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INSECTICIDAL EFFECT OF ABAMECTIN AGAINST LESSER GRAIN BORER (*RHYZOPERTHA DOMINICA* (FABRIUS) (COLEOPTERA: BOSTRICHIDAE) ON COWPEA SEED (*VIGNA UNGUICULATA* (LINNAEUS))

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ABSTRACT

Laboratory tests were carried out to evaluate the efficacy of Abamectin against Rhyzopertha dominica on cowpea. The test was conducted under ambient laboratory conditions (28-35^{0}c and 65-70% r.h.). Thirty unsexed adult insects were bioassayed on 50g cowpea grain sample treated with the Abamectin insecticide at five concentrations: 1.0, 1.5, 2.0, 2.5

Introduction

Post- harvest, growers and handlers typically store legumes grain for multiple purposes. Growers may store their products for future planting, stock feed, or for sale at a later date to maximize return, while handlers manage their storages in order to ensure continuous supply and availability for forward contracted sales. It is during this period that the stored product is susceptible to infestation, and subsequent volume and quality losses, due to insect pests activity. Losses caused by stored product pests are difficult to determine, but on a global scale, it has been estimated that approximately 5% of weight is lost to insect activity in storage (Reza *et al.*, 2015).

Insect pests are well-known problem during sto rage of cowpea, and the lesser grain borer, *Rhyzopertha dominica* (Fab.) is one of the major insect pests of stored grains, especially pulses in Nigeria and other parts of the world (Diganggana, 2013). It is one of the most destructive insect pests of stored grains (Idin *et al.,* 2016). It infests other stored food items such as *Triticum*, beaten rice (Poha), millet, maize, dry fruits etc. (Edde, 2012). The adults are sturdy fliers, which fly from warehouse to warehouse, causing severe infestation and convert the stored grains to mere frass (Manal *et al.,* 2015). Both larvae and adults infest and produce frass and cause weight losses by feeding on grains (FAOSTAT, 2011). Larvae consume both the germ and endosperm during their development in grain and thus produce

and 3.0 ml/kg. Mortality of exposed adults were assessed after 7, 14 and 21days exposure to treated grains. Number of progeny were assessed at 56 and 112days after removal of parent insects. Significance ($p<0.05$) differences in adult mortality were noted between different concentrations and exposure periods on treated grain. Increase in concentrations and exposure period resulted in higher adult mortality and progeny suppression. After 14days exposure to the highest dose rates, 100% adult mortality was achieved. Progeny production was considerably suppressed even with lowest concentrations of 1.0ml/kg. Where 1.2±0.6 and 1.0±0.5 adults recorded compared with untreated control with 91.4±2.9 and 116.0±5.1 after 56 and 112days of storage, respectively. Similarly, the percentage of insect damage kernel and weight loss decreased with increase in concentrations. At 3.0ml/kg no grain damage and weight loss were recorded as compared to 100% and 81.6%, in the untreated control, respectively. Furthermore, the result indicate that germination loss decreased with increase in concentrations of Abamectin. The present results show high insecticidal efficacy of Abamectin towards R. dominica and represent a suitable alternative to the traditional grain protectants.

Key words. *Abamectin .R. dominica . Cowpea . Adult mortality . Progeny Suppression*

more frass than other stored grain insect pests and these feeding activity leads to reduction in germination rates and the vigor of the grains (Arthur *et al.,* 2012). *R. dominica* infestation result in loss of quantity and quality of stored grain, and the cost involved to prevent or control infestations of stored grains insect pests more especially *R. dominica* were very high (Ozkaya *et al.,* 2009). This pest also developed a considerable resistance to most conventional insecticide, while the use of conventional and synthetic insecticides had been relied upon for the management of this insect pest, their adverse effect on the environment and residues on foodhas motivated most of the researcher to search for alternative measures.

