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Full Length Research Paper

Selection of pepper cultivars (C*apsicum* spp.) for the control of bruchids *Callosobruchus maculatus* (F.) on stored cowpea (*Vigna unguiculata* (L.) Walp.) seeds

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To minimize the impact on the environment caused by indiscriminate use of synthetic chemical pesticides, four pepper cultivars were evaluated on their insecticidal activities against *Callosobruchus maculatus* F. on cowpea seeds. Two studies were carried out. Treatments of the first study comprised dried and ground fruits of four pepper cultivars ('Sombo', 'Nsukka Yellow', 'Tatashi' and 'Tanjarawa'), one conventional storage insecticide, Actellic 2% dust (Pirimiphos-methyl), no protectant control with three rates of each protectant at all possible combinations. The treatments were arranged in a completely randomized design (CRD) with three replications. To each treatment were admixed 20 g dry cowpea seeds and six adult bruchids in the ratio of 3 males: 3 females. The second study comprised mixed proportions of a promising but expensive pepper cultivars with a less promising and less expensive cultivar from the first study. The treatments were laid in a completely randomized design (CRD) with three replications. Dried and ground fruits of 'Nsukka Yellow' and 'Tanjarawa' were therefore selected and applied in the ratios of 100:0, 80:20, 60:40, 40:60, 20:80, 0:100 and 0:0 at the rate of 5% of the treated seed weight for this second study. Efficacy of the materials used were based on the number of adult bruchid survival and reduction of oviposition rate (number of eggs laid per seed.). 'Nsukka Yellow' and 'Tanjarawa' cultivars significantly reduced number of bruchid survivors earlier than other pepper cultivars but not lower and earlier than pirmiphos-methly powder treated seeds which caused 100% adult mortality of *C. maculatus* within 8 days after infestation (DAI). All the materials used significantly increased adult mortality of the insect earlier than the no protectant control ($p<0.05$). There was no ovicidal effect of the protectants used earlier than 6 DAI. At 6 DAI all the protectants significantly reduced number of eggs by the bruchids. Differences amongst the protectant rates and protectant interaction did not produce any significant effect both on adult survivors and number of eggs deposited. Mixture of 80% 'Tanjarawa' +20% 'Nsukka Yellow Pepper' fruits caused 100% mortality of the adult bruchids earlier than the other mixtures.

Key words: selection; pepper cultvars, bruchids control, cowpea seeds.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp, is a major source of dietary protein in tropical and subtropical regions of the world especially where availability and consumption of animal protein is low (Opareke et al., 1998; Ofuya, 1986). Postharvest losses of cowpea due to the bruchid *Callosobruchus maculatus* (F.) constitute a major set back in the storage of this crop (Singh et al., 1990). A substantial loss of about 30-80% of the total annual production of cowpea valued at over 30 million US dollars is lost annually in US alone as a result of this pest (Ohiagu, 1985). Synthetic chemical insecticides have been used with great success. But the problems associated with their use and procurement have necessitated the exploration of a more sustainable alternative. A number of plant materials had been tried and found effective. Some include, fresh and deodorized palm oil (Ajaye et al., 1987), powders from *Piper guineense* Schum, and Thonn (Ivbijaro and Agbaja,

1986), *Piper nigrum* L.(Rajapakse, 1990), *Zanthoxylum zanthoxyloides* (Lam.) (Ogunwolu and Odunlami, 1996) and root bark of *Annona senegalensis L*. (Aku et al., 1998). The efficacy of chilli pepper (*Capsicum frutescens* L.) in the control of *C. maculatus* appeared to be conflicting. While Ajayi et al. (1987) reported that ground chilli pepper at 10 g/kg cowpea afforded no significant effect on *C. maculatus*, Ivbijaro and Agbaje (1986) and Ofuya (1986) contended that it caused moderate adult mortality and therefore afforded some degree of protection against post harvest losses caused by this pest. Nevertheless, many of our poor resource farmers still treat their stored cowpea seeds with various cultivars of pepper with great success. In view of these inconsistences it was therefore considered necessary to evaluate various cultivars of pepper commonly found in Nigeria market on their efficacy in the control of *C. maculatus.* This is with a view to selecting the best rate and cultivars that could afford the best control of this pest.

