International Letters of Natural Sciences *Online: 2014-05-30*
ISSN: 2300-9675, Vol. 16, pp 164-178
doi:10.56431/p-96yrx4

Field evaluation of plant extracts for the control of diamond moth (*Plutella xylostella* Linnaeus) infesting Cabbage (*Brassica oleracea* Linn)

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ABSTRACT

Cabbage (*Brassica oleracea* Linn.) is one of the important vegetables grown worldwide. Insect pests have been a major constraint to its production with some reported to have developed resistance to commonly available synthetic insecticides. In order to find alternative control for these pests, field experiments were conducted in the early seasons of 2011 and 2012, to evaluate the efficacy of three plant extracts, *Tephrosia vogelli* Hooks, *Zingiber officinales* Rosh and *Lantana camara* Spanish flag, applied at 5, 10 and 25 % w/v concentrations Delthamethrin (a synthethic insecticide) and an unsprayed plot were included as positive and negative controls respectively. Plots were arranged in a Randomized Complete Block Design (RCBD), with three replications. Mean Data over the two planting seasons were subjected to the analysis of variance and significant means were compared using the least significant difference (L.S.D) at $P < 0.05$. *Z. officinales* extract effectively control *P. xylostella* larvae at all concentrations with 25 % w/v gave the best yield of 0.50 kg/ha while *T. vogelii* and *L. camara* extracts were as effective as Deltamethrin at different concentrations and hours on diamondback-moth (*P. xylostella*) adult The present findings indicated that effective botanicals against Diamondback moth adult and larvae of cabbage can be formulated from extract of *T. vogelii*, *L. camara* and *Z. officinales* at 25 % concentration respectively.

***Keywords*:** Cabbage; Deltamethrin; *Plutella xylostella*; *Z. officinales*; *L. camara*; *T. vogelii*

1. INTRODUCTION

Cabbage is a popular cultivar of the species *Brassica oleracea* Linn. of the family Brassicaceae. It is one of the most important leafy vegetables worldwide and is a crop grown by smallholder farmers in Africa (Talaker, 2000). It has medicinal properties and it is an excellent source of vitamin C, minerals, dietary fibers, folates and especially phytochemicals (Jagerstad *et al*., 2004: Kyung Young Yoon *et al*., 2006: Rodriguez *et al*. 2006). Cabbage also reduces risk of heart disease and stroke, alleviate rheumatisms and skin problems. Fresh cabbage juice has been shown to promote rapid healing of peptic ulcer (USDA 2009).

Despite the long time of Cabbage production in Africa, it still faces several constraints including insect pests. These insect pests includes diamondback moth *(Plutela xylostella*), Cabbage looper *(Tricoplusia ni)*, Cabbage root maggot (*Delia radicum*), Cabbage webworm

(*Crocidolomia Pavonana)*, Common cutworm (*Spodoptera litura)*, Cabbage Borer (*Hellula undalis*), Cabbage aphids (*Brevicoryne brassicae*), imported cabbage worm *(Pieris rapae)*, cutworm *(Agrotis sp)* and Cabbage flea beetle (*Phyllotreta cruciderae*) (Talekar, 1992). These pests can cause serious damage to young transplants and old plants. Damage to the head or wrapper leaves often reduces marketability, hence, there is the need to control insect pests of cabbage.

Management of the pests is heavily reliant on the use of chemical insecticides especially in the developing countries of the tropics (Tabashmik *et al*.,1987; Dandang *et al*, 2003a). Synthetic insecticides have been reported to have some side effects such as mammalian toxicity, environmental pollution, insect resistance and resurgence high cost and unavailability at critical periods (Duke, 1990). Arising from these highlighted problems, there is the need to search for alternatives for synthetic insecticides. Such agents should be pest-specific, non-toxic to humans and other biota, biodegradable, less prone to pest resistance and resurgence, relatively less expensive and with relative ease of application (Devlin and Zettel, 1999; Adebayo, 2003).

