Journal of Agriculture and Food Environment 3(2): 109-121; 2016

Effect of neem powders *(Azadirachta indica* A. Juss) on the preservation of gum Arabic seeds (A*cacia senegal* L. Willd) infested with B*ruchus baudni* (Caill) in Gashua, Yobe State, Nigeria

***Lucy, E., **Aliyu, M. and *Ojiekpon, I. F.**

*National Rubber Research Institute,
Gum Arabic Sub-Station, Gashua, Yobe State, Nigeria.
**Department of Crop Production
Faculty of Agriculture and Agricultural Technology
Abubakar Tafawa Balewa University, Bauchi Nigeria

ABSTRACT

A study was conducted at the Rubber Research Institute of Nigeria (RRIN), Gum Arabic Sub-station Gashua, to determine the efficacy of different concentrations of neem powders against seed borer beetle (B. baudni) of Gum Arabic (A. senegal) seeds during storage, and their germination potential in comparison with a conventional chemical insecticide (aluminium phosphide).. The treatments consisted of neem powders (seed and leaf) at the rate of 4, 8 and 12g/100g seeds, and aluminum phosphide at 0.5g per100g seeds. The control treatment had neither neem powder nor aluminium phosphide. The experiment was laid out in a Completely Randomized Design (CRD) with eight treatments, and repeated three times. Data were collected on adult mortality, adult emergence, seed damage, and percentage weight loss. All data collected were subjected to analysis of variance (ANOVA), while the Duncan's multiple Range test (DMRT) was adopted in separating significantly different means. The results show that 12g neem seed powder had the highest adult mortality (1.67adults at 7th DAT), while adult emergence (0.0 adult) and percentage weight loss (97.0) were lowest at this concentration compared to the control. The effectiveness of 12g neem seed powder was even comparable with that of the synthetic chemical. Fumigant, repellent and contact effects were best exhibited in seeds treated with neem seed powder. In conclusion, an appreciable level of protection on Gum Arabic seeds was achieved using neem powders (seed and leaf) applied at different rates without negative effects on seed viability. Therefore, the application of neem powders could be recommended for effective management of B. baudni infesting A. senegal seeds.

KEYWORDS: Gum Arabic, Seed borer,, Neem powder, aluminium phosphide.

INTRODUCTION

Acacia senegal (L) Willd, popularly known as Gum Arabic, belongs to the family of *Leguminaseae* (Dorthe, 2000, Bein, 1996). Originally, the gum was sent to Arabian ports, and then to Europe, hence the name "Gum Arabic". It is a thorny deciduous tree which reaches up to 15m high. (Baumer, 1983). It has a viable, flat rounded crown while some formed branching from the base. The bark is grayish to yellowish brown, rough fissured and sometimes flaking (Style, 1976). The pods (fruits) have rounded apices. The seeds are kidney shaped. Gum Arabic is a dried colourless to brown exudation from the trunks and branches of *A. senegal* trees (Duke, 1983). It is used extensively in pharmaceuticals and confectioneries as a flavour, in bakeries, and for beverages, environmental protection, animal feeds and domestic uses. In pharmaceuticals, the gum is used for making drugs because of its suspension, stabilizing and emulsifying property (Duke, 1981). Gum Arabic has been used widely in the confectionery industry for sugar crystallization and fat emulsification (Nas, 1979, Anon, 2008). Many citrus oils and other beverages, flavours and emulsions utilize the emulsification properties of the gum. Gum Arabic is widely used in the bakery industry for its low water absorption properties (Cossatter, 1991). The ability of the gum to stabilize foam is utilized in the manufacturing of bear. (Chikami, *et, al.,* 1996). Gum Arabic is good for aforestation programmes. The tree fixes nitrogen into the soil, reduces desertification, enhances soil moisture conservation and reduces soil erosion in arid and semi-arid zones (Weir, 1930). The tree's tender leaves and pods are palatable for animals (Nas, 1979). Locally, the gum is used in local ink preparation, pottery pigmentation, as liquid gum and for dyeing of textiles; various other parts of the tree are also exploited for fuel wood, charcoal and herbal medicine (Bein, 1996). Generally, infestation starts in the field; the insects development continues unhindered even though the seeds are removed from the pods and put into store. The damage involves the consumption of kernels, loss of nutrients, reduced germination of seeds, contamination with filthy materials composed of insect fragments, exuviate and excreta. (Osuji, 1985).

