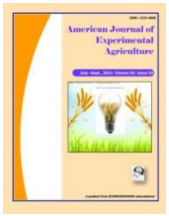

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Comparative Performance of Pyrethrum [*Chrysanthemum cinerariifolium* Treviranus (Vis.)] Extract and Cypermethrin on Some Field Insect Pests of Groundnut (*Arachis hypogaea* L.) in Southeastern Nigeria

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Authors' contributions

This research was carried out collaboratively by all authors. Author FOO designed the study and wrote the first protocol. All the authors were fully involved in the experiment; field work, laboratory extraction, statistical analysis, managing the literature search and editing the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Study to evaluate the insecticidal efficacy of pyrethrum, *Chrysanthemum cinerariifolium,* relative to a synthetic insecticide (Cypermethrin 10 E. C) in the control of some field pests of groundnut was carried out at the Teaching and Research Farm, School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, southeastern Nigeria, from March to November, 2012. The experiment was laid out in a 2 x 4 factorial arrangement fitted into a Randomized Complete Block Design replicated three times. Groundnut seed variety, ICGV-IS 96894 (ICRISAT) was subjected to germination test to ensure viability. Seeds were planted at a spacing of 30 cm x 15 cm (220,000 plants/ha) on 24 (1 m^2) beds with 1 m between furrows. Pyrethrum was extracted through a simple replicable procedure and tested at four rates (0.00, 0.25, 0.50, 0.75 g/100 ml of water). Cypermethrin 10 EC was tested at 0.00, 0.50, 1.00 and1.50 ml/100 ml of water. Insecticides application, pest sampling and leaf damage assessments were carried out at 4, 6 and 8 weeks after planting (WAP). Yield measurement parameters (seed weight, shell weights and pod density) were assessed. Major arthropod pests identified were; *Macrotermes bellicosus* Smeathman, *Peridontopyge* spp., *Helotrichia serrata* Fabricius, and *Oedaleus nigeriensis* Uvarov. Cypermethrin and pyrethrum applications reduced pest incidence (3.25, 2.50, 2.10 insects) and (4.09, 3.62, 3.42 insects), respectively, when compared with unsprayed plots (6.35, 6.16, 6.20 insects) at 4, 6 and 8 WAP. Insecticide type had no significant effect on the population of majority of sampled pests. Sprayed plots had less damaged leaves - 2.80 (cypermethrin) and 2.83 (pyrethrum) as against 4.52 leaves in unsprayed plots at 8 WAP. Sprayed plots also had increased fresh pod weight (0.61, 0.52 kg in cypermethrin and pyrethrum sprayed plots, respectively) as against 0.14 kg in unsprayed plots. Seed weights (0.26, 0.22 kg in cypermethrin and pymethrum sprayed plots, respectively) were significantly distinct from the control (0.06 kg).There were no significant differences (P = .05) in the dry pod or shell weights based on insecticide types. The efficacy of the insecticides was dose related as higher rates gave better performances. Pyrethrum compared favourably with cypermethrin in controlling the field insect pests of groundnut and could serve as alternative to synthetic pesticides in the management of these pests in southeastern Nigeria.

Keywords: Arachis hypogaea; cypermethrin; *Holotrichia serrata; Macrotermes bellicosus; Oedaleus nigeriensis; Peridontopyge spp; pyrethrum extract.*

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.), also called peanut, is a species in the legume or bean family, *Fabaceae*. It is said to have originated from South America, in the region of Bolivia, Argentina and Brazil and is one of the most popular commercial plant groups in West Africa, especially in Northern Nigeria (latitude 10°N). China is the largest producer of groundnut in the world followed by India, USA, Nigeria and Indonesia. In sub-Saharan Africa, groundnut is the 5th most widely grown crop, closely trailing behind maize, sorghum, millet and cassava. Nigeria is the largest producer in Africa, producing 30% of the Continent's total, followed by Senegal and Sudan (each with about 8%), and Ghana and Chad with about 5% each [1].

Groundnut, the third major oilseed of the world, next to soybean and cotton [2], provides a vital source of cash income and nutritious high protein and fatty food. The kernels are eaten raw, roasted, sweetened or processed into peanut butter which is rich in protein and vitamins A and B. They are also consumed as confectionary product. Groundnut oil is edible and is also used in the production of soap, cosmetics, lubricants, olein, stearin and their salts [3]. Groundnuts could prevent child malnutrition and are useful in the treatment of hemophilia, stomatitis and for the prevention of diarrhea. The meal is beneficial for growing children, pregnant women, nursing mothers [4], and is a good source of niacin, which contributes to brain health and blood flow [5].