The basis for this research is an attempt to solve some of the problems facing farmers, like problem of low productivity due to the insect pests attack. Protecting consumers from eating pesticide-contaminated vegetables and exposure of farmers to the toxic synthetic chemicals. Therefore, the objective of this research is to determine the effect of *Tephrosia vogelli* Hooks, *Zingiber officinales* Rosh and *Lantana camara* L. extracts on two developmental stages of *P. xylostella* infesting cabbage insect pest diversity and population, head damage and yield of cabbage.

2. MATERIALS AND METHODS

2. 1. Experimental site

Field study was conducted at Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, Ogbomoso, Nigeria. Ogbomoso is located on longitude 4°30' and latitude 10°5' N. The climate of the region could be described as hot humid tropical falls in Southern Guinea Savanna of Nigeria with a mean temperature of 27 °C and annual rainfall of 1400 mm, marked with dry and wet seasons and characterized by a bi-modal rainfall pattern with peaks in July and September.

2. 2. Experimental materials

The seed of cabbage (var. Copanheng) was obtained from the Seed Project Company Limited Kano, Nigeria. while ginger rhizome was purchased from Sabo Market Ogbomoso Nigeria. Matured leaves of *T. vogelii, L. camara* were collected from the premises of the Department of Crop and Environmental Protection, LAUTECH, Ogbomoso, Nigeria. Deltamethrin was purchased from Farmers Chemical Agro allied Shop Ogbomoso.

2. 3. Preparation of plant extract

Fresh leaves of *L. camara* and *T. vogelii*; and rhizome of *Z. officinales* were harvested at full maturity. The extracts of the three plants species were prepared by weighing 1000 g each of botanical separately and crushed with a mortar and pestle. The crushed plant parts were put in separate plastic buckets containing two liters of water. These were allowed to

settle for 24 hours and the aqueous suspension was filtered through muslin cloth. The filtrate was stored in plastic containers as stock solution for bioassay and kept in the refrigerator until use.

2. 4. Agronomic practices

The Experimental site was manually cleared and divided into - plots. Each plot was divided into beds having 2 m x 3 m dimension with 1 m gap between adjacent plots. A gap of 2 m was used to separate different blocks. A total of thirty three (33) plots were made to accommodate the treatments. Each plot had 5 rows with 6 plants per row spaced out at 0.6 m x 0.5 m. which amounted to 30 plants per plot and 50,000 plants per hectare. The plants were Four plant stands from the middle rows were tagged for data collection.

Cabbage seeds were planted in early season of 2011 and 2012 on 12 May 2011 and 23 May 2012 respectively at the rate of three to four seeds per stand. Thinning was done two weeks after planting (WAP) to achieve one plant per stand. Weeding was done as at when due.

From the stock solutions, 50, 100 and 250 ml each of the solution was diluted with 1000 ml of water to have 5, 10 and 25 % concentration. The unsprayed plots and synthetic insecticides (Deltamethrin used at the rate of 0.8 litres /hectare) were included for comparison. The treatments were applied by spraying the plants very early in the morning on weekly basis. This was done according to the method of Owolade *et al.* (2004) and Oparake (2005) in order to reduce or eliminate pesticide drift. Foliar application was done using hand sprayer which commenced 4 WAP and was repeated at weekly intervals which were made weekly over a 4 - week period given a total of four applications.

2. 5. Data collection and Data Analysis

Data were collected on insect pest population, level of damaged caused by the insect pest, vegetative, head damage and yield parameters. Data collected over the two years were pooled and subjected to analysis of variance (ANOVA) using Randomized Complete Block Design (RCBD) according to by Gomez and Gomez (1987). Significant means were compared using least significant difference (LSD) at 5 % probability level.

