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Effect of Weeds on Calcies Yeild of *Hibiscus Sabdariffa* L in Traditional Agricultural Sector of Sudan

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Abstract Weeds play an important role in the proper stand establishment of the growing crop, which ultimately affect the productivity and quality at the end of the growing season. Hand hoeing is still by far the most widely practiced cultural weed control technique in field crop production throughout the traditional agricultural sector in Sudan, because of the prohibitive costs of herbicides and fear of toxic residue coupled with the lack of knowledge about their use. Fields studies were conducted at North Kordofan state, Sudan, on naturally infested fields within the same area, using three similar fields during 2007/2008 rainy season, to determine optimal weeding frequency for weeding management in two widely used cultivated varieties of *Hibiscus sabdariffa* L, (Elrahad and Elfashir). The majority of weeds in site were the broad leaves (dicotyledons), while grasses (monocotyledons) found in a lesser density. The dominant weed floras were Alhuskaneet (*Cenchrus biflorus* L), Sheilini *(Zornia glochidiata* L) and Alraba (*Trienemara pentanture* L). Weeds reduced yield of the crop by about 75 % compared to weeding twice during the season.

Keywords Weeds, Traditional Sector, Roselle, Yield

1. Introduction

Roselle (*Hibiscus sabdariffa* L) family Malvaceae, known commonly as "Karkade". It is known under different names in different countries viz roselle, razelle, sorrel, red sorrel, Jamaica sorrel, Indian sorrel, Guinea, sorrel, sour -sour, and Queens land jelly plant (Mahadevan *et al.,* 2009; Morton, 1987). It is an important crop in tropical and sub-tropical regions. The economical part of the plant is the fleshy calyx (sepals) surrounding the fruit (capsules).In Sudan fully developed fleshy calyx is peeled off from the fruit by hand and dried naturally under shade to give the dry (calyx), which is the consumable product. The plant, normally grown as annual plant, is 0.5 to 2 meters in height. It has a bushy shape with some what dense canopy of dark green leaves. The colour of the calyx plays an important role in determining the quality of the crop. The crimson red colour is the characteristic and most popular and desirable colour of roselle while other shades and colors exist, including the white or greenish white colour. It is an important cash crop in Western Sudan, particularly in Northern Kordofan State where the largest area of roselle is grown, especially in Elrahad and Um-Rawaba areas. The crop is mostly produced in traditional growing conditions by small-farmers, depending on rainfall and natural soil fertility without using chemical fertilizers or insecticides (El Naim and Ahmed, 2010). Roselle has many industrial and domestic uses. Locally, in the Sudan it is used as a beverage, where the dried calyx is soaked in water to prepare a colorful cold drink. Traditionally the product has been used for medicinal purposes for relief of sour throat and for healing wounds as an anti-septic (Aziz, 2007). Mahadevan *et al* (2009) reported that, in many parts of the world leaves is consumed as green vegetable and the stem is used as a source of pulp for paper industry. Seeds used as a poultry feed and as an aphrodisiac coffee substitute (Anonymous, 1959, Khidir, 1997). The total cultivated roselle area in Sudan during the 99/2000 season was estimated as 140,000 ha (El Naim and Ahmed, 2010). The main production comes from Western Sudan States, and the most of the exported crop is grown in the Eastern Kordofan localities. Roselle is also scattered in the southern region and south Fung area and recently at Abu Naama in the rainfed central clay plains of Sudan (Mclean, 1973). Weeds have been defined as higher plants in the Agro-ecosystem which are not sown, undesired '' out of place' or generally as plants which do more harm than good, (El Naim and Ahmed, 2010). They lead to direct yield losses through competition with the crop for water, nutrients, light, space and/or carbon dioxide. This degree of damage is mainly a function of their number, biomass and leaf area –index as compared with that of the crop. Weeds have different competitive abilities, which determine their

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performance and potential of damage in given situations; most important are vigor, growth habit, seed production, regenerative capacities and time of germination. In addition to competition, weeds can interfere negatively with cultural and harvest practices and may be poisonous and /or harbor pests and diseases. On the other hand, .weeds may have positive properties, when stabilizing the soil adding humus and nutrients to the soil (mainly) and extracting otherwise unavailable nutrients. In addition they might be alternative hosts for predators and used as sources of food, fodder, Fuel, .building material and for other technical purposes.(Weiikersheim, 1991). Groundnut for example is a field crop, but if it germinates in the subsequent culture, it is regarded as undesired ordinary weed. The objectives of this study were: to investigate the effect weeding frequencies on yield and Harvest index of roselle grow in sandy soil of Kordofan, Sudan in rain-fed.

