BOTANICAL PESTICIDE MIXTURES FOR INSECT PEST MANAGEMENT ON COWPEA, *Vigna unguiculata* (L.) WALP PLANTS – 2. THE POD BORER, *Maruca vitrata* FAB. (Lepidoptera: *Pyralidae*) AND POD SUCKING BUG, *Clavigralla tomentosicollis* STAL (Heteroptera: *Coreidae*).

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Abstract

The mixtures of Neem and Eucalyptus leaf extracts with extracts of other plant species was investigated for efficacy in the management of two major post flowering insect pests (Maruca pod borers and Clavigralla tomentosicollis Stal.) of cowpea in the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The results revealed that in 2000 and 2001 seasons the mean number of Maruca vitrata (F.) was reduced (< 1.0 / flower and /or pod) on plots sprayed with leaf extracts of Neem + Lemongrass, Neem + African curry, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. Pod sucking bugs (dominated by C. tomentosicollis) numbers were suppressed (< 1.5 / plant) on plots treated with leaf extracts of Neem + African curry, Neem + Lemongrass, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. These extracts mixtures caused great reductions in pod damage per plant and ensured higher grain yield compared with the unsprayed plots during the two years of investigation. The complementary roles played by individual plant species used for the extracts mixtures in reducing pests numbers and increasing grain yields on sprayed plots suggest the future direction of new formulations of Biopesticides in the management of field pests of crops on farms owned by resource limited farmers in low input agriculture characterizing the developing countries.

Key words: Extracts, mixtures, *Maruca*, coreid bug, control, cowpea.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp is an important grain legume in the diet of many people in third world countries. Nigeria is the largest producer of cowpea in the world. Yield of cowpea is low due to insect pests infestation. The major post - flowering insect pests of cowpea in tropical Africa are the flower bud thrips, *Megalurothrips sjostedti* Tryb., *Maruca* pod borer, *Maruca vitrata* (F.), and pod sucking bugs complex dominated by *Clavigralla tomentosicollis* Stal (Jackai and Daoust, 1986). Complete crop failure may occur where insecticide protection is not introduced especially for improved, high yielding varieties. Efforts to popularize these improved varieties among farmers have been a difficult task due to their high demand for insecticidal sprays, which are expensive for resource limited farmers in Nigeria. This situation coupled with the current economic hardship in the country which led to the removal of various subsidies formerly enjoyed by farmers have made possible the search for alternative sources of insecticide that would become a component of socio-economically sustainable and environmentally friendly crop protection strategies (Jackai and Oyediran, 1991).

Extracts (aqueous or oil) of some plant materials are toxic to some species of insect pests of crops and others are less toxic. These extracts with lethal activity on insects may be applied sole or in mixtures with less toxic plant extracts to ascertain their complimentary or synergistic attributes in the management of crop pests. Neem, *Azadirachta indica* (A. Juss) commonly known as 'Dogon yaro' in Hausa language (best known for its anti malarial attributes) and *Eucalyptus citriodora* Pers. popularly called 'Ganye bature' also in Hausa are trees used in the semi arid and arid ecological zones of Nigeria for shelterbelt establishment and for shades along the roads and farmstead. The use of these plants for insecticidal purposes in storage pests control is documented (Kambu *et al*., 1982; Ivbijaro, 1983; Srivastava *et* al., 1988; Oparaeke, 1997; Dike and Msheila, 1997; Cardet *et al.*, 1998, Lale and Abdulrahman, 1991). However, field activities of Neem and *Eucalyptus* spp. leaf extracts on some pests of crops are varied (Raymunda and Alcazar, 1983; Olaifa and Adenuga, 1988; Tanzubil, 1991; Uwaezuoke, 2002; Oparaeke, 2004). Aqueous extracts and powders of both neem seed and kernel have been shown to interfere with the development of *M. vitrata* and *C. tomentosicollis* in laboratory trials (Jackai *et al.*, Unpublished). The active insecticidal compounds in neem include Azadirachtin, Nimbin, Salannin and Meliatriol (Krauss *et al.*, 1981; Vietmeyer, 1992) which are concentrated more in the seed and tree bark while *Eucalyptus* spp. contain cineol, terpinol, piperitone, phellandrene, phenol and cumminol (Kelly, 1969).

