FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 4 No. 4, December, 2020, pp 85 – 89
DOI: https://doi.org/10.33003/fjs-2020-0404-437

EFFICACY OF *AZADIRACHTA INDICA* AND *CAPSICUM ANNUUM* POWDERS IN THE PROTECTION OF CEREAL SEEDS AGAINST HARVESTER ANTS *MESSOR* (HYMENOPTERA: FORMICIDAE) IN MUBI, NIGERIA.

[1*]Wahedi, J. A., [2]Oaya, C. S., [3]Elkana, S. O. and [4]Ishuwa, M. N.

[1]Department of Zoology, Faculty of Science, Adamawa State University Mubi, Nigeria
[2]Department of Crop Science, Faculty of Agriculture, Adamawa State University Mubi, Nigeria.
[3]Department of Biological Sciences, Taraba State University Jalingo, Nigeria.
[4]Department of Biological Sciences, University of Mkar, Benue State, Nigeria.

Correspondence: wahedijasini010@gmail.com
Phone: +2348065623969

ABSTRACT

Harvester ants (*Messor*) have become a major pest to farmers because they swarm in to houses, farms and injure seeds, seedlings, and fruits, causing great damage to plants that falls within their vicinity. This study compared the efficacy of *Azadirachta indica* (neem) and *Capsicum annuum* (chili pepper) powder for the protection of sorghum and millet grains against harvester ants (*Messor*) at graded levels. Four ants hills (A, B, C, and D) were identified around Adamawa State University Campus. 1.0g, 2.0g and 3.0g of each of the treatment including the positive control (Rambo) was constituted in each ant hill on a petri dish and 100 seeds each for the 2 grains were added. A control (untreated) experiment was set up in every ant hill which contains 100 seeds for every grain but no treatment was added. The results revealed the repellent efficacy of the treatments when compared with the untreated control, but *Capsicum annuum* performed significantly better. Millet grains were also preferred by the ants, as they recorded the highest number of picking. Therefore, a sustainable used of these plant products in the protection of grains in the field from harvester ants is encouraged in order to have a maximum yield.

KEYWORDS: *Azadirachta indica*, *Capsicum annuum*, Harvester ant, Millet, Sorghum

INTRODUCTION

Harvester ants (*Messor*) (Hymenoptera: Formicidae) are ecologically important social insects and efficient granivores of cultivated crops in the tropics and sub tropics (Simcha *et al*., 2015). They are seed dispersal agents and/or seed predators. In the day time, *Messor* spp usually search for plant seeds and other vegetation and take them to their nest for foraging (Arnan *et al*., 2012). They also destroy structures by simply digging their nests around or near structures, and such activity can encourage soil erosion (Ghobadi *et al*., 2015). Harvester ants are among the most ubiquitous and familiar insects occurring in vast number in all habitats but not extremely cold region (Maina *et al*., 2013). They have become closely associated with humans occupying their dwellings throughout the world, including metropolitan areas, despite great variation in geographical locations and habitant. Practically all ants are recognized by abdomen and elbowed antennae (Plowes *et al*., 2013).In desert, ants are major consumer of the seed of annual plants (Maina *et al.*, 2013; Majer *et al.*, 2011). They pick seeds directly from plants, and deposit the chaff on the kitchen maddens at the periphery of the mounds (Simcha *et al*., 2015). The harvester ants normally keep its nest clean all the time, for this reason they cause great damage to plant that are within their compounds (Arnan *et al*., 2012). Because of their feeding activities and colony formation harvester ants became problem to the society particularly to farmers (Tschinkel and Kwapich, 2016; Plowes *et al*., 2013). Harvester ants have become a major pest to farmer in some areas, this is because they swarm into houses, farm, lands and stores and injure seeds, seedlings, fruit and causing great economic losses by their activities (Plowes *et al*., 2013). Farming activity plays an important role in the ability of any nation to feed its citizen Therefore, if the farm produce are not properly protected, especially from the harvester ants the nation will continue to face problem in feeding her citizens (Okrikata *et al*., 2019). The losses associated with *Messor galla* has become enormous, such that insecticides were employed in some cases for effective control (Chaudhary *et al*., 2017).

