EFFECTS OF SOWING DATES AND NITROGEN RATES ON YIELDS AND REVENUE OF WATERMELON (*Citrullus lanatus* THUMB) IN JEMA'A LOCAL GOVERNMENT AREA, KADUNA STATE

Supported by tetfund

S. W. J. Lyocks[1]*, J. Tanimu[2], M. O. Francis[1] and L. D. Ishaku[1]
Agricultural Extension and Management Programme, Samaru, Ahmadu Bello University, Zaria, Kaduna State, Nigeria
Department of Soil Science and Land Resources Management, Federal University Wukari, Taraba State, Nigeria
*Corresponding author: swjlyocks@gmail.com

Received: July 08, 2020 **Accepted:** December 17, 2020

Abstract: A field experiment was conducted between September and December, 2015, in two sites at Katsit, suburb of Kafanchan, Jema'a Local Government area of Kaduna State, Nigeria. The experiment was aimed at determining the appropriate planting date and nitrogen rate for optimum watermelon (*Citrullus lanatus* Thumb) yield, quality and realisable revenue in the study area. The treatments consisted of three planting dates with four levels of nitrogen fertilizer and a control fitted in a Randomized Complete Block Design, replicated three times. Data collected were subjected to analysis of variance; means of treatments significantly different were separated using Duncan Multiple Range Test at 5% level of significance. Economic returns were analyzed using the Gross margin. The results showed that there were significant difference among the treatments in number of fruits and yield per hectare. However, watermelons sown in the middle of September at 30 kg N ha^{-1} fertilizer level gave the highest yield of 36,000 kg ha^{-1} and also gave the highest gross margin of ₦180, 967.00 ha^{-1}. It is therefore recommended that farmers in the study area should plant watermelon in the second week of September and to apply 30 kg N ha^{-1} of fertilizer in order to make optimum profit.
Keywords: Economic returns, fertilizer rate, Kafanchan, sowing date, watermelon

Introduction

Watermelon (*Citrullus lanatus* Thumb) is a very important crop because it has many nutritional and economical values in many sub-tropical countries. The fruit is made up of 94.06% water, 0.27% ash, 0.34% fibre, 0.44% protein, 0.11% fat, and 4.73% carbohydrate (Olayinka and Etejere, 2018). It is a good source of vitamins such as vitamins A and C in form of beta-carotene. Its global consumption is greater than that of any cucurbit family member (FAO, 2007). In certain semi-desert districts, watermelon serves as an important source of water to the natives during dry periods and there are some districts in Africa where it is cultivated for that purpose (Boswell, 2000). In Nigeria, its cultivation which was originally confined to the drier savannah regions of the North, is now gradually gaining ground in the southern parts of the country (Enujeke, 2013a). Its production in Nigeria rose from 175.34 metric tons in 2003 (Project Coordinating Unit and Federal Ministry of Agriculture Crop production Data, PCU/FMARD, 2004) to 139,223 metric tons in 2011 (Toluwase and Owoeye, 2017). Watermelon is relished by a large number of people across the country and even the world as a whole as a fresh fruit. There is an increase in demand for watermelon (*C lanatus*) in Nigeria. In order to improve the yield of watermelon to meet this demand, the nutrient content of soil should be increased to boost soil fertility for optimum yield. One of the ways to achieve this is by using chemical fertilizers mainly Potassium and Nitrogen compounds (Massri, and Labban, 2014).

Watermelon culture is characterized by high nutrients demand within a short period of time (Paula *et al*., 2011); so inadequate fertilization is a main contributor to low yield and fruit quality (Barros *et al*., 2012). Nitrogen (N) is a key component of enzymes, vitamins, chlorophyll and other cell constituents, all of which are essential for plant growth and development. It is thus one of the most important nutrients required for high yield.

