Journal of Agricultural Technology 2012 Vol. 8(6): 2023-2031
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Extraction fractions of ginger (*Zingiber officinale* Roscoe) and residue in the control of field and storage pests

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Amuji, C.F., B.C. Echezona and Dialoke, S.A. (2012) Extraction fractions of ginger (*Zingiber officinale* Roscoe) and residue in the control of field and storage pests. Journal of Agricultural Technology 8(6):2023-2031.

Field and laboratory studies were carried out to evaluate the efficacy of six aqueous extraction rates (5%, 10%, 15%, 20%, 25% and 30%) of ginger and residues in the control of okra flea beetles and cowpea bruchid (*Callosbruchus maculatus* F.) respectively, in Nigeria. The field experiment was a randomized complete block design, with three replications. Laboratory experiment was laid out in a completely randomized design with four replications. Attacke 2.5 EC ® (lambdacyhalothrin) treated and untreated plots were used for field controls. Actellic 2% dust ® (pirimiphous methyl) treated and untreated grains constituted the controls of the laboratory experiment. *Podagrica uniforma* (Jacoby) and *Nisotra sjostedti* (Jacoby) populations were significantly ($P<0.05$) reduced in the field at different ginger extractions rates compared with the untreated. Lambdacyhalothrin treated plots significantly ($P<0.05$) produced a better yield than the untreated, while plots with higher rates of ginger (20%, 25%, and 30%) significantly ($P<0.05$) performed better than their lower rates and untreated plots. Okra fruit weight per plant was increased by 29% with 20% concentration; 43% by 25% concentration and 44% by 30% concentration relative to the untreated check. Higher concentrations of ginger residue (20%, 25%, and 30%) provided better protection against *C. maculatus* adult emergence compared to the untreated control. Fresh ginger extracts and its residues could therefore be harnessed in pre-and post-harvest pest control options respectively.

Key words: cowpea bruchids, efficacy, flea beetles, plant protectants, pre- and post-harvest losses.

Introdution

Many crops are grown in Nigeria but okra (*Abelmoschus esculentus* L. Moench) and cowpea, (*Vigna unguiculata* L. Walpers) are among the most important. This is basically due to their adaptability to the environment (Incalcterra and Vetrano, 2000), flavour and nutritional values as food (Karnataka, 2008). In Okra production the immature pods which are the fruits

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are the desired target of the farmers. The fruits could be eaten raw or cooked; while for cowpea mature seeds could be harvested for immediate consumption or stored for later use.

Okra varieties are known to be attacked by a wide range of insect pests. There are many field insects pests of okra in Nigeria, but *Podagrica uniforma* Jacoby and *Nisotra sjostedti* Jacoby are among the most damaging (Fasunwon and Banjo, 2010). *Podagrica* and *Nisotra* bettles are known to defoliate their host plant by feeding on leaves, as well as, flowers and fruits. The beetles appear in swarms immediately after the first rain, when large number of them may be observed feeding on the leaves, tender stems or growing tips of okra plant (Ahmed *et al*., 2002). Similarly, Kalomolate (1979) reported that the adult beetles of *Podagrica uniforma* and *Nisotra sjostedti* damage not only the leaves and flowers of, but cause pre-mature failing of pods.

Post-harvest losses caused by insect damage, microbial deterioration and other factors remain one of the major problems of cowpea (Mathews, 1993). However, in the past, these infestation losses were often a less serious problem because farmers cultivated traditional varieties which though low yielding, but were generally more resistant to attack by pests. The introduction of high yielding pulse varieties has resulted in increased storage losses since they are usually more susceptible to pest damage (Shazia *et al*., 2006). *Callosobruchus maculatus* (F.) has been identified as one of the major insects associated with dried legumes like cowpea for thousands of years (Messina, 1991).

Currently, synthetic insecticides are the chief means of insect control both in the field and in storage (Jackai and Oyediran, 1991) and have shown efficacy against wide number of pest species of agricultural crop. Chemical control is generally practiced by farmers for higher gains, but its injudicious utilization has created many problems. Sole reliance on chemical control leads to problems of pest resistance, resurgence of pest, pesticide residues, destruction of beneficial fauna and environmental pollution, human poisoning, destruction of natural enemies of pest, crop pollination problem due to honey bee losses, domestic animal poisoning, contamination of livestock products, fish and wild life losses and contamination of underground water and rivers (Karnotaka, 2008). In addition these synthetic pesticides are not easily available among poor resource farmers, and when available are too expensive (Mabbet, *et al*., 1984).

