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# GROWTH AND CALYX YIELD OF ROSELLE (*HIBISCUS SABDARIFFA* L.) AS AFFECTED BY POULTRY MANURE AND NITROGEN FERTILIZER RATES IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA

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## ABSTRACT

Field experiments were conducted at the research farm of the College of Agriculture Lafia in the Southern guinea savanna agro ecological zone of Nigeria ($08^0$ 30/N and $08^0$ 30/E, 18m above sea level) during the rainy seasons 2006 and 2007 to study the effects of nitrogen (0, 2.5 and 5.0 kg $ha^{-1}$) and poultry manure rates (0, 2.5 and 5.0t $ha^{-1}$) on the growth and calyx yield of roselle (*Hibiscus sabdariffa* L.). The nine treatment combinations were laid out in a randomized complete block design with three replications. Plant height, number of leaves per plant, number of branches per plant and total dry matter per plant were all significantly increased by both nitrogen and poultry manure application up to 120 kg N $ha^{-1}$ and 5 t $ha^{-1}$ respectively. Number of days to 50 percent flowering was neither affected by nitrogen nor does poultry manure application. Significant increase in the number of calyx per plant, calyx yield per plant and dry calyx yield per hectare were obtained by the application of 60 kg N $ha^{-1}$ and 2.5 t $ha^{-1}$ of nitrogen and poultry manure respectively. 60 kg N $ha^{-1}$ and 2.5 t $ha^{-1}$ therefore seemed to be the ideal nitrogen and poultry manure rates for the yield and yield attributes of roselle while 120kg N/ha and 5.0t/ha for vegetative growth in the Southern Guinea Savanna of Nigeria.

**Keywords**: Field, dry calyx, dry matter, plant height, flowering.

## INTRODUCTION

Roselle (*Hibiscus sabdariffa* L.) belongs to the *Malvacecae* family, and is an annual or biennial plant cultivated for its stem fibres, edible calyces, leaves and seeds (Rao, 1996). The crop is used in a variety of ways for home consumption, medicinal and industrial uses. Roselle has been reported to respond positively to inorganic fertilizers (Babatunde *et al*., 2002 and Rhoden *et al*., 1993). When roselle is grown for its calyces, only half of the recommended amount of fertilizer for vegetable is applied because excessive nitrogen encourages vegetative growth and reduces fruit production. Small and Rhoden (1991) obtained increased dry matter production with increased applications of ammonium nitrate.

The use of organic manure and other forms of organic matter can also change plant - available micronutrients by changing both physical and biological characteristics of the soil. In many circumstances, these changes improve soil physical structure and water holding capacity, resulting in more extensive root development and chemical soil macro – flora and enhanced soil micro flora and fauna activities all of which can affect available micronutrients level in soil to plant (Stevenson, 1991, 1994).

Considering the high cost of inorganic fertilizers, in Nigeria coupled with their non availability at the right time, adulteration associated with them and other setbacks such as decreased soil productivity leading to nutrient imbalance, there is the need for integrated use of both organic and inorganic fertilizers in a balanced proportion for sustainable crop production to meet the demand of the World's teaming population. However, there is a dearth of information on the combined effect of inorganic fertilizer and organic manure on the growth and calyx yield of roselle. This study was aimed at evaluating the effect of poultry manure and nitrogen fertilizer rates on the growth yield and yield attributes of Roselle.

## MATERIALS AND METHODS

Field experiments were conducted at the research farm of College of Agriculture Lafia in the Southern guinea savanna zone of Nigeria ($08^0$ 30'N and $08^0$ 30/E 18m above sea level on a sandy soil (0.02% total) during the rainy seasons of 2006 and 2007 to assess the growth and yield of Roselle under poultry manure and nitrogen fertilizer rates.

The experiment consisted of three levels of nitrogen in the form of urea (0, 60 and 120 kg N $ha^{-1}$) and three levels of poultry manure (0, 2.5 and 5.0 t $ha^{-1}$). The nine treatment

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combinations were laid out in a randomized complete block design (RCBD) replicated three times. Soil samples were taken to a depth of 30cm and analyzed for physico-chemical properties before fertilizer application.

The crop variety used was Samaru -1882 released by the Institute for Agricultural Research Samaru. It is a plant with a medium height that branches profusely. It matures between four to five months. The stem and petiole are dark-red in color and produces high quality calyces.

Four to five seeds of Roselle were sown on plots consisting of six ridges (75cm apart and 6cm long) at a spacing of 60cm apart (intra-row spacing). Thinning to 2 plants per stand was done after crop establishment.

Poultry manure was incorporated into the soil at the rate of 2.5 and 5.0t/ha before planting while half dose of the nitrogen rates were applied at 3 weeks after sowing and the second dose at 7 weeks after sowing (WAS). The experimental field was kept weed- free at 3, 7, and 12 WAS by manual hoe weeding.