The insecticides control method has been very successful until in the recent years, where research revealed that control methods have declined due to various factors of human behaviours, resistance by the pests, administrative, and prohibitive costs (Maina *et al.*, 2013). It has also been observed that use of the synthetic pesticide has resulted unto several various problems, some of which have been linked with human health hazard, ranging from short term impact such as headaches and endocrine disruption (Wojciechowska *et al*., 2016). Acute danger includes nerve skin and eye irritation and damage. Again, synthetic insecticide has also been linked with environmental contamination, because they are poisonous compound and adversely affecting other organisms beside harmful insect (Chaudhary *et al*., 2017). Accumulation of some insecticides in an environment can pose a serious threat both on wild life and domestic animal (Maina *et al.,* 2013). It is therefore, necessary to find compounds that can efficiently control *Messor* species within minimal damage to farm produce.

Most bio-pesticides are not harmful to non-target organisms including humans, and so this has necessitated the use of plant-based extracts as treatments against insect pests, which have been reported to be effective and environmentally friendly than the dangerous synthetic insecticides (Chaudhary *et al*., 2017).

Meanwhile, both neem and chili pepper have been reported to control stored product insects, of the Order Coleoptera. Authors like Biao *et al*. (2019) and Wahedi *et al.* (2014), reported the insecticidal properties of *Capsicum annuum* against agricultural insects. Wahedi (2012) and Chaudhary *et al*. (2017) reported the insecticidal properties of *A. indica* against insect pests. In this study, both *C. annum* and *A. indica* were tested for their repellent effect against a hymenopteran insect pest, *Messor* spp, as part of the search for effective alternative natural products, other than the synthetic chemical insecticides, which is not friendly to both the human and the environment.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Adamawa State University, Mubi. Mubi is the head quarter of Mubi North Local Government Area of Adamawa State. It is situated in the North Eastern part of Nigeria, between latitude 10^o 12' North and longitude 13^o 10' East. The climate is tropical with average temperature between 32^o and 35^{o}C in dry season and relative humidity ranging from 28 to 45% and an average rainfall of about 1056mm (Adebayo and Tukur, 1999). The people of Mubi area are subsistence farmers, cattle and livestock farmers (Adebayo and Tukur, 1999). Some of the crops grown in Mubi are maize, sorghum, millet, groundnut, cowpea etc.

Collection of materials

Dried neem (*Azadirachta indica*) seed powder was collected around GRA area from neem plantation opposite Garden City Mubi, and was ground into fine powder using electric blender. Dried *Capsicum annuum* (chili pepper) was bought from Mubi main market and was also ground into powder using electric blender. Two separate blenders were used to grind the treatments (plant products of neem and chili pepper) to avoid possible contamination by the two treatments.

Identification of ant hills for the study

Four ant hills were selected around Adamawa State University Mubi for the experiment. Each of the ant hill was tagged A, B, C and D, and served as locations. Ant hills A was located around 2, 5, 6 Boys Hostel of Adamawa State University Mubi; Ant hills B was located around Fishery Department; Ant hills C was located around the Football field B while Ant hills D was located around Science Complex within the University Campus. The four ant hills were at least 1000 meters apart from each other. This is to give the finding a greater validity, so that the result can be generalized on the effect of neem and chili pepper on harvester ants in Mubi.

Seed dressing and experimental setup

The sorghum and millet seed were bought from Mubi main market. For every ant hill, 100 seeds each of sorghum and millet were counted and put in a petri dish. The treatment doses of 1g, 2g, and 3g were constituted as described by Wahedi *et al*. (2014) for neem leaf and chili pepper powders. Each of the treatment doses was added to the 100 seeds per treatment and was replicated four (4) times. The control experiment for both sorghum and millet were constituted and no treatment was applied. These were also replicated four times..

Data collection

Data was collected on a number of seeds that were picked by the ants for the period of five hours, beginning from 7.00 AM at each trial. This is because active foraging activities by harvester ants are during the day time (Arnan *et al*., 2012; Gordon *et al*., 2013).

Data analysis

Data collected was subjected to analysis of variance (ANOVA) using statistical analysis software (SPSS, Version 19.0). The treatment means were separated using LSD at 5% ($P<0.05$) level of significance.

