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Efficacy of extracts from *Jatropha curcas* (L.) and *Azadirachta indica* (A. Juss) on *Alstonia boonei* (De Wild) attacked by *Anobium punctatum* (De Geer)

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ABSTRACT

Studies on the efficacy of ethanolic and water extracts as well as the ashes of the plant parts of Jatropha curcas (L.) and Azadirachta indica (A. Juss) for the control of Anobium punctatum on boards of Alstonia boonei were carried out at the wood work unit of the Michael Okpara University of Agriculture, Umudike. A completely randomized design with three replications was used. Data were collected weekly for one year after application (1 YAA). Result showed that among the plant parts of Jatropha curcas and Azadirachta indica tested, Jatropha Seed and Jatropha Bark, Neem Leaf and Neem Bark were the most effective in controlling the number of boards attacked and number of gallery activities of the insect pest. The least number of pest infestation occurred with ashes of Neem Leaf (4.07) and (29.5) respectively for number of boards attacked and number of galleries on boards, followed by ashes of Neem Bark. All the plant extracts reduced significantly(P>/0.05) the activities of the beetle than the control, which had the highest number of boards of Alstonia boonei attacked as well as the highest number of galleries on boards. Ash treatment however performed better than the other extracts in reducing the activities of the pest. Therefore this study showed that biopesticide extracts from Azadirachta indica and Jatropha curcas could be recommended for further studies.

Keywords*: Jatropha curcas, Azadirachta indica, Biopesticide, Alstonia boonei, Anobium punctatum*

INTRODUCTION

Since pre- historic, man around the world has relied on products derived from forest species for their survival and well being (Delang, 2006). Natural vegetation provides us with an array of products and services that play important role in our national economy and general well being. Although timber has long been considered as the principal product, there are other numerous and vital forest produce, usually collectively called “non-timber forest products” (NTFP) on whose resources the local economies intricately depend (Kang *et al.*, 1981), and to a larger extent are derived outside the products of the vascular cambium (Emery and Rebecca, 2001). The Timber products which have remained the primary forest products are in certain circumstances attacked by various wood-boring insects which differ in their choice of species and condition of the wood- from standing trees to woodwork which has been in service for many years (Nick, 2005). According to Nick (2005), most damage to timberwork is caused by the larvae hatched from eggs laid by the insects in holes and cracks in the wood, which then eat their way into the timber, pupate and then emerge to start the whole cycle again. Infestation in most trees or logs usually dies after felling but evidence of the attack remains permanently in the seasoned wood as wormholes.

Notable among the timber species in the family of Apocynaceae which are more liable to attack by some wood boring insects is *Alstonia boonei* (Mok, 1991). The wood of *Alstonia boonei,* called alstonia in international trade, is used for light construction and light carpentry works and for the production of household implements because of its good working properties and stability. In Ghana it is used for the famous Asante stools and in Nigeria for sound boxes of musical instruments of the Yoruba people. The wood is also used as firewood (Keay, 1989). However, export prospects are doubtful because of the poor durability of the wood as it is easily attacked by fungi and very prone to blue stain and is very susceptible to dry-wood borers, powder-post beetles and termites (Mok, 1991). A common furniture beetle that devastates logs of Alstonia boonei is a wood boring beetle - Anobium punctatum (Babarinde et al., 2008).

More recently as attention is focused on global environmental problems, emphasis has been laid on naturally occurring substances that control pests by non- toxic mechanisms. Hence effort was made in this work to know which plant could be used as biopesticides to protect logs of *Alstonia boonei* from such attacks by *Anobium punctatum.*

MATERIALS AND METHODS

2.1 Site Description

The study was carried out at the Wood Work Unit of the Department of Forestry and Environmental Management of the Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria, located within latitude 5^{o} 29^{1}N and longitude 7^{o} 24^{1}E within the lowland rainforest, on an altitude of 122m above the sea level (Keay, 1959). The annual climatic data of Umudike are: rainfall- 2238mm, maximum and minimum temperature-30^{o}C and 23^{o}C respectively; and 65-80% relative humidity (National Root Crops Research Institute Umudike, Nigeria).

