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Evaluation of plant extracts in the management of insect infestation of soybean (*Glycine max* (L.) Merrill

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ABSTRACT
Insects are the largest group of pests infesting crops at different stages of their development and are mostly controlled with synthetic insecticides. However, the drawbacks associated with the use of these insecticides have necessitated the search for cheaper, environmentally friendly and readily available plant extracts. Field experiments were conducted in Federal University of Agriculture Abeokuta, Ogun State between August and October in the late planting season of 2011 and April to August in the early planting season of 2012 to evaluate the effectiveness of plant extracts in the management of insect pests of soybean (Glycine max). Seeds of soybean variety TGx 1740-2F were sown by drilling at a spacing of 50 cm between the rows and 5 cm within the rows. Aqueous extracts of nine plants namely Azadirachta indica, Ocimum bacilicum, Chromolaena odorata, Delonix regia, Anacardium occidentale, Mangifera indica, Tithonia diversifolia, Vernonia amygdalina and Nicotiana tabacum were applied as treatments at 10% w/v. Lambda-cyhalothrin was used as a standard and water as a control. The experiment was laid out in a Randomized Complete Block Design with three replicates. There was no significant ($p > 0.05$) difference in the number of insects in the extract-treated soybean plants, lambda-cyhalothrin-treated soybean plants and the untreated ones in both seasons. The number of insect infestation in the treated and the untreated soybean plots were low and did not exceed 3. There was no significant ($p > 0.05$) difference in the number and weight of pods per plant, percentage of damaged pods and damaged leaves and number of leaves of treated and untreated soybean plants. The study implies that soybean was infested by a narrow spectrum of insect pests that were of minor relevance in terms of damage to leaves and pods. Lambda-cyhalothrin and plant extracts used in this study had no significant influence on infestation of soybean by insect pests and pod yield. The low population of insect pests encountered in this study suggests that their population is below what can cause economic injury to soybean. The use of lambda-cyhalothrin or extract of the test plants in the control of insect pests of soybean is therefore uneconomical and not recommended.

Keywords: *aqueous extract, Glycine max, insect pests, lambda-cyhalothrin, plant extracts.*

INTRODUCTION

Soybean, *Glycine max* (L.) Merrill is a leguminous vegetable that belongs to the family Fabaceae. The crop is economically important because of its taste and flavour and was ranked as an oilseed crop that provides approximately 50 % of the edible oil of the world (Akparobi, 2009). Dry soybean contains 36 % protein, 19 % oil, 35 % carbohydrate, 5 % minerals and several other components including vitamins (Lius, 1997). Soybean compensates for the shortage of oil and protein of other crops and has gained popularity in Nigeria, outranking cowpea (*Vigna unguiculata* (L.) Walp), because of its potential to supply high quality protein (Akande *et al*., 2007; Vahedi *et al*., 2010; Salwa *et al*. 2011). The crop has been considered as a nutritive food for human needs and livestock, also for industrial and medicinal purposes due to the large amount of macro and micro nutrients it contains (Berglund, 2002).

In spite of its great potential, soybean production is still inadequate in Nigeria owing to various limitations which result in low yield per area. Grain yields of soybean cultivars are generally low in Nigeria compared to other places in the world (Aduloju *et al*., 2009). Yield on growers' farms is often lower than 1000 kg/ha compared to yields > 2500 kg/ha in the USA (Modali, 2004), 3000 kg/ha in Brazil and 3500 kg/ha in Turkey (FAO/STAT, 2004). Production is constrained by low yield due to many factors which include pests and diseases, inadequate soil nutrition and drought (Yusuf and Idowu, 2001), weed and unpredictable weather (Lal, 2009).

Insect pests are a limiting factor in the production of soybean crop wherever the crop has been cultivated for several centuries (Jackai and Singh, 1987; Jackai *et al*. 1990). Initially, very few pests and diseases were found on edible soybean in India; however, as cultivation expanded and became more intensive, pest and disease problems increased in incidence and severity (Akem and Dashiell, 1992). Every growth stage of soybean is infested by insect pests; at the vegetative stage, the crop is very susceptible to silverleaf white fly attack; at flowering stage onwards, soybean becomes attractive to pod-sucking bugs that can seriously reduce yield (Dudge *et al*., 2009). The soybean aphid (*Aphis glycine* Mats) has become one of the most significant insect pests of soybean worldwide (Ragsdale *et al*., 2007). An additional threat posed by the soybean aphid is its ability to transmit soybean viruses (Domier *et al*., 2003). Honeydew excreted by soybean aphids onto leaves lead to the development of sooty mould that restricts photosynthesis (Hartman *et al*., 2001).

