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Research

Effects of Pinching Height on the Growth and Calyx Yield of Roselle *(Hibiscus sabdariffa L.)*

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Abstract

Pinching had been found to regulate plant shape and size, control flowering and fruiting. A pot experiment was carried out at the National Centre for Genetics Resources and Biotechnology (NACGRAB), Moor plantation Ibadan (latitude; 7o24'42"E and longitude; 3o 49' 47" N) between March and October, 2014 to determine the effects of pinching height on the growth and calyx yield of Roselle. The Roselle seeds (NGB01277), used for the experiment were collected from the Seed Testing Unit of NACGRAB. The Roselle plants were grown in polythene bags containing 20 kg of forest top soil. At 8 weeks after planting, the plants were pinched into different heights which made the treatments. Main axis was pinched at 30 cm, 40 cm, 50 cm and 60 cm above soil level, while the control pots were allowed to grow unpinched making 5 treatments, each treatment replicated 4 times. Data were taken on growth parameters: plant height (cm), number of leaves/plant and number of branches/plant. Data were also taken on yield parameters which include number of flowers, number of aborted calyx, number of harvested calyx and weight of harvested calyx. Data collected were subjected to statistical analysis using Analysis of Variance (ANOVA) and the means were separated using Duncan Multiple Range Test (DMRT). Pinching had a positive effect on the enhancement of growth in roselle and increased the productivity of the calyx, compared with the unpinched plants. Roselle plants pinched at 60 cm height gave the highest weight of harvested calyx of 6.22 t/ha which was similar with plants pinched at 40 cm height producing 3.98 t/ha calyx yield. It is recommended to pinch Roselle plants at 60 cm height for economic yield but not below 40 cm height.

KEY WORDS: Calyx yield, Growth, Pinching height, Roselle.

Introduction

Roselle *(Hibiscus sabdaraffa L.)* from the Malvaceae family is a popular vegetable in many tropical regions, cultivated for its leaves, seeds, stems and calyces. There are about 300 tropical and subtropical Hibiscus species (Grubben and Denton, 2004). They have a wide variety of uses as fibre, foods, medicines and ornaments. Roselle is an annual plant which takes about six (6) months to mature. The leaves are divided into three to five lobes and they are arranged alternately on the stem. Each calyx lobe has a prominent central rib and two marginal ribs, these characteristics placed the plant "Roselle" in the section of Furcaria which is the most diverse section of Hibiscus, containing over 100 species of economic importance, such as Kenaf *(Hibiscus cannabinus)*, Roselle *(Hibiscus sabdariffa)* and false Roselle *(Hibiscus acetosella)* (Douglas, 1993). The flowers of Rosella are white to pale yellow in colour, with fleshy and soft calyces. The mature fruits are bright red (Halimatul *et al.,* 2007). Roselle is a deep rooted crop, therefore deep ploughing is recommended in preparing the seed beds. Seeds are planted at the rate of 6-8 kg/ha and approximately 2-5 cm deep. Seeds are usually planted at the beginning of the rainy season, 60 cm - 1 m between rows and 45-60 cm apart. Reduced planting rates produce a larger calyx. Weeding can also increase yield and calyx size. Roselle can perform satisfactorily on relatively infertile soils but for economic purposes, a soil well supplied with organic matters and essential nutrients is important in the production (Adanlawo and Ajibade, 2006). The dried calyces of *Hibiscus sabdariffa* are used in making an infusion beverage known as "Zobo" in Nigeria, while the leaves of Roselle are used as medicine (Akpan, 2000). According to Fasoyiro *et al*., (2005), the dried red calyces have been used to prepare tea, syrup, jams and jellies as beverages, leaves and young shoots of Roselle are eaten raw in salads and the red fleshy calyx lobes chopped and used in fruits salads in the United States. Roselle tea is used to control high blood pressure and its. Leaves are used as a source of mucilage in pharmacy and cosmestics (McClintock and Tahir, 2004). Roselle is used for a popular health drink among Malaysians who consume it for its high vitamin "C" and anthocyanin contents (Eslaminejad and Zakaria, 2011). Despite these enormous potentials, productivity of Roselle is limited because of its long maturity period, thus, there is a need to develop a management system that will enhance calyx production. According to Disabato-Aust, (1988), pruning is done to regulate the plants shape and size, control flowering and fruiting. Among the benefits are extending the blooming time, regenerating the plants and encouraging new growth. Pinching is the removal of a small portion of the plant, involving the growing tips and first set of leaves to facilitate branching. According to Jannick, (1979) the removal of the apical portion of the stem leads to increased vegetative development, promote dry matter accumulation and reduced plant height. This might be due to changes in balance between the root and shoot. Sajjan *et al.,* (2002), showed that the apical bud pinching of Okra at 20 (Days After Sowing) DAS gave the highest number of fruit per plant and the highest value of seed per fruit, when compared with apical bud pinching at 30 DAS and without pinching. Pruning of leaves and side shoots contribute to the ultimate yield in various ways (Premalatha *et al.,* 2006). Therefore, it is important to manipulate canopy architecture through pruning to get maximum marketable yield from crops (Cebula, 1995). This practice is not a common operation in the cultivation of Roselle. Recently, Roselle has drawn the attention of food, beverages and pharmaceutical manufactures because of its commercial potential as a natural food and colouring agent that can replace some synthetic products (Eslaminejad and Zakaria, 2011). Therefore, the focus of this experiment was to determine the effects of pinching heights on the growth and the calyx yield of Roselle.

