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Comparative Toxicity of Aqueous Extract of *Tephrosia Vogelii* and Some Synthetic Insecticides in the Control of Insect Pests of Cucumber (*Cucumis sativus* L.)

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ABSTRACT

A field study was carried out during the early cropping season (March - May) of 2018 to evaluate the efficacy of *Tephrosia vogelii* (a plant extract) and some synthetic insecticides (Lambdacyhalothrin, Imidacloprid and Cypermethrin) on the major insect pests of cucumber and also to assess the yield and yield components of the crop under these treatments. The study was conducted at the Western Farm of the Teaching and Research Farm of the Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike. The experiment was laid in Randomized Complete Block Design (RCBD) with five treatments replicated four times. The Treatments included: 300 g of leaf extract of *Tephrosia vogelii*, 5 ml of Lambdacyhalothrin, 5 ml of Imidacloprid and 5 ml of Cypermethrin. The efficacy of the treatments were evaluated based on the reduction of insects population, mortality rate of pumpkin beetle, percentage number of leaf defoliation, flower damage reduction and fruit weight yield. The results indicated that at 8 Weeks After Planting (WAP) the extract of *T. vogelii* and Cypermethrin significantly ($P<0.05$) reduced the population of pumpkin beetles, melon aphids and the highest mortality count of Pumpkin beetle was also recorded in the plots treated with Cypermethrin. At 4 WAP, the population was 11.5 for Cypermethrin-treated plots and 8.5 for *T. vogelii*-treated plots. These reduced to 1.0 and 5.0 respectively at 8WAP, which translates to 91% and 41% population reductions for Cypermethrin and *T. vogelii*. The results revealed that the Plant extract was not as effective as the synthetic Cypermethrin. The implication of these results is that *T. vogelii* can be used as an alternative to the synthetic insecticides for the control of insect pests of Cucumber in low-input farming systems of the tropics.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a member of the family Cucurbitaceae (gourd family).The crop is thought to have originated in India and some other parts of Western Asia. Cucumber is an annual, warm season, dioecious, creeping or trailing herbaceous vine that grows on trellises or other supports, wrapping around them with thin, spiral tendrils. The stem is stout, simple four- angled and bears large triangular or ovate shaped leaves that form a canopy over the fruits. The fruit of cucumber is roughly elongated with tapeted end (Trebick *et al.,* 2015). The fruits are eaten raw or prepared as salad and pickle while the young leaves are eaten as vegetables or salad particularly in Malaysia and Indonesia (Ojiewo *et al.,* 2015). Cucurbits in general are a family of healthy foods and cucumbers in particular are a prime dieting food being low in calories. One hundred grammes of the fresh fruit of the crop is reported to contain about 96 percent water, a little fibre, a few calories, providing a good source of vitamins A, K and C and a large amount of potassium (Ojiewo *et al.,* 2015). Its high moisture content contributes to its diuretic activity and cleansing action within the body by removing accumulated pockets of metabolic waste materials, chemical toxins especially uric acid and xenobiotics. Hence, Cucumbers could be beneficial for those who are burdened with arthritis. The fruit rind contains high levels of cucurbitacins, which antagonize cancer preventing their proliferation and survival. The rind also has been found to help with symptoms of diabetes since cucurbitacins in cucumber stimulate insulin release and regulate the metabolism of a key hormone in the processing of blood sugar, hepatic glycogen (Ojiewo *et al.,* 2015).