RESULTS

Table 1 showed the effect of treatment (*A. indica* and *C. annuum*) in the protection of sorghum grains from picking by harvester ants (*Messor*). The result showed that there was a significant difference ($P<0.05$) in the number of sorghum grains picked by the harvester ants over the periods of five hours of exposure. Although, most of the sorghum grains picked were within the first hour of the exposure, the picking was spread across the five hours of the exposure. Among the bio-pesticides, *C. annuum* at 3.0g treatment dose recorded the least (87.0±9.38) number of picking. Meanwhile, the positive control (Rambo) had 83.8±4.57 number of picking at 3.0g treatment dose which was the least of all treatments. The results further revealed that bio-pesticides significantly reduced the number of sorghum grains picked by the harvester ants when compared with the negative control (untreated) experiment. The control dishes were highly susceptible to harvester ants' picking, as 100% picking was recorded after just 3 hours of exposure (Table 1).

In Table 2, the effect of treatments in protecting millet grains from foraging by harvester ants is shown. The result showed that there was a significant difference ($P<0.05$) in the number of millets grains picked by the harvester ants over the period of five hours of exposure. The control samples were highly susceptible, as 100% picking was recorded after 3 hours as was in the case of sorghum grains. Meanwhile, among the millet seeds treated with botanicals, the highest (94.0±4.00) picking was recorded in the seeds treated with neem at 2.0g treatment dose, while the least (90.0±9.12) was recorded in the ones treated with chili pepper at 1.0g treatment dose. The positive control significantly (P>0.05) protected the millet grains from harvester ants as they recorded least number of picking ranging between 40.8±47.14 at 3.0g dose, and 44.0±50.86.

Table 3 revealed the susceptibility or preference of grains to harvester ants per treatment. Looking at the various p-values per treatment, there was a significant difference (P<0.05) in *A. indica* and the positive control (Rambo). In all the treatments, the preference appeared to be for millet than sorghum (Table 3).

DISCUSSION

According to Wagan *et al*. (2016), using bio-pesticides can be very efficient in controlling insect pests. This is as a result that the bio-pesticides can serve as fumigants, where their tropical toxicity is greatly and sustainably utilized; or as feeding deterrent, due to their repellent properties.

In this study, the results revealed that all the treatments reduced picking on both sorghum and millet grains by the harvester ants compared to the control (untreated) experiment. Among the treatments, red pepper was able to highly reduce the rate of foraging by harvester ants on both sorghum and millet seeds. This has revealed *Capsicum annuum* (chili pepper) the most efficacious bio-pesticide than *Azadirachta indica* (neem) in protecting grains against foraging by the harvester ants (*Messor*).

However, the rate of foraging by harvester ants on grains in all the treated petri dishes was very low compared with the untreated control experiment. The untreated control experiments within 3 hours of exposure in both sorghum and millet grains were completely picked. This revealed that *A. indica* and *C. annuum* are effective bio-pesticides with strong repellent properties against harvester ants, since they were able to reduce significantly the number of grain picking. Meanwhile, *C. annuum* performed better than *A. indica* in protecting the grains against foraging by the harvester ants. The positive control (Rambo) however, significantly reduced the rate of grain foraging by the harvester ants higher than the bio-pesticides. This suggests that although *A. indica* and *C. annuum* effectively controlled foraging by harvester on sorghum and millet grains, they were not as effective as the synthetic insecticides.

The total number of grains picked was higher in millet than sorghum. This could possibly be because of the relatively small size of millet grains compared to sorghum. This agrees with the study earlier performed by Turaki *et al*. (2012), where lighter grains of millet were foraged more by harvester ants (*Messor* spp) than the relatively larger and heavier grains. Similar result was also reported by Plowes *et al*. (2013), where a preference for grains of moderately small size was observed. When harvester ants (*Messor* spp) presented with various sizes of crushed wheat seeds, those with smaller dimensions were preferred (Plowes *et al*., 2013). Although the petri dishes carrying the grains were randomly placed around the termite mound during the experiment, distance does not affect seed preference for harvester ants (*Messor*) (Pirk and De Casenave, 2010). Study conducted by Plowes *et al.* (2013) shows that distance from the nest does not affect seed preference for harvester ant of the genus *Messor*.

CONCLUSION

In conclusion, the study showed that bio-pesticides, especially the red pepper (*C. annuum*) powder and neem (*A. indica*) seed powder effectively reduced foraging on sorghum and millet grains by the harvester ants (*Messor* spp). Moreover, the total number of grains picked was higher in millet than sorghum. This could possibly be because of the relatively small size of millet grains compared to sorghum. These bio-pesticides are more preferred than the synthetic chemicals since they are none toxic, eco-friendly, safe, available and affordable to local farmers.