Growth parameters like plant height, number of leaves per plant, number of branches per plant and total dry matter per plant, were collected from five randomly selected tagged plants in each plot and the mean recorded. Yield data per plant were collected from ten randomly selected tagged plants in each plot and the mean recorded. The calyx yield /ha was collected from the four inner rows (net plot) and the value obtained, was converted to per hectare basis.

The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967) and significant differences among the treatment means were evaluated using Duncan's Multiple Range Test as described by Duncan (1955).

## RESULTS

Table 1 and 2 shows the soil nutrients status and meteorological data, respectively of the experimental sites in 2006 and 2007.

The soils were sandy, low in both nitrogen and organic carbon. Rainfall was higher in 2006 than 2007 and distributed between March and October. The treatment effects on the parameters measured are presented below:

### Growth Parameters

Table 3 shows the effect of nitrogen and poultry manure rates on the plant height, number of leaves per plant, number of branches per plant and total dry matter per plant of Roselle at 12 Weeks after Sowing (WAS) in both years.

Table 1. Physical and Chemical Properties of the Soils of the Experimental Sites during 2006 and 2007 Rainy Seasons at Lafia.

| Soil Composition | Soil depth (cm) | |
|---|---|---|
| | 2006 | 2007 |
| | 0-30cm | 0-30cm |
| Physical Properties (%) | | |
| Sand | 83 | 80 |
| Silt | 6 | 10 |
| Clay | 10 | 10 |
| Textual Class | Sandy | Sandy |
| Chemical Properties | | |
| PH ($H_2O$) | 6.40 | 6.80 |
| PH $CaCl_2$) | 5.00 | 5.00 |
| % Organic Carbon | 0.32 | 0.30 |
| Total Nitrogen | 0.02 | 0.02 |
| Available Phosphorus | 12.25 | 10.25 |
| Exchangeable bases (C mol $Kg^{-1}$) | | |
| Ca | 3.20 | 3.0 |
| Mg | 0.86 | 0.83 |
| K | 1.39 | 1.35 |
| Na | 0.05 | 0.05 |
| CEC | 6.20 | 6.10 |

Table 2. Rainfall Distribution in Lafia during the 2006 and 2007 rainy seasons.

| Months | Rainfall (mm) | |
|---|---|---|
| | 2006 | 2007 |
| January | - | - |
| February | - | - |
| March | 39.7 | 20.5 |
| April | 1.9 | 88.7 |
| May | 224.7 | 164.4 |
| June | 166.3 | 255.3 |
| July | 304.3 | 244.3 |
| August | 250.9 | 232.9 |
| September | 248.0 | 240.0 |
| October | 84.1 | 33.5 |
| November | - | - |
| December | - | - |
| Total | 1319.9 | 1279.6 |

Source: Synoptic weather station College of Agriculture Lafia

All the growth parameters measured (plant height, number of leaves per plant, number of branches per plant and total dry matter per plant ) were significantly ($p > 0.5$) increased by Nitrogen application up to 120 kg $ha^{-1}$ in both years compared with plots without nitrogen (i.e zero nitrogen ).

Every increase in the rate of Poultry manure application, significantly ($p > 0.5$) increased plant height, number of

leaves per plant, number of branches per plant and total dry matter per plant in both years.

**Yield Parameters**

The effect of nitrogen and poultry manure rates on the number of days to 50 percent flowering, numbers of calyx per plant, Calyx yield per plant and calyx yield per hectare are shown on table 4.

Neither nitrogen nor manure application had significant effect on the number of days to 50% flowering. Application of 60 kg N $ha^{-1}$ gave significantly ($p > 0.5$) higher number of calyx per plant, calyx yield per plant, and calyx yield per hectare compared with plots without nitrogen in both years. Increasing the rate of nitrogen application from 60 kg N $ha^{-1}$ to 120 kg N $ha^{-1}$ gave no further significant increase in the yield parameters measured.

Application of 2.5 t $ha^{-1}$ of manure gave significantly higher number of calyx per plant, calyx yield per plant and calyx yield per hectare in both years compared with plots without manure. Increasing the rate of manure application from 2.5 to 5.0 t $ha^{-1}$ produced no further increase in the yield and yield parameters measured.

## DISCUSSION

The growth, yield and yield attributes of roselle was generally good probably because the rainfall amount and distribution were sufficient to sustain the crop in the years under consideration. Roselle was reported to require about 450-500mm of rainfall well distributed over 90-120 days during the growing season (Morton, 1989).

