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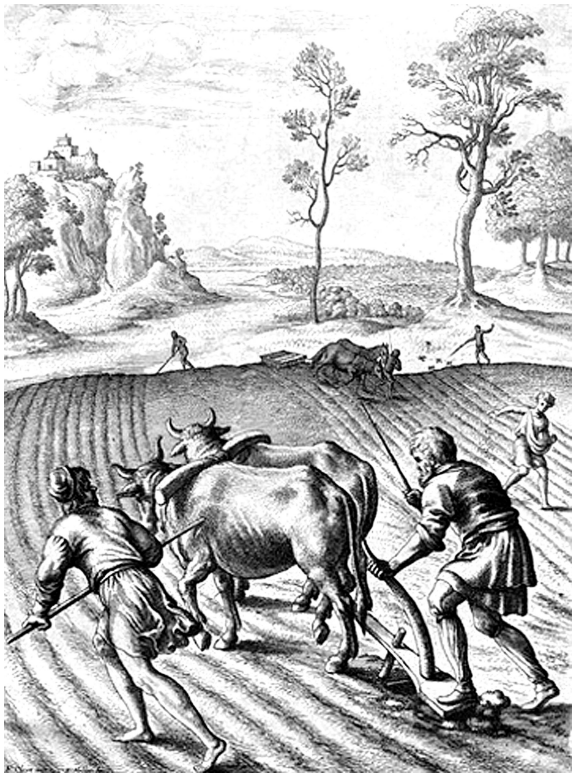

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Comparative Effects of Two Nitrogen Sources on the Growth and Yield of Roselle (*Hibiscus sabdariffa*) in the Rainforest Region: A Case Study of Benin-City, Edo State, Nigeria

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Abstract: A study on the effect of two Nitrogen sources (NPK and Urea) on the growth and yield of two Roselle varieties was undertaken at the Faculty of Agriculture, University of Benin, Edo State, Nigeria. The treatments consisted of 2 varieties (SD, 2003 and DR, 2003) NPK 15:15:15: and Urea fertilizers at 0, 100, 150 and 200 kg h^{-1}, respectively). Factorial combinations of the treatments were laid out in a randomized complete block design, with three replications. The results showed that there were no differences in the fertilizer types in some vegetative characters at 2, 4, 6 and 8 Weeks After Transplanting (WAT). Significant differences were however observed in plant height between the varieties at 10 WAT and for fruit number among the varieties at 10, 11 and 12 WAT, respectively. NPK 15:15:15: Fertilizer was observed to be better than urea while DR 2003 variety did well and so should be recommended for the rainforest zone of Nigeria as it performed better in all the parameters measured.

Key words: Nitrogen, roselle, varieties, fertilizers, NPK, urea, fertility levels

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L. Moench) is an indigenous, underutilized vegetable presently being introduced as a potential crop for the rainforest zone of Southern Nigeria. Prior to this, Giginyu *et al.* (1999) confirmed that it's cultivation has been predominantly in the North East and North West part of Nigeria.

Roselle (*H. sabdarifa* L. Moench) belongs to the family of *Malvaceae* and according to Rehm and Espig (1994), the pattern of growth is that of an erect, bushy, herbaceous annual shrub which can grow up to a height of between 2.4 and 3.0 m. It has red or green main stem depending on landraces and distinct branches. Medlinger *et al.* (1992) revealed that it is probably native to Central or West Africa and it is a short day annual, while the flower buds are actually seed pods of roselle, enclosed in their fleshy calyces. Ogbe *et al.* (1998) described the red pods as the fruits and calyces being fused together and difficult to distinguish from one another.

Aliyu and Tanimu (1996) discovered that in a traditional set up, roselle is cultivated for its leaves, stem, seeds and calyx. They also found out the calyx called Zobo in Hausa dialet, is nationally used as a refreshing drink and medicinal preparation. It is presently receiving industrial attention in the country and Internationally. As documented by Small and Hoden (1991) found out that in many parts of the world, the leaves are consumed as a green vegetable and the stem as possible source of pulp for the paper industry.

Nutritionally, the calyces as reported by FAO (2004) have significant quantities of Vitamins A, C, phosphorous, iron and calcium but low in protein. The young leaves are also known to be rich in digestible protein and that the oil content of roselle seeds may vary from 25 to 30% and that it has similar properties with cotton seed oil.