A limited data – base is available on the use of herbal landraces in Nigeria for field pests control on crops. Some attempts made in the past to reduce pest pressure on crops using botanical preparations have been in favour of storage pests' control. A few trials conducted

so far using plant extracts on arable crops were screen house studies, which may not represent the actual situation on the field, and they are mostly based on the use of sole plant extracts in pests' control. This trial is an aspect of the first part of a long-term assessment of the potential use of mixtures of plant extracts for integrated management of field pests of cowpea.

MATERIALS AND METHODS

The plant materials used in the trials include leaves of Neem (*Azadirachta indica* A. Juss) and *Eucalyptus citriodora* Denn. in mixtures with leaves of *Gmelina arborea* L., Tomato (*Lycopersicum esculentum* L.), Lemongrass (*Cymbopogon citratus* Staph), African curry (*Ocimum gratissimum* L.), Bitter leaf (*Vernonia amygdelina* L.), and African Bush tea (*Hyptis suaveolens* Poit). These materials were collected around Samaru, Zaria in July 2000 and 2001 and dried in the oven at 60 °C overnight. They were grinded in an electric hammer mill into powders and packed in different polythene bags until ready for use. Extract mixtures of Neem and *Eucalyptus* with other plant leaves listed above were prepared by weighing 500 g each of the leaf powders. Each of the powder combinations (Table 1) were soaked in 3.5 l hot water (70 °C) in plastic buckets overnight and filtered the following day with 1.0 l warm water using a muslin cloth. To each of the extracts mixtures was added 250 ml of 20 % solutions of starch and soap to improve on their spread and adherence to the plants bringing the extracts mixtures rate to 10 % w/v. The extracts mixtures were each labeled and sprayed the same day.

The plot size measuring 6.0 x 5.0 m had three main and two discard ridges (one on either side of the main ridges). Each plot was separated by a 1.5 m wide border margin to check spray drift. The field layout consisting of 13 treatments was Randomized Complete Block Design (RCBD) with three replicates per treatment. Three seeds of SAMPEA 7 cowpea variety were sown per hole on ridges 0.25 m (intra row) and 0.75 m (inter row). Galex (Metalachlor 250 g a.i. and Metabromuron 250 g a.i.) and Gramoxone (paraquat) herbicides were mixed and sprayed at 2.5 kg a.i./ha each on plots immediately after sowing to get rid of weeds. Three weeks latter, the plants were thinned to two seedlings per stand. Fertilizer NPK (15:15:15) was top dressed at 250 kg/ha (37.5 kg a.i./ha) after 14 days of sowing. A tank mixture of 0.30 kg a.i./ha each of mancozeb (Dithane M 45) and benomyl (Benlate) was applied every week beginning from the fourth week after sowing to control fungal diseases of cowpea. The leaf extracts mixtures and Uppercott (Cypermethrin 250 g a.i. + Dimethoate 250 g a.i./ha at 1.0 l/ha) were applied between 10.00 am and 12.00 noon with CP 3 knapsack sprayer once every week for four weeks beginning from flower bud initiation / on set of flowering. One cowpea row was sprayed at a pass in each plot and all parts of the plants were copiously wetted with the extracts.

M. vitrata and *C. tomentosicollis* sampling commenced from 7.00 – 9.30 am before each weekly spraying. For *Maruca* pod borers (MPBs), twenty flowers were randomly removed (Amatobi, 1994) from each plot and placed in vials containing 30 % alcohol. These were taken to the laboratory and dissected the next day. The number of pod borers found in each flower was counted and recorded. MPBs were also examined in a random sample of 20 pods taken from 10 plants in a plot. These were also placed in vials containing 30 % alcohol and dissected the next day in the laboratory. MPB larvae found were counted. Adults and nymphs of *C. tomentosicollis* were sampled visually on plants found in a 1.0 x 1.0 m² quadrant, which was located randomly in three different positions within the three inner ridges (main ridges) in each plot. The number of pods damaged per plant was recorded at 10 WAS using the following formula:

$$\% \text{ Pod damage} = \frac{\text{Total No. of pods produced per plant} - \text{No. of undamaged pods x 100}}{\text{Total No. of pods produced}}$$

Data were analyzed after square root or arcsine transformation as appropriate using analysis of variance while treatment means were separated with SAS – SNK test ($P < 0.05$) (SAS Institute, 1989).