Recommended rates of fertilizer for watermelon vary depending on the soil type, the system of production, planting populations, previous management, and the results of soil nutrient assays (Seminis, 2019). In general, watermelons require between 89.62 and 134.5 Kg of N ha^{-1}, as approximately 2.18 kg of N are removed for each ton of fruit harvested (Seminis, 2019). Maluki *et al.* (2016) recommended Calcium Ammonium Nitrate (CAN) fertilizers at the rate of 80 Kg N ha^{-1}; Andrade Júnior *et al.* (2009) observed that 97.61 kg N ha^{-1} produced maximum yield (60.17 t ha^{-1}) while University of Arizona CALS (2019) asserts that with good management, a total of about 140.10 to 196.06 kg Nha^{-1} is usually needed for optimum watermelon production. Furthermore, Morais *et al*. (2008) reported an optimal rate of 267 kg N ha^{-1} gives a yield of 68.59 t ha^{-1}. Nitrogen rates of 180 kg/ha can supply 50 t ha^{-1} field yields (Coelho *et al.*, 2001). Moderate amounts of fertilizer are required to achieve adequate yields in watermelon production (Wael *et al.*, 2017).

As nitrogen is essential for high yields, timing is just as important, since an excess of nitrogen at flowering can reduce flower number, leading to reduction in fruit set. In addition, too much of N at later stages of growth can spoil fruit quality by increasing the level of blemish on the rind and encourages fruit rot (Anon, 2019). This is indirectly linked to the planting period of watermelon. Thus, it is important to confirm rates and timing following local trials that take into account not only the need for high yield but also good quality fruit.

Sowing date is one of the most important factors affecting growth with yield of watermelon. Some experiments on Fodder watermelon (FWM) indicated that the fruit yield depend on sowing date and plant density (Geren *et al*., 2011). Delayed planting in musk melon cv. Flexuous significantly decreased fruit weight and total fruit yield (Muhammad *et al*., 1989). These consequently lead to losses in profitability in watermelon production.

Cultivation of watermelon is economically viable which yields high returns. It is a popular cash crop with huge economic importance to man and is grown by farmers during summer due to its high returns in investment, especially those residing near the urban areas (Enujeke, 2013b). It has relatively low capital requirement to cultivate a hectare; high turnover and there is also ready market as there is a comparatively high demand for watermelon in the Nigerian market today. However, its profitability varies from one part of the country to another. For example, the gross margin (GM) analysis carried out in Kano State by Alfa-nla (2014) indicated that watermelon production yielded a net farm income of ₦25,422.98k per hectare. In another study conducted in Oyo state, Nigeria, the analysis showed a GM of ₦3,855,350.00k (Amao *et al.*, 2014) while Ajewole (2015) obtained a GM of ₦138,440.22k per hectare at Ekiti. Although watermelon is a very important economic vegetable, very little work has been reported regarding its responses to nitrogen levels, sowing time and profitability in the country in general and Southern Kaduna in particular. Because of the high costs of N fertilizer to agricultural production it would be desirable to develop strategies to reduce N input while simultaneously maintaining productivity (Taiz and Geiger, 2002). The study evaluated the effect of varying N fertilizer rates and planting dates on yield, quality and revenue generated from watermelon cultivation in Jema'a LGA of Kaduna State, Nigeria.

Materials and Methods

Location and characteristics of the area

A field experiment was conducted between September and October during the 2015 growing season at two sites at Katsit, Jema'a Local government area in Kaduna State, Nigeria. The site is located between Latitude 9° 34' 52.54" N of the equator and Longitude 8° 17' 33.36" E. (Abaje, *et al.*, 2010). Kafanchan lies on 740 m above sea level, has a tropical climate and an average annual temperature of 24.4°C. In a year, the wet season is warm, oppressive, and overcast while the dry season is hot and partly cloudy. The hot season lasts for 2.6 months, from last week of January to Mid-April, with an average daily high temperature above 33.89°C. Kafanchan experiences extreme seasonal variation in monthly rainfall. It receives an average rainfall of 1540 mm, within a period of 7.7 months, from Mid-March to around first week of November, ending with a sliding 31-day rainfall of at least 12.7 mm. The highest rain falls around mid-August, having an average total accumulation of 241.3 mm for that month. The rainless period of the year lasts for 4.3 months, from November 7 to March 17 (Abaje and Oladipo, 2019).

