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Research Article

Studies on the Damage and Control of Mango Seed Weevil, *Sternochetus mangiferae* (Fab.) in Some Major Mango Producing Areas of Northern Adamawa State, Nigeria

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ABSTRACT
A study was conducted on the damage and control of mango seed weevil (*Sternochetus mangiferae*), an emerging pest in major mango-producing areas of Northern Adamawa State, Nigeria. It focused on four Local Government Areas, grouped into Michika/Madagali and Mubi/Maiha, to assess the pest's impact and control measures. Using a Randomized Complete Block Design with five treatments replicated three times, data were collected on damaged mango flowers, fruits, and seeds. Results showed significant differences among treatments. The highest damage to flowers (7.00; 9.33) and fruits (4.33; 6.00) occurred in untreated trees in Michika/Madagali and Mubi/Maiha, respectively. Trees treated with synthetic insecticides and moringa seed oil had the least damage to flowers (0.33; 1.33) and fruits (0.67; 1.67). These treatments also yielded the highest mean of undamaged fruits (15.00; 13.67) and seeds (14.33; 13.00) in both areas. The study confirmed the mango seed weevil's potential for significant economic damage in the region. Botanical aqueous lures (Prolure and Pklure) proved effective as weevil attractants when hung on trees. Recommendations include the minimal use of synthetic insecticides combined with moringa seed oil, along with plant-based attractants and traps, to ensure sustainable and environmentally friendly pest management. These methods offer biodegradable, ecologically safe, and effective solutions for managing weevils in mango plantations.

Keywords: Damage; Control; Mango; Weevil; Insecticide; Moringa; Pest

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INTRODUCTION

Insect pests constitute about 13.8% out of the 34.9% known pests organisms on world basis, while the remaining losses are due to weeds, diseases and improper management of farm and soils of Agricultural crops (Malgwi, 2007). Although, this varies from crop to crop and place to place. Insect pests alone can cause up to 25-100% yield loss of stored produce if not properly managed (Malgwi and Samaila, 2014; Malgwi, and Onu 2004; Smith and Odongo, 1996; CAB, 2003 and Malgwi, 2007; Oaya and Malgwi, 2014; Oaya *et al.,* 2019).

Mango seed weevil, *S. mangiferae* (F.) has been recorded on mango, *Mangifera indica* L. tree in Asia, Africa, Oceania, Latin America and Australia (CAB and EPPO, 2003). The weevil is strictly monophagous and therefore probably native to the Himalayan foothills of the India-Myanmar region, the origin of the mango (Jagatiani *et al.,* 1988). In the Western Hemisphere, its distribution is limited to several Islands in the Caribbean, French Guiana and Hawaii, where it was first reported in 1905 (Varela *et al.,* 2006). Mango seed weevil is a quarantine pest that prevents the import of mangos into the continental United States from Hawaii and many other mango-producing countries. Mango seed weevil is univoltine. Females oviposit on immature fruits that are 1.9 cm in diameter or larger (Shukla *et al.,* 2015; Hansen *et al*., 1989). The adult female carves out a cavity on the fruits surface and deposits its eggs which are immediately covered by fruits exudate. Neonates burrow through the pulp to the developing seed. Mango seed is solitary, large, flat and ovoid oblong and is surrounded by a fibrous endocarp at maturity (Mukherjee, 1997). As the fruit matures and increases in size, the endocarp thickens and becomes difficult for neonate weevils to penetrate. Larvae feed within the seed and pupate in the seed cavity. Larval development

within the seed takes 20-30 days under field conditions in Hawaii (Pinese and Holmes, 2005). The majority of infested seeds have one or two weevils, but seeds containing five or more weevils have been reported (Shukla *et al.,* 2015; Hansen *et al.,* 1989). The adult weevil emerges within 2 months after the fruit fall to the ground and deteriorate (Pinese and Holmes, 2005). at which time the weevil seeks a protected site (e.g. bark, crevices, rock walls) to aestivate. Adult weevils can live for 2 years when provided fresh mangoes and water (unpublished data).