Ginginyu *et al.* (1999) observed that fertilizer recommendation for roselle in Nigeria is lacking and farmers have attempted the fertilizer rate for Kenaf (*Hibiscus cannabinus)* a crop of the same family and also a fibre that is biochemically and botanically different.

According to Fagbayide (1997), the overall yield and nutritional quality of the crop should be taken into consideration, in any fertilizer programme. Unfortunately, little has been reported on the effects of mineral fertilizers on the yield and quality of the economic portion of roselle especially in the rainforest zone and in particular South Western Nigeria.

Consequently, Ginginyu *et al.* (1999) believed that the application of nitrogen sources to roselle in the rainforest zone of Nigeria is almost a precondition for optimum growth and yield of roselle. The objectives of

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this study were to determine the fertilizer rate and the best nitrogen source for roselle and its effect on growth, yield and yield components as well as a suitable variety for the rainforest area of Nigeria.

MATERIALS AND METHODS

The field trial for 26 weeks from March to October 2004, was conducted at the Teaching and Research farm of the Faculty of Agriculture, University of Benin, Benin City (7°38'N, 5°52'E.) Nigeria. The seeds were first raised in seed trays filled with a 2:1:1 ratio of top soil, well cured poultry manure and river sand which were kept under shade in the screen house. The seedlings were transplanted to the field after four weeks of planting.

The experimental treatments consisted of two varieties: SD 2003 and DR 2003; two Nitrogen fertilizers: Urea and NPK 15:15:15 at 0, 100, 150 and 200 kg ha^{-1}, respectively. The experiment was a 2×4×3 factorial laid out in a randomized complete block design with 3 replications. Soil samples were collected of various portions of the field site (23×10 m) within a 0-15 cm in depth and were analyzed for their physiochemical properties and the result is shown in Appendix I.

The seedlings were transplanted at four weeks old and spaced at 0.75x0.75 m on each bed. The beds were weeded at 2, 6 and 10 Weeks After Transplanting (WAT). Three weeks after transplanting, the treatments were allocated randomly and at 15 cm away from the plants at 0, 100, 150 and 200 kg ha^{-1}, respectively. *Podagrica* beetles attacked the leaves often and these were controlled by use of Nuvacron 40EC at 3 in 500 mL of water.

The sampling of parameters of plant height, number of leaves and leaf area, stem diameter and branch numbers were sampled forth nightly as Roselle grows tall all the time. Number of fruits on the stems were counted at harvest at the 10th, 11th and 12 WAT and were recorded. Soon after harvest, at the end of the 12th week, the fresh and dry weights were carried out by means of destructive sampling using an oven for a period of 72 h at 80°C until constant weight was obtained (Anonymous, 1993).

RESULTS AND DISCUSSION

The favourable responses recorded as a result of fertilizer application is not surprising because as reported by Ehigiator (1998), fertilizer increases the soil fertility so that the yield of crops are no longer dependent on limited, available soil nutrients. Nitrogen plays an important role in the meristematic and physiological activities in plants while phosphorous promote root growth and so enhances nutrient uptake.

Plant height: The insignificant differences in plant height for some weeks (Table 1) has also been confirmed by Rhoden *et al.* (1993) in their investigation, that the increase in Nitrogen did not produce any increase in plant height of roselle. Significant differences observed due to varieties was due to environmental influence. The investigation of Chweya (1992) agrees with this view that it was possible for one vegetable cultivar of the same species to emerge and grow faster than the other in the same location if the environmental conditions are favourable.

Stem diameter: The insignificant differences for the varieties, kinds of fertilizers and fertilizer levels. Observed in Table 2 were supported by Aliyu and Olanrewaju (1996) in their work on *Capsicum annum* where they observed

Table 1: The effect of different levels of NPK and urea on plant height of roselle DR 2003 and SD 2003 varieties (means only)

