

EVALUATION OF KARATE (Lambdacyhalothrin) INSECTICIDE AND NEEM SEED AQUEOUS EXTRACT LATE APPLICATION SPRAY REGIMES IN THE MANAGEMENT OF *Callosobruchus maculatus* ON COWPEA IN SAMARU, ZARIA.

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SUMMARY

Different spray regimes of Lambdacyhalothrin (Karate) applied at the recommended rate and Neem seed aqueous extract applied at 10% w/w were evaluated against field- to-store infestation of cowpea by *Callosobruchus maculatus* in Samaru Zaria. Field and Laboratory trials were conducted in IAR farm, Samaru (11 11'N; 07 38') in the Northern Guinea Savanna ecological zone of Nigeria and in the Storage Entomology Laboratory of Crop Protection Department, Faculty of Agriculture Ahmadu Bello University, Zaria in 2017 and 2018. A total of six treatments coded in order of increasing spray regimes as T1, T2, T3, T4, T5 with T6 as the chemical independent control. All treatments were replicated four times and laid in a randomized complete block design (RCBD) in the field. At the end of the experiment, number of eggs laid on 50 pods from all the treatments were counted and recorded. Harvested pods from all the plots of each treatment were threshed and 500 g of seeds were weighed into 1000 ml kilner and laid in a completely randomized design (CRD) in the storage Entomology Laboratory of crop Protection Department, Ahmadu Bello University, Zaria. Results obtained showed that NSE spray regimes were not as effective as the synthetic pesticide (Karate) in suppressing *C. maculatus* oviposition on cowpea pods and seeds, progeny emergence and in the general protection of the cowpea seeds against *C. maculatus* attack however, both spray regimes of the synthetic pesticide and plant material used, were more effective than the chemical independent control. Karate applied 4X and NSE applied 6X were the most effective treatments observed in the parameters assessed however Karate applied 2X and NSE applied 5X were better than the untreated controlled and are believed to have reduced insecticidal residues.

Keywords: Lambdacyhalothrin, *Callosobruchus maculatus*, neem and aqueous extract

COWPEA *Vigna unguiculata* L. (Walp) is one of the most important comestible legume crop grown in tropical and sub-tropical regions of the world (Ntoukam *et al.*, 2000). As a multipurpose crop, it is grown principally for food and as source of fodder (10) supplying the dietary protein requirements of man and his animals (Magaji *et al.*, 2009). The grains are dried and stored for either local consumption or traded and exported to various countries around the world, especially the European Union. Nigeria was among the leading beans exporting nation of the world but since 2013, the EU has placed temporary import suspension on dried-beans originating from Nigeria due to the discovery of higher pesticides residue found in them ranging between 0.03mg/kg and 4.6mg/kg (Yunusa *et al.*, 2018).

Herbicides and insecticides are the two dominant categories of synthetic pesticides used to suppress weeds and arthropod pests in the production of the most consumed staple foods (legumes, cereals, vegetables, and fruits) in the continent which have been found to be contaminated by one or multiple residues of these chemicals.

Cowpea production and storage in Nigeria is heavily dependent on pesticides usage for optimum yield due to an array of diseases (viral, fungal and bacterial) and insect pests which attack the crop at all growth stages in the field which is continued in the store. During storage, this crop is extremely vulnerable to bruchid attack especially *Callosobruchus maculatus* F. It is the most notorious storage insect pest of cowpea and other comestible legumes in the country causing an estimated damage of about 30,000 tonnes per year of cowpea seeds (Keri, 2009). They are field-to- store pest and their damage to seeds are usually undetected for a major part of the insects' life cycle because they are pestiferous only at the larval stage and develop within the seeds reducing the commercial value of the commodity in terms of losses in weight and quality of grains as well as germinability.

In the field, commonly used herbicides in Nigeria include; Glyphosate, Paraquat, atrazine, 2,4-D-dimethylammonium while the insecticides are; Chlorpyrifos, Dimethoate, Cypermethrin, Lambda-cyhalothrin, Malathion, Dichlorvos, imidachlopid, abamectin, mancozeb, Phostoxin (Aluminium phosphide) and actellic (25 EC) (Pirimiphosmethyl). These chemicals are usually applied by unskilled and illiterate operators using knapsack sprayers carried on their back while others use atomizer, especially cocoa farmers. Exposure to these pesticides occurs mostly during preparations of spray solutions, loading in the tank and during spraying. Poor disposal or reuse of containers for drinking water or local wine as well as eating foods/drinking with contaminated hands previously used in manipulating pesticides are additional sources of poisoning (Bertrand, 2019). Pesticide misuse often results from absence of clear instructions, illiteracy, use of pesticides on wrong crops, poor respect for dosage and inability to properly prepare spray solutions. Worst still, many African countries have few or no documentation of pesticide poisoning and do not give cases of pesticide poisoning the attention it deserves added to the fact that no serious assessment is carried out on the status of the health of the operators with high proximity to these pesticides.

