The Interaction of Fertilizer Levels and Weeding Frequency on Growth and Yield of Roselle

Ibrahim Dauda Bake

Department of Horticulture, Institute of Agricultural Sciences, BHU, Varanasi-221005.

Abstract— *The study investigate the interaction of fertilizer level and weeding frequency on growth and yield of roselle in Yola , Adamawa State of Nigeria . It was observed from the results that all the parameters increased with increase in level of nitrogen fertilizer except number of days to first flowering and number of days to 50% flowering. For all the values of the parameters taken, the lowest was with treatment 0Kg/ha (control). This indicates that roselle performance increased with increased level of nitrogen fertilizer up to 150kgN/ha.*

I. INTRODUCTION

Roselle is a native to the world *tropics probably in the East Indies; Hibiscus sabdariffa* is extensively cultivated in tropical Africa, Asia, Australia and Central America (Schipers, 2009). It is cultivated for its fiber and edible calyx (Facciola, 1990). Roselle has been cultivated in Asia for over 300 years but now cultivated in many countries of the world (Tindal, 1993). It is susceptible to damage from frost and fog (Duke, 1983). The plant exhibits marked photoperiodism, not flowering at 19 hours, but flowering at 11 hours in the United States. Since flowering is not necessary for fibre production, long day light for 3-6 months is a critical factor. Today Roselle has a wide spread in the savannah region of Nigeria where it is cultivated.

Recently, Roselle also known as Jamaican sorrel is probably a native of West Africa and has been cultivated throughout India and part of Asia for centuries. Currently, it is grown throughout the tropics especially, Indonesia, Central eastern java, Indian, Bangladesh, Srilanka, Philippines and West indies. Roselle requires permeable soil, a friable sandy loam with humus. It will adapt to a variety of soil with pH value ranging from 4-5-8.0 (Duke, 1983). Roselle is suitable for tropical climates with well distributed rainfall of 1500-20130mm yearly. It tolerates a warmer and humid climate than kenaf (Hibiscus connabinus). It is shade tolerant and must be kept weed-free. It tolerates floods, heavy wind or stagnant water. Roselle is reported to tolerate annual temperature of 12.5-27.5^{0}C.