In view of the above therefore, alternative method of control will be highly desired. Research on the use of natural pesticides for both field and storage crop protection are increasing because of their low toxicity to human beings (Raja *et al*., 2000).

These natural insecticides especially those of plant origin have proved to be effective, biodegradable, low cost, low technological base, selective and environmentally friendly (Shazia *et al*, 2006). Such plant materials include powders, water extracts, oil and wood ash from plants like Neem tree (*Azadirachta indica*) (Ivbijaro, 1983), groundnuts, palm kernel and coconut (Hall and Harman, 1991). Others are leaf extracts of *Toprasla vogelli*, garlic (Ho *et al*, 1997), basilum (Grainger and Ahmed, 1988), ginger (*Zingiber offficinale*) etc. However, most recent studies on ginger showed that it has both prophylactic and therapeutic cadmium detoxification effect (Egwurugwu *et al*, 2007). It also controls American boll worm, aphids, plant hoppers, thrips, white fly, root knot nematodes, brown leaf spot on rice, mango anthracnose, and yellow vein mosaic (Sridhar *et al*, 2002). They also reported that it has no side effect to humans since ginger rhizome is being consumed by man.

This investigation was aimed at using ginger (*Zingiber officinale* Roscoe) extracts and its by-product (residue), which would ordinarily become a waste for the control of major field insect pests of Okra and *Callosobruchus maculatus* in Cowpea grain storage respectively, which were purposively selected as test crops.

Materials and methods

Treatment preparation

Fresh ginger rhizomes were bought from Nsukka market and ground using manual grinder. To each bowl was weighed out 50g, 100g, 150g, 200g, 250g, and 300g of the ground ginger and labelled. These respective samples were each mixed with 1000 ml of distilled water and allowed to stand for 24 hours. This was later filtered using a 40 mm mesh muslin cloth; the extracts and the residues obtained were labelled appropriately. Thus given; 5%, 10%, 15%, 20%, 25%, and 30% residue concentrations (w/v). The residue's different concentrates were later air dried to a constant weight.

Field experimental design

The field experiment was carried out at the Teaching and Research farm of the Department of Crop Science, University of Nigeria, Nsukka from August to November, 2009. Nsukka is situated in the derived savannah zone within latitude 06 52^1 North and longitude 07 24^1 East, with an altitude of 447.26 m above sea level. The soil in the location of the experiment is classified as ferratic well drained sandy loam, and the okra variety used was Clemson spineless.

Treatments therefore comprised the six extraction rates of ginger, one actellic rate and untreated check laid out in a randomized complete block design with four replications. The plots were separated from one another by a pathway of one meter and also one meter between blocks. Blocking was made against slope. Data on insect count (*P. uniforma* and *N. sjostedti*) at various days after treatment application were collected as well as, the individual fruit weight, girth and length of insects counts were subjected to square root transformation before analysis of variance was carried out on them. The number of fruits per plant and plot, plants with fruits, fruit weight per plot and plant were also noted.

Application of treatments in the field

Ginger: The application of ginger extracts treatments were done on weekly basis with the use of a knap sack sprayer. This commenced 20 days after seedling emergence.

Lambdacyhalothrin: Attacke 2.5 EC (R) (lambdacyhalothrin) was applied at 0.01% foliar spray bi-weekly. The bi-weekly spray commenced on the appropriate plots 20 days after seedling emergence.

Laboratory treatment application and Experimental design

To 20 g of clean wholesome and uninfested cowpea seeds were added 2 g of air dried appropriate ginger extraction residue (chaff) in 250 ml plastic vial with tight fitting but perforated lids for insect aeration. The cowpea seeds and ginger residues were thoroughly add-mixed gently and allowed to stand. The primiphos methyl dust (synthetic chemical control) was weighed out at 2 g per 20 g cowpea seeds, placed in the plastic vial and add mixed with the seeds thoroughly. Six freshly emerged adults (1-2 day old) of *C. maculatus* (3 males and 3 females) were introduced into each vial and placed on the laboratory bench at constant room temperature and pressure. The insects were allowed to mate and oviposit freely for 21 days.

The experimental design was a completely randomized design with three replications. Oviposition and adult emergence were counted. Weight loss was determined as the difference between the cowpea seeds at the beginning of the experiment and at the end.