	Varieties		Fertilizers		Levels of fertilizers			
Period	DR	SD	NPK	Urea	0 kg ha^{-1}	100 kg ha^{-1}	150 kg ha^{-1}	200 kg ha^{-1}
2 WAT	38.27a	34.22a	26.68a	35.81a	23.21a	37.03a	36.26a	35.25a
4 WAT	12.22a	37.48a	37.54a	42.17a	33.32a	41.48a	36.25a	41.83a
6 WAT	56.53a	44.62a	50.98a	50.17a	42.34a	55.43a	46.86a	49.42a
8 WAT	81.56a	60.89b	69.50a	72.94a	62.34a	75.92a	67.17a	70.58a
10 WAT	109.06a	77.66b	91.39a	95.28a	79.53a	94.42a	89.75a	95.83a

Means of the same treatment in a column with different letter(s) are significantly different at 0.05%

Table 2: The effect of different levels of NPK and urea on stem diameter of roselle, DR (2003) and SD (2003) variety (means only)

	Varieties		Fertilizers		Levels of fertilizers			
Period	DR	SD	NPK	Urea	0 kg ha^{-1}	100 kg ha^{-1}	150 kg ha^{-1}	200 kg ha^{-1}
2 WAT	1.73	1.74	1.69	1.79	0.97	1.78	1.76	1.67
4 WAT	2.82	2.41	2.56	2.67	1.72	2.58	2.48	2.51
6 WAT	4.61	4.16	4.46	4.31	3.92	4.73	4.15	4.27
8 WAT	5.83	5.51	5.22	5.10	4.98	5.86	5.43	5.66
10 WAT	7.30	6.15	6.98	6.46	5.72	6.87	6.83	6.48

Table 3: The effect of different levels of NPK and leaf area and number leaves of roselle, DR (2003) and SD (2003) variety (Means only)

	Varieties		Fertilizers		Levels of fertilizers			
Period	DR	SD	NPK	Urea	0 kg ha^{-1}	100 kg ha^{-1}	150 kg ha^{-1}	200 kg ha^{-1}
2 WAT								
L. No	7.89	9.33	8.34	8.83	6.25	9.17	8.42	8.25
LAI	142.95	88.76	110.67	121.04	92.30	119.13	103.77	124.66
4 WAT								
L. No.	41.83	44.72	45.94	40.61	32.16	48.25	40.17	41.41
LAI	142.95	88.76	110.67	121.04	92.30	119.13	103.77	124.66
6 WAT								
L. No	84.11	97.56	84.67	97.00	73.21	94.92	95.17	82.42
LAI	187.21	104.29	144.71	146.79	111.43	153.20	127.63	156.43

Table 4: The effect of different levels of NPK and urea on number of branches of roselle, DR (2003) and SD (2003) variety (means only)

	Varieties		Fertilizers		Levels of fertilizers			
Period	DR	SD	NPK	Urea	0 kg ha^{-1}	100 kg ha^{-1}	150 kg ha^{-1}	200 kg ha^{-1}
2 WAT	7.89	9.33	8.39	8.83	7.34	9.17	8.42	8.25
4 WAT	12.28	13.39	12.61	13.16	10.26	13.83	12.58	12.08
6 WAT	10.28	10.00	10.50	9.78	8.21	11.67	9.58	9.17
8 WAT	11.50	10.50	11.17	11.11	9.74	12.03	11.17	10.27
10 WAT	12.00	11.50	12.16	11.33	10.48	12.82	11.75	10.78

Table 5: Effect of NPK and urea on the number of fruits of roselle at 10, 11 and 12 wat (kg/plant) (means only)

	Varieties		Fertilizers		Levels of fertilizers			
Period	DR	SD	NPK	Urea	0 kg ha^{-1}	100 kg ha^{-1}	150 kg ha^{-1}	200 kg ha^{-1}
10 WAT	4.89a	0.56b	2.28a	2.67a	1.12a	2.67a	1.67a	3.08a
11 WAT	10.39a	0.78b	5.72a	5.44a	4.21a	5.67a	5.17a	5.92a
12 WAT	25.39a	3.94b	18.39a	10.94a	8.61a	14.50a	11.33a	18.17a

Means of the same treatment in the same column and of same letter(s) are not significantly different statistically at p = 0.05

Table 6: The effect of NPK and urea on the fresh and dry weight of two varieties of roselle, DR (2003) and SD (2003) after harvest (kg/plant) (means only)

	Varieties		Fertilizers		Levels of fertilizers			
Plant parts	DR	SD	NPK	Urea	0 kg ha^{-1}	100 kg ha^{-1}	150 kg ha^{-1}	200 kg ha^{-1}
Fresh weight	0.76	0.65	0.75	0.68	0.32	0.68	0.75	0.71
Dry weight	0.19	0.12	0.15	0.17	0.11	0.18	0.15	0.14

that the beneficial effects of N and P could be seen in increasing the growth of stem diameter and thus interpreted as a cumulative increase in growth. The DR 2003 variety and NPK 15:15:15 fertilizer influenced stem diameter to a greater extent than Urea and SD 2003 variety of Roselle.