Fertilizer rate calculation

To determine the fertilizer rate for a particular nutrient, the desired nutrient rate was multiplied by 100 and divided by the percentage of the nutrient in the fertilizer. Thus the various N rates of 30, 60, 90, and 120 kg N per ha using 20-10-10, the rate of fertilizer required was calculated as shown below:

For (30 x 100)/20 = 150 kg NPK 20-10-10 ha^{-1} (3 bags of 50 kg).

Same method was used for computing the rates for 60, 90, and 120 k N ha^{-1}

Treatments and experimental design

The experiment consisted of fifteen treatments made up of four rates of inorganic fertilizer (NPK 20-10-10) at 30, 60, 90 and 120 kg N ha^{-1} equivalent to 150 kg (3 bags of 50 kg), 300 kg (6 bags of 50 kg), 450 kg (9 bags of 50 kg) and 600 kg (12 bags of 50 kg) respectively. The control had zero fertilizer rate. The method of application was side placement, during the second and fifth weeks after planting. There were three planting dates, (1st, 15th and 29th September, represented by PD_1, PD_2 and PD_3, respectively). The figures after the planting dates (30, 60, 90, and 120) represent the fertilizer levels (rates). The plots consisted of three rows of watermelons sown on raised beds at an interval of 1 metre within the row, 75 cm between the rows, and within a total plot size of 5 x 3 m = 15 m^2 (0.108 ha). The treatments were replicated three times, fitted into a Randomized Complete Block Design (RCBD).

Sowing and crop management

Before land preparation, pre-sowing soil samples were obtained from the top soil (0 – 20 cm) using a soil auger. The samples were subjected to physio-chemical analyses table 1. For the purpose of this experiment, seed germination test was carried out on the seeds that were used. The germination percentage on the experimental site was 73%.

The variety used for the experiment was the Florida giant (large, oblong light green) which is one of the popular cultivars grown in commercial quantities by farmers in the area. The first sowing was carried out on 1st September, followed by 15th, and 29th September, respectively. The spacing between replicates was 1 meter, while the spacing between subplots/treatments within replicates was 0.5 meter.

Two to three seeds were sown after holes were drilled manually using the thumb. The seedlings were later thinned to one plant per stand during the first manual weeding operation at 2 weeks after emergence, during which the different rates of NPK fertilizer treatments were also applied. Weeding was carried out as at when due up till the harvesting time.

Measurements of yield parameters

The yield parameters observed were (number of fruits per plot, weight of fruits and the yield of fruits in kg per hectare) were calculated. The fruit quality (fruit length, fruit diameter and rind thickness) were also observed. Number of fruits in each treatment were counted and recorded. The fruit diameter as well as fruit length were also measured using the meter rule and recorded for each treatment in centimeters (cm). The rind thickness was measured using Vanier Caliper in millimeters. The weight of fruits was determined in kilograms by the use of weighing balance.

Data analysis

The data collected from the field were subjected to Analysis of variance (ANOVA) using Genstat V.6 package and the significantly different treatment means were separated using the Duncan Multiple Range Test at 5% level of significance.

The profitability of producing watermelon under the various fertilizer rates and sowing dates was determined using the Gross Margin Analysis. The costs and returns to water melon production were estimated using the gross margin analysis as follows;

GM = TR-TVC

Where: GM = Gross margin in Naira/ha; TR = Total revenue in Naira/ ha (i.e. Unit Price x Quantity); TVC = Total variable cost in Naira/ha; TR = Total Revenue = Price x Quantity i.e. PQ

