

NIGERIAN JOURNAL OF ENTOMOLOGY (2002) 19:22-30**Comparative Efficacy of Twelve Botanicals and two Synthetic Insecticides Against the Lesser Grain Borer, *Rhyzopertha dominica* Fabricius (Coleoptera: Bostrichidae) on Stored Sorghum.**S. O. OKUNADE¹, J. O. WILLIAMS² and M. H. IBRAHIM¹¹Nigerian Stored Products Research Institute, (NSPRI)
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ABSTRACT

The efficacy of some botanicals were compared with one another and with that of two synthetic powdered insecticides, Pirimiphos – methyl (Actellic) and permethrin (Coopex) in Nigerian Stored Products Research Institute, Entomology Laboratory Kano, between February and April, 2000 for seven weeks on grains of sorghum. The botanicals tested include *Arachis hypogaea*, *Annona senegalensis*, *Dichrostachys platycarpa*, *Eragrostic major*, *Euphorbia lateriflora*, *Mitracarpum scabrum*, *Monechma hispida*, *Ocimum americanum*, *O. viride*, *Parkia Filieoidae*, *Pennisetum glaucum* and *Striga senegalensis*. The botanicals were applied at the rate of 2.0g/100g grains while the synthetic powder were applied at the rate of 0.05g/100g grains.

The results show that there was significant difference ($P \leq 0.05$) in adult mortality between the treatments after seven weeks of storage. While the two synthetic insecticides resulted in 100% adult mortality, there was no significant difference between them and *Ocimum americanum* which gave mean mortality of 93.25%. not significantly different ($P \geq 0.05$) in mean percentage adult insect mortality with 75.76%, 71.16% and 70.52% respectively. *D. platycarpa* followed with adult mortality of 60.96%; *P. filicoidae* (bark of stem) and *P. glaucum* recorded 50.70% and 44.60% respectively. The poor performance of the latter is traceable to the smaller quantity of the botanical admixture. *S. senegalensis*, *M. hispida* and *E. major* gave mean percentage mortalities of 42.53%, 42.48% and 40.01% respectively, while *A. hypogaea* with mean percentage mortality of 30.46% was not significantly different from the control with a mortality of 19.86%.

INTRODUCTION

Sorghum (*Sorghum bicolor*) is an important staple food in the tropics and subtropical regions of the world. It belongs to the family Gramineae; with many varieties and hybrids. An origin of Northeast Africa and Asia where it has been grown for over 2000 years, the crop is known by various names in different locations. Sorghum is called guinea corn in West Africa, Kafri corn in South Africa, mtama in East Africa, durra in Sudan, jvar / jomar / cholam in India, kaoliang in China and also mil in USA (Miller, 1977). The crop is known to thrive well in areas too hot and dry for economic maize production. Depending on the variety, Sorghum grains are mostly spherical and colour could be creamy white, yellow, pink/red, and sometimes purple. It is used as food for man and livestock, bread, beer and porridge making as well as in the manufacturing of baby foods.

Sorghum is grown almost all over Nigeria today but it constitutes a major crop in northern Nigeria and the middle belt than in the south. To the Hausas, sorghum is known as "daru" while the Igbo people call it "Okili" "Ajata" "Okoli" and the Yorubas "baba" "Okor-baba" "bomo" (Anon., 1996). In a study, it was reported that a total of 3,816,000 tonnes of threshed sorghum grain was produced from a cultivated area of about 5.67 million ha in the 1973/74 cropping season. (Anonymous, 1974). This production figure notwithstanding, coupled with the fact that sorghum grains are considered as one of the major durable stored crops, a substantial quantity of the harvested grains never got to the consumers' table due to the devastating activities of insect pests and sometimes rodents. At times they could cause very serious damage on the grains to the extent that the crop could have no further use for anything whatsoever.