Over dependence coupled with the above mentioned problems has resulted to high residual pesticide deposits beyond acceptable global standards in Nigerian grains. Many accidents due to pesticides misuse have been reported in different parts of the World, and the presence of pesticides in food grains, fruits, vegetables, the environment and even in mother's milk is a matter of grave concern (FAO, 2005). Of all the pesticides released into the environment every year by human activity, persistent pesticides are among the most dangerous (FAO, 2005). They are highly toxic, causing an array of adverse effects, notably death, diseases and birth defects among human and animals. Specific effect can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system (FAO, 2005).

The global quest towards reduction in pesticide use and eventual phasing out of synthetic chemicals in grain production has called for a paradigm shift both in research and practice, to the use of more eco-friendly and benign pest management methods that can reduce the harmful effects of chemical pesticides on man and his environment (Bertrand, 2019) And promote the exportation of these produce.

The use of organic, plant-based pesticides against insects which may not only be effective and inexpensive for protecting crops, but also safer and more environmentally friendly, is timely. Neem seed oil is known to alter the hormones of bugs so that they cannot fly, breed or eat (Kalia, 2011) and therefore could be a natural source of an insecticide. The objective of this research was to evaluate the efficacy of different spray regimes of lambdacyhalothrin and neem seed aqueous extract in suppressing the development of *C. maculatus* infestation in the store. Since it is a field-to-store pest, it is believed that, late application of pesticides at the reproductive stages of the crop growth, could possibly reduce infestation ab-initio in the field and subsequently in the store and thus minimizing pesticide usage in cowpea production and storage.

MATERIALS AND METHODS

White SAMPEA-7 variety (i.e. IAR-48) known to be highly susceptible to *C. maculatus* attack was obtained from seed production unit of Institute for Agricultural Research (IAR), Ahmadu Bello University (ABU), Zaria and used for the experiment while ripe neem seeds for the aqueous extract formulation were collected on the ground under neem trees within the premises of the same Institute. Lambdacyhalothrin (Karate) was purchased from a popular agro-chemical shop (Farmers' Escort) in Samaru, Zaria market.

Neem Seed Aqueous Extraction: Ripped neem seeds were collected, depulped, washed and adequately air-dried under shade in the storage entomology laboratory of Crop Protection Department, A.B.U, Zaria. The dried seeds were then decorticated by lightly pounding in a mortar

with pestle, chaff removed and pulverized into fine powder. Two (2) kg of the powder was weighed and soaked in 5 litres of warm water and allowed to stay overnight in a bucket. The suspension was then sieved into another bucket using a muslin cloth and about 5 g of soap solution was added and stirred vigorously. The resultant mixture was transferred into a 20 litre Knapsack sprayer and water added to the appropriate volume ready for use. The formulation of 2 kg neem seed powder in 20 liters of water was equivalent to 10% w/w application rate.

Experimental Phases and Treatments: Field and laboratory trials were conducted in IAR farm, Samaru (11° 11' N; 07° 38' E) in the Northern Guinea Savanna ecological zone of Nigeria and in the Storage Entomology Laboratory of Crop Protection Department, Faculty of Agriculture Ahmadu Bello University, Zaria in 2017 and 2018.

The field was ploughed, harrowed to a fine tilth and plots were established on the 15th of August 2017 and 17th of August 2018 respectively. Each plot measured 4 m x 5 m was planted with IAR-48 (SAMPEA-7) cowpea seeds with an inter-row spacing of 75 cm and intra-row spacing of 30 cm and followed with normal agronomic practices to ensure good growth.

A total of six treatments were used and they included:

- i. Karate (Lambdacyhalothrin) applied two times (2X) (i.e. at flower bud formation and at 50% podding).
- ii. Karate applied three times (3X) (i.e. at flower bud formation, 50% podding and 75% podding).
- iii. Karate applied four times (4X) (i.e. at flower bud formation, 50% podding, 75% podding and two weeks before harvest).
- iv. Neem seed extract (NSE) applied five times (5X) (i.e. application in weekly intervals beginning from flower bud formation to one week before harvest).
- v. NSE applied six times (6x) (i.e. application in weekly intervals beginning from flower bud formation to harvest)

- vi. An untreated control (i.e. water applied at weekly intervals beginning from flower bud formation to harvest)

All treatments were coded in the order of increasing spray regimes as T1, T2, T3, T4, T5 respectively with T6 as the untreated control. All treatments were replicated four times and laid in a randomized complete block design (RCBD) while application of the insecticides were done using a 20 litre CP3 Knapsack sprayer. At the end of the experiment, number of eggs laid on 50 pods from all the treatments were counted and recorded. Harvested pods from all the plots of each treatment were threshed and Seeds (500 g) were weighed into 1000 ml kilner jars for the second experiment in the storage Entomology Laboratory of Crop Protection Department, Ahmadu Bello University, Zaria.

