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The Potential for Controlling *Maruca vitrata* Fab. and *Clavigralla tomentosicollis* Stal. Using Different Concentrations and Spraying Schedules of *Syzigium aromaticum* (L.) Merr and Perr on Cowpea Plants

Oparaeke, Alphonsus Mbonu
Department of Crop Protection, Institute for Agricultural Research,
Ahmadu Bello University, P.M.B 1044, Samaru, Zaria, Nigeria

Abstract: The efficacy of different rates (5, 10 and 20% w/v) and application schedules (2, 4 and 6 weekly spraying) of *Syzigium aromaticum* (L.) Merr and Perr extracts was investigated in two years field trials for the control of the legume pod borer, *Maruca vitrata* Fab. and the coreid bug, *Clavigralla tomentosicollis* Stal. on cowpea plants. The different concentrations and spraying schedules of aqueous extracts of clove, *S. aromaticum* exhibited considerable reduction on the populations of *M. vitrata* and *C. tomentosicollis* as compared to the untreated check. Of the clove extract treatments tested, 10 and 20% rates with four and six weekly applications were superior to 5% rate at all weekly schedules. Pod damage was equally reduced and there was a substantial increase in grain yield at higher concentrations and more frequent sprayings but their values were inferior to the synthetic insecticide treatment. Clove extract could form an integral part of a new approach to pest control on arable crops in small farm holdings commonly found in limited resource farmers' enterprises in Africa.

Key words: Clove extract, concentration, spraying, *M. vitrata*, *C. tomentosicollis*, control, cowpea

Introduction

The legume pod borer *Maruca vitrata* Fab. and the coreid bugs of several species predominated by *Clavigralla tomentosicollis* Stal., constitute the major constraints to cowpea production in tropical Africa (Jackai and Adalla, 1997). Adults and nymphs of *C. tomentosicollis* suck the sap from immature pods resulting in wrinkling of the seed coat, pod abscission, abortion, premature drying and incomplete pod fill (Hill and Waller, 1990). An infestation of two bugs per plant was reported to lower seed weight by 40-60%, the number of seeds by 25-36% and the seed quality by 94-98% (Hill and Waller, 1990). On the other hand, *M. vitrata* infestation on cowpea is capable of causing a yield loss of 20-80% where control measure is absent (Singh and Allen, 1980). Young larvae of *Maruca* pod borer attack the flowers feeding inside and causing the flowers to abort. They also bore into immature pods feeding on the developing seeds while the young terminal leaves are also damaged.

Currently, insecticidal application is the only effective and economic control measure available (Jackai and Oyediran, 1991). The application of insecticides as a control measure has some constraints, which include, high mammalian toxicity, pest resistance, high costs of procurement and technology for application as well as environmental degradation. These constraints coupled with the economic crisis in many developing countries have made it expedient to search for sustainable alternative pest management strategy that would be safe, cheap, simple and ecologically sound and acceptable for control of crop pests. One of the alternatives to the synthetic insecticides is the use of biopesticides and insecticidal plants are blazing the trail in the screening exercise (Olaifa *et al*., 1988; Oparaeke, 1997; Ogunlana *et al*., 2002). Many herbal landraces across the African landscape are known to possess chemical defenses involving repellent, antifeedant and toxins, which protect them from insect pests attack. One of such plants currently under investigation in the research laboratory of Crop Protection Department, Ahmadu Bello University, Zaria is clove, *Syzigium aromaticum* (L.) Merr. and Perr. (Myrtaceae). The tree is evergreen, growing up to 18-20 m high with smooth gray bark. The tree is found in the rain forest and southern Guinea savanna of Nigeria and in the Cameroun (Dalziel, 1985). It produces the dried flower buds that yield the cloves used in food flavouring in many countries across the African continent. Extracts from clove have shown effectiveness against some crops pests (Oparaeke *et al*., 2002; Oparaeke and Daria, 2001).

There is a paucity of information on the optimum rates of application and schedules of clove extracts for maximum grain yields on cowpea and this investigation seeks to fill such gap.

Materials and Methods

The trials were conducted in 1999 and 2000 cropping seasons under natural infestation on the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, (11°11′ N and 07°38′ N) located in the northern Guinea savanna of Nigeria. The field used for each trial measured about 0.4 ha and was prepared by spraying with glyphosate (at 5 l ha^{-1}) and allowed to fallow for three weeks before disc-harrowing and ridging at 0.75 m apart. The tests were conducted using split plot design and each treatment was replicated three times. The main plot consisted of clove extracts, synthetic insecticide and untreated plants. Sub plots comprised of three concentrations (5, 10 and 20% w/v) and spraying regimes (2, 4 and 6× weekly applications). Main plot size was 3.75×45.0 m and sub plot size was 3.75×5.0 m. There were five ridges per plot (three main rows and two discards). Each plot was separated by 1.5 m wide border along the ridge and two unplanted ridges.

