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Aqueous Extracts from Lantana (*Lantana Camara*) Roots and Leaves can Control Cowpea (*Vigna Uinguculata*) Insect Pests and Improve Grain Yields

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I. Introduction

Cowpea (*Vigna unguiculata* (L) Walp) is a key legume crop, which is one of the cheapest sources of high-quality proteins, vitamins, and minerals for most rural families in Africa. Although cowpea has a high grain yield potential ranging from 1.5-3.0 t/ha, the actual yields in the traditional cropping systems in Africa are consistently low as the range is between 50 and 350 kg/ha (Oyewale *et al.,* 2013). The low yields have been attributed to several biotic and abiotic factors (Kyei-Boahen *et al*., 2017; Peksen, 2007). The biotic factors that cause yield reduction include insect pests, parasitic plants as well as viral, fungal and bacterial diseases while the abiotic factors include poor soil fertility, drought, heat, acidity, and stress due to intercropping with cereals (Amatobi *et al.,* 2005; Singh *et al.,* 2003).

Some of cowpea insect pests of economic importance are aphids *(Aphis craccivora* Koch), foliage beetles *(Ootheca mutabilis)*, flower bud thrips (*Megaluro thrips sjostedti* Tryb), legume pod borer (*Maruca vitrata* Fab) and the sucking bug complex, e.g., *Clavigralla spp*, *Nezeera viridula, Aspavia armigera* (Amatobi *et al*., 2005; Kanteh *et al*., 2014).

There are multiple methods utilized in combating these troublesome pests ranging from synthetic chemical use, biological and cultural control methods (Barzman *et al*., 2015). Although very effective but continuous use of synthetic chemical insecticides can affect the health of humans, contaminate the environment, hurt beneficial insects such as bees earthworms and termites (Baidoo *et al.,* 2017; Tillman and Mulrooney, 2000). Utilization of synthetic pesticides for pest control around the world has caused tremendous damage to the environment, pest resurgence, pest resistance to insecticides and legal effects on non-target organisms (Oyewale *et al*., 2013). These problems brought the idea of botanical insecticides as a promising alternative to insect pest control.

Botanical insecticides are host specific, environmentally friendly, and are more compatible with the environmental components (Isman and Machial, 2006). Thus there is a need to develop cheaper and safer alternatives for insect pest control, including plant-based products (Dayan *et al.,* 2009). Many plants possess chemical substances with a remarkable

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biological activity which provides protection, and resistance against pest and herbivores (War *et al*., 2018).

The aim of this study was, therefore, to investigate the insecticidal activity of *L. camara* leaves and roots applied at different rates in controlling cowpea insect pests (*A. craccivora*, *O. mutabilis,* and *M. vitrata*).

II. Materials and Methods

a) Site description

The research was conducted at Cotton Research Institute, Sanyati District, Mashonaland West Province, Zimbabwe. The area falls under natural farming region 11 b (Mugandani *et al*., 2012). The meteorological data showed that the mean annual rainfall ranges between 800-1000mm with an average maximum temperature of 32.5°C and an average minimum temperature of 18.5°C. The area has sandy clay loamy soils (Mugandani *et al*., 2012).

b) Experimental design and treatment description

The experiment was laid out in a Randomized Complete Block Design (RCBD) with six treatments replicated three times. The treatments are described in Table 1.

Table 1: Description of treatments

Treatment	Description	Spray mixture
1	*L. camara* leaves	50 g/l of water
2	*L. camara* leaves	75 g/l of water
3	*L. camara* roots	50 g/l of water
4	*L. camara* roots	75 g/l of water
5	Uncontrolled treatment	negative control/untreated
6	Dimethoate 40 EC	2.5 ml/l of water/positive control

