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Assessing gum Yield from *Acacia senegal* during its Peak Picking in relation to Growth Attributes

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ABSTRACT

The second gum picking from *Acacia senegal* trees is always the highest and the peak. This research was conducted in Acacia agricultural Project during 2020 to investigate the relation between crown diameter and yield of gum arabic trees. It also investigated relation between number of branches and yield. Data was collected using field data sheet where all measurements were conducted on trees. The tree girth was measures using Caliper, tree height measures by measuring stick, crown diameter measured by diameter tape while gum yielded was weight by sensitive balance. Data was analysed where maximum, minimum, averages, and standard deviation were calculated. Relations between measured parameters were correlated. The results showed no significant differences between gum yield (g) in the two sites. The average yield (g) of a tree in the 2nd picks in El Rahad and Sheikan was 138.8±97.6 and 133.6±92.9 respectively. Positive relation between crown diameter (cm) and yield in El Rahad and Sheikan sites was found where R2 values were 0.178 and 0.29 respectively. There was also positive relation between number of branches and yield (g) in El Rahad and Sheikan sites where R^2 values 0.05 and R^2 = 0.06 respectively. The yield of one single productive tree due to eight pickings in El Rahad and Sheikan was 1112 (g) and 1068(g) respectively.

Keywords: *Acacia senegal*, gum arabic tree, yield.

1. INTRODUCTION

Sudan is the world's largest producer of gum Arabic, providing a bout (78%) of international gum market (Almeghar, 2016). *Acacia senegal* is the most important multi-purpose tree species in the Sudan (Ballal 1991). *Acacia senegal* variety *senegal* is the main source of gum arabic and a well-established traditional agroforestry tree component in Sudan (Raddad, 2013). The traditional production of gum arabic is an off-season income-generating activity for most of the farmers in this region. Gum Arabic is one of the main crops produced in the traditional rain-fed agricultural sub-sector in Sudan (Abdel aziz et al, 2018) Gum yields have decreased, and so has the gum trade, because of biotic, physical, socioeconomic and institutional reasons (Barbier, 2000; Ballal *et al*. 2005). In recent years, the traditional *Acacia senegal* agroforestry system has been disrupted due to misuse of lands, drought, desertification, the massive increase in human and animal population, and the overall declining trend in gum arabic yield, all these factors collectively lead to the decrease in gum production and supply (Awouda 2000;

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Ballal 2008, Fadl and Gebauer 2004). There are four different systems for gum arabic production in Sudan. They included small scale system (traditional in small areas 5 -25 feddan), large scale system (50-500 feddan), gum production in Forest National Corporation Project, and Gum production with contracted Projects. Acacia Agricultural Project is typically to the last one (Ramly et. al. 2021). This research investigated the yield of gum Arabic tree in Acacia Agricultural Project during the second picking in season of 2020. FAO (2004) identified gum Arabic as a potential commodity in world trade while it has been the main stay of the Sudanese economy for over 400 years (Lawal, 1998). The yields increase from the first picking, reach their peak in the second, and then decrease slightly in the third pick and sharply thereafter (Bellal, 2005). The highest gum production of could be gain when trees tapped in early October (Eltahir and Ismaeil, 2020, Ballal, 2005). Hashab trees which tapped in November produced lower gum quantities (Eltahir and Ismaeil, 2020). Research approved that the second picking is the most potential one. This research investigates the relation between crown diameter and yield of gum arabic trees; it also investigates relation between number of branches and yield during the second pocking.

