in order to make money and the increasing demand of the crop due to its nutritional values and the need to expand the growth of watermelon, the study therefore aimed at finding an appropriate levels of NPK fertilizer and irrigation frequency that will ensure good growth, development and fruit yield of watermelon in the coastal plain soil of Delta State, Nigeria.

2. MATERIALS AND METHODS

Field experiment were carried out in the 2017 and 2018 cropping seasons in a coastal plain soil in Illah. The vegetation is of humid rainforest with rainfall distribution of 1,850 – 2,550 mm/annum (NIMET, 2018). The topography is low-levelled and undulating and the soil is acid coastal plain soil. It is low in organic carbon (0.83%), low in total nitrogen (0.068%) low in phosphorus (6.83 mgkg⁻¹) and cation exchange capacity (6.74 cmolk⁻¹) Table 1. The temperature varied from 32.6°C to 34. 3°C and a relative humidity of 75 – 82% (NIMET, 2018).

Field study: A piece of land measuring 50 × 60 m² was mapped out into basins of 2 × 60 m² each. Soil samples were randomly collected from the basins for the analysis of the initial physico-chemical properties of the soils. Watermelon variety “sugar baby” was sown in rows per basin with a sowing depth of 20cm at 25cm row sowing at seed rate of 100 kg/ha. Planting was done by drilling and later thinned to 3 seedlings per basin 2 weeks after sowing. The basins were uniformly irrigated a day after sowing via a flowing stream through irrigation canal. The experiment was a factorial experiment laid out in a randomized complete block design (RCBD). The treatments were NPK fertilizer rates of 0:0:0, 50:25:25, 80:40:40 and 120:60:60 kgN, P₂O₅ and K₂O and irrigation intervals of 6; 12 and 18 days intervals were replicated 3-times.

Fertilizer was applied according to rates in two (2) split doses at 2 and 6 weeks (WAP) by ring method 5cm away from the crop. Irrigation treatments were done at 6,12 and 18 day interval. Weeding was done as at when necessary and insect pests were controlled using an insecticide called KARETE at 100mls/20litres of water. The crop was harvested at full maturity at about 80 days after planting.

Data collected were vine-length, number of branches per plant, days to 50% anthesis, number of fruits per plant weight of fruits per plant and total fruit yield.

Statistical analysis: Data collected were subjected to analysis of variance (ANOVA). Differences between means were separated using Duncan Multiple Range Test (DMRT). Main effects of the treatment interactions were determined for all the parameters evaluated. Correlations coefficient was worked out to determine the relationship between growth, yield characters and total fruit yield of the crop.

3. RESULTS AND DISCUSSION

3.1. SOME PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL USED IN THE STUDY

The initial soil physico-chemical properties of the experimental site (Table 1) showed that the soil was sandy clay loam in texture with 71.52% sand and 20.48% clay. The pH value of 5.18 indicated strongly acidic soil condition. The experimental site was low in organic carbon (0.38%), total nitrogen (0.064%), available phosphorus (6.83 mgkg⁻¹) and cation exchange capacity (6.74 cmolkg⁻¹). The results of the initial physico-chemical properties are in consonance with reports of NIMET (2018) which indicated the meteorological data for the region.

Table 1: Some physical and chemical Properties of the soil used in the study

Variables	Value Obtained
Soil pH (H ₂ O)	5.18
Organic carbon (%)	0.38
Total nitrogen (%)	0.06
Available phosphorus (mgkg ⁻¹)	6.83
Exchangeable Ca (cmolkg ⁻¹)	2.20
Exchangeable Mg (cmolkg ⁻¹)	2.08
Exchangeable K (cmolkg ⁻¹)	0.04
CEC (cmolkg ⁻¹)	6.74
Particle Size distribution (%)	
Sand	71.52
Silt	8.00
Clay	20.48
Textural class	Sandy clay loam

3.2. EFFECTS OF NPK FERTILIZER RATES AND IRRIGATION INTERVALS ON THE LENGTH OF VINE AND NUMBER OF BRANCHES/PLANT OF WATER-MELON (*CITRULLUS LUNATUS*)

