Bio-insecticidal Efficacy of some Plant Extracts and Synthetic Dust on Control of *Callosobruchus maculatus*(Motscholsky) in Cowpea Seeds

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Abstract:-The use of inorganic chemicals has proven to eradicate pests faster and more toxic with an efficiency record of up to 100% mortality to the target pest. Nevertheless, its residual effect on soil micro-organisms, and toxicity to animals and human beings, necessitated the need to curb this menace. However, the use of organic pesticides which have always been a better substitute has also been observed recently to be slower in the eradication of the pest when compared to inorganic chemicals. Hence, the need to adopt an Integrated Pest Management system (IPM). A sequel, to the above, the Bio-insecticidal efficacy of some plant extracts and synthetic dust on the control of *Callosobruchus maculatus* in cowpea seeds were investigated. Two botanicals: neem*(Azadirachta Indica) and* pawpaw (*Carica papaya)*were used in combination with synthetic dust at different treatment combinations for the control of *C.maculatus*. The cowpea seeds were obtained from the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. Clean seeds showing no visible sign of beetle egg covers, presence of adults or their exit holes were used. The botanical plant extracts were obtained from a herbal store in Owerri**,** Nigeria. They were oven-dried at 60°c for 48hrs and grounded to a powder form in an electric mill. The synthetic dust (pirimiphos-methyl and permethrin) was used at a fixed application rate of 0.1g while the botanical powders were varied at 0.02, 0.04, 0.06, 0.08, 0.1 g/ 20 seeds. Both the synthetic dust and the plant extracts were used singly and in combination. The mortality of *C. maculatus* was monitored within the time intervals of 12, 24, 48 and 72 hrs. The result showed that at 24 hrs post-treatment, the percentage mortality of *C.maculatus* in treatment involving neem powder (0.1g) mixed with pirimiphos-methyl (0.1g) was significantly the highest but was not different from mortality in treatments involving Neem powder (0.08g) mixed with permethrin (0.1g) and Neem powder (0.1g) mixed with permethrin (0.1g). Five treatments, including the control, recorded zero mortality at 24hrs post infestation. The result showed that a sub-lethal dose of neem powder (0.1g) mixed with pirimiphos-methyl (0.1g)/20grams of cowpea seeds produced 100% adult mortality of *C. maculates* at 24hrs post-infestation thus recommended dose of insecticidal materials.

Keywords: Integrated Pest Management, Storage Pest, Stored Seeds, Insecticidal Plant, Inorganic Chemical, Eco-system.
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1. Introduction

Legumes occupy an important place in the nutrition of Nigerians because; their edible seeds form a cheap source of protein in their diets. Food legumes have been described as "poor man's meat" because animal protein sources are seldom affordable by the majority of the populace [3]. Cowpea *(Vignciun*guiculateWalp) is one of the world's most important grown legumes. It is indigenous to Africa but grown all over the tropics and sub-tropics. The dried cowpea is highly nutritious, containing 24% protein, 20% oil and carbohydrate with minerals and other nutrients. It is also consumed as green or dry leaves, green pods, green peas, and dry grains or fed to livestock folders [5]. In storage, over 20% of cereals have been lost as a result of pest infestations [8]. Pest can be controlled in several ways, natural resistance, sealed storage, chemical, fumigation and biological control [4]. These various pest attacks are major reasons for low yields obtained by African farmers, resulting in a downward thread in the country's economy. *Callosobruchus maculatus* is extremely pestiferous to the stored seeds of these legumes [11]. Prominent, among the control methods, is the use of the chemical in the control of pests; this can be either through the use of organic or inorganic pesticides.

The most effective method of controlling *C. maculatus* damage to cowpea is currently the use of conventional synthetic insecticides [13]. Synthetic pesticides have proven to be one of the most effective control agents against all pests of major pulses; this is because they eradicate pests faster with an efficient rate of up to 100% mortality. They are also, easy to apply and can get in the way of pests that hide in small craves and other hidings. However, considering the drawbacks of pesticide residues in the grain, this has several effects such as vertebrate toxicity, pest resistance, resurgence, widespread environmental hazards and the high cost of the chemical products. They also cause damage to natural enemies associated with synthetic pesticide use, are toxic to animal and human being, deteriorates the natural quality of soil and in long run, causes pollution when run off with surface water table. Also, the use of resistant varieties which would have served as an alternative is associated with the problem of the loss of resistance genes in the subsequent generations. In place of these, organic insecticide usage is being advocated, to curb the menace of synthetic insecticides.