Adult weevils of *S. mangiferae* are dark brown to black with grey markings and are 6-9 mm long. They possess typical weevil features and a tough exoskeleton. Weevils spend the winter living under loose bark around the base of mango trees or in the forks of branches. They may also live in leaf litter around the tree and approximately 25% of the adults over-winter in the seed. Adult weevils can live for two years, so even with a crop failure in one season some weevils can survive into the following year. During flowering the adult weevils leave their sheltered areas under loose tree bark and litter under the trees and move into the outer canopy of the tree to feed on new growth and to mate prior to egg-laying. Monitoring for egg-laying on young fruit is the best way to detect adult activity during fruit growth. If weevil eggs are detected, chemical control can be used to reduce weevil populations to low levels. Treatments timed to coincide with early fruit set when weevil adults are in the canopy will give the best results targeting known ´hot spots´ to maximize the benefits of treatments. A weevil control program should use three strategies to control weevil infestation; quarantine, hygiene and chemical control (Anon, 2014, Oaya and Malgwi, 2014).

There are few document on the mango seed weevil *S. mangiferae* severity, damage potential and adaptable control measures to combat the insect pest especially in the developing world like Nigeria, yet, it poses serious and unimaginable threat to mango plantations in major mango producing areas of the country. Nobody knows exactly how the weevil entered into the country, but it was most probably through importation of exotic varieties of mango fruits and seeds through improper quarantine, since the weevils are normally found in the seeds of mango fruits (Malgwi and Oaya, 2014; Shukla *et al.,* 2015).

The survey covered the some major mango producing areas of Northern Adamawa State to determine the incidence, damage potential and developing suitable and adaptable control measures for the control of the mango weevil within the study areas.

In view of the aforementioned, some major mango producing areas were identified and the hot spot areas where *S. mangiferae* were prevalent and severe. The degree of damage and loss, its economic significance, its status as a subtle destructive insect pest and its bio-ecology was ascertained. Control measures of the insect pest were carried out in order to proffer solution to the desperate farmers in the study areas (Anon, 2014) during the 2024 mango season. Different control measures were tried. These include; use of traps (Prolure) and Pklure), synthetic pesticides (Karate) and botanicals (moringa seed oil).

MATERIALS AND METHODS

Study Areas

The Survey of some major mango producing areas of Northern Adamawa State during the period where mango fruits were produced was evaluated. Four Local Governments were sampled and grouped into two as Michika/Madagali and Mubi/Maiha Local Governments respectively.

Procedure/Method

The experiment was carried out in Michika/Madagali and Mubi/Maiha mango belts in Northern Adamawa State respectively during the 2024 mango season to determine and to evaluate the damage and effects of some control measures against the mango weevil, *S. mangiferae.* Fifteen mango trees were sampled for the experiments in each of the locations and were organized in a Randomized Complete Block Design setting. There were five treatments (control measures) which were replicated three times giving a total of fifteen experimental units (mango trees) in each location.

The experiment was conducted from March to June ending being the peak of the mango season. The traps were set and replaced twice a week. Two branches were selected on each mango tree. On each selected branch of the mango tree, two traps were placed for both Trap 1 (Prolure) and Trap 2 (Pklure) respectively. An average of 50 insects was trapped in Trap 1 while Trap 2 had an average of 150 insects per each round of trapping.

The moringa seed oil and the synthetic insecticide were applied thereafter on the same number of selected mango trees (15) in both locations. The insects trapped were identified at the insect museum of the Department of Crop Protection, Ahmadu Bello University, Zaria. The insect pests, species complex list is here attached.

Sampling

Sampling and collection of data was carried out on the damage potential and loss caused by the insect pest (by destructive sampling) using a seed-splitting device or detection and a hand lens for seed examination after splitting. Farmers that required compensation were paid for their mango fruits that were used as sites for the experiments. Application of control measures on

the mango trees were done by spraying with Prodal 130 EC (acetamiprid 100g/l + Lambda cyhalothrin 30g/l) as described by Malgwi and Samaila (2015).

