Tropentag 2008
University of Hohenheim, October 7-9, 2008
Conference on International Research on Food Security, Natural Resource Management and Rural Development

The Consequences of Defoliation of Gum Arabic Tree (*Acacia senegal*) by Sahelian Tree Locust (*Anacridium melanorhodon melanorhodon*) for the Gum Producers in North Kordofan State, Sudan

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Abstract

Gum Arabic is one of the main crops produced in the traditional rain-fed agricultural sector of Sudan. It is a non-timber forest product harvested from gum Arabic tree (mainly *Acacia Senegal* var. *senegal*). Gum Arabic provides on average 12% of the gross domestic product of the country and accounts for about 15 – 10 % of the income of the gum producers and other farmers in the gum belt across Sudan, respectively.

The most serious pest of gum Arabic tree is the tree locust *Anacridium melanorhodon melanorhodon* Walker. A study, conducted in North Kordofan State focused on the estimation of the degree of defoliation by outbreaks of the tree locust and on the socio-economic consequences for local gum Arabic producers. Moreover the study tries to cover the reactions of the local gum producers on tree locust outbreaks and the possibilities for compensation of the (financial) losses.

Defoliation of gum Arabic tree by the pest resulted in a loss of yield connected with a reduction of the benefits to the local communities practicing the gum production as one of the main activities. The study showed highly significant differences in crop yield before (273.9 kg/ha) and after (93.8 kg/ha) tree locust outbreak. The pest reduced the per hectare benefits from gum production from 292.6 to -21.2 Sudanese Pound (SDG). In addition, tree locust outbreak leads to a delay of the tree tapping time from October to January/February due to the effects of the pest on foliage of gum Arabic tree.

The study was considered to be base not only for policy makers to avoid the economical losses but also for more research work concerning the ecology of the insect and the strategies of control.

Introduction

Gum Arabic is one of the main crops produced in the traditional rain-fed agricultural sub-sector in Sudan. It is a non timber forest product of the genus *Acacia*; namely *Acacia senegal* L., locally called

hashab tree. It constitutes the backbone of world gum trade in quality and quantity and represents 90% of the total value of the gum exports (GAC 2000).
Among the main constraints of the production of gum Arabic are insect pests, particularly the Sahelian tree locust, *Anacridium melanorhodon melanorhodon*. Because the production of gum Arabic contributes substantially to the income of the small local farmers, the loss of gum due to outbreaks of the pest insects is – beside ecological aspects - of socio-economical relevance. Thus, the aims of our study were (1) to determine the effects of defoliation of *hashab* tree by *Anacridium melanorhodon melanorhodon* on gum Arabic production during the period of outbreak, and (2) to assess the losses of income shouldered by gum producers due to the damage of gum trees.

Methodology

The assessment of the impact of tree locust infestations on gum production was based on interviews (group discussions) with local farmers in ten villages, which were randomly selected in the study area (North Kordofan State). The selected villages represent 10% of villages reported by the Gum Arabic Research Centre to encompass gum gardens as a component of the traditional production system within the gum belt of the state. Within each village respondents were randomly selected for group discussion. According to KRUEGER & CASEY (2000) the optimum number of participants for group discussions varies between six to ten participants. This range is manageable and large enough to gain a variety of perspectives and small enough not to become disorderly or fragmented. Thus, the number of participants in the group varied from 6 – 13 persons, depending on the number of inhabitants available in the village. In each village two group discussions were held, making a total of twenty. The interviews mainly focused on gum productivity, costs of production and benefits per unit area. Data were analyzed by using Mann Whitney U-Test as a non-parametric measurement.

Results and Discussions

Definition of tree locust outbreak

As derived from the group discussions with the gum producers in the study area the number of locusts on *Hashab* trees during an outbreak varied between 46 and 94 and reached on average 70 individuals (Table 1).

Table (1) Number of individuals of Sahelian tree locust per tree during pest outbreaks in the study area according to the results of group discussions

Villages	Number of insect per tree	Average
Elhemera	40 -100	70
Tayba	60 -100	80
Ummatarig	50 -150	100
El karra	50 - 90	70
Umsemama	30 - 90	60
Um dawan ban	40 - 100	70
Krinka	60 - 80	60
Shalota	50 - 90	70
Wad Gasim	50 -70	60
Ummkada	30 -70	50
Total average	**46 - 94**	**70**

Consequences of tree locust outbreak on gum production

Based on the results of the interviews outbreaks of the Sahelian tree locust reduced the amount of gum produced by hashab tree in the respective villages drastically (Table 2). On average the production of gum Arabic was reduced from 0.43 g per tree and tapping event (variance: 0.009) without an impact of tree locusts to 0.20 g per tree and tapping event (variance: 0.0020678) after an outbreak of the pest insect. That means an average loss of 53.5%.