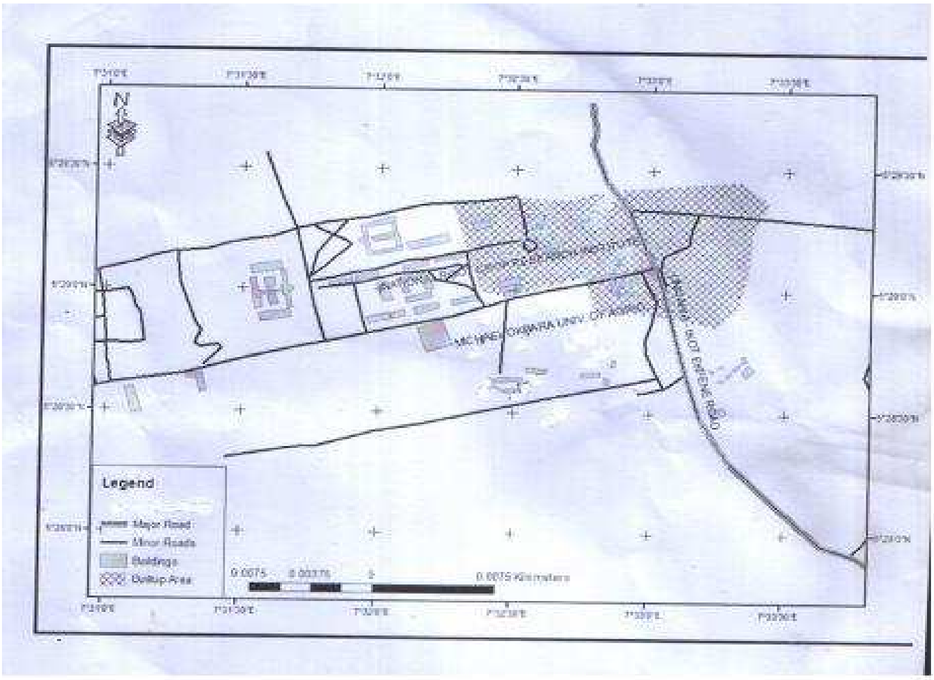

Figure 1: Map of the Study area (source: google map)

Figure1. Map of the study area (Google Map).

2.2 Methodology

Dried logs of *Alstonia boonei* were bought from Timber market, Umuahia, and sawn into boards of 25cm x 12.5cm x 0.75cm and laid in the Wood Work Unit of the Department of Forestry and Environmental Management, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The experiment was laid out in a Complete Randomized Design (CRD) with three replicates.

2.2.1 Processing and application of plant extracts of Jatropha curcas (l.) and Azadiracht indica (A. juss) on boards of Alstonia boonei

Aqueous and ethanolic extracts of the plant parts were obtained using the cold extraction method (Harborne, 1973). All tested samples (leaves, seeds, bark and roots) were carefully dried in the oven at 65^{o}C and sieved. 3kg each of the processed sample was soaked in the appropriate solvent (water and ethanol) and allowed to stand overnight at room temperature. The next day, each mixture was shaken for an hour in a reciprocal mechanical shaker and then filtered through a twofold Mushin cloth to obtain the crude extract for both water and ethanol. Ethanol extracts were recovered from dry ethanol in a soxyhlp apparatus and were reconstituted in sterile water before use. The boards were wholly soaked in the appropriate extracts. On the other hand, the ashes of the plant parts were mixed thoroughly with the boards. Seeds of *Jatropha curcas* could not burn to ashes, therefore ashes of seeds of both *Jatropha* and Neem were not included in the experiment.

3. Statistical and Computational Procedures

Data were collected on cumulative number of galleries on each boards and cumulative number of boards attacked in each treatment and analyzed statistically at p<0.05 using Fisher's Least significant difference (F-LSD), to test for significant differences between treatment means according to the procedures of Steel and Torrie (1980).