2. MATERIALS AND METHODS

2.1. Study area

This research was conducted in Acacia project areas in North Kordofan state namely El Rahad and Sheikan sites. El Rahad site is located 37 Km south east Elobied while Sheikan site is located about 35 Km south Elobied. The total area of the project is 28000 feddans which was planted with gum arabic trees in 1997. The inter-row spacing is 3m and the intra-row spacing is 5m. Hashab trees were found evenly grown, approximately about 280 hashab tree/ feddan (Acacia Project Reports, 2007). Hashab plantations in El Rahad site were more or less stunted possibly due to soil compaction (Taha, 2006).The soil is hard crust; generally flat, non-cracking clay mixed with Aeolian sand and with low infiltration rates locally named Gardud (FAO, 1997). Sheikan Site is located south to Elobied City covering an area of 12000 feddan. The climate is semi-arid with annual rainfall ranging from less than 200 mm in the north to about 350 mm in the south; the temperature is highest during July ranging 30 - 40° C (Abdulla, 2006). The trees were planted in regular base. Water harvesting techniques were done using different agricultural machines. Thinning and replanting were done during the second and the third year to achieve the optimum tree density. Currently the tree density per hectare is 500. The trees now are in peak production stage.

2.2. Methodology

The data was obtained from Acacia Agricultural Project. The data collection based was done using field data sheet where all measurements were conducted on trees. The tree girth was measures using Caliper, tree height measures by measuring stick, crown diameter measured by diameter tape while gum yielded was weight by sensitive balance.

2.3. Data analysis

The data was managed and entered in Microsoft Excel. The statistical analysis was done where counts, averages, maximum, minimum and standard deviation were calculated. Correlation between crown diameter and yield and between number of branches and yield was also done. Results were presented in figures and tables.

3. RESULTS AND DISCUSSION

3.1. Growth and yield parameters in El Rahad

Analysis was done to 50 productive trees in El Rahad. The results showed that the average girth of the trees was 8.5±3 cm, average of crown diameter was 4.5±1.3, and average number of branches was 2 branches, average tree height was 3.1±0.9 m and average gum yield was 138.8±97.6g. The estimated yield for up to 8 pickings resulted as 1112g. The results of measured indicators indicated that trees are in the optimum production age. In a similar study, Eltahir (2020) found that the average yield of high gum yield hashab trees was 7600g (7.6±2.1 kg/tree/season). When compared the two different yield, if was found that trees yields different even from one variety. The highest yield was recorded for a high yield trees which are well known for high production. However, producing of 1112g per season is accepted (Table 1).

3.2 Growth and yield parameters in Sheikan

Analysis was done to 58 productive trees in Sheikan. The results showed that the average girth of the trees was 6.9±1.9cm, average of crown diameter was 3.6±0.9, and average number of branches was 2 branches, average tree height was 2.8±0.6m and average

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gum yield was 133.6±92.9g. The results of measured indicators indicated that trees are in the production age although the amount produced is not the highest compared to High Yielding Hashab Trees (Table 2).

Table (1) Growth and yield parameters for *Acacia senegal* trees grown in El Rahad site.

	girth (cm)	Crown diameter	No branch	Height (m)	Gum yield (g)
Average	8.5±3	4.5±1.3	2.1±0.7	3.1±0.9	138.8±97.6
Maximum	18.0	8.7	4.0	6.5	455.0
Minimum	3.0	1.75	1.0	1.5	9.0

Table (2) Growth and yield parameters for *Acacia senegal* trees grown in Sheikan site.

	Girth (cm)	Crown diameter	No branch	Height (m)	Gum yield (g)
Average	6.9±1.9	3.6±0.9	2.2±0.9	2.8±0.6	133.6±92.9
Maximum	14	6.4	5	4.15	505
Minimum	4	2.25	1	1.6	15

Plate 1 *Acacia senegal* trees planted in El Rahad site (Photos credited (Muneer, 2021))

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Plate 2 *Acacia senegal* trees planted in Sheikan site (Photos credited (Muneer, 2021))

3.3. Relation between crown diameter and trees yield in El Rahad

In figure 1, the relationship between crown diameter and tree yield in El Rahad site was positive, with increase of crown diameter there was an increase in the gun yield from *Acacia senegal* trees. The R^2 value was 0.1777. Some trees are exceptional case with regards to yield, their crown is small however, and their yield is higher. This means that not only crown diameter which effect on yield but many other climatic factors such as temperature and rainfall for instance. It was stated that higher yields of gum arabic are obtained under adverse conditions, which is contrary to forage yield (Eltahir and Ismaeil, 2020).

