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Effect of Sowing Dates, Intra-Row Spacings and Nitrogen Fertilizers of the Productivity of Red Variant Roselle (*Hibiscus sabdarifa* L)

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ABSTRAK

Eksperimen-eksperimen ladang telah dikendalikan semasa musim hujan (Jun - Oktober) 1999 dan 2000, di ladang penyelidikan Universiti Abubakar Tafawa Balewa, Bauchi, Nigeria untuk mengkaji kesan-kesan amalan agronomi ke atas pertumbuhan dan hasil rozel. Tiga amalan agronomi(tarikh penyemaian, ruang antara baris dan tahap pembajaan nitrogen) pada tiga tahap setiap satu, digabungkan secara berfaktor untuk memberikan jumlah 37 kombinasi rawatan. Kesemuanya disusun dalam pola blok lengkap secara rawak dengan tiga replikasi. Kebanyakan keputusna adalah tinggi signifikan (P≤ 0.01). Tarikh penyemaian (Jun) memberikan min kelopak bunga yang paling tinggi (2035.15 kg/ha) dan hasil biji benih (2391.19 kg/ha) kedua-dua tahun. Ruang antara baris (80 cm) memberikan min kelopak bunga paling tinggi (1671.99 kg/ha) dan hasil biji benih (2067.36 kg/ha). Ini adalah bukti daripada eksperimen tersebut bahawa lebih awal tarikh penyemaian, lebih luas ruang antara baris dan lebih tinggi tahap pembajaan nitrogen, lebih tinggi pengeluaran "roselle variant red)". Sehubungan dengan itu, rozel disemai pada bulan Jun pada ruang 80 cm antara baris perlu dibaja 60 kg N/hektar untuk pengeluaran optimum di kawasan kajian.

ABSTRACT

Field experiments were conducted during the rainy seasons (June – October) of 1999 and 2000, at the research farm of Abubakar Tafawa Balewa University, Bauchi, Nigeria to study the effects of some agronomic practices on the growth and yield of roselle. Three agronomic practices (sowing dates, intra-row spacing and nitrogenous fertilizer levels) at three levels each, were factorially combined to give a total of 27 treatment combinations. These were laid out in a randomized complete block design with three replications. Most of the results obtained were highly significant (P≤0.01). Sowing dates (June) gave the highest mean calyx (2035.15 kg/ha) and seed (2391.19 kg/ha) yields in both years. Intra-row spacing (80 cm) gave the highest mean calyx (1651.11 kg/ha) and seed (2024.40 kg/ha) yields. Also, application of 60 kg N/ha gave the highest mean calyx (1671.99 kg/ha) and seed (2067.36 kg/ha) yields. It is evident from the results of this experiment that, the earlier the sowing of dates, the wider the intra-row spacing and the higher the nitrogenous fertilizer level, the higher the productivity of red variant roselle. Sequel to these facts, roselle sown in June at intra-row spacing of 80 cm should be applied with 60 kg N / ha for optimum productivity in the study area.

INTRODUCTION

The Roselle plant (*Hibiscus sabdariffa.* L) commonly called Jamaica sorrel, Indian sorrel, red sorrel, Roselle (English, German and French), "*Ishapa*" (Yoruba), "*Yakuwa*" (Hausa), Sour-sour and "*Aswe*" (Tiv), was first described in 1976. It belongs to the family *Malvaceae.* It is an annual, upright, branched plant reaching a height of between 1.0 – 2.5 m depending on the cultivar (Norman 1992). It requires a fertile, well-drained soil with a high organic matter content. The leaves, tender shoots, succulent calyces and immature fruits of the Roselle are chopped and added to sauces. The succulent calyces are also used for making syrups, jelly, jam, chutney and alcoholic drinks. It has been reported that the plant is also grown in other places for fibre and pulp from its stem and about 17% of edible oil

is extracted from the seed, which is also eaten by poultry (Tindall 1992).