The significant increased in plant height, number of leaves per plant, number of branches per plant and total

Table 3. Effects of Nitrogen and Poultry Manure rates on Plant height, number of leaves per plant, number of branches per plant and total dry matter per plant of Roselle during the 2006 and 2007 rainy seasons.

| Treatment | Plant Height (cm) | | Number of Leaves | | Number of Branches | | Total Dry matters (g) | |
|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| Nitrogen (Kg $ha^{-1}$) | | | | | | | | |
| 0 | 72.77c | 70.70c | 203.07c | 197.98c | 29.07c | 28.73c | 16.73c | 14.86c |
| 60 | 89.90b | 88.47b | 225.57b | 221.82b | 41.89b | 40.18b | 19.35b | 18.19b |
| 120 | 103.30a | 101.32a | 254.84a | 251.76a | 52.47a | 50.76a | 28.08a | 26.08a |
| SE± | 2.94 | 3.45 | 8.62 | 8.99 | 1.18 | 1.58 | 0.75 | 1.00 |
| Poultry Manure (t $ha^{-1}$) | | | | | | | | |
| 0 | 73.38c | 71.83c | 187.04c | 182.22c | 33.64c | 31.87c | 15.2c | 14.12c |
| 2.5 | 91.11b | 87.55b | 233.90b | 229.51b | 39.75b | 38.09b | 19.64b | 19.60b |
| 5.0 | 101.47a | 101.12a | 262.55a | 259.02a | 50.04a | 49.71a | 28.60a | 25.41a |
| SE | 2.94 | 3.45 | 8.62 | 8.99 | 1.18 | 1.58 | 0.75 | 1.00 |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS |

NS = Not Significant. All means followed by different letter(s) within the same treatment group and column are statistically different at 5% level of significance

Table 4. Effect of Nitrogen and poultry manure rates on the number of days to 50% flowering, number of calyx per plant, calyx yield per plant and calyx yield per hectare of Roselle during the 2006 and 2007 rainy seasons.

| Treatment | Days of 50% flowering | | Number of calyx plant $^{-1}$ | | Calyx yield plant$^{-1}$ | | Calyx yield $ha^{-1}$ (Kg) | |
|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| Nitrogen (Kg $ha^{-1}$) | | | | | | | | |
| 0 | 83.78 | 81.89 | 63.36c | 60.69c | 36.73c | 34.22c | 414.5c | 362.42c |
| 60 | 84.00 | 82.67 | 79.02a | 78.38a | 53.99a | 52.20a | 618.38a | 605.43a |
| 120 | 81.89 | 82.67 | 77.69ab | 76.96ab | 53.27ab | 50.33ab | 600.50ab | 532.84ab |
| SE± | 1.69 | 1.19 | 3.98 | 3.10 | 2.48 | 2.74 | 33.74 | 30.95 |
| Poultry Manure (t $ha^{-1}$) | | | | | | | | |
| 0 | 84.00 | 81.55 | 64.56c | 64.56c | 35.40c | 35.40c | 374.16c | 325.18c |
| 2.5 | 83.22 | 82.78 | 80.78a | 77.38a | 58.12a | 50.88a | 622.03a | 579.51a |
| 5.0 | 82.44 | 82.89 | 74.73ab | 74.09ab | 50.47ab | 50.47ab | 637.03ab | 560.00ab |
| SE | 1.69 | 1.19 | 3.98 | 3.10 | 2.48 | 2.74 | 33.74 | 30.95 |
| Interaction | NS | NS | NS | NS | NS | NS | NS | NS |

NS = Not Significant. All means followed by the same letter(s) within the same treatment group and column are not statistically different at 5% level of significance

dry matter per plant obtained by the application of Nitrogen and manure up to 120 kg N $ha^{-1}$ and 5.0 t $ha^{-1}$ respectively, could be due to the fact that both nitrogen and manure are essential nutrients for plant growth and development (Brady, 1984). The number of days to 50 percent flowering was neither significantly enhanced by nitrogen nor poultry manure application probably due to the fact that flowering in Roselle is controlled by day length and variety but not fertilizer application. The significantly higher number of calyx per plant, calyx yield per plant and calyx yield per hectare recorded by the application of moderate rates of nitrogen and poultry manure (i.e. 60 kg N $ha^{-1}$ and 2.5 t $ha^{-1}$ respectively) and not the highest rate of nitrogen and manure (i.e. 120 kg N $ha^{-1}$ and 5.0 t $ha^{-1}$) could be due to the fact that excessive nitrogen and manure reduce fruit number and yield but enhances plant growth as earlier reported by (Aliyu *et al*., 1996). The higher calyx yield (kg per hectare) recorded in 2006 compared to 2007 could be due to the higher amount of rainfall and even distribution recorded in 2006 compared to 2007

## CONCLUSION

From the results obtained, it can be concluded that for vegetative growth of Roselle, application of 120 kg $ha^{-1}$ of nitrogen and 5.0 t $ha^{-1}$. of poultry manure seems to be the ideal nitrogen and poultry manure rates in this agro-ecology ; while for reproductive yield, 60 kg $ha^{-1}$ of nitrogen and 2.5 t $ha^{-1}$ of poultry manure appears to be the ideal nitrogen and poultry manure rates respectively.

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