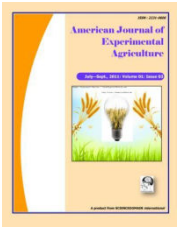

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Effects of Neem (*Azadirachta indica* A. Juss) Products on *Aphis craccivora* and its Predator *Harmonia axyridis* on Cowpea

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Research Article

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ABSTRACT

Aims: To assess the effectiveness of two neem formulations in the control of cowpea aphid, *Aphis craccivora* and how these affect its predator *Harmonia axyridis*.
Study Design: The experiment was conducted in a Randomized Complete Block Design in which cowpea was planted on raised beds.
Place and Duration of Study: The experiment was conducted on an experimental farm of the Department of Theoretical and Applied Biology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana during the minor rainy season of 2009.
Methodology: Two neem-based products were prepared from dried neem seeds: aqueous neem kernel extract (ANKE) and neem kernel powder (NKP). A standard chemical insecticide, lambda cyahalothrin was used as a reference insecticide and a control. There were four treatments and four replications. The neem formulations and chemical insecticide were sprayed onto cowpea plants to control *A. craccivora*. Data were collected on numbers of *A. craccivora, H. axyridis* and number of damaged leaves as well as the yield of cowpea.
Results: Significantly more *A. craccivora* were collected on the control plots than on the treated plots (P= 0.020). The numbers of *A. craccivora* on ANKE and NKP-treated plots did not differ significantly (P=0.320). *Harmonia axyridis* numbers on the various treatments did not differ significantly (P=0.301). Significantly more leaves were damaged on the control plots than the treated plots (P=0.012) but damaged leaves on the 2 neem-treated plots did not differ significantly.
Conclusion: The two neem products were effective in reducing the population of *A. craccivora*. Thus application of neem products can be used as an alternative to chemical insecticide to control *A. craccivora*.

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Keywords: Aphis craccivora; cowpea; Harmonia axyridis; neem; insecticides.

1. INTRODUCTION

Cowpea, *Vigna unguiculata* L. (Walp.) is widely grown in the tropics and subtropics for human consumption as well as food for animals (Singh and Van Emden, 1979). It is mainly grown as a secondary crop in association with other staples such as maize, sorghum, millet and cassava. It is also cultivated as a monocrop in areas where other crops fail as a result of drought. Cowpeas originated from the Savannah region of West and Central Africa (Colby and Steele, 1976) and like many crops with long history of cultivation are subjected to losses as a result of insect pest attack (IITA, 1984).

In Africa, yields of cowpea are consistently low, averaging between 100 and 250kg/ha. These low yields have been partly attributed to insect pest attack (Singh and Jackai, 1985). These insect pests damage the crop both in the field and in storage (Monti et al., 1997). Aphids, *Aphis craccivora* (Hemiptera: Aphididae) attack the plant at the seedling stage, flower thrips, *Megalurothrips sjo*stedti (Thysanoptera: Thripidae) at the flowering stage and the pod borer, *Maruca testulalis* (Lepidoptera: Pyralidae*)* at the pod formation stage (Taylor, 1981) all cause significant damage to cowpea plants. Pests' infestations result in economic losses to farmers. *Aphis craccivova* is widespread on cowpea causing significant damage to cowpea plants in much of tropical Africa and Latin America (Chalfant, 1976). In Nigeria, aphids are important on cowpeas grown in the dry season under irrigation and have also been reported in outbreaks resulting from pesticide application (Don-Pedro, 1980). Apart from their effects on cowpea plants, *A. craccivora* are important as agents in the transmission of viral diseases of cowpeas (Chalfant, 1976).

In Africa, the legume pod borer, *Maruca testulalis* (Geyer) is one of the most important field pests of cowpea (Taylor, 1981). In Kenya, losses up to 80% occur on indigenous cowpea varieties as a result of attack by *M. testulalis* (Okeyo-Owuor et al., 1983). Young larvae feed on tender plant stems, terminal shoots and peduncles during vegetative growth and on flowers. Older larvae feed continuously on flowers and newly formed pods causing severe damage and yield losses (Jackai, 1981). Among the major field pests of cowpea is the flower thrips, *Megalurothrips sjostedti.* According to Ezueh, (1981), attack by nymphs and adult *M. sjostedti* during the pre-flowering period may damage the terminal leaf bud and bracts or stipules causing the latter to become deformed with brownish yellow appearance.