High productive potential due to various traditional and or local agronomic practices have been noticed in Roselle production. However, local farmers who have never deemed it fit to ascertain the effect of these agronomic practices on the productivity of Roselle are undertaking most of these practices. Good agronomic practices such as spacing, time of sowing and fertilizer application have been affiliated to high and economic yield potentials (Onwueme 1990). However, the effects of these agronomic practices need to be monitored in order to ascertain the optimum range for high productivity. In Nigeria, the cultivation of this crop is assuming greater importance due to its demands for both domestic and industrial use (Adekpe and Adigun 2000). It is against this background, coupled with a lack of available information on the agronomy of the Roselle and current emphasis on demand driven research, that this research was initiated.

The aim of this research was to ascertain the effects of some agronomic practices on the productive potential of red variant Roselle. This would be achieved by determining the best sowing date, the most appropriate intra-row spacing and the optimum level of nitrogen fertilizer for Roselle growth and yield.

MATERIALS AND METHODS

The experiments were conducted during the 1999 and 2000 rainy seasons (June – October) at the Abubakar Tafawa Balewa University research farm. The site is located at 10^0 17', 9^0 49' and 609.3 m above sea level in the northern Guinea savanna ecological zone of Nigeria. The site received a total rainfall of 1,230.7 mm and 1,041.9 mm in 1999 and 2000 respectively. The average temperature observed during the experimental periods was 26.75°C in both years.

Soil analysis of the experimental site is presented in Table 1. Seeds of local red variant roselle cultivar were sown on already ploughed, harrowed and leveled land. Three factors which were factorially combined at three levels each are explicitly explained and coded as follows:

(a) Sowing Dates (SD): The sowing dates were: SD1 = Early (4^{th} week of June); SD2 = Mid (2^{nd} week of July); and SD3 = Late (1^{st} week of August).

(b) Intra-row Spacings (S): The inter-row spacing was kept constant at 60cm while the intra-row spacings were: S1 = (40 cm); S2 = (60 cm); and S3 = (80 cm).

(c) Nitrogen fertilizer levels (N): This was obtained by spot application of urea fertilizer as follows: N1 = (0 kg/ha); N2 = (30 kg/ha); and N3 = (60 kg/ha).

TABLE 1
Physico-chemical properties of soil in the experimental site at 0-15cm depth

Properties	1999	2000
pH (1:1) soil and water	6.24	6.09
Organic Carbon (g/kg)	6.10	5.89
Total Nitrogen "	1.20	1.07
C / N Ratio	5.10	6.78
Avail. P (ug/g)	7.80	6.88
C.E.C (Cmol / kg)	5.00	5.02
Exchangeable bases (Cmol (+)/ kg)		
Ca	2.60	2.68
Mg	0.84	0.81
K	0.23	0.56
Na	0.11	0.15
Base saturation	75.60	83.69
Particle size Distribution (%)		
Sand	75.80	3.90
Silt	9.20	10.04
Clay	15.00	16.06
Texture	Sandy loam	Sandy loam

These gave a total of 27 treatment combinations and were laid out in a randomized complete block design with three replications. The total number of plots was 81 and each plot size was 5 m x 4 m = 20 m^2 which gave a total cultivable or experimental area of 1620 m^2 (0.162 ha).

All the standard agronomic practices (land preparation, weeding, pest and disease control) were carried out uniformly in both years, and growth and yield data collected were subjected to an analysis of variance. Duncan's Multiple Range Test was used to separate the means (Snedecor and Cochran 1967).

RESULTS AND DISCUSSION

Effects of Sowing Dates

Effects of sowing dates on the growth of roselle are presented in *Fig. 1*, while Table 2 presents the effect of sowing dates on the yield of roselle. From the results obtained in *Fig. 1*, an early sowing date (June) gave the highest plant height of 107.00 cm; 173.04 cm, canopy diameter of 89.96 cm; 98.56 cm, and number of branches per plant of 28.56; 30.63 in 1999 ; 2000 respectively at harvest 12 weeks after sowing (WAS). It was also observed that there was a direct relationship between growth and yield parameter data, hence, the same sowing date (June) = SD1 gave the highest values for yield parameters such as number of calyces per plant of 59.89 and 61.04, calyx weight of 1930.30 and 2140.00 kg/ha and seed weight of 2370.75 and 2411.62 kg/ha in 1999 and 2000 respectively (Table 2). On the other hand, the last sowing date (August) gave the lowest values of 71.74 cm; 72.77 cm, 71.33 cm; 72.74 cm and 14.41; 14.65 in the year 1999; 2000 for plant height, canopy diameter