Control Measures

Two botanical aqueous lure namely Prolure and Pklure were investigated along with an organic product Pflure for their potential as attractant for trapping insects which were used hanged on the mango trees (Okroafor, 2014). Control measures using moringa seed oil sprayed on mango trees at flowering stage and at unripe fruit stage before physiological maturity were carried out as reported by Malgwi and Samaila (2014). Synthetic insecticide, karate (Lambda cyhalothrin) was also used as a control measure.

10 % solution of moringa oil was thoroughly mixed with 50 % (w/v) solution of bar soap as an emulsifier to enhance uniform distribution, persistency and to avoid surface tension on the leaves and other plant parts as done by Oparaeke and Dike (2005). A spray volume of 200 L/ha is usually recommended. However, 200ml was applied on the branches of the mango tree. The insecticide Karate was sprayed at the 1.25ml per liter of water and was sprayed on the barches of the mango. All applications were carried out using Micron sprayer.

Biology of Mango Seed Weevil

The biology and the life-cycle of the insect pest both in the Laboratory and on the field were studied. In the laboratory insect rearing cages were used to compare with documented literature in Australia. On the field at Michika/Madagali, direct observations were carried out by destructive sampling on the field for different life stages from egg laying and direct infestation on selected mango fruits caged with muslin cloth to prevent spreading as earlier described by Malgwi (2007).

Data Collection

Data were collected on mean number of damaged mango flowers per five internodes, mean number of damaged fruits per branch, mean number of damaged and mean number of undamaged mango seeds.

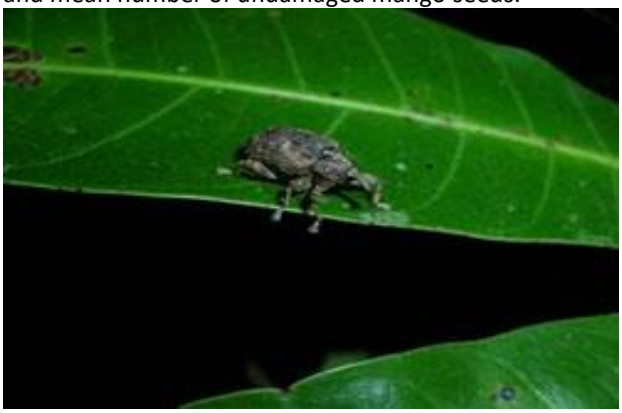

Plate I: Adult Mango seed weevil

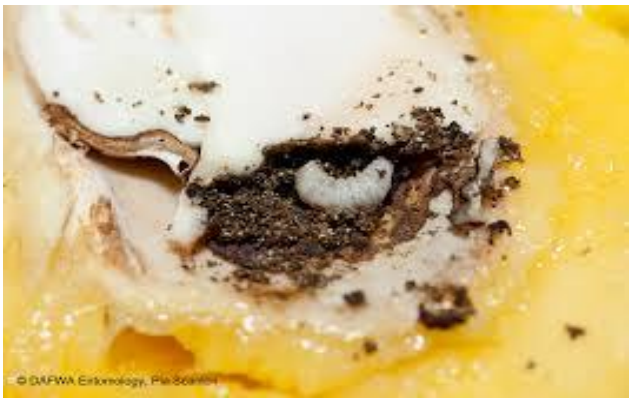

Plate II: Larva of mango seed weevil*, S. mangiferae S. mangiferae* (Anon, 2014)

Data Analysis

Data collected were subjected to the analysis of variance (ANOVA) appropriate to Randomized Complete Block Design (RCBD) according to Gomez and Gomez (1984). The treatment means were separated using the Student Newman Keuls (SNK) at $P \leq 0.05$ level of probability.