However, production of this important crop is strongly constrained by attacks of insect pests which decimate the above ground structures of the plant especially in humid tropical locations. Major insect pests associated with the crop include cucumber beetles, red pumpkin beetles, fruit flies, squash bugs, aphids, whiteflies, squash vine borers and two-spotted spider mites. Losses due to attacks of these insects may reach up to 35–75% at the seedling stage or total crop failure (100%) in severe infestations of the field (Khan *et al*., 2012). Control of these insect pests so far is largely achieved by synthetic chemical treatments such as Cypermethrin, acetamiprid, bifenthrin or malathion. In the view of many workers, overuse and/or misappropriation of these interventions are harzadous to both environmental and mammalian health (Jallow *et al*., 2017). Owing to these, several researchers in recent years have reported the insecticidal activity of tropical higher plants (Asawalam, 2006). Asawalam (2006) reported that extracts derived from *Piper guineense* effectively checked the ravages of *Sitophilus zeamais* on stored maize grains whereas Oparaeke (2007) noted that powder from the same plant substantially reduced the populations and attacks of *Maruca sp.* and *Clavigralla sp.* on cowpea in the field. The use of extracts of the fish poison bean (*Tephrosia vogelii*) as plant-derived insecticide for veterinary and conventional crop production in Tanzania, Uganda and other countries in East Africa has been reported (Denza *et al*., 2007). Recently, researchers in Western Nigeria found that extracts of *T. vogelii* reduced the population of *Phyllotreta coniferea, D. undecimuctata, Bactrocera curcubitae, Zonocerus variegatus* and *Podagrica spp.* on treated roselle (*Hibiscus sadbarilla* L.) (*Zobo* plant) and water melon (Olaniran and Adebayo, 2013; Olaitan and Adebayo, 2015). However, evaluations of the insecticidal efficacy of extracts of the plant against the major insect pests of the crop in Umudike Southeastern Nigeria are scarcely available.

Therefore, this work is tailored to assess the efficacy of extract of *T. vogelii* for the control of major insect pests of cucumber in Umudike Southeastern Nigeria, and to evaluate the impacts of the treatments on the yield and yield components of the treated crop.

MATERIALS AND METHODS

Experimental site

The study was conducted from March - May 2018 cropping season at the Michael Okpara University of Agriculture Western Farm Umudike, which is located on the latitude 5^0 29^1N and longitude 7^0 33^1E with average annual rainfall of 2177mm and temperature of 29^0C-31^0C with relative humidity of 50-90 in the rain-forest ecological zone of Southeastern Nigeria (NRCRI, 2016).

Source of seeds and Field Preparation

The seeds of Cucumber (Var: Poinsette) (Fig. 1) obtained from the Research and Training (R&T) Unit of the College of Crop and Soil Sciences of Michael Okpara University of Agriculture Umudike (MOUAU) were used for the study. The Research field was ploughed, tilled and ridged manually using hoe that made for easy breakage of the soil lumps to enable proper establishment of the crop. Five tonnes per hectare (5 tonnes/ha) of poultry manure was incorporated into the ridges during preparation (Enujeke, 2013; Agu *et al*., 2015). The seeds were sown three per hole at a spacing of 60 cm × 50cm on the two sides of the ridges and later thinned to one seedling after emergence to achieve one plant per stand. Each experimental plot measured 2m × 2.5m and consisted of four rows of ridges. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The whole field was weeded at fortnightly intervals (Enujeke, 2013; Agu *et al*., 2015).

Table 1: Layout (Design) of the experimental field

REP 1	REP 2	REP 3	REP 4
Cypermethrin	Lambdacyhalothrin	Imidacloprid	*Tephrosia vogelii*
Imidacloprid	Control	*Tephrosia vogelii*	Lambdacyhalothrin
Tephrosia vogelii	Cypermethrin	Lambdacyhalothrin	Control
Lambdacyhalothrin	Imidacloprid	Control	Cypermethrin
Control	*Tephrosia vogelii*	Cypermethrin	Imidacloprid

Table 2: Soil Physico-chemical properties of the experimental site in 2018 cropping season

Physical Properties	
Sand g/kg	759.00
Silt g/kg	80.00
Clay g/kg	161.00
Textural class	Sandy loam
Chemical Properties	
pH(H_2O)	4.50
Phosphorous (Mg/kg)	13.50
Total Nitrogen (g/kg)	0.90
Organic Carbon (g/kg)	2.20
Organic matter (g/kg)	3.78
Calcium (cmol/kg)	2.80
Magnesium (cmol/kg)	1.40
Potassium (cmol/kg)	0.07
Sodium (cmol/kg)	0.22
Exchange acidity (cmol/kg)	1.98
ECEC (cmol/kg)	76.35