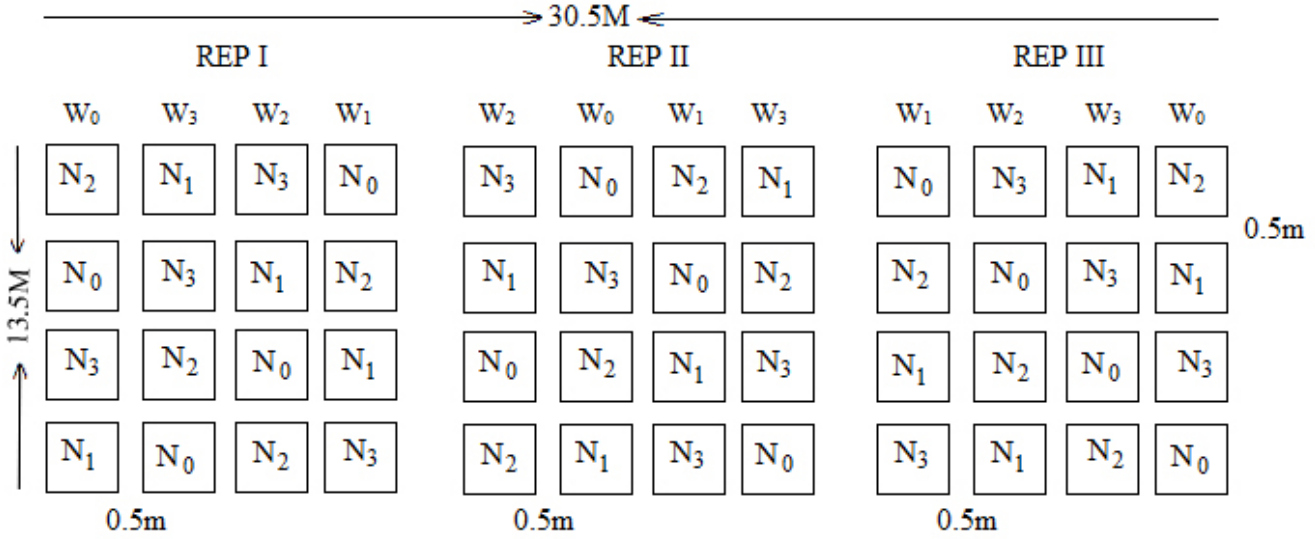
II. MATERIALS AND METHODS

2.1 Location of the study area

The experiment was conducted in two successive cropping seasons under rainfall conditions at Yola during 2013 and 2014 cropping seasons. The experiment was conducted at the Teaching and Research farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola. Yola is located between latitude 9^0 and 10^{0}N and longitude 11^0 and 14^0 east at an altitude of 158.5cm above sea level (Adebayo, 1999). The annual rainfall in 2013 and 2014 was 577.5mm and 644.1mm, respectively and the length of rainfall was 160-210 days and mostly from April to October. The annual minimum and maximum temperature of the area were 24.8^{0}C and 38.6^{0}C, respectively. Soils were randomly sampled by digging three boring of 0 -30 cm depth. The soil sampled were bulked, air dried and sieved through 2mm mesh before analysis for physical and chemical properties in the Soil Science Laboratory of the Department of Cop Science, Adamawa State University, Mubi.

2.2 Experimental design and treatments

The experiment was laid out in a Split Plot Design (Fig. 1), with weeding frequency as main plots and fertilizer rates as the sub-plot treatment. The fertilizer rates were 0kgN/ha 50KgN/ha, 100KgN/ha and 150KgN/ha. Weeding regime treatments included no weeding at all, weeding at 2 weeks after emergence, and weeding at 4, 6 and 8 weeks after emergence. The total land area of the experiment was 30.5m × 13.5m (411.75m^2). Each sub-plot size of the experiment was 2 × 3m (6m^2) with 1m pathway between the replications and between each main plots which 0.5m pathway was between sub-plots. The seed that was planted was procured from the local farmers in the study area. The cultivar is the Ex-Mubi (dark red calyx).



Main Plot Treatments

W_0 = Control (no weeding)

W_1 = Weeded at 2 weeks after emergence

W_2 = Weeded at 2 and 6 weeks after emergence

W_3 = Weeded at 4, 6 and 8 weeks after emergence

Subplot Treatments

N_0 = 0 KgN_2ha^{-1} Control (no fertilizer)

N_1 = 50 KgN_2ha^{-1}

N_2 = 100 KgN_2ha^{-1}

N_3 = 150 KgN_2ha^{-1}

FIG. 1 FIELD LAYOUT OF THE EXPERIMENT KEY

2.3 Land preparation

The land was cleared manually using cutlass and hoe, thrashes were gathered and removed before ploughing after which harrowing and levelling was done manually. The seeds were planted on flat ground after marking the plot out. Sowing was done in June 2013 and 2014 by dibbling method with 6-7 seeds per/hole and planting depth of 3-4cm after emergence the seedlings were thinned to 2 seedlings per hole. The spacing used was 60cm between rows and 40cm between stands. Weeding was done manually with hoe to control weeds according to the treatments. Fertilizer was applied in two split doses; first dose was weeks after emergence. The second dose was applied at three weeks after first application at the rate 0kgN/ha, 50KgN/ha, 100KgN/ha and 150KgN/ha after converting to grams per hectare.

$$N = \frac{Quantity\ of\ N\ to\ be\ applied\ x\ 100}{Percentage\ N\ in\ urea}$$

2.4 Data collection and Data analysis

The Data were collected in the following manner: Five plants were picked randomly per plot and were measured from the base up to the apex at 4,8,12 weeks and at harvest. Data collected on these parameters were subjected to analysis of variance (ANOVA) according (Akindele, 1996) using SAS version (8.1) 2013 start user guide computer package. Means were separated using Duncan Multiple Range Test method by the same author using the same statistics software at 5% level of probability

III. RESULT AND DISCUSSIONS

3.1 Interaction effects of weeding frequency and fertilizer level on plant height at harvest in 2013 and combined analysis

The result of the interaction effect of weeding frequency and fertilizer levels on plant height in 2013 season and combined analysis are presented on Table 1. The interaction of weeding thrice and 150kgN/ha produced the tallest height of 161.1cm, while no weeding and 0kgN/ha produced the shortest plant height of 76.7cm in the combined analysis, weeding thrice and

150kgN/ha produced plant height or 164.1cm tall all the other treatments while no weeding and 0kgN/ha gave the shortest plant height of 77.Ocm (Table 1).

