Effect of Different Planting Dates on Phenology, Yield and Melatonin Concentration in Okra (Abelmoschus esculentus L. Monech) Fruit

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Abstract- ***Okra (Abelmoschus esculentus L. Monech) is an important vegetable crop consumed for its rich minerals and vitamins, but little is known about the presence and concentration of other rich nano particles like Melatonin in its fruits. A study on the effects of planting dates on the phenology, yield and melatonin concentration in Okra (Abelmoschus esculentus L. Monech) fruit was carried out during the planting season of 2023 at the Teaching and Research Farm of Rufus Giwa Polytechnic, Owo. The experiment was laid out using Randomized Complete Block Design (RCBD). The treatments comprised of three planting date (D1=1/7/23, D2=8/7/23 and D3=15/7/23) randomized into plots by table of random numbers. Each plot measures 2.50 x 1.50m with work space of 0.5m between plots. Treatments were replicated four times in each block. The result of the study showed that second planting date had significant effect on the phenology and yield okra fruit. Also, presence of melatonin was identified in okra fruit and its concentration was influenced by third planting date in the study area. This is an indication that appropriate planting date improves the yield and melatonin concentration in okra***

Keyword: Planting Date, Phenology, Yield, Melatonin Concentration, Okra Fruit.

I. INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Monech), is a semi-fibrous annual dicotyledonous herb belonging to the family Malvaceae (Ruchi and Rupinder, 2019). The crop is a fruit vegetable widely grown in many parts of the world, particularly the tropical and subtropical countries for its medicinal value and as raw material for industry (Saifullah and Rabanni, 2009, Ruchi and Rupinder, 2019). The seeds are also a good source of oil, minerals and medically important compounds with high dietary nutritive value up to 20% protein (Obeng-Ofori and Sackey, 2003), good balance of amino acids such as lysine and tryptophan in diets (Sanjeet *et al.,* 2010). However, the presence of melatonin in okra has not been reported or documented in recent studies.

Okra is a warm season crop which grows well under hot and humid condition whose temperature range is between 25°C to 40°C and night temperature of 22°C is for proper growth, flowering and fruit development (Ruch and Rupinder, 2019). Low night temperature of about 17^0C is reported to affect seed germination (Ruchi and Rupinder (2019). The sudden rise or fall in temperature at any phase of crop growth can affect the normal growth, flowering, pollination, fruit development and subsequently decreases the crop yields (Afroza *et al*., 2010).

Manipulation of planting date of crop is one of the cultural practices design to situate crop against temperature hazards (Frank and Roland, 2009). Good understanding of right planting date plays an important role in increasing crop yields as it provides suitable environmental conditions at all the growth stages of the crop (Frank and Roland, 2009). Appropriate planting date has advantage of favourable climatic conditions, increased growth duration, proper rainfall and optimal temperature during establishment and early vegetative growth that will eventually favour high fresh weight of fruit, more number of fruits per plant and ultimately increases fruit yield per plant (Bake *et al.,* 2017). On the other hand, delayed planting hampered vegetative growth due to warmer temperature during the growth period, which promotes excessive early stem growth, reduces flowering time and reduced incident radiation photosynthesis thus, affecting dynamics of reproductive growth and

development and subsequently reduced yields (Ruchi and Rupinder, 2019).

Melatonin is a wide spread molecule among living organisms involved in multiple biological, hormonal and physiological processes at cellular, tissue, and organic levels acting as a free radical scavenger, up-regulating antioxidant enzymes, reducing mitochondrial electron leakage, and interfering with pro-inflammatory signaling pathways, thus promoting health by protecting oxidative stress (Bahare *et al.*, 2019). Melatonin has been detected in various medicinal and food plants and its concentration are widely variable with highest concentration found in plant generative organ (Bahare *et al.,* 2019). The factor responsible for the high concentration therefore becomes subject of interest in this study.

The objective of this study therefore is to evaluate the effects of different planting dates on the growth, yield and melatonin concentration in okra (*Abelmuschus esculentum* L. Moench)

II. MATERIALS AND METHODS

Location

The experiment was conducted at the Teaching and Research Farm, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. The area lies within latitude 7^0 12` N and longitude 5^0 35 E with an elevation of 344m above sea level. The rainfall distribution pattern is bi-modal with mean annual rainfall of 1800 mm. The temperature ranges from 24^0 C and 27^0 C for minimum and maximum and is evenly distributed throughout the year. The atmospheric demand is usually high during dry season and low atmospheric demand during wet season with relative humidity of 80% (Falowo and Imeeokparia, 2015). The soil of the experimental site was loamy sand having pH of 5.48 (1:2 H_2O), organic carbon of 1.59%, organic matter content was 2.74%. Nitrogen content was 0.29mg/kg, phosphorus of 12.62mg/kg, potassium – 0.37cmol /kg and magnesium was 0.90 and cmol /kg in soil sample at 0–30cm depth.