Damage to the soybean plant (defoliation) can be up to 30 % at vegetative stage, 15 % at flowering stage and 25 % at maturity stage. Before flowering, soybeans tolerate up to 33 % leaf loss without loss of yield. However, recent data shows that *Helicoverpa* populations inflicting less than 33 % damage can cause serious yield loss, because the larvae not only feed on leaves, but also attack terminals and auxiliary buds. Ndam *et al*. (2012) reported that the impact of insect pest damage on soybean has not attained the level of economic concerns though a wide spectrum of insects were found associated with the crop. The insect pests of soybean can be controlled with synthetic insecticides; however, concern for the environment has shifted control measures to the use of bio-pesticides and plant extracts. This study therefore evaluates the efficacy of extracts from Neem (*Azadirachta indica*), Fever plant (*Ocimum bacilicum*), Mexican Sunflower (*Tithonia diversifolia*), Mango (*Mangifera indica*), Bitter leaf (*Vernonia amygdalina*), Siam weed (*Chromolaena odorata*), Tobacco (*Nicotiana tabacum*), Cashew (*Anacardium* *occidentale*) and Flamboyant tree (*Delonix regia*) at managing insect pests of soybean.

MATERIALS AND METHODS

Location of experiment and source of soybean seeds

The experiment was carried out in the late planting season of year 2011 and repeated in the early planting season of year 2012 at the Research Farm of Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. The soybean (*Glycine max*) cultivar TGx 1740-2F used for the study was sourced from the Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

Sources of plant materials and preparation of extract

Young leaves of nine plant species namely: Neem (*Azadirachta indica*), Fever plant (*Ocimum bacilicum*), Mexican Sunflower (*Tithonia diversifolia*), Mango (*Mangifera indica*), Bitter leaf (*Vernonia amygdalina*), Siam weed (*Chromolaena odorata*), Tobacco (*Nicotiana tabacum*), Cashew (*Anacardium occidentale*) and Flamboyant tree (*Delonix regia*) were harvested from their parent plants where they grow naturally on fields in FUNAAB, Ogun State and were taken to the laboratory of the Department of Crop Protection. The plants were selected on the basis of ease of availability, cultivation and history of insecticidal and medicinal attributes.

The young leaves were thoroughly washed to remove dust or any dirt on them and then dried under shade (air dried) at room temperature (27± 2^{o} C) for about 10 days till they were thoroughly dried. The dried leaves were mechanically grinded and the powder was sieved. One hundred gram (100 g) of dried and powdered leaves from each plant was poured into 1000 ml of water (10 % w/v) and left for 24 hrs. The mixtures were shaken vigorously, allowed to settle and later decanted. The decanted solutions were filtered using Whatman No 1 filter paper and used as treatments. Fresh extracts were prepared for each spraying.

Field preparation and sowing of seeds

Tillage was done mechanically using a tractor mounted implement (Disc plough) and harrowed after a week. Sowing of seed was done by the drilling method. A space of 50 cm between the rows and 5 cm within the rows was used and the seeds were sown at a depth of 3 cm. Weeding was done manually using hoes at 4 and 8 weeks after planting (WAP).

Application of treatments

One litre each of the mixture of the powder of the plants and water (10 % w/v) was sprayed on each of the replicated soybean (*Glycine max*) plot with the aid of hand sprayer. The volume per area was determined through calibration using area-volume method. There were two controls; spraying of soybean plants with the synthetic insecticide (lambda-cyhalothrin) and spraying of soybean plants with water. Application of treatments was done at 3, 5 and 7 weeks after planting (WAP).

Collection of data

Plant height of soybean at 3, 5 and 7 WAP was taken using meter rule on five randomly selected plants from the 2 middle rows. Number of insects found in the upper and lower surfaces of the leaves as from 4 WAP till 7 WAP were counted per plot. The insects were counted visually between the hours of 7 and 10 am when the insect pests were relatively inactive. At the physiological maturity, the number of leaves per plant was counted and the number of damaged leaves was noted. Number of pods per plant was determined by finding the mean of the sum of all the pods harvested from the 5 tagged plants in each plot**.** Pods harvested from five tagged plants were weighed and the mean determined for weight of pod per plant. Any pod with at least a hole or scraped was considered damaged.