3.2 Effects of weeding frequency and fertilizer levels on number of branches per plants

The results of the effects of weeding frequency and fertilizer levels on number of branches in 2013 and 2014 cropping seasons and the combined analysis are presented on Table 2. There was significant effect of weeding frequency on roselle number of branches at all the stages of measurement for both the years and the combined analysis. At 4WAS in 2013 the weeding thrice treatment showed significantly higher number of branches of 10.98 compared to the no weeding treatment while the weeding once treatment which had number of branches (7.87 and 9.90) respectively, that were not significantly different with the weeding twice treatment.

TABLE 1
INTERACTION EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON PLANT HEIGHT IN 2013 AND COMBINED ANALYSIS

Plant height at harvest								
			2013				Combined	
	WO	W1	W2	W3	W0	W1	W2	W3
NO	76.7e	110.0de	125.4bcd	130.5abcd	77.0e	110.7cde	130.1abcd	135.3abcd
N1	114.6cd	127.0abcd	127.2abcd	146.5abc	109.0de	119.3bcd	128.3abcd	152.3ac
N2	137.6abcd	136.3abcd	138.6abcd	140.6abcd	128.3abcd	133.0abcd	147.3abc	149.4ab
N3	140.9abcd	149.8ab	159.0a	161.1a	135.4abcd	144.8cbcd	159.0a	164.1a
SE±		34.51				36.97		

Key
W0 = No weeding ***NO = No fertilizer***
W1 = Weeding once at 2WAS ***N1 = 50kgN/ha***
W2 = Weeding twice at 4 and 6 WAS ***N2 = 100kgN/ha***
W3 = Weeding thrice at 4, 6 and 8 WAS ***N3 = 150kgN/ha***

Above table showed a significantly higher number of branches under the weeding thrice treatment compared with all the rest of the wedding frequency treatments. Similarly, at 8WAS in 2013 the weeding thrice treatment had significantly greater number of branches (17.08) compared to no weeding and weeding once treatments only. The 2014 result at 8WAS also showed significantly greater number of branches of 17.52 compared to no weeding and weeding once treatments. Similarly the combined analysis gave significantly greater number of branches of 17.30 at the weeding thrice treatment compared to weeding once and no weeding treatment which produced 15.41 and 11.93 respectively. Number of branches at 12WAS followed a similar pattern. In 2013 the weeding thrice treatment which product (102.62) number of branches. There was no significant difference among the weeding thrice, weeding twice and weeding once treatments. In 2014 weeding thrice regime produced greater number of branches (12.79) compared to the no weeding and weeding once treatments. Under the combined analysis gave significantly greater number of branches of 20.95 were recorded under the weeding thrice treatments compared to weeding once and no weeding treatments which produced 18.81 and 14.52 branches respectively.

TABLE 2
EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON NUMBER OF BRANCHES PER PLANT IN 2013, 2014 AND COMBINED ANALYSIS

	Number of branches 4 WAS			**Number of branches 8 WAS**			**Number of branches 12 WAS**			**Number of branches harvest**		
Treatments Weeding	2013	2014	Comb.	2013	2014	Comb.	2013	2014	Comb.	2013	2014	Comb.
Wo	7.87c	1.58c	4.73d	12.15c	11.70c	11.93c	12.62c	16.42c	14.52c	23.72c	25.02c	24.37c
W1	9.90b	3.8b	6.49c	15.33b	15.48b	15.41b	18.10a	19.53b	18.81b	27.68b	30.50b	29.09b
W2	10.73ab	3.83b	7.28b	16.35ab	16.74a	16.55a	19.19a	20.45ab	19.82ab	29.64b	33.07ab	31.35b
W3	10.98a	5.33a	8.15a	17.08a	17.52a	17.30a	20.10a	21.79a	20.95a	34.33a	35.33a	35.07a
Fertilizer												
NO	7.87c	1.83c	4.85d	12.15c	12.15c	12.12d	14.22c	14.22c	14.69c	14.45d	22.06b	21.91c
N1	9.70b	2.67c	6.18c	15.24b	15.05c	15.15c	15.58c	19.25b	17.42c	29.53a	29.13c	29.33b
N2	10.64ab	4.08b	7.36b	16.23ab	16.50b	16.37b	18.53b	21.80a	20.17b	31.78a	35.06b	33.42a
N3	11.25a	5.25a	8.25a	17.29a	17.81a	17.55a	21.68a	22.44a	22.06a	31.98a	31.45a	35.22a
Interaction												
W x N	**	NS	NS	**	**	**	NS	NS	*	*	NS	*

Means in a column followed by the same letter (s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT).