Some insect pests such as white grubs (*Phyllophaga* spp*),* termites (*Macrotermes bellicosus* Smeathman), gram pod borers (*Helicoverpa armigera* Hubner), groundnut leaf miners (*Aproaerema modicella* Deventer), Aphids (*Aphis craccivora* Koch.), etc attack the plant and this may result to low yield, reduction in pod size, poor yield quality, and loss in market value [6-8].

The damages caused by these field pests have been mainly controlled with organochlorines

(DDT, Thiodanetc); organophosphates (Monocrotophos, Dimethoate, etc); carbamates (Unden, Carbofuran, etc) and, more recently, pyrethroids (Permethrin, Cypermethrin, Imidacloprid, etc) [9-11].

Despite the efficacy of these synthetic insecticides, several adverse effects have been reportedly resulting from their misuse. These include; human poisonings, destruction of natural enemies, insecticide resistance, crop pollination problem due to honey bee losses, domestic animal poisonings, contaminated livestock products, fish and wildlife losses [12]; contamination of underground water and rivers, high persistence of the compounds, resurgence and genetic resistance of pests, adverse affect on non–target beneficial pests [13], etc. Cypermethrin 10 EC, used as a standard in this study, is a synthetic insecticide of choice in Nigeria. It is used in large scale commercial agricultural application as well as in consumer products for domestic purposes [14].

The ever- increasing problems associated with synthetic insecticides have synergized keen interest in the use of plant products as bioinsecticides. Botanicals are relatively safe, non-persistent, eco-friendlier and readily available [15]. Pyrethrum, a bioinsecticide, processed from the dried flower heads of *Chrysanthemum cinerariifolium* is said to have low mammalian toxicity, broad spectrum activity, is environmentally friendly and fast acting [16, 17]. Despite the worldwide acclaim for this plant, its cultivation and use in Nigeria is very limited.

Due to a dearth of information on the field pests of *A. hypogaea* in the Owerri west ecological zone of southeastern Nigeria, there is a compelling need to ascertain these field pests at different growth stages of the crop. In consideration of the debilitating effects of synthetic chemicals, it is also pertinent to screen biopesticides, especially pyrethrum, which would not be harmful to the farmers or end users of the treated produce.

2. MATERIALS AND METHODS

2.1 Site Location

The experiment was carried out at the Teaching and Research Farm of the Federal University of Technology, Owerri, Nigeria, from March to November, 2012. The area is between latitude 5°25' N and longitude 7°2' E in the Tropical Rainforest Zone of southeastern Nigeria. The experiment was rain-fed.

2.2 Collection and Preparation of Test Materials

Seeds of *Arachis hypogaea*, SAMNUT 23, were sourced from the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. This variety is also known as ICGV-IS 96894 under International Crops Research Centre for Semi-Arid Tropics (ICRISAT) nomenclature [18]. The variety is early maturing (90-100 days), has red seed colour with potential pod yield of 2,000kg/ha [19]. Pyrethrum, from the flower head of the plant, *Chrysanthemum cinerarifolium* Treviranus, was collected from a farm in Mawingo, Central Kenya. It was shade dried to prevent loss of active principle by sunlight, crushed into powdery form with pestle and mortar and weighed out at 0.25, 0.50 and 0.75 g. The weighed samples were mixed with 100 ml (respectively) of water in a container and allowed to settle for three hours. The solution was filtered through a fine muslin cloth and the active principle recovered and applied immediately.

Cypermethrin 10 E. C. was purchased from an agrochemical store in Owerri, Imo Sate, Nigeria. The insecticide was measured out with a syringe at 0.5, 1.0 and 1.5 ml, and mixed with 100 ml of water. Approximate recommended rate is 1.0 ml Cypermethrin/100 ml of water. The procedure was repeated on each spraying day.

2.3 Germination Test

Germination test was carried out by random selection of 30 wholesome seeds from the groundnut seeds kept in a bag. Ten seeds each were placed inside 3 Petri-dishes that contained absorbent Whatman's No. 44 filter papers moistened with water. Daily checks were carried out for 10 days and germination rate recorded from the 4^{th} day.

2.4 Land Preparation

The site was cleared, pegged and beds made. Each bed had a dimension of 1m x 1m with furrows of 1 m in between. Altogether, the field contained a total of 24 beds.

2.5 Manure Application

Organic manure (cured poultry droppings) was basally applied on each of the beds and was

incorporated into the soil at a rate of 2 kg per bed before planting.

2.6 Sowing and Weeding

The seeds were planted at a spacing of 30 cm x 15 cm. Two seeds were planted per hole, which was rogued down to a plant/hole after germination. This gave a total of 22.0 plants per bed and 220,000 plants per hectare.