RESULTS

The results of the studies on the damage and control of the mango seed weevil, *S. mangiferae* in some major mango producing areas of Northern Adamawa State, Nigeria, shows that, there was significant difference among the treatments and the locations in terms of damaged, undamaged number of flowers, fruits and seeds.

The highest mean number of damaged flowers per five internodes was recorded in the controls (no control measures applied) in both Michika/Madagali and Mubi/Maiha mango growing areas (7.00 and 9.33) and the least were observed on internodes treated with insecticide and moringa seed oil solution (1.33; 2.00; 1.67; 2.67) in both locations respectively.

Moreover, the highest mean number of damaged fruits per branch were recorded in the controls in both locations (4.33; 6.00) respectively while the least were recorded on branches treated with insecticide and moringa seed oil solution in both locations, Michika/Madagali) (0.33; 1.33) and Mubi/Maiha (0.67; 1.67) respectively as presented in Table 1 and as seen on Plate III.

On the other hand, the highest mean number of undamaged mango fruits per branch was recorded on mango fruits treated with insecticide and moringa seed oil solution (15.00; 13.67 and 14.33; 13.00) in both Michika/Madagali and Mubi/Maiha mango growing areas respectively. The least was seen in the controls in both locations (4.33 and 3.00).

Conversely, the highest mean number of damaged mango seeds per branch in both locations was recorded in the controls (3.67 and 4.33) while the least was observed on mango branches treated with insecticide and moringa seed oil solution (0.33; 1.00 and 0.67; 1.33) respectively as shown on Table 2.

Consequently, the results on both Tables 1 and 2 shows that, all the parameters measured were higher in Mubi/Maiha mango producing areas with the exception of mean number of undamaged mango fruits per branch which was higher in Michika/Madagali mango producing areas as shown by the results. The combined insect pests specie complex was also recorded and reported for both locations and in all parameters measured as presented on Table 3.

Table 1: Mean Number of Damaged Mango Flowers and Fruits in Some Mango Growing Areas of Northern Adamawa State

Treatments	Damaged fruits per five internodes		Damaged mango fruits per branch	
	Michika/Madagali	Mubi/Maiha	Michika/Madagali	Mubi/Maiha
Trap 1 (Prolure)	2.67[b]	3.67[b]	1.67[b]	2.67[b]
Trap 2 (Pklure)	2.33[b]	3.33[b]	1.33[b]	2.33[b]
Moringa seed oil	1.67[c]	2.67[c]	0.67[c]	1.67[c]
Insecticide (Karate)	1.33[c]	2.00[c]	0.33[c]	1.33[c]
Control	7.00[a]	9.33[a]	4.33[a]	6.00[a]
Standard Error	2.00	2.55	1.00	1.50

Means followed by the same letter (s) in the same column are not significantly different at P≤ 0.05 level of probability using the Student Newman-Keuls (SNK) method of mean separation.

Plate III: Damaged Mango fruits (Field Survey, 2024)

Table 2: Mean Number of Damaged Fruits and Undamaged Mango Seeds in Some Mango Growing Areas of Northern Adamawa State Areas

Treatments	Mean Number of Undamaged Mango Fruits per Branch		Mean Number of Damaged Mango Seeds per Branch	
	Michika/Madagali	Mubi/Maiha	Michika/Madagali	Mubi/Maiha
Trap 1 (Prolure)	9.67[c]	8.30[c]	1.67[b]	2.67[b]

Trap 2 (Pklure)	12.33[b]	11.00[b]	1.33[b]	2.33[b]
Moringa seed oil	14.33[ab]	13.00[a]	0.67[c]	1.33[c]
Insecticide (Karate)	15.00[a]	13.67[a]	0.33[c]	1.00[c]
Control	4.33[d]	3.00[d]	3.67[a]	4.33[a]
Standard Error	1.50	0.90	1.00	1.60

Means followed by the same letter (s) in the same column are not significantly different at P≤ 0.05 level of probability using the Student Newman-Keuls (SNK) method of mean separation

