Effect of grafting (rootstock) on Morphological Changes of Scions in some Acacia Species

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Abstract: The experiments were conducted in Singa nursery, Forests National Corporation, Sinnar State, Sudan, during the period 2009-2013. The study aimed to test the hypothesis that, grafting of both Acacia mellifera and Acacia senegal as Scions onto Acacia polyacantha as rootstocks and A. senegal alone as scion onto A. mellifera and A. seyal as rootstock, has the ability to inspire and change leaf, branch, stem, thorn and fruit morphology of grafted Scions (A. mellifera and A. senegal). Five replicates were used; each replicate represents ten plants of each species Acacia polyacantha, A. senegal, A. seyal and A. mellifera. Splice grafting was conducted using polythene bags, filled with sand and clay soil, with ratio 1 to 2 respectively. The same replicates and treatments were applied to A. senegal as scions, A. mellifera and A. seyal as rootstocks. The seedlings were placed in a greenhouse designed specifically for the experiment, with 50% shade. Observations were used to determine the healing in seedling stages and morphological changes on the leaf, thorn, stem, and fruits of grafted plants (Scions), in the treated scions in field stages. Data were recorded and analyzed. The results showed that the success of healing was ranged between 80 - 84% and the overall mean percentage was above 81%. The leaf shape of grafted A. mellifera (Scions) was completely different from the origin (control), which seems to be more similar to Acacia polyacantha leaflet, hence appeared small in size, compared with the control, with change percentage 90%, while the fruit (pods) of the grafted scions of Acacia senegal onto A. mellifera were also changed, exhibited aggregate (group) fruits that emerged from peduncle, more similar in shape to A. mellifera fruits. The change percentage was 75%. The thorns of A. senegal (scion) onto A. mellifera were completely reduced sharply in numbers beside branching increase, showing multiple branched tree, compared with the control of single stem, , with a 75% change in thorn and 88% change in branches. The 20 to 75% change in thorns was observed in A. mellifera scion/A. polyacantha rootstock and A. senegal scions/A. mellifera rootstock respectively. The modifications that occurred, in the emerged leaves, fruits, number of branches, thorns and stems of scions, reflect the remarkable effect of rootstock on scion. These morphological changes produced grafted A. senegal tree, that may become a superlative futuristic gum tree, expected to contribute in gum production, by producing a commercially viable superior grade of gum Arabic, nevertheless this entails further investigation, to test the produced gum quality. This result concluded that, grafting of wood plant A. mellifera, A. polyacantha and A. senegal seedlings stages have a positive effect on morphological change on leaves and fruits, number of branches, thorns and stems on scions of plants. These findings will flourish production in the gum Arabic and range sectors by maximizing benefits which can be reaped from gum and seeds and hence boost farmers’ income in rural areas.

Index terms: Grafting, Acacia mellifera, Acacia senegal, Acacia polyacantha, Scion, morphological changes.

