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NEW RECORD AND PRELIMINARY BIO-ECOLOGICAL STUDIES OF THE LEAF CATERPILLAR, *Noorda blitealis Walker* (Lepidoptera: Pyralidae) IN SUDAN

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ABSTRACT
The drumstick tree (*Moringa oleifera* Lam.), native to India-Pakistan-Nepal borders, is now becoming widely distributed and naturalized in several countries worldwide. The tree possesses various edible parts with high nutritional and medicinal values. Therefore, the area under *M. oleifera* is continuously expanding in Sudan as well as in many other countries during recent years. However, various devastating insect species are known to cause serious damage to such marvelous tree particularly in its native region. A few months ago, a sudden outbreak of unfamiliar caterpillar was occurred on *M. oleifera* and caused severe defoliation to the crop in Khartoum State, Sudan. Accordingly, field surveys and preliminary studies were carried out to evaluate the situation, identify the pest species and to find out possible means of control. Based on morphological characteristics, depending on several literatures, the insect was identified as the green leaf caterpillar (*Noorda blitealis* Walker), the well known leaf defoliator of *Moringa* spp. in different counties. This seemed to be the first record of this pest in Sudan. The results of preliminary investigations on certain bio-ecological features were outlined, besides the results of some botanical extracts in controlling the pest. More emphasis should be given to such an important pest to indicate its distribution limit and possible means of eradication, or otherwise effective means of management, before invading new areas in the country.

KEYWORDS: *Moringa oleifera*; *Noorda blitealis*; damage; neem extract; Sudan.

INTRODUCTION

The drumstick tree (*Moringa oleifer*a Lam.), of the Family Moringaceae and the Order Brassicales, is one of about thirteen *Moringa* species found worldwide. It was believed to be native to India-Pakistan-Nepal borders, but now is becoming widely distributed and grown in several countries, particularly in tropical and subtropical regions. Besides some other species, *M. oleifera* is recently being the most widely cultivated in numerous countries in Asia, including the Arabian Peninsula, in central and south America and in most African countries like Benin, Burkina Faso, Cameron, Senegal, Mauritania, Niger, Nigeria, Chad, Mali, Togo, Tanzania, Zanzibar, Uganda, Kenya, Eritrea and Sudan (Nasir and Ali, 1972; Ramachandran *et al*., 1980 and Parrotta, 2001).

As a vegetable, the plant possesses various edible parts (leaves, tender pods and fruits, flowers, etc.) with high nutritional and medicinal values. They are rich in proteins, minerals (e.g., Al, Ca, K, Na) and vitamins (A, C, B, etc). The leaves are the most nutritious parts which said to contain high levels of important vitamins and all the essential amino acids. Important secondary metabolites such as tannins, saponins and alkaloids were also found, which seem to contribute to its medical properties. The nutritional potential of *M. oleifera* was also proved for animal feed (FAO, 1982; Dahot, 1988; Gupta *et al*., 1989 and Kawo *et al*., 2009). Therefore, the area under *Moringa* cultivation is continuously expanding in Sudan as well as in many other countries during the recent years. Regarding problems of Moringa production in the world, some insect pests were placed among the main limiting factors of the crop. They included; the green leaf caterpillar *Noorda blitealis* Wlk., budworm *Noorda moringae* Tam., hairy caterpillar *Eupterote mollifera* Wlk., pod fly *Gitona distigma*, bark caterpillar *Indarbela quadrinotata* Wlk. and stem borer *Indarbela tetraonis* (Moore). The leaf caterpillar (*N. blitealis*) is the most serious pest attacking Moringa leaves. The recorded hosts of this pest are entirely restricted to the plant family Moringaceae. Due to the wide expansion of Moringa cultivation in the world, the pest is continuously widening its area of distribution during the last years. It was reported from most countries in South East Asia, Middle East and Arabian Peninsula. In Africa, it was reported from Ethiopia, Kenya, Somalia, South Africa, Namibia, Gambia, Niger, Madagascar and La Reunion (Nair, 1970; Butani and Verma, 1981; Butani and Jotwani, 1984; Gillett, 1997; Demuelenaere, 2001; Parrotta, 2001 and Anon., 2012).