Source of materials

Okra seed (V-35) and herbicide (Force-up) were source from 'Le-Shelter Agro Input and Supplies', Aruwajoye shopping complex, Ijebu-Owo, Ondo State, Nigeria and farm yard manure was sourced from the Rufus Giwa Polytechnic, Owo, poultry farm.

Land preparation and Experimental Design

The land for the study was cleared, manually tilled, clods reduced with club and plots were arranged in succession, following different planting date using simple farm tool. Blocks and plots were defined by using measuring tape, line and pegs. 15 tons of poultry manure was worked into the soil with hoe to enhance fertility.

The experiment was laid out using Randomized Complete Block Design (RCBD). The treatments comprised three planting dates (D1, D2 and D3) randomized into plots by balloting method. Each experimental block contains three plots with each plot measuring 2.50 x 1.50m and a work space of 0.5m between plots. Each treatment was replicated four times (R = R [Repetition = Replication]), the planting dates D1 (1/7/23), D2 (8/7/23) and D3 (15/7/23) as treatments. Prior to planting, the plots were left for 7 day to enhance the germination of weed seeds, then application of contact herbicides to knock down germinated weeds. Okra seeds were planted two weeks after cultivation, 7 days after contact herbicide application, in alignment with each planting date, at spacing of 50 x 50cm at 1cm depth. Weeding was carried out at flower initiation and later at three weeks interval to prevent weed competition.

Materials used for the extraction of melatonin

Plastic rubber, plastic knife, Boss B101 125 W plastic blade electric hand blender, beaker, ethanol, stirrer-glass rod, filter paper, volumetric flask, aluminum chloride, test tube, distilled water, sodium trioxo-nitrate V, quercetin, melatonin, aliquot extracts, UV-visible 721 instrument.

Processes involve in extraction

The harvested okra fruits were sliced into durable sizes fit for drying and easy handling using plastic knife to prevent corrosion. A sliced okra fruit was sundried for 3 days, then air dried until it was completely dry and later grounded to powder, using the Boss B101 W plastic blade electric hand blender. Powder was sieved to remove shaft.

Fine ground sample of 0.5 g of okra was weighed into a 100 ml beaker and 80 ml of 95% Ethanol added and was stirred with a glass rod to prevent lumping. The mixture was filtered through a filter paper into a 100 ml volumetric flask (AOAC, 2012).

Total melatonin content was measured with the Aluminum Chloride colorimetric assay, 1.0 ml of Aliquot extracts and 1.0 ml standard Quercetin solution (10, 20, 40, 60, 80, 100 mg/ml) was positioned into test tube and 4.0 ml of distilled water and 0.3 ml of 5% Sodium nitrate solution was added into each. After 5 minutes, 0.3 ml of Aluminum chloride was added. 6 minutes 2.0 ml of 1 mol sodium hydroxide was added (AOAC, 2012).

Finally, volume was made up to 10 ml with distilled water and mixed properly. Orange yellowish color was developed. The absorbance was measured at spectrophotometer using UV-visible 721 instrument. The blank was performed using distilled water, using Quercetin as standard (AOAC, 2012).

The data of total melatonin was plotted using standard Quercetin. The data of total melatonin were expressed as;

$$\frac{\text{Mg of Quercetin}}{\text{100g of dry mass}}$$

Data collection and Analysis

Data collection commenced at 8 weeks after planting (WAP) from 5 tagged plant in various plots, at different planting dates and was carried out fortnightly, until maturity. Data were collected on growth (number of leaf / plant, leaf area index, stem girth and plant height) and yield (number of fruit / plant, fruit length, fruit girth, fresh fruit weight, fruit stalk length, fruit yield) and melatonin concentration parameters.

Data were subjected to the analysis of variance (ANOVA) using IBM SPSS statistics (version 25) to test for significant differences in all parameters and means were separated by Duncan Multiple Range System (DMRS).

III. RESULTS

Effect of different planting date on plant height, number of leaf, leaf area index, and stem girth of okra at 8 WAP and 50% flowering stage

The monthly variation in rainfall, temperature and relative humidity during the study period, specifically rainfall, peaked in September (275.6 cm), while minimum temperatures remained relatively stable between 20.8^0C and 25.0^0C. Relative humidity was highest in April and September (Figure 1).