c) Field operations

Land preparation, basal dressing, and sowing of cowpea

The experimental site was disc plowed and harrowed to produce a fine tilth. Pegging was conducted and the site was divided into three blocks. The blocks were separated by 100 cm pathways. Plots were marked using a hoe, and each plot measured 7.2 m^2 (4 mx1.8 m), 0.7 m alleys between plots were maintained. The inter-row spacing was 0.45 m with an in-row of 0.20 m. Planting was done on the 31^{st} of January 2018. The planting stations were marked using hoes and three seeds were placed at each planting station 4 cm deep, and then covered with soil to maintain good seed soil contact. The seeds were sown on flat land. Basal fertilizer, compound D (N_7, P_{14}, K_7 was applied at 200 kg/ha. Gap filling was done at two weeks after crop emergence (WACE). Thinning was carried out at three WACE, to leave one plant per planting station. Other operations such as weeding were conducted according to general cowpea agronomy recommended in Zimbabwe.

d) Preparation of extracts

Fresh leaves and roots of *L. camara* were collected from the Cotton Research Institute fields. These were dried under shade to avoid photo-oxidation of active ingredients (Roshanak et al., 2016). Further preparation of the plant materials were done following the procedures described by Mapuranga *et al*., (2016). The dried leaves and roots were ground to a powder using pestle and mortar. The powder for both the extracts was then sieved using a 5 mm sieve to obtain a fine powder. The powder was then measured according to treatments. The powder for a single application for each treatment, as described in Table 1, was then soaked in water for 24 hours and then filtered using a Whatman filter paper size 15. A drop of liquid soap was added to act as an emulsifier. Early application of extracts was done to prevent the photodecomposition of extracts. This was in line with the method used by (Owolade *et al*., 2004). The treatments were sprayed at 7-day intervals from 3-7 WACE after crop emergence. The remaining mixture was discarded after each application.

e) Data collection

Data was collected from three weeks after crop emergence (WACE), within three middle rows, a distance of 0.5 m from the borders was discarded on either side of the plot, and five randomly selected plants were marked with a tag. Data on main insect pests (*Aphis craccivora, Ootheca mutabilis and Maruca mutabilis*) was recorded from the tagged plants between 7:00 and 9:00 am when the insects were inactive. Pod damage, leaf damage and yield were also assessed. The aphid population density was rated based on a visual estimation scale of 1-6 (Kanteh *et al*., 2014).

Table 2: Aphid scoring system for cowpeas

Score	Number of aphids	Appearance
1	No aphids	No infestation
2	1 – 100	A Few individuals
3	101 – 300	A few isolated colonies
4	301 – 600	Several small colonies
5	601 – 1000	Large isolated colonies
6	> 1000	Large continuous colonies

Source: (Kanteh et al., 2014)

O. mutabilis population density was assessed by physically counting and recording the number of adult beetles found on the plants. Pod damage was assessed by examining the pods during their growth period. Five plants were selected at random from the net plot, and the number of damaged pods recorded separately for each plant. This was done at 7 days intervals and the counts were non-cumulative. The number of damaged leaves was assessed to examine the occurrence of foliage beetles and leaf eaters. The number of damaged leaves was assessed, and recorded, and the counts were also non-cumulative. The yield for the entire net plot (which measured 3 m x 0.90 m) was harvested, packed according to treatments, and weighed.

f) Data analysis

Data for insect observation and yield were analyzed for Analysis of Variance (ANOVA) and significant means separated by Fishers Least Significant Difference (LSD) at 5% level of significance.

III. Results

a) Effects of L. camara plant extracts on A. craccivora population at 3 to 6 WACE

The data shows that there were no significant differences (p=0.78) among treatments means at 3 WACE. At 4 WACE, there were significant differences (p<0.001) among treatment means, with all the plant extracts treatments (*L. camara* leaves at 50g/l, *L. camara* leaves at 75g/l, *L. camara* roots at 50g/l and *L. camara* roots at 75g/l) being comparable to the dimethoate sprayed treatment. The uncontrolled treatment had the highest aphid population (Table 3). At 5 WACE, there was a significant difference (p<0.001) between treatment means, *L. camara* leaves at 50g/l, *L. camara* leaves at 75g/l, and *L. camara* roots at 75gl^{-1} were comparable to each other and had the lowest aphid population (Table 3). The uncontrolled treatment and *L. camara* roots at 50g/l had the highest aphid population (Table 3). At 6 and 7 WACE, there were no significant differences between treatment means (p>0.10) and (p>0.56), respectively.