In recent years, there was an increasing interest on Moringa cultivation in Sudan. It is now being grown in many areas including the Khartoum State. Before three months during early August 2012, a sudden outbreak of an unfamiliar caterpillar was occurred for the first time on *M. oleifera* in Khartoum area. Therefore, field surveys and preliminary studies were carried out to identify the pest, evaluate the situation and collect more information, as an step forward to combat the problem.

MATERIALS AND METHODS

Field investigations

A field survey was carried out in early August 2012 on a *Moringa oleifera* farm in southern Khartoum (Tayba El-Hassanab area), upon a farmer request suffering damage of unknown pest. The plant leaves were found severely defoliated by heavy attack of a lepidopterous caterpillar. The crop damage was estimated, and field observations were taken on several aspects including damage characteristics, feeding habits and the insect behavior. Remarks were also taken on predators found associated with the pest. Most observations were documented with photos using an Olympus digital camera, X-785; 7.1 megapixels. Samples from the insect larvae were collected for laboratory studies.

Regular subsequent visits were pursued to the farm, where a preliminary experiment was conducted to evaluate two botanical extracts, viz., neem (*Azadirachta indica*) seeds kernel water extract and Argel (*Solenostemma argel*) leaves extract, in controlling the pest. One concentration (3% w/v) was used from each extract, sprayed at ten days intervals. This concentration was suggested based on a small laboratory test of neem seeds water extract against the larvae, and also depending on some indigenous literature of neem results against other vegetable pests (Satti and Nasr, 2006). A total of four sprays were applied at ten days intervals, coupled with damage counts by recording the number of infested plants per 100 randomly selected plants per plot.

Laboratory studies

The collected larvae were reared in petri dishes, fed on *Moringa* leaves to obtain the different developmental stages of the pest for morphological descriptions. Shapes, colours and some morphometric measurements of all stages were reported. Descriptions, measurements and photos of small parts were made possible under a binocular microscope provided with a Labomed digital camera and an eyepiece micrometer. Moreover, durinig the above mentioned rearing of the insect, the general duration periods of the life cycle were briefly noted.

As a pre-step to field application of botanical extract, a preliminary small test was conducted to assess water extract of neem seeds at two concentrations (1.5% and 3% w/v) against the 3rd instar larvae of the pest, compared with an untreated control. This was done in petri dishes where larvae were provided with treated leaves of *M. oleifera*, and observed daily for mortality or any unusual progress.

RESULTS AND DISCUSSION

Laboratory results

The morphological investigations revealed some general descriptions of different stages of the insect. The egg was oval in shape and almost creamy in colour. It hatched into a tiny caterpillar, less than 3 mm in length. The larva gets larger and larger in size as it moults from one instar to another. It is lacking prothoracic shield, and the whole body is covered with fine and light creamy hairs. This seems to mimic those fine hairs which observed covering petioles and small branches of its host, the *Moringa* plant. The body lengths of all instars ranged between 3-17mm. The average sizes (length X width) of last instar larva, pupa, and adult male and female were, 16.0±0.4 X 4.1±0.1, 8.7±0.6 X 3.8±0.2, 8.5±0.4 X 2.50.3 and 13.5±1.6 X 2.8±0.2 mm, respectively. Head size of adult was 1.5±0.1 X 2.2±0.0mm. Generally, the insect sizes were highly affected by the feeding capacity, as starved larvae showed diminished sizes. Larval colour was mostly creamy and sometimes pale green to creamy or pinkish. Intermittent brown strips were appeared along the lateral sides of the larval body. Head capsule of larvae were creamy to light brown colour. Pupae were brownish and became darker after about four days, when adults were fully formed. They enclosed in creamy pupal cases made of silken threads built by the larvae. The adult bodies were dark brown alternated with creamy colour. At rests, the wings overlapped in triangular shape. Forewings were creamy in background, with numerous mosaic dots and blotches of dark brown colour on whole surfaces, and ended posteriorly with wide dark brown bands. The hindwings were creamy and also with wide dark brownish bands at the posterior margins. Both wings were terminated with fringes of hairs, being brownish in forewings and creamy in hindwings. A forward protruded beak representing the maxillary and labial palpi is seen from the adult head. The antennae rest backward passing on top of head and body dorsum. The legs tarsi were 5-segmented, each carry a pair of claws. Plate (1) shows some stages of the pest. Roughly, the insect took about 17 days from egg hatching up to adult emergent, with a total larval duration of 11 days and a pupal period of 6 days.

