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Daily Food- Intake and the Effect of *Acacia Senegal* Leaf Stage on Tree Locust Hopper Development in Acacia Project, North Kordofan, Sudan

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Abstract

The present study was conducted in the Institute of Gum Arabic Research and Desertification Studies laboratory for three successive seasons; 2007/2008, 2008/2009 and 2009/2010). The main objective of the study is to investigate the daily food-intake and the effect of leaves stage on the total developmental period of hoppers of the tree locust, *Anacridium m. melanorhodon*. Sexually mature male and female adults of tree locusts were captured and kept in a cage (2 X 2 X 2metre) and left for breeding. After eggs-laying and hatching, six iron cages covered with fine wire mesh were prepared and arranged in two sets (set_1 and set_2). In each cage in set_1 and set_2, 20 1st instar hoppers were introduced; 500 gm of old and young hashab leaves were added daily to the cages in set_1 and set_2, respectively. Loss in weight of fresh leaves (500gm) under the lab condition was tested and subtracted from daily food-intake. The daily food consumed by the different stages of tree locust fed on old and young leaves were approximately equivalent to their body weight which ranged between 23 mg- 2000 mg for the first instar and adult, respectively. In all seasons the total developmental periodof hoppers varied; those instars which were fed on old leaves the duration was 68 days, those which were fed on young leaves the duration was 59 days, the sixth instar hadlonger duration while the first instar had shorter duration. The study concluded that both adult and hopper of tree locust can eat daily an amount of old and young hashab leaves equal to its body weight.

Keywords

Hoppers of Tree Locust, *Acacia Senegal* Leaves, Daily Food-Intake

1. Introduction

In the Sudan, *A. melanorhodon*have a wide range of distribution in the east at the Red Sea maritime plain and it has been noticed breeding regularly in the Red Sea hills. From there it extends south as far as Eritrea and on the west through Kassala to the Nile valley. It appears to be most abundant in the south- west (Darfur and Kordofan) where it is the pest. From Khartoum it extends up the Blue Nile and Gezira district, between the Blue and White Niles [13]. According to [9] there is five to six instars for male of *A. m melanorhodon* and six or seven for female. [5] recorded six instars for both male and female, while only five instars were recorded by [8] and [12] under laboratory conditions. Copulation takes place after the first rains and copulating pairs stay on trees until eggs lying begins (June-July). Eggs are laid in damp soil during the rainy season 10-20 days after copulation. A female lays 1-3 egg pods containing 150-200 eggs. The incubation period takes two weeks but no evidence

of diapause has been found. The eggs hatch to give hoppers. The development of the hopper stages takes 48-69 days; the first fledglings appear in September-October [8, 10, and 9]. Imagoes remain in a resting maturity stage until the first rain of the following year in May- June [8 and 3]. [11] reported that a winged locust weighing 2grams, during its gregarious phase, can eats an amount of fresh leaf equivalent to its body weight per day, and a swarm covering $1Km^2$ (50 million locusts) can destroy a hundred ton of vegetal material. They are the most voracious pests known capable of eating their own weight (2-3g) of vegetation daily [1]. Plagues of locusts devastate crops, pastures, orchards and entire countries or even continents. In 1958, the locust invasion of Ethiopia resulted in losses of 50-150 thousand tonnes of cereals in less than six months, equivalent to the annual cereals requirement of about one million people [2].

[15], reported that about $275 million was spent on application of 15 million litres of pesticides in the locust plague of 1986-1989, the first in many years in the Sahel covering over 25.9 million hectares of land [14].

In tropical regions swarms of migrating imagoes chronically attack gum arabic tree in the dry season, during the gregarious phase the species causes great damage to acacias [11, 16 and 3]. Generally tree locusts feed on leaves especially of *Acacia senegal*, and *Zizyphusspina-christi* (Siddir), in addition to a number of cultivated fruit and shade trees, and others such as *Grewiatenax* and *Balanitesaegyptiaca*. Cotton is occasionally attacked, mainly by moving swarms of adults. Tree locusts feed by night, but a hungry locust will feed at any time. Hoppers seem to move upwards for feeding, with the result that the upper and younger portions of trees are defoliated in a very characteristic manner i.e. leaf defoliation starts regularly from bottom to top. Barking of young *Acacia* trees by hoppers has been observed on several occasions. Hoppers show a certain degree of preference when trees of *Acacia chrenbergiana* and *Zizyphusspina-chrsti* were growing together, only the latter was attacked, whereas in other localities the former was also eaten and the leaves were usually attacked from the edge [3]. Young individuals often puncture holes and eat round within the circumference [8]. There are many plants species recorded as hosts of *A. m. melanorhodon*, in general, there are enough trees for roosting, but when trees are scarce or absent, tree locusts may spread out on shrubs and crops [12].

Leaves of Acacia species have been found to contain homoarginine, pipecolic acid and 4-hydroxy-pipecolic acid; these amino acids were more concentrated in young leaves than in old leaves especially *Acacia senegal* leaves as cited by [6]. The latter reported that *Anacridiummelanorhodon* preferred feeding on palatable media (young leaves) where the concentration of these amino acids was greater than in old leaves.

However, locusts could have beneficial effects as a source of protein in animal nutrition like some other insects. [4] analyzed the locust, *Schistocercagregaria* for use both as food and fertilizer. The locusts (adult) were reported to have 61.75% crude protein and 16.95% fat. Therefore, locust could be a good source of cheaper protein compared to fishmeal in animal rations. And this will assist many countries to cut down expenses incurred on the control of this devastating but valuable pest.