Analysis of Data

Statistical analysis of data was done based on SAS's general linear models procedure (SAS Institute, 1988). The data collected on the field was subjected to analysis of variance (ANOVA) and significant means (P < 0.05) was separated using Duncan Multiple Range Test (DMRT). Data on insect count was subjected to square root transformation before analysis.

RESULTS

Number of insect pests in the late planting season of 2011 and early planting season of 2012

The number of insect pests on the plant extract-treated soybeans, lambda cyhalothrin-treated soybeans and untreated soybeans were not significantly (P > 0.05) different from each other in the late planting season of 2011 and early planting season of 2012 (Tables 1 and 2).

Percentage damage of soybean leaves and pods in the late planting season of 2011 and early planting season of 2012

In the late planting season of 2011, the % leaves damaged in the treated and untreated soybean plants were not significantly (P > 0.05) different from each other, except in soybean plants treated with extract of *C. odorata* and lambda-cyhalothrin that differed significantly (P < 0.05) from each other. The % leaves damaged in treated and untreated soybean in the early planting season of 2012 were not significantly (P > 0.05) different from each other (Table 3). In the late planting season of 2011, the % pod damage in treated and untreated soybean plants were not significantly (P > 0.05) different from each other (Table 3). The % pod damage in the treated and untreated soybean, in the early planting season of 2012 were not significantly (P > 0.05) different from each other, except in soybean plants treated with lambda-cyhalothrin and the untreated soybean that differed significantly (P < 0.05) from each other.

Table 1. Number of insect pests found on *Glycine max* in the late planting season of 2011

Treatments	Insect type and number					
	Monolepta species	*Barombiella humeralis*	*Luperodes lineatus*	*Chrysolagria* species	*Aspavia armigera*	*Nezara viridula*
Azadirachta indica	1.08^a	0.12^a	0.44^a	0.00^a	0.00^a	0.00^a
Ocimum bacilicum	1.00^a	1.01^a	0.33^a	0.00^a	0.00^a	0.00^a
Tithonia diversifolia	1.09^a	1.07^a	1.04^a	0.00^a	0.00^a	0.00^a
Mangifera indica	1.05^a	0.28^a	0.36^a	0.00^a	0.00^a	0.00^a
Vernonia amygdalina	1.00^a	0.13^a	1.41^a	0.08^a	0.08^a	0.00^a
Nicotiana tabacum	0.05^a	0.23^a	0.19^a	0.00^a	0.00^a	0.00^a
Delonix regia	1.00^a	0.18^a	0.35^a	0.00^a	0.00^a	0.00^a
Anacardium occidentale	1.33^a	1.10^a	0.44^a	0.00^a	0.00^a	0.00^a
Chromolaena odorata	1.05^a	0.22^a	0.41^a	0.08^a	0.00^a	0.08^a
Lambda cyhalothrin	1.00^a	0.14^a	0.13^a	0.00^a	0.00^a	0.00^a
Control	1.00^a	1.16^a	1.16^a	0.17^a	0.08^a	0.00^a

Means with the same alphabet along the column are not significantly different from each other.

Table 2:Number of insect pests found on *Glycine max* in the early planting season of 2012