Materials and methods

A pot experiment was carried out between March and October, 2014 at the experimental site of National Centre for Genetics Resources and Biotechnology (NACGRAB) Moor Plantation Ibadan,(latitude; 7o24'42"E and longitude; 3o 49' 47" N) to determine the effects of pinching height on the growth and calyx yield of Roselle. The Roselle seeds (NGB01277), used for the experiment were collected from the Seed Testing Unit of National Centre for Genetics Resources and Biotechnology (NACGRAB). The top soil used for the experiment was forest top-soil collected at National Cereals Research Institute (NCRI) compound Moor plantation Ibadan. The design used for this experiment was Completely Randomized Design (CRD) comprising of 5 treatments which include 4 pinching heights: 30 cm, 40 cm, 50 cm and 60 cm above soil level and control of unpinched plants replicated four times. The plants were pinched at four weeks after transplanting (4WAT) which was equivalent to eight weeks after planting (8WAP), using secateurs. Data collected on the growth parameters at 2 weeks interval from 8 to 22 WAT include; plant height (cm), number of leaves, stem diameter (mm) and number of branches. Data were also collected on yield parameters include; number of flowers, number of aborted calyces, number of harvested calyces and weight of harvested calyces. Data collected were subjected to statistical analysis

using Analysis of Variance (ANOVA) and the means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

Results

Pre- cropping Soil Analysis

The soil pH was neutral; the soil was high in organic matter, nitrogen, available phosphorus and exchangeable bases, which can sustain the growth of Roselle. The textural class was sandy loam (Table 1).

Effects of pinching heights on plants heights of Roselle

Plant heights of unpinched and plants pinched at varying height were similar at 8 weeks after planting (WAP) when pinching was done. While the plant heights of pinched plants were maintained, the unpinched plants had its height increased from 49.28 cm at 8WAP to 81.88 cm at 22 WAP (Table 2). At 10WAP, plants pinched at 60 cm significantly produced plants taller plants than the unpinched pots. Between 12WAP and 16WAP control plants significantly produced taller plants than pinched plants except 60 cm pinched plant. Beyond 16 WAP, plants pinched at 50 cm and 60 cm height produced comparable heights as the unpinched plants, though control plants gave the highest value of plant height of 81.88 cm.

Table 1: Pre-cropping soil analysis

Composition	Value
pH (H2O)	6.64
Org. C (g/kg)	4.03
Total N. (g/kg)	0.56
Available P (mg/kg)	10.15
Exchangeable bases (cmol/kg)	
Ca	2.34
Mg	1.98
K	0.98
Na	1.09
Extractible Micronutrients (mg/kg)	
Zn (mg/kg)	6.42
Cu (mg/kg)	4.85
Mn (mg/kg)	7.42
Fe (mg/kg)	5.42
Pb (mg/kg)	2.48
Particle Size Analysis (g/kg)	
Sand	576.8
Silt	354.6
Clay	68.6
Textural class	Sandy loam

Table 2: Effect of pinching height on plant height (cm) of Roselle

Treatments	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP	20 WAP	22 WAP
No Pinching	49.28	54.63b	63.25a	66.25a	71.10a	76.78a	78.65a	81.88a

Pinching at 30cm	51.70	30.00e	30.00d	30.00d	30.00d	30.00c	30.00b	30.00b
Pinching at 40cm	55.40	40.00d	40.00c	40.00cd	40.00cd	40.00bc	40.00b	40.00b
Pinching at 50cm	58.20	50.00b	50.00b	50.00bc	50.00bc	50.00abc	50.00ab	50.00ab
Pinching at 60cm	65.80	60.00a	60.00a	60.00ab	60.00ab	60.00ab	60.00ab	60.00ab
	ns							