Weeding was done at 3 WAP and later at intervals with the use of hoes and hand pulling (rogueing).

2.7 Field Application of Plant Extract and Cypermethrin 10 EC

The plant extracts and Cypermethrin 10 EC, in water, were foliar- sprayed using a 250 ml hand sprayer and were applied thrice at weekly intervals.

2.8 Pest Sampling

Insect pests were collected with a sweep net, cellophane bags and sample bottles. Others were hand-picked using hand gloves and plastic forceps. Samplings were carried out at 4 WAP (onset of flowering), 6 WAP (initiation of pegging, one to 2 weeks after fertilization) and 8 WAP (during pod development). These were done a day before and 2 days after each spray regime and twice during the pod and seed development stages. Collected insects were stored with chloroform and later identified in the laboratory.

2.9 Leaf Damage Assessment

Leaf damage assessment was done through visual recording of the number of leaves damaged by insects. It was carried out by counting the number of leaves damaged by insects on 6 selected and tagged stands. Damage assessments were recorded at 4, 6 and 8 weeks after planting (WAP).

2.10 Yield Measurement

Yield measurements were achieved through the following parameters:

2.10.1 Seed weight

The seed weight was measured after the pods from each bed were harvested and the seeds from dehisced pods weighed, using Camry Emperor weighing balance (model J1111427541) in kilogram (kg).

2.10.2 Shell weight

The shell weight measurement was carried out after drying under shade.

2.10.3 Pod density

The pod density was assessed twice. First, immediately after harvest, the pods from each bed were washed to remove soil and then weighed in the field. The second measurement was taken after drying, under room temperature in the laboratory.

2.11 Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) for Randomized Complete Block Design (RCBD) in a 2 x 4 factorial arrangement replicated three times. GENSAT Computer Software for data analysis was used and mean separation procedure was as described by [20] using Least Significant Difference at P = .05 level of significance.

3. RESULTS AND DISCUSSION

The major arthropod pests identified were termites, *Macrotermes bellicosus* Smeathman, 1781 (*Blattodea*: *Termitidae* -Macrotermitinae); millipedes, *Peridontopyge* spp. (*Diplopoda*: *Odontopygidae*); white grub larvae, *Helotrichia serrata* Fabricius, 1781 (*Coleoptera*: *Scarabaeidae*) and Nigerian grasshoppers, *Oedaleus nigeriensis* Uvarov, 1926 (*Orthoptera*: *Acrididae*) (Table 1). Other arthropod pest incidences were occasional and insignificant to report. The identified pests were in consonance with earlier works which implicated termites (*Odontotermes* spp.), white grubs (*Holotrichia consanguinea, H. serata*) and millipedes (*Peridontopyge* spp.) as the major, widespread, economic pests of groundnut in Sub-Saharan Africa [6-8]. Other coleopteran pests such as wireworms (*Agriotes lineatus*) and false wireworms (*Gerocephalum* spp.) have been reported to be of occasional importance [21].

The effect of pyrethrum, cypermethrin and their application rates on the field pests and leaf damage of groundnut plants at different growth stages are also as contained in Table 1. Statistical analysis of the main effect showed that

cypermethrin and pyrethrum applications reduced total pest incidence (3.25, 2.50, 2.10 insects) and (4.09, 3.62, 3.42 insects), respectively, when compared with unsprayed plots (6.35, 6.16, 6.20 insects) at 4, 6 and 8 WAP. Except for *O. nigeriensis* (1.75 and 0.50) and *M. bellicosus* (0.50 and 1.25) at 4 and 8 WAP, respectively, insecticide type had no significant effect on the population of majority of sampled pests. Sprayed plots had less damaged leaves - 2.37, 2.73, 2.80 (average, 2.63) (cypermethrin) and 2.58, 2.90, 2.83 (average, 2.77)(pyrethrum) as against 3.17, 3.60, 4.52 (average, 3.76)(control) in unsprayed plots at 4, 6 and 8 WAP, respectively. Insecticide type also had no significant effect on leaf damage control.

The second rate gave the second best protection of groundnut against *M. bellicosus* (0.17, 0.50 and 0.50 insects) at 4, 6 and 8 WAP, respectively. The third (highest) rate recorded the lowest number (0.00, 0.17 and 0.50) of sampled *M. bellicosus* across the growth stages, respectively. Expectedly, the control plots were the most infested by the termites at all the stages. The various application rates followed the same efficacy trend against other sampled field pests.