Treatments	Insect type and number					
	Monolepta species	*Barombiella humeralis*	*Luperodes lineatus*	*Chrysolagria* species	*Aspavia armigera*	*Nezara viridula*
Azadirachta indica	0.22[a]	0.00[a]	1.83[a]	0.08[a]	0.08[a]	0.17[a]
Ocimum bacilicum	0.00[a]	0.00[a]	2.50[a]	0.08[a]	0.33[a]	0.08[a]
Tithonia diversifolia	0.33[a]	0.00[a]	1.09[a]	0.25[a]	0.00[a]	0.17[a]
Mangifera indica	0.22[a]	0.00[a]	1.33[a]	0.08[a]	0.17[a]	0.17[a]
Vernonia amygdalina	0.00[a]	0.00[a]	1.08[a]	0.17[a]	0.00[a]	0.17[a]
Nicotiana tabacum	0.00[a]	0.00[a]	1.25[a]	0.08[a]	0.17[a]	0.17[a]
Delonix regia	0.11[a]	0.17[a]	1.67[a]	0.08[a]	0.08[a]	0.00[a]
Anacardium occidentale	0.11[a]	0.00[a]	1.42[a]	0.08[a]	0.00[a]	0.00[a]
Chromolaena odorata	0.11[a]	0.00[a]	0.75[a]	0.00[a]	0.00[a]	0.17[a]
Lambda cyhalothrin	0.11[a]	0.00[a]	0.00[a]	0.00[a]	0.00[a]	0.08[a]
Control	0.00[a]	0.08[a]	0.75[a]	0.00[a]	0.08[a]	0.00[a]

Means with the same alphabet along the column are not significantly different from each other.

Table 3: Percentage of soybean leaves and pods damaged in the late planting season of 2011 and early planting season of 2012

Treatments	Percentage of soybean leaves damaged and percentage pods damaged			
	2011		2012	
	% soybean leaves damaged	% soybean pods damaged	% soybean leaves damaged	% soybean pods damaged
Azadirachta indica	62.23[a]	5.34[a]	62.46[a]	2.84[a]
Ocimum bacilicum	53.70[a]	6.34[a]	62.78[a]	3.10[ab]
Tithonia diversifolia	57.55[a]	6.05[a]	59.50[a]	3.47[ab]
Mangifera indica	52.21[ab]	6.54[a]	53.11[a]	2.51[a]
Vernonia amygdalina	52.03[ab]	7.56[a]	51.61[a]	4.34[a]
Nicotiana tabacum	45.47[ab]	6.87[a]	60.40[a]	3.20[ab]
Delonix regia	49.97[ab]	6.64[a]	55.32[a]	3.50[ab]
Anacardium occidentale	51.07[ab]	7.61[a]	50.95[a]	3.79[ab]
Chromolaena odorata	69.09[a]	7.50[a]	57.60[a]	2.78[ab]
Lambda cyhalothrin	26.64[b]	6.82[a]	39.94[a]	2.23[b]
Control	54.81[ab]	6.54[a]	47.40[a]	3.07[a]

Mean with the same alphabet along the column are not significantly different from each other.

Height of treated and untreated soybean plants in the late planting season of 2011 and early planting season of 2012

In the late planting season of 2011, soybean plants treated with the extracts of lambda-cyhalothrin was not significantly ($P > 0.05$) taller than soybean plants treated with other extracts except soybean plants treated with extract of *T. diversifolia*. In the early planting season of 2012, the height of the treated and untreated soybean plants were not significantly ($P > 0.05$) different from each other. Lambda-cyhalothrin treated soybeans were significantly ($P < 0.05$) shorter than other treated soybean plants, except those treated with extract of *A.*

occidentale and untreated soybean plants (Table 4).

Number of leaves in treated and untreated soybean plants in the late planting season of 2011 and early planting season of 2012

In the late planting season of 2011, the number of leaves on treated and untreated soybean plants were not significantly (P > 0.05) different from each other, except number of leaves in soybean plants treated with extract of *A.occidentale* which was more (P < 0.05) than the number of leaves in untreated soybean. Number of leaves on *A. occidentale* and lambda-cyhalothrin differed significantly (P < 0.05) from each other (Table 4). The number of leaves on treated and untreated soybean plants in the early planting season of 2012 were not significantly (P > 0.05) different from each other, except number of leaves in soybean plants treated with extract of *T. diversifolia* and lambda-cyhalothrin that differed significantly (P < 0.05) from each other (Table 4).

Number of flowers in treated and untreated soybean plants in the late planting season of 2011 and early planting season of 2012

In the late planting season of 2011, the number of flowers on treated and untreated soybean plants were not significantly (P > 0.05) different from each other. Soybean plants treated with extract of *M. indica* and lambda-cyhalothrin differed significantly (P < 0.05) from each other. The number of flowers on treated and untreated soybean plants in the early planting season of 2012 were not significantly (P > 0.05) different from each other, except on soybean plants treated with extract of *C. Odorata* and lambda-cyhalothrin that differed significantly (P < 0.05) from each other (Table 4). The number of flowers on soybean plants treated with lambda-cyhalothrin was not significantly (P > 0.05) different from the number on the untreated soybean plants (control). However, the number of flowers on soybean plants treated with extract of *V. Amygdalina* was significantly (P < 0.05) higher than the number in the untreated soybean plants (control) (Table 4).