3. RESULTS

Z. officinales extract was significantly better at ($p = 0.05$) in the control of *P. xylostella* larvae with mean number of 0.71 ±0.00 compared with Deltamethrin (1.71 ±0.34). The best control against *P. xylostella* larvae was observed at 25 % concentrations w/v. Application of *T. vogelii* and *L. camara* extracts were as effective as Deltamethrin at different concentrations on diamondback-moth (*P. xylostella*) adult. The mean number of *P. xylostella* adult on *T. vogelli* and *L. camara* were (0.91 ±0.20, 0.76 ±0.05, 0.71 ±0.00 0.91 ±0.20, 0.76 ±0.05, 0.76 ±0.05 and 0.85 ±0.14 at 5.10 and 25 % concentrations respectively. The efficacy increased with repeated spraying across the treatments. With respect to hours after spraying as hours increases, rate of insect pest decreases. Plant height increased with increase in concentrations, with *Z. officinales* having the highest mean value (22.71 ±1.74 cm) at 25 % w/v concentrations followed by *T. vogelii* (21.44 ±0.34 cm) at the same concentration. However, as the concentrations of plant extracts increased, the rate of leaf damage decreased with the exception of the plot treated with *Z. officinales*, *L. camara* - treated plot at 25 % (w/v)

concentrations had the least mean value (1.25 ±0.14) of head damage and *Z. officinales at* 25 % concentrations gave the best yield.

Table 1. Effect of botanicals on Diamondback moth (*Plutella xylostella)* population at 1st spraying.

TREATMENTS	CONCENTRATIONS						
	(%)	24HAS	24HAS	48HAS	48HAS	72HAS	72HAS
		DBML	DBMA	DBML	DBMA	DBML	DBMA
Control	unsprayed	0.81±0.10	0.82±0.05	0.88± 0.17	O.71±0.00	0.71±0.00	O.71±0.00
Z. officinales	5	0.81±0.10	1.44±0.54	0.76± 0.05	1.24±0.38	0.76± 0.50	0.96±0.04
L. camara	5	1.31±0.44	0.88±0.14	1.66± 0.39	0.90±0.12	0.76 ±0.00	0.91±0.04
T. vogelii	5	0.76± 0.05	0.84±0.13	1.71 ±0.00	0.85±0.14	0.71 ±0.00	O.71±0.00
Z. officinales	10	0.71±0.00	0.81±0.96	0.76± 0.05	0.90±0.09	0.91±0.20	0.87±0.16
L. camara	10	1.32 ±0.61	0.88±0.14	1.18 ±0.47	0.94±0.23	0.91± 0.20	0.86±0.08
T. vogelii	10	1.79± 0.24	0.94±0.23	1.66 ±0.36	0.88±0.17	1.29 ±0.58	O.71±0.00
Z. officinales	25	1.62±0.38	1.84±0.89	1.18± 0.24	1.25±0.41	1.00 ±0.21	0.76±0.05

L. camara	25	1.31± 0.31	1.02±0.30	1.83 ±0.48	1.05±0.17	1.00 ±0.21	0.86±0.08
T. vogelii	25	1.02± 0.16	0.81±0.96	0.85± 0.14	0.71±0.00	1.05 ±1.14	O.71±0.00
Deltamethrin	0.04	0.91 ±0.20	0.82±0.05	1.07± 0.10	O.71±0.00	1.19 ±0.30	0.76±0.05
LSD (5 %)		0.61	0.44	0.62	2.26	0.59	0.10

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha), DBML = Diamondback moth larva, DMBA = Diamondback-moth Adult, HAS = Hours after spraying.

Table 2. Effect of botanicals on Diamondback moth (*Plutella xylostella*) population at 2nd spraying.

TREATMENTS	**CONCENTRATIONS**						
	(%)	24HAS	24 HAS	48HAS	48 HAS	72HAS	72 HAS
		DBML	DBMA	DBML	DBMA	DBML	DBMA
Control	Unsprayed	0.99±0.72	0.90±0.09	0.85±0.14	0.76±0.05	0.76±0.05	0.71±0.00
Z. officinales	5	2.18±0.69	1.57±0.43	0.81±0.09	0.82±0.05	0.90±0.09	0.81±0.09
L .camara	5	2.36±0.82	0.91±0.20	1.73±0.58	0.81±0.09	1.54±0.43	0.91±0.13