However, [15] highlighted some advantages of organic pesticides over synthetic chemicals. They considered bio-insecticides as biological methods of controlling pests which introduce bio-pesticide organisms in the crop fields as natural predators with the ultimate motive to check on the pests, but not to eliminate the pest. Also, the biodiversity of the crop field is not changed nor is its ecosystem hampered.[15] their research recorded that bio-insecticides generally have features of strong selectivity, in addition to controlling pests and diseases, they produce little toxic residue which is of minimal risk to both animal and human health. They further established that many bio-pesticides have zero or low re-entry and handling intervals where microbial biopesticides can produce on or near the target pest and disease, thereby, giving some self-perpetuating control. The study affirmed that botanical insecticides have many insecticidal ingredients with special modes of action, which makes it difficult for pests to develop resistance. However, [17], [15] observed that there are several lapses recorded even in the organic pesticides among which are: being too slow in action of killing pests when compared to conventional chemicals pesticides, having shorter persistence in the environment and this makes them susceptible to unfavourable environmental conditions. A sequel, to the above-integrated pest management schemes for pulses, is being developed to avoid unnecessary pesticide applications. [13],observed that economic thresholds are being developed for pests of green gram (Vignaradiata [L.] R. Wilczek) and black gram (Vignamungo [L.]Hepper) to control their population. The adoption of these integrated practices by farmers in resource-poor communities has improved food security in rural areas tremendously. This potentially decreases management costs, reduces the use of pesticides and adopts a more sustainable pest management practice by minimizing reliance on a chemical to control and ultimately keeping the target pest number below action thresholds[1]**.** Sequel to the above, a combination of synthetic insecticides i.e. pirimiphos-methyl, permethrin and plant extracts derived from Neem*(Azadirachta Indica)* and pawpaw (*Carica papaya)* leaf extract in the control of *C.maculatus* was evaluated.

2. Material and Methods

2.1 Experimental material and source

The study was carried out at the Crop production, research laboratory of the University of Agriculture and environmental sciences, Umuagwo, Owerri. The *C. maculatus* used were derived from a culture maintained in Kilner jars under ambient laboratory conditions of 28± 2°C and 70 ± 2%, relative humidity. *C. maculatus* was maintained on Ife brown cowpea variety. The cowpea seeds were obtained from the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. Clean seeds showing no visible sign of beetle egg covers, presence of adults or their exit holes were used. The cowpea seeds were disinfected by storing them in a deep freezer for two weeks before use.

2.2 Preparation of Insecticidal powders (Neem and *Carica papaya)*

The two treatment plants used for the studies are namely neem*(Azadirachta Indica) and* pawpaw (*Carica papaya)* as bio-powder plant protectants, selected plants' leaves were cut, surface sterilized with 0.1% HgCl2 and washed to remove disinfectant with sterile distilled water. Each sterilized leaf's parts were kept for drying in a hot air oven at 60oC for 48 hours, dried leaves part was crushed to powder with the help of a grinder. The test leaves powders thus obtained passed through a sieve to get fine powder and stored in polythene bags.

2.3 Synthetic insecticides

However, the two synthetic insecticides dust used were pirimiphos-methyl (Actellic) and permethrin (Coopex) and both were obtained from an Agro-allied chemical store located within Owerrimetropolis, Nigeria.

2.4 Experiment 1; Mortality of C. *maculatus* in cowpea treated with neem powder alone and in combination with pirimiphose- methyl or permethrin dust

In this experiment, Twenty grams of Ife brown cowpea in a plastic Petri plate (8.5cm diameter) was treated with *neem* powder alone and in combination with pirimiphos-methyl and another plastic Petri plate with neem powder alone and combination with a permethrin dust.

Twenty (20) freshly emerged adults of *C.maculatus* (10 males and 10 females) were introduced. Five rates of *neem* powder (0.02, 0.04, 0.06, 0.08 and 0.1g) were each applied sole and each rate in combination with 0.1g of pirimiphos-methyl. The same procedure was used in the sole and each rate in combination with 0.1g of permethrin dust. However, pirimiphose- methyl dust was used solely at 0.1g while the other treatment involved permethrin dust being used solely as well. A control was set up involving no application of plant powder or synthetic insecticide. Each treatment was replicated three times, including the control. The experimental setup was placed in a wooden cupboard in the research laboratory. Adult mortality count in the introduced *C.maculatus* was taken at 12, 24 and 48 hours (post-introduction). Several adult exit holes on seeds were the variable used to determine seed damage after Fi progeny emergence and this was taken 35 days post-treatment.

2.5 Experiment 2 - Mortality of *C. maculates* cowpea treated with pawpaw leaf dust alone and in combination with pirimiphose- methyl or permethrin dust.

The procedure described in Experiment 1 was followed except that Pawpaw dust was used instead of neem.

2.6 Data Analysis

Data collected on each trait were subjected to the following statistical tools using SPSS statistical packages. Percentage data were transformed using arcsine transformation before analysis. Analysis of variance (ANOVA) was carried out to determine significant effects among the various treatments, Treatment means for all the characters were compared using Duncan's Multiple Range Test at the 5% level of probability.