Table 3: Effects of *L. camara* leaf and root extracts on *A. craccivora* population at 3 to 7 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)				
	3	4	5	6	7
L. camara leaves 50g/l H_2O	0.6	0.2^a	0.07^a	0.133	0.00
L. camara leaves 75g/l H_2O	0.33	0.2^a	0.00^a	0.00	0.00
L. camara roots 50g/l H_2O	0.67	0.33^a	0.40^{bc}	0.20	0.07
L. camara roots 75g/l H_2O	0.67	0.27^a	0.07^a	0.00	0.00
Uncontrolled treatment	0.67	1.07^b	0.60^c	0.07	0.07
Dimethoate 40 EC 2.5 ml/l H_2O	0.67	0.13^a	0.13^{ab}	0.00	0.00
Mean	0.6	0.367	0.211	0.07	0.02
P value	0.78	< 0.001	< 0.001	0.10	0.56
LSD (5%)	0.5333	0.4064	0.2745	0.1720	0.1089
CV (%)	13	22	20	18	32

Means followed by the same letter in a column are not significantly different at p < 0.05.

b) Effects of L. camara plant extracts on leaf damage at 5 and 6 WACE

At five weeks, there were significant differences (p<0.001) among treatment means. *L. camara* leaves at 75g/l (2 leaves), and *L. camara* roots at 75g/l (1.87 leaves) were comparable and had the least number of damaged leaves (Table 4). *L. camara* leaves at 50g/l (2.67 leaves) and dimethoate sprayed treatment (2.47 leaves) were also comparable to each other (Table 4). The uncontrolled treatment had the highest number of damaged leaves (5.0 leaves), (Table 4). At 6 WACE, there were significant differences (p<0.001) among treatment means. *L. camara* leaves at 50g/l (no damage), *L. camara* leaves at75g/l (0.33 leaves), *L. camara* roots at 75g/l (0.33 leaves) and Dimethoate (0.53 leaves) treatments had the least number of damaged leaves which were not significantly different from each other (Table 4). *L. camara* roots at 50g/l and Dimethoate treatments were also not significantly different with 1.07 and 0.53 leaves, respectively (Table 4). The uncontrolled treatment had the highest number of damaged leaves with 1.80 leaves (Table 4).

Table 4: Effects of *L. camara* plant extracts on leaf damage at 5 and 6 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)	
	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	2.67^{ab}	0.00^a
L. camara leaves 75g/l H_2O	1.87^a	0.33^a
L. camara roots 50g/l H_2O	3.33^b	1.07^b
L. camara roots 75g/l H_2O	2.0^a	0.33^a
Uncontrolled treatment	5.0^c	1.80^c

Dimethoate 40 EC 2.5 ml/l H_2O	2.47^{ab}	0.53^{ab}
Mean	2.89	0.678
P value	< 0.001	< 0.001
LSD (5%)	1.197	0.6745
CV (%)	27	22
Means followed by the same letter in a column are not significantly different at $p < 0.05$		

c) Effects of L. camara plant extracts on O. mutabilis population at 4 to 6 WACE

The results of the study showed that at 4 WACE; there were no significant differences (p=0.79) among treatment means. At 5 WACE; there were significant differences (p<0.001) between treatment means. *L. camara* leaves at 50g/l, and 75g/l and *L. camara* roots at 50g/l, and 75g/l were comparable with the dimethoate treatment (Table 5). The uncontrolled treatment was different from all the other treatments. At 6 WACE, there were no significant differences (p=0.59) among treatment means.