RESULTS

4.1. Effect of Extracts, Plant Parts and Plant Species on Number of Boards attacked and number of galleries on boards

The effects of extract on the number of boards of *Alstonia boonei* attacked by *Anobium punctatum* and the number of galleries of *Anobium punctatum* on boards of *Alstonia boonei* were significant ($P \geq 0.05$). For the number of boards attacked, no statistical difference existed between means of ethanolic (6.22) and water (6.11) extracts (Table 1). Results showed that ash gave a significant least pest infestation on boards (4.61) while the control recorded the highest number of boards attacked (10.00). Similar trend followed on the number of galleries on boards. Here ethanol and water extracts had same statistical mean results. Ash was most effective in reducing the number of galleries on boards of *Alstonia boonei* (20.00) while control recorded the highest infestation (134.7) (Table 1).

The effect of plant part on the number of boards attacked and the number of galleries on boards respectively was significant ($P \geq 0.05$). On the number of boards attacked, bark (6.12) and leaf (5.73) gave statistically the same least mean number of boards attacked by the insect pest. Root (6.96) gave better performance over the control (7.27) which had the highest mean number of boards attacked. Similarly, bark (40.0) best inhibited the gallery activities of the pest on boards of *Alstonia boonei* while control still gave the highest number of galleries on boards (Table 1).

The effect of plant species on the number of boards attacked and the number of galleries on boards was equally significant ($P \geq 0.05$) with mean results showing better performances of Neem in reducing both the number of boards attacked(5.29) and the number of galleries on boards (28.4) over Jatropha (7.25) and (56.2) respectively. However, in each case, Jatropha gave statistically better performance over the control (Table 1).

Table 1: Effect of extract, plant part and plant species on the number of boards attacked and number of galleries on boards at 1YAA

Treatment	One year after application(1 YAA)	
Extract	**Number of boards**	**Number of galleries**
Ash	4.61(2.23)[be]	20.0(4.35)[be]
Control	10.00(3.24)[a]	134.7(11.60)[a]
Ethanol	6.22(2.58)[cf]	37.5(6.07)[cf]
Water	6.11(2.56)[df]	40.7(6.25)[df]
LSD0.05	**0.62**	**7.14**
Plant Part		
Bark	6.12(2.55)[be]	40.0(5.85)[b]
Control	7.27(3.57)[a]	67.3(8.42)[a]
Leaf	5.73(2.44)[ce]	50.2(6.54)[c]
Root	6.96(2.72)[df]	51.7(6.87)[c]
LSD0.05	**0.62**	**7.14**
Plant species		
Control	9.27(5.57)[a]	77.3(9.42)[a]
Jatropha	7.25(2.78)[bd]	56.2(7.18)[bd]
Neem	5.29(2.36)[ce]	28.4(5.66)[ce]
LSD 0.05	**0.58**	**6.73**

Figures in parenthesis are square root transformed data

Means of control and means followed by same letters within the same column and treatment do not significantly differ at 5% level of probability.

4.2. Effect of plant parts of Jatropha curcas and Azadirachta indica on the Number of Boards attacked and the Number of Galleries on boards.

Plant parts of the two species gave significant ($P \geq 0.05$) effects on both the number of boards attacked and the number of galleries on boards of *Alstonia boonei* (Table2). On the number of boards attacked, although no statistical differences existed between the means of Jatropha Bark (7.07), Jatropha Leaf (7.40) and Jatropha Root (7.29), Jatropha Bark gave better pesticidal performance. On the other hand, Neem Leaf (4.07) and Neem Bark (5.18) gave significantly the least number of boards attacked over Jatropha. In each case, control (8.27) maintained the highest number of boards attacked (Table 2).

Jatropha Bark (42.90) significantly inhibited the gallery activities of the insect pest better than either Jatropha Root (54.72) or Jatropha Leaf (70.90). However, Neem Leaf (29.52) and Neem Bark (37.11) offered better pesticidal effect against the gallery activities of the insect pest in comparism with Jatropha Bark. In each case also, control had the highest infestations on boards (87.32) (Table 2).