T. vogelii	5	0.91±0.13	0.91±0.20	1.28±0.38	0.86±0.08	0.96±0.18	0.71±0.00
Z. officinales	10	1.20±0.27	1.05±0.18	0.86±0.08	0.71±0.00	0.76±0.05	0.76±0.05
L .camara	10	1.35±0.65	0.76±0.05	1.37±0.67	1.01±0.18	0.99±0.21	0.71±0.00
T. vogelii	10	2.12±0.94	0.76±0.05	1.57±0.43	0.71±0.00	1.63±0.55	0.71±0.00
Z. officinales	25	0.71±0.00	2.39±0.77	0.71±0.0	0.71±0.00	0.71±0.05	0.71±0.00
L. camara	25	2.41±0.53	0.76±0.05	3.07±0.42	0.76±0.05	1.31±0.59	0.71±0.00
T. vogelii	25	1.23±0.38	0.71±0.00	1.00±0.29	0.81±0.09	0.94±0.23	0.76±0.05
Deltamethrin	0.04	1.71±0.34	0.85±0.14	1.89±0.46	0.71±0.00	0.91±0.20	0.76±0.05
LSD (5%)		0.85	0.64	0.77	0.14	0.42	0.12

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha), DBML = Diamondback moth larva, DMBA = Diamondback-moth Adult, HAS = Hours after spraying

Table 3. Effect of botanicals on Diamondback moth (*Plutella xylostella)* population at 3rd spraying.

TREATMENTS	CONCENTRATIONS						
	(%)	24HAS	24 HAS	48HAS	48 HAS	72HAS	72 HAS
		DBML	DBMA	DBML	DBMA	DBML	DBMA
Control	Unsprayed	1.80±0.41	0.71±0.00	1.44. ±0.37	**1.0±0.00**	1.52±0.47	**1.0±0.00**
Z. officinales	5	2.80±1.03	2.59±0.56	0.81±0.09	1.03±0.24	0.76±0.05	0.76±0.05
L. camara	5	2.50±0.18	0.71±0.00	2.30±0.32	0.76±0.05	2.26±0.35	0.85±1.14
T. vogelii	5	1.91±0.63	0.71±0.00	1.75±0.32	0.76±0.05	1.57±0.43	0.71±0.00
Z. officinales	10	1.83±1.02	2.21±0.23	0.71±0.00	0.71±0.00	0.76±0.05	0.71±0.00
L. camara	10	1.90±1.01	0.71±0.00	1.51±0.81	0.86±0.08	2.26±0.35	0.82±0.05
T. vogelii	10	1.97±0.59	0.84±0.00	1.84±0.36	0.71±0.00	1.57±0.43	0.71±0.00
Z.. officinales	25	3.85±1.54	3.78±0.80	1.05±0.34	0.94±0.23	0.71±0.00	1.05±1.17

L. camara	25	4.42±0.69	0.76±0.05	3.73±0.37	0.86±0.08	3.39±0.16	1.19±0.41
T. vogelii	25	1.80±0.89	0.82±0.05	1.54±0.51	0.9±0.12	1.96±0.70	0.71±0.00
Deltamethrin	0.04	3.37±0.74	0.9±0.12	2.15±0.01	0.9±0.12	2.63±0.76	0.71±0.00
LSD (5%)		1.56	0.17	1.15	0.77	1.13	0.24

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha), DBML = Diamondback moth larva, DMBA = Diamondback-moth Adult, HAS = Hours after spraying

Table 4. Effect of botanicals on Diamondback moth (*Plutella xylostella)* population at 4th spraying.

TREATMENTS	**CONCENTRATIONS**						
	(%)	24HAS	24 HAS	48HAS	48 HAS	72HAS	72 HAS
		DBML	DBMA	DBML	DBMA	DBML	DBMA
Control	Unsprayed	1.71±0.19	0.71±0.00	1.08±0.21	0.71±0.00	1.59±0.38	0.71±0.00
Z. officinales	5	1.99±0.23	2.45±0.21	0.76±0.05	0.94±0.00	0.71±0.00	0.71±0.00
L. camara	5	2.00±0.51	0.71±0.00	2.06±0.31	0.71±0.00	1.65±0.57	0.71±0.00