Statistical analysis

Insect counts data were normalized before subjecting them to analysis of variance using arc-sine transformation method, while the oviposition and *C. maculatus* emergence were transformed using square root method. All values were statistically analysed using Genstat discovery edition 2007. Means were separated using Least Significant Difference at 5 % level of significance.

Results and discussions

The results obtained in this study were in line with the attributes of ginger as has been documented by many researchers (Iqbal and Paswal, 1995; Amer *et al*., 2003). It showed that populations of *Podagrica uniforma* and *Nisotra sjostedti* on the plots treated with ginger extracts were appreciably reduced compared with the untreated (0% ginger) control (Table 1). Moreover, this significant difference shown by the plots treated with Lambdacyhalothrin and ginger extracts of 25% and 30% over the untreated control throughout the period of the experiment was as a result of toxic effects of the chemical and extract on *P. uniforma* and *N. sjostedti* as confirmed by some authors like Bandara and Seneviranta (2000). This resulted in lower populations of the insect which was consistent throughout the sampling period.

Plots treated synthetic insecticides (lambdacyhalothrin) significantly ($P<0.05$) increased fruit girth, fruit length, fruit weight, number of fruits harvested, number of plants with fruits and number of fruits per plant compared to the plots treated and untreated with ginger (Table 2 and 3). This was attributed to toxic effects of the synthetic chemical on the insect pests of the crop which normally defoliates the crop leaves and thereby reduces the photosynthetic surfaces of the plant. Higher rates of ginger aqueous extract (20 to 30) increasingly significantly ($P< 0.05$) improved the yield and yield components of okra in the field relative to their lower rates (5% to 15%) and check. This is such that fruit weight (g/plant) was increased by 29% with 20% extraction rate; 43% by 25% extraction rate; 44% by 30% extraction rates but up to 110% with the synthetic chemical.

The weight loss analysis showed that the ginger residue at higher concentration had better result, hence the progressive reduction in weight loss (Table 4) as the percentage, concentration increased, which although did not differ significantly. The highest ginger residue concentration of 30 % was comparable with that of the synthetic chemical treated control (pirimiphos methyl). This trend was followed in the number of perforations observed in the seeds, but the synthetic chemical treated control was the best and thus differed significantly ($P<0.05$) with both the ginger treated and untreated control. On the rate of adult emergence, at 14 days after infestation, the treatments did not differ in their effects. At 21 days after treatment, the ginger residue treated grains showed reduced adult *C. maculatus* emergence compared to the untreated grains such that there was a progressive decrease in adult emergence as the percentage concentration increases. This confirms the bio pesticidal property of the ginger residue.

The analysis on the oviposition results (Table 5), were similar to that of the adult emergence. This was not surprising as an egg would always hatch into an adult on completion of life cycle of an insect; but the major difference is that, in oviposition they were significantly ($P<0.05$) different with the untreated, especially the ginger residue at higher concentrations. The synthetic insecticides pirimihpos methyl dust was superior to other treatments in reducing the number of eggs, but the ginger residue treatments were better than the untreated. This confirms that the ginger residues have ovicidal, and deterrent properties on stored products. Similarly, Oparaeke and Daria (2005) reported that *Syzygim aromaticum* powder significantly prevented oviposition of *C.maculatus*. Similar results were obtained using other spices such as African nutmeg (*Myristica fragrans Houtt*), clove (*Syzygium aromaticum*), garlic (*Allium sativum*), chilli pepper (*Capsicum annum*) and West African pepper powders (Su, 1977; Onu and Aliyu, 1995). These fewer numbers of eggs laid on the ginger treated grains could be as a result of the ginger residues disrupting the mating and sexual communication as well as deterring females from laying eggs. However, as the experiment progressed there was a continual decrease in the ability of the ginger to prevent the oviposition. After the second week it became relatively less important against oviposition, although still better than the control (untreated) (Table 5).