I. INTRODUCTION

Acacia senegal (L.) wild belong to the family leguminosae and subfamily mesosidoidae according to Ross [1] and [2] five varieties of Acacia senegal have been recognized, including A. senegal var. senegal, A. senegal var. kernessis, A. senegal var. rostra, A. senegal var. leorhachis and A. senegal variety pseudoglaucaphyla. [3]. A. senegal Native range Angola, Botswana, Burkina Faso, Eritrea, Ethiopia, Gambia, Kenya, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sudan, Tanzania, Uganda, Zambia, Zimbabwe. The pods are straight, thin, flat, short stalked and oblong (7.5 x 2 cm), green and pubescent when young, maturing to shiny bronze, often with dark patches and bearing prominent veins; seeds 3-6, smooth, flat, rather small, shiny, dark brown [4] the classification of the belt in which the species occurs under the low rainfall wood-land savanna on sand in western Sudan and on clay in central and eastern Sudan. The gum belt extended within the rainfall range of 280-450mm/ annum on sand and within average rainfall 500mm/ annum on clay plain [5] Gum tree, A. senegal has the ability to be grafted onto other Acacias in nursery condition, this may help in increasing yield per tree and resolve other problems in term of pest and disease [6]. Asexual reproduction known as vegetative propagation is widespread in plants. In vegetative propagation apportion of one plant gives rise to a
completely new plant. Both plants have identical genes. Asexual reproduction has a great commercial importance. Once a plant variety with desirable characteristics has been developed through vegetative propagation, the new plant can be applied by gardeners and farmers. Cutting can be taken from a plant and the cut can be treated to encourage it to grow roots, or a cutting can be grafted as a form of grafting, most often used commercially. In this procedure the auxiliary buds are grafted onto the stem of another plant. It is quicker and easier to test for protoplasts instead of entire plants, for desired characteristics such as resistance to bacteria and fungi, high temperature and drought. Protoplast can be made to fuse together. In one experiment a potato and tomato protoplasts were fused and the hybrid plant was eventually grown; perhaps protoplast fusion will eventually allow a botanist to alter the genetic makeup of a variety of plant [7] Graft methods can be classified into three categories, bud graft, branch graft and stem graft, the plant root system suitable for distant grafting as rootstocks such as ginger, lily, sweet potato, potato and yam. Other plants with thick stem are also appropriate for grafting as rootstocks such as caster, sunflower, sesame, maize and sorghum. According to the graft mode of stock and scion can be divided into plug graft, clef graft and splice graft [8]. Grafting use as a means to improve quality. It has been reported that grafting can affect pH, sugar, color, texture, carotenoid content and flavor [9]. Initiation of morphogenic Scions by grafting induces morphological changes on leaves, flowering and fruits due to genetic changes that have potential in genetic improvement [10]. Grafting of tomato as restock and potato as a scion resulted in changing leaf shape, showed a graft-transmissible RNA from the tomato rootstock can change leaf morphology of potato scion [11]. Using hetero-grafting techniques with cucumber as scion and pumpkin as stock, showed evidence of the selective system for the delivery of specific RNA molecules into developing tissues of scions through the sieve element [12, 13, 14& 15]. Several phloem proteins having a wide RNA–binding activities are able to move through interspecific grafts from melon (Curcumas melon L) to pumpkin. It has long been believed that a long distance signal, named florigens is transported from the leaves to the apex [16] the scion characteristics can be changed by grafting [17] and [18]. Some of these changes might be responsible for the transport of the gene transcript [19]. Grafting Acacia senegal onto Acacia mellifera is possible in young seedling using splice grafting, the union percentages ranged between 60 to 80% within 6 to 8 weeks. Grafting has a significant effect on growth performance of plant [20]. The world population was 1550 billion as the estimated total in the year 1900, while in 2000 the total population was coming to 6280 billion. At present more than two of every three people on this earth not get enough food daily to enable them to live a completely healthy and contented life. According to recent United Nation statistics, the population increase by more than 13 million persons every year [21] Gum Arabic is the main product. A. senegal produces some 90 % of the marketed gum Arabic sold in the world. Annual world commercial production varies from 20,000 to 60,000 tons per annum, averaging 40,000. 80% of the world trade used to originate in the Republic of Sudan, particularly in the Kordofan province; but this has decreased and other countries are developing their own production, as it is an open ended marker. Production varies widely and wildly from 10 g to 10 kg per tree / annum. The average may be of the order of 100 g per tree and up to 250 g / tree / annum in the best managed orchards of Kordofan Human medicine: bark, leaves and gum are used to treat gastric disorders, hemorrhage, ophtalmia, colds, diarrhea, as emollient, astringent; the gum is considered an aphrodisiac. The flowers are relished by honeybees [22]. In Sudan the gum Arabic is one of the most important agricultural product, that support the national economy, as feasible source that generate hard currency and lift poverty in rural areas. As the production is decreasing, beside the deterioration in gum productivity per tree and rainfall fluctuation in gum belt, for these reasons it is high time to seek for transformative approaches or techniques of grafting, that help in soaring-up gum production per tree, which was the aim of this study, to test the hypothesis that wood plant (A.mellifera, A.senegal, Aseyal and A.compylacantha) have the ability to be grafted, onto each other ,with morphological transformation in scions, due to rootstocks effect.