Results and Discussion

Some physical and chemical properties of the experimental site

Selected physical and chemical properties are presented in Table 1. The soil texture was sandy loam. The soil pH in water and $CaCl_2$ was moderately acidic, 6.20 and 5.60, respectively. This is similar to what is generally observed in the Southern Guinea Savanna of Nigeria. The organic carbon was high 17.10 g kg^{-1}. This is expected because of the high vegetation of the region as a result of high rainfall. The total N was high (2.45 g kg^{-1}) as compared to other areas of the savanna. This corroborates the high organic matter content of the soil, which is the major source of N in soils. The available Phosphorus (21.00 mg kg^{-1}), exchangeable Ca^{2+} (8.30 cmol kg^{-1}), Mg^{2+} (2.48 cmol kg^{-1}), Na^{+} (2.70 cmol kg^{-1}), and CEC (17.50 cmol kg^{-1}) were all high, except K^{+} (0.46 cmol kg^{-1}) which was medium. This made the soil to be high in inherent soil fertility status for the cultivation of most crops (Chude *et al.*, 2011).

Table 1: Some physical and chemical properties of soil of the experimental site

Parameter	Property
Physical Properties	
Particle size distribution	
Sand (g kg^{-1})	600.00
Silt (g kg^{-1})	160.00
Clay (g kg^{-1})	240.00
Texture class	Sandy clay loam
Chemical Properties	
pH in water (1:2.5)	6.20
pH in 0.01 $CaCl_2$ (1:2.5)	5.60
Organic Carbon (g kg^{-1})	17.1
Total N (g kg^{-1})	2.45
Available P (mg kg^{-1})	21.00
Exchangeable Bases	
Ca (cmol kg^{-1})	8.30
Mg (cmol kg^{-1})	2.48
K (cmol kg^{-1})	0.46
Na (cmol kg^{-1})	2.70
Exchangeable Acidity (H + Al)	0.60
CEC	17.50

Table 2: Effects of different planting dates and varying nitrogen levels on the yield of watermelon

Treatments	Number of fruits per plot	Yield (kg) per hectare
$PD_1$0	8.67bcd	17340bcd
PD_1 30	5.67cd	11340cd
PD_1 60	7.00bcd	14000bcd
PD_1 90	7.33bcd	14660bcd
PD_1 120	7.00bcd	14000bcd
PD_2 0	13.67ab	27340ab
PD_2 30	18.00a	36000a
PD_2 60	7.67bcd	15340bcd
PD_2 90	9.67bcd	19340bcd
PD_2 120	15.00ab	30666.6ab
PD_3 0	3.67d	7340d
PD_3 30	8.33bcd	16660bcd
PD_3 60	9.00bcd	18000bcd
PD_3 90	13.90abc	19333.3bcd
PD_3 120	10.67bcd	21340abc
SE $\pm$	2.205	0.754

Values within columns followed by the same letters are not significantly different at $p \leq 0.05$; PD_1, PD_2 and PD_3 stand for 1st, 15th and 29th planting dates; Values after planting dates (0, 30, 60, 90 and 120) represent Fertilizer levels applied in kg ha^{-1}

Results of the effects of Nitrogen rates and planting dates on yield parameters of watermelon are shown in Table 2. The results show that the 15th, September sowing date gave significantly ($P < 0.05$) higher values on the number of watermelon fruits, and the yield of fruits/ha, especially at Nitrogen rate of 30 kg N ha^{-1} (Table 2). This was followed by the 120 kg N ha^{-1} and the zero N rates (control) also at the 15th, September sowing date. The least number of fruits were obtained at the 29th September planting date at zero N rate (control). These results are in consonant with the report of Anon (2019) which showed that the level of Nitrogen fertility has more influence on the growth and yield of watermelon than any other single plant nutrient. Nitrogen is the nutrient most used by watermelon crops and greatly influences its growth (Silva *et al*., 2012). The level of nitrogen fertility has more influence on the growth and yield of watermelon than any other single plant nutrient because it is the nutrient that is most deficient in Nigeria's soils (Mustapha *et al*., 2011). Nitrogen deficiency is the most common nutrient problem for watermelon production. N deficiencies at any time during the season can affect crop yield and quality, and deficiencies when fruit size ranges from 4 to 6 inches in diameter can be the most damaging (Warncke, 2007). Excess N can promote vegetative growth at the expense of flowering and fruiting, thereby decreasing the soluble solids content (Dalmazzo *et al*., 2017).