Number of leaves and leaf area index: The insignificant differences for number of leaves and leaf area index between the varieties and fertilizer levels at the beginning of the trial (Table 3) agrees with the results of Small and Hoden (1991) who worked on the effect of Nitrogen uptake of Roselle, on leaf area and number of leaves, respectively.

Also the non-significant differences observed in the interaction between NPK and Urea fertilizers on these parameters (Table 3) was supported by Ibrahim *et al.* (1998) where it was reported that in the interaction of N and P on *Amaranthus*, there was an indication that the application of either N or P without the other failed to have any effect on leaf yield.

Number of branches: The existence of non-significant differences in number of branches were observed for all the treatments (fertilizer levels and varieties) as in Table 4, especially in 100 kg ha^{-1} of NPK 15:15:15 and Urea (46 N) than the 150 or 200 kg ha^{-1} NPK 15:15:15, respectively, as the latter levels produced lower yields. This fact was also revealed by Sanni *et al.* (2000) who worked on garden eggs and observed that the flowers, branches and fruit numbers were also affected. The result also supported the previous findings of Bindinger *et al.* (1996) who observed that environmental factors have detrimental effects on plants hence low number of fruits for 150 and 200 kg ha^{-1} of NPK 15:15:15 and urea, respectively.

Number of fruits: The DR (2003) variety was observed to perform better than the SD (2003) variety in terms of calyx production. There were significant differences at 10, 11 and 12 WAT among the varieties (Table 5). There was, however, no significant difference with the different levels of fertilizer or type of fertilizer used, although the plants

supplied with NPK did better for both varieties in calyx production than all the control. This result corroborates the findings of Tijani-Eniola *et al.* (2000) on leafy vegetables and confirmed the views of Olasatan (1994) who reported the significant benefits derived from adequate application of fertilizer (NPK) to vegetable crops.

The superiority of SD (2003) over DR (2003) is in consonance with the investigation of Joshua (1999) who confirmed that varieties of same crops may differ in growth rate, reproductive cycle and yield duration. This low fruit production of SD (2003) could also be attributable to genetic trait as well as to environmental conditions. This was substantiated by Kang (1998) who revealed that even if genetic traits are equal for crop varieties, environmental condition could reduce the number of fruits in vegetable crops.

Fresh weight and dry weight: The non-significant differences of both fresh and dry weight for all the parameters tested (Table 6) is in line with Rhoden *et al.* (1993) investigation on Roselle when he reported that the increase observed in dry matter production three weeks after additional nitrogen application,did not bring about any significant difference.

CONCLUSIONS

Based on the results of the trial, the growth and yield of DR (2003) and SD (2003) were both affected by type of fertilizers and levels. Most of the parameters studied performed better at 100 kg ha^{-1} for both kinds of nitrogen sources but the yield was more influenced by NPK compared to Urea at 100 kg ha^{-1}. The main significance was from the varieties where DR (2003) out yielded SD (2003).

NPK is recommended for this ecological zone as it supported not only the growth rate but yield of Roselle. Also, the DR (2003) variety is recommended for the rainforest zone of Nigeria as it has a higher resistance to pests and diseases which are prevalent in the rainy seasons especially as most crops in the south are rain fed.

Appendix 1: Physical and chemical properties of soil at the experimental site

Parameter	Unit	Value
pH (1:1)	-	5.26
Organic carbon	%	0.89
Sand	%	83.8
Clay	%	14.2
Silt	%	2.0
Textural class	Sandy loam	
Available phosphorous	ppm	11.6
Total nitrogen	%	0.093
Calcium (ca)	meg/100 g soil	0.19
Magnesium (mg)	meg/100 g soil	0.17
Potasium (k)	meg/100 g soil	0.16
Exchangeable acidity	pH	0.285
Cation exchange capacity	Cmol (+) kg 1	1.45

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