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Insecticidal Effects of Some Plant Leaf Extracts in the Control of Insect Field Pests of *Amaranthus hybridus* L

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Abstract

A field trial was conducted at the Botanical garden of department of Plant Science and Biotechnology, Abia State University, Uturu, Nigeria to assess the insecticidal effect of aqueous leaf extracts of *Azadirachta indica*, *Ocimum gratissimum* and *Vernonia amygdalina* on insect field pests of *Amaranthus hybridus*. The experimental design was randomized complete block with three replicates. Aqueous leaf extracts of the powdered samples of these plants were uniformly sprayed on the experimental material at 30 g/l twice weekly from 10 to 38 days after sowing. *A. hybridus* plants sprayed with aqueous leaf extracts of the different plants had lower percentage leaf and leaf area damage compared to the control. Percentage leaf damage followed this order: *A. indica* < *V. amygdalina* < *O. gratissimum* < control, with percentages leaf damage of 25-27%, 34-46%, 32-49% and 47-73%, respectively. Percent leaf area damage were 18.6%, 31%, 45.8% and 61.2% for *A. indica*, *O. gratissimum*, *V. amygdalina* and control, respectively. Significantly ($P < 0.05$) higher plant height, root length and dry matter production were obtained in plants sprayed with aqueous leaf extract of *A. indica* in contrast to the other treatments, which had comparable values with the control. The results indicate that *A. indica* if properly harnessed can be used as a biopesticide in the control of insect field pest of *A. hybridus*.

Keywords: Biopesticide; Field pest; *Amaranthus hybridus*; Leaf extract

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Introduction

Amaranthus hybridus is a herbaceous, short lived, annual vegetable which belongs to the

family Amaranthaceae. It is commonly grown for its edible leaves [1]. *A. hybridus* is one of the most delicious leafy vegetable consumed in Nigeria especially in the South western part. Nigeria is reported to be the largest producer

and consumer of Amaranth in Africa, followed by Ghana, Benin Republic and Senegal in West Africa; Kenya, Uganda, Cameroon, Gabon, Tanzania and Ethiopia in East and Central Africa; South Africa, Zambia and Zimbabwe in Southern Africa [2,3]. Vegetable amaranth is a popular vegetable because of its palatability, early maturity and high nutritive value [4]. Leaf amaranth is used as a steamed vegetable in soups and stews. The leaves, stem and head are reportedly high in protein (15 to 24 % on a dry-matter basis) [5]. Green leafy vegetables are rich source of beta-carotene, ascorbic acid, minerals and dietary fibre [6]. Martirosyan *et al.* [7], stated that regular consumption of amaranth reduces blood pressure, cholesterol levels and improves the body's antioxidant status and immunity. *A. hybridus* is recommended as a good food with medicinal properties for young children, lactating mothers and for patients with fever, anemia or kidney complaints.

However, every part of *A. hybridus*, be it the leaves, stem, buds, flowers, fruits and seeds are a source of food for a wide range of pests resulting in reduced yield. Aderolu *et al.* [8], in their survey on insect pest of amaranths in Ibadan, Southwest Nigeria identified sixty insect species associated with amaranth crop with *Hymenia recurvalis* Fab. (Lepidoptera: Pyralidae) being the most abundant as well as the most important defoliator of *Amaranthus species*. Foliar damage by insect pests not only decreases yield but also reduces the market value leading to economic loss. Insect pest infestations are one of major constraint to production of amaranths [4]. According to Oerke and Dehne [9], pests contribute 30-40% of crop loss worldwide while the loss in the tropics is reported to be even higher than 40% [10]. Synthetic pesticides have been successfully used in the control and management of crop pests. However, their use has been restricted because of their environmental pollution effect, carcinogenicity, high and acute residual toxicity and long

