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Crops Yield Assessment Using Agro Forestry Practices

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Abstract. The present study was conducted over two seasons (2009/2010 and 2010/2011) at Abu Nama forest reserve in Abu Hugar Governorate, Sennar State, Sudan with the objective of evaluating the effect of agro forestry inter-planting on crops yield of sorghum, sesame and ground nut. The experiment was compared the effects of inter-cropping to three traditional rain fed crops with and without *Acacia senegal* trees. Treatments were inter-cropping at tree spacing of 4×4 m, and 4×8 m and sole cropping. Randomized complete block design (RCBD) with three replications were adopted. The results showed that crop yields were increased under inter-cropping. Although, this increase could be attributed to the raised soil fertility and shelter under *Acacia senegal* trees, but gum yield was decreased in inter-cropped plots.

Keywords: *Acacia senegal*, Tree crop interaction

1. Introduction

Ecologically the study area is classified as low rainfall savanna, ranging between 400 and 700 mm from June to October. The vegetation was predominantly thorny Acacias such as *Acacia mellifera*, *Acacia nubica*, *Acacia seyal*, *Acacia nilotica* and *Acacia senegal* which was later clear-felled for mechanized agriculture. Wind speed is moderate 7.8 kph with occasional dust storms in summer. The soil is dark cracking clay (vertisol). Extensive mechanized agriculture led to land degradation in these schemes. Reforestation of the abandoned agricultural schemes with *Acacia senegal* was restored to as a measure of reclaiming these degraded sites. This was enforced since early seventies in Abu-Hugar locality, El-Dali locality and El-Mazmum rain fed mechanized schemes. It was indicated by several authors that *Acacia senegal* rejuvenates soil and improves crop yield [3][4]. However, Mohamed [6] reported that inter-cropping with *Acacia senegal* increased the yield of sorghum (19%). Agro forestry systems have the potential to make use of degraded lands by the improving effects of trees. Agro forestry may be practiced by integrating trees into farming system or by integrating farmers into the forest [8].This research was proposed to monitor and assess the effect of *Acacia senegal* plantation on formerly abandoned agricultural schemes, and formulate future practices for rehabilitation of similar degraded sites. The slight decline in rainfall reached near Dali-Mazmum on over the last 30 years, which is consistent with marked decrease in rainfall for Kordufan province, may have led to a fall in potential productivity. Impacts of the Finnish Forestry Assistance to the Sudan started to materialized by chosen three principles field sites from which was Dali area, to subject the clay plain between the Blue Nile and the White Nile where massive land degradation has occurred after failures in large scale commercial agriculture and where land rehabilitation for small holder farming was started in the 1980s using Acacia plantations.

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2. Materials and Methods

The experiment was conducted in Abu Naama-Sinnar State-Sudan. It is located 400 km south to southeast of Khartoum along the Blue Nile river. The topography of the state is generally flat. The soil is dark colored alkaline clay, which swells and becomes extremely sticky when wet, but develops wide and deep cracks when dry. The temperature varies from a mean daily minimum of 14° C to the maximum of 40° C. The average annual rainfall is about 500 mm mainly between June and October. The site was cleared completely, and fenced where ever necessary. It was laid down 10×20 m during May, and seeds were sown during August after testing for germination at the recommended spacing of 25 cm for sorghum.

The seed rates were three seeds per hole as per the standard practice of Abu Nama Agricultural Research Station. Crop was cultivated for two seasons. The experimental design was used randomized complete block design (RCBD) with three treatments and three replications. Collected data was analyzed by using SAS statistical software. The following crop growth parameters were measured:

2.1. Plant Height (cm)

Small representative samples which will not affect the growth were chosen; five plants were selected from the centre of each plot and tagged for height measurement using the measuring tape from ground level (root collar) to starting point of branch sprout.

2.2. Number of Leaves

Five plants were selected from the centre of each plot, and the average numbers of leaves were recorded.