Also, because of the inherent high soil fertility, of the area, the 30 kg N ha^{-1} performed better than the other treatments. Many researchers have reported that when the N content of soil is too high, it may end up favouring vegetative growth at the expense of crop yield (Faria *et al.*, 2000).

The result further proved that sowing date is very important in the production of watermelon. The sowing dates and the N rates however, had no significant effects on the fruit length. The treatments performance was not consistent or had no clear pattern in terms of increase or decrease on fruit diameter and rind thickness. However, the second sowing date (15th September) and the N level of 30 kg N ha^{-1} again gave the highest value on the diameter of the fruit (Table 3). Application of N fertilizer had significant effect by increasing the rind thickness of the watermelon (Table 3). The pooled values for both sites, watermelon plants with 120 kg N ha^{-1} applied yielded fruits with thin rinds followed by 90 kg N ha^{-1} and 30 kg N ha^{-1} while fruits with the thickest rind was recorded under the control (0 Kg N ha^{-1}).These have further proved that, the second planting date (15th September) and the application of 30 kg N ha^{-1} were the best for watermelon production in Kafanchan. These results also corroborate the work of other scientists who found that the time of sowing and quantity of N application may affect the yield of watermelon significantly. Ncebo (2010) in his work Kwa-zulu Natal South Africa reported that crop yield decreased from 1368t ha^{-1} for September planting to 247t ha^{-1} for January planting. Excess N can promote vegetative growth at the expense of flowering and fruiting, thereby decreasing the soluble solids content (Faria *et al.*, 2000). Less than 50% of the N applied is absorbed by the plant (Hawkesford, 2012) and the rest can be lost by leaching, especially in sandy soils (Prasad and Hochmuth, 2015). That was why the higher rates of 60, 90 and 120 kg N ha^{-1} could not give the highest values of both yield and quality.

Table 3: Effects of different planting date and varying nitrogen levels on the quality of watermelon

Treatments	Fruit Length (cm)	Fruit Diameter (cm)	Rind Thickness
$PD_1$0	11.17a	11.83abc	9.00ab
PD_1 30	12.00a	14.00a	8.33ab
PD_1 60	11.17a	11.33abc	4.67c
PD_1 90	11.50a	12.50ab	9.00ab
PD_1 120	12.67a	13.43ab	10.00a
PD_2 0	11.67a	12.33abc	9.00ab
PD_2 30	12.33a	14.00a	9.33ab
PD_2 60	11.60a	12.33abc	8.33ab
PD_2 90	10.17a	10.67abc	7.67ab
PD_2 120	9.00a	10.33abc	7.33bc
PD_3 0	10.30a	8.50abc	7.07ab
PD_3 30	12.67a	10.83abc	7.00ab
PD_3 60	8.83a	10.67abc	7.50ab
PD_3 90	10.07a	11.50abc	7.77ab
PD_3 120	11.27a	11.00abc	9.40ab
SE $\pm$	1.423	1.132	0.858

Values within columns followed by the same letters are not significantly different at $p \leq 0.05$; PD_1, PD_2 and PD_3 stand for 1st, 15th and 29th planting dates; Values after planting dates (0, 30, 60, 90 and 120) represent Fertilizer levels applied in kg ha^{-1}

Table 4: Effects of different planting dates and varying nitrogen levels on gross margin of watermelon production