All the Kilner jars containing the seeds were capped with a piece of muslin cloth with 10 mesh/cm for ventilation but precluded the entry or exit of insects. The set up was then laid in completely randomized design (CRD) repeated four times on Laboratory benches at room temperature $23\pm 3^{\circ}\text{C}$ and 70 – 80% relative humidity. The number of eggs on seeds were counted and recorded fourteen days after experimental set up while the first (F_1) and second filial generations (F_2) were monitored and recorded 30 to 35 days and 60 to 70 days after experimental settings respectively. At each stage of progeny emergence count, both live and dead insects from all the treatments were immobilized in a refrigerator, sieved and collected using an aspirator and the number obtained recorded while the grains were returned into the jars in each case. At the end, percentage seed damage and seed germination test were conducted. Percentage damage was determined by using the formula below:

$$\text{Damage (\%)} = \frac{\text{number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

While seed germination was evaluated by randomly picking ten seeds from each jar and placed on petri-dishes lined with moistened filter paper. This was observed for five days with daily moistening of the set up and percentage germination was determined as follows:

$$\text{Germination (\%)} = \frac{\text{number of seeds germinated}}{\text{Total number of seeds}} \times 100$$

Data obtained were subjected to analysis of variance (ANOVA) and means were separated using the least significant difference (LSD).

RESULTS

Results of *C. maculatus* oviposition on 50 pods and 100g seeds of cowpea are shown in Table 1. Oviposition on 50 cowpea pods revealed that, synthetic insecticide treated plots had significantly lower ($P < 0.05$) mean oviposition compared to NSE which in turn had significantly lower mean oviposition than the untreated check. Karate applied 4X had the least mean oviposition (45.0) which was significantly lower ($P < 0.05$) than 3X of its application. Karate applied 2X and NSE applied 6X were statistically at par and had significantly lower mean oviposition than NSE applied 5X. The highest mean oviposition was recorded on the untreated check plots. A similar trend was observed in oviposition on 100g threshed cowpea seeds except that in this case oviposition was greatly reduced and records of mean oviposition from plots that received 2X application of Karate and 6X NSE were not at par as in the former and had lower mean records.

Results on the efficacy of late pesticides application on *C. maculatus* in terms of F_1 and F_2 progeny emergence, grain damage and germination are shown in Table 2. It indicated that, all treated plots significantly suppressed ($P < 0.05$) progeny emergence, reduced grain damage and almost indifferent in germination compared to the untreated control.

Application of Karate applied (3X) and 4X as well as NSE applied 6X, were at par and had significantly lower ($P < 0.05$) mean number of F_1 progeny emergence compared to Karate applied

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2X and NSE applied 5X which were themselves also at par and significantly lower ($P<0.05$) than the untreated check with the highest mean F₁ progeny emergence (202.0). Grains from treated plots after F₁ emergence also had significantly lower ($P<0.05$) mean damage value compared to the untreated check. The least mean grain damage was recorded from plots that received 4X application of karate (3.5), followed by 6X NSE (5.0), 3X karate (6.0), 5X NSE (6.8) which were at par and significantly lower than 2X karate application (10.5) and the untreated check (20.5).

At F₂, mean progeny emergence value was highest from untreated check plots and least from plots that received 4X applications of karate while there were no significant differences among the remaining treatments however; there was a geometric increase in the mean number of insects that emerged at F₂ compare to F₁. Result from germination test showed that, all insecticide treated plots except karate applied 2X had significantly higher ($P<0.05$) percentage seed germination compared to the untreated check.

Table 1: Mean Effect of Late Pesticides Application on oviposition of *Callosobruchus maculatus* on Cowpea pods and seeds

Treatments	Number of eggs /50 pods	Number of eggs / 100 g seeds
Karate 2X	75.0 ^c	25.0 ^d
Karate 3X	60.0 ^d	20.0 ^e
Karate 4X	45.0 ^e	10.0 ^f
NSE 5X	80.0 ^b	35.0 ^b
NSE 6X	75.0 ^c	30.0 ^c
Untreated check	240.0 ^a	105.0 ^a
LSD	2.48	2.43

Means in a column with the same superscript are not significantly different at $P<0.05$ level.