II. MATERIALS AND METHODS
The study was conducted in the Forests National Corporation nursery, in Singa town during the period July 2010-2013. Seeds of A.mellifera A.senegal A. seyal and A. polyacantha were collected from Okalma forest, Singa state. On the first of January seeds were sown separately in polythene bags filled with clay and sand soil with 2:1 ratio respectively. Watering was done frequently every two days. When seedlings reach three weeks old, splice grafting was used. The treatment was done as follows; the shooting tips of young seedlings above the cotyledons of each species were scratched on one side. The scabbled sides were attached each other using plastic tape. Fifty seedlings of the same age and size of A.mellifera were used as rootstock splicing with A.senegal as scion (Figure 1). The same treatment was applied for another 50 seedlings prepared (scions) of A. mellifera and another 50 seedlings of A. senegal scenes where the scabbled scions of both species were spliced with A. polyacantha as rootstock; the spliced parts were wrapped using scotch tapes too. The same reciprocal treatment was done using the same steps for A. mellifera as scion and A. polyacantha as stock and A.senegal scion/A.seyal. The entire treated seedlings
were left for eight weeks, after wrapping with plastic tapes and placed on the seedling bed, with 50% shading. Irrigation was done every two days by the use of flooding. The healing of scions was observed, and then removals of plastic tapes were carrying out. The grafted seedlings of all species i.e. *A. mellifera* onto *A. polyacantha* and *A. senegal* onto *A. mellifera* and *A. seyal* were nursing in the nursery for two weeks before transferring to the field, where 20 seedlings of each treatment were planted. Observations were recorded on the morphological changes, leaves shape and size branching, flowering and fruiting. Data were analyzed to determine the percentages in morphological changes.

**Figure (1)** Shows the method of treatment, where (middle, first). Then plastic was removed after four weeks, started from the first day of splice grafting operation. And when the healing parts observed clearly (left, first), then separation from each other are done after the two grafted plants growing together and unified, forming one plant (middle, second). After that left for two weeks as hardening period, before transfer to the field (right photo number four).

**III. RESULTS AND DISCUSSIONS**

These results showed that the healing rate between the treated specimens was ranged between 80 to 84% while overall percentage was above 81%, which reflect a high success of the union (Table 1). This results in agreement with what was reported by [6] on healing rate in acacias seedling stages. The leaf size (compound or leaflet) of (scions) of *A. mellifera*, that grafted onto *Acacia polyacantha* (rootstocks) gave different shape compared with the origin (control) in field stage, where the leaf become visible very resemble to *Acacia polyacantha* leaf, particularly in apex end as observed (Figure2a). The flowers emerged in the grafted *A. senegal* (scion) on to *A. mellifera* (rootstock) when trees are two years old while the control trees not take the same behavior although have the same age and treatments. This may indicate appositive signal for the reduction of the tree duration, which will help in intensify the species in the area wise and gum quantity wise later. The scion (*A. senegal*) flower emerged in a huge number, pedunculated in an aggregated manner at exile, which not like that in the natural tree i.e. it is an anomaly behavior. The fruits (pods) produced by scions showed different shape, size and number, which formed in the form of clusters (group), but similar in shape, size and apex end to that produced by original *A. mellifera* which reflect the effect of rootstock on the scion. These results indicated that genetic change was happening due to grafting process which in line with what was reported by [10].

**Figure (2a):** Shows branches (scions) of *A. mellifera* grafted onto *A.compylacantha*, the shape and the size are completely changed in both compound leaf and leaflets.
Leaves change observations and evidences in scions