Treatments	Gross Income₦	Total Variable Cost₦	Gross Margin₦	Cost: Benefit ratio
$PD_1$0	126500ab	25100f	101400ab	5.04
PD_1 30	141167ab	30200e	110967ab	4.67
PD_1 60	158833ab	40400d	118433ab	3.93
PD_1 90	135500ab	43833c	91667b	3.09
PD_1 120	162167ab	50600a	111567ab	3.20
PD_2 0	146667ab	25100f	121567ab	5.84
PD_2 30	211167a	30200e	180967a	6.99
PD_2 60	118833ab	40400d	78433ab	2.94
PD_2 90	60000ab	45500b	14500c	1.32
PD_2 120	102167ab	50600a	51567b	2.02
PD_3 0	48667b	25100f	23567bc	1.94
PD_3 30	88833ab	30200e	58633b	2.94
PD_3 60	72000b	40400d	31600bc	1.78
PD_3 90	117667ab	45500b	72167ab	2.59
PD_3 120	117833ab	50600a	67233ab	2.33
SE $\pm$	37743.150	26.217	34014.988	

Values within columns followed by the same letters are not significantly different at $p \leq 0.05$;PD_1, PD_2 and PD_3 stand for 1st, 15th and 29th planting dates; Values after planting dates (0, 30, 60, 90 and 120) represent Fertilizer levels applied in kg ha^{-1}

Watermelon production has both nutritional and economic values. The results showed that treatment $PD_2$30 (sown on 15th September i.e. second sowing date, where 30 kg N ha^{-1} was applied), yielded the highest gross margin of ₦180,967.00 per hectare (Table 4). The high economic returns (₦180,967, ₦121,567 and ₦118,433) which were obtained from treatments $PD_2$30, $PD_2$0 and $PD_1$60, respectively can be attributed to the lower costs incurred on lower quantities of fertilizer (30 kg N ha^{-} and 60 kg N ha^{-}) applied to the mid-September planted watermelon and the 60 kg N ha^{-1} applied to the first week of September planted watermelon. The low fertilizer costs reduced the total cost compared to the gross revenue. Fertilizer is the second important cost factor to hired labour in watermelon production and it accounted for about 6% of the total variable cost (Adeoye *et al.*, 2011). Although the highest economic return was obtained from watermelon planted during mid-September, there was no significant difference between treatments of crops planted in the first week. More so, it is worthy of note that returns corresponding to the first week of planting 1st September), performed better on the average. These, suggest that timely planting and low fertilizer application stimulate good growth responses from the watermelon. The highest gross margin figure obtained in this study compares well with the findings of Adeoye *et al.* (2011) who got a Gross Margin of (₦232,918.06 ha^{-1}) in a survey carried out in Oyo state. The two high cost benefit ratio values were correspondently obtained from the treatments with the highest GM. The 5.04 Cost – benefit ratio obtained at zero N level at the first planting period further supports the lowering cost's effects due to non-application of fertilizer. The benefit (mainly income) far outweighs cost by four times. There is much gain in watermelon production. The returns obtained in this study were higher than the ₦87,300.97 reported by Toluwase and Owoeye (2017) obtained at Ekiti.

Conclusion

Application of varying Nitrogen levels on watermelon planted at different dates have significant ($P < 0.05$) influence on both the yield parameters and Gross margin of the crop. The quality of the crop (Fruit length and rind thickness) was not significantly affected by both the sowing date and the N rates. It is recommended that watermelon in the study area should be planted during the second week of September (15th September) and 30 kg N ha^{-1}($PD_2$30), because this treatment gave higher values of number of fruit per plot, fruit diameter and yield per hectare. The fertilizer should be applied by side dressing.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

References

Abaje IB & Oladipo EO 2019. Recent changes in the temperature and rainfall conditions over Kaduna State, Nigeria. *Ghana J. Geogr.*, 11(2): 127 – 157.

Abaje IB, Ishaya S & Usman SU 2010. An analysis of rainfall trends in Kafanchan, Kaduna State, Nigeria. *Res. J. Envtal. and Earth Sci.*, 2(2): 89-96.

Adeoye IB, Olajide-Taiwo FB, Adebisi-Adelani O, Usman JM & Badmus MA 2011. Economic analysis of watermelon based production system in Oyo State, Nigeria. *J. Agric. and Bio. Sci.*, 6(7): 53-59.