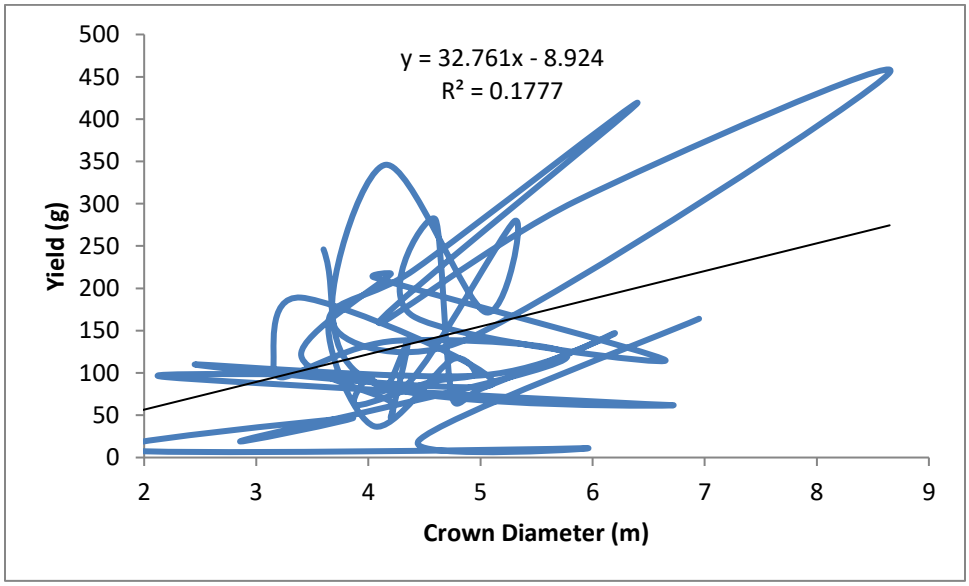

Figure 1 Relationship between crown diameter and trees yield during second picking at El Rahad site

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3.4. Relation between number of branches and trees yield

Figure 2 showed the relationship between number of main branches and gum yield. It was found that there was positive relationship between number of branches and the yield for many of trees. Here, the relationship is positive but weak where R^2 value was 0.048. It was also observed that the trees with multi stem used to produce high quantity of gum if all are tapped.

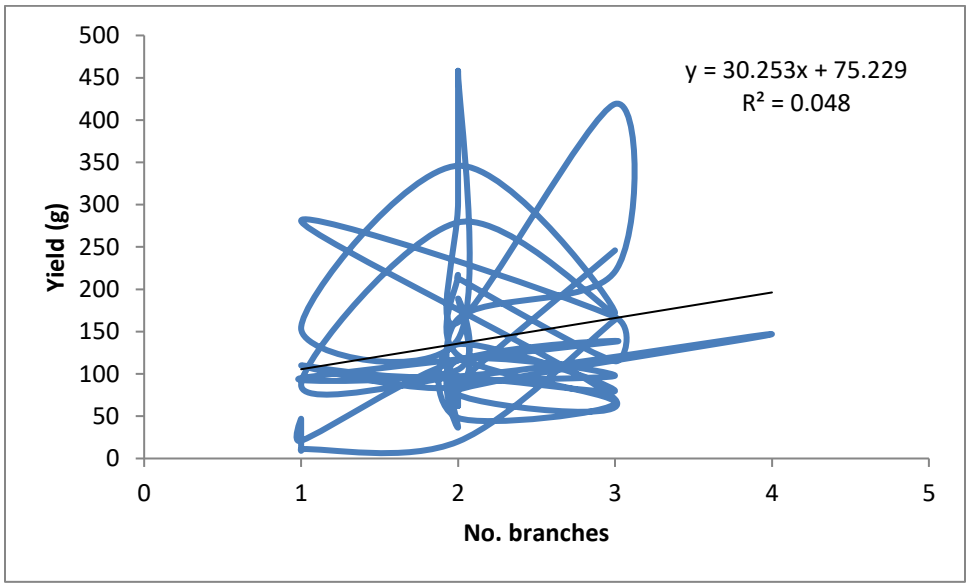

Figure 2 Relationship between number of branches and gum yield at 2nd picking, El Rahad

