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The potential of neem based pesticides in integrated insect pest management in Nigeria: Aspects for more scientific investigation

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Abstract

Azadirachta indica (A) Juss which is commonly called Neem was introduced to Nigeria from Ghana, and was first grown from the seeds in Maiduguri, in the then Bornu province (Now Borno State), Nigeria in 1928. Aside its medicinal importance, neem products have great pesticidal and most especially insecticidal potential. Various neem formulations such as oil, seed kernel powder and, leaf and seed kernel extracts have been experimented for the control of different insect pests with appreciable success thereby bringing to the fore the potential of neem in insect pest management. However, for these research findings to be propagated and accepted by our low-resource/grass-root farmers, who happens to be the backbone of Nigerian Agriculture, the researches need to be holistic; hence the following aspects which so far have not received serious attention are recommended for further investigation in Nigeria. These aspects include; on farm trials, cost benefit analysis of neem based pesticides, evaluation of the potential of neem products to act as synergists/to be synergized particularly by other botanicals, determination of neem trees with better insecticidal properties; environmental impact, phytotoxicity, pest resurgence and pest resistance assessments of neem based pesticides.

INTRODUCTION

The rise in incidences of insect pest resistance to synthetic insecticides and other environmental and health concerns occasioned by their indiscriminate use have led to the quest for cost-effective and biodegradable insecticides with greater selectivity. Therefore, an ideal insecticide which will meet our current need and that of the foreseeable future must be specific, non toxic to mammals, biodegradable, less disposed to insect pest resistance and comparatively less expensive (cheap) [1]. The characteristics of neem based insecticides shows that it meets these criteria. *Azadirachta indica* (Neem) is important most especially in the Northern Nigerian forestry as it constitutes the largest population of trees in the region. It is commonly called "*Dogon yaro"* after the first caretaker of the neem tree in Maiduguri, the capital of Borno State; Northern Nigeria [2]. Though its leaves are used as sources of biochemicals, its fruits are the major sources [3, 4] Traditional methods mostly used whole plants or plant parts with minimal modification. Most of these crude methods are still in use today. In Nigeria, farmers have for a long time been using aqueous extracts of neem seed sprayed with twigs from tree branches, to put off insect pests from their crops. Modern methods for using neem products include the application of low-volume or ultralow-volume sprays; powders, seed and seedling treatments; and soil amendments [4].

Research reports in Nigeria have shown that neem products are wonderful tools against insect pest of different groups such as Lepidoptera, Coleoptera, Homoptera, Hemiptera and Doptera both on the field and storage crops [5]. For example, the antifeedant effect of neem extract on *Zonocerus variegates* (L.) was reported by [6]. Okrikata and Anaso [7] reported the efficacy of some neem kernel dust formulations to be as efficacious as a recommended synthetic pesticide against pink stalk borer (*Sesamia calamistis,* Homps) in Nigerian Sudan savanna. The insecticidal activity of neem was evaluated on two (2) major cowpea pests larvae of *Maruca testulalis* (Geyer) and *Clavigralla tomentosicollis* (Stal) and neem proved effective in acting as an insecticide and affected the rates of development of both pests [9].

Efficacy of Neem formulations in checking chaffy panicles caused by stemborers in Northern Nigeria

Practically, everywhere that sorghum (*Sorghum bicolor* [L.] Moench) is grown, lepidopterous stemborers constrains production [10]. During the advanced stage of the crop, tunneling could be observed on the stalk and peduncle which reduces the quality of fodder, weakens the stalk and peduncle which could result to lodging or even breakage and/or interfere with the translocation or supply of metabolites and nutrients resulting in the production of chaffy panicles [10].A two (2) years field experiment was conducted in Maiduguri, Borno State of Northern Nigeria to assess the efficacy of different Neem seed powder formulations in checking chaffy panicles on sorghum occasioned by stemborer species. The experimental design used was the Randomized Complete Block Design (RCBD) and the treatments evaluated are;

1. Untreated control
2. Sevin 85 (A recommended synthetics for the control of stemborer infestation)
3. Neem Seed Powder

Equal volume by weight of the following;

4. Neem Seed Powder, Finesand
5. Neem Seed Powder, Kaolin dust
6. Neem Seed Powder, Sawdust

The trial had four replicates and all cultural practices as recommended by BOSADP [11] was followed in raising the crops to maturity and 0.5g of each of the treatment was applied into the whorl of sorghum beginning fifteen (15) days after emergence and repeated at intervals of seven (7) and ten (10) days,

respectively until 50% booting was attained following the procedure used by [12]. The data collected was on percentage plants with chaffy panicles and the data was subjected to analysis of variance (ANOVA) and the significant difference between treatments were based on estimates of least significance difference (LSD) at 1% level of probability. The table below shows the result obtained;

Table 1. Effect of neem based pesticide on the incidence (%) of chaffy panicles

	Incidence of Chaffy panicles		
Treatments	Year 1	Year 2	Mean
Untreated Control	3.73	2.65	3.19
Sevin 85	1.58	1.58	1.58
Neem seed powder	0.50	0.50	0.50
Neem seed powder, Finesand	0.50	0.50	0.50
Neem seed powder, Kaolin powder	0.50	0.50	0.50
Neem seed powder, Sawdust	1.58	0.50	1.04
Mean	1.40	1.04	1.22
SED	1.05	1.00	1.01
LSD	NS	NS	1.96
			**

1. Mean of four replicated trials.
2. NS = Not significant at 1% level of probability.
3. ** = Significant at 1% level of probability (P<0.01)

The Table above shows that all the treatments were able to check the incidence of chaffy panicles caused by stemborer species. While the individual year's data shows that the various insecticidal treatments reduced stemborers activities, the data analysis shows no significant difference between all the treated and the untreated. However, the combined data analysis shows that all the treatments significantly (P<0.01) controlled stemborers activities in relation to the untreated control. These observations shows that neem has antifeedant effect and is also systemic in action which is also in line with the discoveries of Ascher [13, 14,15]. The biological activities of the various neem seed powder formulations vis-à-vis Sevin 85 butresses the need to recommend neem seed kernel powder formulations and most especially neem seed kernel powder + fines and more so as we take into consideration factors such as being cheap, safer and friendly to both the user and the environment which are all shortcomings of synthetic pesticides.