Figure 1: Mature and Fruit bearing cucumber plant Var. Poinsette**) growing in the field**

Preparation of the plant material

The leaves of ***Tephrosia vogelii*** (Fig 2) obtained from a herbarium in Umuahia were used for the bio-insecticidal trial. The leaves were washed repeatedly under running tap water and then air dried for one day on the laboratory bench of the College; afterwards were crushed with mortar and pestle, 300g of the crushed plant materials was weighed with a sensitive scale after which each of the paste was put into a five liter plastic bucket containing 1000 ml of water. The soaked plant materials was allowed to stay overnight, filtration was done with muslin cloth and filtrates collected were stored in a five litre plastic keg.

Figure 2: *Tephrosia vogelii* growing in a herbarium in Umuahia, Abia State, Nigeria

On Farm Experiment

The on-farm experiment was done based on the methods adopted by Olaniran and Adebayo (2013) and Olaitan and Adebayo (2015). The Application of the treatment on the cucumber commenced two weeks after planting (WAP) and this was done early in the morning with 5-litre capacity hand-held sprayer. The treatments were applied as sprays with *Tephrosia vogelii* plant extract applied at 300g/plot, Imidacloprid at 5ml/plot, Lambdacyhalothrin at 5ml/plot and Cypermethrin at 2ml/plot. This was diluted with five litters of clean water to achieve the same spraying volume. Spraying of the crop with the insecticides was repeated at seven-day intervals and weekly observations taken.

DATA COLLECTION AND ANALYSIS

Data were collected on populations of the following insect pests: melon aphids (*Aphis gossypii)*, pumpkin beetle (*Aulacophora foveicollis)* and cucumber beetle (*Diabrotica undecimpunctata*) which infested the test crop in the field. Percentage number of the infested leaves, flowers as well as weight of the fruits from both the treated crop and the controls were also collected. Data collected were analyzed by Analysis of variance (ANOVA) using (STAT MODEL). Significant means were separated and compared using Fisher's Least Significant Difference at 5 level of probability.

RESULTS

Results from the study indicated that three (3) major insect-pests: cucumber beetle (*Diabrotica undecimpunctata*); pumpkin beetle (*Aulacophora foveicollis*) and melon Aphids (*Aphis gossypii*)) were associated with attacks on cucumber in Umudike Southeastern Nigeria. The mean insect pest population results on the treated cucumber are presented in Table 3. It showed that at 4 WAP, the highest number of pumpkin beetles was observed in the control plot (12.5) followed by the plots treated with Imidacloprid (12.3), whereas the least pumpkin beetle population was obtained in plots treated with Cypermethrin (1.0) at 8WAP. Although there was no significant difference (P>0.05) recorded between Lambdacyhalothrin (4.5) Imidacloprid (4.0) and plant extract (5.0) at 8WAP, this showed that the synthetic insecticide (Cypermethrin) was the most active and significantly (P<0.05) effective in reducing the population of pumpkin beetle when compared with the plant extract.

Similarly, on the population of melon Aphids over a period of time, at 4WAP it was observed that the control had the highest number of Aphids (13) followed by Lambdacyhalothrin-treated plots (11). The plots treated with Cypermethrin had the least incidence of Aphids (1.8) at 4WAP while there was no significant difference (P>0.05) between Imidacloprid and Lambdacyhalothrin as well as between these synthetics and the plant extract. Mean result obtained at 8WAP showed that highest number of Aphids was obtained in the control plots (4.0) followed by the Lambdacyhalothrin (3.3). The least Aphids population was obtained in plots treated with Cypermethrin (0.5) at 8WAP followed by the plant extract (1.8) at 8WAP. This showed that the plant extract (*Tephrosia vogelii)* and the synthetic insecticides (Cypermethrin) can be used for the control of Melon Aphids.

The mean results obtained at 4WAP showed that the highest number of cucumber beetles was observed in the control plots (3.8) followed by the Lambdacyhalothrin (3.3) and Imidacloprid (2.0) respectively. The least number of cucumber beetles was obtained in plots treated with Cypermethrin (0.5) and *Tephrosia vogelii* (1.8) at 4WAP: the plant extract proved effective at 8WAP (3.0) when compared with the synthetic insecticides although there was no significant difference (P>0.05) between the synthetic insecticides and the plant extract.