3.5. Relation between crown diameter and trees yield in El Rahad

The relationship between crown diameter and tree yield in Sheikan site was also positive, with increase of crown diameter there was an increase in the gun yield from *Acacia senegal* trees. The R^2 value was 0.2927. Some trees are exceptional case with regards to yield, their crown is small however, and their yield is higher, e.g. a tree with 3.25 m of crown yielded 400g in the second pocking. This also means that not only crown diameter which effect on yield but many other biotic and a biotic factors such as temperature and rainfall as climatic factors (Figure 3).

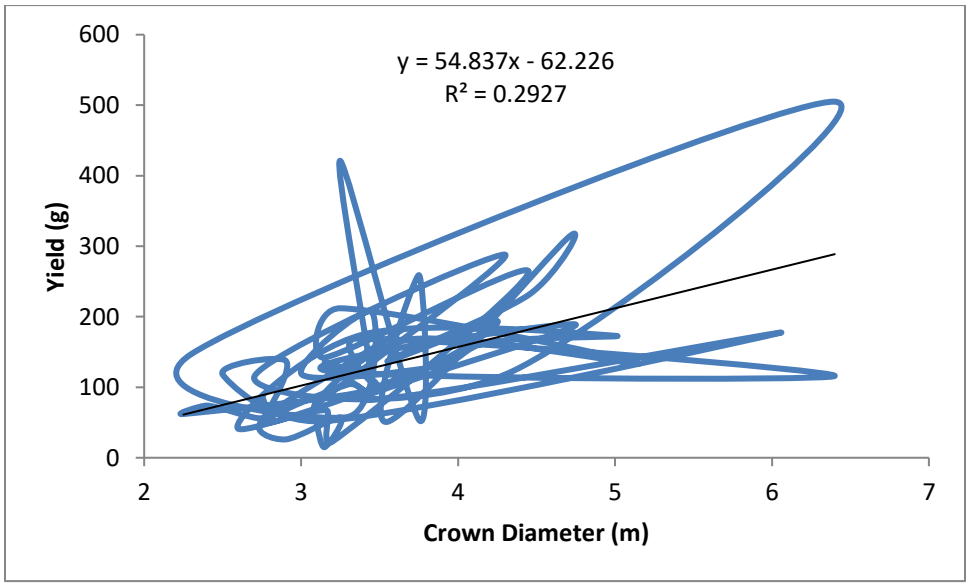

Figure 3 Relationship between crown diameter and gum yield at 2nd picking at Sheikan site

3.6. Growth and yield parameters in Sheikan

Figure 4 showed the relationship between number of main branches and gum yield. It was found that there was positive relationship between number of branches and the yield for many of trees. The relationship found weak where R^2 value was 0.048. It

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was also observed that the trees with multi stem used to produce high quantity of gum if all are tapped in a year however, in the second year the quantity of gun decreases.