2. Materials and Methods

Sexually mature male and female adults of tree locusts were captured and kept in a cage of dimension 2 X 2 X 2 metre at the Gum Arabic Institute yard and left for breeding and eggs-laying. After eggs-laying and hatching six iron cages (60 X 60 X 60cm), covered with fine wire mesh, were prepared with sandy soil at the bottom and arranged in two sets. Three cages in each set, in each of the six cages, sexually unidentified 20 1st instar hoppers were introduced. Old and young hashab leaves (500 mg) were added daily to each cage in set_1 and set_2, respectively. Set_1 is devoted for old leaves and Set_2 is devoted for young leaves i.e. old leaves +hoppers in set_1 and young leaves +hoppers in set_2 to check development and daily food-intake. To calculate the daily loss in weight of both young and old leaves due to the surrounding environment, 500 mg of old and young leaves were put in two separate petridishes in the lab at room temperature for 24 hours, and then weighed again. The difference in weight between the quantity of leaves introduced (500 mg) and the weight of the leaves after 24 hrs represents the daily loss on dry-basis. The actual daily amount of hashab leaves consumed by hoppers will be equal to the daily amount of hashab leaves that was introduced (500 mg) minus the daily loss on dry-basis. The following parameters in each cage were checked and recorded daily; average weight of hoppers, amount of hashab leaves added, amount of hashab leaves consumed, developmental period of each hopper stage and mortality of hoppers.

3. Results and Discussion

For each of the six different instars and fledglings, three parameters were measured (daily food-intake, weight and developmental period) for three successive seasons (2007/2008, 2008/2009 and 2009/2010). In all seasons (Table 1) the total developmental period of instars which are fed on old leaves from 1st instar hopper till reach the adult stage was 68 days, i.e. 6, 7, 7, 8, 12, 21 and 7 days for 1st instar hopper, 2nd instar hopper, 3rd instar hopper, 4th instar hopper, 5th instar hopper, 6th instar hopper and fledgling respectively. The sixth instar had longer developmental period (21 days) while the first instar had shorter developmental period (6 days).

In all seasons (Table 2) the total developmental period of instars which are fed on young leaves from 1st instar hopper till reach the adult stage was 59 days, i.e. 5, 5, 6, 7, 9, 19 and 8 days for 1st instar hopper, 2nd instar hopper, 3rd instar hopper, 4th instar hopper, 5th instar hopper, 6th instar hopper and fledgling respectively. The sixth instar had longer developmental period (19 days) while the first instar had shorter developmental period (5 days), the instar hoppers fed

on young leaves reach an adult stage 9 days before those which are fed on old leaves. This is because young leaves contain more amino acids [6]. The latter reported that leaves of *Acacia* species contains homoarginine, pipecolic acid and 4-hydroxy-pipecolic acid which are preferred, palatable and attractive by tree locust and these substances are more concentrated in *Acacia senegal* leaves than in leaves of other *Acacia* species. [8], [10] and [12] reported that the development of the hopper stages takes 48-69 days depending on the food and environmental condition.

In all seasons the daily food consumed by the different stages of tree locust fed on old and young leaves were approximately equivalent to their body weight which ranged between 23mg - 2000mg for the first instar and adult, respectively. [11] reported that a winged locust weighs about 2grams, during its gregarious phase, eats the equivalent of its own body weight per day. Tree locusts are the most voracious pests known capable of eating their own weight (2-3g) of vegetation daily [1].

Table 1. *Daily food-intake and developmental period of hoppers fed on old leaves (seasons 2007/2008, 2008/2009 and 2009/2010).*

Hopper stages	Average weight of hopers (mg)	Developmental period of hoppers (day)	Daily food consumed by hoppers (mg)
1st instar hopper	24-26	6	24-25.3
2nd instar hopper	26.3-41.6	7	25.6-40
3rd instar hopper	45-200	7	41-198.3
4th instar hopper	210-553.1	8	205-552.3
5th instar hopper	593-800	12	595-793.3
6th instar hopper	1000-1500	21	980-1500
Fledgling	2000	7	2000
Total nymph duration		68	

Table 2. *Daily food-intake and developmental period of hoppers fed on young leaves (seasons 2007/2008, 2008/2009 and 2009/2010).*

Hopper stages	Average weight of hopers (mg)	Developmental period of hoppers (day)	Daily food consumed by hoppers (mg)
1st instar hopper	24.3-26	5	23-25
2nd instar hopper	26.3-43	5	25.6-40
3rd instar hopper	45-203.1	6	41-200
4th instar hopper	208.6-556.2	7	205-555
5th instar hopper	602-823.1	9	595-813.6
6th instar hopper	1000-1800	19	980-1700
Fledgling	2000	8	2000
Total duration		59	

4. Conclusions and Recommendations

Both adult and hopper of tree locust are voracious pests can daily eat an amount of old and young hashab leaves equal to its body weight so that they have a devastating effect on hashab tree. Hoppers which are fed on hashab trees of newly foliage develop faster and reach the adult stage before those which are fed on hashab trees of old foliage.

The study recommended that further research much be conducted on the possibility of detecting trees which are more preferred and palatable for tree locusts than hashab trees, so as be grown within hashab as trap trees.

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