3. Results

Table 1 Adult *C. maculatus* mortality in cowpea treated with neem powder alone and in combination with permethrin or pirimiphos methyl

Treatment combination	Rate of application	Mean %12hrs	Adult mortality24hrs	48hrs	Mean no of an adult exit hole
NA	0.02	0.0a	0.0a	0.0a	I9.4e
	0.04	0.0a	0.0a	0.0a	19.0e
	0.06	1.7a	11.6bc	23.3bc	19.5cd
	0.08	3.3a	25.0bc	48.3cd	19.5cd
	0.10	10.0de	40.0F	65.0cd	18.6bc
N-Per	0.02+0.1	0.0a	0.0a	3.3ab	15.8e
	0.04+0.1	1.6bc	5.0bc	11,6bc	15.0cd
	0.06+0.1	8.3de	25.0bc	40.0cd	16.1 be
	0.08+0.1	16.6f	73.3de	85.0e	10.0ab
	0.1+0.1	20.0 g	75.0e	100.0g	6.0a
N+Pir	0.02+0.1	0.0a	0.0a	8.3ab	14.0e
	0.04+0.1	0.0a	5.0bc	16.6bc	I6.0cd
	0.06+0.1	5.0bc	15.0bc	40.0cd	16.5bc
	0.08+0.1	11.6e	35.0cd	75 .0de	11 .0ab
	0.1+0.1	15.0f	65.0cd	100.0f	9.0a
PerA	0.1	0.0a	0.0a	0.0a	20.1e
PirA	0.1	0.0a	0.0a	0.0a	20.6f
Con	0.0a	0.0a	0.0a	0.0a	27.8g

Neem -Alone-NA, neem+permethrin-N+per, Neem +pirimiphos-N+pir,
Permethrin Alone-per A, Pirimophos-methyl alone-Pir A, control-con
note: means bearing the same letters are not significantly different at p=0.05 (dmrt)

At 12 hours post infestation, the percentage mortality of C,*maculatus* was significantly highest in treatment involving 0.1g Neem powder mixed with 0.1g permethrin (Tab 1). This was closely followed by the treatment involvingNeem powder (0.1g) mixed with pirimiphos-methyl (0.1g). Adult mortality was not recorded in nine treatments including control, at I2hrs post-infestation. At 24 hrs post-treatment, percentage mortality of *C.maculatus* in treatment involving Neem powder (0.1g) mixed with permethrin (0.1g) was significantly highest but was not different from mortality in treatments involving Neem powder(0.08g) mixed with permethrin (0.1g) and neem powder (0.1g) mixed with pirimiphos-methyl (0.1g). Five treatments, including the control, recorded zero mortality at 24hrs post infestation. Also, treatments involving Neem powder (0.1g) mixed with pirimiphose-methyl (0.1g) and Neem powder(0.1g) mixed with permethrin (0.1g) recorded 100% mortality, at 48hrs post-infestation. Three treatments, including the control, recorded zero mortality, after 48hrs post infestation. The number of adult exit holes was significantly highest in the control treatment. It was significantly lower in treatment involving combinations of Neempowder with permethrin (0.1g +0.lg) and Neempowder with pirimiphos-methyl (0.1g +0.1 g) than in other treatments (Table 1).

Table 2: Adult *C.maculatus* mortality in cowpea treated with pawpaw powder alone and in combination with permethrin or pirimiphos-methyl.

Treatment combination	Rate of application	Mean % 12hrs	Adult mortality24 hrs ■	48hrs	Mean no of adult exit holes
PawA	0.02	0.0a	0.0a	0.0a	20.6f
	0.04	0.0a	0.0a	0.0a	20.4de
	0.06	1.6a	6.6a	I5.0bc	20.4cd
	0.08	5.0bc	13.3ab	25.0bc	I7.6bc
	0.10	6.6cd	18.3ab	35.0c	18.4bc
Paw+Per	0.02+0.1	0.0a	0.0a	1.6ab	17.4cd
	0.04+0.1	0.0a	8.3ab	26.6c	I7.2cd
	0.06+0.1	5.0bc	11.6ac	35.0c	16.5bc
	0.08+0.1	10.0de	30.0cd	80.0d	12.0ab
	0.1	21.6g	55.0e	88.3e	11.0a
Paw+Pir	0.02+0.1	0.0a	0.0a	3.3ab	18.2f
	0.04+0.1	0.0a	3.3a	11.6a	17.8cd
	0.06+0.1	3.3 be	11.6ab	23.3c	16.0bc
	0.08+0.1	I3.3de	30.0cd	78.3de	14.0ab
	0.1+0.1	15.0f	46.6de	86.6e	12.0ab
Per A	0.1	0.0a	0.0a	0.0a	20.4f
Per A	0.1	0.0a	0.0a	0.0a	20.2de
Con		0.0a	0.0a	0.0a	28.4g

pawpaw Alone-pawA, pawpaw+permethrin-paw+per, pawpaw+pirimiphos-paw+pir, permethrin alone-per A, perimorphs-methyl alone-Pir A,control-con
note: means bearing the same letters are not significantly different at p=0.05 (dmrt)