MATERIALS AND METHODS

Two trials were carried out in the laboratory of Department of Crop Science, University of Nigeria, Nsukka, Nigeria (Latitude 06º 52′N. Longitude 07º 24′E and altitude 447.26 m, above mean sea level). The laboratory mean temperature and relative humidity were 29±2ºC and 78±3%, respectively. Each trial lasted for eight weeks. Adult stock of the bruchids was obtained from Nsukka main market in Enugu State. A susceptible cowpea (cv. Ife Brown) was used to maintain the culture in a 500 ml plastic container. The plastic container was securely covered with a perforated muslin cloth held in place with two tight rubber bands. Four cultivars of pepper fruits- 'Nsukka Yellow', 'Tanjarawa', 'Tatashi' and 'Sombo' were harvested fresh, matured and ripe from the multiplication farm of Department of Crop Science, University of Nigeria, Nsukka. The fruits were dried in an oven at 50ºC for 5 days. Each dried sample was milled into fine powder and kept in a sealed dry dessicator for the experiment. Some quantities of wholesome dry cowpea seeds (cv. Ife Brown) was also procured from the main market and fumigated with phostoxin (aluminum phosphide). The fumigated samples were later sieved to remove dead insects, exuviate and frass after airing for 48 h. The actellic 2% dust (pirimiphos-methyl) was bought from a major chemical manufacturing company in Nigeria – Chemical and Allied Products PLC.

Experiment I

Each of the four dried pepper samples and Actellic dust was weighed out at three rates of 1.0, 2.0 and 3.0 g corresponding to , 10% and 25% and added to 20 g of the fumigated wholesome cowpea seeds in a 200 ml plastic container. Perforated muslin cloth was used to cover each container to ensure adequate ventilation. The muslin bag was held in place with two tight rubber bands. The seeds and test materials were shaken thoroughly in the container until the materials were evenly distributed among the seeds. The content of the plastic containers was allowed to settle down for two hours before the introduction of the insects (Ajayi, et al., 1987). Six freshly emerged adults of *C. maculatus*, 3 males : 3 females were then introduced into each vial and arranged in a completely randomized design on a laboratory bench. The check comprised the container with no protectant (i.e. with neither pepper powder nor actellic dust). The number of adult bruchids that survived in each container was recorded every two days after infestation. The percentage adult survival was later calculated. Also recorded was the number of eggs per cowpea seed from a random sample of 10 seeds per container.

Experiment II

This experiment involves the proportional mixtures of the costly but most effective pepper cultivar 'Nsukka Yellow' with a less costly and less effective cultivar (Tajarawa) from experiment I. This is to establish the best combination of the two cultivars that could reduce the quantity of the former while maintaining its efficacy. In the second trial therefore, the most promising pepper powder used in experiment I was selected and mixed with another less promising powder in the ratios of 100:0, 80:20, 60:40, 40:60, 20:80, 0:100 and 0:0. The mixtures were applied to the fumigated wholesome cowpea seeds at the rate of 5% of the seed weight (20 g). The mixture ratio of 0:0 constituted the control. Both the procedure and data collected were the same as in experiment I.

Statistical analysis

Egg counts and damage percentages were subjected where necessary to appropriate transformation procedures before analysis of variance was carried out on them. Mean separations were done using Fisher's Least Significant Difference (F-LSD) as outlined by Obi (2002).

RESULTS AND DISCUSSION

All the protectants significantly reduced adult survival of *C. maculatus* in all the sampling dates, relative to the control at $P < 0.05$ (Table 1). Counts taken at 6 days after infestation (DAI) showed that Actellic 2% dust was the most effective. Actellic caused 100% mortality of the adult insects within 6DAI, 'Nsukka Yellow Pepper' caused about 88%, 'Tanjarawa' caused about 88%,'Tatashi' caused about 82% while 'Sombo'caused about 78% adult mortality during the same period. Differences in percentage survival amongst the protectant rates and their interactions with the different protectants did not attain any level of statistical significance. At 4 DAI, all the protectants and their interactions with protectant rates did not produce any significant effect on the number of eggs deposited on the seeds (Table 2). However, at 6 DAI, both the dry ground pepper fruits and Acetellic dust significantly reduced number of eggs laid by the insects relative to the control ($P < 0.05$). Seeds treated with Actellic 2% dust had the least number of eggs. The egg counts on Actellic treated seeds were significantly lower than counts on 'Nsukka Yellow Pepper' and 'Tatashi' treated seeds but not significantly lower than counts on 'Sombo' and 'Tanjarawa' treated seeds (Table 2).