Table 3: Mean population count of the major insect pests attacking the treated cucumber over a period of 8 weeks.

	Insect Pest Population and Time of evaluation of pesticide effects (Weeks)														
	4 WAP			**5 WAP**			**6 WAP**			**7 WAP**			**8WAP**		
Treatment	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Lambdacyhalothrin	7.3	11.0	3.3	7.5	4.0	4.5	7.5	10.5	5.0	7.5	6.8	4.2	4.5	3.3	7.3
Cypermethrin	11.5	1.8	0.5	2,3	1.0	1.0	2,3	1.3	1.1	4.5	2.3	3.3	1.0	0.5	6.8
Imidacloprid	12.3	8.5	2.0	6.0	3.5	3.8	6.0	5.8	4.4	7.0	4.8	4.8	4.0	1.8	4.8
T. vogelii	8.5	8.5	1.8	5.8	1.0	4.5	5.8	6.3	5.5	5.8	4.3	0.8	5.0	1.8	3.0
Control	12.5	13.0	3.8	11.3	8.0	5.5	11.3	11.8	6.1	9.3	9.5	8.0	5.5	4.0	5.3
Mean	10.4	2.3	2.3	7.0	3.5	3.9	7.0	7.1	4.4	6.8	5.5	4.2	4.0	2.3	5.4
LSD (0.05)	**4.1**	**5.1**	**1.6**	**3.3**	**3.9**	**2.6**	**3.3**	**5.6**	**NS**	**2.6**	**3.7**	**NS**	**3.2**	**1.8**	**NS**

A = Pumpkin beetle (*Aulacophora foveicollis*)
B = Melon Aphids (*Aphis gossypii*)
C = Cucumber beetle (*Diabrotica undecimpunctata*)

The mean effects of the treatments on the mortality count of the insect pests on treated cucumber over a period of 8 weeks are presented in Table 4. Results obtained from the analysis of variance showed that there were significant differences (P<0.05) among the treatments in all the weeks, the mortality count recorded in the control plots (4WAP - 1.5, 5WAP - 1.8, 6WAP - 2.0, 7WAP - 2.3, 8WAP - 2.7) were significantly lower when compared to other plots. However, the synthetic insecticide (Cypermethrin) recorded the highest mortality count (4WAP - 6.0, 5WAP - 7.2, 6WAP - 8.1, 7WAP - 9.0, 8WAP - 9.9) at each weekly interval. This showed that the plots treated with Cypermethrin recorded significantly (P<0.05) the highest mortality count, while there was no significant difference between the plant extract, Imidacloprid and Lambdacyhalothrin.

Table 4: Mean mortality count of the major insect pests attacking cucumber in the farm due to the treatments for 8weeks.

Treatments	**4 WAP**	**5 WAP**	**6 WAP**	**7 WAP**	**8 WAP**
Lambdacyhalothrin	4.0	4.8	5.4	6.0	7.5
Cypermethrin	6.0	7.2	8.1	9.0	9.9
Imidacloprid	4.0	4.8	5.4	6.0	7.2
Tephrosia vogelii	3.5	4.2	4.7	5.3	6.3
Control	1.5	1.8	2.0	2.3	2.7
Mean	**3.8**	**4.6**	**5.1**	**5.7**	**6.7**
LSD (0.05)	2.6	3.1	3.5	3.8	NS

*WAP = Weeks After Planting

Results presented in Table 5 showed the level of leaf damage reduction due to the application of extracts of *Tephrosia vogelii* and the synthetic insecticides. The results showed that the highest number of leaf defoliation was recorded in the control plots (4WAP - 10.0, 5WAP -13.8, 6WAP -16.0, 7WAP - 18.0, 8WAP - 21.8) while the least number of leaf defoliation was recorded in the plots treated with Cypermethrin (4WAP - 4.3, 5WAP - 7.0, 6WAP - 7.3, 8WAP - 10.3), respectively. Number of leaf defoliation of (6.3 - 4WAP, 9.0 - 5WAP, 11.0 - 6WAP, 15.0 - 7WAP, 17.5 - 8WAP) were recorded on the treated crop following exposure to extract of *T. vogelii* sprays. However there was no significant difference between the effects of the plant extract (*T. vogelii*) and the synthetic insecticides.