Table 2: Effect of plant parts of plant species on the number of boards attacked and number of galleries on boards at 1YAA

	Plant Species					
Plant Parts	**Number of boards attacked**			**Number of galleries on boards**		
	Control	Jatropha	Neem	Control	Jatropha	Neem
Bark		7.07(2.74)^{be}	5.18(2.36)^{be}		42.90(6.10)^{be}	37.11(5.60)^{be}
Control	8.27(3.57)^{a}			87.32(6.42)^{a}		
Leaf		7.40(2.81)^{ce}	4.07(2.07)^{cf}		70.90(8.37)^{cf}	29.52(4.71)^{ce}
Root		7.29(2.79)^{de}	6.62(2.65)^{dg}		54.72(7.08)^{dg}	48.70(6.67)^{df}
LSD0.05	**0.71**			**8.24**		

Figures in parenthesis are square root transformed data

Means of control and means followed by same letters within the same column and treatment do not significantly differ at 5% level of probability.

4.1.3. Effect of extracts of Jatropha curcas and Azadirachta indica on the number of galleries on boards

Extracts of plant species were only significant ($P \geq 0.05$) on the number of galleries on boards (Table 3). Here Jatropha Ash (25.8) significantly inhibited the gallery activities of the insect pest better than either Jatropha Ethanol (46.1) or Jatropha Water (52.9). However, Neem Ash offered better protection (14.2) over Jatropha Ash. Neem Ethanol (28.9) and Neem Water (28.4) had no statistical difference in their effect. In each case, control had the highest gallery activities of the insect pest (134.7).

Table 3: Effect of extracts of plant species on the number of galleries on boards at 1YAA

Extracts	**Plant Species**		
	Control	Jatropha	Neem
Ash		25.8(4.92)^{be}	14.2(3.78)^{be}
Control	134.7(11.60)^{a}		
Ethanol		46.1(6.79)^{cf}	28.9(5.35)^{cf}
Water		52.9(7.25)^{dg}	28.4(5.26)^{df}
LSD0.05	**4.08**		

Figures in parenthesis are square root transformed data

Means of control and means followed by same letters within the same column and treatment do not significantly differ at 5% level of probability.

Figure 2: typical gallery activity of Anobium puctatum

DISCUSSION

5.1. Pesticidal Effects of Jatropha curcas (l.) and Azadirachta indica (A. juss) plant parts on Alstonia boonei (De wild)

Results of the study indicated that the plant parts exhibited various degrees of toxicity to the beetle *Anobium punctatum*. The most promising of the plant materials were the Jatropha Bark, Jatropha Seed and Jatropha Root, as well as Neem Leaf and Neem Bark. However, Neem Leaf Ash was adjudged the most potent because it best inhibited the gallery activities of the beetle as well as gave the overall least number of boards of *Alstonia boonei* attacked by the beetle followed closely by Neem Bark Ash. However, the low pesticidal performance of Neem Seed in this study varies with findings of Golob and Webley (1980); Saxena et al., (1989) which highlighted the use of Neem seeds for protection against insect pests including weevils, *Sitophilus* spp., khapra beetles, *Trogoderma granarium* and lesser grain borer, *Rhizopertha dominica.* This might be due to environmental variables of humidity and temperature as the Azadirachtin content in seed kernels varies with the geographical location of the Neem plants (Ermel *et al*., 1987). The Azadirachtin content has also been analysed in relation to development and growing conditions of the trees (Gruber, 1991). According to Singh (1987), the relationships between the active ingredient, antifeedant activity and climatic factors are not straight forward but high temperature and relative humidity and exposure to light decrease the content of Azadirachtin in neem seeds.