Leaf damage result showed that the various rates of application significantly (P = .05) reduced the number of damaged leaves sampled across the growth stages. Leaves from groundnut plants sprayed with the third (highest) rate were the least damaged (1.82, 2.10 and 2.23 leaves) at 4, 6 and 8 WAP, respectively. Comparatively, the control plots recorded the highest (3.17, 3.60 and 4.52) number of damaged leaves, respectively. It could be reasonably inferred that cypermethrin and pyrethrum had basically the same statistical effect on pest incidence and leaf damage of the plant.

The interactive effect of application rate with insecticide type is shown in Table 2. There was only a significant interaction on the number of sampled *O. nigeriensis* all through the plant's growth stages. Applying cypermethrin at the third rate (1.50 ml/ 100 ml) recorded the lowest (0.33, 0.00 and 0.67) number of sampled target pests at 4, 6, and 8 WAP, respectively.

Table 3 records the effect of application rates and insecticide types on fresh pod, dry pod, seed and shell weights. The sprayed plots had increased fresh pod weight (0.61, 0.52 kg in cypermethrin and pyrethrum sprayed plots, respectively) as against 0.14 kg in unsprayed plots. Seed weights (0.26, 0.22 kg in cypermethrin and pyrethrum sprayed plots, respectively), were significantly distinct from the control (0.06 kg).There were no significant differences (P = .05) recorded in the dry pod or shell weights based on insecticide types.

There were significant (P= .05) differences with the various application rates on fresh pod and seed weights, respectively. The third rate gave the highest (0.57 and 0.30 kg) fresh pod and seed weights, respectively. The second rate was next with 0.56 and 0.27 kg fresh pod and seed weights, respectively. The efficacy of the insecticides was dose related as higher rates gave better performances.

Interaction effects of application rate with insecticide type on fresh pod, dry pod, seed and shell weights were not statistically significant (Table 4). However, the highest rate of cypermethrin (1.50 ml/ 100 ml) accounted for the highest fresh pod weight (0.58 kg), dry pod weight (0.47 kg), seed weight (0.32 kg) and shell weight (0.17 kg). These were, however, not statistically different from the effect of pyrethrum at the highest rate (0.75 g/ 100 ml).

Though cypermethrin performed marginally better than pyrethrum in some parameters, both treatments, however, showed no statistically significant differences (P = .05) in most parameters studied.

The effectiveness of cypermethrin in the control of insect pests of cotton, fruits, vegetable crops and as an indoor insecticide has been noted [22]. It has been reported that cypermethrin 10% EC, when sprayed at 10% w/v concentration, controlled the post flowering insect pests and increased pod and seed weight/plant of cowpea [23] and in conjuction with dimethoate gave the highest economic cowpea grain yield [24].

Table 1. Main effects of application rate and insecticide type on target field pests of groundnut and leaf damage at different growth stages

Treatments	4 WAP						6 WAP						8 WAP					
Application Rates	**Mb**	**Ps**	**Hs**	**On**	**Total**	**LD**	**Mb**	**Ps**	**Hs**	**On**	**Total**	**LD**	**Mb**	**Ps**	**Hs**	**On**	**Total**	**LD**
Control	1.17	1.17	1.17	2.84	6.35	3.17	1.50	0.83	1.33	2.50	6.16	3.60	1.83	1.00	1.00	2.37	6.20	4.52
First rate	0.33	0.50	0.50	2.17	3.50	2.57	0.83	0.33	0.33	1.60	3.09	2.88	0.67	0.17	0.33	1.34	2.51	302
Second rate	0.17	0.50	0.50	1.84	3.01	2.33	0.50	0.33	0.50	0.84	2.17	2.67	0.50	0.00	0.30	0.67	1.47	2.77
Third rate	0.00	0.33	0.33	1.17	1.83	1.82	0.17	0.00	0.00	0.50	0.67	2.10	0.50	0.00	0.17	0.17	0.84	2.23
LSD 0.05	**0.816**	**NS**	**NS**	**0.204**		**0.396**	**0.758**	**NS**	**0.532**	**0.304**		**0.359**	**0.876**	**NS**	**NS**	**0.731**		**0.764**
Insecticide Type																		
Cypermethrin	0.42	0.58	0.50	1.75	3.25	2.37	0.58	0.33	0.42	1.17	2.50	2.73	0.50	0.25	0.42	0.93	2.10	2.80
Pyrethrum	0.42	0.67	0.75	2.25	4.09	2.58	0.98	0.42	0.67	1.55	3.62	2.90	1.25	0.33	0.50	1.34	3.42	2.83
LSD 0.05	**NS**	**NS**	**NS**	**0.123**		**NS**	**NS**	**NS**	**NS**	**NS**		**NS**	**0.619**	**NS**	**NS**	**NS**		**NS**

