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ESTIMATION OF PLANTING DATES FOR ROSELLE (*HIBISCUS SABDARIFFA* L.) IN THE HUMID TROPICAL ENVIRONMENT OF OWERRI, SOUTHEASTERN NIGERIA.

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ABSTRACT

In order to fill the gap existing between the production and consumption of roselle in the humid tropical areas of Nigeria, this experiment was carried out in Owerri between May and December, 2012 to evaluate the effects of planting dates and accessions on the growth and performance of roselle (Hibiscus sabdariffa). Six planting dates including planting at monthly intervals from May to October and two accessions (Purple calyx and Green calyx) were evaluated. The experiment was laid out as a 2 x 6 factorial in Randomized Complete Block (RCB) with three replications. Results revealed that all roselle crops planted in May through August flowered within the same period (26 – 29th September) which coincided with the period of short days in the northern hemisphere. Consequently, roselle planted in May produced flower buds significantly (138 days after planting) compared to other dates. July sown roselle in addition to producing flower bud relatively earlier (80.2 days after planting), had comparably higher number of flower buds/plant and calyx length. Roselle sown in September and October however did not flower. For use as vegetables in soup making, green calyx roselle should be sown in May and harvested not later than 8 weeks after planting. Planting in July appears to favour early flowering and is appropriate for purple calyx roselle.

Keywords: Roselle, Accession, Planting Date, Month, Calyx Length.

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L.) is an important vegetable of the Malvaceae family together with Okra. Roselle is native to the region that stretched from India to Malaysia and almost all parts of the crop including the fleshy fruits, leaves, stems, flowers (Calyces), seeds and fibre are important sources of food, raw materials and foreign exchange (Schipers, 2000; Galaudu, 2006). Its antihypertensive properties and use in folk medicine as a diuretic, laxative and in food colourings have continued to attract the attention of food and beverages manufacturers, and pharmaceutical industries. In spite of these medicinal and food values, roselle cultivation is limited in Nigeria and farmers plant the crop without due consideration to appropriate planting date (Futuless *et al*., 2010).

Roselle is tolerant to dry weather, especially during the latter stages of growth and is also sensitive to variation in length of days. Attention, therefore, should be targeted at the appropriate

day length much more than rainfall. Youdeowei *et al*. (1986) states that the timing of farm operations is important for the growth of all crops, especially annuals that are susceptible to drought or late rain which are beyond the farmers' control. In India, sowing is usually at the beginning of the rainy season (Mehdi Ansari *et al*., 2013). In Northern Nigeria, roselle planted in Mid-July showed superior vegetative qualities (Futuless *et al.,* 2010). Appropriate planting dates bring about proper growth and development of plants resulting in maximum yield of the crop and economic use of land (Islam *et al*., 2010). Deviation from appropriate sowing period (early or late sowing), leads to yield loss (Ologunde, 1987; Sárvári and Futó, 2000; Berzsenyi and Lap, 2001). In Iran, delay in sowing date from May 10 to June 20 led to 58% flower loss and 60% reduction in yield of fresh flowers (Barzgaran, 2011). In the humid tropical environment of south-eastern Nigeria, where roselle is priced for its calyx from which the popular beverage called "Zobo" is prepared, there is dearth of information on the growth and development of the crop. This study was, therefore carried out to determine appropriate planting dates for roselle in the humid environment of Owerri.

MATERIALS AND METHODS

This study was carried out at the Teaching and Research Farm of the Federal University of Technology, Owerri, Imo state. Owerri lies on **Latitude** 5° 30' 01" N and **Longitude** 7° 01' 44" E in the tropical rainforest region of Nigeria. The temperature ranges between a minimum of 20°C and a maximum of 32°C with relative humidity of about 83%. The area has a mean annual rainfall of about 2500 mm. The meteorological data for the location during the period of study is presented in Table 1.