Ajewole OC 2015. Income and factor analysis of watermelon production in Ekiti State, Nigeria. *J. Econ. and Sust. Devt*., 6(2): 67-72.

Alfa-nla Muhammad Babatunde Adeniyi 2014. Unpublished M.Sc Thesis submitted to the School of Postgraduate Studies, Ahmadu Bello University, Zaria, in Partial Fulfillment of the Requirement for the Award of Master of Science in Agricultural Economics, Faculty of Agriculture, Ahmadu Bello University, Zaria.

Amao SA, Ajiboye BO, Adeagbo TA & Akinyemi OA 2014. Profitability of watermelon to farmers in Ibarapa Central Local Government Area of Oyo State. *Int. J. Res.* (IJR), 1(9): 563-568.

Andrade Jr. A, Silva C, da Silva Dias N, Rodrigues B & Ribeiro V 2009. Response of watermelon to nitrogen fertigation. *IRRIGA*, 14: 115 – 122.

Anonymous 2019. Yara East Africa Ltd. www.yara.co.ke/crop-nutrition/melon/role-of-nitrogen -in-melon production/accessed 12/12/2019

Barros MM, Wellington FA, Leandro TBC, Neves AJ & de Campos JMT 2012. Production and quality of watermelon under nitrogen fertilization. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 16(10): 1078-1084.

Boswell VR 2000. Watermelon, an African native of world popularity: Our vegetable travelers. *National Geographic Magazine*, 96(2): 1 – 4.

Chude VO, Malgwi WB, Amapu IY & Ano OA 2011. Manual on Soil fertility Assessment. Federal Fertilizer Department, in collaboration with, National programme for Food Security, Abuja-Nigeria.

Coelho EF, Sousa VF, Souza VAB & Melo FB 2001. Efeitos de níveis de N e K aplicados por gotejamento na cultura do meloeiro (*Cucumis melo* L.) em solo arenoso. *Ciência e Agrotecnologia, Lavras*, 25(1): 23-30.

Dalmazzo Nowaki RH, Bernardes Cecílio Filho A, Teixeira De Faria R, Wamser AF & Mendonza Cortez JW 2017. Effect of Nitrogen Fertilization on Yield and Quality of Watermelon, cv. top gun Revista Caatinga, vol. 30, núm. 1, enero-marzo, 2017, pp. 164-171 Universidade Federal Rural do Semi-Árido Mossoró, Brasil

Enujeke EC 2013a. An assessment of some growth and yield indices of six varieties of watermelon (*Citrulus lanatus* Thumb) in Asaba area of Delta State, Nigeria. *Int. Res. J. Agric. Sci. and Soil Sci.*, 3(11): 376-382.

Enujeke EC 2013b. Response of watermelon to five different rates of poultry manure in Asaba Area of Delta State, Nigeria. *J. Agric. and Veter. Sci*., 5(2): 45-50; www.iosrjournals.org.

FAO 2007. Crop Water Management-watermelon. Land and Water Management Division, Food and Agriculture Organization (FAO), p. 145.

Faria CMB DE, Costa ND, Pinto JM, Brito LT, De L & Soares JM 2000Níveis de nitrogênio por fertirrigação e densidade de plantio na cultura do melão em um Vertissolo. *Pesquisa Agropecuária Brasileira, Brasília,* 35(3) 491 – 495.

Geren H, Avcıoglu R, Soya H, Kır B, Demiroglu G & Kavut YT 2011. A preliminary investigation on the yield and some yield characteristics of forage watermelon (*Citrillus lanatus* (Thunb.) Matsum. & Nakai var. citroides (Balley) Mansf.) grown as second crop, 4th National Seed Congress of Turkey, 14-17 June 2011, *Samsun*, 2: 157-161.

Hawkesford M 2012. Functions of Macronutrients. In: Marschner, P. (ed.). Marschner's mineral nutrition of higher plants. New York: Elsevier, cap. 6: 135-189,

Maluki M, Ogweno J & Gesimba1 RM 2016. Evaluation of nitrogen effects on yield and quality of watermelon {*Citrullus lanatus* (Thunb.) Matsumara & Nakai} grown in the coastal regions of kenya. *Int. J. Plant & Soil Sci.*, 9(2): 1-8.