Table 5: Effects of *L. camara* plant extracts on *O. mutabilis* population at 4 to 6 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)		
	4 WACE	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	0.27	0.02^{a}	0.73
L. camara leaves 75g/l H_2O	0.33	0.27^{a}	0.67
L. camara roots 50g/l H_2O	0.40	0.33^{a}	0.93
L. camara roots 75g/l H_2O	0.53	0.20^{a}	0.47
Uncontrolled treatment	0.40	1.00^{b}	0.87
Dimethoate 40 EC 2.5 ml/l H_2O	0.47	0.07^{a}	0.73
Mean	0.40	0.34	0.73
P value	NS	< 0.001	NS
LSD (5%)	0.3836	0.4233	0.5309
CV (%)	30	08	17
Means followed by the same letter in a column are not significantly different at $p < 0.05$ NS- Not Significant			

d) Effects of L. camara plant extracts on (M. vitrata) at 5 and 6 WACE

Assessments of *M. vitrata* population started at 5 WACE, and there were significant differences (p=0.009) between treatment means. The treatments with *L. camara* leaves at 50g/l, *L. camara* leaves at 75g/l, *L. camara* roots at 50g/l, and *L. camara* roots at 75g/l were comparable with the dimethoate treatment (Table 6). The uncontrolled treatment had the highest population mean (Table 6). At 6 WACE, there were highly significant differences (p<0.001) between treatment means. The treatments *L. camara* leaves at 50g/l, *L. camara* leaves at 75 g/l, *L. camara* roots at 50g/l, and *L. camara* roots at 75g/l were not significantly different from dimethoate sprayed treatment (Table 6).

Table 6: Effects of *L. camara* plant extracts on *M. vitrata* at 5 and 6 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)	
	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	0.93^{a}	0.60^{a}
L. camara leaves 75g/l H_2O	0.47^{a}	0.267^{a}
L. camara roots 50g/l H_2O	1.013^{a}	0.67^{a}
L. camara roots 75g/l H_2O	0.93^{a}	0.33^{a}
Uncontrolled treatment	2.13^{b}	1.40^{b}
Dimethoate 40 EC 2.5 ml/l H_2O	0.53^{a}	0.27^{a}
Mean	1.02	0.589
P value	0.009	< 0.001
LSD (5%)	0.931	0.539
CV (%)	15	16
Means followed by the same letter in a column are not significantly different at $p < 0.05$		

e) Effects of L. camara plant extracts on pod damage at 5 and 6 WACE

At 5 WACE, there were significant differences ($p<0.001$) between treatment means. *L. camara* leaves at 75g/l had the lowest number of damaged pods (0.53 pods). *L. camara* roots at 75g/l and dimethoate treatments were comparable, and had less damaged pods than *L. camara* leaves at 50g/l, and *L. camara* roots at 50g/l. The uncontrolled treatment had the highest number of damaged pods (3.07 pods) at 5 WACE. At 6 WACE, there was a significant difference ($p<0.001$) between treatment means. The plant extracts treatments were comparable to each other and the uncontrolled treatment had the highest number of damaged pods (1.6 pods) (Table 7).

Table 7: Effects of *L. camara* plant extracts on pod damage at 5 and 6 WACE

Treatment	Number of damaged pods per plant	
	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	1.20^{ab}	0.87^{a}
L. camara leaves 75g/l H_2O	0.53^{a}	0.40^{a}
L. camara roots 50g/l H_2O	2.13^{bc}	0.93^{a}
L. camara roots 75g/l H_2O	1.40^{ab}	0.47^{a}
Uncontrolled treatment	3.07^{c}	1.60^{b}
Dimethoate 40 EC 2.5 ml/l H_2O	1.07^{ab}	0.40^{a}
Mean	1.57	0.778
P value	< 0.001	< 0.001
LSD (5%)	1.09	0.56
CV (%)	10	20
Means followed by the same letter in a column are not significantly different at $p < 0.005$		

f) Effects of plant extracts on cowpea yield

Different application rates of *L. camara* leaves had no significant effect on the yield. *L. camara* leaves at 50g/l and *L. camara* leaves at 75g/l(Figure 1. Similarly, different application rates of *L. camara* roots had no significant effect on yield, however, leaf extracts had the highest yield (1902kg/ha) as compared to roots extracts, which resulted in a yield of 1444kg/ha, (Figure 1). Treatments, where leaf extracts were used had better yield than the positive control (dimethoate), which had 1756 kg/ha.