Abamectin is the most popular insecticide of the avermectin family which belongs to an earlier generation of natural insecticides synthesized from fermenting products of the actinomycete *Streptomyces avermitilis* Kim and Godfellow. It has cuticular and stomach actions, and is effective against insect pest including coleopteran. It acts by stimulating the release of gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter. It is rapid used to protect many crops from insect and mite pests (Athanassiou *et al.,* 2010). Like most other insecticides, avermectins are nerve poisons. They stimulate the gamma-aminobutyric acid (GABA) system, a chemical "transmitter" produced at nerve endings, which inhibits both nerve to nerve and nerve to muscle communication. The affected insect becomes paralyzed, stops feeding, and dies after a few days. AvidTM, used against mites and leaf-miners, is said to spare some of the major parasites of the miner and some predacious mites. When applied to foliage, it is absorbed by the leaves, where feeding insects encounter the poison (Phillips and Throne, 2009). In the current study, evaluated the efficacy of abamectin against *R. dominica* (F.). The influence of dose rate and exposure interval on the insecticidal efficacy of abamectin was assessed. Finally, progeny production of the insect on the cowpea was examined.

Materials and Methods

The experiments were conducted in Entomology Laboratory of the Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, Nigeria. Latitude 11° 50ˈ N, 13° 9ˈE. All the experiments were conducted under ambient laboratory conditions. Temperature and relative humidity during the study was measured using hygrometer.

Maintenance of stock culture

Parent *R. dominica* used in the experiment were obtained from laboratory stock culture, which has been maintained for over a year. The culture was maintained in 1.5L capacity bottles containing cowpea seeds in order to maintain a stock culture for continuous fresh supply of large number of insects required for the experimentation. Fresh broken seeds was introduced periodically for proper development of the beetles. Culture thus maintained was used throughout the period of investigation. Dead adult beetles and frass was periodically removed to avoid storage mite infestation.

The cowpea seeds

The seeds of cowpea varieties (Borno Brown) was obtained in Borno State Agricultural Development Program (BOSADP), Maiduguri.

Preparation of Cowpea Grains

The cowpea seed was cleaned and disinfested for10days using refrigerator and then equilibrated and was kept in plastic buckets covered with lids until commencement of the experiments.

Grain treatment and Bioassay Procedure

The grain was treated at the following concentration rates 0.0, 1.0, 1.5, 2.0, 2.5 and 3.0ml/kg, respectively. For each treatment combinations 250g of clean disinfested cowpea grain was placed in 1liter capacity bottles and the appropriate amount of Abamectin was added to each samples. The jars were capped and then shaken manually to achieve uniform distribution of oil concentration on the entire grain.

All experiment was laid out in Completely Randomized Design, with six treatments replicated five times. Fifty gram (50g) of cowpea seeds per 250 ml capacity jar was prepared. Cowpea seeds was infested using 30 pairs of unsexed 1-2 days old adult *R. dominica*. Five other 50g replicates was prepared and left uninfested which was served as untreated control.

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Determination of management practice on Seed germination

Germination test was evaluated where fifty (50) cowpea seeds from each replication in each of the treatment was randomly pick and uniformly placed on top of non-toxic whatman filter paper moistened and placed in a petri dish. Germination was judged by the appearance of the radicle, was counted daily up to eight (8) days. At the final count, the number of normal and dead seedling was assessed. The SGP was calculated as follows

$$SGP\ (\%) = \frac{\text{number of germinated seeds}}{\text{Total seed number on petri dish}} \times 100$$

Data Analysis

Data on mortality was arcsine transformed to normalize to variance and then subjected to analysis of variance (ANOVA). The data was corrected for mortality in control using the Abbott's formula (Abbott, 1925). The means was separated using Tukey Kramer's Honestly Significant Difference (Tukey Kramer's HSD) test. All statistical tests were considered significant at the p≤ 0.05 level.