degradation period resulting in pesticide residue in food [11,12]. World Health Organization (WHO) according to Schmutterer [13] reported the poisoning of at least 3 million agricultural workers out of which 20,000 deaths are recorded annually due to pesticide usage. These have necessitated the need to develop non-toxic safe and effective biodegradable alternatives to synthetic pesticide and botanicals have been found useful in this regard. Survey carried out by Mwine *et al.* [14], established that thirty-four species belonging to eighteen families are currently used in traditional plant production practices in Uganda with *Azadirachta indica* being one of the most useful species. Okunkola *et al.* [15], had earlier reported that the aqueous extract of *A. indica* bark was as effective as a synthetic insecticide, Cymbush in controlling foliage feeders of vegetables. Onunkun [16], reported significant reduction in population of flea beetles infesting Okra (*Abelmoschus esculentus*) due to the leaf extracts of *Jatropha curcas*, *Vernonia amygdalina* and *Annona squamosa*. In view of the benefits of *A. hybridus*, the great damage from insect attack in the field and the negative effects of synthetic insecticide use, this study was carried out to evaluate the insecticidal effect of aqueous leaf extracts of *Azadirachta indica*, *Ocimum gratissimum* and *Vernonia amygdalina* on insect field pests of *A. hybridus*.

Materials and Methods

Study location

The experiment was conducted at the botanical garden of Plant Science and Biotechnology, Abia State University, Uturu, Nigeria. Uturu lies on latitude 7° 6' north and longitude 6° 0'. The area is characterized as humid agro-ecological zone of south eastern Nigeria and the soil is sandy loam.



Sources of materials

The seeds of *A. hybridus* used in this study were sourced from National Horticultural Research Institute (NIHORT), Okigwe, Imo State, Nigeria. The leaves of *Azadirachta indica*, *Ocimum gratissimum* and *Vernonia amygdalina* were collected from the school environment.

Land preparation

The site was manually cleared and marked into three blocks which represent the replicates. Each block was divided into four plots measuring 210cm x 250cm each and raised as beds. A pinch of *A. hybridus* seeds were sown directly into the beds at a depth of 2cm and sowing spacing of 30cm x 50cm apart. After germination, the resulting seedlings were thinned down to one seedling per hole. The plots were properly labeled based on the treatments.

Experiment design and treatments

The experiment was laid in a randomized complete block design and replicated thrice. The aqueous leaf extracts of the three plants (*A. indica*, *O. gratissimum* and *V. amygdalina*) were the treatments. The control was also included, which represent plants that were not sprayed with any extract. Thus, a total of four treatments were used.

Preparation of aqueous extract and treatment application

The leaves were washed to remove dirt and sand particles. After which, they were dried separately in a hot air oven at 60°C until a constant weight was achieved. Thereafter, the dried leaf samples were ground into powder. 30g each of the powdered samples was soaked separately in a litre of water, stirred continuously for 5 mins and allowed to stand for 12 hours prior to use. Before application, the

suspension, which had been allowed to stand for 12 hours, was filtered using muslin cloth and the filtrate made up to 1 litre. The extracts were sprayed on the plants of their respective plots at 6.00 am twice weekly, Mondays and Fridays from 10 to 38 days after sowing (DAS).

Data Collection and Analysis

Data were collected on total number of leaves, number of damaged leaves, percentage leaf damage, total leaf area, damaged leaf area, percentage leaf area damage, plant height, stem girth, root length and dry weight. Five leaves were randomly selected and tagged and used for these measurements. The number of leaves produced per *A. hybridus* plant for each of the treatments was counted and the mean number recorded. The number of leaves with holes created as a result of insect infestation was also counted and the mean recorded as the number of damaged leaves. The percentage leaf damaged was calculated as: % leaf damage = no. of damaged leaves / number of leaves per plant x 100. The above measurements were done at weekly interval from 17-38 DAS. Total leaf area, leaf area damage, plant height, root length, stem girth and dry weight of the plant were determined at 38 DAS. Leaf area produced per plant was determined by planographic method. Leaf area damage was determined by determining the area of the holes created on the leaves and summing them up. Then, the percentage leaf area damage was determined by dividing the leaf area damage by the leaf area and multiplying the result by 100. The stem girth was measured with a micro meter screw gauge; plant height was measured with a meter rule from the base of the stem at soil level to the terminal bud of the main stem, while for the root length, the plants were carefully uprooted and the length measured with a meter rule from the base of the stem at soil level to the tip of the root. The uprooted plants were dipped in a bucket of water to wash off the soil particles adhering to the roots. The water was allowed to drain and thereafter, the uprooted plants were

chopped into pieces, packed in an envelope and dried in an oven at a temperature of 80°C until a constant weight was achieved. It was then weighed using an electronic balance and the mean weight recorded as the dry weight.