Soil samples were randomly collected to 15 cm depth using a soil auger. Samples were bulked, air-dried and the soil's physical and chemical properties determined in the Analytical laboratory of the Department of Soil Science and Technology (Table 2).

The experiment was laid as a 2 x 6 factorial in RCBD and replicated six times. Two roselle accessions (purple petiole/calyx and green petiole/calyx) and six planting dates (11th May, 11th June, 11th July, 11th August, 11th September and 11th October) were evaluated. The roselle seeds were planted out on flat at a spacing of 75 cm between rows and 50 cm within row. Two split doses of NPK 20-10-10 at the rate of 350 kg/ha were applied at 2 weeks after planting (WAP) and at the onset of flowering. Data were collected on agronomic and reproductive parameters such as Plant height, Number of leaves, Number of branches, Dry matter accumulation, Number of days to flower bud appearance, Number of flower buds/plant, and Fresh Calyx length. All data were subjected to Analysis of Variance (ANOVA) and significant means were separated using LSD at 5% using the Genstat (Ed. 4).

Table 1. Meteorological Data for the Experimental Area (Owerri) from the Months of January to October, 2012

Months	Rainfall (mm)	Rain Days	Temp. (^{0}C) Max.	Min.	Rel. Hum. (%)	Dew point (%)
Jan.	Nil	Nil	32.5	29.0	78.5	23.7
Feb.	120	3	32.2	29.5	78.3	24.6
Mar	68	6	32.4	29.0	80.0	24.5
Apr	102	8	31.5	29.7	80.5	25.0
May	114	12	32.0	29.5	79.6	24.5
June	145	14	32.5	29.3	79.8	24.7
July	155	16	31.8	29.5	78.5	24.5
Aug	130	10	31.0	29.0	78.3	24.2
Sept	135	12	31.5	29.5	78.8	24.5
Oct	132	10	31.6	29.4	78.5	24.2
Mean	130.4	11.7	31.7	29.4	90.4	24.5

Source: Agro meteorological station, Owerri (ADP, OWERRI, 5 km from experimental site)

Table 2. Pre-planting Soil Physical and Chemical Properties

Soil parameter	Value
Ph	6.06
Total Nitrogen (kg/ha)	0.031
Organic carbon (g/kg)	0.5985
Percentage Organic matter	1.0348
Available phosphorus (mg/kg)	0.335
Total Exchangeable Bases (cmol/kg)	2.631
Ca^{2+}	0.006
Mg^{2+}	0.008
K^{+}	2.297
Na^{+}	0.32
Total Exchangeable Acidity (cmol/kg)	0.12
H^{+}	0.08
Al^{3+}	0.04
Effective Cation Exchange Capacity	2.751
% sand	94.24
% silt	2.0
% clay	3.76
Soil textural class	Sandy

RESULTS

The pre-planting soil analysis showed that the soil was sandy with its attendant low concentrations of exchangeable bases (Table 2). Organic matter content was very low (1.0348%), but soil pH (6.06) was favourable for plant growth (Choudhury, 1977; Duke, 1983).

The Results of the ANOVA showed that planting dates of roselle had a significant effect on roselle establishment. Roselle planted in May had significantly highest establishment count of 89.7% compared with other dates of planting while the significantly least establishment count (9.2%) was obtained in roselle planted in September (Table 3). The interaction between planting date and accessions did not significantly affect roselle establishment.

The planting dates significantly influenced the production of leaves while accessions did not affect the number of leaves per roselle plant (Table 4). Roselle planted in May had significantly more leaves at 4 and 8 WAP, July at 12 WAP while June planting date had relatively higher leaves at 16 WAP. Significant interaction exists between planting date and accession type at 12 WAP.