RESULTS

The leaf extract mixtures significantly ($P < 0.05$) reduced *M. vitrata* and *C. tomentosicollis* numbers in treated plots compared with the untreated control during the two seasons. Extract of neem leaf in combination with that of *O. gratissimum*, *C. citratus*, *L. esculentum*, *V. amygdelina*, and *H. suaveolens* as well as a mixture of *Eucalyptus* with *O. gratissimum* leaf extracts performed better than plots sprayed with other plant extracts mixtures but the first two leaf extract mixtures were comparable with plots treated with the recommended rate of Uppercott (a synthetic insecticide) (Figs. 1 & 2). Percentage pod damage was significantly lower in plots treated with leaf extract of Neem in mixtures with *C. citratus*, *O. gratissimum*, and *L. esculentum* leaf extracts compared with the untreated control or any other leaf extract mixtures. Similar trend of increased ($P < 0.05$) grain yields was observed in

plots sprayed with the above three extract mixtures in both years (Figs. 3 & 4). However, all the leaf extracts mixtures were inferior to Uppercott on pods protection and grain yield.

DISCUSSION

The results of the present study show that aqueous leaf extracts of Neem in combination (mixtures) with leaf extracts of other plant species exhibited various levels of reduction of pod borers and pod sucking bugs numbers and offered various degrees of protection to cowpea plants compared with *Eucalyptus* based extract formulations. This study ranked leaf extract of Neem in mixtures with Lemongrass, African curry, Tomato, and Bitter leaf as well as the mixture of *Eucalyptus* with African Bush tea superior to other leaf extracts mixtures in that order, on MPB and PSB control, damage reduction and yield increases. The suppression of MPB numbers in cowpea flowers and /or pods could be due to suffocation and /or antifeedant activity of neem material since the insect lives inside the preferred structures of the cowpea plant outside the reach of most insecticides. It is suspected that the extracts mixtures might have been absorbed by the flowers / pods through osmotic pressure causing the insect to stop feeding. It is also possible that as the flowers / pods absorbed the spray liquid the soft body of MPB larvae living and feeding in the preferred plant parts could have absorbed the extract mixtures resulting to death of the insects. This observation is buttressed by the fact that when flowers / pods of plants sprayed with these extracts were opened, some moribund MPB larvae were found. This study also elucidates the potential of leaf extracts mixtures of different plant species as biocide for management of PSBs on cowpea plants. The number of PSB was drastically reduced (< 1.5 insects / plant) in plots sprayed with the above aqueous extracts mixtures and the mechanism of action could be contact since some of the bugs were found on the ground some few minutes after spraying with symptoms of hypo-excitability, staggered walking on one side of the limb, abdominal extrusion and death.

Several authors have reported the potential of some of the plant species evaluated in this study as Biopesticides against several species of crop pests. With the exception of African curry leaf, Lemongrass, and *Eucalyptus*, leaves of other plant species used in this trial are insecticidally weak (Tanzubil, 1991; Dike and Msheila, 1997; Oparaeke, 1997). Although, Neem contains two major triterpenoids (Azadirachtin and Salannin), which has antifeedant, repellent and growth regulatory properties (Warthen *et al.,* 1978; Reed *et al.,* 1982; Vietmeyer, 1992), its concentration in the leaves of Neem tree is low compared with the seed or stem bark (Varanatse and Ladan, personal communication). So, the efficacy of Neem leaf extract in mixtures with leaf extracts of other plant species could not be attributed to the potency of the former but due to the complementary or synergistic activities of the latter. *Eucalyptus* spp. on the other hand contain high cineol, terpinol, piperitone, cumminol citronellol and phellandrene (Penfold and Willis, 1961; Kelly, 1969) which confer on the tree its insecticidal properties and making its wood useful as electric poles world wide. Since leaf extracts of some of the plant species used in this trial are individually not very effective as botanicals it would appear that mixing them at the right ratio and concentration with extracts from other plant species would enhance their potency for pest control. The performance of leaf extract of Neem + Lemongrass, Neem + African curry and Neem + Tomato in the control of MPBs and PSBs was encouraging and consequently led to better pod protection with attendant increase in grain yields on treated plots.