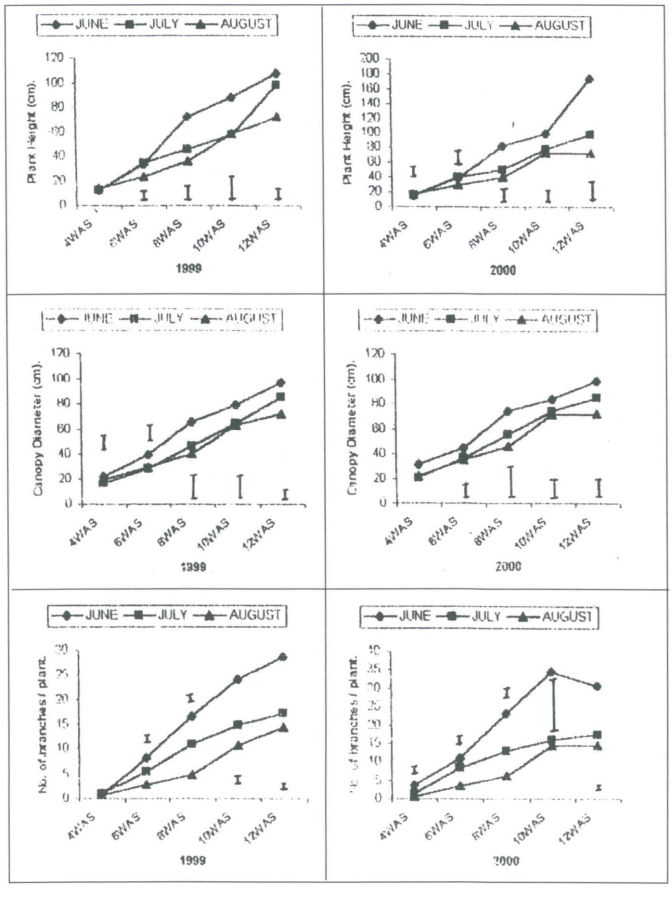

Fig. 1: Effects of sowing dates on plant height, canopy diameter and the number of branches per plant in 1999 and 2000

TABLE 2
Effects of sowing dates, intra-row spacings and nitrogenous fertilizers on some yield components in roselle

	No. of calyces / plant		Calyx weight (kg/ha)		Seed weight (kg/ha)	
	1999	2000	1999	2000	1999	2000
Sowing Dates						
June	59.89a	61.04a	1930.30a	2140.00a	2370.75a	2411.62a
July	34.37b	37.42b	1503.44b	1610.48b	1850.03b	2041.04b
August	29.85c	27.00c	1290.37c	1290.37c	1590.14c	1702.08c
Intra-row spacings						
40 cm	40.04b	42.46c	1501.96c	1590.41b	1852.70c	1901.25c
60 "	45.89a	45.94b	1580.85b	1661.45a	1950.44b	1958.01b
80 "	38.19b	52.06a	1631.30a	1670.92a	2003.79a	2045.00a
Nitrogenous fertilizer levels						
0 kg N/ha	32.63c	37.03c	1510.26c	1551.06c	1861.00c	1904.72c
30 "	37.26b	42.06b	1560.30b	1602.03b	1920.24b	1978.62b
60 "	54.22a	59.02a	1652.56a	1691.41a	2032.68a	2102.04a

Means not followed by same letter in the same sub-colon are significantly different (P≤0.01).

and number of branches per plant respectively. In fact, the earlier the sowing date, the higher the productivity of roselle. This agrees with the work of Lakshmi *et al.* (1995) and Lamido (1999) who recommended June in India and Bagauda Kano, Nigeria respectively.

The reason for this trend of results is probably due to the fact that the earlier the sowing dates, the longer the growing period and total rainfall received during the growing periods. Adequate supply of moisture would eventually boost the growth rate as well as timely maturity hence a higher productivity of the roselle.