Means with same letter (s) in a Colum are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT) WAP= weeks after planting

Effects of pinching heights on number of leaves/plant of Roselle

There were no significant differences in the number of leaves among the treatments (Tables 3). At 8WAP, plants pinched at 50 cm height gave the highest number of 179 leaves which was similar with other treatments. A gradual rise in leaf production was observed in pinched plants till 12 WAP beyond which a fall was observed. However, in the control plants the number of leaves/plant reached its peak at 14 WAP. Plant pinched at 60 cm height gave the highest value of number of 162 leaves/plant which was not different significantly from other treatments at 22WAP, while plant pinched at 30 cm height gave the least value of 23 leaves/plant (Tables 3).

Table 3: Effect of pinching height on number of leaves/plant of Roselle

Treatments	**8 WAP**	**10 WAP**	**12 WAP**	**14 WAP**	**16 WAP**	**18 WAP**	**20 WAP**	**22 WAP**
No Pinching	177.25	215.00	186.25	194.75	137.00	97.75	84.75	51.00
Pinching at 30cm	155.50	168.75	146.50	121.75	56.25	41.50	36.25	22.75
Pinching at 40cm	176.25	185.25	167.75	163.75	151.00	161.50	160.75	112.60
Pinching at 50cm	178.75	200.50	202.00	200.25	152.00	122.75	94.75	63.25
Pinching at 60cm	167.50	195.75	193.25	226.25	203.25	204.75	188.25	162.00
	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns

ns: not significant

WAP: weeks after planting

Effect of pinching Height on number of branches/plant of Roselle

There were no significant differences in number of branches, except at 10WAP, 14WAP and 16WAP (Table 4). However, there was a gradual increase in the number of branches produced by the plants during the period of growth. Lowest number of 10 branches was from plants pinched at 30 cm at 10 WAP which was comparable with the control plants but was significantly lower than other treatments. The same trend was observed at 16 WAP where the least value of 11 branches was from plants pinched at 30 cm which was similar with the control plants and significantly lower than other treatments, highest value of 16 branches coming from plants pinched at 60 cm. Beyond this point, rate of branching reduced which made the treatments to produce similar results (Table 4).

Table 4: Effect of pinching height on number of branches/plant of Roselle

Treatments	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP	20 WAP	22 WAP
No Pinching	10.50b	9.75	11.00bc	11.25b	12.25	12.50	13.00
Pinching at 30cm	9.75b	10.00	10.25c	10.50b	11.25	12.00	15.00
Pinching at 40cm	12.75a	13.00	13.50bc	14.75a	15.75	16.00	17.50
Pinching at 50cm	13.25a	13.25	13.50ab	14.25a	15.00	15.75	16.50
Pinching at 60cm	15.25a	15.75	15.75a	15.75a	16.25	17.50	18.00
		Ns			Ns	Ns	Ns

ns: not significant

Means with same letter (s) in a Colum are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT) WAP: weeks after planting

Effects of pinching height on number of flowers, number of aborted calyx and number of harvested calyx/plant of Roselle

While the control and plant pinched at 30 cm produced similar results, the number of flowers was significantly lower than other treatments (Table 5). Plants pinched at 50 cm height gave the highest of 14 flowers which was different significantly from the unpinched plants and plant pinched at 30 cm height which gave the least of 2 flowers. Unpinched plants experienced more calyx abortion of 7 while the plants pinched at 30 cm produced the least number of aborted calyx of 0.25 which was comparable with one another. Except plants pinched at 30 cm, pinching tend to favour calyx production. Plant pinched at 60 cm height produced 42 calyces which is significantly higher than the control and plants pinched at 30 cm height which had the least value of 5 calyces

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Table 5: Effect of pinching height on plant height (cm) of Roselle

Treatments	Number of flowers/plant	Number of aborted calyx/plant	Number of harvested calyx / plant
No Pinching	3.00b	6.75	7.75b

Pinching at 30cm	2.25b	0.25	5.25b
Pinching at 40cm	12.25a	1.50	24.00a
Pinching at 50cm	13.50a	3.00	16.25a
Pinching at 60cm	10.75a	3.25	41.50a
		Ns	

ns: not significant

Means with same letter (s) in a Colum are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT) WAP: weeks after planting

Effect of pinching height on calyx yield (t/ha) of Roselle

The highest calyx yield of 6.22 t/ha was obtained from the plants pinched at 60 cm height which was significantly higher than other treatments except plants pinched at 40 cm height which gave the yield of 3.98 t/ha. Plants pinched at 30 cm height gave a lower yield than the unpinched plants that had a yield of 1.22 t/ha (Figure 1).