Despite the attention given to neem based pesticides, the development (which is still at its lowest ebb in Nigeria) of neem based pesticides will not be unconnected to broadening the scope of neem research. Therefore the following aspects are suggested for investigation/further investigation.

Aspects of Neem Research requiring more scientific investigation in Nigeria

1. **Socioecomic studies:** The knowledge that a pesticide suppresses or kill a high percentage of target pests may not appeal to a farmer as much as identifying that a product increases his yield and eventually, his profit and that the product is friendly both to himself and to his environment. There is need therefore for neem research in Nigeria to incorporate the monetary profitability of neem vis-à-vis synthetic pesticides. This data should be generated on trial plots on farmers' field in order to encourage acceptability. Social factors affecting the acceptance of this seemingly new technology should also be assessed.

2. **Environmental Impact Assessment:** The general belief is that neem products are safer against most non-target organisms but this assertion cannot be a blanket statement as there are instances where neem products have harmed non-targets [16]. This calls for the need to determine neems effect on a wider scale perhaps categorizing the effects as "No effect" and "Slight effect" and the like on specific/group of organisms and most especially as it relates to parasitoids and predators.The assessment should also include evaluating neem products not only in the laboratory, but also on the field, as it is on record that some neem formulations exhibit different effect on the field when compared to the laboratory. For example, neem had a strong growth regulatory effect on larvae of the predator green lacewing C. *carnea* and lady bird beetle *Coccinella septempunctata* in the laboratory, but not in the field [17]. Such variation in efficacy need to be further

investigated.

3. **Assessment of pest resistance or resurgence associated to Neem:** While some scientists are of the opinion that the multiplicity of active ingredients in neem confer on it multiple modes of action which makes it difficult for insects to develop resistance to it [18]. This position should not just be taken conclusively. There is need for more research on the potential and ability of insect pests to develop resistance to neem. Again there is need to investigate whether neem products can cause insect pest resurgence (increase in insect pest population) as there are instances where synthetic insecticides kills natural enemies of the pest giving way to increase in the pest population

4. **Collection and breeding of neem germplasm with desirable characteristics:** Varying neem germplasm have varying degrees of pesticidal activity. There is therefore a need to select and breed neem germplasm that are not only high yielding but equipped with higher qualities for insect pest management. There is also need to investigate the influence of various agroclimatic situations as they the insecticidal property of neem plants grown on them for the purposie finding the environmental conditions that should be recommended for mass growing of neem to be used as source of the biopesticide.

5. **Evaluating other botanicals for the possibility of serving as synergist for neem and vis versa:** A drawback for neem is its slow effects on insects and rapid breakdown owing to some environmental conditions such sunlight and rainfall which calls for more frequent applications to attain the desired pest control. This therefore creates the need to investigate the possibility of recruiting other environmentally benign biocides that could be used as synergists/binders for neem. Lessons can be drawn from previous researches such as the one where extracts of *Prosopis* spp. and *Vitex negundo* synergises nuclear polydedrosis virus against *Helicorverpa armigera* and/or plants materials serving as synergists to synthetics as the case of *Sesamum* oil mixed with permethrin dust and/or neem oil mixed with dichloro-diphenyltrichloroethane (DDT) [19].

CONCLUSION AND RECOMMENDATIONS

Insect pest management is facing economic and ecological challenges worldwide due to the human and environmental hazards caused by majority of the synthetic insecticide chemicals. Neem holds a lot of promise in tackling theses challenges considering the fact that it possesses most of the characteristics of an ideal pesticide [20]. The pesticidal action of neem is not fully understood for all pests. The compound azadirachtin which is the most used ingredient in commercial products, may act as an insect growth regulator by interfering with ecdysone (they key insect molting hormone), thereby preventing immature insects from moulting. Neem compounds may also repel insects, stop their feeding, inhibit reproduction and cause other interruptions [4]. Research reports in Nigeria have shown the efficacy of neem based products (either in crude or semi-refined form) in managing various groups of insect pests be it on the field or in storage.The need to encourage crude extracts/neem insecticides with complex mixtures of active ingredients as against isolating a single active ingredient from the plant product is exemplified in the outcome of a laboratory trial where Feng and Isman [21], reported that Green peach aphid, *Myzus persicae* evolved nine fold resistance to pure azadirachtin over 35 generations when it was applied to the plants at LC_{50} level but not against neem seed extracts containing the same amount of azadirachtin as part of a complex mixture. This goes to encourage the use of complex mixture of the plant products as they will pose different behavior modifying and physiological processes disruption effect on the insect thereby preventing resistance by insect pests. This however, is one of the aspects that require more studies. Again, genetic and agronomic manipulations of neem tree varieties to meet a set standard for natural insecticide should be explored, while evaluating the monetary benefits the farmer stands to gain when he/she uses neem products as against synthetics in checking insect pest. The need to also embark on environmental impact assessment with a view to ascertaining the actual level of safety both to man and his environment in relation to the use of neem products as insecticide need to be explored and also, the potential of neem acting as a synergist or being synergized are all aspects amidst others that need more attention in Nigerian neem research.

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