The present study shows that mixtures of plant extracts at 10 % w/v exhibited insecticidal activity against the target pests and thus indicating their potentials for development as botanicals for the management of MPBs and PSBs on cowpea plants. These materials did not show any phytotoxicity effect on treated plants. In Nigeria, where this trial was conducted all the plant species used are readily available for local farmers' use. Since the materials are employed in trado-medicine for treatment of various disease disorders the fear of health hazard associated with the synthetic insecticides application is allayed. The biodegradable property of these materials would also reduce any potential hazard to the environment. Further studies are required to find out the effects of these plant materials and others on insect pests of other cultivated crops and testing their appropriate spraying regimes for effectiveness.

ACKNOWLEDGEMENT

The authors are grateful to Messrs Gideon Gbilin, Emeka, Nnamdi and Obiora for technical assistance in data collection and to the Director, Institute for Agricultural Research, Ahmadu Bello University, Zaria for permission to publish this paper.

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Received for publication on October 28 , 2004
Accepted for publication on February 23 , 2005

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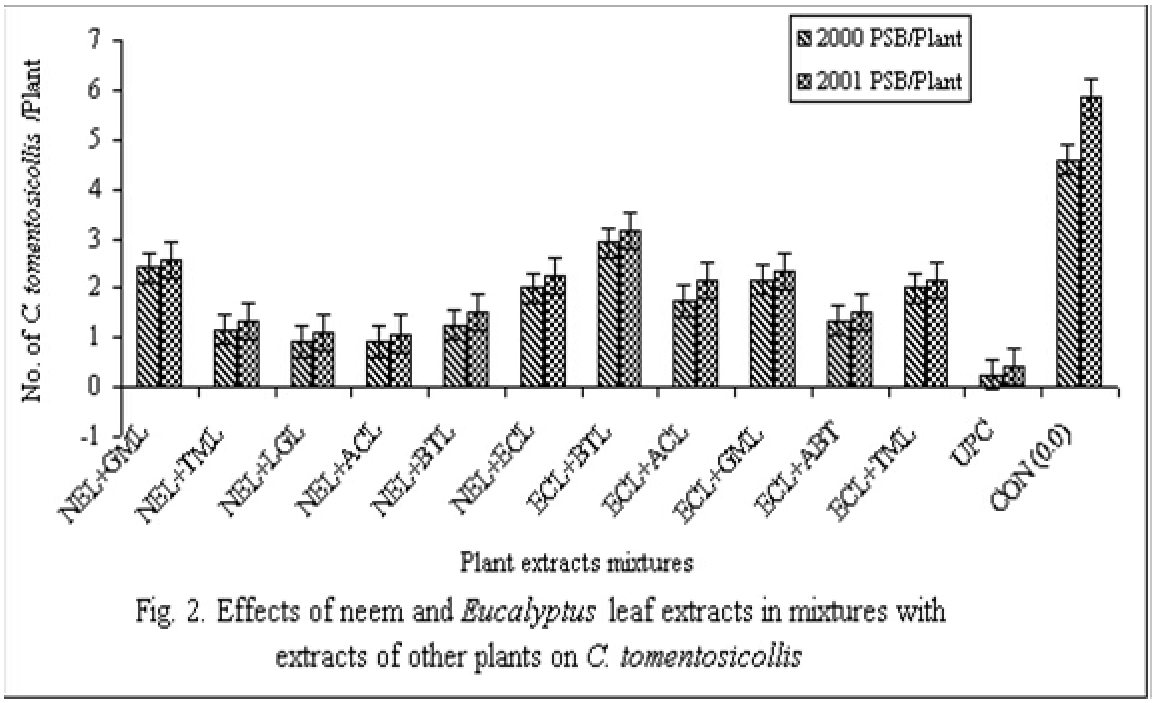

Fig. 2. Effects of neem and *Eucalyptus* leaf extracts in mixtures with extracts of other plants on *C. tomentosicollis*