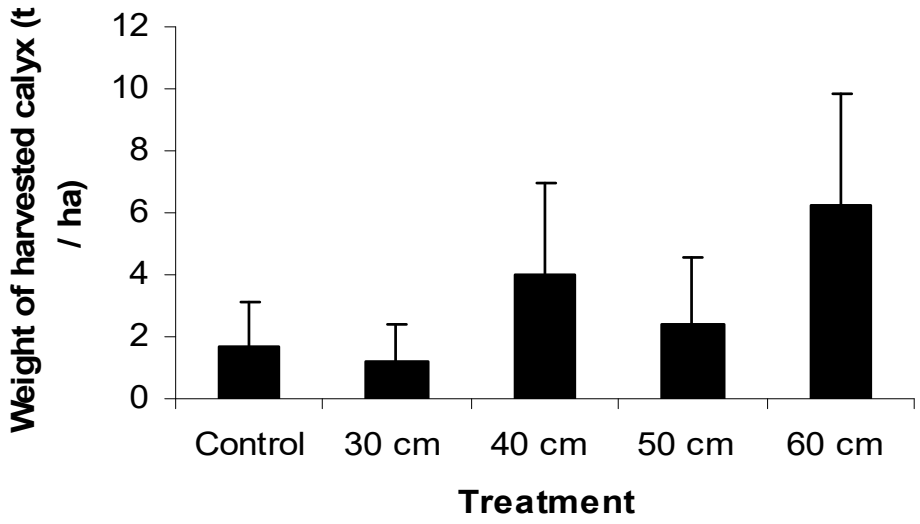

Fig. 1: Effect of pinching Height on calyx yield (t/ha) of Roselle

Discussion

Apical bud pinching of Roselle at various heights substantially affected the growth and productivity of the plant when compared with the unpinched plants (Bosch, 2004). As a result of apical dominance, plant height of Roselle was maintained in the pinched plants unlike in unpinched plants where plant height increased by 66% which is at variance with the report of Akinpelu *et al.,* (2011) where length of pruned cucumber vine increased significantly than the unpruned cucumber. However, the observed comparable results between the control plants and plants pinched at 50 cm and 60 cm suggest that pinching at these heights follow natural growth pattern of the plant under investigation. As plant transit from vegetative to reproductive stage, there was a reduction in the number of leaves produced to give way for flower production. There is no exception in Roselle as rate of leaf production reduced significantly as they approached flowering. This is more pronounced in pinched plant as substantial drop in leaf production, an

indicator of approaching flowering stage, was exhibited early at 12 WAP unlike in unpinched plants where such reduction was experienced late at 16 WAP which may be responsible for low calyx yield. Branching in Roselle was generally enhanced by pinching when compared with the unpinched plants as earlier observed by Sajjan *et al.,* (2002),.According to Bosch, (2004), pruning increased production properties of plants, promote branching and facilitate harvesting. Usually, removal of apical bud stimulates lateral growth which is evident in this work except pinching at 30 cm which produced similar result with the control plant, indicating that pinching at this height may not be appropriate if a high yield is desired in Roselle cultivation. Since the flowers are borne on the branches, pinching of Roselle above 30 cm may be desirable in improving the calyx yield of Roselle. Expectedly, except plant pinched at 30 cm, pinched plants produced more flowers than the unpinched plants as a result of enhanced growth, especially branching, in pinched plants (Disabato-Aust, (1988), Sajjan *et al.,* (2002). This trend was also observed in production of marketable calyx as harvested calyx was significantly higher in plants pinched at 60 cm, 50 cm and 40 cm than plant pinched at 30 cm and unpinched plants which produced similar results. Conversely, unpinched plants suffered more calyx abortion than the pinched pots which may be due to pruning effect which reduced crowdedness and thus maximizing available resources for growth (Humphries and Vermillion, 1994).

Conclusion

Pinching helps Roselle plants develop more branches, more leaves and more flowers. Roselle plants pinched at 60 cm height gave the highest weight of harvested calyx which is similar with plants pinched at 40 cm height. It is recommended to pinch Roselle plants at 60 cm height for economic yield but not below 40 cm height.

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