Table 5: Mean leaf damage reduction on the test crop due to application of leaf extract of *Tephrosia vogelii* and some synthetic insecticides

Treatments	**4 WAP**	**5 WAP**	**6 WAP**	**7 WAP**	**8 WAP**
Lambdacyhalothrin	5.0	9.8	9.8	11.3	11.5
Cypermethrin	4.3	7.0	7.3	8.3	10.3
Imidacloprid	6.0	10.3	11.0	15.0	17.5
Tephrosia vogelii	6.3	9.0	11.5	13.8	15.0
Control	10.0	13.8	16.0	18.0	21.8
Mean	6.3	10.0	11.1	13.3	15.2
L.S.D$_{(0.05)}$	2.7	3.9	2.3	3.0	3.5

*WAP = Weeks After Planting

Table 6 shows the effect of extract of *T.vogelii* and some synthetic insecticides on flower damage over a period of 7 weeks post treatment of the test crop. Results showed that the application of treatment reduced the number of flowers damaged when compared to the control (5WAP (2.8), 6WAP (1.8), 7WAP (1.8) which has the highest number of flower damaged. The flower damage was observed to increase at 5WAP and decline at 6WAP in plots treated with Cypermethrin (5WAP - (1.0), 6WAP – (0.5) and *Tephrosia vogelii* (5WAP- (1.5), 6WAP- (0.3) due to the application of treatment and fruits set. There was no significant difference observed between the synthetic insecticides and the plant extract.

Table 6: Mean cucumber flower damage reduction due to treatment with some synthetic insecticides and leaf extract of *Tephrosia vogelii*.

Treatments	5 WAP	6 WAP	7 WAP
Lambdacyhalothrin	1.8	1.5	1.3
Cypermethrin	1.0	0.5	1.3
Imidacloprid	1.0	1.8	1.5
Tephrosia ***vogelii***	1.5	0.3	1.8
Control	2.8	1.8	1.8
Mean	1.6	1.2	1.5
LSD (0.05)	NS	NS	NS

*WAP = Weeks After Planting

In terms of the mean fruit yield from the test cucumber crop, results obtained from the study are presented in Fig. 3. The results showed that the plots treated with Cypermethrin which recorded 12,000 (kg/ha) significantly (P<0.05) gave the highest fruit yield per hectare while the control (untreated) plots gave the lowest fruit yield (3000 kg/ha). This was because the treatments effectively reduced the incidence (mean insect population) and attacks (severity) of the insect pests on the treated crop. However there was no significant difference in fruit yield per hectare in the plots treated with synthetic insecticides and plant extract.

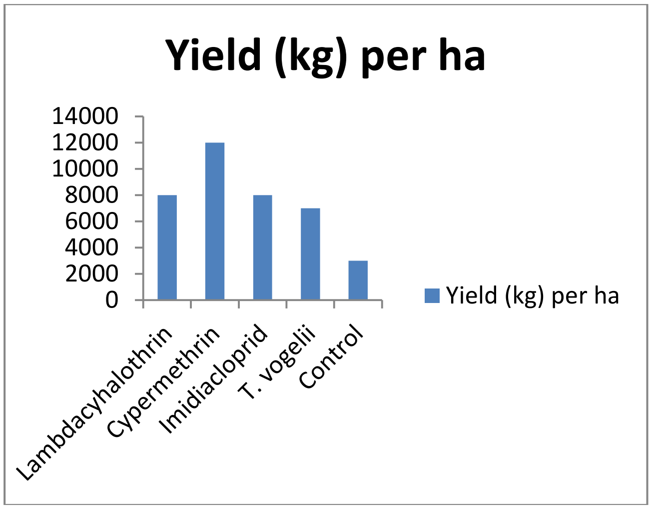

Figure 3: Fruit yield (kg) per hectare of the treated cucumber plants in the field

DISCUSSION

Generally, findings in this study showed that irrespective of time of observation and collection of data, the mean insect population on the control (untreated) experimental plots had the highest (P≤0.05) number of insect pests attack compared to those treated with the synthetic insecticides and extract of *T. vogelii*. It also depicted that the plots treated with Cypermethrin (synthetic) recorded the highest mortality of the test pest species, followed by those treated with extracts of *T. vogelii* which effectively and substantially controlled the insect pests of cucumber.