The degree of success achieved in cowpea production in most of the producing regions was as a result of the level of pest control. The pest control options available to large scale farmers include the use of insecticides (Jackai and Adalla, 1997), cultural control and the use of resistant varieties. Most cowpea growers in tropical Africa are small holders and do not use insecticides on their crops (Jackai and Singh, 1983). However, with increases in farm sizes as well as farmer education regarding the use of insecticides, chemical control of pests is increasingly being used against flower and pods as well as storage pests (Durand et al., 1984). Significant control is achieved with either systemic or contact insecticides such as endosulfan, dimethoate and carbofuran (Akingbohungbe, 1982; El-Sebae and Saleh, 1970). Other synthetic chemical insecticides are used to control cowpea aphids, but these have undesirable side effects such as toxicity to humans and other animals (Don-Pedro, 1980).

Plant products such as black pepper, soya bean oil, lemon oil, palm oil and neem extracts have been shown to be effective on storage pests (Pereira, 1983; Obeng-Ofori, 2007). However, the effectiveness of some of these products on field pests has not been fully exploited. Over 400 species of insect pest have been found to be susceptible to neem products, most of them belonging to Orders Lepidoptera and Coleoptera (Schmutterer, 1990). The leaves, seed and oil have all been found to possess pest control strategies; the pest control strategies include pesticidal, antifeedant, repellent, hormonal and growth inhibitory activity (IRRI, 1982). Several biologically active compounds have been isolated from different parts of the neem tree. One of the most important is azadirachtin, which is a potent growth regulator and an antifeedant (Butterworth and Morgan, 1968; Warthen et al., 1989). This study assessed the efficacy of two neem-based formulations on the field pest *A. craccivora* and its predator *H. axyridis* and how these compared with a standard chemical insecticide.

2. MATERIALS AND METHODS

2.1 Preparation of Neem Products

Fresh ripe fruits of neem were collected from the coastal areas of the Volta Region of Ghana. They were air-dried under the shade for 3 weeks. Two neem–based products were prepared from the dried seeds; these were aqueous neem kernel extract (ANKE) and neem kernel powder (NKP). Two thousand grammes of neem seeds were crushed to break them and subsequently grounded into powder. Aqueous neem kernel extract was prepared by weighing on a balance (Sartorius, AG Germany, ME 235S) 50 g of the powder which was mixed with 30 ml of sesame oil. One litre of water was added to the mixture, stirred and left standing for 6 hrs after which the solution was filtered to remove larger particles.

2.2 Planting of Cowpea

A total plot size 400 m^2 was used for the study. It was divided into four blocks each of which was divided into 4 plots with an alley of 1 m between the plots. There were 40 plant stands on each plot, with 0.6 m between 2 plant stands in each column and 0.4 m between the rows. The experiment was conducted in a randomized complete block design (RCBD) with four treatments and replicated four times. The treatments were aqueous neem kernel extract (ANKE), neem kernel powder (NKP), chemical insecticide PAWA (active ingredient lambda cyahalothrin 25g a.i $litre^{-1}$) used as reference chemical and control plants. Cowpea (var. Asontem) was sown at 2 seeds per hole and thinned to1 seedling 10 days after germination. Application of pest control measures was conducted 2 weeks after germination (WAG). Aqueous neem kernel extract (ANKE) was applied using a portable hand held sprayer and the solution was applied onto the leaves and stems. Neem kernel powder (NKP) was applied by hand at a rate of 2 g/plant stand. Chemical insecticide was applied at the recommended rate with different application equipment. The control plants were left unsprayed. A second application of the control measures was done 3 weeks after the first one.

2.3 Weed Control

Clearing of weeds on the plots was done by using a hoe 2 weeks after germination and subsequently at 3 week interval.