According to Cornes (1967, 1973) there are a total of 37 different species of insect pests found on stored sorghum grains. These are made up of seven major stored grain pests; five pests of occasional importance, nineteen pests found only occasionally and stray while the remaining six are predators. Some pests in these categories are field-to-store pests. The lesser grain borer, *Rhizopertha dominica* (F) is one of the major insect pests of stored sorghum grains in the tropics (Cornes, 1973; Haines, 1991; Anon., 1996). Both larvae and adult stages are pestiferous on the grain. They bore into and feed within the grains thereby leaving grains hollow and riddled with holes and cause severe powdering. In some cases, wooden storage structures could also be affected by these beetle whose adults are about 2 – 3mm in length and are shiny brownish black in colour.

The principal control measures has been chemical application such as fumigant, pyrethroids (e.g. permethrin, daltamethrin etc.) while non-chemical control include drying grain to moisture content of at least 9.0%, admixture with pepper mill powder, sand and ash. However, employment of synthetic insecticides has been

greatly circumscribed by high cost of the insecticides, abuse by illiterate farmers, high mammalian toxicity because of their persistent residues (Lale, 1995; Adedire and Ajayi, 1996). Thus, research into the suitability of other botanicals as protectant of sorghum grains under storage has been embarked upon. More so, the discovery of such botanicals will increase their usage and hence reduce the cumbersome trouble caused by those that are weed on farms. The present investigation was carried out along this direction.

MATERIALS AND METHODS

Visits were paid to some selected villages in northern Nigeria where a total of 12 botanicals used by farmers in the storage of grains were collected and shade-dried (Table 1). The sorghum grain used for the screening exercise is the local variety "Kaura" obtained from the experimental demonstration farm of Nigerian Stored Products Research Institute (NSPRI) Kano. The grain was further sun dried to a moisture content of 12.00% and then fumigated with Aluminum phosphide tablets (Protex[®]) for six days and thereafter exposed on flat trays in the laboratory for 24 hours to get rid of the insecticides. The fumigated grains were then sieved to remove dirt and dead insects and other extraneous substances.

One hundred grammes of sorghum grains were measured into each Kilner Jar and admixed with 2.0g (2%) each of the botanicals that have been shade-dried and made into semi-powdered form by squeezing between the hands, and left to settle down for about 2 hours. The synthetic insecticide dusts were also admixed at 0.05g/100g grains. Into each jar, a total of 14 adult male and female *Rhizopertha dominica* in ratio 1:1 were introduced into each jar, covered with muslin cloth held with metal ring. Each treatment was replicated four times and kept in the Entomological Laboratory of NSPRI Kano. The set up was left for seven weeks after which the mean percentage mortality rates were determined. The data collected were analyzed using System Analytical Statistics (SAS).

RESULTS AND DISCUSSION

The result indicated that there are significant differences ($P \leq 0.05$) between the various treatments, indicating a very likely possibility of efficacy of some of the botanicals in controlling *R. dominica* in stored sorghum. The reliability of this result is being further authenticated by the high mean value of 62.85%. The small value of coefficient of variation (C.V) - 8.06 of the twelve botanicals tested gave mean mortality rates of over 60%, one gave 50.7% while between 40 - 44.60% was recorded on four and one had about 30% mean mortality rate (Table 2).