Cowpea variety, SAMPEA 7 a medium duration type with a maturity period of 80-85 days was the test seed. The variety has a semi erect growth habit and is highly susceptible to all major insect pests of cowpea in this ecological zone where the experiment was conducted. The seeds were dressed with Apron Plus 50 D (at one satchet per two kilogrammes seeds). Three seeds were sown in the first week of August in both seasons at 0.25 m apart giving 20 plants per ridge. Galex (Metalachlor 250 g a.i. L^{-1} and Metabromuron 250 g a.i. L^{-1}) was sprayed pre-emergent at 2.5 kg a.i., ha^{-1} after sowing. The seedlings were thinned to two plants per hole 2-3 weeks after sowing (WAS) and top-dressed with fertilizer (NPK 27:10:10) at 200 kg ha^{-1}. Benomyl was applied at 0.33 kg a.i., ha^{-1} once every week for four weeks beginning from 4 WAS to control fungi diseases.

Dried clove inflorescence were purchased from a local market in Samaru and oven-dried at 60°C for 12 h to stabilize the dried weight of samples. The dried materials were ground in an electric mill and 250, 500 and 1000 g of the powder representing 5, 10 and 20% w/v respectively were weighed into separate plastic buckets containing 3.5l tap water. The solutions were vigorously stirred, covered and allowed to stand overnight. The extracts were filtered with 1.0 l tap water using muslin cloth. 250 mL of 20% starches and flaked bar soap each was added to the extracts in the plastic buckets bringing the solutions to 5l.

At 6 WAS which coincided with flower bud formation/onset of flowering, the crop was sprayed with the required extract doses and at appropriate spraying schedules while the synthetic insecticide was sprayed 4× at weekly intervals. The spray was directed all over the plant using CP Knapsack sprayers at discharge rate of 100 l ha^{-1} and one row of plant was covered per trip. Before spraying, insect populations were sampled within the three sample rows between 7.0 and 9.0 a.m every week. *M. vitrata* was assessed by randomly picking 20 flowers from 10 plants in each plot. The flowers were placed in vials containing 30% alcohol and dissected the next day in the laboratory. The number of *Maruca* pod larvae found was recorded. *Maruca* pod borers were also sampled by randomly picking 10 pods per plot and these were dissected and borer larvae observed were recorded. Adults and nymphs of *C. tomentosicollis* were assessed visually on plants located in three 1.0×1.0 m quadrants, which were randomly placed within the sample rows in each plot (Amatobi, 1994). Pod damage was rated at 70 Days After Planting (DAP) using the formula below:

$$\%\ \text{Pod damage} = \frac{\text{Total No. of pods produced/plant-No. of undamaged pods/plant} \times 100}{\text{Total No. of pods produced/plant}} \qquad (1)$$

Grain yield was recorded from harvested dried pods in the sample rows after threshing and winnowing.

All the data obtained were angular transformed before analysis of variance was performed while treatment means were separated by Student Newman Keuls test ($p<0.05$) (SAS, 1990).

Results

All the treated plots had significantly lower numbers of *Maruca* Pod Borers (MPBs) and Pod Sucking Bugs (PSBs) in both years of study compared with the untreated control (Table 1). The synthetic insecticide treatment controlled PSBs better ($p<0.05$) than some clove extract treatments but was not superior to 20% extract with four or six-applications on MPBs control. Among the clove extracts, higher rates of application (10 and 20% w/v) with more frequent schedules (four and six-applications) recorded less number of MPBs and PSBs during the period under investigation compared with lower rate of extract (5%) with less frequent schedules (2-applications).

Table 1: Effect of different rates and spraying schedules of clove extracts on the populations of *Maruca* pod borer and *C. tomentosicollis*

	Mean No. of *M. vitrata* flower^{-1} and/or pod		Mean No. of *C. tomentosicollis* plant^{-1}	
Treatment	1999	2000	1999	2000
C1 R1	1.4b	1.2b	1.9b	2.9b
C1 R2	1.3bc	1.1bc	1.7bc	2.7bc
C1 R3	1.1c-f	0.8c-f	1.6c	2.5c
C2 R1	1.2bcd	0.9bcd	1.2d	2.1d
C2 R2	1.1b-e	0.8c-f	1.1de	1.9de
C2 R3	0.9def	0.7def	1.1de	1.8de
C3 R1	1.0def	0.7def	0.9def	1.9def
C3 R2	0.8efg	0.6efg	0.8ef	1.7ef
C3 R3	0.8fg	0.5fg	0.7f	1.6f
UPC	0.6g	0.4g	0.4g	0.6g
CON (0.0)	3.6a	2.4a	5.7a	7.2a
S.E ±	0.07	0.05	0.06	0.08