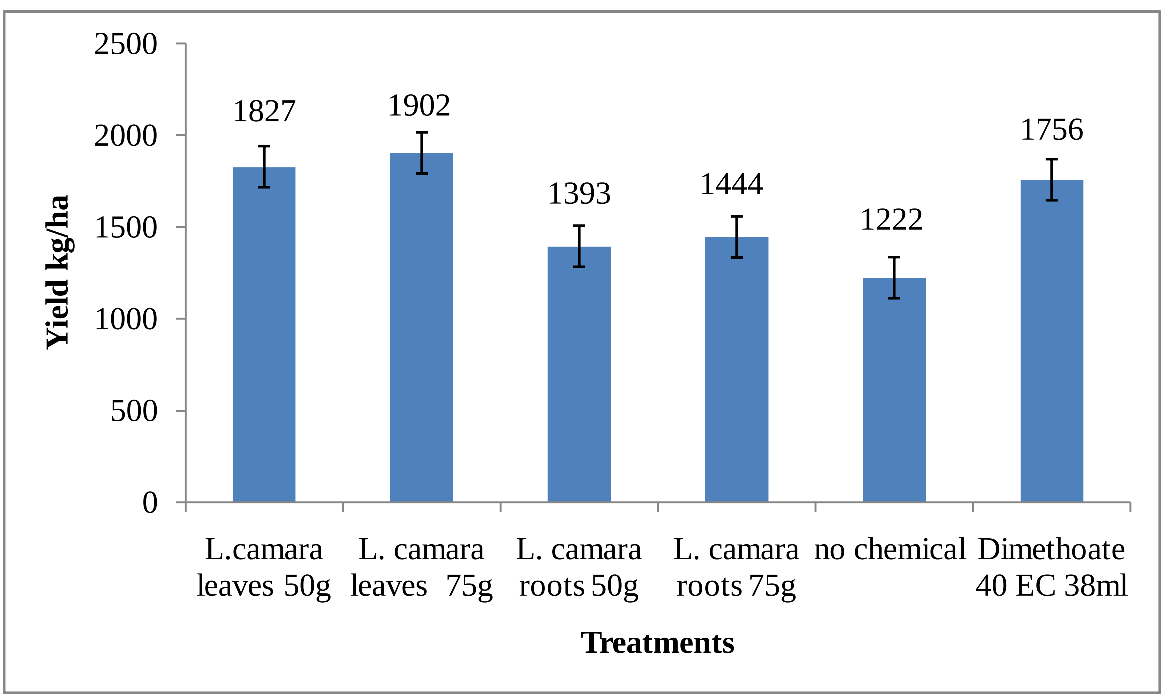

Figure 1: Effects of *L.camara* plant extracts on cowpea yield

IV. Discussion

a) Effects of L. camara plant extracts on A. craccivora population at 3 to 7 WACE

The consistent and significant decrease in the numbers of insect pests on the treated plots indicates the effectiveness of the plant extracts. *L. camara* leaf and root extracts reduced *A. craccivora* population at 4 and 5 WACE. The plant extracts showed insecticidal activity at the two application rates used (50g/l and 75g/l) on *A. craccivora* control. The finding means aphids can be controlled effectively by *L. camara* leaves and roots extracts. The use of natural products and their analogs have been done for the management of agricultural insect pests (Mvumi and Maunga, 2018). In the current study, mortality could have been due to the properties of *L. camara*, Lantadine A, and Lantadine B, which possess insecticidal properties. *Lantanine* plant metabolite from *L. camara* has been characterized as having defensive mechanisms against insect pests (Dash *et al*., 2015; Mvumi and Maunga, 2018). The obtained results corroborated the findings of Baryakabona and Mwine (2017), who found out that *L. camara* leaf extracts have pesticidal effect on the cabbage aphid. Most plants (including *L. camara*) have oils and alkaloids, which are effective as control agents against several insect pests, including aphids.