2.4 Data Collection

Observation of the plants for the presence of *A. craccivora* and *H. axyridis* was conducted 1 week after germination on all the treatments. Data collection of the pest and its predator were conducted every week. This was done by randomly selecting 5 plants on each plot. On each plant 5 leaves were selected, 2 from the upper, 1 from the middle and 2 from the lower sections of the plant. The numbers of *A. craccivora* and *H. axyridis* were on each occasion counted and recorded. The numbers of damaged leaves (curled and distorted) for each plot and treatment were recorded and the means were calculated.

2.4.1 Harvesting

Harvesting of the pods was done 65 days after germination. Dried pods were harvested from the inner rows of plants. The seeds were removed and placed in labelled envelopes. The seeds were dried for 4 days and weighed using a top pan balance (Mettler Toledo, Switzerland). The mean for each treatment was calculated.

2.4.2 Data analysis

Data collected were analyzed using ANOVA and the means were separated using the SNK test with SAS programme (Version 9) (SAS, 2005). Significant difference was set at $P< 0.05$.

3. RESULTS

3.1 *A. craccivora* Population

Cowpea aphid, *Aphis craccivora* was found on the field during the second week of growth of the plant. They were found on all the plots, remaining on the plants until 8 weeks after germination. The largest number of *A. craccivora* was recorded on the control plants whilst the insecticide-sprayed plants recorded the least number of cowpea aphids (Table 1). Significantly fewer aphids were counted on the treated than on the untreated (control) plots ($P =0.030$). The numbers of *A. craccivora* on ANKE-sprayed and NKP-treated plots did not differ significantly ($P=0.608$).

Table 1. The effects of two neem products on *A. craccivora*, its predator, *H. axyridis* and growth parameters (Minor season, 2009)

Treatment	*A. craccivora*	*H. axyridis*	Damaged leaves	Yield (g)
Control	24.8[a]	5.2[a]	40.5[a]	38.5[a]
NKP	9.8[b]	4.1[a]	21.8[b]	112.7[b]
ANKE	6.8[b]	4.0[a]	19.2[b]	130.5[b]
PAWA	3.3[b]	2.0[a]	8.7[b]	160.5[c]

Within the same column means with the same letter are not significantly different (P > 0.05)

One week after the first spraying, very low numbers of *A. craccivora* were counted on all the sprayed plots with the exception of the control. On the unsprayed plants aphid numbers remained relatively high (Fig. 1), remaining comparatively higher throughout the sampling period. The largest number of *A. craccivora* on the control plants was recorded during the 5th week. On the neem- sprayed plants the largest number of *A. craccivora* was recorded 4 weeks after the first spraying, remaining low during subsequent weeks.