Table 1. Percentage survival of adult *Callosobruchus maculatus* exposed to different protectants at various rates of application and at 2, 4, 6 and 8 days after infestation (DAI).

Percentage survival of adult *Callosobruchus maculates**								
2DAI**					**4 DAI****			
Rate(g/20gcowpea)					**Rate(g/20gcowpea)**			
Protectant	1	2	3	Mean	1	2	3	Mean
Sombo	45.00	51.79	41.75	46.18	45.00	38.49	41.75	41.75
Nsukka yellow	55.05	48.54	58.30	53.96	11.75	11.75	23.04	15.51
Tanjarawa	54.76	55.05	66.51	58.77	35.24	23.04	30.00	29.43
Tatashi	41.29	45.00	45.00	43.76	34.79	19.79	30.00	28.19
Actellic 2%	15.00	35.24	24.12	24.79	0.00	8.04	0.00	2.68
No protectant	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
Means	**50.18**	**54.27**	**54.29**	**52.91**	**36.13**	**31.85**	**35.80**	**34.59**
6DAI**					**8 DAI****			
Rate(g/20gcowpea)					**Rate(g/20gcowpea)**			
Protectant	1	2	3	Mean	1	2	3	Mean
Sombo	19.79	19.79	24.12	21.23	19.79	0.00	16.08	11.96
Nsukka yellow	8.04	8.04	19.79	11.96	0.00	0.00	16.08	5.36
Tanjarawa	11.75	16.08	8.04	11.96	3.04	16.08	0.00	8.04
Tatashi	11.75	11.75	27.83	17.11	11.75	8.04	19.79	13.19
Actellic 2%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No protectant	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
Means	**23.55**	**24.28**	**28.3**	**25.37**	**21.60**	**19.02**	**23.66**	**21.42**

F-LSD$_{(0.05)}$ for comparing any 2 cultivar means

2DAI	4DAI	6DAI	8DAI
10.51	14.21	12.41	10.16

* Values subjected to ercsine transformation before analysis of variance; original values presented in the table.
** Days After Infestation.

Table 2. Number of eggs laid by *Callosobruchus maculatus* treated with different rates of protectants.

Protectant	**Number of eggs per cowpea seed***							
	4DAI**				**6 DAI**			
	1	**2**	**3**	**Mean**	**1**	**2**	**3**	**Mean**
Sombo	3.22	4.39	2.75	3.45	3.22	4.39	2.50	3.37
Nsukka yellow	3.69	3.70	5.29	4.23	3.69	3.70	5.29	4.23
Tanjarawa	2.25	4.21	3.58	3.35	2.25	4.22	3.58	3.35
Tatashi	2.70	6.13	4.55	4.46	2.67	6.13	4.55	4.45
Actellic 2%	1.65	1.56	1.84	1.69	1.65	1.56	1.84	1.69
No protectant	2.34	4.28	3.69	3.44	12.64	14.05	13.56	13.42
Means	**2.64**	**4.05**	**3.62**	**3.44**	**4.35**	**5.68**	**5.22**	**5.08**

F-LSD $_{(0.05)}$ for comparing any 2 ultivar means

4DAI	6DAI
-	2.00

* Values subjected to square-root transformation before analysis of variance; original values presented in the table.
** Days after Infestation

Combinations of 80% 'Tanjarawa' + 20% 'Nsukka Yellow Pepper' caused 100% adult bruchid mortality earlier within 6 DAI than other proportional combinations (Table 3).The application of either 100% 'Tanjarawa' or 100% 'Nsukka Yellow Pepper' caused 100% adult bruchid mortality at 8 DAI. All the protectants nevertheless significantly reduced adult bruchid survival in all the sampling dates. The oviposition rate was also significantly reduced after 6 DAI by all the proportional mixtures compared to no protectant control at $P < 0.05$

Table 3. Effect of proportional combination of 'Tanjarawa' and 'Nsukka Yellow' pepper on percentage adult survival of *Callosobruchus maculatus* at 2, 4, 6 and 8 days after infestation.