Table 2: Mean Effect of Late Pesticides Application on F₁, F₂ Progeny emergence, Percentage Seed Damage and Germination of *Callosobruchus maculatus*

Treatments	Insect number (F ₁)	Damage grains (F ₁)	Insect number (F ₂)	Damage grains (F ₂)	% Germination
Karate 2X	149.5 ^b	6.8 ^{bc}	750.0 ^{bc}	83.8 ^{ab}	72 ^c
Karate 3X	73.0 ^c	5.0 ^{bc}	900.0 ^{ab}	76.5 ^b	90.5 ^a
Karate 4X	64.5 ^c	3.5 ^c	425.0 ^c	28.0 ^d	95 ^a
NSE 5X	149.0 ^b	10.5 ^b	650 ^{bc}	86.3 ^{ab}	94 ^a
NSE 6X	93.5 ^c	6.0 ^{bc}	900.0 ^{ab}	45.8 ^c	92 ^a
Untreated	202.0 ^a	20.5 ^a	1125 ^a	99.3 ^a	58 ^d
check	31.70	6.43	351.13	16.45	5.23
LSD					

Means in a column with the same superscript are not significantly different at P<0.05 level.

DISCUSSION

There are basically two forms of *C. maculatus* (sedentary and active forms) that differ in life history characteristics and physiology (Utida, 1972). Infestation of cowpea in the field by this pest is caused by the high density of the active forms in stored beans or laboratory cultures which cause individuals to move to new areas with less competition and higher quality habitats. Insecticide treated plots were more effective in suppressing oviposition, progeny emergence and caused reduced damage to cowpea seed without significantly affecting its germination.

NSE spray regimes were not as effective as the synthetic pesticide (Karate) in suppressing *C. maculatus* oviposition on cowpea pods and seeds, progeny emergence and in the general protection of the cowpea seeds against *C. maculatus* attack however, both spray regimes of the synthetic pesticide and plant material used, were more effective than the chemical independent control. Karate applied 2X was as effective as NSE applied 6X in inhibiting oviposition on cowpea pods and seeds compared to the control. Karate (Lambda-cyhalothrin) is a synthetic pyrethroid which causes fast knock down effect on insects via disrupting and compromising the insect's central

nervous system resulting to paralysis. Paralyzed insects could not feed and would die because of their inability to conduct their regular bodily functions. Karate must have caused either adult or egg mortality in the field leading to reduced cowpea infestation in the store during storage. This report agrees with the findings of Badii *et al.* (2013) who showed that, application of Lambda-cyhalothrin based insecticides drastically reduced the population of thrips, pod-borers and pod-sucking bugs especially at the egg and larval stages of development.

The oviposition inhibition on pods and seeds by neem aqueous extract in this research could have been due to the synergistic biological activity of neem formulation- a plant well known for its insecticidal effect in addition to stomach poisoning, repellent and antifeedant properties (FAO, 2005). The malign nature of plant materials is currently responsible for the exploration of phytochemicals or plant products for the management of field and storage pests (Tripathi *et al.*, 2009). The findings of this research is congruent to the reports of (Magaji *et al.*, 2009) who showed 50% mortality of *C. maculatus* when powdered neem was applied at 0.25/20 g of cowpea and Raja *et al.* (2001) revealed the oviposition deterrence, antifeedant activity and reduction in adult emergence of *C. maculatus* .

Oviposition deterrence observed on insecticide treated plots resulted in the inhibition of F₁ and F₂ progeny emergence, reduced seed damage without any significant effect on seed germination. Karate applied 4X and NSE applied 6X were the most effective treatments observed in the parameters assessed, followed by Karate applied 3X and NSE applied 5X when compared to other treatments and the control. These findings corroborate the report of Uddin and Abdulazeez (2013) who found that aqueous extracts and powders of *Jatropha curcas*, *Azadirachta indica* and *Ceratotheca sesamoides* applied at 1.5%, 2.0% and 2.5% weight/volume inhibited progeny emergence without affecting cowpea germination. A similar report was given by Olotuah (2002) and Antoine *et al.* (2018) who showed that several plant materials, including powders, crushed

plants and essential oils (EO), were active against eggs, larvae, and adults of *C. maculatus*, through dose-dependent mortality responses.

The general trend observed in this research was that as the efficacy of the insecticide treated plots in all the parameters assessed increases with increased in the number of spray regimes per treatment i.e. as the number of spray regime increases there was a corresponding decrease in oviposition, progeny emergence and damage with no effect on germination.

CONCLUSION

Cowpea seeds collected from all insecticides treated plots were more protected against *C. maculatus* damage as insecticides applied 2X, 3X, 4X as well as 5X and 6X for synthetic and NSE respectively, effectively suppressed field- to- store infestation of cowpea by *C. maculatus* with an outstanding performance recorded from seeds collected from plots treated with Lambda-cyhalothrin applied 4X. Lower spray regime of Karate applied 2X was as effective as NSE applied 6X and both were significantly better than the chemical independent control. Grains obtained from this low spray regime and from NSE (highly degradable), would contain low insecticide residue and as such can be suggested for use by farmers or incorporated into any integrated pest management programme to promote the exportation of these produce in International markets.

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