2.3. Crop Yyield (kg/ha)

Seed yield for crop at each plot of 20×10 m distance for inter-cropping, and of 7×6 m distance for the sole crop was collected at harvest time; weighed in kg and then converted to yield per hectare. Crop was harvested at maturity, and seeds weighed on a field balance for each plot in kg, after that converted to yield per hectare.

Yield per hectare = 10000 × kg per plot / Plot area (m).

3. Results and Discussion

3.1. Plant Height

The plant height of sorghum grown with and without *Acacia senegal* tree is shown in table 1. Analyses of variance showed that there is a significant difference in an inter-cropping at 4×4 m, and both for inter-cropping at 4×8 m and sole cropping. For both seasons, the inter-cropping at 4×4 m attained the highest height (180 cm) followed by the inter-cropping at 4×8 m (150 cm), and the sole cropping (139 cm).

In case of sesame and ground nut, height growth was found the highest in inter-cropping at 4×4 m, and the lowest in sole cropping system (Table 1). Although during the first season, there is significant difference found between inter-cropping at 4×4 m and sole cropping. However, in second season, there are no significant differences between the three cropping systems for both sesame and ground nut crops.

Table 1. Plant height (cm) of crops grown with and without *Acacia senegal* trees

Treatment	Season 2009-2010			Season 2010-2011		
	Sorghum	Sesame	Ground nut	Sorghum	Sesame	Ground nut
Inter-cropping at 4×4 m tree spacing	180.0[a]	159.9[a]	21.2[a]	189.3[a]	157.1[a]	19.9[a]
Inter-cropping at 4×8 m tree spacing	150.0[b]	138.0[b]	18.4[b]	152.1[b]	140.0[a]	18.8[a]
Sole cropping	139.0[b]	136.1[b]	17.5[b]	137.0[b]	135.2[a]	17.0[a]
	LSD=37.6	LSD=17.7	LSD=2.3	LSD=29.5	LSD=28.5	LSD=2.9

Note: same letter in same column indicates is not significantly different at P <0.05

3.2. Number of Leaves

The number of leaves for all crops was decreased by the increased of tree spacing (Table 2). Significant reduction of leaves was observed in sorghum crop with increasing the tree spacing. The crops seem to decrease their leaves to compensate for the reduction of light.

Sesame did not show differences in leaf numbers in these two seasons for three treatments (Table 2). But, for ground nut, there was found significant differences in leaves number in two growing seasons at 4×8 m inter-cropping and sole cropping systems. In this respect, Nsereldin [7] reported that there was no significant difference in number of leaves with the different tree spacing adopted in Nyala locality, since the leaves are considered as the centers for carbohydrate production, through photosynthesis process increasing number of leaves usually associate with increasing in seed yield.

Table 2: Number of leaves of crops grown with and without *Acacia senegal* trees

Treatment	Season 2009-2010			Season 2010-2011		
	Sorghum	Sesame	Ground nut	Sorghum	Sesame	Ground nut
Inter-cropping at 4×4 m tree spacing	5.1[a]	72.1[a]	45.1[a]	9.2[a]	80.0[a]	51.0[a]
Inter-cropping at 4×8 m tree spacing	4.2[ab]	69.2[a]	39.3[b]	6.8[b]	72.3[a]	40.1[a]
Sole cropping	3.7[c]	45.8[a]	37.1[a]	6.1[b]	65.1[a]	39.0[b]
	LSD=0.45	LSD=15.4	LSD=9.2	LSD=0.70	LSD=14.9	LSD=8.6

Note: same letter in same column indicates is not significantly different at P <0.05

3.3. Crops Yield (kg/ha)

Yield of sorghum was found significantly higher at the inter-cropping spacing of 4×8 m (1786.7 kg/ha) as compared with the inter-cropping spacing of 4×4 m (1205.0 kg/ha) and sole cropping (750.0 kg/ha). In the second season, sorghum yield followed the same pattern as season one; giving yield of (1315.5 kg/ha) for 4×8 m, 895.0 kg/ha for 4×4 m, and 407.5 kg/ha for the sole cropped system. The result is similar to that obtained in sandy soils by Mohamed [6] in Eldemokeya forest reserve who reported a yield of 166 kg/ha for inter-cropped and 135 kg/ha for sole cropping. Similar finding were reported by Nsereldin [7] in Nyala Gardud soil giving 600 kg/ha and 380 kg/ha yields for sorghum at the inter-cropping spacing 8×8 m and 4×8 m respectively.