Key: *NS: Non Significant; Mb: Macrotermes bellicosus (Termites); Ps: Peridontopyge* spp *(Millipedes)*
Hs: Helotrichia serrata (White grub larvae); On: Oedaleus nigeriensis (Nigerian grasshoppers).
LD: Leaf damage

Rates: *Pyrethrum Extract: Rate 1 = 0.25 g/100 ml of water; Rate 2 = 0.50 g/100 ml of water;*
Rate 3 = 0.75 g/100 ml of water;
Cypermethrin 10 EC: Rate 1 = 0.50 Ml/100 Ml of Water; Rate 2 = 1.00 Ml/100 Ml Of Water;
Rate 3 = 1.50 Ml/100 Ml of Water

Table 2. Interactive effects of application rate with insecticide type on target field pests of groundnut and leaf damage at different growth stage

Treatments		4 WAP						6 WAP						8 WAP					
Application Rates	**Insecticide Type**	**Mb**	**Ps**	**Hs**	**On**	**Total**	**LD**	**Mb**	**Ps**	**Hs**	**On**	**Total**	**LD**	**Mb**	**Ps**	**Hs**	**On**	**Total**	**LD**
Control	CYP	1.33	1.33	1.00	2.67	6.33	3.10	1.33	0.67	1.33	2.33	5.66	3.50	1.00	1.00	1.00	2.40	5.40	4.30
	PYM	1.00	1.00	1.33	3.00	6.33	3.23	1.67	1.00	1.67	2.67	7.01	3.67	2.67	1.00	1.00	2.34	7.01	4.73
First rate	CYP	0.00	0.33	0.33	2.00	2.66	2.47	0.67	0.33	0.50	1.33	2.83	2.83	0.33	0.00	0.33	1.00	1.66	2.93
	PYM	0.33	0.67	0.67	2.33	4.00	2.67	1.00	0.33	0.67	1.87	3.87	2.97	1.00	0.33	0.33	1.67	2.33	3.10
Second rate	CYP	0.00	0.33	0.33	1.67	2.33	2.27	0.33	0.33	0.33	0.33	0.67	2.67	0.33	0.00	0.33	0.33	0.99	2.53
	PYM	0.33	0.67	0.67	2.00	3.67	2.40	0.67	0.33	0.33	1.00	2.33	2.73	0.67	0.00	0.33	1.00	2.00	3.00
Third rate	CYP	0.00	0.33	0.33	0.67	1.33	1.63	0.00	0.00	0.00	0.33	0.33	2.10	0.33	0.00	0.00	0.00	0.33	1.77
	PYM	0.00	0.33	0.33	1.67	2.33	2.00	0.33	0.00	0.00	0.67	1.00	2.23	0.67	0.00	0.33	0.33	1.33	2.70
LSD 0.05		**NS**	**NS**	**NS**	**0.311**		**NS**	**NS**	**NS**	**NS**	**0.424**		**NS**	**NS**	**NS**	**NS**	**NS**	**0.798**		**NS**

Key: *CYP.: Cypermethrin; PYM.: Pyrethrum; NS: Non Significant; Mb: Macrotermes bellicosus (Termites); Ps: Peridontopyge* spp *(Millipedes); Hs: Helotrichia serrata (White grub larvae); On: Oedaleus nigeriensis (Nigerian grasshoppers); LD: Leaf damage*

Rates: *Pyrethrum Extract:* ***Rate 1*** *= 0.25 g/100 ml of water;* ***Rate 2*** *= 0.50 g/100 ml of water;* ***Rate 3*** *= 0.75 g/100 ml of water;*

Cypermethrin 10 EC: ***Rate 1*** *= 0.50 ml/100 ml of water;* ***Rate 2*** *= 1.00 ml/100 ml of water;* ***Rate 3*** *= 1.50 ml/100 ml of water*

Table 3. Main effects of application rate and insecticide type on fresh, dry, seed and shell weights (Kg)

Treatments	Fresh Pod Weight	Dry Pod Weight	Seed Weight	Shell Weight
Application Rates				
Control	0.14	0.31	0.06	0.11
First rate	0.53	0.43	0.23	0.12
Second rate	0.56	0.44	0.27	0.14
Third rate	0.57	0.46	0.30	0.15
LSD 0.05	**0.876**	**NS**	**0.057**	**NS**
Insecticide Type				
Cypermethrin	0.61	0.42	0.26	0.14
Pyrethrum	0.52	0.40	0.22	0.12
LSD 0.05	**0.079**	**NS**	**0.026**	**NS**

Key: *NS: Non Significant*

Table 4. Interactive effects of application rate with insecticide type on fresh, dry, seed and shell weights (Kg)