Table 3. The Effects of Planting Dates and Roselle Accessions on the Establishment Count (%)

Planting date	Accessions		
	Purple calyx	Green calyx	Mean
May	86.70	92.80	89.75
June	73.30	37.80	55.60
July	70.60	71.70	71.10
August	66.70	48.10	57.40
September	4.40	13.90	9.20
October	37.00	44.10	40.60
Mean	56.40	51.4	

$LSD_{0.05}$ (Planting date) = 2.02
$LSD_{0.05}$ (Accession) = ns
$LSD_{0.05}$ (Planting date x Accession) = ns

Table 4. The Effects of Planting Date and Roselle Accessions on the Number of Leaves

Weeks After Planting												
	4			8			12			16		
Planting date	Accessions			Accessions			Accessions			Accessions		
	Purple Calyx	Green calyx	Mean	Purple Calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean
May	10.67	8.67	9.67	35.33	40.67	38.00	5.40	11.80	8.60	1.47	10.40	5.93
June	6.40	5.47	5.93	11.20	11.40	11.30	13.43	9.45	11.44	18.28	18.17	18.22
July	6.60	7.05	6.83	25.50	34.93	30.22	40.34	22.00	31.17	13.17	10.25	11.71
August	5.00	4.33	4.67	15.67	13.22	14.45	4.00	16.75	10.38	1.33	5.91	3.62
September	1.09	1.11	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	6.92	7.58	7.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	6.11	5.70		14.62	16.70		10.53	10.00		5.71	7.45	
$LSD_{0.05}$ (Planting date)	= 1.808			6.159			6.677			5.845		
$LSD_{0.05}$ (Accession)	= ns			Ns			Ns			Ns		
$LSD_{0.05}$ (Planting date x Accession)	= ns			Ns			9.443			Ns		

While the planting dates Significantly influenced the number of branches produced per roselle plant at 8, 12 and 16 WAP, the effects of accession, and the interaction between planting date and accessions were significant (Table 5). Accessions planted in May had significantly more branches per plant. Roselle plant height was significantly affected by planting dates (Table 6). Roselle planted in May had the significantly taller plants at 4, 8, and 16 WAP compared to other planting dates. At 12 WAP however, roselle planted in July were tallest (57.5 cm) compared to other planting dates.

The effects of planting dates and on root, stem, leaf and total dry matter contents of roselle plant taken during the vegetative stage was highly significant. Roselle planted in May partitioned the highest dry matter in the root, stem, and leaf (Table 7). Consequently, the total dry matter per plant (21.6 g) produced when roselle was planted in May was significantly higher when compared to other planting dates.

Roselle planted in May produced flower buds at 138 days after planting (DAP). This was the significantly longest number of days to flower bud production when compared to other planting dates (Table 8). Although, roselle planted in August were earliest to produce flower bud at 75.6 DAP, they had relatively fewer flower bud/plant (2.26), and shorter fresh calyx length (0.47 cm) compared to other planting dates. Roselle planted in July on the other hand, produced flower bud at 80.2 DAP and had significantly more flower buds and longer fresh calyx.

Table 5. The Effects of Planting Date and Roselle Accession on Number of Branches/Plants

Weeks After Planting												
	4			8			12			16		
Planting date	Accessions			Accessions			Accessions			Accessions		
	Purple calyx	Green calyx	Mean	Purple Calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean
May	0.00	0.00	0.00	7.87	9.33	8.60	10.00	12.40	11.20	10.27	13.27	11.77
June	0.00	0.00	0.00	0.93	0.87	0.90	5.47	3.89	4.68	8.64	6.94	7.79
July	0.00	0.00	0.00	5.53	7.62	6.57	8.78	7.78	8.28	8.18	11.00	9.59
August	0.00	0.00	0.00	3.33	3.00	3.17	2.78	5.08	3.93	3.44	5.25	4.35
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	0.25	0.083	0.167	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	0.042	0.014		2.94	3.47		4.50	4.86		5.09	6.08	
$LSD_{0.05}$ (Planting date)	= ns			1.667			2.307			4.441		
$LSD_{0.05}$ (Accession)	= ns			Ns			Ns			Ns		
$LSD_{0.05}$ (Planting date x Accession)	= ns			Ns			Ns			Ns		