However, the foregoing characteristics which came in consistency with some literatures (Rachappa *et al*., 2002; Ananthakrishnan, 2004; Murugesan, 2008), have suggested the detection of the Moringa green leaf caterpillar (*Noorda blitealis* Walker 1859), of the Family: Pyralidae and Sub-family: Odontiinae, as the first record in Sudan. No information was found about this pest in the country. The reason for such a breakout was unclear, but it was thought that this insect is a new comer to the area. The species was believed to be an exotic one introduced by a way or another from outside, most probably from one of the neighboring countries those harbouring the pest.

The results of laboratory test of neem water extract on the 3rd instar larvae of the pest were depicted in Fig. (1). The lowest concentration (1.5% w/v) showed progressive increases in insect mortality up to the fourth day post exposure (60% mortality). No further mortality was occurred thereafter, and the remaining larvae were pupated normally. On the other hand, the highest concentration (3% w/v) manifested steady increases in mortality up to the fifth day (80% mortality), as the best effective treatment. It was observed that the feedings of larvae were highly reduced in both neem treatments, suggesting the occurrence of an antifeedant effect in neem extract. These larvae finally became smaller in sizes and sluggish in movement. The larvae those completed their development also gave adults with smaller sizes than those of the control. These results were encouraging to proceed forward in using the neem extract for controlling the current pest. However, the various biological activities (e.g., antifeedant, repellent, growth regulatory effects) of neem products were documented in different studies (Schmutterer, 1990; Koul, 1999 and Satti and Elamin, 2012).

Field results

The earlier surveys conducted in early August (2012), on *M. oleifera* farm at southern Khartoum had showed severe damage to the plant leaves. The pest induced complete defoliation of most trees. The initial count conducted revealed that >90% of plants in the farm were infested by the pest, of these 55%, 30% and 15% of the plants reflected 80-100%, 50-80% and < 50% damage, respectively. The larvae generally feed in concealed way on the undersides of leaves hanging themselves with fine networks of silken threads. In addition, they sometimes fold or rolled the leaf blades around their bodies and feeding inside, especially during hot time of the day (Pl. 1). Actually, it appears that all stages of the pest are living in some sorts of mimicry and concealment in all living attributes including shapes, colours and habitats, as they seem to camouflage their natural enemies. When a larva was disturbed, it shrinks itself inside the web, but once forced to get out it shows swift movement and can't be caught easily. More touch or disturb, the larva shows quick writhing and escaped away. The larvae were feeding voraciously on the plant, and more than eight leaves were observed to be eaten by a last instar larva in one day. Thus, complete skeletonizations of leaves were occurred which appear in translucent sheets and dried up (Pl. 2). In heavy infested plants black colour feces of larvae were observed scattered on the leaves, look as if were weeds' seeds. The insect is chiefly a leaf feeder, but the stem pith and bark were found to be attacked, merely when the crop was cut during the routine pruning. In this case, the larva finds its way to the stem through such cuttings, and feeding either on the corky content inside the stem heart or on the fleshy bark under the skin. The infested stem can be easily detected from observing the sawdust (mixed with fecal pellets) that pushed out from the larval boring (Pl. 2). Therefore, special care should be taken during cutting period to avoid stem infestation, whether through prophylactic treatment of insecticides on pruned stems or adoption of certain cultural measures. Also, smoothness of cutting edges on stems might help to reduce the vulnerability to attack. These observations confirmed the previous identity of the pest, and more or less agreed with several authors in many characters (Rachappa *et al*., 2002; Ananthakrishnan, 2004; Negusu, 2005 and Murugesan, 2008).