Massri M & Labban L 2014. Comparison of different types of fertilizers on growth, yield and quality properties of watermelon (*Citrllus lanatus*). *Agricultural Sciences*, 5: 475-482.

Muhammad E, El-Habar G & Muhammad ARS 1989. Effect of planting dates and plant spacing on the growth and yield of *Snake cucumber* cv. local. *Ann. Agric. Sci*., 34: 1113-1121.

Mustapha S, Voncir N & Umar S 2011. Content and distribution of nitrogen forms in some black cotton soils in Akko LGA, Gombe State, Nigeria. *Int. J. Soil Sci.*, 6: 275-281.

Ncebo SZ 2010. Wild watermelon (*Citrullus lanatus* L.) Landrace production in response to three seedling growth media and field planting dates an unpublished Master of Science in Agriculture (Crop Science) Thesis Submitted in partial fulfillment of the requirements of the degree of Master of Science in Agriculture (Crop Science) School of Agricultural Sciences and Agribusiness Faculty of Science and Agriculture University of KwaZulu-Natal Pietermaritzburg.

Neuzo Batista de Morais, Francisco Marcus Lima Bezerra, José Francismar de Medeiros e Sérgio Weine Paulino Chaves 2008. Response of watermelon cultivated under different levels of water and nitrogen. *Revista Ciência Agronômica*, 39(3) 369-377, jul-set, 2008 Centro de Ciências Agrárias - Universidade Federal do Ceará, Fortaleza.

Olayinka BU & Etejere EO 2018. Proximate and chemical compositions of watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai cv red and cucumber (*Cucumis sativus* L. cv Pipino). *Int. Food Res. J.,* 25(3): 1060-1066.

Paula JAA, Medeiros JF, Miranda NO, Oliveira FA & Lima CJGS 2011. Metodologia para determinação das necessidades nutricionais de melão e melancia. *Rev. Bras. Eng. Agríc. Ambient,* 15(9): 911-916.

PCU/FMARD 2004. Project Coordinating Unit and Federal Ministry of Agriculture Crop production Data in Nigeria.

Prasad R & Hochmuth G 2015. Understanding Nitrogen Availability from Applications of Anaerobically Digested Beef-Cattle Manure in Florida Sandy Soil. UF Department of Soil and Water Science.

Seminis 2019. Watermelon Nutrient Analysis: Agronomic Spotlight. https://seminis-us.com/resources/agronomic-spotlights/watermelon-nutrient-analysis/

Silva MVT, Chaves SWP, Medeiros JF, Souza MS & Santos APF 2012. Acúmulo e exportação de macronutrientes em melancieiras fertirrigadas sob ótimas condições de adubação nitrogenada e fosfatada. *Agropecuária Científica no Semi-Árido,* 8: 61-70.

Taiz L & Zeiger E 2002. Plant Physiology. 3.ed. Sunderland, Sinauer Associates.

Toluwase SOW & Owoeye RS 2017. Cost-benefit analysis of watermelon production in Ekiti State, Nigeria. *RJOAS*, 6(66): 307-314.

University of Arizona CALS 2019. Nitrogen Management Guide for watermelon – from Nitrogen Fertilizer Management in Arizona. https://cals.arizona.edu/crops/soils/aznwatermelon.pdf

Wael M Elwakil, Nicholas SD, Freeman JH & Mossler MA 2017. Florida Crop/Pest Management Profile: Watermelon1 Florida Crop/Pest Management Profile: Watermelon1, CIR1236, University of Florida/IFAS Extension http://edis.ifas.ufl.edu.

Warncke D 2007. Nutrient management for cucurbits: Melons, pumpkin, cucumber, and squash. Department of Crop and Soil Sciences, Michigan State University. 2007 Indiana CCA Conference Proceedings.