Key

W0 = No weeding
W1 = Weeding once at 2WAS
W2 = Weeding twice at 4 and 6 WAS
W3 = Weeding thrice at 4, 6 and 8 WAS

NO = No fertilizer
N1 = 50kgN/ha
N2 = 100kgN/ha
N3 = 150kgN/ha

Branches in 2013, 2014 and the combined analysis followed similar trend. In 2013 the weeding thrice treatment still produced significantly greatest number of branches of 34.33 as against the no weeding once treatment with 27.68 and the weeding twice which has 29.64, However, there was significant in number of branches between weeding twice and weeding once treatments. Similarly in 2014 and the combined analysis at harvest, weeding thrice gave significantly greatest number of branches of 35.07 respectively combined to all the other weeding regimes which also differed significantly from each other.

Table 2 showed significant effect of fertilizer treatment on number of branches at all the stages of measurement for both the cropping seasons of 2013 and 2014 as well as the combined analysis. At 4WAS the 2013 season result showed that the 150kgN/ha treatment produced significantly greater number of branches of 11.25 compared to the 0kgN/ha and the 50kgN/ha treatment, although statistically at per with the 100kgN/ha treatment. The result followed the same pattern in 2014 at this same stage of measurement. The combined analysis of 4WAS indicated that the 150kgN/ha treatment produced significantly greater number of branches compared to all the other fertilizer levels which also significantly differed from each other. In 2013, 2014 and the combined at 8 WAS the 150kgN/ha fertilizer treatment produced significantly greater number of branches of 17.29, 17.81 and 17.55 Similarly at 12 WAS, in 2013 cropping season the 150kgn/ha fertilizer treatment

recorded significantly greater number of branches of branches of 21.68 compared to 0kgN/ha, 50kgN/ha and 100kgN/ha fertilizer treatments which gave 14.22, 15.58 and 18.53 respectively. The 2014 and combined result produced significantly greater number of branches (22.44 and 22.06) compared to 0kgN/ha and 50kgN/ha treatments. The results of the effects of fertilizer treatment at harvest followed similar trend with the other stages of measurement. In 2013 the 15kgN/ha treatment gave rise to the greater number of branches (31.98) compared to the 0kgN/ha treatments. In 2014 the 150kgN/ha produced significantly greater number of branches of 38.45 compared to the 0kgN/ha, 50kgN/ha and 100kgN/ha, with 21.76, 29.13 and 35.06 respectively. The combined analysis at harvest showed significantly greater number of branches of 35.22 with the 150kgN/ha compared with 0kgN/ha and 50kgN/ ha fertilizer levels.

The was significant interaction effect of weeding frequencies and fertilizer levels on the number of branches at 4WAS in 2013 and 8WAS in 2013, 2014 and the combined analysis, at 12WAS and harvest in the combined analysis 2013 (Table 2).

3.3 Interaction effects to weeding frequency and fertilizer levels on number of branches per plant

The results of the interaction effect of weeding frequency and fertilizer levels on number of branches per plant are presented on Table 3 and 4. There was significant effect of weeding frequency and fertilizer levels on number of branches. At 4WAS in 2013 the weeding thrice treatment and 150kgN/ha treatment produced highest branches (11.9) while no weeding and 0kgN/ha produced least number of branches. At 8WAS in 2013 weeding thrice and 150kgN/ha treatments produced the highest branches of 19.7, while no weeding and 0kgN/ha treatments produced the least branches of 4.0. The combined analysis followed similar trend. The weeding thrice and 150kgN/ha treatment still produced the highest number of branches of 19.5 and no weeding and 0kgN/ha produced least number of branches of 4.4. At 12WAS the combined analysis weeding thrice and 150kgN/ha produced highest branches of 23.9, while no weeding and 0kgN/ha produced the least branches of 7.8. At harvest in 2013 weeding thrice and 150kgN/ha produced highest branches of 36.6 compared with all other treatments. The combined analysis followed similar trend where weeding thrice and 150kgN/ha produced highest

TABLE 3
INTERACTION EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON NUMBER OF BRANCHES PER PLANT IN 2013, 2014 AND THE COMBINED ANALYSIS