The low aphid scores on *L. camara* sprayed plots were probably due to the anti-feedent property of this plant (Yuan and Hu, 2012 and Baidoo *et al*., 2017). The results obtained concur with the work of Yuan and Hu (2012) and Isman (2005), who found out that extracts from the leaves of *L. camara* exhibited antimicrobial, fungicidal, insecticidal and nematicidal activities because it contains flavonoids, triterpenoids, and alkaloids such as lantanine which have insecticidal action. The results of this study are also in agreement with the studies done by Rajashekar *et al*., (2014), which showed that methanol extracts from *L. camara* leaf powder were efficacious against test storage pests, *Sitophilus oryzae, Callosobruchus chinesis*, *Tribolium castaneum.* This observation means they probably have an effect on other insect pests in field crops. Mvumi and Maunga (2018), also found out that *L. camara* leaves have an insecticidal effect against aphids. Seeds and leaf extract of flowering *Lantana camara* (Baidoo and Adam, 2012) have also proved efficacious against cabbage aphid (Mekuaninte *et al*., 2011).

b) Effects of L. camara plant extracts on O. mutabilis

Assessment of *O. mutabilis* population started at 4 WACE. The botanical insecticides were not effective at 4 WACE when the first assessment was done. Both Oparaeke (2006) and Isman (2008) reported that there is a time lag from the application of plant extracts, and effect observation and this is one of the main challenges of using them. The leaves and roots extracts of *L. camara* reduced the population of *O. mutabilis* at 5 WACE. The results of the study are similar to the work of Baidoo *et al*. (2017), who found out that *L. camara* leaves and roots extracts significantly reduced the numbers of the flea beetle (*Podagrica puncticollis*) on okra crop.

c) Effects of L. camara plant extracts on M. vitrata at 5 and 6 WACE

The decrease in the population of *M. vitrata* after the use of *L. camara* leaf and root extracts at 5 and 6 WACE implies that *L. camara* leaf and roots extracts can effectively control *M. vitrata*. The highest populations of *M. vitrata* were recorded in uncontrolled treatment. The results of the present study agrees with the work of Oparaeke *et al*. (2005), which shows that the aqueous leaf extracts of Neem in combination with leaf extracts of other plant species exhibited a reduction of *M. vitrata*. The suppression of *M. vitrata* numbers in cowpea flowers and pods could be due to suffocation and anti-feedant activity of *L. camara* material since the insect lives inside the preferred structures of the cowpea plant outside the reach of most insecticides (Oparaeke *et al*., 2005).

The active compounds from the plant extracts could have been absorbed by the flowers and pods through osmotic pressure and thus resulted in their anti-feedant action against the pests (Oparaeke *et al*., 2005). Another explanation could be that as the flowers or pods absorbed the spray liquid, the soft body of *M. vitrata* larvae inside the plant parts could have absorbed the active substances causing their death. The explanation above is supported by the observation that when flowers or pods of plants sprayed with these extracts were opened, some moribund *M. vitrata* larvae were seen.

d) Effects of treatments on cowpea yield

The less the cowpea that was affected by the insect pests, the more the yield because leaves had the opportunity to manufacture food for the development of the pods. Thus the leaf area index was reduced and consequently the quantities of carbohydrates that contribute to plant biomass thereby resulting in low yields of cowpea

V. Conclusion and Recommendations

a) Conclusion

L. camara leaf and root extracts have an insecticidal effect on the control of *A. craccivora*, *O. mutabilis,* and *M. vitrata* in cowpeas. The consistent and significant reduction in pest's numbers on *L camara* treatments indicated the effectiveness of the plant extracts in reducing insect pests numbers. The study also showed that applying root extracts at 75g/l was most effective in *A. craccivora* control. For *O. mutabilis* and *M. vitrata*, 50g/l and 75g/l showed the same effect for both the leaf and root extracts.

b) Recommendations

The results of this study can lead to the recommendation that farmers can use L. camara leaf, and roots extracts to control O. mutabilis and M. vitrata at 50g/l. A. craccivora can be controlled with 50g/l and 75g/l of leaf and root extracts respectively.