Plant height progressed with the age of okra plant. At 8WAP, D3 and D2 had 25.82cm and 19.44cm while D1 recorded 4.01cm. D3 and D2 values were not significantly ($p< 0.05$) different from each other, but both were significantly different from value obtained at D1. At 50% flowering stage the same trend of growth in height as in 8 WAP was observed at D1, D2 and D3 (Table 1).

The number of leaf produced were not significantly ($p<0.05$) influenced by planting date at 8 WAP and 50% flowering stage across the three planting dates. D3 influenced increase in value of number of leaf at both 8WAP and 50% flowering stages of okra plant growth in this study (Table 1).

At 8 WAP, leaf area index (LAI) of okra was highest at D2 (238.12), followed by D3 (209.48) while the least was obtained in D1 (70.15). There was no significant difference between values of D2 and D3. However, at 50% flowering stage D3 (253.47) recorded the highest value, followed by D2 (147.81), then D1 (107.87). There was significant difference among values (Table 1).

At 8 WAP, D3 recorded the highest value in stem girth. The value was not significantly ($p<0.05$) different from value obtained at D2, but significantly ($p<0.05$) different from value of D1. Also, D2 was not significantly ($p<0.05$) different from D1 (Table 1).

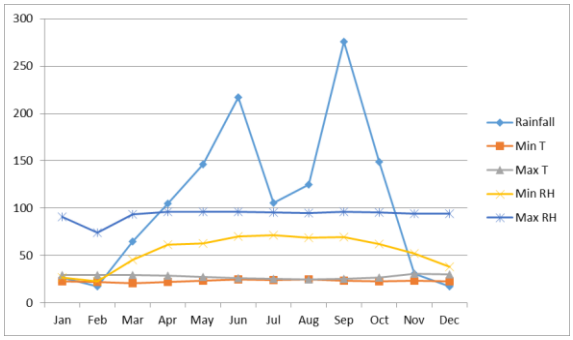

Figure 1: Monthly variation in rainfall, temperature and relative humidity of the study site during 2023 cropping season.
Source: Ago-meteorological observation centre (ABET-Agricultural and Bio-environmental Technology Department), Rufus Giwa Polytechnic, Owo.

Table 1: Effect of different planting date on plant height, number of leaf, leaf area index, and stem girth of okra at 8 WAP and 50% flowering stage
Weeks After Planting

	PLH		NOL		LAI		STG	
PLTD	8WAP	50%	8WAP	50%	8WAP	50%	8WAP	50%
D1	4.01^{b}	17.52^{b}	5.85^{a}	7.86^{a}	70.15^{b}	107.87^{b}	1.64^{b}	2.81^{b}
D2	19.44^{a}	29.49^{a}	7.23^{a}	12.83^{a}	238.12^{a}	147.81^{ab}	2.97^{ab}	4.69^{a}
D3	25.82^{a}	40.32^{a}	7.65^{a}	13.87^{a}	209.48^{a}	253.47^{a}	3.77^{a}	5.49^{a}

Values followed by the same letter in a column are not significantly different at $p<0.05$ according to Duncan's multiple range test (DMRT).

Key: PLH (Plant height), NOL (Number of leaf), LAI (leaf area index), STG (stem girth), WAP (week after planting), 50% (50% flowering stage), D1 (First planting date), D2 (Second planting date), D3 (Third planting date).

Effect of different planting dates on fruit characteristics, yield and melatonin concentration of okra at Harvest

A total of four harvests were pooled together and the mean was considered as yield per plant. Number of fruit per plant was not significantly ($p<0.05$) influenced by planting date. The highest number of fruit per plant was obtained at D2 (15.41) followed by D1 (13.57), then D3 (12.76).

Fruit length was not significantly ($p<0.05$) influenced by planting date, though the highest value was obtained in D2, followed by D1, then D3 (5.39, 3.02 and 2.99) (Table 2).

Fruit girth was significantly ($p<0.05$) influenced by planting date, setting D2 at the peak (13.26) with significant difference from values obtained at D3 and D1 (9.48 and 9.06). The values of D3 and D1 were not significantly ($p<0.05$) different.

Planting date had no significant effect on fresh fruit weight of okra plant studied. D2 recorded the highest value (9.64), next was D3 (4.26) and the least was D1 (4.01)

Fruit stalk length was significantly influenced by planting date. D2 recorded the longest fruit stalk length (4.15) which was not significantly ($p<0.05$) different from values of D1 (1.55) but significantly ($p<0.05$) different from D3 (1.46). D1 and D3 did not show significant difference (Table 2).