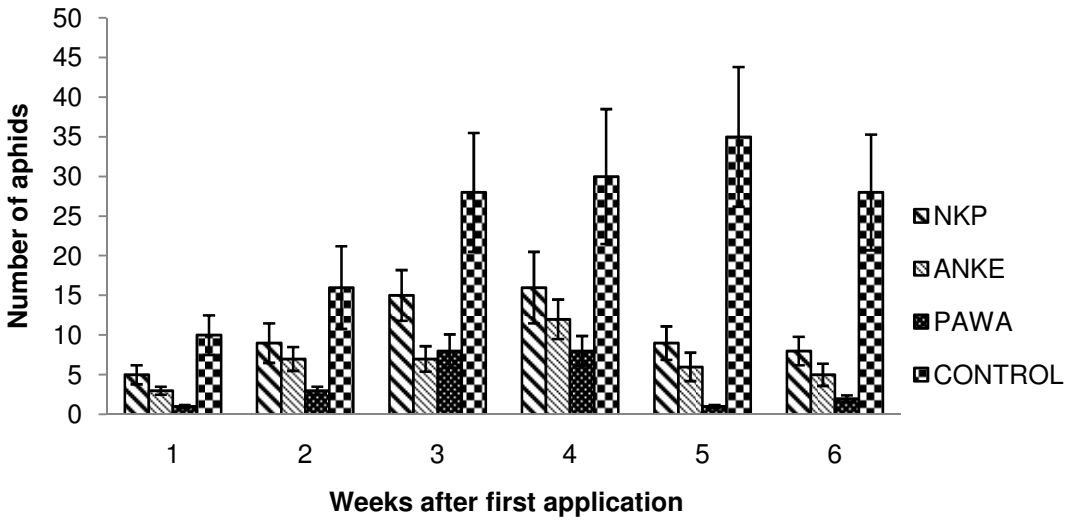

Fig. 1. Weekly numbers of cowpea aphids after first spraying

3.2 *Harmonia axyridis* Population

Harmonia axyridis was detected on cowpea plants during the 3rd week of the growth of the plant. They were found in close association with *A. craccivora*. *H. axyridis* numbers were largest on the control plants and least on the insecticide-sprayed plants (Table 1). The difference was not significant (P=0.201). On the control plants, adult *H. axyridis* numbers remained relatively high throughout the sampling period reaching its peak during the 6th week (Fig. 2).

3.3 Leaf Damage

The number of leaves damaged was largest on the control plants. A mean of 40.5 damaged leaves were recorded, whilst the insecticide-sprayed plants recorded a mean of 8.7 damaged leaves (Table 1). Significantly more leaves were damaged on the control plants than on the sprayed plants (P=0.012). However the numbers of damaged leaves on the neem-treated plants and the insecticide-treated plants did not differ significantly.

3.4 Yield of Cowpea

The yield of cowpea seeds from the various treatments showed that plants sprayed with chemical insecticide had the highest yield whilst the unsprayed plants had the least yield (Table 1). The differences in yield were significant (P = 0.021). The difference in yield between the two neem products was not significant (P=0.411) but both of them differed significantly from that of the insecticide –sprayed plots.

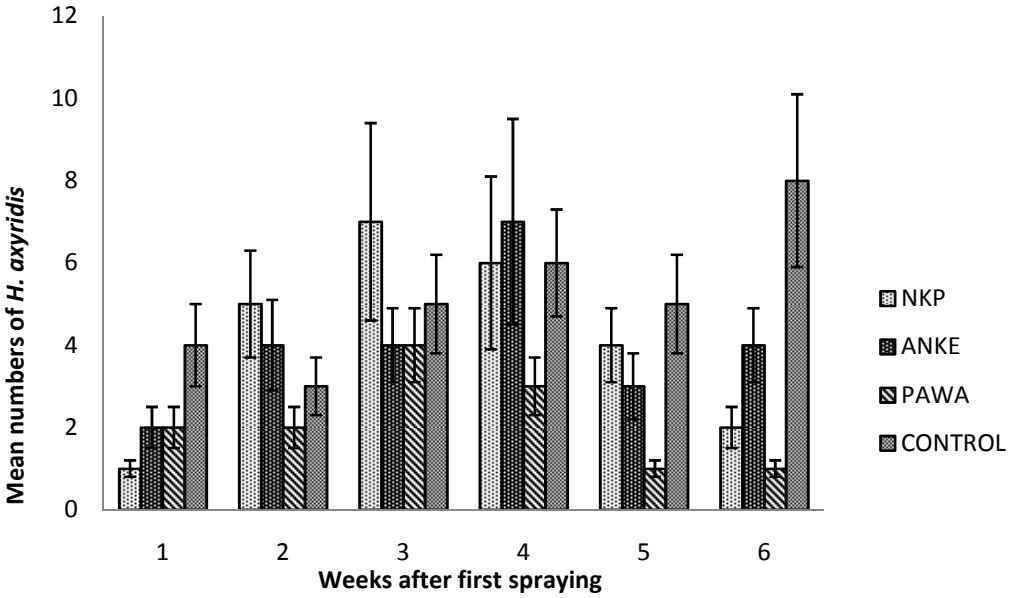

Fig. 2. Numbers of *H. axyridis* counted after first spraying

4. DISCUSSION

Cowpea is infested on the field by a number of pests including the cowpea aphid, *A. craccivora*, small soft-bodied insects that feed by piercing plant tissues to withdraw plant juices. The activities of this pest can rob the plant of essential food nutrients leading to retardation of growth and low yield. The application of the two neem products proved effective in reducing *A. craccivora* numbers on cowpea plants. As a result of the use of the two neem products, *A. craccivora* numbers were reduced. *A. craccivora* numbers on NKP and ANKE-treated plots were only 39.5% and 27.4% respectively compared with the control. The reduction in aphid numbers was higher on ANKE-treated plots than on NKP-treated plots even though the difference was not significant.