Number of pod per plant and pod weight in the late planting season of 2011 and early planting season of 2012

The number of pods per plant and pod weight in the late planting season of 2011 and the early planting season of 2012 are depicted in Table 5. In the late planting season of 2011 and early planting season of 2012, there was no significant (P > 0.05) difference in the number of pods per plant in all the treatments. The pod weight in the treated and untreated soybean plants were not significantly (P > 0.05) different from each other in the late planting season of 2011. The pod weight in lambda-cyhalothrin treated soybean in the early planting season of 2012 were not significantly (P > 0.05) higher than weight of pods from soybean treated with plant extracts except those treated with extract of *T. diversifolia*, *V. amygdalina* and *A. occidentale*. The pod weight in lambda-cyhalothrin treated soybean was significantly (P < 0.05) higher than weight of pods from soybean plants treated with extracts from *T. diversifolia*, *V. amygdalina* and *A. occidentale*

Table 4: Agronomic characters of soybean plant in the late planting season of 2011 and early planting season of 2012

	Agronomic characters of the soybean plant					
	2011			2012		
Treatments	Plant Height	Number of leaves	Number of flowers	Plant Height	Number of leaves	Number of flowers
Azadirachta indica	49.02^{ab}	9.67^{bc}	32.07^{ab}	46.60^{a}	15.60^{ab}	28.60^{abcd}
Ocimum bacilicum	50.87^{ab}	11.60^{abc}	31.33^{ab}	49.76^{a}	15.93^{ab}	27.07^{abcd}
Tithonia diversifolia	54.91^{a}	10.87^{bc}	28.53^{ab}	55.09^{a}	20.20^{a}	32.47^{abc}
Mangifera indica	42.39^{ab}	12.60^{abc}	40.93^{a}	43.83^{a}	16.13^{ab}	14.00^{cd}
Vernonia amygdalina	45.71^{ab}	12.33^{abc}	34.80^{ab}	46.99^{a}	13.60^{ab}	43.53^{ab}
Nicotiana tabacum	41.92^{ab}	14.73^{ab}	22.73^{ab}	46.68^{a}	12.87^{ab}	22.40^{a-d}
Delonix regia	43.95^{ab}	9.60^{bc}	24.87^{ab}	46.67^{a}	14.67^{ab}	29.67^{a-d}
Anacardium occidentale	48.77^{ab}	16.73^{a}	37.27^{ab}	39.02^{ab}	14.53^{ab}	21.53^{b-d}
Chromolaena odorata	47.47^{ab}	11.07^{abc}	30.40^{ab}	43.93^{a}	16.28^{ab}	46.80^{a}
Lambda cyhalothrin	37.92^{b}	8.73^{c}	13.07^{b}	26.99^{b}	9.00^{b}	7.33^{d}
Control	45.39^{ab}	9.40^{bc}	28.27^{ab}	41.41^{ab}	15.70^{ab}	11.40^{cd}

Means with the same alphabet along the column are not significantly different from each other.

Table 5: Number of pods per plant and pod weight (g) in the 2011 and 2012 planting seasons

	Number of pods per plant and pod weight (g)			
	2011		2012	
Treatments	Number of pods per plant	Pod weight per plant (g)	Number of pods per plant	Pod weight per plant (g)
Azadirachta indica	11.73^{a}	5.34^{a}	44.60^{a}	22.66^{ab}
Ocimum bacilicum	11.33^{a}	6.34^{a}	40.33^{a}	20.54^{ab}
Tithonia diversifolia	12.80^{a}	6.05^{a}	37.33^{a}	18.74^{b}
Mangifera indica	10.93^{a}	6.54^{a}	49.20^{a}	24.84^{ab}
Vernonia amygdalina	12.33^{a}	7.56^{a}	31.00^{a}	15.30^{b}
Nicotiana tabacum	9.67^{a}	6.87^{a}	40.40^{a}	20.59^{ab}
Delonix regia	10.13^{a}	6.64^{a}	35.00^{a}	17.98^{a}
Anacardium occidentale	9.80^{a}	7.61^{a}	32.33^{a}	16.38^{b}
Chromolaena odorata	11.00^{a}	7.50^{a}	48.53^{a}	24.47^{ab}
Lambda cyhalothrin	8.87^{a}	6.82^{a}	63.80^{a}	35.59^{a}
Control	9.47^{a}	6.54^{a}	47.67^{a}	24.15^{ab}

. Means with the same alphabet along the column are not significantly different from each other.