Results

Total number of leaves produced per *A. hybridus* plant sprayed with aqueous leaf

extract of the different plants did not vary significantly from each other and from the control in all the sampled days except on 38 DAS (Table 1). *A. hybridus* plants sprayed with aqueous leaf extract of *O. gratisimum* produced number of leaves that was significantly ($P<0.05$) higher than the control. Whereas, total number of leaves produced by plants sprayed with the leaf extracts did not vary significantly.

Table 1: Effects of different plant extracts on total number of leaves and damaged leaves of *A. hybridus* at different sampled days.

Treatment	17 DAS		24 DAS		31 DAS		38 DAS	
	TNL	NDL	TNL	NDL	TNL	NDL	TNL	NDL
Control	9	4.2	10.8	6.7	12.3	7.5	13.5	9.8
<i>A. indica</i>	9.9	2.5	11.5	3.3	13.8	3.8	15	4.1
<i>V. amygdalina</i>	7	2.4	9.8	4.5	14.2	4.9	17.2	6.3
<i>O. gratisimum</i>	9.8	3.4	10.5	5.1	16	5.1	18.5	7.8
LSD (0.05)	NS	1.2	NS	1.9	NS	2.1	4.2	2.4

DAS=days after sowing; TNL=total number of leaves; NDL=number of damaged leaves.

However, significant variation ($P<0.05$) existed among the treatments in the number of damaged leaves in all the days sampled (Table 1). Plants sprayed with *A. indica* and *V. amygdalina* had comparable number of damaged leaves with those sprayed with *O. gratisimum* but significantly lower number of damaged leaves than the control at 17, 24 and 31 DAS (Table 1). At 38 DAS, plants sprayed with *A. indica* had number of damaged leaves that did not differ significantly from those of *V. amygdalina* but was significantly lower than those sprayed with *O. gratisimum* and the control. In the same vein, plants sprayed with *V. amygdalina* had number of damaged leaves that were similar to those sprayed with *O. gratisimum* but significantly lower than those of the control. Those of the control and *O. gratisimum* on the other hand had number of damaged leaves that were at par. The lowest percentage leaf damage was recorded in plants sprayed with *A. indica*; this was closely followed by those sprayed with *V. amygdalina* and the highest was recorded in the control plants (Figure 1). In addition, the percentage

leaf damage of plants sprayed with *A. indica* followed almost a static response while the control followed a linear response as the plants age. Those of *V. amygdalina* and *O. gratisimum* followed the same pattern and were rather an erratic response. Total leaf area was significantly ($P<0.05$) higher in plants sprayed with *O. gratisimum* in comparison with those sprayed with the other leaf extracts (Figure 2). The control plants and those sprayed with *A. indica* and *V. amygdalina* produced statistically similar leaf area values. Like in leaf damage, the least percentage leaf area damage was recorded in plants sprayed with *A. indica*; followed by those sprayed with *O. gratisimum* and the highest was recorded in the control (Figure 3). Significant differences ($P<0.05$) were found among the treatments in the growth parameters assessed with the exception of the stem girth (Table 2). Plants sprayed with *A. indica* had significantly the highest plant height, root length and dry weight while plants sprayed with the other plant extracts had comparable values with the control plants.