The reduction in aphid numbers on the neem-treated plots could be attributed to the antifeedant effect of neem which led to starvation and ultimately the death of the insects. The major component of neem seed kernel, azadirachtin is the chemical responsible for its antifeedant properties (Warthen et al., 1989). However, the effects of the treatment were not immediate, since the aphids were found actively moving on the leaves a few days after the application. Thus there was a delayed effect of neem on susceptible insects after application. This delayed effect has been reported by Schmutterer (1990), who suggested that after application of neem products, most insects continue to feed on the treated plants for some time. According to Schoonhoven (1992), the amount of food ingested reduces as a result of the influence of the secondary antifeedant effect of the extract which disrupts food intake. The variable levels of control of aphids on cowpea indicate that the host plant influences the effectiveness of neem treatment. Comparing the two neem products, it appears that the aqueous extract was more effective in controlling cowpea aphids than the

powder. The lower effectiveness of neem kernel powder might be due to the fact that it was partly blown away by the wind; therefore fewer of them remained on the plant.

H. axyridis is an important predator of *A. craccivora*. Their numbers remained relatively high on the control plants throughout the sampling period whilst lower numbers were recorded on the insecticide–treated plots. The lower numbers of *H. axyridis* on the insecticide-treated plots might be related to the negative effects of the insecticide. These predators on their own can keep the population of insect pests in check. The largest number of *H. axyridis* was recorded on the control plots which incidentally recorded the largest number of *A. craccivora*. This was an indication of the dependence of *H. axyridis* population on that of *A. craccivora*. Thus the reduction in the predator population on ANKE and NKP-treated plots was due to the reduction in prey numbers on those plots. According to Perry and Roitberg (2005), Coccinellids are typically predators of Hemiptera such as aphids. The results also showed a significant increase in yield as a result of the use of the two neem products compared to that of the control plots. The yield from the neem-treated plots was as good as that on the insecticide-treated plots. The treated plants had significantly fewer damaged leaves than the control plants. The larger number of damaged leaves on the control plots resulted in the lowest yield. In Togo, Dreyer (1986) reported that aqueous neem extract as well as the neem oil were highly effective against the leaf hopper, leaf miner and leaf rollers. He also showed that total feeding damage caused by lepidopterous larvae and grasshoppers was negligible compared to the control. Neem products have no detrimental effects on non target organisms, killing only the susceptible insects. Its use can therefore be promoted as an alternative to chemical insecticides.

5. CONCLUSION

The results of the study have shown that the two neem products were effective in controlling *A. craccivora* on cowpea. However, the aqueous extract was more effective in controlling aphids than the powder formulation. As a result of the reduction in aphid numbers on the neem-treated plots, the yield was better than that on the control plots. The yield from the neem-treated plots also compared favourably with that of the insecticide-treated plots. The effect of the chemical insecticide on *H. axyridis* was more destructive than the neem products since fewer of them were found on the insecticide-treated plots. Neem products can be used as alternative to chemical insecticides in areas where the plant grows.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Akingbohungbe, A.E. (1982). Seasonal variations in cowpea crop performance at Ile-Ife in Nigeria and the relationship to insect damage. Insect Sci. Appl., 3, 287-296.

Butterworth, J.H., Morgan, E.D. (1968). Isolation of substances that suppresses feeding in locusts. J. Chem. Commun., pp. 23-24.

Chalfant, R.B. (1976). Chemical control of insect pests of the southern pea in Georgia. Agric. Exp. Stn. Res. Bull., 179, 31.

Colby, L.S., Steele, W.M. (1976). An Introduction to the Botany of Tropical Crops, pp. 91-95. London: Longmans. 2nd Edition.

Don-Pedro, K.N. (1980). A population explosion of *Aphis craccivora* Koch following DDT application in a cowpea plot *(Vigna unguiculata*) cultivar (Prima) in Nigeria. J. Nat. Hist., 14, 617-19.

Dreyer, M. (1986). Field and laboratory trials with simple neem products as protectants against pests of vegetable and field crops in Togo. Proceedings of 3rd International Neem Conference, Nairobi, Kenya, pp. 431-447.