Effect of Intra-row Spacings

Plant height, canopy diameter and the number of branches per plant were highly significant (P≤0.01) as shown in *Fig. 2.* The effects of intra-row spacings on the yield of roselle are presented in Table 2. From the results, intra-spacing at 80 cm gave the highest values for plant height (94.48 cm; 119.44), canopy diameter (83.30 cm; 86.63) and number of branches per plant (22.00; 22.56) in (1999; 2000) respectively at harvest (12 WAS). It was also observed that intra-spacing at 80 cm gave the highest values for calyx weight (1631.30; 1670.92), seed weight (2003.79; 2045.00) in (1999; 2000) respectively. This is with the exception of a number of calyces / plant, where the same intra-spacing gave the lowest value of 38.19 in 1999. This agreed with the findings of Sermsri *et al.* (1987) and Bala *et al.* (1999) who recommended highest intra-row spacing of 75 cm. It therefore means that, a plant may possess high number of calyces with lighter weights and vice versa. This may be due to the fact that, the plants may have been producing increased number of calyces, at the expense of size and/or weight of the calyces borne on the plant.

It is evident that, the wider the intra-row spacing from (40 cm - 80 cm), the higher the calyx weight from (1501.96 –1631.30; 1590.41 – 1670.92 kg/ha) and seed weight from (1852.70 – 2003.79; 1901.25 – 2045.00 kg/ha) in the years (1999; 2000) respectively. This can be attributed to the fact that, with wider spacing, there would be greater light interception as well as nutrient availability. There would also be higher number of branches and/or leaves as well as a wider canopy diameter, and hence, better photosynthetic activities.

Effects of Nitrogenous Fertilizers

Fig. 3 shows the effects of nitrogenous fertilizer levels on the growth, while the effects of nitrogenous fertilizers on yield are presented in Table 2. In summary, 60 kg N/ha gave the highest productivity values of calyx weight (1652.56; 1691.41 kg/ha) and seed weight (2032.68; 2102.04 kg/ha) while 0 kg N/ha gave the lowest productivity values of (1510.26; 1551.06 kg/ha) and seed weight (1861.00; 1904.72 kg/ha) in the years (1999; 2000) respectively.

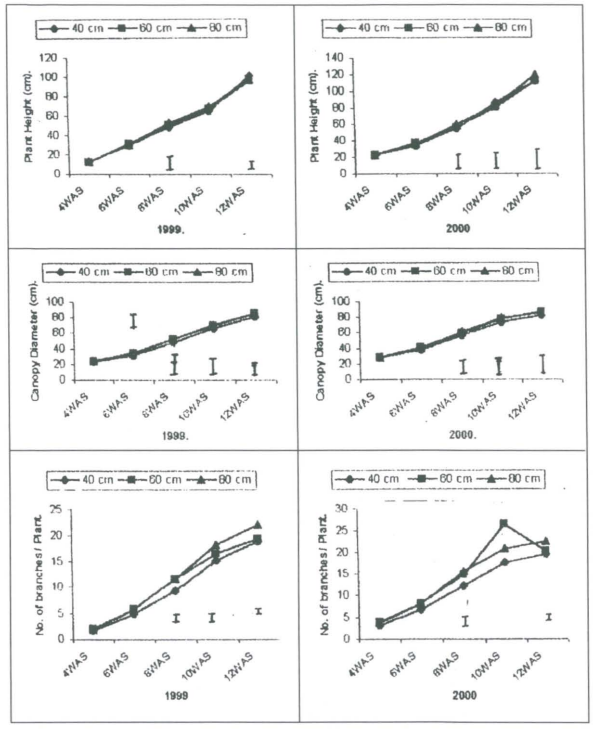

Fig. 2: Effects of intra-row spacings on plant height, canopy diameter and the number of branches per plant in 1999 and 2000