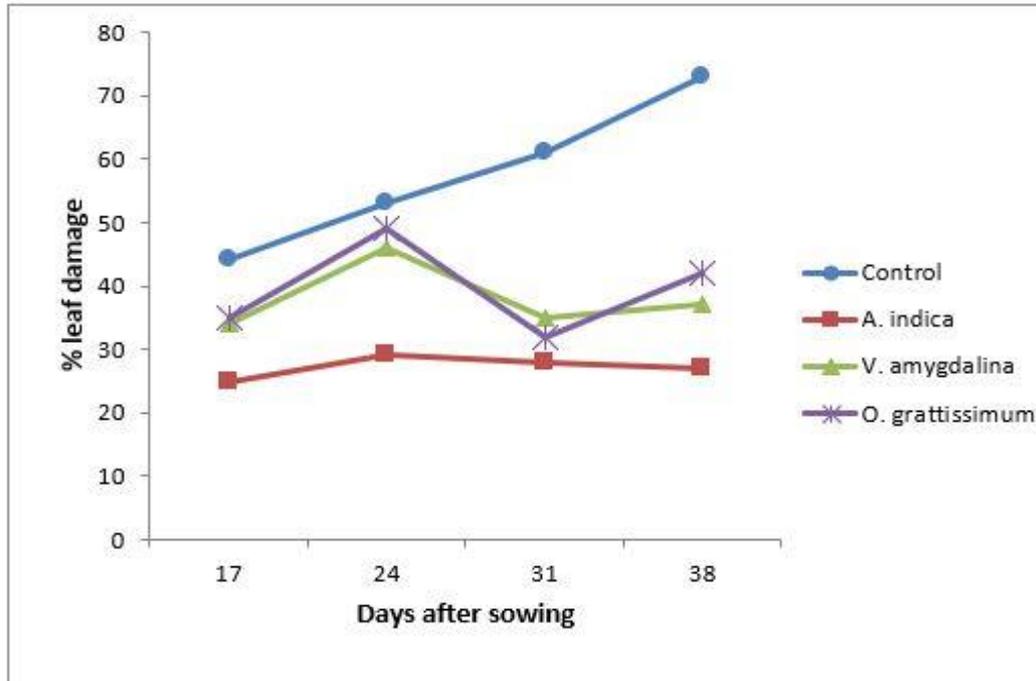


Figure 1: Effect of treatments on percentage leaf damage of *A. hybridus*.

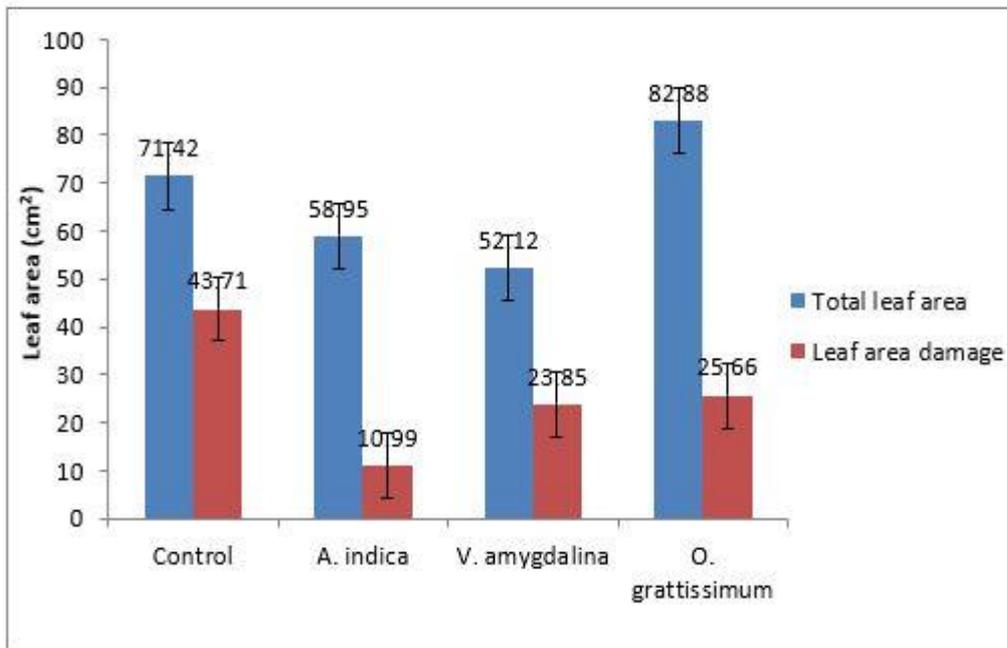


Figure 2: Effect of treatments on total leaf area (cm²) and leaf area damage (cm²) of *A. hybridus*.