Results and Discussion

4.1 Effect of Abamectin insecticide on mortality of *R. dominica* adults after 7, 14 and 21 days of exposure.

Mortality (%±SE)			
Application (ml/kg)	7days	14days	21days
0.0	1.2±0.6d	1.7±0.7c	3.3±1.0c
1.0	57.3±3.6c	76.7±2.8b	95.3±0.8b
1.5	68.0±5.9bc	86.7±2.8ab	100.0±0.0a
2.0	84.6±3.9ab	100.0±0.0a	-
2.5	87.3±4.6a	100.0±0.0a	-
3.0	96.7±2.1a	100.0±0.0a	-
F	80.1	843	4132
P	<0.0001	<0.0001	<0.0001

Mean followed by same letter are not significantly different from each other at p<0.05 according to Tukey Kramer'S HSD Test

Effect of Abamectin insecticide on mortality of *R. dominica* adults after 7, 14 and 21 days of exposure. The results presented in Table 1 indicate that abamectin insecticide cause high mortality of *R. dominica*. Significant differences in adult mortality were observed among different dose rates of abamectin insecticide. Increased with increase in dose rates in all cases cause high mortality of test insect. Abamectin insecticide at a rate of 1.0ml/kg gave 57.3±3.6 mortality of *R. dominica* after 7 days of exposure, while as the dose rate increases, the rate of mortality also increases, at 3.0ml/kg mortality 96.7±2.1 also at 7 days of exposure when compared with untreated control 1.2±0.6 (Table 1). However, after 14days exposure the result showed significant differences among the different dose rates of abamectin on cowpea was observed. Generally, after 14days exposure interval high mortality 76.7±2.8% was observed at the lowest concentration rate of 1.0 ml/kg. At the highest dose rate of 3.0ml/kg, 100% mortality was recorded when compared with untreated control 1.7±0.7%. Moreover, after 21days of exposure, at dose rate of 1.0ml/kg 95.3±0.8% mortality was recorded, thus even at 1.5ml/kg 100.0% mortality was achieved when compared with untreated control of 3.3±1.0% (Table 1).

Table 2: Mean number (%±SE) of progeny, percent dead progeny and progeny inhibition of *R. dominica* adults exposed to cowpea treated with Abamectin insecticide

	56days			112days		
Doses (ml/kg)	Mean no. of progeny	% dead progeny	% progeny inhibition	Mean no. of progeny	% dead progeny	% progeny inhibition
0.0	98.2±5.4a	6.4±0.5a	-	127.4±5.6a	10.4±1.7a	-
1.0	2.6±0.9b	3.6±1.6b	97.4	1.2±0.6b	4.8±2.1b	99.1
1.5	0.0±0.0b	1.2±0.7b	98.9	0.8±0.4b	-	100
2.0	0.0±0.0b	-	-	0.0±0.0b	-	100
2.5	0.0±0.0b	-	-	0.0±0.0b	-	100
3.0	0.0±0.0b	-	-	0.0±0.0b	-	100
F	315	13.4		504	15.4	
P	<0.0001	<0.0001		<0.0001	<0.0001	

Mean followed by same letter are not significantly different from each other at p<0.05 according to Tukey Kramer'S HSD Test

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Effect of Abamectin insecticide on progeny production and percent progeny inhibition of *R. dominica* adults on treated cowpea.

Effect of Abamectin insecticide on progeny production and percent progeny inhibition of *R. dominica* adults on treated cowpea.

The result on progeny development and progeny inhibition of *R. dominica* showed significant differences among the different dose of Abamectin insecticide after 56 and 112 days of storage (Table 2). The results show that there were very few F_1 progeny 2.6±0.9 and high progeny inhibition of 97.4% was achieved at dose rate of 1.0ml/kg of Abamectin after 56 days of storage when compared with untreated control with 98.2±5.4. Even at the highest dose rate of 2.0 ml/ kg no F_1 progeny were developed. After 112 days of storage, the result reveal that at the least dose rate of 1.0ml/kg only 1.2±0.6% adults developed and inhibition of 99.1% of adult progeny emerged was recorded. As the dose rate increases to 2.0ml/kg, no F_2 adult progeny were developed. When compared with 127.4±5.6 in the untreated control and the inhibition rate was 99.1% at the lowest dose rate (Table 2).