References Références Referencias

1. Amatobi, C.I, Dike, M.C. and Oparaeke, A.M. (2005). Integrated Pest Management of thrips and Maruca on Cowpea at Samaru. Cropping Scheme Meeting Report on Legume and Oil seed Research Programme, IAR Ahmadu Bello University, Zaria Nigeria 5:23 – 24.
2. Baidoo, P. K, Adam J. I. (2012). The effects of extracts of *Lantana camara* (L.) and *Azadirachta indica* (A. Juss) on the population dynamics of *Plutella xylostella, Brevicoryne brassicae* and *Hellula undalis* on cabbage. *Sustainable Agriculture Research*, 1(2): 29-234.
3. Baidoo, P.K., Adu, E. and Peprah, S. (2017) The Role of ethanolic extracts of leaves and roots of *Lantana camara* (L.) in the Management of Pests of Okra Abelmoschus esculentus (L.) Moench. Advances in Entomology, 5: 99-108. https://doi.org/10.4236/ae.2017.53010. Available from: https://www.researchgate.net/publication/ 318568221_The_Role_of_Ethanolic_Extracts_of_Leaves_and_Roots_of_Lantana_camara_L_in_the_Management_of_Pests_of_Okra_Abelmoschus_esculentus_L_Moench [accessed Feb 24 2020].
4. Baryakabona, S., and Mwine, J. (2017). Evaluation of the efficacy of crude extracts of tick berry *Lantana camara* and Mexican marigold *Tagetes minuta* against Cabbage aphids *Brevicoryne brassicae*. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS),* 33 (1): 169 – 181.
5. Barzman, M., Bàrberi, P., Birch, A.N.E., Boonekamp, P., Dachbrodt-Saaydeh, S., Graf, B., Hommel, B., Jensen, J.E., Kiss, J., Kudsk, P., Lamichhane, J.R., Messéan, A., Moonen, A., Ratnadass, A., Ricci, P., Sarah, J., and Sattin, M (2015) Eight principles of integrated pest management. *Agron. Sustain. Dev.* 35, 1199–1215. https://doi.org/10.1007/s13593-015-0327-9.
6. Dash, S.S., Bag, B.G. & Hota, P. (2015) *Lantana camara* Linn leaf extract mediated green synthesis of gold nanoparticles and study of its catalytic activity. *Appl Nanosci* 5, 343–350. https://doi.org/10.1007/s13204-014-0323-4
7. Dayan, F.E., Cantrell, C.L and Duke, S.O (2009) Natural products in crop protection. *Bioorganic & Medicinal Chemistry* 17: 4022 – 4034
8. Isman, M. B. (2005). Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology,* 51:45-66.
9. Isman, M.B. (2008) Botanical insecticides: for richer, for poorer. *Pest management science*, 64:, 8-11.
10. Isman, M.B. and Machial, C.M. (2006) Pesticides based on plant essential oils: from traditional practice to commercialization. *In* M. Rai and M.C. Carpinella (eds.), *Naturally Occurring Bioactive Compounds*, Elsevier, BV, pp 29–44.
11. Kanteh S.M., Norman J.E., Sherman-Kamara, J., (2014) Effect of Plant Density and Weeding Regime on Population and Severity of Aphids (*Aphis craccivora* Koch) and Foliage Beetles (*Ootheca mutabilis* Sahl) on Cowpea in Sierra Leone. *International Journal of Agriculture and Forestry* 4(1): 24-33 DOI: 10.5923/j.ijaf.20140401.04.
12. Kyei-Boahen S, Savala C. E. N., Chikoye D, Abaidoo R (2017) Growth and Yield responses of cowpea to inoculation and phosphorus fertilization in different environments. *Front. Plant Sci.* 8:646. doi: 10.3389/fpls.2017.00646.
13. Mapuranga R, Jimu F, Musiniwa F, Muzemu S, Madanzi T (2016). Efficacy of aqueous extracts of *Aloe zebrina* Baker, *Capsicum annum* L. and *Melia azedarach* L. against Aphis gossypii Glover (Homoptera: Aphididae) International Journal of Agronomy and Agricultural Research (IJAAR). 9 (2):36-46.
14. Mekuaninte B., A. Yemataw, T. Alemseged & R. Nagappan (2011). Efficacy of *Melia azadarach* and *Mentha piperita* plant extracts against cabbage aphid *Brevicoryne brassicae*. *World Applied Science Journal*, 12 (11):2150 -2154.
15. Mugandani R., Wuta M., Makarau A and Chipindu B (2012) Re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change. *African Crop Science Journal*, 20, (2)- 361 – 369.
16. Mvumi, C., & Maunga, P. R. (2018). Efficacy of lantana (*Lantana camara*) extract application against aphids (*Brevicoryne brassicae*) in rape (*Brassica napus*) over varied periods of time. *African Journal of Biotechnology* , 17(8): 249-254.
17. Oparaeke, A.M. (2006) The potential for controlling *Maruca vitrata* Fab. and *Clavigralla tomentosicollis* Stal. using different concentrations and spraying schedules of *Syzigium aromaticum* (L.) Merr and Perr on cowpea plants. *Journal of Plant Sciences*, 1: 132-137.
18. Operaeke, A. M., Dike, M. C. and Amatobi, C. L. (2005). Botanical pesticide mixtures for insect pest management on cowpea, (*Vigna unguiculata*). *Agricultura Tropica et subtropica,* 38: (2) 1-38.
19. Owolade, O. F., Alabi, B. S., Osikanlu, Y. O. K., Odeyemi, O. O. (2004). On-farm evaluation of some plant extracts as bio fungicide and bio insecticide