TABLE 1: Botanicals And Synthetic Dust Tested Against *R. dominica*

SCIENTIFIC NAME	FAMILY	COMMON NAME	PLANT PART USED
BOTANICALS:			
<i>Annona senegalensis</i> Pers	Annonaceae	Wild custard apple	Leaves
<i>Arachis hypogaea</i> L.	Fabaceae	Groundnut cake	Powder of g/nut cake
<i>Dichrostachys platycarpa</i> Welw – a shrub	Leguminosae	Not – known	Leaves and stem
<i>Eragrostis major</i> Hochst	Gramineae	Not – known	Leaves and stem
<i>Euphorbia lateriflora</i> Sch. Et thon/	Euphorbiaceae	Not – known	Stem
<i>Mitracarpum scabrum</i> Zuk	Rubiaceae	Not – known	Leaves and stem
<i>Monechma hispida</i> Hochst	Acanthaceae	Not – known	Leaves and stem
<i>Ocimum americanum</i> Linn (edible type)	Labiatae	American basil	Leaves and stem
<i>Ocimum viride</i> Wild (Non edible)	Labiatae	Mosquito plant	Leaves and stem
<i>Parkia filicoidae</i> Welw	Leguminosae	African Locust bean tree	Bark of the stem
<i>Parkia filicoidae</i> Welw	Leguminosae	African Locust bean tree	Powder of husks/peel of the fruit
<i>Pennisetum glaucum</i>		Millet shaft + ash	Shaft + ash (from any plant) in equal proportion
<i>Striga senegalensis</i> Berth	Scrophulariaceae	Witchweed	Leaves and stem
SYNTHETIC DUSTS:			
Permethrin (0.5%)	-	Coopex	Dust
Pirimiphos – methyl (2%)	-	Actellic, 2% dust	Dust.

Table 2 : Comparison Of Percentage Mortality Of Adult *Rhyzopertha dominica*(F) On Treated Sorghum Grains.

Botanical/Synthetic dusts	Mean % mortality	
Primiphos-methyl*(Actellic dust)	100	+37.15
Permethrin (Coopex dust)	100	+37.15
<i>Ocimum americanum</i>	93.25	+30.40
<i>Ocimum viride</i>	83.78	+20.93
<i>Annona senegalensis</i>	79.50	+16.65
<i>Mitracarpum scabrum</i>	75.76	+12.91
<i>Parkia filicoides</i> (Powder of Peel of fruit)	71.16	+8.31
<i>Euphorbia lateriflora</i>	70.52	+7.57
<i>Dichrostachys platycarpa</i>	60.96	+1.89
<i>P. filicoides</i> (bark of tree)	50.70	+12.15
<i>Pennisetum glaucum</i> + ash	44.60	+18.25
<i>Striga senegalensis</i>	42.53	+20.32
<i>Monechima hispida</i>	42.48	+20.37
<i>Eragrostis major</i>	40.01	+22.84
<i>Arachis hypogaea</i>	30.46	+32.39
Control (untreated)	19.89	+42.96

SE = 3.58; CV = 8.06; Mean = 62.85
 0.05g synthetic dust /100g grains; 2g botanical / 100g grains
 N/B Means with the same letter are not significantly different

The two synthetic powders, Actelic and Coopex gave 100% mortality rate. The plant, *Ocimum americanum* was not significantly different ($P \geq 0.05$) from these synthetic powders in mortality rate. This work thus added to the usefulness of this important plant which according to Grainge and Abined (1988) is used as fumigants against various insect pests. Jacobson (1975) had also reported its usefulness as mosquito repellent. Our survey confirmed that farmers in most of the northern states and in the middle belt of Nigeria use leaves of the plant as spices in soup and other local dishes. Apart from its fragrant odour, another possible feature that could have adapted the plant for versatility is the presence of oil which according to Martin and Ruberts (1975) could be extracted by steam distillation. The findings from this research further show the potential usefulness of the plant. With further research, this could be converted into a locally formulated pesticide; either in liquid or powder formulation.

O. viride which is of the same family and genus with *O. americanum* and *Armona senegalensis* are not significantly different ($P \geq 0.05$) with mortality rates of 83.78% and 79.50% respectively. The former has been reportedly effective as mosquito repellent in addition to its medicinal usage (Mcludoo, 1945). The sweet persistent fragrant odour which is a characteristic of *O. americanum* is lacking in *O. viride* and this may be responsible for the slight significant difference between them.