The predators found associated with the pest on Moringa were mainly different species of spiders including cobweb weavers, saltisids and thomosids. Other predators found were *Chrysoperla carnea*, *Cydonia vicina* and some species of mantids (Pl. 3). Spiders seem to be the most important natural enemies feeding on the larvae of *N. blitealis*. However, these bioagents may need more detailed studies to evaluate their actual roles in suppressing the population of the pest. Rachappa *et al*., (2002) stated that spiders exert a natural control on the population of *Noorda blitealis*. Also, the role of a praying mantid (Mymenopodidae) and an ant (*Myrmilaria* sp.) as predators of the current pest was reported by Negusu (2005).

The field results of botanical treatments (neem and Argel) on insect damage at the different spaying and counting intervals were demonstrated in Fig. (2). It is clear that the field was suffering severe infestation when the experiment was commenced. The first chart in the figure which showed the results of count after ten days from the first spray revealed appreciable reduction in damage by the two extracts as compared to the untreated control. Steady decreases in infestation were depicted from the subsequent sprays, and both extracts were resulted in good control (<10% infestation) after one month from the start of the experiment. However, the receded trend in control damage during the last count could be attributed to migration of insects to other suitable locations due to the high defoliation of the field. Actually, it was observed that when complete defoliation was occurred in most plots, armies of caterpillars were seen to migrate to other neighboring fresh fields. This usually happened at night. In general, the results of this preliminary evaluation revealed the potential of the studied extracts in controlling the current pest and encourage additional research to exploit such resources in an integrated pest management. Considering the literatures, the results of different neem products (EC, Dust and WDP) applied in different concentration (1, 2, 3, and 4%) on mulberry (*Morus* spp.) leaves revealed that neem products significantly altered the feeding and larval duration, and influenced the larval mortality in Moringa hairy caterpillar, *Eupterote mollifera* Walker (Gangwar, 2012). The insecticidal activities of *Solenostemma argel* extracts were also proved against different insect pests in the Sudan (Yousif and Satti, 2008; Bakhiet and Taha, 2009).

PLATE 1. Some stages of *Noorda blitealis* on *Moringa oleifera* (Aug., 2012). They include- from left to right: Top) Last instar larva, a larva concealed in silken web, a larva enrolled a leaf blade. Bottom) A pupa in casing, new pupae, late pupae, Adult.

PLATE 2. Damage of *Noorda blitealis* larvae on leaves and stem of *Moringa oleifera* in Khartoum, Aug., 2012.

PLATE 3. Examples of predators detected on *Moringa oleifera* in Khartoum, Aug., 2012; from left: Spiders, *Cydonia vicina*, *Chrysoperla* egg, an adult mantid.