Protectants	% survivors (DAI)* y			
	2	4	6	8
100% Tanjarawa+0% Nsukka Yellow	31.53	27.83	24.12	0.00
80% Tanjarawa+20% Nsukka Yellow	66.79	57.92	0.00	0.00
60% Tanjarawa+40% Nsukka Yellow	58.59	45.00	45.00	8.04
40% Tanjarawa+60% Nsukka Yellow	51.79	27.83	24.12	16.08
20% Tanjarawa+80% Nsukka Yellow	29.83	16.08	16.08	0.00
0% Tanjarawa+100% Nsukka Yellow	41.58	19.79	19.79	0.00
0% Tanjarawa+0% Nsukka Yellow	90.00	90.00	90.00	90.00
Mean	**52.87**	**39.78**	**31.30**	**16.30**
S.e.d	15.34	9.44	7.65	6.08
LSD (5%)	32.90	20.24	16.8	13.04

*DAI = Days after infestation
y Values subjected to arc sine transformation before analysis of variance; original values presented in the table.

Table 4. Effect of proportional combination of "Tanjarawa" and "Nsukka Yellow" pepper on oviposition by adult *Callosobruchus maculatus* at 2, 4, 6 and 8 days after infestation.

Protectants	Number of eggs per seed (DAI)*y			
	2	4	6	8
100% Tanjarawa+0% Nsukka Yellow	3.92	3.04	2.49	2.40
80% Tanjarawa+20% Nsukka Yellow	2.41	2.02	4.77	7.07
60% Tanjarawa+40% Nsukka Yellow	2.73	1.86	4.28	2.68
40% Tanjarawa+60% Nsukka Yellow	4.24	3.83	2.96	3.55
20% Tanjarawa+80% Nsukka Yellow	3.41	3.76	2.30	3.83
0% Tanjarawa+100% Nsukka Yellow	3.23	2.38	2.93	7.07
0% Tanjarawa+0% Nsukka Yellow	3.61	3.58	9.32	10.27
Mean	**3.36**	**2.92**	**4.15**	**5.27**
S.e.d	1.25	1.04	1.26	1.32
LSD (5%)	2.69	2.24	2.70	2.83

*DAI = Days after infestation
y values subjects to square root transformation before analysis of variance: original values presented in the table.

(Table 4). Earlier than 6 DAI, there was no significant difference between the control and the treated cowpea seeds on the number of eggs deposited on the seeds. The insecticidal efficacy of the protectants tested was therefore ranked as follows: Actellic 2% dust > 'Nsukka yellow pepper' > 'Tanjarawa' > 'Tatashi' > 'Sombo' > no protectant control. Actellic 2% dust is a conventional synthetic insecticide specifically formulated with high insecticidal activities on stored product pests (Anon, 1993).

The efficacy of the pepper fruits to *C. maculatus* was attributed to the pungency of the various pepper fruits used. Pungency in pepper fruit is caused by capsaicin and its level in pepper varies among different spice pepper cultivars (Rehm and Espigs, 1991). The level of capsaicin amongst the pepper fruits used could therefore be said to be in the order: 'Nsukka yellow pepper' >'Tanjarawa' > 'Tatashi'.> 'Sombo' in view of their relative "hotness" and toxicity to adult *C. maculatus,* although it was not investigated in this study. Low capsaicin pepper fruits are therefore more likely to be less effective in bruchid control and vice versa. The relative pungency of the different pepper cultivars and not application rates could therefore explain the inconsistent results obtained in the control of *C. maculatus* using chilli-pepper by earlier workers. While Ajayi et al. (1987) did not observe any protectant effect of chilli-pepper on *C. maculatus*, Ofuya (1986) demonstrated that it afforded some degree

of protection against the pest. All the protectants also deterred oviposition by the pest in this study probably through their toxicity on the potential egg laying adults. This result supports earlier observation by Lale (1994) who demonstrated some repellency and oviposition deterrence by some powdered chilli pepper fruits against the bruchid. The proportional combinations of 80% Tarjarawa + 20% "Nsukka yellow" pepper led to a better prospect both for bruchid control and oviposition deterrence than either 100% Nsukka yellow pepper or 100% Tanjarawa. It is likely that this combination may have produced a more remarkable synergistic toxic effect on the bruchid than other combinations and thereby reduced drastically the quantity of the expensive "Nsukka Yellow" cultivar used in the study. The protectant rates effect were not significantly different, suggesting that the efficacy of pepper fruit is dependent more on the cultivar type and not on their dosage. The selection of pepper cultivars with high pungent fruits will therefore accelerate the control of *C. maculates* on stored cowpea.

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