2. Materials and Methods

A field experiment was conducted during season 2007/ 2008 under rainfed conditions in two fields naturally weeds infested in North Kordofan State, Sudan. The fields were: Abu Haraz, and Khor taqqat. The experiment was laid out in a randomized complete block design (RCBD) with four replications. The plot size was 5×4 meters consisted of 7 rows with 5 m along. The weeding treatments consisted of four levels (no weeding, weeding once (at 2weeks), weeding twice (at 2 and 3 weeks) and weeding three times (at 2, 4 and 6 weeks after sowing) designated as W_0, W_1, W_2 and W_3 respectively. Two widely used cultivated varieties of roselle (Elrahad, and Elfashir) were used in the experiment, designated as V_1 and V_2, respectively. Sowing dates on 11th of July. Seeds were sown on rows at spacing of 70 cm apart and 40 cm within row, five seeds were placed in each hole. The plants were thinned to two plants per hole, two weeks later. The weed species found at each site were recorded at 15 DAS and then continued as interval of 14 days. Weeds counts made by placing the quadrate (0.5m x 0.5m) at random locations in plots repeated four times in order to obtain a reasonably good estimate of small weeds. The relative weed densities were calculated.

A destructive sample of five plants was taken at random from the five inner rows of experimental plot at maturity to measure the following yield attributes.

- Number of calyces per plant
- Calyces yield per plant (g): The calyces of five plants were peeled off from the capsules by using simple hand tools. The calyces were dried under shade to constant weight, and then average calices yield per plant (g.) was determined.
- Final calyces yield (kg / ha). Calculated by using the following formula:

$$\text{Calyces yield (Kg /ha)} = \frac{\text{calyces yield (kg) of plot}}{\text{Harvested plot area (m}^2\text{)}} \times 10000$$

- Harvest index was determined by using the following formula:-

$$\text{Harvest index} = \frac{\text{Economical Yield X 100}}{\text{Biological yield}}$$

Data were analyzed statistically using analysis of variance according to Gomez and Gomez (1984) procedure for a randomized complete block design. The differences of means were identified by Duncan's Multiple Range Test (DMRT) at $P \geq 0.05$

3. Results and Discussion

3.1. Weeds and Stand

The majority of weeds in the experimental sites were the broad leaves (dicotyledons), while grasses (monocotyledons) found in a lesser density (Table 1)**.** The presence and absence of weed species during the growing season are presented in Table 2. The majority of weeds in the experimental sites were the broad leaves (dicotyledons), while grasses monocotyledons) found in a lesser density**.** The dominant weed flora infesting Roselle (Karkade) during growing season were *Cenchrus biflorus* L (Alhuskaneet), *Zornia glochidiata* L (Sheilini) and *Trienemara pentanture* L (Alraba). They had relative weeds density of 27%, 21% and 11% respectively. El Naim and Ahmed (2010) found that the *Cenchrus biflorus* L was the most dominant weed in fields of Kordofan.

Table 1. Weeds Classification and Their Relative Density of non Weeded Roselle (Karkade) During the Growing Season in The Experiment Site

Scientific name	Classification	Local name	Weeds density
Cenchrous biflours.	Monocot	Alhuskaneet	27%
Zornia glochidiata.	Dicot	Sheilini	21%
Trienemra pentanture.	Dicot	Alraba	11%
Sesamum alatum.	Dicot	Simsim Elgumal	4%
Ocimum basilicum.	Dicot	Elryhan	0.7%
Echinocola colonum.	Monocot	Aldiffera	4%
Rullia patula.	Dicot	Tagtaga	7%
Corchorus olitorius.	Dicot	Almlukhia	3%
Tribulus trerrestris.	Dicot	Aldraisa	0.3%
Ipomea kordofana.	Dicot	Eltabar	1.6%
Solanum dobium.	Dicot	Aljubain	6%
Abutilon figarinum.	Dicot	Alniada	7.0%
Ipomea sinensis.	Dicot	Elhantoot	0.3%

3.2. Growth and Yield Attributes

Weeds decreased plant height (Table 2). The significant differences in plant height among treatments may be attributed to the competition of weeds for soil moisture, nutrients, light and carbon dioxide. Weeding facilitates plants to have more resources for growth, these results agreed with El Naim and Ahmed (2010) who showed that, increasing weeding times increased plant height, due to efficient weed control.