Synthetic pesticides have been used for many years to control agricultural insect pests, including those that damage durable food grains in storage. However, considerable problems may arise from the continued application of these insecticides, including the development of resistance of insect pests, pollution of the environment and hazards from handling of such toxic compounds (Golob and Wedley, 1980).

Nevertheless, nature has offered us a variety of plant products that have proven useful for use in crop protection, a potential which deserve our interest. Although these botanical insecticides seem to belong to another age, they still contribute to good pest management programmes, since they tremendously minimize certain risks incurable by the farmers, consumers and the environment (Stoll, 1992). Insecticides of plant origin have been available for many years. It is perhaps not a coincidence that in Africa, plants and plant products have played an important role in traditional methods of protecting crops against pests and disease vectors (Ivbijaro, 1990). Additionally, the protection of stored products by the use of plant materials is an age-old practice among small scale farmers in Africa (Poswal and Akpa, 1991).

In view of the aforementioned problems associated with gum Arabic seeds at the small scale farm level, and problems associated with procurement and use of synthetic insecticides (Teetes and Gilstrap, 1986), this study was carried out using neem since it is relatively safe, easily adoptable as well as affordable to most of our rural farmers.

Conventional pesticides have been extensively used all over the world to check infestation of gum Arabic seed in the field and in storage. However, their use is currently being discouraged globally because of the problems related to environmental pollution and contamination of food and water, development of insect's resistance, high mammalian toxicity posing health hazards to users, and high costs of acquiring and using them (Baumer, 1983). For this reason, naturally occurring and biodegradable insecticides could be used as alternatives.

This study was intended at determine the efficacy of neem seed and leaf powders against storage insect pests of *A. senegal* seeds, and to evaluate the effect of neem seed and leaf powders on the viability and germination potentials of treated A. senegal seeds.

MATERIALS AND METHODS

Experiment Site

The experiment was conducted in the laboratory of Rubber Research Institute of Nigeria (RRIN) Gum Arabic sub-station Gashua, Yobe State, located at latitude 12^{o} 46'N, longitude 11^{o} 00'E, and altitude 360m above sea level. Yobe is located in the Sahel savannah vegetation zone of Nigeria.

Experimental Containers of *A. senegal* Seeds

The experimental containers were 24 plastic cups of 15cm in height and 10cm in diameter. Each container was covered with a piece of muslin cloth and held firmly with a rubber band to provide room for adequate air circulation and to trap the insects inside the container. The *A. senegal* gum Arabic seeds were harvested from fully matured pods of *A. senegal* trees at the RRIN's Gum Arabic sub-Station in Gashua. The seeds were extracted by hand-peeling the pods before cleaning and storage. *A. senegal* seeds with emergence holes or egg debris on the testa were considered infested and removed. The uninfested seeds were sterilized by sunning and sieving method for seven days to kill any residual insect. These seeds were then stored under anaerobic condition by using polythene bags for the experiment.

Sourcing and Culturing of Insects

To establish a culture of *Bruchus baudni* in the laboratory, adult bruchids (seed borers) were obtained from previously infested seeds sampled. The insects were brought to the laboratory and cultured on the insecticide-free, whole seeds in ambient temperature of 27^{o}C and relative humidity ranging from 55-75 percent. Emerged bruchids from the culture were used for the experiment. The technique used by Bandara and Saxena (1995) for sexing and handling of bruchus was used in the experiment. The plastic cups were covered with muslin cloth fastened with rubber bands to prevent contamination of experimental materials and escape of the insects. A seven-day period was allowed for mating and oviposition. The parent stock was sieved out and the seeds containing eggs were cultured further to obtain F1 progenies.

Preparation and use of Plant Material

The neem parts evaluated for insecticidal activity and other pertinent information are provided in Table 1.