4.3 Effect of Abamectin insecticide on insect damage grain (IDG) caused by *R. dominica*

Application rates (ml/kg)	Damage percentage	Percentage weight loss	Germination loss
0.0	100.0±0.0a	92.4±2.3a	90.0±4.6a
1.0	1.8±1.3b	9.2±1.4b	11.8±1.6b
1.5	1.0±0.9b	1.6±0.7c	7.8±0.5bc
2.0	0.8±0.4b	1.0±0.0c	6.4±1.2c
2.5	0.6±0.4b	0.9±0.4c	4.8±0.6c
3.0	0.0±0.0b	0.0±0.0c	1.8±0.5c
F	6386	1001	1298
P	<0.0001	<0.0001	<0.0001

Mean followed by same letter are not significantly different from each other at p<0.05 according to Tukey Kramer'S HSD Test

Effect of abamectin on grain damage, weight loss and germination percentage caused by *R. dominica*

The result presented in Table, 3 show that the percentage of insect damage grain (IDG), weight loss and germination loss was significantly affected by mahogany seed oil treatments. There were significant differences in the number of damage grains among different dose rates (Table, 3). In the untreated control after 112 days of storage complete (100%) grain damage was recorded and this was significantly higher than values in all other treatments. The result revealed that at the lowest dose rate of 1.0 ml/kg 1.8% grain damage and 9.2% weight loss were recorded; and as the dose rate increases no grain damage and weight loss was recorded at 3.0 ml/kg. Moreover, the result indicate that germination loss was not affected by different treatment concentration when compared with the untreated control thus at 1.0ml/kg 11.8±1.6% germination loss was recorded, at 3.0ml/kg 1.8±0.5% was observed when compared with 90.0±4.6% on untreated control (Table, 3).

Discussion

The result of the present study has showed that abamectin insecticide had significant effect on the adults of *R. dominica* when compared with control. All the dose rates were quite very effective in causing mortality, reducing the grain damage and as well as weight loss. This study has shown that abamectin tested at all dose level has good insecticidal effect. The best results obtained were observed at 2.5ml and 3.0ml doses where 100.0% of the insect died within 14 and 21days. The results of higher dose show that abamectin had good insecticidal effect because it adequately controlled the bostrichids. Both lower and higher doses had controlled the *R. dominica* at 2ml/kg caused complete mortality of the test insect. Abamectin was effective against the tested species, effectiveness was affected by exposure interval. According to our findings, exposures longer than 7days are required for abamectin to be effective, of *R. dominica*. generally, the increase in mortality was higher after 14days of exposure than 7days later, compared with the initial mortality at 7day. Hence, 14days of exposure can be considered as a sufficient exposure interval for a satisfactory control level. Kavallieratos *et al.,* (2010) showed that abamectin is highly effective against the rice weevil *Sitophilus oryzae* (L.), *R. dominica* and confused flour beetle *Tribolium confusum* Jacquelin du Val at the rate of 1mg a.i/kg and that it could be used in practice as a grains protectant. Hussain *et al.,* (2005) reported high efficacy levels against larvae of *Tribolium castaneum* (Herbst), where as in a more recent study Athanassiou and Korunic (2007), confirmed abamectin efficacy in an enhanced mixture with diatomaceous earth (DE) against several stored-product pests. However, according to our findings, 1.5 mg/kg abamectin gave almost complete mortality of test insect even at 7days of exposure. Treating grain with 1.5mg/kg of abamectin it is possible to achieve satisfactory protection. Progeny suppression is crucial for long term stored grain protection.

Conclusion

Based on the results obtained, it is concluded that abamectin insecticide has potential effect in management of *R. dominica* against stored cowpea.

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