At 12 hrs post-infestation, treatment involving 0.1g papaw powder mixed with 0.1g permethrin recorded the highest adult mortality of 21.6 % while other treatments, including the control, recorded no mortality except treatments involving 0.08g papaw powder mixed with 0.1g permethrin and 0.1g papaw powder mixed with 0.1g permethrin (Table 2). None of the treatments recorded 100% mortality, at 24hrs and 48hrs post infestation but the highest significant adult mortality was recorded in treatment involving Pawpaw powder (0.1g) mixed with permethrin (0.1g) of 88.3%. Seven treatments including the unprotected control and those involving the use of synthetic insecticides alone recorded zero percentage mortality (Table 2). Cowpea seeds in the control treatment had the highest number of adult exit holes. Cowpea treated with Pawpaw powder mixed with permethrin (0.1g + 0.1g) exhibited significantly fewest adult exit holes which were, however, no fewer than holes in seeds treated with Pawpaw powder+ pirimiphos-methyl (0.1g + 0.1g) and pawpaw(0.8g) mixed with 0.1g pirimiphos-methyl (Table 2).

4. Discussion

There have been global calls for caution in the use of synthetic organic insecticides in crop protection against pest attacks because of human health hazards posed by them and other environmental concerns [11]. A method of achieving this is to reduce the rate of application [1]. The results of

this study have shown that a sub-lethal dose of neem powder (0.1g) mixed with pirimiphos-methyl (0.1g)/ 20grams of cowpea seeds produced 100% adult mortality of *C. maculates* at 24hrs post-infestation. This result further, established that there is great potential in reducing the rate of application of synthetic organic insecticides by mixing with sub-lethal doses of insecticidal plant materials or botanicals. Botanicals are usually perceived to be relatively safe and non-toxic to humans and more environment-friendly [9] and may reduce the undesirability of synthetic organics in this duration. [8]reported that an application rate of 0.4 g/20 g of *E. aromatic* and *P.guineese* powder was effective in the control of *C.maculatus* as 100% adult mortality was recorded at 48 and 72 hrs post-infestation.

In this study, neem powder singularly applied produced highly significant mortality (60%) of *C.maculatus* before being mixed with synthetic insecticides, this confirmed its potency as a pesticide plant. However, when mixed with a sub-lethal dose of 0.1g of Neem powder mixed with a low rate (0.1g) of pirimiphos-methyl/ 20 grams of cowpea seeds, the synergy produced 100% adult mortality of *C.maculatus* at 48 and 72 hrs, respectively.

` Some workers, like [6], [5], and [13] had opined that a few plants in the tropical flora with confirmed biological efficacies against species of stored products insects were sufficient insecticidal to merit scientific formulation. Mixing insecticidal plant materials with synthetic organics can be regarded as a mixed formulation of insecticidal [6]. The low rate of the synthetic organic appeared to have synergized the sub-lethal dose of the botanical to produce increased toxicity to the insects. For instance, the low rate of each synthetic organic used did not cause mortality of the insects at the times of observations, but when mixed with 0.08 g and especially 0.1g of each botanical, the mortality caused to the insects was about doubled. Synergism in mixed formulations of insecticides has been reported by [7],[10], and[16] in their various research works, and the synergy trigged homologous phenomenon in insects has been used as a case study.

Homologous is a phenomenon in which a stimulating effect is induced in insects or other arthropods with a sub-lethal dose of possible combinations which causes the female to lay more viable eggs that develop into adults [2]. In this study, there appears to be the semblance of this phenomenon when neem powder alone was applied for the control of *C.maculatus,* a significantly higher number of adult weevils, as indicated by the number of exit holes that emerged.

5. Conclusion

The result of this work has further substantiated the good potential of combining low doses of insecticidal plant powder and low doses of synthetic organic dust for effective protection of stored grains against insect infestation and arid damage. The adoption of this application rate especially in cowpea storage across the entire country will over time increase the quality and quantity to producers and decrease the environmental impact of the management of pests in crop production, storage, and a well-balanced eco-system with little or no residual effect.

6. Recommendation

The best rate of application was the treatment involving a sub-lethal dose of neem powder (0.1g) mixed with pirimiphos-methyl (0.1g)/ 20grams of cowpea seeds which produced 100% adult mortality of *C. maculates* at 24hrs post-infestation, therefore this study recommends the above rate as the most effective to achieve desired pest control of *C.maculatus* in cowpea storage.

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