Treatments		Fresh Pod Weight	Dry Pod Weight	Seed Weight	Shell Weight
Application Rates	**Insecticide Type**				
Control	CYP	0.48	0.32	0.17	0.12
	PYM	0.50	0.33	0.16	0.11
First rate	CYP	0.53	0.43	0.27	0.12
	PYM	0.53	0.42	0.20	0.12
Second rate	CYP	0.57	0.45	0.28	0.15
	PYM	0.55	0.43	0.25	0.12
Third rate	CYP	0.58	0.47	0.32	0.17
	PYM	0.57	0.45	0.28	0.13
LSD 0.05		**NS**	**NS**	**NS**	**NS**

Key*: NS: Non Significant*

The efficacy of the insecticide could be as a result of its action as a stomach and contact poison and its debilitating action on the nervous system [25]. It has also been reported that due to its low vapour pressure (1.3×10^{9} mmHg at 20°C), the insecticide is absorbed as aerosols through stagnant surfaces like soil and foliage which are further exposed to atmospheric oxidation and solar radiation [26]. Though cypermethrin, which contain synthetic pyrethroids, is often dubbed as "safe as chrysanthemum flowers", it should be noted that they are chemically engineered to be more toxic with longer breakdown times, often formulated with synergists for increased potency, thereby compromising the human body's ability to detoxify the pesticide [27]. Cypermethrin could, therefore, cause debilitating health and environmental hazards [28, 29].

The performance of pyrethrum extracts in the experiment is commendable when related to the crude extraction method employed. Its action has been attributed to the presence of pyrethrin as an active insecticidal component [30]. Pyrethrin is reported to attack the nervous systems of all insects, and when not present in lethal doses, could act as a repellent and 'exciter' – increasing their activity and ability to 'flush' out insects from their hiding places thereby increasing their exposure with the insecticide [17].

Earlier report [31] has implicated six biologically active chemicals in pyrethrin: Pyrethrin I ($C_{21}H_{28}O_3$), Pyrethrin II ($C_{22}H_{28}O_5$), Cinerin I ($C_{20}H_{28}O_3$), Cinerin II ($C_{21}H_{28}O_5$), Jasmolin I ($C_{21}H_{30}O_3$) and Jasmolin II ($C_{22}H_{30}O_5$). Pyrethrin I, cinerin I, and jasmolin I are esters of chrysanthemic acid whereas pyrethrin II, cinerin II, and jasmolin II are esters of pyrethric acid. Chrysanthemic and pyrethric acids combine with one of three alcohols (pyrethrolone, cinerolone or jasmololone) to form the respective six active ingredients [32]. These acids are strongly lipophilic and rapidly penetrate many insects and paralyze their nervous system [33] and exert quick knockdown effects on a wide range of insect pests, causing paralysis within a few minutes and acting as contact poison that affects their central nervous system by blocking their nervous function [34].

Later findings by [35] showed that apart from pyrethrin, glandular trichomes are found in pyrethrum flower-head achenes and leaves. These trichomes are reportedly filled with many compounds among which sesquiterpene lactones (STLs) are the major constituent Pyrethrosin has earlier been established [36, 37] as the major isolate of STL which exhibits several biological properties. These isolates are insecticidal [38], cytotoxic [39], antibacterial [40], antifungal [41] and has root growth inhibitory activity [37]. They are also reported to have antifeedant activity against herbivores and are fungistatic against seedling-specific pyrethrum pathogens [35].

Pyrethrum STLs have, however been shown to cause allergic reactions [42]. This drawback has been ameliorated by improved refining techniques that yield pyrethrin oil preparations containing only trace amounts of STLs which no longer cause dermatitis [43].

Despite its efficacy, the natural pyrethrin insecticides have the desirable environmental properties of being both non-toxic to mammals and non-persistent [44].

4. CONCLUSION

The efficacy of pyrethrum is statistically comparable to cypermethrin in its ability to control the field insect pests of groundnut and could serve as alternative to synthetic pesticides in the management of these pests in southeastern Nigeria.

The use of the bioinsecticide could assist in arresting the prevailing dumping of thousands of tons of poisonous pesticides on agricultural soils. It is recommended that the potential of pyrethrum extract as a protectant for field crops and its cultivation in Nigeria be further explored.