Table 1: Information on Nomenclature and Conditions of Experimental Plant Materials and Parts

Plant material /others	Common name	Family	Parts used & conditions
Azadirachta indica	neem	meliaceae	dried seeds
Azadirachta indica	neem	meliaceae	dried leaves
Alluminiun sulphate			grounded

Neem – seed kernel powder (NSKP): Mature neem berries and leaves were collected from RRIN staff quarters, Gashua, and both parts were dried separately under shade. The dried berries were moistened in water, de-pulped, dried again and decorticated to extract the kernels. The kernels were manually crushed in a mortar with a pestle, and ground to a fine power using an electric blender. The neem leaves were also manually crushed in a mortar with a pestle and milled to a fine powder using an electric blender as well (Golob, et al., 1980; Jackai, 1981; Schmutterer and Ascher 1984). The plant materials were kept separately in air-tight containers to avoid contamination.

Experimental Design and Parameters Evaluated

The experiment was laid out in a Completely Randomized Design (CRD) with the two neem parts (seed and leaf) each at three different levels 4, 8 and 12g 100g seeds and aluminum Phosphide (AlP) at 0.5g/100g seeds. The control treatment had neither neem powder nor aluminium phosphide. This gave eight different treatments. The treatments were introduced into a total of 24 transparent plastic cups covered with white muslin cloth using rubber bands to hold it firmly. Each of the treatments was repeated three times. The milled neem powders (seed and leaf), AlP, and untreated (control) were thoroughly admixed with 100g of *A. senegal* seed; contained in 24 translucent bottles, at the rate of 4, 8 and 12g as described by (Stoll, 1992; Adebayo and Gbolode 1994). Adult bruchids were introduced into the bottles containing the treatments with *A. senegal* seeds and were confined by covering the open end of each bottle with a muslin cloth tied firmly with a rubber band. The whole setup was kept in a culture room throughout the period of the experiment. The parameters evaluated were five, namely, adult mortality, adult (progenies) emergence, seed damage, percentage weight loss and viability test to determine the insecticidal activity of the test products. These were measured and recorded using standard methods (Ojiekpon and Aghughu, 1997; Turnbull, et al., 1983).

Analysis of Data

Data were subjected to analysis of variance using a computer software, SAS for windows. Means were separated at 0.05% level of probability using the Duncan's multiple range test (DMRT) technique.

RESULTS

Table 2 shows the effect of neem powder and aluminum phosphide on adult mortality of *Bruchus baudni* on stored *Acacia senegal* seeds. Seeds treated with aluminum phosphide though statistically similar to 12g neem seed powder, recorded the highest mortality compared to the rest treatments at 7^{th} day after infestation. At 14^{th} day after treatment (DAT), the untreated seeds (control) appeared statistically similar to seeds treated with neem leaf powder regardless of concentration. The mean number of mortality was significantly lower compared to seeds treated with neem seed powder.

In Table 3 are shown the effects of neem powder and aluminum phosphide levels on adult emergence of acacia seed borer taken at 42, 49, 56 and 63 DAT. Untreated seeds of *A. senegal* recorded the highest adult emergence of *B. baudni* compared to the rest of the treatments at 42, 49, 56 and 63 DAT. However, 4g neem leaf powder was statistically similar (P>0.05) with untreated check at 63 day after infestation, though untreated seeds recorded the highest adult emergence.

Table 2: Mean values of adult mortality of *Bruchus baudni* of *Acacia senegal* as influenced by neem powders and aluminum phosphide at 7^{th} and 14^{th} DAT

TREATMENT	7^{th}	14^{th}
NSP (4g)	2.67^{a}	3.00^{bc}
NSP (8g)	2.33^{a}	2.33^{c}
NSP (12g)	1.67^{ab}	2.00^{cd}
NLP (4g)	3.00^{a}	5.00^{ab}
NLP (8g)	3.00^{a}	4.00^{abc}
NLP (12g)	2.67^{a}	3.33^{abc}
AlP (0.5g)	0.00^{b}	0.00^{d}
Control	3.67^{a}	5.67^{a}
SE±	0.73	0.72
LS	*	**

Means followed by same letter (s) on the same column do not differ significantly (P>0.05). DAT = Days after treatment; NSP = Neem seed powder; NLP = Neem leaf powder; AlP= Aluminum phosphide; DMRT=Duncan's multiple rest test; SE± = Standard Error.