Table 1. Effect of ginger extract on mean number of field insect pests of Okra (*P. uniforma* and *N. sjostedti*)

Ginger % extraction	**Mean Insect count two days after Spray**							
	1DAS	7DAS	14DAS	21DAS	28DAS	35DAS	42DAS	49DAS
0	26.9	2.92	3.13	3.49	3.25	3.16	3.43	3.66
5	1.77	2.49	2.31	2.75	2.57	2.80	2.82	3.01
10	1.85	2.20	2.27	2.55	2.54	2.64	2.69	2.86
15	1.71	2.20	2.31	2.26	2.54	2.59	2.50	2.79
20	1.64	2.17	2.11	2.25	2.06	2.39	2.48	2.63
25	1.69	2.10	2.12	1.97	1.97	2.47	2.44	2.64
30	1.31	2.09	1.98	1.63	1.83	2.27	2.29	2.59
Lambda cyhalothrin	0.71	0.84	1.18	1.14	1.18	1.26	1.64	1.38
$LSD_{(0.05)}$	0.74	0.59	0.50	0.79	0.71	0.57	0.59	0.50

Where DAS= days after spraying

Table 2. Individual fruit effect of the treatments

Ginger (% extraction)	Fruit		
	Girth (cm)	Length (cm)	Weight (g)
0	5.76	6.04	9.46
5	6.16	7.53	9.77
10	6.20	7.68	10.74
15	6.22	8.05	10.81
20	6.29	8.48	11.18
25	6.39	8.91	12.42
30	6.55	9.24	12.48
Lambdacyhalothrin	7.93	10.94	15.31
$LSD_{(0.05)}$	1.062	1.505	3.028

Table 3. Effect of ginger extracts on yield and yield components of Okra

Ginger (% extraction)	No of plants with fruits	No of fruits per plant	Fruit weight (g) per plant
0	1.70	0.89	10.06
5	1.93	0.90	11.03
10	2.10	0.98	11.73
15	2.35	0.99	12.18
20	2.40	1.08	13.0
25	2.45	1.14	14.39
30	2.90	1.15	14.48
Lambdacyhalothrin	3.45	1.34	21.13
$LSD_{(0.05)}$	0.796	0.1754	2.615

Table 4. Effect of the ginger residue on the weight loss (WTD) and number of perforations (NP) on the cowpea grain at 21 days after infestations

Ginger Residue (% extraction)	WTD	NP
0	1.04	2.92
5	0.98	2.61
10	0.85	2.56
15	0.82	2.32
20	0.77	2.31
25	0.74	2.30
30	0.69	2.10
Pirimiphosmethyl	0.64	1.27
$LSD_{(0.05)}$	N.S	0.795

Table 5. Ginger residue treatment effects on *C. maculatus* oviposition count

Ginger- residue (%Extraction)	**Oviposition**	**Count**	**(Days after**	**Infestations)**
	2	9	14	21
0	4.19	6.03	6.66	6 .66
5	3.99	5.98	6.58	6.58
10	3.84	5.70	6.59	6.59
15	3.80	5.76	6.42	6.42
20	3.59	5.43	6.03	6.03
25	3.52	5.43	5.74	5.74
30	3.40	4.98	5.35	5.35
Pirimiphosmethyl	2.45	0.03	0.01	0.01
$LSD_{(0.05)}$	0.898	1.174	1.456	1.456

Table 6. Effect of ginger residue treatments on *Callosobruchus maculatus* count on stored cowpea grain

Ginger-residue (% extraction)	**Emergence count (Days**	**after infestations)**
	14	21
0	0.70	6.60
5	0.70	6.59
10	0.70	6.42
15	0.70	5.34
20	0.70	1.92
25	0.70	1.70
30	0.70	1.54
Pirimiphosmethyl	0.70	0.71
$LSD_{(0.05)}$	N.S	1.29

Conclusion

Although, Lambdacyhalothrin had a better control of the field insect pests of okra which then translated to better yield, its well-known health concern to human beings and livestock may negate its positive impact. However, since ginger extracts, showed better results over the control (untreated) on population reduction of *Podagrica uniforma*, *Nisotra sjostedti* and consequently better yield, its prospect for control the of these pests of okra is highly recommended. The use of ginger is more eco-friendly, readily available, cheap, easily biodegradable, and less toxic to mammals.

From this study, it can be confirmed that ginger residue gotten after extraction of potent materials using water; has both prophylactic and therapeutic effect against *C. maculatus* in cowpea grains storage. However, the reduction in oviposition and adult emergence strongly suggests that ginger residue could effectively be used to control *C. maculatus* in cowpea. Therefore, the study recommends a further investigation, to see if the ginger residue could be combined with other plant extract to have a complimentary and prolonged effect on the total control of *C. maculatus* in cowpea grains storage.

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(Received 27 March 2012; accepted 30 October 2012)