	Number of branches 4 weeks after sowing								Number of branches 8 weeks after sowing							
	2013				2013				2014				Combined			
	WO	W1	W2	W3	W0	W1	W2	W3	W0	W1	W2	W3	W0	W1	W2	W3
NO	3.1	8.6	9.8	10.0	4.7	14.0	14.5	15.3	4.0	14.0	15.0	15.3	4.4	14.0	14.8	15.3
N1	9.0	9.2	10.3	10.3	13.5	15.2	15.7	16.6	12.7	14.2	15.8	17.4	13.1	14.7	15.7	17.0
N2	9.5	10.3	11.1	11.7	15.0	16.2	16.6	17.1	14.4	16.8	17.3	17.6	14.7	16.5	16.9	17.4
N3	9.9	11.4	11.8	11.9	15.4	15.9	18.6	19.3	15.5	16.9	18.9	19.7	15.6	16.5	18.8	19.5
SE±	0.43	0.43	0.43	0.43	1.07	1.07	1.07	1.07	0.60	0.60	0.60	0.60	0.84	0.84	0.84	0.84

Key
W0 = No weeding
W1 = Weeding once at 2WAS
W2 = Weeding twice at 4 and 6 WAS
W3 = Weeding thrice at 4, 6 and 8 WAS
NO = No fertilizer
N1 = 50kgN/ha
N2 = 100kgN/ha
N3 = 150kgN/ha

TABLE 4
INTERACTION EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON NUMBER OF BRANCHES IN 2013, 2014 AND COMBINED ANALYSIS

	12 weeks after sowing 2014			Number of branches harvest							
	Combined				2013				Combined			
	W0	W1	W2	W3	W0	W1	W2	W3	W0	W1	W2	W3
NO	7.8i	15.5g	16.8fg	17.9ef	11.7f	17.3e	28.0d	31.3bc	11.5i	20.0h	26.2g	30.0ef
N1	13.0h	17.5ef	19.1de	20.0d	26.7d	29.7cd	27.9d	33.9abc	25.2g	28.5fg	29.2fg	34.4abce
N2	17.0fg	20.8bcd	20.8bcd	22.1abc	26.9d	30.7bcd	34.0abc	35.5ab	28.6fg	32.5bcef	35.6abc	37.0ab
N3	20.2cd	21.6b	22.6ab	23.9a	29.6cd	33.0abc	28.7d	36.6a	32.2cef	35.4abc	34.4ab	39.9a
SE±		1.87				5.08				4.62		

Key
W0 = No weeding
W1 = Weeding once at 2WAS
W2 = Weeding twice at 4 and 6 WAS
W3 = Weeding thrice at 4, 6 and 8 WAS
NO = No fertilizer
N1 = 50kgN/ha
N2 = 100kgN/ha
N3 = 150kgN/ha

Number of branches of 38.9 while on weeding and 0kgN/ha recorded the least number of branches of 11.5 (Table 4).

3.4 Effects of weeding frequency and fertilizer levels on leaf width

Table 5 presents the result of the effects of weeding frequency and fertilizer levels on leaf width in 2013 and 2014 cropping seasons and the combined analysis. There was significant effect of weeding frequency on roselle leaf width at all the stages of measurement for both the years and combined analysis except at 4 weeks after sowing (WAS) during the 2013 cropping season. In 2014, the sampling at 4 WAS showed a significantly greater leaf width under weeding thrice treatment compared with the no weeding, weeding once and weeding twice. The combined analysis at 4WAS showed a significantly longer leaf width under weeding thrice treatment of 9.44cm compared with all the other treatment. Similarly, at 8WAS in 2013 the weeding thrice treatment had significantly greater leaf width compare to the no weeding and weeding once treatments but even though statistically similar with the weeding twice treatment. The 2014 result at 8WAS showed significantly greater leaf width compared to the no weeding and weeding thrice treatments. Similarly, the combined analysis gave significantly greater no weeding treatment which produced 11.49cm and 10.50cm respectively.