T. vogelii	5	1.82±0.56	0.71±0.00	2.38±0.89	0.71±0.00	1.25±0.36	0.76±0.05
Z. officinales	10	2.27±0.71	1.10±0.03	0.76±0.05	0.71±0.00	0.71±0.00	0.71±0.00
L. camara	10	2.15±1.10	0.71±0.00	2.06±0.31	0.71±0.00	1.62±0.05	0.71±0.00
T. vogelii	10	1.78±0.30	0.71±0.00	2.38±0.89	0.71±0.00	1.81±0.52	0.76±0.05
Z. officinales	25	1.77±0.96	2.76±1.18	0.71±0.00	0.71±0.00	0.71±0.00	0.84±0.13
L. camara	25	4.03±0.62	0.71±0.00	3.75±0.41	0.71±0.00	3.18±0.36	0.76±0.05
T. vogelii	25	1.59±0.38	0.71±0.00	2.06±0.31	0.71±0.00	1.36±0.19	0.76±0.05
Deltamethrin	0.04	3.07±0.57	0.76±0.05	3.58±0.57	0.71±0.00	2.51±0.40	0.76±0.05
LSD (5%)		1.06	0.85	0.70	0.13	0.84	0.10

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha), DBML = Diamondback moth larva, DMBA = Diamondback-moth Adult, HAS = Hours after spraying.

Table 5. Effect of botanicals on plant height of cabbage after spraying.

TREATMENTS	CONCENTRATIONS	WEEKS AFTETR SPRAYING			
	%	WEEK 1	WEEK 2	WEEK 3	WEEK 4

Control	Unsprayed	11.20± 42.1	13.54±2.00	17.07±2.10	20.37±0.71
Z. officinales	5	10.40± 21.33	12.75±1.60	14.29±1.10	17.51±0.88
L. camara	5	10.54± 1.43	14.42±1.60	17.2±11.23	18.6± 1.40
T. vogelii	5	12.96± 0.46	15.17±1.90	18.60±1.40	18.6± 1.40
Z. officinales	10	15.12±2.30	17.34±1.80	20.33±1.13	20.78±0.98
L. camara	10	9.75± 2.58	12.09±2.70	16.87±1.76	19.17±1.70
T. vogelii	10	14.29±1.98	15.77±1.02	16.42±2.10	16.42±2.09
Z. officinales	25	16.29±0.87	18.62±0.56	20.37±0.71	22.71±1.74
L. camara	25	11.53±0.84	14.35±1.30	17.21±1.23	21.87±2.60

T. vogelii	25	17.42±1.17	18.99±1.84	20.84±1.73	21.44±0.34
Delthamethrin	0.04	12.57±2.96	16.25±2.88	19.43±2.60	20.92±0.88
L.S.D		6.13	6.05	5.60	2.66

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha).

Table 6. Effect of botanicals on leaf damage of cabbage after spraying.

TREATMENTS	CONCENTRATIONS	WEEKS AFTETR SPRAYING			
	%	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Control	Unsprayed	56.89±19.8	53.27±12.14	75.61±7.49	69.44±9.20
Z. officinales	5	45.54±12.73	49.58±13.79	58.25±9.50	48.95±1.27
L. camara	5	70.82±14.89	63.94±9.70	75.28±3.60	74.53±5.20
T. vogelii	5	80.98±8.24	74.27±4.72	87.81±5.00	81.81±3.05

Z .officinales	10	56.01±11.25	56.39±9.70	60.02±5.7	71.75±7.48
L. camara	10	65.46±22.37	62.53±16.00	73.28±1.40	77.54±6.70
T .vogelii	10	64.54±11.38	70.37±6.20	67.22±10.8	54.10±1.90
Z. officinales	25	68.32±16.08	58±87±8.90	75.97±7.50	69.44±9.20
L. camara	25	61.92±30.18	56.25±21.90	53.39±8.60	65.39±9.39
T. vogelii	25	91.71±19.05	63.46±19.50	50.92±9.70	57.91±10.12
Delthamethrin	0.04	63.21±13.65	62.65±14.1	54.44± 2.60	75.90±5.24
L.S.D		36.63	28.39	16.94	12.59

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha).