Table 3: Effect of neem powders and aluminum phosphide on adult emergence of *Bruchus baudni* on stored *A. senegal* seeds weekly starting from 42 days after infestation.

TREATMENT	42	49	56	63
NSP (4g)	0.00^{b}	0.67^{b}	0.00^{b}	0.67^{b}
NSP (8g)	0.00^{b}	0.00^{b}	0.00^{b}	0.67^{b}
NSP (12g)	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}
NLP (4g)	1.67^{b}	3.00^{b}	6.00^{b}	11.67^{ab}
NLP (8g)	0.33^{b}	1.33^{b}	2.33^{b}	9.00^{b}
NLP (12g)	0.00^{b}	0.67^{b}	3.00^{b}	5.33^{b}
AlP (0.5g)	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}
Control	18.33^{a}	18.33^{a}	17.33^{a}	26.67^{a}

Means in the same column with same superscript letter/s are statistically (P>0.05) the same.

Table 4 shows the effect of neem powder and aluminum phosphide on percentage seed damage of *Acacia senegal* seed at 63 day after infestation. On seed damage, 12g neem seed powder and aluminum phosphide had lower seed damage compared to the rest treatments and control. Similarly, 12g neem seed powder is statistically comparable to the treated seeds except untreated check which was not effective at 63 DAT.

TABLE 4: Effect of neem powders and aluminum phosphide on seed damage of *Acacia senegal* infested with *Bruchus baudni* at 63 day after infestation.

TREATMENT	63 DAT
NSP (4g)	0.336^{bc}
NSP (8g)	0.33^{bc}
NSP (12g)	0.00^{c}
NLP (4g)	1.33^{b}
NLP (8g)	0.33^{bc}
NLP (12g)	0.33^{bc}
AlP (0.5g)	0.00^{c}
Control	4.00^{a}
SE $\pm$	0.336
LS	***

Means in same column with same superscript/s do not differ significantly (P> 0.05).

Table 5 shows the effect of neem powder and aluminum phosphide on percentage weight loss of *Acacia senegal* attacked by *Bruchus baudni* taken at 63 DAT.

TABLE 5: Effect of neem powders and aluminum phosphide on percentage weight loss of stored *A. senegal* seed attacked by *B. baudni* at 63 days after infestation.

TREATMENT	% Weight loss
NSP (4g)	7.67[a]
NSP (8g)	5.33[a]
NSP (12g)	3.00[a]
NLP (4g)	32.00[b]
NLP (8g)	14.00[a]
NLP (12g)	14.67[a]
AlP (0.5g)	3.33[a]
Control	53.53[c]
SE $\pm$	4.835
LS	***

Means within same column with same superscripts are not significantly different (P>0.05).

The mean seed weight of Acacia seeds that were attacked by *Bruchus baudni* but treated with neem powder and aluminum phosphide was heavier when compared to untreated Acacia seeds. However, seed weight of Acacia seeds treated with 12g neem seed powder were heavier than those treated with 4g neem leaf powder. The findings of this study are in conformity with that of Seck *et al*., (1991). They reported that leaves and kernels of *Azadirachta indica* increased adult mortality of *C. maculates* and protected weight loss by more than 90%.

In Table 6, it can be seen that all the levels of the neem powders gave good germination percentages and with no effect on seed viability after the experiment at 63DAT when compared to the control which recorded 40% germination. However, the germination was higher at 4g neem leaf powder (73.3%).

TABLE 6: Effect of neem seed powders and Aluminum phosphide on percentage seed germination of *Acacia senegal* seeds infested by *Bruchus baudni* at the end of the experiment.