Generally Elfashir variety (V_2) had significantly greater plant height than (V_1). Significant Differences in plant height among varieties were reported by El Naim and El Naim (2010), Cheweya (1992) and sulaiman (2005). The significant differences among weeding treatments in leaf area index (LAI) were observed in this study. Increased weeding fre-

quencies increased leaf area index. This was due to better control of weeds. The reduced competition and increased availability of resources like nutrients, soil moisture and light paved way for higher leaf area per plant (leaf area index). These results are conformity with the findings of Kumara *et al* (2007) and El Naim and Jabereldar (2010).

Table 2. Presence (+) and Absence (-) of Weed Species During The Growing Season of un Weeded Roselle

Weed species	Local name	Days from sowing						
		15	30	45	60	75	90	105
Zornia glochidiata.	Sheilini	+	+	+	+	+	-	-
Abutilon figarinum.	Alniada	+	+	+	+	+	+	-
Solanum dobium.	Aljubain	+	+	+	+	+	+	-
Sesamum alatum.	Simsim	-	+	+	+	+	+	+
Ipomea kordofana.	Eltabar	-	+	+	+	+	+	-
Trienemra pentanture.	Alraba	-	+	+	+	+	+	-
Corchorus olitorius.	Almlukhia	-	+	+	+	+	-	-
Ocimum basilicum.	Elryhan	-	+	+	+	+	+	+
Ipomea sinensis.	Elhantoot	-	+	+	+	+	+	-
Rullia patula.	Tagtaga	-	-	+	+	+	+	-
Cenchrous biflours.	Alhuskaneet	+	+	+	+	+	+	-
Echinocola colonum.	Aldiffera	-	-	+	+	+	+	+

Table 3. Effect of Weeds and Varieties on Plant height and Number of Calyces per plant of Roselle

Treatments	Abuharaz		Khortaqqat	
	Plant height (cm)	Number of calyces	Plant height (cm)	Number of calyces
W_0	17.30 [c]	3.5 [c]	25.51 [a]	2.13 [a]
W_1	37.35 [b]	14.64 [b]	52.95 [b]	9.00 [a]
W_2	42.01 [a]	18.38 [a]	53.67 [b]	10.75 [a]
W_3	44.10 [a]	21.75 [a]	54.70 [b]	11.63 [a]
SE±W	2.09	1.40	3.56	0.63
V_1	37.04 [a]	11.94 [b]	51.25 [a]	8.38 [a]
V_2	33.34 [a]	17.06 [a]	42.17 [a]	8.38 [a]
SE±V	1.48	0.99	2.52	0.44
SE±W×V	2.96	1.98	5.03	0.88
CV%	16.48	27.26	20.83	21.09

Similar letters are not significantly different at the 0.05 level of probability according to Duncan Multiple Range Test

The weeds and weeding treatments had significant differences in mean number of branches per plant (Table 4). This result may be attributed to vigorous plant with less competition for light, nutrients, and free space in weed free environment. Similar results were reported by El Naim and Ahmed (2010).

In the present study, increased levels of weeding increased the number of calyces per plant (Table 3). These results agree with Small (2006), Adjun (2003), Baylan *et al* (1983) and El Naim and Ahmed (2010).

They showed that weeding three times resulted in high crop vigor score in number of calyces per plant. Moreover Ibeawuchi *et al.* (2005) reported that component of yield; pod number per plant can severely reduced by weed competition. The conservation water by plants due to weeding frequency could explain this result and this facilitating the growth essentials for regulating growth. The non significant differences among cultivars in number of calyces per plant might be to genotypic factors. Sulaiman (2005) reported that a significant variation among roselle cultivars in number of calyces per plant.

Table 4. Effect of Weeds and Varieties on Number of Branches per plant of Roselle

Treatments	Abu Haraz			Khor taqqat		
	V_1	V_2	Mean	V_1	V_2	Mean
W_0	0.5	0.6	0.4 [c]	0.5	0.7	0.6 [c]
W_1	4.3	4.5	4.5 [b]	8.0	5.3	6.5 [b]
W_2	6.0	5.0	5.1 [a]	8.2	6.45	7.5 [a]
W_3	6.4	7.5	7.5 [a]	8.4	7.40	7.9 [a]
Mean	4.3	4.5		6.3	5.1	
SE± W	0.45			0.48		
SE± V	0.31			0.34		
SE±W×V	0.63			0.69		

Similar letters are not significantly different at the 0.05 level of probability according to Duncan Multiple Range Test.