Lajide *et. al.* (1998) also reported the efficacy of a member of this genus *O. basilicum* in controlling *Sitophilus zeamais*. *A. senegalensis* leaves are very fragrant and has been used as food/drink and for medicinal purposes by humans as well as repellent to control stored grain pests. (Dalziel, 1937; Giles, 1964). These usage, coupled with the observations in this study are possibly traceable to the persistency of the leaf fragrance which is almost as strong as that of *O. americanum*. *M. scabram*, *P. filicoides* (powder of peel) and *E. lateriflora* and compared favourably well with each other in their efficacy with mean percentage mortality rates of 75.76%, 71.16% and 70.52% respectively. Each of these plants has a good history of usage as insecticides or for other means. It is therefore not too surprising that they yielded better results here. *Mitracarpum scabrum* is used in the treatment of hair-lice, and itch (Martin and Ruberte, 1975) and the treatment of various types of skin ailments in most part of the middle belt and southern Nigeria. *P. filicoides* (Powder of peel) is used for beautifying mud wall buildings especially the palaces of prominent traditional rulers in northern Nigeria. *E. lateriflora*, a soft shrub is planted as hedges and the milky juicy sap produced by the plant is used to control *Pediculus humanus capitis*. (Dalziel, 1937). These plants, especially *M. scabrum* and *E. Lateriflora* (leaves and juice respectively) contain some insecticidal substances responsible for the mortality of *R. dominica* on sorghum under storage. *D. platycarpa* a very thorny scrambling shrub in the bush which forms dense thickets (Muzik, 1970) has mean mortality rate of 60.96%. The efficacy of the plant is possibly traceable to the unique feature it possesses.

There was no significant difference between *P. filicoides* (stem bark) and *P. glaucum* (chaff) + ash. This is possibly traceable to the absence of odour and low concentrations of botanicals in each treatment which were not enough to prevent the survival of the pest. (The quantity of botanicals used for each treatment was just as much as that used by the farmers). *S. senegalensis*, *M. hispida* and *E. major* performed rather poorly with percentage mean mortality of 42.53%, 42.48% and 40.01% respectively. *S. senegalensis* commonly called witchweed is a very noxious parasitic weed of cereals in the tropics (Muzik, 1970; Sherif *et. al.*, 1987). It however lacks sufficient potential of causing significant mortality of *R. dominica* in sorghum under storage. The rough leaves of *M. hispida* must have conferred additional advantage on the plant to cause such a high mortality on the pest. while the very unpleasant smell of *E. major* must have been responsible for the high

mortality recorded (Jacobson, 1975). It may be likely that combining some of these botanicals will yield better results. The lower mean mortality rate of 30.46% recorded for *A. hypogaea* (which is not too different from that of the control (19.87%) is traceable to the fact that oils of groundnut seeds which acts on alkaloids (arachine) and has been reported to be an effective insecticide on *Callosobruchus maculatus*, (Golob and Webley, 1980) has already been extracted. The residue left, which was used for this experiment lacks the required active ingredients to kill the pest and also could not serve as anti-feedant to the pest. Anon. (1996) reported the presence of *R. dominica* in oil seed such as groundnuts and even some legumes. It is possible therefore that *R. dominica* must have taken advantage of the presence of *A. hypogaea* and hence feed on the grains with little restriction. The small traces of the seed oil left in the residue blocked the spiracles/ tracheal system of the pest and hence the mortality rate recorded.

CONCLUSION

From this research, it is apparent that not all the botanicals utilized by farmers in storing their food are actually very effective. While some are products of chance, others are being used by farmers due to their cultural belief or otherwise. Yet some others are still being used because the farmers felt anything can work on insect (just as in the case of pesticide abuse whereby some farmers are guilty of applying herbicides on stored grains). Nevertheless, some botanicals are very effective and could be comparable to synthetic insecticides if well managed. The medium or less effective ones could be "upgraded" in effectiveness perhaps by combining them with others. More work still has to be done on this. The active ingredients of the promising botanicals need to be investigated and isolated in order to make local synthetic pesticides from them. This development will go a long way in saving developing countries huge sums of foreign exchange being incurred on the importation of synthetic chemicals annually.