TREATMENT	% Germination
NSP (4g)	73.3
NSP (8g)	63.3
NSP (12g)	66.7
NLP (4g)	66.7
NLP (8g)	66.7
NLP (12g)	63.3
AlP (0.5g)	66.7
Control	40.0

DISCUSSION

The results clearly show the dependence of insecticidal activity on rate of application of insecticidal neem powder. Similar findings were previously reported by Golob *et al* (1982); Sharaby (1988); Misari and Usman (1990). However, the findings of Bhagat and Tripathi (1989) contrasted with these as they reported a decreasing efficacy of neem leaf powder as concentration was increased from 1g to 3g/100g grain.

All the concentrations of neem powder were found to be effective in reducing adult emergence at 42, 49, 59 days after infestation. The effectiveness of the neem powders in reducing emergence of *Bruchus baudni* on stored Acacia seed was more pronounced especially when the crop stored for a longer period (3 months) of time (Maina *et al.,* 2012). At 63 days after infestation all rates of neem powder proved to be effective in reducing adult emergence of *Bruchus baudni,* except 4g neem leaf powder which was ineffective in suppressing adult emergence at 63 DAT. There was direct relationship between number of adult emerged and quantity of neem leaf powder applied.

The inability of 4g neem leaf powder to suppressed adult emergence could probably be due to low concentration, of the neem leaf powder. In addition it could be due to atmospheric loss of plant's strong odour.

Nevertheless, neem powder has promising potentials in reducing adult emergence of *Collusobruchus maculatus* (Yakubu, 2005). Yusuf and Ahmed (2005) reported that the rate of 8g/100g of grain reduced infestation at 42 and 63 DAT. Protective methods are used if grain is to be stored longer than 2 months. The lowest concentration (4g/100g grain) therefore, proved to be the least effective in reducing seed damage.

Although Neem seed and Neem leaf have been found to be effective in suppressing weevil damage in stored maize (Ogunwolu and Wajilda, 1996), the result of the experiment shows that the leaf of Neem was slightly more effective on the Acacia Borers. This funding could be likened to that of Bhagal and Gripathi (1989), who reported slight toxicity of Neem leaf powder on the adults of *R. dominica* on maize.

A. senegal seed weight loss was also investigated from the different treatments applied at 63 DAT, and the results were similar to the findings of Singh (1985). The mean grain weight of Acacia seeds that were treated with neem powder and aluminum phosphide were heavier compared to untreated Acacia seeds. However, grain weight of Acacia seeds treated with 12g neem seed powder were heavier than 4g neem leaf powder. The findings of this study are in conformity with that of Seck *et al*. (1991). They reported that leaves and kernesl of *Azadirachta indica* increased adult mortality of *C. maculates* and protected weight loss by more than 90%. This indicates the efficacy of Neem seed powder and possibly some other concentration of Neem leaf powder.

The results of this study clearly show the dependence of insecticidal activity on rate of application of insecticidal materials (Table 7). Similar findings were previously reported by Glob e*t al*. (1982); Sharaby (1988); and Misari and Usman (1990). However, the findings of Bhagat and Tripathi (1989) contrasted with these as they reported a decreasing efficacy of neem leaf as concentration was increased from 4 to 12 g/100g grain.

On percent seed germination, the treated seeds of *A. senegal* attacked by *Bruchus baudni* had higher germination percentage to the untreated. Increase in percent germination of seed which received treatment agreed with the finding of Gupta *et al*. (1989). They reported that neem dose did not impair germination. In fact, rice seedlings raised from seeds treated with 2.5g seed kernel extract or with 2% neem cake were more vigorous and had higher root and shoot growth indices and dry weights than those germinated from untreated seeds (Abdulkareem *et. al*., 1989; Karshon, 1975). On the other hand, Ranasinghe and Dharmasena (1989) reported poor percentage germination when cowpea was treated with neem oil at 10 days before testing but significantly increased at 30 days.

CONCLUSION

In conclusion, the results of the experiment showed that there exists potentialities in the use of neem powders (seed and leaf) for the control of *Bruchus baudni* in stored acacia seeds at the rate of 12g/100g seeds. It can therefore be conveniently used as a substitute the synthetic chemical, aluminum phosphide.