Planting date had no significant effect on fruit yield per plant. The highest yield value was recorded in D2, followed by D1 and the least value was obtained in D3 (4.00, 2.70 and 2.38)

Result showed that melatonin was present in okra and the yield was significantly ($p<0.05$) influenced by planting date. D3 recorded the highest value (0.024) of melatonin concentration which was significantly ($p<0.05$) different from values obtained at D2 (0.021) and D1 (0.020) (Table 2)

Table 2: Effect of different planting dates on fruit characteristics, yield and melatonin concentration of okra at Harvest

Yield Parameters

PLTD	NOF/P	FRL (cm)	FRG (cm)	FFRW (g)	FSTL (cm)	YLD/PLT (kg)	MLTC (%)
D1	13.57[a]	3.02[a]	9.06[b]	4.01[a]	1.55[ab]	2.70[a]	0.020[b]
D2	15.41[a]	5.39[a]	13.26[a]	9.64[a]	4.15[a]	4.00[a]	0.021[b]
D3	12.76[a]	2.99[a]	9.48[b]	4.26[a]	1.46[b]	2.00[a]	0.024[a]

Values followed by the same letter in a column are not significantly different at $p<0.05$ according to Duncan's multiple range test (DMRT).

Key: PLTD (Planting dates), NOF/P (Number of fruits per plant), FRL (Fruit length), FRG (Fruit girth), FFRW (Fresh fruit weight), FSTL (Fruit stalk length), YLD/PLT (Fruit yield / plot), MLTC (Melatonin conc), D1 (First planting date), D2 (Second planting date), D3 (Third planting date).

Discussion

Effect of Different Planting Dates on the Vegetative Growth of Okra (*Abelmonschus esculentus* L. Moench Var V-35) at 8 and 10 WAP

The weather scenario in figure I supports the observed vegetative growth trends. The second and third planting dates (D2 and D3) coincides with months of moderate rainfall and optimal temperature ranges, which likely favoured photosynthetic activity and nutrient uptake. This stability in minimum temperature and high relative humidity during July and August provided ideal conditions for okra development. Jing *et al*., (2019), in a study conducted with lettuce, reported that temperature range of 22 to 25 °C and light intensity of 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ favoured photosynthetic and biochemical activities in lettuce.

The three planting dates D1, D2 and D3 were found to influence the vegetative growth parameters of okra, particularly as the plant progressed in age. The significant increase in growth parameters at D2 [(8/ 7/ 2022) second planting date] and D3 [(15/ 7/ 2022) third planting date] could be attributed to availability of suitable temperature range which might have enhanced plant metabolic activities like photosynthesis due to favorable weather conditions. Similar observation was made by Ruchi Sood and Rupender Kaur (2019) on the suitability of temperature range on the physiological activities of okra. According to Dash *et al.,* (2013) proper environment, moisture and other natural resources, as observed in this study, result in better growth of plant.

Effect of different planting dates on fruit characteristics, yield and melatonin concentration of okra

Yield and yield attributes of okra showed enhancement in response to planting date. From the result, D2 significantly influenced number of fruit per plant and fruit stalk length and other attributes increased, but not significantly different from other treatment values. The better performance attributed to D2 could be earliness of fruiting occasioned by good vegetative growth that was enhanced by favourable weather scenario of the second planting date (8/ 7/ 2022). Ruchi Sood and Rupender Kaur (2019) reported that favourable temperature and good sunshine result in the quick emergence and early flowering of okra leading to accumulation of more photosynthates thereby inducing early fruiting and increase yield. However, D3 [(15/ 7/ 2022) third planting date] recorded increase concentration of melatonin. Increase concentration could be as a result of reduced precipitation of D3 which might have propelled hormonal agitation of biochemical activities leading to production of melatonin to balance nutrient flow in okra plant. Arnao *et al*., (2022) reported that melatonin behaves as an excellent plant master regulator acting on nitrogen metabolism and also improves important pathways such as photosynthesis, water economy, carbohydrate and lipid metabolism.

CONCLUSION

Planting date had influence on the growth, yield and melatonin concentration in okra (*Abelmoschus esculentum* L. Moench) fruit. Second planting date (D2) and third planting date (D3) was shown to have the highest vegetative growth. The second planting date (D2) had the highest record in fruit yield while the third planting date (D3) influenced melatonin concentration in okra fruit. Practical solution for okra growers to obtain improved yield with high nutritional value at farm level involve appropriate planting date. On the longer term the development of coping strategies to leverage yield and melatonin concentration, in relation to planting date looks more enhancing.

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