Moreover, Lehmann et al. [5] reported that the inter-cropped is slightly higher than the mono-cropped sorghum yield. The yield increase of inter-cropped sorghum may be due to the higher fertility under *Acacia senegal* trees as stated by Bayola et al. [1] since sorghum yield at inter-cropping system 4×8 m attained the higher yield (1786.7 kg/ha) as compared to the yield at intercropping spacing 4×4 m (1205.0 kg/ha). This can be explained by Nair et al. [9] conclusion that if soil is relatively fertile, competition for light between crops may be the main critical factor when water is adequate. Recent data about the yield of mechanized agriculture at Wad Elnayal area showed that the mean yield for the sorghum at the five recent years is about 660 kg/ha at mean annual rainfall of about 552 mm compared with 1500 kg/ha as the mean for sorghum production at 879.5 mm mean annual rainfall in this study.

During the two seasons, the highest yield was found at 4×4 m inter-cropping system for both sesame and ground nut (Table 3). In kordofan sandy soils, Fald [2] indicated that tree density has a profound impact on ground nuts productivity giving yields of 356 kg/ha for inter-cropping.

Table 3: Yield of crops grown with and without *Acacia senegal* trees (kg/ha)

Treatment	Season 2009-2010			Season 2010-2011		
	Sorghum	Sesame	Ground nut	Sorghum	Sesame	Ground nut
Inter-cropping at 4×4 m tree spacing	1205.0[a]	285.0[a]	1180.0[a]	895.0[a]	63.5[a]	61.2[a]
Inter-cropping at 4×8 m tree spacing	1786.7[b]	428.6[b]	1952.5[b]	1315.5[b]	486.3[b]	1154.8[b]
Sole cropping	750.0[c]	342.5[c]	997.5[c]	407.5[c]	278.8[a]	751.3[c]
	LSD=447.2	LSD=26.6	LSD=114.4	LSD=278.8	LSD=89.8	LSD=136.3

Note: different letters in same column indicates is significantly different at P <0.05

3.4. Gum Yield (kg/tree)

Gum yield from *Acacia senegal* trees decreases when inter-cropped with field crops probably due to the inherent competition between the trees and the field crops. The gum yield at the inter-cropping spacing 4×4 m was 0.8 kg/tree, at 4×8 m spacing was 1.1 kg/tree and at sole cropping was highest 2.1 kg/tree in 2010 (Table 4). A similar result was reported by Mohamed [6] at Eldomekeya site, who attributed the reduction to the strong competition between trees and crops for water. Moreover, gum yield was reduced at the second season 2011, giving 0.7 kg/tree at inter-cropping spacing 4×4 m, and 0.8 kg/tree at 4×8 m inter-cropping spacing and 1.6 kg/tree for sole cropping. Due to inadequate rainfall in 2011, is mainly responsible for poor gum production.

Table 4: Gum yield (kg/tree) for three cropping patterns

Treatment	Gum yield in 2010	Gum yield in 2011
Inter- cropping 4×4 m	0.8[a]	0.7[a]
Inter- cropping 4×8 m	1.1[a]	0.8[a]
Sole cropping	2.1[b]	1.6[b]
	LSD=0.4	LSD=0.2

Note: same letter in same column indicates is not significantly different at P <0.05

4. Conclusion

Agro forestry systems based on *Acacia senegal* can, apart from their environmental benefits, also make full use of the available resources and thus lead to a higher combined yield as a compared to growing trees or agricultural crops alone. This is the result, mainly from improved soil fertility. The gum yield can be significantly increased when inter-planted without agricultural crops that result from competition between trees and crops.

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6. References

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