Durand, R.N., Pasco, R., Bingham, W. (1984). The hand-held 'Electrodyn' sprayer: an operational tool for better crop management in developing countries. Proc. Br. Crop Prot. Con Pests Dis.

El-Sebae, A.H., Saleh, M.R. (1970). Aphicidal properties of safer insecticides against *Aphis craccivora* on cowpea crop, Alexandria J. Agric. Res., 18, 131-34.

Ezueh, M.I. (1981). Nature and significance of pre-flowering damage by thrips to cowpea: Entomol. Exp. Appl., 29,305-12.

IITA. (1984). Annual report for 1983: Int. Inst. Trop. Agric. Ibadan, Nigeria, pp. 218.

International Rice Research Institute (1982). Neem may be a source of safe insecticide. IRRI Report, 2, 1-3.

Jackai, L.E.N., Adalla, C.B. (1997) Pest management practices in cowpea: a review. In: Singh, B. B., Mohan, B.R., Raj, K. E.,Jackai, L. E. N. (Eds.) (1997). Advances in Cowpea Research. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). IITA, Ibadan Nigeria, pp. 341-351.

Jackai, L.E.N., Singh, S.R. (1983). Varietal resistance on integrated pest management of cowpea (*Vigna unguiculata*) pests, Insect Sci. Appl., 4, 199- 204.

Jackai, L.E.N. (1981). Relationship between cowpea crop phenology and field infestation by legume pod borer *Maruca testulalis*: Ann. Entomol. Soc. Am., 74, 402-408.

Monti, L.M., Murdock, L.L., Thottapplly, G. (1997). Opportunities for biotechnology in copea. In: Singh, B.B., Mohan, B.R., Raj, K.E., Jackai, L.E.N. (Eds.) (1997). Advances in Cowpea Research. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). IITA, Ibadan Nigeria, pp. 341-351.

Obeng-Ofori, D. (2007). The use of botanicals by resource-poor farmers in Africa and Asia for the protection of stored agricultural products. Stewards Postharvest Review, 6(5), 1-8.

Okeyo-Owuor, J.B., Agwardo, P.O., Simbi, C.O.J. (1983). Studies on the legume pod-borer, *Maruca testulalis* (Geyer)-V. Larval population. Insect Sci. Appl., 4, 75-81.

Pereira, J. (1983). The effectiveness of six vegetable oils as protectants of cowpeas and Bambarra groundnuts against infestation by *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). J. Stored Prod. Res., 19, 57-62.

Perry, M., Roitberg, B. (2005). Ladybird mothers mitigate offspring starvation risk by laying trophic eggs. Behavioural Ecology and Sociobiology, 58, 578–586. doi: 10.1007/s00265-005-0947-1.

SAS Insitute (2005). Statistical Analytical Systems SAS/STAT User's guide version 9(1) Cary NC: SAS Institute Inc.

Schmutterer, H. (1990). Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. Annu. Rev. Entomol., 35, 271- 297.

Schoonhoven, L. (1992). Aphicidal properties of safe insecticides against *Aphis craccivora* on cowpea crop. Alexandria J. Agric. Res., 18, 131-34.

Singh, S.R., van Emden, H.F. (1979). Insect pests of grain legumes: Annual Review of Entomology, 24, 255- 278.

Singh, S.R., Jackai, L.E.N. (1985). Insect pests of cowpeas in Africa: Their life cycle, economic importance, and potential for control. In Cowpea Research Production and Utilization, ed. Singh, S.R. and Ratchie, K.O., pp. 217- 23. London: John Wiley, pp. 448.

Taylor, T.A. (1981). Distribution, ecology and importance of bruchids attacking grain legumes and pulses in Africa. In: The ecology of bruchids attacking legumes (pulses). Labeyrie, W., Junk (Eds.). The Hague, Netherlands, pp. 199-203.

Warthen, J.D. Jr., Uebel, E.C., Dutky, S.R., Luspy, W.R. (1989). Adult house fly feeding deterrent from neem seeds. USDA/SEA Agric. Res. Results, Northeast. Ser., 2, 1-11.