Raising varieties and clones, with high pyrethrum content for the purpose, should be looked into, as the potency is dependent on content.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Harvest Choicein Science. Groundnut; 2010.
Available:http://harvestchoice.org/commodities/groundnut
2. FAO. Food and Agricultural Organisation of the United Nations. FAO Food outlook; 1990.
Available:www.hort.purdue.edu/../peanut.html
3. Himal J. Economic importance of groundnut oilseed crop. Oilseed Crop Groundnut India Meghmani Organics Limited, Ahmedabad. 2009a;14:12.
Available:http://agropedia.iitk.ac.in/?q=content/economic-importance-groundnut
4. Kenny A, Finn K. Groundnuts (*Arachis hypogea*), women and development: Impact on nutrition and women's roles in West Africa; 2004.
Available:http://forest.mtu.edu/pcforestry/resources/studentprojects/groundnut.html
Anonymous. Peanut as the world healthiest food; 2007.
Available:http://www.en.wikipedia.org/wiki/peanut
5. Johnson RA, Gumel MH. Termite damage and crop loss studies in Nigeria – the incidence of termite scarified groundnut pods and market samples. Tropical Pest Management. 1981;27: 343-350.
6. Johnson RA, Lamb RW, Wood TG. Termite damage and crop loss studies – a survey of damage to groundnut. Tropical Pest Management. 1981;27: 325-342.
7. Lynch RE, Ouedrago AP, Dicko I. Insect damage to groundnut in semi-arid tropical Africa. In Agrometeorology of Groundnut. Proceedings of an International Symposium, 21-26 August, ICRISAT Sahelian Centre, Niamey, Niger. Patancheru, A. P. 502 324, ICRISAT, India. 1986;175-183.
8. Jat MK, Tetarwal AS. Pests of groundnut and its management. Krishisewa Agriculture Information Hub; 2014.
Available:http://www.krishisewa.com/cms/disease-management/234-groundnut-pests.html
9. Jasani H. Insect Pest Management in Groundnut. Agropedia; 2009.

Available:http://agropedia.iitk.ac.in/content/insect-pest-management groundnut
10. McGill NG, Bade GS, Vitelli RA, Allsopp PG. Imidacloprid can reduce the impact of the White grub *Antirogus parvule* on sugar cane. Crop Protection. 2003;22: 1169-176.
11. Pimentel D, Andow D, Dyson-Hudson K, Gallahan D, Jacobson S, Irish MK, Moss A, Schreiner1, Shepard M, Thompson T, Vinzant B. Environmental and Social Costs of Pesticides: A preliminary assessment. Oikos. 1980;34:126-140.
12. Grzywacz D, Leavett R. Biopesticides and their role in modern pest management in West Africa. Natural Research Institute/University of Greenwich Collaboration; 2012.
Available:http://www.nri.org/news/archive/2012/20120413-biopesticides.htm
13. Ayoola SO, Ajani EK. Histopathological Effects of Cypermethrin on Juvenile African Catfish (*Clarias gariepinus*). World Journal of Biological Research. 2008;001(2)2:1-14.
14. Isman MB. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Ann. Rev. Entomol. 2006;51:45–66.
15. Dayan FE, Cantrell CL, Duke SO. Natural products in crop protection. Bioorganic & Medicinal Chem. 2009; 17:4022–4034.
16. Pavela R. Effectiveness of some botanical insecticides against *Spodoptera Littoralis* Boisduvala (Lepidoptera: Noctudiae), *Myzus persicae* Sulzer (*Hemiptera: Aphididae*) and *Tetranychus urticae* Koch (*Acari*: *Tetranychidae*). Plant Protect. Sci. 2009;45:161-167.
17. Ndjeunga J, Ntare BR, Waliyar F, Echekwu CA, Kodio O, Kapran I, Diallo AT, Amadou A, Bissala HY, Da Sylva A. Early adoption of modern groundnut varieties in West Africa. Working Paper Series No. 24. Sahelian Centre, BP 12404 Niamey, Niger. International Crops Research Institute for the Semi-Arid Tropics. Patancheru, Andhra Pradesh, India. 2008;62.
Available: http://oar.icrisat.org/2360/
18. ICRISAT. International Crops Research Institute for the Semi-Arid Tropics. The groundnut seed project. Development of sustainable groundnut seed systems in West Africa: Towards improving the productivity and quality of groundnut; 2003;1.
Available:http://www.icrisat.org/gsp/default.asp
19. Wahua TAT. Applied statistics for scientific studies Africa-link press, Ibadan, Nigeria. 1999;108-248.
20. Umeh VC, Youm O and Waliyar F. Soil pests of Groundnut in Sub-saharan Africa .Intnl. J. Trop. Insect Sci. 2001; 21:23-32.
21. Takahashi N, Mikami M, Matsuda T, Miyamoto J. Photodegradation of the pyrethriod insecticide Cypermethrin in water and on soil surface. J. Pesticide Science. 1985;10:629-642.
22. Degri MM, Maina YT, RichardBI.Effect of Plant Extracts on Post Flowering Insect Pests and Grain Yield of Cowpea (*Vigna unguiculata (*L.) Walp.)) in Maiduguri, Semi Arid Zone of Nigeria. Journal of Biology, Agriculture and Healthcare. 2012;2(3):46-51.
23. Amatobi, CI. Insecticide application for economic production of cowpea grains in the Northern Sudan savannah of Nigeria. International Journal of Pest Management. 1995;41(1):14–18.
24. Jin H, Webster GRB. Persistence, penetration and surface availability of Cypermethrin and its major degradation products in elm bark. J. Agric. Food Chemistry. 1998;46:2851-2857.
25. Bacci E, Calamari D, Gaggiand C, Vighi M. An approach for the prediction of environment distribution and fate of Cypermethrin. Chemosphere. 1987;16: 1373–1380.
26. Beyondpesticides. Pyrethroids/ Pyrethrins. Beyond Pesticides Rating: Toxic. 2014. Available:http://www.beyondpesticides.org/infoservices/pesticidefactsheets/toxic/pyrethroid.php
27. Elbetieha A, Daas SI, Khamas W, Darmani H. Evaluation of the toxic potential of cypermethrin pesticide on some reproductive and fertility parameters in the male rats. Arch. Environ. Contam. Toxicol. 2001;41:522-528.
28. ETN. Extension Toxicology Network. Cypermethrin: Pesticide Information Profiles; 1996.
Available:http://ace.orst.edu/cgi-bin/mfs/01/pips/cypermet.htm
29. Morris SE, Davies NW, Brown PH, Groom T. Effect of drying conditions on pyrethrins content. Industrial Crop Production. 2006;23(1):9-14.
30. Moorman R, Nguyen K. Identification and qualification of the six active compounds in a pyrethrin standard. J. Assoc. Off. Anal. Chem. 1997;65:921-926.