The results showed that, the grafted emerged leaves of scions (A. mellifera) that grafted onto A. compylacantha, took the shape of A. mellifera compound leaves but small in size compared with the origin (Figure 2 b) Shows morphological changes on leaves of A. mellifera (Scion), when grafted onto A. compylacantha as rootstock. The first photo (left) confirmed the change in scion, where the leaflet looks too small in comparison with the origin, in the same one. The original compound leaf of A. mellifera in comparison to grafted emerged leaf from A. mellifera as a scion (Middle and right photos). Here also the effect of scion is clear in both compound and leaflets size and length. This may help in increasing the ability of the grafted tree (scion), to tolerate the tough drought condition, due to reduction in leaf size, that happened by grafting and hence reduction in transpiration and evaporation, this finding supported by [21], who reported that changes in the scion are controlled by the rootstock through controlled uptake, synthesis, and translocation of water, minerals and hormones. The results also showed that the number of branches in grafted A. senegal as scion onto A. mellifera as rootstock is high and the thorns are observed either attenuate or completely absent in branches compared with the control and crown shape look like that of A. mellifera (scion) this confirmed by what was reported by [28 and 29], who stated that Acacia mellifera which Known as hook thorn is usually a multi-stemmed, much branched, obconical shrub up to about 2m tall. The canopy is widest at the top like an upside-down cone and the tree is usually branched low down and the crown has a substantial horizontal spread that often exceeds its height (Figure 3) Shows the huge amount of branches originated from multi-stem grafted A. senegal (Scion) onto A. mellifera (rootstock) (left). It has an appositive potential impact on gum Arabic, it may lead to increase gum exponentially. A. senegal grafted onto A. mellifera which resembling A. mellifera in branch form (not upright) like A. senegal as stated by [5 and 29]. The tree also with scant thorns and multi-stem(right). This result will act as a positive impact on gum production, which may help the farmer to tap and collect gum product, without any thorn annoyance during tapping operation, beside that the increasing in branch number, inevitably meant the increasing in gum production, as the farmer concentrated mainly on a branch during tapping operation. The changes that occurred on the leaves, branch and thorn of scions, due to grafting techniques, confirmed the effect of grafting on morphological changes and pulled out a very clear signal or evidences that grafting approach has ability to affect the morphological performance of scions on woody plants (A. mellifera and A. senegal). The result coincided with result that stated by [23] on morphological changes on potato scion, when grafted onto tomato rootstock. The changes of leaves that were observed in scion of A. mellifera when grafted onto A. polyacantha is affirmed by what was reported by [24] on the leaf of pepper (scion), when grafted on tomato as rootstock and eggplant as a scion onto tomato as rootstock and with what was reported by [26] who stated that tomato rootstock could up or down regulate gene expression of eggplant scions. This imitation indicated that, the rootstock has a great influence, to change the morphology of scion due to grafting. This is in line with [13, 14, 23 & 25] who stated that the scion is affected by mRNA and protein migrating from the root stock.

<table>
<thead>
<tr>
<th>Treated species</th>
<th>Type of treatment</th>
<th>Number of treated seedlings</th>
<th>Number of healed seedlings</th>
<th>Percent success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. mellifera/ onto A. mellifera</td>
<td>Splice</td>
<td>50 onto 50</td>
<td>40 x 40</td>
<td>80</td>
</tr>
<tr>
<td>Acacia polyacantha</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. senegal/ onto A. mellifera</td>
<td>Splice</td>
<td>50 onto 50</td>
<td>42 x 42</td>
<td>84</td>
</tr>
<tr>
<td>A. senegal/ onto A. mellifera</td>
<td>Splice</td>
<td>50 onto 50</td>
<td>40 x 40</td>
<td>80</td>
</tr>
<tr>
<td>A. senegal/ onto A. compylacantha</td>
<td>Splice</td>
<td>50 onto 50</td>
<td>40 x 40</td>
<td>80</td>
</tr>
<tr>
<td>Overall mean.</td>
<td>Splice</td>
<td>50 onto 50</td>
<td>41 x 41</td>
<td>81.0</td>
</tr>
</tbody>
</table>