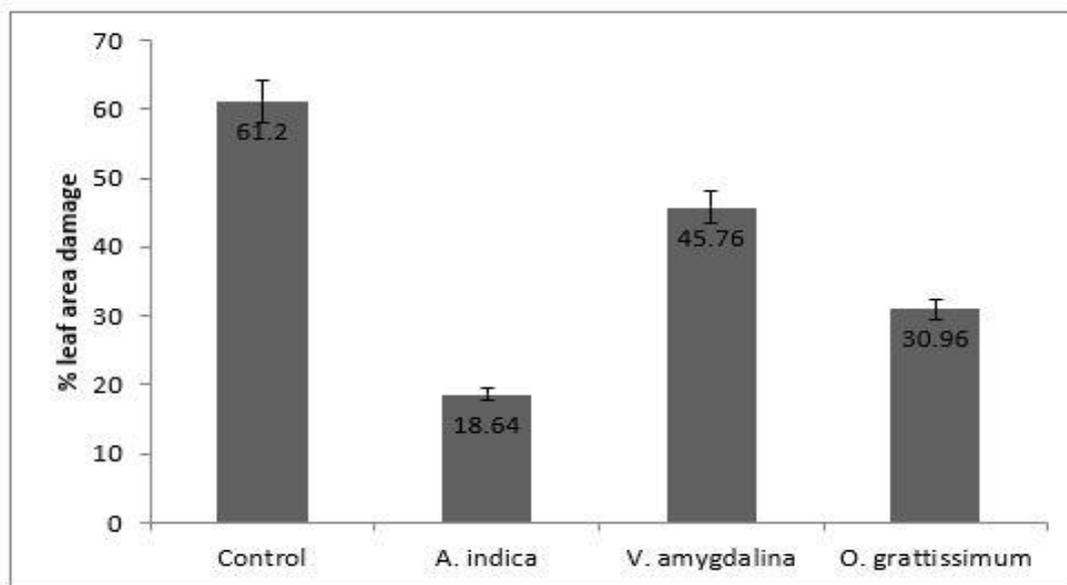


Figure 3: Effect of treatments on percentage leaf area damage of *A. hybridus*.

Table 2: Effect of treatments on growth parameters of *A. hybridus*.

Treatment	Plant height (cm)	Root length (cm)	Stem girth (mm)	Dry weight (g)
Control	27.5	29.5	11.2	5.8
<i>A. indica</i>	36.3	43	13.3	13.6
<i>V. amygdalina</i>	28.5	25.9	10.5	6.8
<i>O. grattissimu</i>	28.8	26.5	10.8	7.1
LSD (0.05)	5.4	6.7	NS	4.9

Discussion

The results showed that aqueous leaf extracts of the different plant species exhibited some level of control of the field pests of *A. hybridus* as they recorded lower percentage leaf damage and leaf area damage in relation to the control. Decrease in percentage leaf damage and leaf area damage owing to the application of the plant extracts is an indication of reduced number of foliage pests of *A. hybridus*. It is also an indication that the extracts possess insecticidal attribute in reducing insect attack. This was also reported by Okpako *et al.* [17], on repellance effect of aqueous extract of alligator pepper (*Aframomum melegueta* K. Schum) on insect pests of okra. Our result is in

conformity with the reports of Aderolu *et al.* [8], who reported decrease in insect population and number of damaged leaves of Amaranth sprayed with neem extracts.