31. Head SW. Composition of pyrethrum extract and analysis of pyrethrins. In: Pyrethrum: The Natural Insecticide. Cadisa JE (ed.). Academic Press. New York, NY. 1973;25-49.
32. Reigart JR, Roberts JR. *Recognition and Management of Pesticide Poisonings*, U.S. Environmental Protection Agency; 1999. 401 M Street SW (7506C), Washington, DC 20460. Available:http://www.epa.gov/pesticides/safety/healthcare/handbook/handbook.pdf
33. Bhat B, Menary R. Pyrethrum production in Australia: its past and present potential. J. Australian Institute of Agric. Sci. 1984;494:189-192.
34. Ramirez AM, Stoopen G, Menzel TR, Gols R, Bouwmeester HJ, Dicke M, Jongsma MA. Bidirectional secretions from glandular trichomes of pyrethrum enable immunization of seedlings. Plant Cell. 2012;10:4252–4265.
35. Doskotch RW, Elferaly FS. Isolation and characterization of (+)-sesamin and beta-cyclopyrethrosin from pyrethrum flowers. Canadian Journal of Chemistry. 1969;47:1139-1146.
36. Sashida Y, Nakata H, Shimomura H, Kagaya M. Sesquiterpene lactones from pyrethrum flowers. Phytochemistry. 1983;22:1219–1222.
37. Mourad LS, Salah OO, Osama S, Amal A. Insecticidal Effect of Chrysanthemum coronarium L. Flowers on the Pest Spodoptera littoralis Boisd and its Parasitoid Microplitis rufiventris Kok. with Identifying the Chemical Composition. Journal of Applied Sciences. 2008;8(10): 1859-1866.
38. Bach SM, Fortuna MA, Attarian R, de Trimarco JT, Catalán CA, Av-Gay Y, Bach H. Antibacterial and cytotoxic activities of the sesquiterpene lactones cnicin and onopordopicrin. Natural Product Communications. 2011;6(2): 163-166.
39. Picman AK, Towers GHN. Anti-bacterial activity of sesquiterpene lactones. Biochemical Systematics and Ecology. 1983;11:321–327.
40. Picman AK. Anti-fungal activity of helenin and isohelenin. Biochemical Systematics and Ecology. 1983;11:183–186.
41. Rickett FE, Tyszkiewicz K, Brown NC. Pyrethrum dermatitis. I. The allergenic properties of various extracts of pyrethrum flowers. Pesticide Science. 1972;3:57–66.
42. Ramirez AM, Saillard N, Yang T, Franssen MCR, Bouwmeester HJ, Maarten A. Jongsma MA. Biosynthesis of Sesquiterpene Lactones in Pyrethrum (*Tanacetum cinerariifolium*). PLoS ONE. 2013;8(5):e65030. DOI:10.1371/journal.pone.0065030.
43. Bullivant MJ, Pattenden G. Photodecomposition of natural pyrethrins and related compounds. Pesticide Science. 1976;7(3):231–35.

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