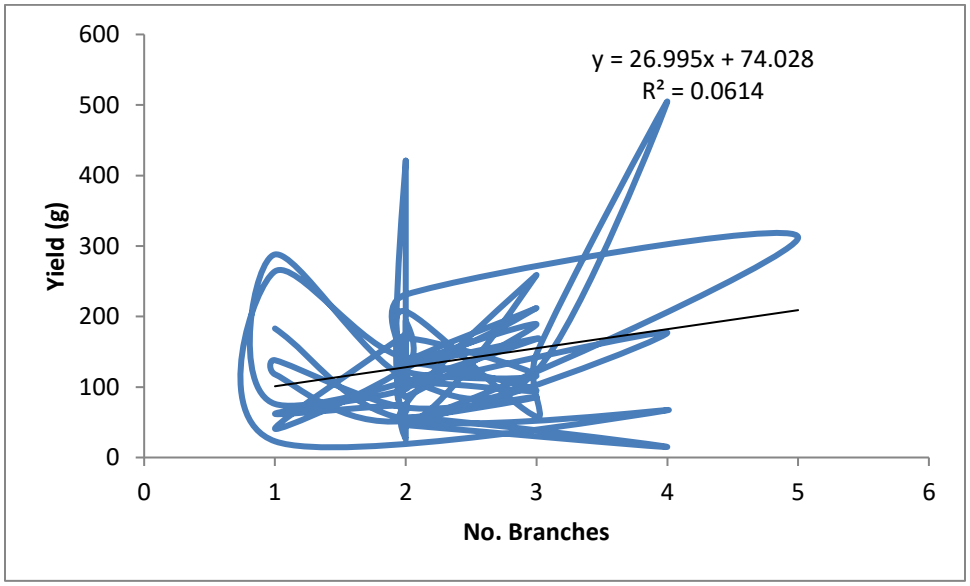

Figure 4 Relationship between number of branches and trees yield during second picking at Sheikan site.

Comparison of growth measures between two sites

Figure 5 showed no significant differences between the two sites in term of average tree girth, number of branches but for tree height. Trees at El Rahad site are higher than in Sheikan site. There is also no significant differences between the yield in two sites. The average yield in El Rahad is 138.8±97.6g while in Sheikan is 133.6±92.9g.

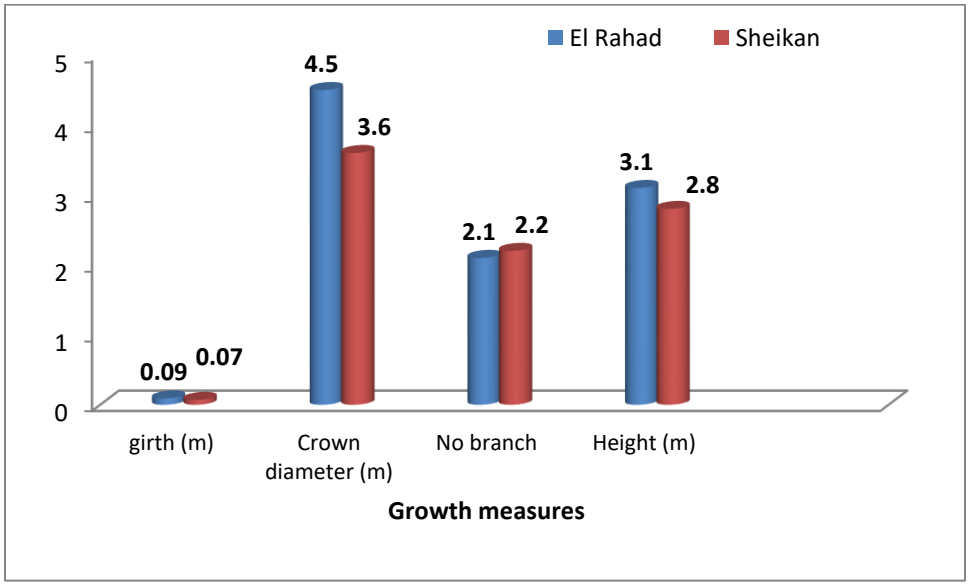

Figure 5 Comparison of growth measures between two sites

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Plate 3 gum (8 nodules) on branches and stems of *Acacia senegal* tree (Photos credited (Muneer, 2021)).

4. CONCLUSION AND RECOMMENDATION

Acacia senegal trees have ability to continuously exudate gum when are tapped during October under favourable tapping condition. The second picking was is the peak for gum exudation and production. According to review, the third picking follows the second in term of high produced amount of gum. The relationship between crown diameter and the yield and also between number of branches and yield is always positive. Not only the month, crown and number of branches which control the amount of gum produced but also other factor are included for instance genetic factors, tapping tool, climatic factors, indigenous knowledge and know how. It is recommended to accumulate knowledge on all factors that enhance gum exudation so as to maximize the yield and to assure sustainable production.

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Authors' contributions

This current research work was collectively done by the two authors. MESE brought the idea, supervised the whole work and written the manuscript. RHSH collected the data, managed it and participated in data analysis. No conflict of interest encountered between authors.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Data and materials availability

All data associated with this study are present in the paper.

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