Table 3: Insect Pests Complex

Common Names	Scientific Names	Order	Family
Carpenter ant	*Componotus spp.*	Hymenoptera	Formicidae
Lesser bulb fly	*Eumerus spp.*	Diptera	Syrphidae
Copper tailed blow fly	*Chrysomya chloropyga* Wied	Diptera	Calliphoridae
Horse flies	*Tabanius par.* Walk	Diptera	Tabanidae
Clown beetle	*Hypocacculus buqueti* Mars	Coleoptera	Histeridae
Mango seed weevil	*Sternochetus mangiferae*	Coleoptera	Curculionidae
Mango leaf hopper	*Amrtodus atkinsonri*	Hemiptera	Cicadellidae
Fruit fly	*Bactrocera dorsalis*	Diptera	Tephritidae
Mango leaf cutting weevil	*Deporus mangiferae*	Coleoptera	Curcullionnidae
Mango butterlfy	*Enthalia garuda*	Lepidoptera	Nymphalidae

DISCUSSION

The inference drawn from the results of the study shows clearly that, the mango seed weevil *S. mangiferae* can cause great economic loses to mango farmers in both Michika/Madagali and Mubi/Maiha mango growing areas. This further buttress the findings by Follett and Gabbard (2000) who stated that, mango seed weevil infestation can increase flower, fruits and seed damage to an unimaginable rate. The study has also established and confirmed that mango seed weevil is a major insect pest of mango and could be responsible to a large extent for the low or reduction in mango production in the areas under review.

The presence of the weevil was characterized by flower abortion, premature fruits fall, and reduction in both quality and quantity of the mango fruits. The assertions agree with Pen *et al*. (1998) who reported that, the weevil causes great damage to mango pulp, rendering it unmarketable, reduces the germination potentials of the mango seed, premature fruit fall or drop and more so causes decay and rotting of mango fruits from the seed.

The insect pests management used provided considerable control against the weevil. The use of chemical which is a common management practice or method gave good results compared to other control methods in both locations. This is in consonance with Oaya (2020) that the use of synthetic insecticide for insect pests control is still the most effective and efficient pest control method. This is because of its quick action and residual effects on the target organism.

Both moringa seed oil and some botanical aqueous lure (PPC) that were used as traps (Okoroafor, 2014) were also effective against the weevils in both Michika/Madagali and Mubi/Maiha mango growing areas as shown by the results. This corroborates the findings of Follett and Gabbard (2000) and Okoroafor (2014) who reported that, moringa seed oil sprayed on mango trees at flowering, fruits setting and at unripe fruits stages before physiological maturity can effectively reduce mango seed weevil infestation to the nearest minimum. They also asserted that, botanical aqueous lure (Prolure and Pklure) were effective as attractants for trapping the weevils when they were hanged on the trees.

Apart from the mango seed weevils, some insect pest species were found and identified as insect pests of mango as depicted by the combined insect pests complex for both locations. It was also observed that, the mango seed weevils, *S. mangiferae* were more prevalent in Mubi/Maiha mango producing area.

CONCLUSION

Mango seed weevil, *S. mangiferae* may not be a common insect pest of interest among mango farmers in both Michika/Madagali and Mubi/Maiha mango producing areas. However, the study has doubtlessly found out that, the weevil has the potential of causing great and unimaginable economic damage and loses of mango produce. Mango farmers and indeed other tree crop farmers often rely heavily on the use of synthetic insecticides for pest management. This study has observed that, moringa seed oil along with the

attractants and traps that are seen as botanicals or pesticides of plant origin gave considerable control of the weevil in both Michika/Madagali and Mubi/Maiha mango producing areas. The study revealed that, mango seed weevil, *S. mangiferae* is a potential and major pest of mango in the study areas. It is also recommended that, minimal use of synthetic insecticides along with botanicals or insecticides of plant origin such as moringa seed oil, plant-based attractants and traps etc can provide good and sustainable management of the weevil particularly in the study areas. These botanical are ecologically safe, biodegradable sustainable and eco-friendly.

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