Means in a column followed by the same superscript (s) are not significantly different by SAS-SNK test ($p<0.05$)
Keys: C1=5% w/v, C2=10% w/v, C3=20% w/v, R1=2 weekly application, R2=4 weekly applications, R3=6 weekly applications

Table 2: Effect of different rates and spraying schedules of clove extracts on pod damage and grain yield of cowpea

Treatment	Mean% pod demage plant^{-1}		Mean grain yield ha^{-1}	
	1999	2000	1999	2000
C1 R1	39.5b	40.1b	457.1b	503.5b
C1 R2	37.4b	38.0b	495.9b	529.1b
C1 R3	34.8c	35.3c	521.1b	600.0b
C2 R1	28.5d	28.9d	591.0c	774.7c
C2 R2	22.4e	22.8e	861.5d	992.0d
C2 R3	20.4ef	20.7ef	977.1e	1098.7e
C3 R1	19.6f	19.9f	1082.2f	1194.7f
C3 R2	16.4g	16.7g	1176.7g	1290.7g
C3 R3	14.9g	15.1g	1271.3h	1205.3h
UPC	10.0h	10.2h	1428.3I	1448.0i
CON (0.0)	90.4a	91.8a	148.5a	150.7a
S.E ±	0.58	0.63	19.1	23.8

Means in a column followed by the same superscript (s) are not significantly different by SAS-SNK test ($p<0.05$)
Keys: C1=5% w/v, C2=10% w/v, C3=20% w/v, R1=2 weekly application, R2=4 weekly applications, R3=6 weekly applications

The percentage pod damage was significantly higher ($p<0.05$) while grain yields were less in the untreated control than in the treated plots. The synthetic insecticide treatment caused significant reduction in pod damage due to pests infestation and consequently increased grain yields among treated plots while 20 and 10% extracts with 6 and 4-weekly applications respectively, had reduced pod damage and produced more grains among the clove extracts treated plots (Table 2). Compared with 4-applications at 10% extract rate, it was evident that 6-weekly application schedules gave the best control of both target pests at 20 and 10% rates and protected pods from attack but was not particularly outstanding. However, grain yields obtained from 6-weekly application schedules at 20 or 10% rates were significantly higher ($p<0.05$) compared with that from 4 or 2-weekly applications schedules at the three rates (5, 10 and 20%) tested.

Discussion

As shown in Table 1 and 2, aqueous extract of *S. aromaticum* has great potential for use as biopesticides particularly in farms managed by smallholder farmers in developing countries. In this experiment, the efficacies of different concentrations and spraying schedules of *S. aromaticum* extracts against MPBs and PSBs infestations were varied. 20 and 10% clove extracts with 6 and 4-weekly applications gave better control of both pests while the former was outstanding between the two. Spraying of cowpea against insect pests is aimed at not only to maximize yields but also to ensure better quality grains. Hence, an increase in spray schedules at higher extract rates have shown better option in the control of cowpea pests with improved yield performance.

This result was consistent with that obtained by Ogunlana *et al*. (2002), Oparaeke *et al*. (2002), Tanzubil (1991) and Olaifa and Adenuga (1988) who investigated the efficacies of different botanicals against various species of crops pests and found them toxic to those pests. The apparent insignificant differences observed in MPB control between 5% clove extract with 6 weekly applications and 20 or 10% extracts with more frequent sprayings could be attributed to high incessant rainfall, long interval of spraying, slow action of extracts and changes in the population pattern of the pests within the season. However, one important observation made during extracts application indicates that at 20 or 10% rates spray liquid in direct contact with the target pests caused hyper-excitability reaction shown by hysterical movements of the antennae and abdomen, genital extrusion, curling of the body (as in the case of *Maruca* larvae) and death within a few minutes of spray liquid contact. MPB and PSB are by far the major threats to cowpea yield and grain quality in Africa. The high grain yields recorded in plots sprayed with 6 and 4-applications of extracts were made possible due to the semi determinate growth pattern and reproductive nature of the test variety. More frequent spraying at shorter intervals during the reproductive growth phase for this cowpea variety is essential to ensure better performance as it would encourage the continued presence of spray liquid in the cowpea environment thereby exposing other pests to the lethal action of the extracts.

Although, six weekly applications of clove extract gave more yields than four weekly applications at all the three concentrations tested, there is the need to find out their economic implications with the view of recommending to farmers one with the best economic advantage. As indicated earlier the synthetic insecticide treatment reduced pod damage and produced more grains compared with clove extracts. However, its well-documented constraints might be disadvantageous in farms managed by limited resource farmers in developing countries. There is also the need to isolate, identify and characterize some other active principles in clove for use in pesticidal formulation to reduce the bulkiness of plant materials used.

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