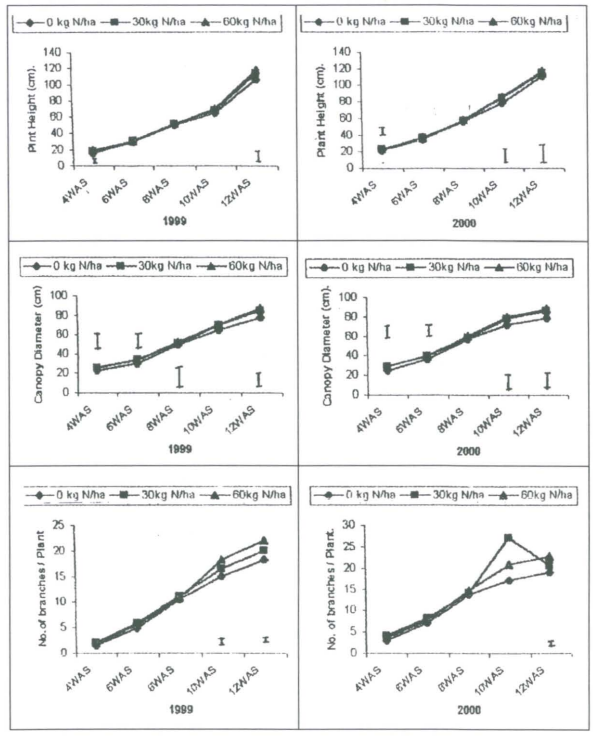

Fig. 3: Effects of nitrogenous fertilizer on plant height, canopy diameter and the number of branches per plant in 1999 and 2000

TABLE 3
Effects of interactions between factors on some yield components in roselle (mean of 2 years)

Interactions	No. of calyces / plant	Calyx weight (kg/ha)	Seed weight (kg/ha)
	(a): **Sowing dates + Spacings**		
SD1S1	57.00a	1860.44c	2290.37c
SD1S2	63.11a	1920.78b	2370.12b
SD1S3	59.56a	2000.67a	2460.77a
SD2S1	27.11d	1410.89f	1740.52f
SD2S2	45.33b	1530.33e	1880.69e
SD2S3	30.00cd	1560.11d	1910.88d
SD3S1	36.00c	1240.56i	1530.20i
SD3S2	29.22cd	1300.44h	1600.50h
SD3S3	24.33d	1330.11g	1630.73g
	b): **Sowing dates + Nitrogenous fertilizer**		
SD1N1	41.33c	1850.33c	2280.01c
SD1N2	49.11b	1910.44b	2350.43b
SD1N3	89.22a	2030.11a	2490.83a
SD2N1	30.44d	1430.67f	1760.76f
SD2N2	34.22cd	1480.67e	1820.86e
SD2N3	38.44c	1590.00d	1950.48d
SD3N1	26.11d	1240.78i	1530.25i
SD3N2	28.44d	1280.78h	1580.44h
SD3N3	35.00cd	1340.56g	1650.74g
	(c): **Spacings + Nitrogenous fertilizer**		
S1N1	36.22cd	1440.33h	1770.48i
S1N2	37.78c	1480.56g	1820.68e
S1N3	46.11bc	1600.00d	1960.94d
S2N1	32.22cd	1520.33f	1870.42g
S2N2	40.22c	1580.33e	1940.80e
S2N3	65.22a	1650.89b	2040.10b
S3N1	29.44d	1570.11e	1930.11f
S3N2	33.78cd	1620.00c	1990.26c
S3N3	51.33b	1700.78a	2100.01a

Means not followed by the same letter in the same sub-colon are significantly different ($P \leq 0.01$).
SD = Sowing Date, S = Intra-row spacing and N = Nitrogen level.

The results indicated that better growth would be achieved with nitrogenous fertilizer application, and hence increased yield (productivity). This could be the reason for the high productivity obtained from the highest nitrogen fertilizer level (60 kg N/ha). The results agree with the work of Fawusi (1983) as reported by Norman (1992) who recommended the same range of fertilizer for both corchorus and roselle. It was also discovered in this experiment that the application of nitrogenous fertilizers boosted the growth rate in terms of plant height, canopy diameter and number of branches per plant *(Fig. 3)*. This eventually enabled the plants to escape the shortage in rainfall which normally set in towards the end of the growing season, especially during the latest sowing date (August).