TABLE (1) Type of treatment, Percent success of grafting A. mellifera onto A. compylacantha and A. senegal onto A. mellifera, A. polyacantha and A. seyal.
Change observations, in scion flowering and fruiting stage, bark and prickles:
The results of grafting A. senegal as scion onto A. mellifera as rootstock, showed that the effect of grafting on fruits that emerged from scion were significant, different in number and shape from the control. The change percentage in scion was 75 to 90% in grafted A. mellifera onto A. comylacantha (Figure 5) and 75 to 90% in A. senegal onto A. mellifera (Figure 6), while 50 to 90% in A. senegal onto Acacia polyacantha and 75 to 80% A. senegal onto A. seyal respectively (Table 2). (Figure 7 and 8). The scions of A. senegal produced flowers in great number, beside that the flower during fructification formed fruit, an abnormality to that occurred in the natural condition, without grafting, as in the control. The A. senegal scions/ A. mellifera rootstock, have given an extremely rare set of natural identical groups of fruits (10 to 25 pods) bearing by one peduncle (Figure 4a), not formal resemblance to the origin, that naturally pedunculate in spikes either solitary, or grouped in twin to triplets as maximum ones [7 and 22] this increase in pods due to rootstock affect will consider as potential impact because it is fructifying scion of A. senegal. The pods in general took the same colors, but differ in shape so far (Figure 4a, right), which conflicting to what was reported by [10] on fruits produced by scions. This result reflected that grafting has ability to effect on morphological changes of scions, which supported by [10 and 16] who stated that the initiation of morphogenic scions by grafting, induce morphological changes on leaves, flowers and fruits due to genetic changes, that have potential in genetic improvement. And reported by the [14] that color can be affected by grafting and the type of rootstock used this in conformity with [16] in inter-generic grafting, from melon to pumpkins. Beside that the result coincided with [7] in grafting as a vehicle that can be used for genetic makeup, to improve variety, and in line with in delivering RNA to scion from rootstock through sieve cells. This result supported by [26] who reported that the affected genes in scion due to grafting are related to functions, including general metabolism, signal transduction, stress response, cell cycle/division and transcription/translation. From the semblance (Figure, 4a), the branches bearing flowers are not upright, like that of A. senegal but look more resembling to that of A. mellifera (photo. One left) and the peduncle of flower bearing a lot of fruits from the beginning 10 to
25 pods in number per peduncle (photo. Two and three middle in clockwise pattern), opposite to that of natural A.senegal pods as stated by [ 5 and 22]. The fruits look like that of A. mellifera fruit in constituting or shape and size with no constricted portion ,between seeds clearly observed (photo. Four, right).this similarity is supported by [27 and 29] in describing A.mellifera pods who reported that, the fruit are pods, thin to almost papery, flat and oval shaped, narrowing at both ends. The increase in the number of branches, in A. senegal scions and decreasing in thorn numbers in the same scene, was well observed in the field stage of A. senegal scions, with change percentage 88% to 75% respectively in the tested trees, answering the question that grafting effect is beneficial and not deleterious.

**Figure (4a):** Shows the flowering and fruiting stages of A. senegal scion, when grafted onto A. mellifera (rootstock).

**Change observations on scion morphology in thorn and fruiting stage**

The study showed that there is an obvious clear observation, of morphological change was happening in fruit produced by A. senegal scion/A.seyal rootstock, where the inflorescences formed fruits in aggregated form similar to that produced by A.seyal in nature and completely different of that produced by A.senegal intern of number per peduncle or spike (Figure, 4b)the figure shows that the Photo one to the left is triplet pods fruits produced by untreated A.senegal, where its behavior in pair or triplets pods per axil as stated by [7], while the image number two, to the right in the same photo, is a scion of A. senegal fruits after grafting onto A.seyal as rootstock, it is obviously formed in clusters, more resembling to that of rootstock of A.seyal fruits, rather than A. senegal ordinary fruit. A.senegal as control produced prickly twig with triplets' thorns (Figure 4b middle). The thorn less branch of A. senegal scion (Figure 4b right) Shows obviously the change was happening ,when compared it with the thorny branch of the control .This change in scion lead to produce thorn less of A. senegal tree (Figure 4c middle photos) that may help in tapping and gum collection operation ,compared with a traditional one. The observations of the thorns number on the grafted scions (branches) were either disappeared completely, or become very scanty (4b) not hinder or interrupt the farmers, to climb a tree without any type of hindrance. (4c) .In general this mutation, will help in seed production of A.senegal and hence more areas will be planted naturally or artificially, beside a contribution on fodder for livestock. This phenomenon generated by grafting effect, should look for by Research Seed Centre, to improve and revive the gum Arabic and range sector, as well as to help farmers on tapping access able trees and accessible gum collection. This will lay concrete way to protect trees by farmers and polish gum Arabic in position in addition to lessening rural pauperism, boost food security, and incomes of farmers.The result confirming, the effect of root stock of A.seyal on Scion of A.senegal.

**Figure (4b):** Shows the morphological changes on scions fruits and thorns due to grafting.
Figure (4c): Shows grafted *A. senegal* onto *A. mellifera* with multi stems (scions) of *A. senegal* originated from the root stock of *A. mellifera* (middle). The bark fissured covered with a white scale easy to be peeled out by hand (left).

The gum produced by grafted scion of *A. senegal* became easy for collecting as shown here a farmer climb a tree and handling a branch due to lack of thorns (middle, left and right) compared with branch of the original tree (right) where appears prickly, difficult to be touched by hand, as shows in this photo.