Table 6. Effect of Planting Date and Roselle Accession on Plant Height (cm)

Weeks After Planting												
	4			8			12			16		
Planting date	Accessions			Accessions			Accessions			Accessions		
	Purple calyx	Green calyx	Mean	Purple Calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean
May	15.20	16.30	15.75	28.92	36.58	32.75	46.30	62.60	54.40	63.80	86.00	74.90
June	5.03	4.70	4.87	11.80	11.40	11.60	33.70	25.90	29.80	60.10	71.50	65.80
July	7.67	9.05	8.36	24.47	32.02	28.24	58.20	56.90	57.50	42.10	55.90	49.00
August	8.80	8.28	8.54	19.25	23.58	21.42	19.90	22.00	20.95	28.90	42.30	35.60
September	1.08	2.77	1.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	12.83	9.67	11.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	8.44	8.46		14.07	17.26		26.30	27.90		32.50	42.60	
$LSD_{0.05}$ (Planting date)	= 2.02			4.941			9.71			12.49		
$LSD_{0.05}$ (Accession)	= ns			2.853			Ns			7.21		
$LSD_{0.05}$ (Planting date x Accession)	= ns			Ns			Ns			Ns		

Table 7. Effect of Planting Date and Roselle Accession on Dry Matter Content/Plant (g/plant)

Planting dates	Plant Part: Root			Leaf			Stem			Total		
	Accessions			Accessions			Accessions			Accessions		
	Purple Calyx	Green calyx	Mean	Purple Calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean
May	2.667	2.533	2.60	11.47	10.93	11.20	8.93	6.67	7.80	23.07	20.13	21.60
June	0.467	0.510	0.488	2.13	5.15	3.64	1.07	0.80	0.93	3.67	6.46	5.06
July	1.277	0.887	1.082	3.50	3.07	3.29	3.45	2.78	3.11	8.22	6.74	7.48
August	0.46	0.773	0.617	0.47	1.10	0.78	0.99	1.57	1.28	1.91	3.45	2.68
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	0.812	0.784		2.93	3.38		2.41	1.97		6.14	6.13	
$LSD_{0.05}$ (Planting dates)	= 0.3463			2.951			1.503			3.912		
$LSD_{0.05}$ (Accessions)	= ns			Ns			Ns			Ns		
$LSD_{0.05}$ (Planting dates x Accessions)	= ns			Ns			Ns			Ns		

Table 8. Effect of Planting Date and Roselle Accession on Some Reproductive Parameters of Roselle

Planting Dates	Reproductive parameters: No of days to flower bud appearance Accessions			No of flower bud/plant Accessions			Fresh calyx length (cm) Accessions		
	Purple Calyx	Green calyx	Mean	Purple Calyx	Green calyx	Mean	Purple calyx	Green calyx	Mean
May	136.5	139.5	138.0	0.75	4.58	2.67	0.00	1.50	0.75
June	111.0	105.3	108.2	1.67	4.57	3.12	0.00	1.77	0.88
July	77.30	83.00	80.2	4.06	3.84	3.95	4.03	1.60	2.82
August	75.90	75.30	75.6	2.00	2.52	2.26	0.00	0.93	0.47
September	100.2	100.8	100.5	0.00	0.00	0.00	0.00	0.00	0.00
October	100.2	100.8	100.5	0.00	0.00	0.00	0.00	0.00	0.00
Mean	100.2	100.8		1.41	2.59		0.67	0.97	
$LSD_{0.05}$ (Planting date)	= 13.29			2.789			1.484		
$LSD_{0.05}$ (Accessions)	= ns			Ns			Ns		
$LSD_{0.05}$ (Planting dates x Accessions)	= ns			Ns			Ns		

DISCUSSION

The pre-planting soil analysis showed that the soil of the experimental site was sandy with low organic matter contents. Consequently, the soil had low nitrogen and phosphorus contents. Exchangeable bases and cation exchange capacity were also low. This justified the need for the blanket application of NPK 20:10:10 at the rate of 350 kg/ha. Ohiri (1992) had similarly reported that soils of south-eastern Nigeria have low cation exchange capacity (CEC), and low base saturation.