ACKNOWLEDGEMENT

The authors wish to acknowledge the contribution of Williams Chintem of Taraba State University, Jalingo, Taraba State, for the statistical analyses, and the University security guards for making sure the experiment, being on the field was secured from unwarranted tamper by passer-byes.

TABLE 1: Efficacy of treatments in the protection of millet grains from picking by harvester ants.

Treatment	Dose (g)	Average number of picking per hour (Mean±SD)					Total
		1	2	3	4	5	
Control	0.0	43.8±3.5	42.0±2.21	14.2±0.95	0.00±0.00	0.00±0.00	100.0±6.66[a]
A. indica	1.0	34.0±6.68	24.8±9.91	17.5±9.67	11.8±4.19	10.3±17.3	94.5±6.80[a]
	2.0	27.5±2.66	22.8±6.07	17.5±7.04	9.8±4.19	10.0±4.32	87.5±11.59[ab]
	3.0	23.3±5.37	26.3±8.05	24.8±16.82	11.8±8.69	10.0±8.04	96.0±5.56[a]
C. frutescens	1.0	30.3±14.81	19.5±5.00	15.5±1.73	15.0±1.41	12.3±5.18	92.5±9.57[ab]
	2.0	28.3±12.5	16.3±4.03	16.8±4.11	16.5±5.74	14.5±3.00	92.3±2.00[ab]
	3.0	22.5±2.39	19.3±4.99	15.5±4.04	16.5±2.08	10.8±3.30	87.0±9.38[ab]
Rambo	1.0	23.5±8.18	15.5±5.00	18.5±1.29	17.8±4.5	12.0±4.39	86.5±2.64[ab]
	2.0	21.3±6.07	17.3±5.50	16.0±2.00	17.3±2.62	15.5±5.80	89.8±1.89[ab]
	3.0	18.0±2.70	20.8±7.5	16.8±0.95	13.5±1.29	14.8±2.75	83.8±4.57[b]

Means carrying the same alphabet along the columns are not significantly different (P>0.05).

TABLE 2: Effect of treatment in the protection of sorghum grains against harvester ants picking.

Treatment	Dose (g)	Average number of picking per hour (Mean±SD)					Total
		1	2	3	4	5	
Control	0.0	41.8±5.90	41.0±4.54	17.2±2.50	0.0±0.00	0.0±0.00	100.0±12.94[b]
A. indica	1.0	36.8±5.56	18.5±8.10	15.0±2.16	12.3±2.10	11.3±0.95	91.3±7.36[b]
	2.0	26.5±2.51	23.0±2.58	17.8±4.42	15.8±4.78	11.0±4.76	94.0±4.00[b]
	3.0	24.3±5.73	22.3±4.34	17.5±2.51	5.8±3.46	12.5±3.87	92.8±4.03[b]
C. frutescens	1.0	36.3±10.5	20.5±7.18	12.8±2.06	11.0±4.89	9.5±1.91	90.0±9.12[b]
	2.0	31.0±8.04	23.0±7.07	14.8±1.25	14.3±7.76	8.5±3.87	92.5±0.57[b]
	3.0	27.3±6.39	23.5±6.35	18.5±7.50	11.5±3.87	9.5±4.79	90.3±10.17[b]
Rambo	1.0	15.0±18.8	6.8±8.05	7.3±9.14	9.3±11.58	4.8±5.85	43.0±49.65[a]
	2.0	13.0±15.09	6.5±7.89	9.8±11.26	9.0±10.67	5.3±6.07	44.0±50.86[a]
	3.0	8.3±9.74	9.0±11.86	8.8±10.11	6.3±7.22	8.5±9.84	40.8±47.14[a]

Means carrying the same alphabet along the columns are not significantly different (P>0.05).

TABLE 3: Efficacy of treatments on total number of grain picking

Grain	Treatment		
	A. indica	*C. frutescence*	Rambo
Millet	96.67	90.93	86.70
Sorghum	92.70	90.60	42.60
P-value	0.107	0.006	0.528

REFERENCES

Adebayo, A. A. and Tukur, A. L. 1999. Adamawa State in maps Paraclete publishers Yola, Pp.215.

Arnan, X., Molowny-Horas, R., Rodrigo, A. and Retana, J. (2012). Adler, Frederick R (ed.), "Uncoupling the Effects of Seed Predation and Seed Dispersal by Granivorous Ants on Plant Population Dynamics", *PLoS ONE*, 7 (8): 1–11.