Effect of Interaction Between Factors

Interaction between sowing dates and spacing; sowing dates and nitrogen fertilizer levels as well as spacing and nitrogen fertilizer levels on the yield of roselle are presented in Table 3. Table 3 (a) shows that roselle sown in June and intra-spaced at 80 cm (SD1S3) gave the highest significantly different ($P \leq 0.01$) number of calyces / plant of 59.56, calyx weight 2000.67 kg/ha and seed weight of 2460.77 kg/ha. Table 3 (b) indicated that Roselle sown in June and fertilized with 60 kg N/ha (SD1N3) gave the highest significantly different ($P \leq 0.01$) values for all the yield components. The results also indicated that intra-spacing at 80 cm with 60 kg N/ha of fertilizer applied (S3N3) gave the highest significantly different ($P \leq 0.01$) calyx weight of 1700.78 kg/ha and seed weight of 2100.01 kg/ha. However, it was also observed that roselle intra-spaced at 60 cm with 60 kg N/ha (S2N3) gave the highest number of calyces/plant of 65.22 (Table 3(c)). This formed the basis for treatment combination SD1S3N3 to achieve the highest calyx weight (2120.33 kg/ha) and seed weight (2610.17 kg/ha), while on the other hand, treat-

TABLE 4
Interactions effects between sowing dates, intra-row spacings and nitrogen fertilizers on some yield components of Roselle (mean of 2 years)

Interactions	No. of calyces/plant	Calyx weight (kg/ha)	Seed weight (kg/ha)
SD1S1N1	47.33de	1770.00f	2170.71f
SD1S1N2	52.67d	1850.67e	2280.37e
SD1S1N3	71.00c	1960.67c	2420.04c
SD1S2N1	34.00e	1850.33e	2280.10e
SD1S2N2	48.67de	1920.67d	2360.98d
SD1S2N3	106.67a	2000.33b	2460.27b
SD1S3N1	42.67e	1930.67d	2380.21d
SD1S3N2	46.00de	1960.00c	2400.94c
SD1S3N3	90.00b	2120.33a	2610.17a
SD2S1N1	24.00f	1360.00m	1670.28lm
SD2S1N2	27.00ef	1360.67m	1670.96l
SD2S1N3	30.33ef	1530.00j	1880.33i
SD2S2N1	40.00e	1450.67l	1790.44k
SD2S2N2	45.67de	1530.33j	1880.60i
SD2S2N3	50.33de	1610.00h	1980.03g
SD2S3N1	27.33ef	1490.33k	1830.54j
SD2S3N2	30.00ef	1560.00i	1920.02h
SD2S3N3	34.67e	1630.00g	2000.08g
SD3S1N1	37.33e	1200.00s	1470.46q
SD3S1N2	33.67e	1230.33r	1510.70p
SD3S1N3	37.00e	1300.33o	1600.45n
SD3S2N1	22.67f	1260.00q	1540.71n
SD3S2N2	26.33f	1290.00op	1580.81n
SD3S2N3	38.67e	1360.33m	1670.98l
SD3S3N1	18.33f	1280.33p	1570.58n
SD3S3N2	25.33f	1340.00n	1640.82m
SD3S3N3	29.33ef	1370.00m	1680.78

Means not followed by the same letter in same colon are significantly different (P≤0.01).
SD = Sowing date, S = Spacing and N = Nitrogen level.

ment combination SD3S1N1 had the lowest calyx weight (1200.00 kg/ha) and seed weight (1470.46 kg/ha) as deduced from Table 3 and shown in Table 4.

CONCLUSION

For optimum productivity, it can be recommended that roselle should be sown in June, or as early as rainfall is established during the growing season, in the northern guinea savanna ecological zone of Nigeria. There should be enough space within the rows or ridges, of about 80 cm. Also, nitrogenous fertilizer at 60 kg N/ha can be used to boost initial growth in roselle production. This has been found to increase productivity in terms of yield. However, further research into wider intra-row spacings as well as higher nitrogenous fertilizer levels are suggested for better growth as well as increased yield in roselle production.

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