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REFERENCES

- ADEDIRE, C. O and. AJAYI, T.S. 1996 Assessment of the insecticide properties of some plant extracts as grain protectants against the maize weevil, *Sitophilus zeamais* (M) *Nigerian Journal of Entomology* 13: 93-101
- AJAYI, O; AROKOYO, J.T; NEZAN, J.T, OLAYINKA, O.O; MDIRMBULA, B.M. and KANNIKE, O.O 1987. Laboratory assessment of the efficacy of some local plant materials for the control of storage insect pests. *Samaru Journal of Agricultural Research* 5 (1&2): 81-86.
- ANON., 1974, Agricultural Development in Nigeria 1973-1985. Federal Ministry of Agriculture and Natural Resources (FMANR), Lagos PP 558.
- ANON., 1996. A guide to insect pests of Nigerian Cops; Identification, Biology and Control. *Natural Resources Institute (NRI), ODA, U.K.* 253P
- CORNES, M.A. 1967. New records of insect associated with stored products in Nigeria Part 11 *Technical Reports Nigerian Stored Products Research Institute.* 2;73-89
- CORNES M.A. 1973. A check list of the insects associated with stored products in Nigeria. Technical report No. 11, *Nigerian Stored Products Research Institute Annual Report (1971)* pp. 73-98
- DALZIEL, J. M. 1916. A Hausa botanical vocabulary. T. Fisher Unwin Ltd., London 119.
- DALZIEL, J.M. 1937. Flora of West Tropical Africa. Crown Agents 1927-1936.
- DALZIEL, J.M. 1973. The useful plants of West Tropical Africa, Crown Agents for Overseas Government and Administration, London.
- GILES, P.H. 1964. The storage of cereals by farmers in Northern Nigeria. *Tropical Agriculture* 41: 197-212.
- GRAINGE, M. and AHMED, S. 1988 – Handbook of plants with pest control properties. John Wiley and Sons, New York.
- GOLOB, P. and D. J. WEBLEY, 1980: The use of plants and minerals as traditional protectant of stored products. *Tropical Products Institute Publication* No. G 138 ODA, London, UK.
- HAINES, C. P. 1991. Insects and Arachnids of Tropical Stored products: Their Biology and Identification (A training Manual) *Natural Resource Institute, U. K.* 246p.
- JACOBSON, M. 1975. Insecticides from plants- A review of the literature, 1953-1971 USDA. Agricultural Handbook No 461, ARS-USDA, Beltsville, M.D.

- LAJIDE, L.; ADEDIRE, C.O., MUSE, W.A and AGELE, S.O. 1998, Insecticidal activity of powders of some Nigerian plants against the maize weevil (*Sitophilus zeamais* (Motsch). In; LALE N.E.S.' MOLTA, N.S., DONLI, P.O.; DIKE, M.C. and AMINU KANO, M. (EDS), 1998 Entomology in the Nigerian economy; Research focus in the 21st century. *Entomological Society of Nigeria (ESN)*, Maiduguri, Nigeria. *ESN Occasional Publication* 31:227-235
- LALE, N.E.S. 1995 An overview of the use of plant products in the management of stored product Coleoptera in the tropics. *Journal of Post-harvest Food and Information* 6,69N-75N
- MARTIN, F.W. and RUEBERTE, R.M. 1975 Edible leaves of the tropics. *Proceedings Institute of Tropical Agriculture*, Puerbo Rico
- MCLUDOO, N.E. 1945 Bureau of Entomology and plant quarantine publication 12-661 (USDA)
- MILLER, F.R. 1977. Sorghum. In: *Mcgraw-Hill Encyclopedia of food Agriculture and nutrition*. Edited by S.H Lapedes. McGraw HILL Book company, New York
- MUZIK, T.J. 1970 *Weed Biology and control*. McGraw-HILL Book company, New York
- SHERIF, A.M; HANNA, W.W and BERHANE, M. 1987. The problems of *Stipa* (Scrophulariaceae) in Ethiopia. In; *Parasitic flowering plants* (Weber, H. Chr. and Frostruter, W. eds) Marburg, F.R.G. PP 755-762.