On the other hand, the high pesticidal performances of Jatropha Seed, Jatropha Bark and Jatropha Root are similar to the report that extracts and crude oil from the seeds of *J. curcas* have traditionally been used as an insect repellent, molluscide and rodenticide (Duke 1985). The insecticidal activity of extracts of *J. curcas* plant parts have been reported for the tobacco hornworm, *Manduca sexta*, cotton bollworm, *Helicoverpa armigera*, melon aphid, *Aphis gossypii*, pink bollworm, *Pectinophora gossypiella*, leafhoppers, *Empoasca biguttula*, Chinese bean weevil, *Callosobruschus chinensis*, maize weevil, *Sitophilus zeamays*, potato tuberworm moth, *Phthorimaea operculella*, pink stalk borer, *Sesamia calamistis*, American cockroach, *Periplaneta Americana*, German cockroach, *Blatella germanica* and the milkweed bug, *Oncopeltus fasciatus* (Shelke *et al*. 1985; Sauerwein *et al*. 1993; Solsoloy 1995; Wink *et al*. 1999). Aiyelaagbe *et. al* (1998) had also reported that stems of Jatropha curcas had been suggested to possess various biological activities including anti-insect, antimicrobial, cytotoxic, anti-inflammatory, and molluscicidal activities.

5.2 Medium of extraction on pesticidal activities of Jatropha curcas and Azadirachta indica.

The high performances of water and ethanolic extracts of both *Jatropha curcas* and *Azadirachta indica* in this study confirm the views of Badam *et al*., (1987); Jeyasakthy *et al*., (2013) and Udeinya *et al.*, (2008) that over 195 species of insects in West Africa, India, Myanmar etc are affected by aqueous and methanolic neem extracts, and insects that have become resistant to synthetic pesticides are also controlled with these extracts. Further, water extract from fresh leaves gave a good control of stem borers in maize, *Chilo partellus,* when applied into the plant whorls in Mozambique (Segeren, 1993).Various reports have equally shown the antimicrobial and pesticidal activities of ethanolic and aqueous extracts from different parts of *J. curcas* plant. However, the efficacy of extracts to inhibit infestation and microbial growth seem to vary according to extraction procedures and application methods. Many variables such as formulation, dosage, potency and persistence were known to influence the performance of an insecticide in any insect control programme (Hassal, 1990; Ajayi and Lale, 2001)

The comparatively better performance of the ash over the other extracts and the best pesticidal effects of ashes of Neem leaf and Neem bark point to the fact that the development of *Anobium punctatum* was greatly inhibited best by these ashes. To treat stored products with ash is a common method of protection against insect pest (Golob and Webley, 1980). The ash is either mixed thoroughly or added to the stored product in various layers. Some ashes made from fruits, seeds, leaves etc of local medicinal plants have been demonstrated to be effective in protecting stored products against pest depredation (Ivbijaro, 1983). Wood ash, as well as sand, tobacco dust and dolomite, provided a good protection of maize stored for six months in Malawi (Golob, 1984). Segeren (1993) further observed that Leaf extract in water was not as effective as Neem leaf powder against the stem borers in maize.

Although the protective mechanisms of ash is unclear., Golob and Webley, (1980) however concluded that desiccation and suffocation are two possible ways of how insects are affected and there may be a variation in how effective different ash products are owing to differences in texture and chemical composition. The plant pesticides did not automatically stop the activities of the beetle after application. Stone (1992) reported that since biopesticides are insect growth regulator, there is usually no immediate knockdown effect as insects may continue to feed. However, due to their repellant effects, insect feeding will be reduced.

CONCLUSION

The efficacy of these plant extracts in reducing damage and control of *Anobium punctatum* infestation on boards of *Alstonia boonei* during storage could be very exciting and offers protection and better utilization of this timber species (*Alstonia boonei*). Since many biopesticides function by interfering with a pathogen's ability to infect a susceptible plant either directly through parasitism or indirectly through the production of secondary compounds, timing is critical as effective control requires that the application of materials begins prior to conditions favorable for disease development or immediately following the first symptoms of disease. The technology of ash processing and application is simpler and cheap, and should therefore be embraced as a more appropriate plant pesticide formulation.

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