The effect of NPK fertilizer and irrigation rates on vine-length and number of branches per plant is shown in Table 2. Increase in rates of NPK fertilizer from 0:0:0 to 50:25:25 KgN, P₂O₅ and K₂O significantly increased vine length from 516.3cm to 608.2 cm and 514.3cm to 610.2 cm in the corresponding 2018 seasons. The same increase in the number of branches per plant was observed in the corresponding season. Further increase to 80:40:40 also increase vine length to 728.2cm in 2017 season and 750.2 in 2018. The same trend was observed on the number of branches per plant in this manner 32.0 to 35.3 but reduced significantly to 28.2 and 32.3 in 2018 season. Further increase in application rates to 120:60:60 significantly reduced vine length to 520.3cm and 530.4 in the 2017 and 2018 seasons. Number of branches per plant was also statistically similar even when there was a reduction in the number of branches per plant in the years of cropping (Table 2). Similar observations were made by NIHORT (2008), Mani et al (2006) who reported that fertilizer rates affected growth and yield parameters of crops.

Table 2: Effects of NPK Fertilizer rates and irrigation intervals on the length of vine and number of branches/plant of water-melon (*Citrullus lunatus*)

Treatment	Length of Vine (cm)		Number of branches/plant	
	2017	2018	2017	2018
NPK Fertilizer (Kg/ha)				
0:0:0	516.3 ^b	514.3 ^b	24.2 ^c	22.3 ^b
50:25:25	608.2 ^{ab}	610.2 ^{ab}	32.0 ^{ab}	28.2 ^b
80:40:40	728.2 ^a	750.2 ^a	35.3 ^a	32.3 ^a
120:60:60	520.3 ^b	530.4 ^b	21.6 ^b	17.4 ^c
SE±	50.4	49.4	**	**

Irrigation Intervals				
6	534.2 ^b	514 ^b	24.6 ^b	21.3 ^a
12	741.2 ^a	710.4 ^a	36.0 ^a	21.3 ^a
18	502.2 ^b	492.2 ^b	21.0 ^c	18.4 ^b
SE±	46.4	42.2	2.25	2.08
Interaction				
NPK × II	NS	NS	NS	NS
NPK × I				

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

NS = Not significant.

3.3. EFFECTS OF NPK FERTILIZER RATES AND IRRIGATION INTERVALS ON DAYS TO 50% ANTHESIS AND NUMBER OF FRUITS PER PLANT OF WATER-MELON (*CITRULLUS LUNATUS*)

Effects on days to 50% anthesis and number of fruits per plant (Table 3) showed that there were statistically similar and no much effect on treatment rates from the control. Even when the rates were increased from 0:0:0 to 120:60:60 KgN, P₂O₅ and K₂O. there was no statistical difference. The same trend was observed in the 2018 seasons. Number of fruits were significantly influenced by rates as application rates of 0:0:0 to 50:25:25 KgN, P₂O₅ and K₂O reduced the number of fruits per plant to the value of 0:0:0 kgN, P₂O₅ and K₂O of 4.0 and 3.5 respectively (Table 3). This is not different from the findings of Nduka and Ike (2017) who reported that certain rates of fertilizer could enhance growth and yield of crops, but could depress yield at very high levels of application.

Table 3: Effects of NPK Fertilizer rates and irrigation intervals on days to 50% anthesis and number of fruits per plant of water-melon (*Citrullus lunatus*)

Treatment	Days to 50% anthesis			No of fruits/Plants		
	2017	2018	\bar{X}	2017	2018	\bar{X}
NPK Fertilizer rates (Kg/ha)						
0	40.0 ^b	42.0 ^b	41.0 ^b	3.0	4.0 ^b	3.5 ^b
30	42.0 ^b	43.0 ^{ab}	42.5 ^{ab}	4.0 ^b	6.0 ^b	5.0 ^b
60	43.0 ^a	45.0 ^a	44.0 ^a	7.0 ^a	9.0 ^a	8.0 ^a
90	40.0 ^b	41.5 ^b	40.8 ^b	3.0	4.0 ^b	3.5 ^b
SE±	0.38	0.40	0.36	0.5	0.61	0.59
Irrigation interval						
6	42.8 ^a	43.6 ^a	43.2 ^b	3.6 ^b	4.8 ^b	4.2 ^b
12	42.5 ^a	49.9 ^a	46.2 ^a	3.9 ^a	5.5 ^a	4.7 ^a
18	4.0 ^b	40.5 ^c	40.8 ^b	1.7 ^c	3.2 ^c	2.5 ^c
SE±	**	0.35	0.36	**	**	**
Interaction						
NPK x I	NS	NS	NS	NS	NS	NS