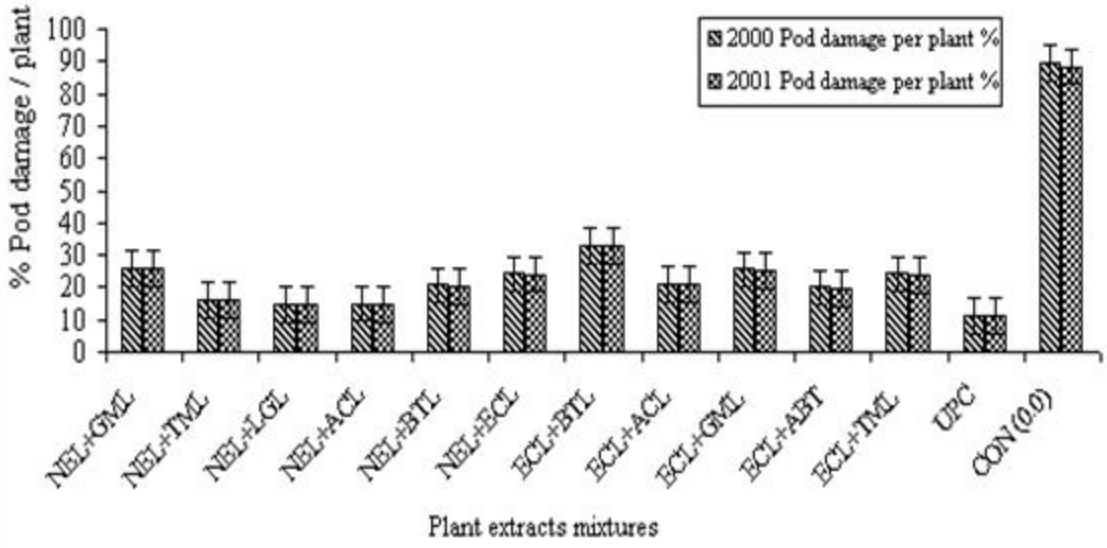

Fig. 3. Effects of neem and *Eucalyptus* leaf extracts in mixtures with other extracts of plants on percentage pod damage of cowpea

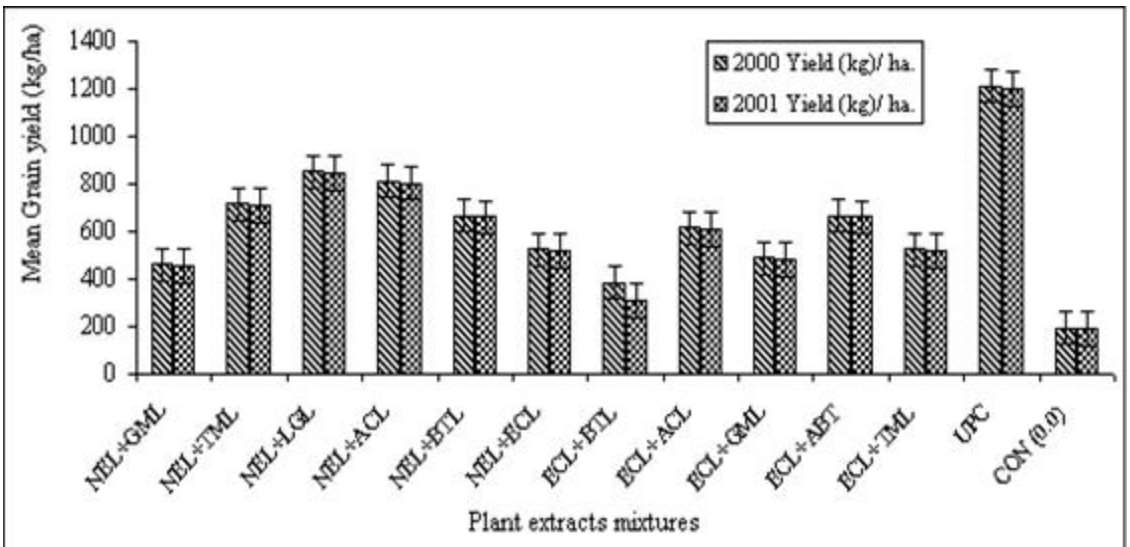

Fig. 4. Effects of neem and *Eucalyptus* leaf extracts in mixtures with extracts of other plants on grain yield of cowpea.