However, the number of damaged leaves and the percentages of damaged leaf and leaf area damage were consistently lower in plants sprayed with leaf extract of *A. indica* in comparison with the other extracts. The percentage leaf damage followed this order: *A. indica* < *V. amygdalina* < *O. grattissimum* < control. This is an indication that *A. indica* had greater pesticidal effect than the other two plant extracts. Hamd *et al.* [18], reported the effectiveness of neem extract against aphid predator field pest. The leaf and

seed extracts of the neem tree *Azadirachta indica* A. Juss have been shown to affect over 200 insect species including some species of aphids, beetles, caterpillars, leaf miners, mealybugs, scales, thrips, true bugs and whiteflies and is also the most popular botanical pesticide against foliage feeding pests [8]. According to Basedow *et al.* [19], and Ehisianya *et al.* [20], *A. indica* based products are very effective or even more effective than synthetic pesticides in the control of aphids and white flies. Plant secondary metabolites have been implicated as substances that confer pesticidal potency to botanicals [21]. These secondary metabolites include alkaloids, terpins, phenols, etc. The bioactivity of *A. indica* has been attributed to various chemical compounds (secondary metabolites) numbering over 250, which include diterpenoids, triterpenoids, trinitriterpenoids D-lactose, hexanortriterpenoids, octanortriterpenoids and enneanoorpenoids. These compounds act in concert, thereby giving no room for the development of pest's resistance; they exhibit significant anti-feedant, pesticidal, microbial and inert growth disrupting properties, they also cause reduction in pests activity, feeding fecundity and adult longevity thus causing reduction in pests population and deterring settling of pests on hosts [22].

The linear response observed in the control on percentage leaf damage as the plant aged signifies continues feeding of foliage pests on *A. hybridus* leaves. This also connotes increase in pest population and goes further to support the effectiveness of the plant extracts used in the control of insect field pests of *A. hybridus*. Plants sprayed with neem extract showed more or less a static response in percentage leaf damage as the plant aged. This clearly shows the protective effect of neem extract against the foliage pests of *A. hybridus*. This agrees with the earlier report of Aderolu *et al.* [8], that the leaf and seed extracts of the neem tree, *Azadirachta indica* A. Juss is the most popular botanical pesticide against foliage feeding

pests. The responses of plants sprayed with the other two extracts, *V. amygdalina* and *O. gratisimum* on percentage leaf damage as the plants aged were similar. This showed that extracts of *V. amygdalina* and *O. gratisimum* exerted similar effect on the pests of *A. hybridus*. *V. amygdalina* and *O. gratisimum* have also been reported to be effective in controlling insect pests [16,23-25]. *V. amygdalina* has been found to control field pests because of its extreme bitterness. The main anti-insect components of *V. amygdalina* were identified as vernodalin and 11,13-dihydrovernodalin as well as several vernoniosides [26].

Assessment of the growth parameters showed that plants sprayed with *A. hybridus* extract had significantly the highest plant height, root length and dry weight. This is attributable to the decrease in the number of damaged leaves and leaf area damage recorded due to the application of neem leaf extract. Reduced leaf area damage will result in higher photosynthetic activity and this will ultimately increase growth. Results indicated that plants sprayed with *O. gratisimum* produced significantly ($P < 0.05$) the highest number of leaves and leaf area in contrast to plants sprayed with the other leaf extracts and the control. *O. gratisimum* in addition to being an insect repeller may also function as a foliar spray in improving vegetative growth of vegetables if properly harnessed.

Field observation showed that none of the extracts used in this study produced any phytotoxic effect; neither leaf-yellowing nor shedding was observed. In addition, none of the plant extracts used inhibited growth. These go to support their use as suitable biopesticides. The results of this study showed that the aqueous leaf extracts of the three plant extracts used had pesticidal effect on insect field pests of *A. hybridus*. Amongst the three plant extracts, aqueous extract of *A. indica* proved to be superior. Therefore, *A. indica* can provide

suitable alternative for pest control of vegetable crops like *A. hybridus* and can form the basis for a successful commercialization of bio-pesticide in developing countries like Nigeria.

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