DISCUSSION AND CONCLUSION

In this study, the numbers of insects encountered in the soybean plants in the early and late seasons were low. This result is similar to the findings of Ndam *et al*. (2012) which indicated that the population of insect pests of soybean and their natural enemies were generally low in a two year experiment. Similarly, Raheja and Apeji (1980) reported low population of pod sucking bugs of soybean in Northern Nigeria. Likewise, NCCES (1994) reported that foliage-eating insects are always present in practically all soybean fields throughout the growing season, but most fields suffer no yield loss since the number of foliage feeders usually remains at low to moderate levels. In this study, the low number of insects encountered may likely be as a result of low and restricted cultivation of soybean in the study area. Jackai and Singh (1987) and Jackai *et al*. (1990) reported that insect pests of soybean constitute limiting factor in the production of soybean crop where it has been cultivated for several centuries. Akem and Dashiell (1992) reported that initially, very few pests and diseases were found on edible soybean in India, but pest and disease problems increased in incidence and severity as cultivation expanded and became more intensive. In this study, the low number of insects encountered in the soybean plants negates the use of synthetic insecticide or plant extract for their control as it offers no comparative advantage.

Jembere *et al.* (1995) and Okonkwo and Okoye (1996) reported that the use of synthetic insecticide is costly, presents undesirable effects on non-target organisms, aids development of resistant strains and generally not environmentally friendly. The authors suggested the need to determine the economic injury level (EIL) and economic threshold (ET) of insects before application of treatment as ill-timed treatment can lead to severe insect infestation later in the same season. The numbers of the insects in the plant extract–treated, synthetic insecticide-treated and untreated soybean plants were not significantly different from each other. This is similar to the findings of Ndam *et al*. (2012) that indicated no significant differences between sprayed and unsprayed soybean plots or between individual insecticides in terms of percent reduction in the population of both phytophagous insects and beneficial arthropods at all growth stages. The percent leaf damage by foliage-eating insect pests in soybean plants treated with plant extracts and the untreated ones in both planting seasons were not significantly different from each other. This may be due to the low number of foliage feeders in the treated and the untreated plots. It may also have resulted from the compensatory mechanism in the damaged leaves. Soybean was reported to possess the ability to compensate to a large extent for loss of or damage to the foliage as a result of indeterminate nature of most cultivars that continually add new leaf materials throughout the season (Hammond *et al*., 1991). NCCES (1994) reported that younger plants that have not begun to bloom or fill pods can tolerate greater foliage damage than plants which are fruiting.

The percent pod damage in soybean treated with plant extracts and the untreated ones in both planting seasons were low and not significantly different from each other. This may be due to the low diversity of pod sucking bugs encountered in this study. Singh and Taylor (1978) reported complex of pod sucking bugs infesting soybean to include *Mirperus jaculus*, *Riptortus dentipes*, *Clavigralla tomentosicolis*, *Anoplocnemis curvipes*, *N. viridula* and *A. armigera*. In this study, however, only *A. armigera* and *N. viridula* were encountered. The non-significant difference between the insect population in the plant extract-treated soybean and the untreated ones may be due to the low number of the insect pests encountered in this study. Ndam *et al*. (2012) reported that the impact of insect pest damage on soybean has not attained level of economic concerns though a wide spectrum of insects were found associated with the crop.

The study implies that soybean was infested by narrow spectrum of insect pests that were of minor relevance in terms of damage to leaves and pods. Lambda-cyhalothrin and plant extracts used in this study had no significant influence on infestation of soybean by insect pests and pod yield. The low population of insect pests encountered in this study suggests that their population is below what can cause economic injury to soybean. The use of lambda-cyhalothrin or extracts of the test plants in the control of insect pests of soybean in FUNAAB is therefore uneconomical and not recommended.

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