TABLE 5
EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON LEAF WIDTH OF ROSELLE IN 2013 AND 2014 AND COMBINED ANALYSIS

	Leaf Width 4 WAS			Leaf width 8 WAS			Leaf width 12 WAS		
Treatment	2013	2014	Combined	2013	2014	Combined	2013	2014	Combined
Weeding									
WO	8.08a	8.52c	10.21b	10.79c	10.50d	10.37b	10.49c	10.49c	10.43c
W1	8.38a	9.32b	8.85B	10.60B	12.38B	11.49C	11.43A	12.07B	11.75B
W2	8.62a	9.65b	9.13b	11.07ab	13.27a	12.71a	12.28a	13.13a	12.70a
W3	8.83a	11.04a	9.94a	11.83a	13.59a	12.71a	12.28a	13.13a	12.70a
Fertilizer									
NO	7.93a	9.04b	8348c	10.25b	11.50c	10.88c	10.20c	10.82b	10.51c
N1	8.01b	9.38b	8.69bc	10.78ab	12.21b	11.50b	11.18b	12.3a	11.60b
N2	8.60ab	9.52b	9.10b	10.98ab	12.58b	11.78b	11.68b	12.59a	12.14b
N3	9.29a	10.59a	9.94a	11.69a	13.73a	12.71a	12.88a	12.82a	12.85a
Interaction									
SE±	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means in a column followed by the same letter (s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT).
Key
W0 = No weeding ***NO = No fertilizer***
W1 = Weeding once at 2WAS ***N1 = 50kgN/ha***
W2 = Weeding twice at 4 and 6 WAS ***N2 = 100kgN/ha***
W3 = Weeding thrice at 4, 6 and 8 WAS ***N3 = 150kgN/ha***

Leaf width at 12 WAS followed a similar pattern. In 2013 the weeding thrice treatment produced longer leaf width compared with no weeding treatment which produced 10.37cm but par with weeding thrice produced the greatest leaf width of 13.13cm as against the on weeding twice and weeding thrice treatments. In combined analysis there was also significant effect in leaf width, where weeding thrice treatment gave greatest leaf width of 12.70 cm compared to no weeding and weeding once treatments but similar to the weeding twice treatments.

Table 5 showed significant effect of fertilizer treatment on leaf width at all the stages of measurements for both the cropping season of 2013 and 2014 as well as the combined analysis. At 4WAS the 2013 result showed that the 150kgN/ha treatment produced significantly greatest leaf width of 9.29cm compared to the 0kgN/ha and 50kgN/ha treatments, although at par with the 100kgN/ha treatment. The result followed the same pattern in 2014 at this stage of measurement. The 4 WAS re3sults indicated that the 150kgN/ha treatments recorded 10.59cm compared to all the other fertilizer levels treatments, no weeding, weeding once and weeding twice (9.04cm, 9.38cm and 9.52cm) width and the combined analysis also showed significant leaf width (150kgN/ha). At 8 WAS application of 150kgN/ha produced significant by greatest leaf width compared with all other treatments in 2013, 2014 and the combined analysis respectively. Similarly, at 12 WAS in 2013 cropping season 0kgN/ha 50kgN/ha , 100kgN/ha fertilizer treatments. The 2014 and combined analysis result produced significantly higher leaf width (12.82cm and 12.85cm) compared to the OKg/ha and 50kgN/ha treatments.

There was no significant interaction of weeding frequency and fertilizer levels on roselle leaf width in 2013, 2014 and the combined analysis at 4, 8 and 12 WAS (Table 8).

3.5 Effects of weeding frequency and fertilizer levels on leaf length

The result of the effect of weeding frequency and fertilizer levels on leaf length in 2013 and 2014 cropping seasons and the combined analysis are presented on Table 8. There was significant effect of weeding frequency on roselle leaf length at all the stages of measurement for both the years and the combined analysis. At 4 WAS in 2013 the weeding thrice treatment recorded significantly longest leaf compared to the no weeding treatment which was not significant different with the weeding once and weeding twice treatments. I

TABLE 6
EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON LEAF WIDTH OF ROSELLE IN 2013 AND 2014 AND COMBINED ANALYSIS

	Leaf Width 4 WAS (cm)			Leaf width 8 WAS (cm)			Leaf width 12 WAS (cm)		
Treatment	2013	2014	Combined	2013	2014	Combined	2013	2014	Combined
Weeding									
WO	10.25b	10.61b	10.43c	12.23b	12.25c	12.24c	12.28b	12.01c	12.14c
W1	10.72ab	10.99ab	10.85bc	12.68ab	13.45b	13.06b	13.72a	14.01b	13.86b
W2	10.95ac	11.58a	11.33ab	13.08ab	13.81ab	13.45ab	13.92a	14.73ab	14.33ab
W3	11.34a	11.72a	11.46a	13.63a	14.37a	14.00a	14.38a	15.21a	14.79a
Fertilizer									
NO	10.07c	10.26c	10.16c	12.00c	12.65c	12.33c	12.11c	12.58b	12.34c
N1	10.23c	10.46c	10.34c	12.52ab	13.29bc	12.91b	13.45b	14.09a	13.77b
N2	10.92b	11.40b	11.16b	13.02b	13.78ab	13.40b	14.01ab	14.43a	14.27ab
N3	12.04a	12.78a	12.41a	14.07a	14.15a	`14.11a	14.72a	14.86a	14.79a
Interaction									
W x N	NS	NS	NS	NS	NS	NS	NS	NS	*

Means in a column followed by the same letter (s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT).