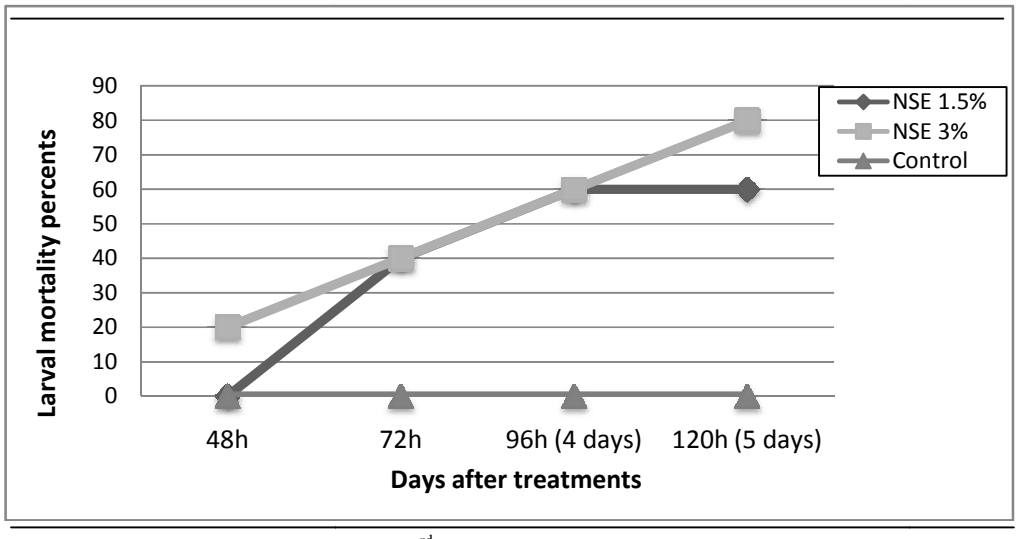

FIGURE 1. Mortality percents of *Noorda blitealis* 3rd instar larvae fed on *Moringa oleifera* leaves treated with neem seeds water extract (NSE), at different intervals post exposure, September 2012.

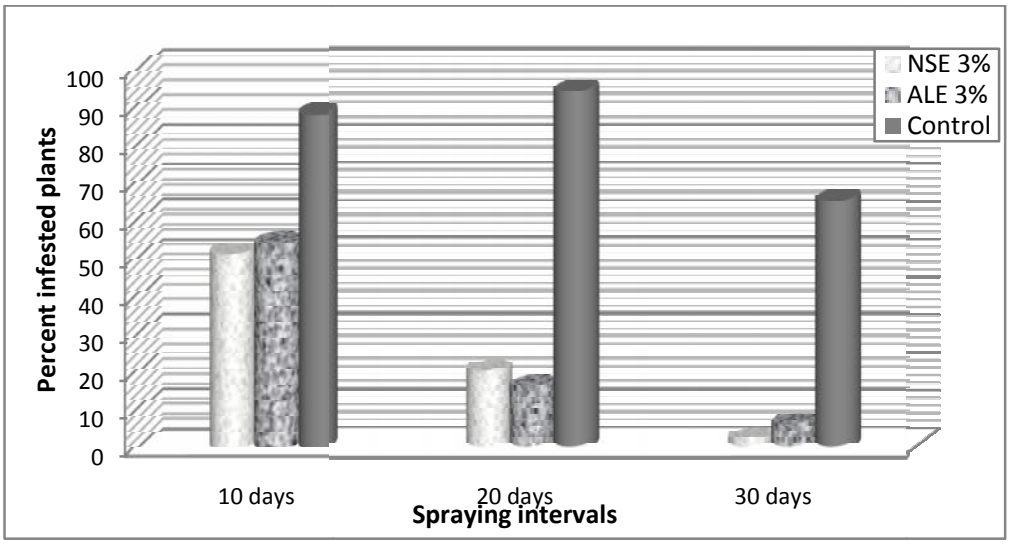

FIGURE 2. Effects of neem seeds water extract (NSE) and Argel leaves extract (ALE) on *Moringa oleifera* infestation(%) by *Noorda blitealis*, at ten days intervals from each spay (Sep./ Oct-2012).

CONCLUSION

The present study declared the detection of *Noorda blitealis* on *Moringa oleifera* in Khartoum State, as a first record in Sudan. The sudden outbreak that occurred in August 2012 which leaded to complete defoliation of a Moringa farm, explained how the insect is so dangerous to the production of this vital crop. The concealed feeding and living behaviour of the pest, and the reasons behind its un-preceded sudden flare-up in this year, may complicated the situation and prompted urgent systematic research studies to find suitable solutions for the problem.

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