Table 5. Effect of Weeds and Varieties on Calyx diameter and Calyces Yield (Kg/ha)

Treatments	Abuharaz		Khortaqqat	
	Calyx diameter	Yield (kg/ha)	Calyx diameter	Yield (kg/ha)
W_0	2.36 [b]	108.2 [c]	2.51 [a]	80.7 [b]
W_1	2.72 [a]	621.3 [b]	2.65 [a]	295.9 [a]
W_2	2.96 [a]	818.8 [b]	2.61 [a]	317.5 [a]
W_3	2.72 [a]	1132.3 [a]	2.63 [a]	365.7 [a]
SE±W	0.042	74.6	0.04	27.68
V_1	2.53 [b]	518.9 [b]	2.57 [a]	278.4 [a]
V_2	2.72 [a]	816.6 [a]	2.63 [a]	248.5 [a]
SE±V	0.03	53.01	0.03	19.57
SE±W×V	0.06	106.01	0.06	39.15
CV%	4.48	31.75	4.74	28.61

Similar letters are not significantly different at the 0.05 level of probability according to Duncan Multiple Range Test

Increased weeding frequencies increased the calyces yield per unit area (Table 5). This is because the number of calyces per plant and calyces diameter improved with levels of weeding, which led to increased yield (g /plant) and finally increased yield per unit area. Khater and Ahmed (1992),

El Naim and Ahmed and El Naim *et al* (2010) found that the competition of weeds for light, water and minerals reflected on metabolic process of the plant and finally caused reduction in yield.

In this study, increased frequency of weeding increased the number of calyces per plant (Table 3). These results agree with the results of Small (2006), Adjun (2003) and Baylan *et al.* (1983) and El Naim and Ahmed (2010). They observed that weeds free plant resulted in high crop vigor score in number of calyces per plant. Moreover El Naim and Ahmed (2010) reported that component of yield; pod number

per plant can severely reduced by weed competition. The conservation water by plants due to weeding frequency could explain this result and this facilitating the growth essentials for regulating growth. The non significant differences among varieties in number of calyces per plant might be to genotypic factors. Sulaiman (2005) reported that a significant variation among roselle cultivars in number of calyces per plant. Significant differences in the calyx diameter were observed among the treatments (Table 4). Weeds significantly lower the calyx diameter. This result agree with findings of El Naim and Ahmed (2010)

Significant differences among varieties in calyx diameter were obtained; by Mahmoud *et al*. (1996) and Sulaiman (2005). They reported that land races of roselle in Sudan have considerable variation in size of calyx. Chowdhury *et al.* (1995) reported that, weed free regime gave the highest yield than no weeding regime. Elfashir (V_2) had greater yield per unit area than Elrahad (V_1). This is because V_2 cultivar had the highest calyx's number and calyx diameter. Similar findings reported were by Sulaiman (2005). Non significant differences were reported among the treatment in harvest index (Table 6). This is because the weeding frequencies and variety had similar effect in the economical and biological yield. These results are similar findings obtained by El Naim and Ahmed (2010) and El Naim *et al*. (2010).

Table 6. Effect of weeds and Varieties on Harvest Index of Roselle

Treatments	Abuharaz	Khortaqqat
W_0	20.25 [a]	14.95 [a]
W_1	25.21 [a]	18.01 [a]
W_2	24.27 [a]	20.25 [a]
W_3	22.12 [a]	18.85[a]
SE±W	1.38	1.14
V_1	18.12 [b]	17.54
V_2	27.17 [a]	18.85 [a]
SE±V	0.98	0.99 [a]
SE±W×V	1.95	1.99
CV%	17.00	22.26

Similar letters are not significantly different at the 0.05 level of probability according to Duncan Multiple Range Test

Increased weeding frequencies increased the calyces yield per unit area (Table 5). This is because the number of calyces per plant and calyces diameter improved with levels of weeding, which led to increased yield (g /plant) and finally increased yield per unit area. Khater and Ahmed (1992) found that the competition of weeds for light, water and minerals reflected on metabolic process of the plant and finally caused reduction in yield. Chowdhury *et al.* (1995) reported that, weed free regime gave the highest yield than no weeding regime. Elfashir (V_2) had greater yield per unit area than Elrahad (V_1). This is because V_2 cultivar had the highest calyx's number and calyx diameter. Similar findings reported were by Sulaiman (2005). Non significant differences were reported among the treatment in harvest index (Table 6). This is because the weeding frequencies and variety had similar effect in the economical and biological yield. These results are different from that obtained by Alam *et al*.(1995) in cotton.

4. Conclusions

Based on the results of this study, the weeding three times at 15, 30 and 45 days after sowing are effective to control weeds and recommended to improved yield of roselle crop in sandy dunes of north Kordofan (Sudan) under rain-fed conditions in traditional agricultural sector.

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