### TABLE (2)

Treated species, Type of treatment, number of transplanted treated seedlings, a number of plant leaf and flower morphological changes and changes percentage of grafting *A. mellifera/compylacanth*, *A. senegal/A. mellifera*, *A. senegal/A. compylacatha* and *A. senegal/A. seyal*.

<table>
<thead>
<tr>
<th>Treated species</th>
<th>Type of treatment</th>
<th>Number of transplanted treated seedlings</th>
<th>Number of plant leaf, fruit, and branch morphological changes</th>
<th>Percent (%) morphological changes on scions (leaf and fruit)</th>
<th>Percent (%) morphological changes on scions (branch) and thorn</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) <em>A. mellifera onto A. compylacantha</em></td>
<td>Splice</td>
<td>20</td>
<td>18.00-15.00-18</td>
<td>90.00-75.00</td>
<td>90.00-20.00</td>
</tr>
<tr>
<td>(control: <em>A. mellifera</em>)</td>
<td></td>
<td>20</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
</tr>
<tr>
<td>(2) <em>A. senegal onto A. mellifera</em></td>
<td>Splice</td>
<td>20</td>
<td>15.00-15.00-19</td>
<td>75.00-75.00</td>
<td>88.00-75.00</td>
</tr>
<tr>
<td>(control: <em>A. senegal</em>)</td>
<td></td>
<td>20</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
</tr>
<tr>
<td>(3) <em>A. senegal onto A. compylacantha</em></td>
<td>Splice</td>
<td>20</td>
<td>15.00-15.00-18</td>
<td>75.00-75.00</td>
<td>80.00-10.00</td>
</tr>
<tr>
<td>(control: <em>A. senegal</em>)</td>
<td></td>
<td>20</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
</tr>
<tr>
<td>(4) <em>A. senegal onto A. seyal</em></td>
<td>Splice</td>
<td>20</td>
<td>10.00-18.00-18</td>
<td>50.00-90.00</td>
<td>90.00-10.00</td>
</tr>
<tr>
<td>(control: <em>A. senegal</em>)</td>
<td></td>
<td>20</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
<td>0.00-0.00-0.00</td>
</tr>
<tr>
<td><strong>Over all mean.</strong></td>
<td>Splice</td>
<td>20</td>
<td>14.5.0-15.7-18</td>
<td>72.7-78.0</td>
<td>89.5-29.0</td>
</tr>
</tbody>
</table>
Figure (5): Shows the rate of morphological changes on leaves (scions) of *A. mellifera* (scion) when grafted onto *A. polyacantha* as rootstock.

Figure (6): Shows the rate of morphological changes on (scions) of *A. senegal* when grafted onto *A. mellifera* as rootstock.

Figure (7): Shows the rate of morphological changes on (scions) of *A. senegal* when grafted onto *A. polyacantha* as rootstock.
IV. CONCLUSION

The results of this study revealed that, grafting of A. senegal as scions onto A. mellifera and A. polyacantha as rootstocks, beside A. mellifera as a scion onto A. polyacantha as stock, produced grafted A. senegal (scion) with morphological changes in tree shape, bark, thorn availability, fruit quantity and leaves shape and size i.e. root stock has the ability to change scion conclusively, in woody plants, when grafting approach adopted. These changes in morphology will expect to have a positive impact, on productivity (yield) of gum and also accessible in the reciprocal treatments. This change of leaves and crown shape, implies genetic change, which may pave the way widely, for producing trees have the ability, to produce high quantities of gum due to the high number of branches, resolve the problems of low yield in the normal production. And may help in producing tree tolerant to diseases, drought and with high gum production in quantity and quality-wise. Further study is needed, to test the behavior of progeny (seeds) that in term of productivity and tolerances for diseases, drought, and branching beside gum quality.

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[27] http://books.google.com/books?id=RpVJJH3kV0oC&pg=PA156&lpg=PA156&dq=acacia+mellifera+fruit+pods&source=bl&ots=gRAC56PaEb&sig=NNfhDCuK44NXvNu4qd0k1Jqyg&hl=ar&sa=X&ei=yQuvUozyLoLMygPNvo#v=onepage&q=acacia%20mellifera%20fruit%20pods&f=false