Key
W0 = No weeding
W1 = Weeding once at 2WAS
W2 = Weeding twice at 4 and 6 WAS
W3 = Weeding thrice at 4, 6 and 8 WAS
NO = No fertilizer
N1 = 50kgN/ha
N2 = 100kgN/ha
N3 = 150kgN/h

2014 same trend followed where weeding thrice regime gave longest leaf width compared to the no weeding treatment. The combined analysis at 4WAS showed a significant longest leaf at the weeding thrice treatment compared with no weeding and weeding once treatments. Similarly, at 8WAS in 2013 the weeding thrice treatment had significantly longer leaf compared to no weeding treatment. The 2014 results at 8WAS also showed significantly longest leaf of 14.37cm under weeding thrice compared to no weeding and weeding once treatments. combined analysis also followed same trend, which gave significantly longest leaf of 14.00cm under the weeding thrice treatment compared to weeding once and no weeding treatment which produced 13.6cm, and 12.24cm long respectively. Leaf length at 12 WAS followed similar pattern. In 2013, the weeding thrice treatment produced longest leaf compared to no weeding treatment. The 2014 and combined result showed significantly longer leaf under weeding thrice compared with no weeding and weeding once treatments, which was statistically similar with the weeding twice treatment.

Table 8 showed significant effect of fertilizer treatment on leaf length at all the stages of measurement for both the cropping seasons of 2013 and 2014 as well as the combined analysis. At 4WAS the 2013 season result showed that 150kgN/ha treatment produced significantly longest leaf of 12.04cm compared to 0kgN/ha, 50kgN/ha and 100kgN/ha treatments. The result followed the same pattern in 2014 at this stage of measurement. The combined analysis at 4WAS indicated that the 150kgN/ha gave rise to significantly, longest leaf of 12.41cm compared to all the other fertilizer treatment of 0kgN/ha,

50kgN/ha and 100kgN/ha. At 8 WAS the 150kgN/ha fertilizer treatment produced the significantly longest leaf of 14.07cm, 14.15cm and 14.11cm in 2013, 2014 and the combined analysis compared to the 0kgN/ha fertilizer treatment. Similarly a 12WAS, in 2013 cropping seasons the 150kgN/ha fertilizer treatment recorded to significantly longest leaf of 14.72cm as against the 0kgN/ha and 50kgN/ha and fertilizer treatments. The 2014 and combined analysis results produced significantly longer leaf of 14.86cm and 14.76cm compared to the 0kgN/ha and 50kgN/ha treatments, which were statistically similar to the 100kgN/ha treatment. There was no significant interaction of weeding frequency and fertilizer levels on roselle leaf length in 2013, 2014 and combined of weeding frequency and fertilizer levels on roselle length at 12WAS and at combined analysis (Table 6).

3.6 Interaction effect of weeding frequency and fertilizer levels on leaf length

The result of interaction effect of weeding frequency and fertilizer levels on leaf length at 12 WAS and combined analysis is presented on Table 7.

TABLE 7
INTERACTION EFFECT OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON LEAF LENGTH IN THE COMBINED ANALYSIS

	Leaf length at 12 weeks after sowing			
	Combined analysis			
	WO	W1	W2	W3
No	9.4i	12.9gh	13.3f	13.8e
N1	12.1fg	13.8e	14.0e	14.6d
N2	13.1fg	14.1e	14.7d	15.0c
N3	13.4f	14.6d	15.4b	15.8e
SE+		0.29		

Key

WO= No weeding ***NO= No fertilizer***
W1= Weeding once at 2WAs ***N1 = 50kgN/ha***
W2= Weeding twice at 4 and 6 WAS ***N2 = 100 kgN/ha***
W3= Weeding thrice at 4, 6 and 8 WAS ***N3 = 150kgN/ha***

Combined analysis, the interaction effect on leaf length showed significantly longest leaf length under weeding thrice treatment and 150kgN/ha treatment compared to no weeding and weeding once treatments.