Biao, L., Mei, Y., Rui, Shi. and Min, Y. (2019). Insecticidal activity of natural capsaicinoids against several agricultural insects. *Natural Product Communications*, 1-7. DOI: 10.1177/1934578X19862695

Chaudhary, S., Kanwar, R. K. and Sehgal, A. (2017). Progress on Azadirachta indica based biopesticides in replacing synthetic toxic pesticides. *Frontiers of Plant Science,* 8:1-13.

Ghobadi, M., Agosti, D., Mahdavi M. and Jouri, M. H. (2015). Effects of harvester ants' nest activity (*Messor* spp.) on structure and function of plant community in a Steppe Rangeland (Case Study: Roodshoor, Saveh, Iran). *Journal of Rangeland Science*, 5:269-83.

Gordon, D. M., Dektar, K. N. and Pinter-Wollman, N. (2013). Moreau, Corrie S (ed.), "Harvester Ant Colony Variation in Foraging Activity and Response to Humidity", *PLoS ONE*, 8 (5): 1–6.

Maina, Y. Y., Degri, M. M., Sharah, H. A. Musa, H. A. (2013). The effect of harvester ants (*Messor* species) nest on farmer's productivity in semi-arid zone of Maiduguri, Nigeria. *Journal of Environmental Issues and Agricultures in Developing Countries,* 5 (1): 34-39.

Majer, J., Gove, A., Sochacki, S., Searle, P. and Portlook, C. (2011). A comparison of the autecology of two seed-taking ant genera. Rhytidoponera and Melophorus. *Insectes Sociaux,* 58 (1): 115-125.

Okrikata, E., Anaso, C. E. and Bukar, S. M. (2019). Evaluation of Spent Engine Oil and other Natural Materials on the Emergence of Harvester Ants (*Messor galla* Forel). *International Journal of Advanced Biological and Biomedical Research*, 7 (4): 335-341.

Pirk, G. I. and De Casenave, J. L. (2010). Influence of seed size on feeding preferences and diet composition of three sympatric harvester ants in the central Monte Desert, Argentina. *Ecological Research*, 25: 439-445.

Plowes, N. J. R., Johnson, R. A. and Holldobler, B. (2013). Foraging behaviors in the ant genus Messor (Hymenoptera: Formicidae: Myrmicinae). Myrmecological News, 18: 33-49.

Simcha, L., Gideon, G. and Dalia, G. (2015). Conservative harvest habit by harvester ants exploiting fields of bread wheat. *Israel Journal of Plant Sciences*, 62 (1-2): 17-21.

Tschinkel, W. R. and Kwapich, C. L. (2016). The Florida harvester ants, Pogonomyrmex badius, rely on germination to consume large seeds. *PloS One*, 11 (11): e0166907. doi:10.1371/journal.pone.0166907.

Turaki, Z. G. S., Turaki, J. Z., Zira, J. D. and Abba-Masta, A. B. (2012). Estimation of haulage capacity and nest activity of different sizes of harvester ant (*Messor galla* Forel) for major small grain cereals in Nigeria. *Journal of Stored Products and Postharvest Research*, 3(7):83 – 86.

Wagan, T. A., Chakira, H., He, Y., Zhao, J., Long, M. and Hua, H. (2016). Repellency of Two Essential Oils to *Monomorium pharaonis* (Hymenoptera: Formicidae). *BioOne*, 99 (4): 608-615.

Wahedi, J. A. (2012). Laboratory Evaluation of neem (*Azadirachta indica* Linn (Meliaceae)) seed powder and seed oil for the control of *Sitophilus zeamais* (Coleoptera: Bruchidae) on stored maize. *Adamawa State University Journal of Scientific Research, 2* (2): 110-115.

Wahedi, J. A. David, L. D., Edward, A., Mshelmbula, B. P. and Zakariya, R. (2014). Efficacy of garlic (*Allium sativum*), Red pepper (*Capsicum frutescens*), Yellow pepper (*Capsicum annuum*) on Cowpea weevils (*Callosobruchus maculatus*) and their potentials in seed protection. *International Journal of Pure and Applied Sciences and Technology*, 23 (1): 34-39.

Wojciechowska, M., Stepnowski, P. and Golebiowski, M. (2016). The use of insecticides to control insect pests. *Invertebrate Survival Journal*, 13: 210-220.