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

NS = Not significant

xx. = highly significant

3.4. EFFECTS OF NPK FERTILIZER RATES AND IRRIGATION INTERVALS ON WEIGHT OF FRUIT YIELD INDICES OF WATER-MELON (*CITRULLUS LUNATUS*)

On the effect of treatment on weight of fruits (Table 5), the same trend was observed as further increase in rates to 120:60:60 KgN, P₂O₅ and K₂O simultaneously decrease the yield characters evaluated. Similar results were reported by Ibrahim *et al.* (2011), Aquaah(2006 and Swain *et al.*(2006)

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Increase in irrigation intervals from 6 -12 days interval significantly increased vine length, from 534.2 cm to 744.2cm in the 2017 season and 514.2cm to 710.4cm in 2018 season but further increase in irrigation regime to 18 days interval had reduction effect on the parameters evaluated. Number of branches per plant also depressed with further increase in irrigation intervals to 18 days interval in the corresponding years. The same trend was observed on the number of fruits per plant, weight of fruits per plant and total fruit yield. However further increase to 18 days interval significantly decreased the growth and yield characters investigated (Table 2). On days to 50% anthesis and number of fruits per plant (Table 3) the same trend of statistical similarity was observed. Further increase to 18 days irrigation interval relatively reduced days to 50% anthesis in both seasons. The same trend was observed on the number of fruits per plant, weight of fruits per plant and total yield of fruits (Tables 3, 4 and 5).

Table 4: Effects of NPK fertilizer rates and irrigation intervals on weight of fruits/ plant of water-melon (*Citrullus lunatus*)

Treatment	Weigh of fruit/plant (g)		
	2017	2018	\bar{X}
NPK fertilizer (Kg/ha)			
0	9.0 ^b	9.6 ^b	9.3 ^b
30	13.0 ^{ab}	15.4 ^{ab}	14.2 ^a
60	16.0 ^a	17.2 ^a	16.6 ^a
90	7.0 ^c	9.0 ^c	8.0 ^c
SE±	1.20	1.38	1.32
Irrigation Interval			
6	9.0 ^b	11.0 ^b	10.0 ^b
12	16.6 ^a	18.8 ^a	17.7 ^a
18	8.10 ^b	9.65 ^c	1.01 ^c
SE±	0.85	1.02	0.12
Interaction			
NPK x I	NS	NS	NS

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

NS = Not significant.

Table 5: Effects of NPK fertilizer rates and irrigation intervals on total fruit yield (t/ha) of water-melon (*Citrullus lunatus*)

Treatment	Weigh of fruit/plant (g)		
	2017	2018	\bar{X}
NPK fertilizer (Kg/ha)			
0	6.44 ^b	5.60 ^c	6.02 ^c
30	8.68 ^{ab}	6.65 ^{ab}	7.66 ^b
60	12.9 ^a	10.24 ^a	11.57 ^a
90	4.50 ^c	6.08 ^c	5.29 ^c
SE±	0.21	0.26	0.19
Irrigation Interval			
6	7.52 ^b	4.44 ^c	8.46 ^b
12	14.50 ^a	16.59 ^a	15.50 ^a
18	6.08 ^b	7.12 ^b	6.6 ^b
SE±	0.64	0.72	0.70
Interaction			
NPK x 1	NS	NS	NS

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

NS = Not significant

3.5. INTERACTION EFFECTS OF NPK FERTILIZER AND IRRIGATION INTERVALS

The interaction effects of NPK fertilizer and irrigation intervals were not significant, and application rates of 80:40:40 KgN, P₂O₅ and K₂O produced the highest numbers of growth characters investigated and fruit yield in both seasons evaluated. The relationship that existed between total yield and growth components of watermelon indicated a positive and significant correlation with vine-length (0.768), number of branches per plant (0.584), weight of fruit per plant (0.645) number of fruits per plant (0.345) were significantly correlated with fruit yield. Days to 50% anthesis (-0.541) was highly significant but negatively correlated with fruit yield. The high significant correlation between growth and yield characters evaluated implied that they all contributed greatly either directly or indirectly in promoting good growth and fruit yield of watermelon in the study location.

4. CONCLUSION AND RECOMMENDATION

In conclusion, a good fertilizer rate and irrigation interval are complimentary in advancing dry season crop production in the southern part of Nigeria.

The present study showed that the use of NPK fertilizer rates of 80:40 :40 KgN, P₂O₅ and K₂O and 12 days irrigation interval favourably influenced growth and yield parameters of watermelon, hence the fertilizer rate and irrigation regime are recommended for increased production of the crop.

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CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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