Table (2) Gum production (g) per tree and tapping event with and without tree locust outbreak in the selected villages of the study area – villages: (1) Elhemara, (2) Tayba, (3) Ummatarig, (4) El karra, (5) Umsemama, (6) Um dawan ban, (7) Krinka, (8) Shalota, (9) Wad Gasim, (10) Um kadada

village	1	2	3	4	5	6	7	8	9	10
without	0.5	0.4	0.5	0.4	0.3	0.5	0.3	0.6	0.4	0.4
with	0.25	0.2	0.2	0.2	0.15	0.19	0.14	0.3	0.2	0.2

Per season the average gum production of an *Acacia senegal* tree without locust attack was estimated to be 2.15 kg (5 tappings, each with 0.43g per tree). Based on an average number of 120 trees per ha, the amount of gum Arabic produced on a hectare amounts to 258 kg. This result corresponds with BALLAL (2003), who reported that the yield of a hectare was 200 to 240 kg. After an outbreak of tree locust the average production per tree and season reached only 0.8 kg. So, tree locust reduced the production by 62.8%. This loss was due to - as mentioned above – the reduction in yield from 0.43 to 0.2 g/tree and tapping event, and - in addition – the reduction of the number of tapping events from 5 to 4.
Moreover, tree locust outbreak affected the time of tapping from first of October or November to the end of January in some areas and to first of March in other areas. The difference of the two dates is due to the variations in climatic conditions, especially temperature as well as amount and distribution of rainfall. This result corresponds with BALLAL et al. (2005), who stated that gum yield was highly positively correlated with annual rainfall.

Table (3): Production (kg/ha) of gum Arabic before and after tree locust outbreak in the respective villages - villages: (1) Elhemara, (2) Tayba, (3) Ummatarig, (4) El karra, (5) Umsemama, (6) Um dawan ban, (7) Krinka, (8) Shalota, (9) Wad Gasim, (10) Um kadada

villages	1	2	3	4	5	6	7	8	9	10
Production before	342.5	206	300	270	212.4	405	162	282	259.2	300
Production after	102.7	61.8	72	135	88.5	102.6	56.7	112.8	86.4	120

As deduced from Table 3 the production of gum Arabic in all 10 villages was 2739.1 kg during the normal season situation. When there was tree locust outbreak it was estimated to be 938.55 kg resulting in a loss of 65.74%. This result corresponds to BALLAL (2003) who stated that the gum yield dropped by about 30% in mid November tapping. This drop increased to about 60% on the first of December (late tapping). Therefore, tree locust outbreak delays the time of tapping, because of the loss of carbohydrate resources essential for the production of gum (gum is polysaccharides and few of minerals like calcium, magnesium, potassium and sodium). According to WEWETZER et al. (1993) *Acacia senegal* suffers from the attack of tree locust *Anacridium melanorhodon melanorhodon* Walk, especially during years of outbreak because the pest causes defoliation connected with the decrease of photosynthetic capacity and the quality of stored carbohydrates. Finally, the gum yield is negatively affected.

The effect on financial benefits from gum Arabic production

The benefits of gum Arabic production per hectare varied highly significant between the villages before and after tree locust outbreak (Table 4). The average benefit of gum Arabic was 292.6 SDG per season and village without tree locust outbreak. With tree locust outbreak it was reduced to -21.18 SDG. That means an average percentage loss of 107.24 %.
CHIKAMAI (1996) pointed out that one of the principal factors that govern gum production is biotic interaction including pests, mainly tree locust. TAHA (2006) summarized the socio-economic factors affecting the production of gum. Main factor was the income generation and the

labor supply. Tree locust outbreak led to reduction in gum production and the consequences were a decrease in the income of gum producers as well as narrowing the choice for labor to find work. The question here is how the local or small gum producers cover the loss in production as a result of tree locust outbreak? The group discussion which was held in the study area, indicate that in case of tree locust outbreak the gum producer has two options, either to be animal herder or to migrate to work in the big towns. This will affect the stability of the producer, and supply of gum Arabic. Moreover, the production of gum in the dead season after the harvesting of agricultural crops creates job opportunities.

Table (4) Gum arabic benefits (Sudanese Pounds) per hectare before and after tree locust outbreak in the respective villages – villages: (1) Elhemara, (2) Tayba, (3) Ummatarig, (4) El karra, (5) Umsemama, (6) Um dawan ban, (7) Krinka, (8) Shalota, (9) Wad Gasim, (10) Um kadada

Villages	1	2	3	4	5	6	7	8	9	10
Benefits before	448.23	220.17	392.61	292.44	225.29	407.17	138.57	363.41	208.75	229.11
Benefits after	16.68	-39.39	-17.79	62.94	14.66	-76.67	-40.44	-75.77	-33.17	-22.89

Conclusions

The gum Arabic tree (*hashab*), *Acacia senegal*, suffers from attack of tree locust *Anacridium melanorhodon melanorhodon* Walk during years of outbreak. This pest causes defoliation, and thus decreases gum yield and finally the benefit of local farmers. Therefore, there is a high necessity to investigate and estimate the damage caused by such a pest as a prerequisite for the development of management concepts to stabilize the socio-economic situation of local gum producers.

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