3.7 Effect of weeding frequency and fertilizer levels on days to first flowering

In 2013, 2014 and combined analysis, it was observed that no weeding consistently took significantly longer days to first flower emergence. There was however, no significant deference in the number of days to first flower emergence between weeding once and twice in all seasons and the combined analysis. Weeding thrice however, produced statistically least number of days to first flowering emergence in all seasons and the combined, though in 2013 it was statistically at par with wedding twice.

Application of nitrogen indicated significant effect on days to first flowering (Table 8). The result indicated a progressive and significant decrease in the number of days to first flowering with increase in applied N in all year and the combined analysis except in 2013 where there was no significant difference between the control and 150kgN/ha. There was no significant interaction effect of weeding frequencies and fertilizer levels on roselle days to first flowering in 2013, 2014 and combined analysis (Table 8).

3.8 Effects of weeding frequency and fertilizer levels on days to 50% flowering

The no weeding treatment as indicated in table 10 produced statistically the longest days to 50% flowering in al years and the combined analysis. However, all other weeding treatments produced statistically similar number of days to 50% flowering in all years while under the combined analysis, weeding thrice produced statistically the shortest day to 50% flowering.

TABLE 8
EFFECTS OF WEEDING FREQUENCY AND FERTILIZER LEVELS ON LEAF WIDTH OF ROSELLE IN 2013 AND 2014 AND COMBINED ANALYSIS

	Leaf Width 4 WAS (cm)			Leaf width 8 WAS (cm)			Leaf width 12 WAS (cm)		
Treatment	2013	2014	Combined	2013	2014	Combined	2013	2014	Combined
Weeding									
WO	10.25b	10.61b	10.43c	12.23b	12.25c	12.24c	12.28b	12.01c	12.14c
W1	10.72ab	10.99ab	10.85bc	12.68ab	13.45b	13.06b	13.72a	14.01b	13.86b
W2	10.95ac	11.58a	11.33ab	13.08ab	13.81ab	13.45ab	13.92a	14.73ab	14.33ab
W3	11.34a	11.72a	11.46a	13.63a	14.37a	14.00a	14.38a	15.21a	14.79a
Fertilizer									
NO	10.07c	10.26c	10.16c	12.00c	12.65c	12.33c	12.11c	12.58b	12.34c
N1	10.23c	10.46c	10.34c	12.52ab	13.29bc	12.91b	13.45b	14.09a	13.77b
N2	10.92b	11.40b	11.16b	13.02b	13.78ab	13.40b	14.01ab	14.43a	14.27ab
N3	12.04a	12.78a	12.41a	14.07a	14.15a	`14.11a	14.72a	14.86a	14.79a
Interaction									
W x N	NS	NS	NS	NS	NS	NS	NS	NS	*

Means in a column followed by the same letter (s) are not significantly different at 5% probability level of the Duncan's Multiple Range Test (DMRT).

Analysis of yield of roselle plants using parameters such as dry seed weight, fresh and dry weight of calyx indicated that there was significant effect of weeding frequency and fertilizer levels on yield of roselle plants. With adequate fertilizer and moisture, yield of roselle reaches a plateau. Fresh and dry weight of stem, fresh and dry weight of calyx of roselle in this present study increased with increase in nitrogen levels. This is agreement with Akanbi *et al.*, (2012) reported that reselle plants respond favorably to nitrogen fertilizer supporting the present findings on yield based on calyx assessment. Odusanya *et al.*, (1999), Okosun (2010) and Babatunde (2011) observed increased in calyx yield as a result of nitrogen fertilizer which was attributed to increase in crop photosynthetic ability, as a result of good vegetative growth induced by those treatments. The yield of roselle was also doubled when N- levels was increased from 100 – 150kgN/ha. The 0kgN/ha recorded the lowest yield and highest nitrogen level (150kgN/ha) recorded highest yield. Akanbi *et al.*, (2013)

IV. CONCLUSION

Weeding thrice treatment recorded the highest yield per hectare while zero frequency ranked the least the least. These results are in tandem with Aldrich (1984) who reported that weeding can increase the yield of calyx size of roselle plant. High number of calyx per plant was recorded in plot weeded thrice than plot with no weeding. This could be to the fat. That plants weeded thrice received more nutrients and light for their growth thereby producing more calyces. Similarly observed that application of nitrogen fertilizer significantly influenced number of pods produced per plant and number of seeds per pod in two years trial.

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