on cowpea in Southern West Nigeria. *Journal of Food Agriculture and Environment*, 2 (2): 237 – 240.

20. Oyewale, R. O. and Bamaiyi, L. J. (2013). Management of cowpea insect pests. *Scholars Academy Journal of Biosciences,* 1: (5) 217-226.
21. Peksen, E. (2007). Yield performance of cowpea (*Vigna unguiculata* L. Walp.) cultivars under rainfed and irrigated conditions. *International Journal of Agricultural Research, 2:* 391-396.
22. Rajashekar, Y., Ravindra, K. 1. V., Bakthavatsalam, N. (2014). Leaves of *Lantana camara* Linn. (Verbenaceae) as a potential insecticide for the management of three species of stored grain insect pests. *Journal of Food Science and technology*, 51: (11) 3494-3499.
23. Roshanak, S., Rahimmalek, M and Goli, S.A.H (2016) Evaluation of seven different drying treatments in respect to total flavonoid, phenolic, vitamin C content, chlorophyll, antioxidant activity and color of green tea (*Camellia sinensis* or *C. assamica*) leaves. *J Food Sci Technol.* 53(1): 721–729. doi: 10. 1007/s13197-015-2030-x
24. Singh, B. B., Ajeigbe, H. A., Tarawali, S. A., Fernandez-Rivera, S., and Abubakar, M. (2003). Improving the production and utilization of cowpea as food and fodder. *Field Crop Res.* 84: 169–177. doi: 10.1016/S0378-4290(03)00148-5
25. War, A.R., Taggar, G.K., Hussain, B, Taggar, M.S., Nair, R.M., Sharma, H.C., (2018) Plant defence against herbivory and insect adaptations, *AoB PLANTS*, 10(4), ply037, https://doi.org/10.1093/aobpla/ply037
26. Yuan, Z and Hu X.P., (2012) Repellent, antifeedant, and toxic activities of *Lantana camara* Leaf Extract Against *Reticulitermes flavipes* (Isoptera: Rhinotermitidae) *J. Econ. Entomol*. 105(6); DOI: http://dx.doi.org/10.1603/EC12026.