REFERENCES

Abdulkareem, R.C. Sexena, M.E.M. Boncodin, V. Krishnasamy, and D.V. Seshu. (1989). Neem as seed treatment for rice before sowing: effects on two homopterous insects and seedling vigor. J.Econ. Entomol. 82:1219-1223.

Adebayo, T. A. and Gbolode A. A. (1994). Protection of stored cowpea from *Callosobruchus maculatus* F. Using plant products. Journal of Insect Science and its Application 15 (2): 185-189.

Anon. (2008), Gum Arabic market news service. Int. Trade Centre, http//www., intracen, org/mns, pp35.

Bandara, K.A.N.P., Sexena R.C. (1995) . *Journal of stored products Research*, 1995, 31: 97-100.

Barner, R.D; Filer, D.L. and Milton, S.J. (1996). Acacia Karroo; Monogragh and annotated bibliography. Oxford forestry Istitute, UK, FPP R4526.

Baumer, M. (1983). Notes on trees and shrubs in arid and semi- arid regions. Rome FAO. Forestry Division.

Bein, E. 1996. Useful trees and shrubs in Eritrea. Regional Soil Conservation Unit (RSCU), Nairobi, Kenya.

Bhagat, O.P. and Tripathi, V.K. (1989). The efficacy in combination with tulsi against *Rhyzopertha dominica* (F.) in stored maize, Neem neemsletter. 6 (4). Indian Agricultural Research Institute, New Delhi.

Chikami, B. N., Philips, G.O. and Casadei, E. (1996). Characterization and Specification of Gum Arabic, Technical Co-operation Programme. Project No. TCP/RAF, 457pp.

Cossatter, C. (1991). *Acacia senegal*: gum tree with promise for agroforestry. N.F.T. Highlights, No, 19-20.

Dorthe, J. (2000). *Acacia senegal* L. Willd, seed Leaflet. Denida Forest Centre Denmark, http:// www.dfs. dk.

Duke, A.J. (1981), *Acacia senegal* (L.), Willd Handbook of Energy crops. http://www.hort. Produce edu/newcrop/duke/*Acacia senegal*. html.

Duke J.A. (1983). *Acacia senegal*. (L.) Willd, Handbook of Energy Crops Unpublished Purdue University. Centre for new crops and plants products.

Golob, P. and Wedley B.T. (1980). The use of plant product and minerals as traditional protestants of stored products. Tropical Product Istitute 9 No. 38; 31pp.

Gupta, H.C., J.P. Verma,S.S. Bareth, and B.N. Mathur. (1989). Evaluation of some nonedible oils as grain protectants in wheat and their subsequent, effect on germination Indian J. Entomol. 50: 147-150.

Ivbijaro, M. F. (1983). Preservation of cowpea, *Vigna unguiculata* L. (Walp), with the neem seed, *Azadirachta indica* A. juss. Protection Ecology, 5 (2): 177-182.

Ivbijaro, M.F. (1990.) Natural pesticides: Role and Production Potential in Nigeria. National workshop on the Pesticide Industry in Nigeria University of Ibadan, Sept. 24-27, p.24.

Jackai, L.E.N. (1991). Touse of Neem in controlling Cowpea Pest International Institute of tropical Agriculture IITA Research 7: 5-11.

Maina, Z. Dauda, and D.M. Mailafiya, (2012). "Efficacy of aging stored neem seed oil and varietal resistance for the management of C. maculates (F.) Infesting stored cowpea (Vigna unguiculata) L. Walp." In Storage International Journal of Crop Science, Vol.4,pp, 79-83.

Misari, S.M. and Usman, S.A. (1990). Evaluation of neem products and synthetic insecticides for the control of rust red flour beetle, Tribolium castaneum Herbst. On stored groundnuts. In legumes and oilseeds Research Samaru, Zaria. Cropping Scheme Meeting, 1990. Pp.19-21.

Nas, L. (1979), Tropical legumes; Resources for the future. National Academy for Science,Washington D.C. pp.279-283.