Extracts of spice and other medicinal higher plants have been reported to exhibit appreciable levels of insect killing activities (Amuji *et al.,* 2012). Many workers have reported that extracts of *T. vogelii* exhibited strong insecticidal activity against several insect pests of agricultural crops (Adebayo 2003; Babarinde *et al.,* 2001). According to Koona and Dorn (2005), powdered hexane extracts of dried leaves of *T. vogelii* effectively protected legumes seeds in storage against attacks from bruchids and reduced the damage caused by *Callosobrunchus maculatus. C. chinensis* and *Acanthoscelides obstectus* on the treated seeds by 7.1% compared with 99.8% recorded on grains in the control experiment. Similarly, a dose-dependent percentage reduction of 45-64 on populations of P*. coniferea, D. undecimpucteta* and *B. curcubitacae* on treated water melon has been reported. Also in another field trial, Olaniran and Adebayo (2013) reported that up to 51-80% reduction of populations of *Z. variegatus* and *Podagrica spp*. on roselle (Zobo plant) treated with extracts of *T. vogelii*. Findings in this study where the mean population of the three assayed insect pests were effectively reduced and statistically (P<0.05) high numbers of these cucumber decimating insects killed by the extracts are in conformity with the reports of the various workers above.

In this study also, statistically (P<0.05) higher yield (8000-12000 kg/ha) and yield parameters were recorded on the treated cucumber crop compared to plants in the control group (3000 kg/ha). These are in strong agreement with the reports of Olaniran and Adebayo (2013) who found that treatment of roselle (*Zobo* plant) with extracts of *T. vogelii* and *Azadirachta indica* either singly or in combination; in addition to reducing the populations of *Podagrica spp* and *Z. variegatus* significantly increased the yield from the treated crop. Secondary metabolites of tropical higher plants are reported as their arsenal against pests and pathogens (Enyiukwu *et al*., 2014). The ability of *T. vogelii* extract to stem the population and attacks of the assayed insect pests and consequently increased the mean fruit yield of the treated cucumber may have been due to its rich content of water soluble secondary metabolites such as rotenone, rotenolone, rotenoids such as tephrosin and deguelin or some solvent soluble fatty acids reported to possess insecticidal attributes (Denza *et al*., 2009; Enyiukwu *et al*., 2016; and Chukwu, 2018).

However, the low mean yield recorded on the plants in the untreated control plots could be attributed to the attacks from high levels of the populations of the 3 insect pest species on the treated cucumber which led to increased loss of foliage, larger disruption of meristematic areas and/or translocation of products of photosynthesis of the affected plants thereby leading to inhibition of rapid cell multiplication, reducing photosynthesis and energy formation (Eifedeyi and Remison, 2010).

With the exception of Cypermethrin, all the synthetic treatments used in this study are pyrethroids and neo-nicotinoids known to be easily degraded when exposed to heat and UV-light (Brown, 2006, Enyiukwu *et al*., 2014). Therefore the higher percentage mortality of the insect pests' populations and consequently higher significant fruit yield recorded on plots treated with cypermethrin compared to those exposed to the extract of *T. vogelii* and the synthetic copies of pyrethrin and nicotine may have been informed by the longer persistence of cypermethrin on the treated cucumber crop and the environment than the other treatments.

CONCLUSION

In conclusion therefore, leaf extract of *T. vogelii* could be used as an effective plant-derived pesticide for controlling the insect pests of cucumber (*C. sativus* L.) for increased production of the crop in low input agricultural systems of sub-Saharan Africa.

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