Table 7. Effect of botanicals on yield and head damage of cabbage.

TREATMENTS	CONCENTRATIONS %	YIELD Kg/ha	HEAD DAMAGE %
Control	Unsprayed	0.28 ±0.02	1.41 ±0.22
Z. officinales	5	0.19 ±0.06	1.66 ±0.30
L. camara	5	0.21 ±0.12	2.00 ±0.28
T .vogelii	5	0.24 ±0.07	1.50 ±0.14
Z. officinales	10	0.31 ±0.06	1.66 ±0.08
L. camara	10	0.38 ±0.22	1.41 ±0.41
T. vogelii	10	0.24 ±0.08	1.83 ±0.14
Z. officinales	25	0.50 ±0.13	1.50 ±0.25
L. camara	25	0.29 ±0.08	1.25 ±0.14
T. vogelii	25	0.23 ±0.39	1.33 ±0.44
Delthamethrin	0.04	0.28 ±0.08	1.83 ±0.36
L S D (5%)		0.14	0.25

Values are mean (± SEM) (n = 3). LSD values are applicable along the column. Delthamethrin (0.8 l/ha).

4. DISCUSSION AND CONCLUSIONS

Among the plant extracts, *Z. officinales* extract proved effective in controlling *P. xylostella* larva at different concentration but gave the best at 25 % concentrations. Insect population decreased as exposure hours increased and when compared with synthetic insecticides, it performed better. This agrees with the work of Dadang *et al.* (2009) who reported that *Piper retrofractum* and *Annona squamosa* extracts were more effective than synthetic insecticides (Deltamethrine) in controlling *Crocidolomia pavonana* (F.) and *P. xylostella* (L.) which are insect pests of cabbage. Prakash Rao (1997) and Sridhar *et al* (2002) reported that the active ingredients in *Z. officinale* which are pungent makes it a very good insecticides with repellent mode of action against insect pests such as aphids, leaf miner, bollworm and thrips. Gingerols and shogaols are the active insecticidal materials in *Z. officinale* rhizome (Goto *et al.*, 1990).

Conversely, it was observed from this study that *Z. offícnales* was ineffective against *P. xylostella* adult and as its concentrations increased the population of *P. xylostella* adult increased. This shows that it does not have effect in controlling adult insect population of cabbage. This corroborates with the work of Hala *et al.* (2010) who reported that plant extracts of *Z. officinale* showed good level of efficiency against nymphs of *Bemisia tabaci* and *Aphis craccivora*. Dadang *et al*. (2007) reported that extract of *Aglaia odorata* was effective in controlling several agricultural insect pests including *P. xylostella* and *Crocidolomia pavonana* larvae.

Deltamethrin and *L. camara* - treated plots had higher population of *P. xylostella* larva compared with the other insect at different concentrations and HAS. This showed that *L. camara* was ineffective as Deltamethrin in controlling the *P. xylostella* larva. Report shows that synthetic insecticides do not have much effect in reducing insect population but rather increased. Ninsin (1997) observed that *P. xylostella* was resistant to many conventional insecticides and so spraying DBM infested cabbage plot often has little effect on the pest. Youdeowei (1988) and Shelton (1993) reported that DBM can cause serious damage even with application of several different insecticides because of its ability to develop resistance to almost all insecticides.

Prevalence of leave damage pointed out that as the concentrations increases in *T. vogelii*, *L. camara* leaves damage reduced. This corroborates the work of Isirima (2010) that leaf damage decreased with increasing application of the plant extracts (garlic and ginger). Throughout the period of this study the effectiveness of the extracts of *Z. officinales* kept on decreasing with increase in the time after application. This may be due to photo - degradation of its bioactive composition. It is recommended that extract of *Z. officinales* at 25 % concentration should be evaluated for its bioactive against other field insect pests of cabbage in order to establish its spectrum of activity.

Acknowledgements

The authors wish to acknowledge Dr. S.A Babarinde, Department of Crop and Environmental Protection Ladoke Akintola University of Technology Ogbomoso, Nigeria.

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(Received 19 May 2014; accepted 27 May 2014)