Ogunwolu, E.O. and Wajilda A.T. (1996). Suppression of seed bruchid (*callosobruchus maculatus* . F) development and damage on cowpea (*Vigna unguilata* (L.) Walp.) with *Zanthoxylum zanthoxyloides* (Lam.) Watern. (Rutaceae) root bark powder and pirimiphos methyl Crop protection. 15 (7): 603-607.

Ojiekpon, I.F. and Aghughu, O. (1997). Studies on the production pattern of gum Arabic in Nigeria. Paper presented at the Rubber Research Institute of Nigeria seminar series at RRIN conference Hall Iyanomo 24th April, 1997.

Osuji, F.(1985). Outlines of stored products Entomology for the tropics, Fourth Dimension Publishers, Enugu, Nigeria.

Poswal, M.A.T. and Akpa, A.D. (1991).Current trends in the use of traditional and organic methods for the control of crop pests and diseases in Nigeria. Tropical pest management. *Callosobruchus maculatus* 37 (4): 320-333.

Ranasinghe, M.A.S.K. and Dharmasena, C.M.D. (1989). Effect of three vegetable oils on oviposition and egg hatchability of cowpea bruchid, Proc. Int., workshop on the use botanical pesticides. Int. Rice Res. Inst., Manila, 1984. 15pp. (Mimeo).

Schmutterer, H. and Ascher,K.R.S. (1984). Natural pesticides from neem tree and other tropical plants. Proceedings of 2nd International Neem Conference, 1983, G.T.Z. Eschborn, Germany. Extract of Azadirachta indica, Petiveria alliacea, and Piper guineenses on the Variegatus. Proceedings of the 3rd International Neem Conference, Nairobi, Kenya.

Seck, D., B. Sidibe, E. Haubruge and C. Gaspar, (1991). La protection des.Strocks de niebe (*Vigna unguiculata* (L.) Walp.) en milieu rural: Utilization de differentes formulations a base de neem (*Azadirachta indica* A. juss.) Provenant du Senegal. Mededelingen Van de faculteit Landbouwwetenschappen, Jijksuniversiteit Gent, 56:1217-1224.

Sharaby, A. (1988). Evaluation of some Myrataceae plan leaves as protectants against the infestation by stitophilus oryzea L. and S. granaries L. Insect Science and its application 9 (4):465-468.

Singh, S.R., Jackai; L.E.N., 1985. Insect pests of cowpea in Africa: their life cycle, economic importance and potential for control. In Sing S. R., Rachie K.O. (Edus.) Cowpea Research, Production and Utilization. John Wiley and Sons. Chichester,pp.217-232.

Stoll, G. (1982). Natural Crop Protection in the tropics Verlag Joseph Magraf Weikersheim, Germany, 188pp.

Stoll, G. (2000). Natural Crop Protection in the tropics: Letting Information come to life. 2nd enlarged edition. Margraf Verlag 2000.

Style, B. T. (1976). The bases population: Taxonomic studies, In: Manual on species and Provenance Research with particular reference to the tropics (eds. Burley. J. and P.J) wood.

Teetes G.L. and Gilstrap, (1996). Development and evaluation of systems for controlling insects pests of sorghum and millet by intergration of resistant variety, cultural manipulation and biological control Projects TAM-125. In INTs or MIL.Annaul Report for 1986, pp 214-222.

Turnbull, Doram, J.C., Turnbull, J.W., Boland, D.J., Gunn, B.V. (1983). Handbook on seeds of dry-zone acacias. A guide for collecting, extracting, cleaning and storing the seed and for treatment to promote germination of dry- zone- acacias. FAO, RAO, Rome Italy.

Yakubu, A.I. (2005). Potential of Khaya senegalensis on Callosobruchus maculates. Journal of stored Product Research. 13:19-23.

Yusuf, S.R. and Ahmed, B.I. (2005). Effect of application rate on some plant materials in the control of maize weevil Sitophilus zeamais in stored maize. Nigerian journal of pure and Applied Science. 8: 180-189.

Weir, A. H. W, (1930), Report of Gum Arabic in Borno Province, Nigeria.1-24.