From the available data, the months from June to October received more rain with more rainy days compared to the month of May. As a result, the plots for Roselle planted in June through October were saturated with water during the days following planting. Consequently, Roselle planted in May had highest establishment count of 89.7% compared to other planting dates. While establishment count was 71% for Roselle planted in July, other planting dates had establishment count that ranged from 9.2–55.6%. Durant and Scott (1981) have similarly reported that having rainfall within a few days of sowing reduces seed vigour and establishment. Although, moisture and oxygen are two factors which are important for germination and seedling emergence, water logging can deprive emerging seedling of oxygen and kill it before it can emerge from the soil.

Roselle root, stem and leaf dry matter contents were significantly affected by variations in the planting dates. Roselle planted in May partitioned the significantly highest dry matter in the roots, stem and leaves. Planting dates significantly affected the number of days to flower bud appearance as the duration of vegetative growth was shortened with progressive planting dates. All Roselle plants sown before September produced flower buds at about the same period (26th–29th September), the number of days it took to produce flowers however, differed because of the planting dates. For instance, Roselle planted in May had flower buds produced on 26th September which was approximately 138 DAP. While June sown Roselle produced flower buds on 27th September (108 DAP), July sown Roselle produced flower buds on 29th September (80 DAP). This period (26th–29th September) coincided with shorter days in the northern hemisphere. Owerri is located on latitude 5º30'01"N and longitude 7º01'44"E in the northern hemisphere (Anon., 2014; Thomas and Vince-Prue, 1997). The effect of daylength was remarkable on roselle sown in August as they produced flower buds earlier than others at 76 DAP on 26th September. However, September and October sown roselle produced flowers on 21st December and 20th January, respectively which approximated to 106 DAP. These observations corroborated Twain (2002) who reportes that the photosensitivity of Roselle is responsible for its delay in flowering under conditions of long day length as the plant may not flower when sunlight duration is above 11 hours.

In this study, Roselle accessions were not able to carry the flower bud to maturity and have them develop into flowers. This may be as a result of nutrient stress as evidenced in the soil chemical

properties (Table 2). In this study, soil analysis showed very low soil fertility level consequently 350 kg/ha NPK 20-10-10 was applied in split doses to the Roselle plots. The effectiveness of this application may have been limited by the high amount of rain received during the duration of the study. This may have resulted in the leaching of much part of the nutrients applied in the fertilizer.
Other reproductive parameters such as number of flower bud/plant and fresh calyx length also showed significant differences with respect to planting dates and varieties. Roselle planted in July had significantly more flower buds (3.85 buds per plant) and longest fresh calyx length of 2.82 cm. Considering also that July planted Roselle had lower disease incidence and severity, and performed relatively better across all parameters evaluated. Planting in July is recommended for Roselle in the humid tropical environment of Owerri. Futuless *et al.* (2010) has similarly reported that Roselle sown in Mid-July in Northern Nigeria had superior qualities ranging from vegetative growth, calyx yield, number of fruits, fresh calyx length and dry calyx yield.

CONCLUSION

Roselle planted in May showed high vegetative growth at the expense of reproductive growth. They were also more predisposed to fungal (*Alternaria spp*) infection especially after 8 WAP due to high relative humidity. On the other hand, roselle planted in July had a relatively moderate vegetative growth which was carried through flowering. Roselle planted in July produced flower buds significantly earlier and had comparatively more flower buds and longer fresh calyx.
Consequently, roselle grown for the leaves may be planted in May, and should be harvested not later than 8 WAP to avoid possible fungal infection. Roselle grown for calyx, however, should be planted in July in Owerri to allow for early and enhanced flowering during the short day length periods of September.

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