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Original Research Article

Evaluation of the Insecticidal Potential of *Jatropha curcas* Seed Extracts on Pests of Okra in the Field

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Abstract: Okra (*Abelmoschus esculentus*) is one of the main plants of high nutritional importance cultivated in Cameroon. However, its production is compromised by many constraints including the presence of insect pests, which are responsible for losses in the farms. The present study was carried out on the campus of the University of Yaoundé I. Its objective was to evaluate the insecticidal potential of *Jatropha curcas* seed extracts on the insect pests of okra. Two varieties of okra (Clemson and Hire) were used. Five treatments (T0: control, T +: Lamida gold 90EC insecticide, T-EAQ: treatment with the aqueous extract of *J. curcas* seeds, T-EAC: treatment with acetone extract of *J. curcas* seeds, T-E EAE: treatment with ethyl acetate extract of *J. curcas* seeds) were used in a completely randomized block design with three repetitions. Growth parameters, the number of insects, severity of phyllophages and fruit yield were evaluated. The results showed that a treatment and varietal effect was observed statistically significant on all growth parameters. The pests identified were: *Aphis gossypii*, *Cheilomenes sp*, *Dydercus spp*., *Nisotra spp*., *Podagrica spp*., *Zonocerus variegatus*. Aqueous and organic extracts of *Jatropha curcas* seeds were effective as Lamida gold insecticide against phyllophages in compared to the control. The best yield was obtained in T-EAQ treatment (9945.45), followed by T+ (8917.31), T-EAE (6712.9) and T-EAC (6149.9) compared to control T0 (4791.3). Variety V2, although having a susceptibility to insect attack, presented the highest yield (7158.9 kg/ha) compared to (6503.78kg/ha) for V1. Aqueous and organic extracts of *J. curcas* seeds appear to be a promising avenue in the integrated control of okra pests. Therefore, they can be valorized.

Keywords: Potential, insecticide, extracts, *Jatropha curcas*, *Abelmoschus esculentus*, phyllophages.

INTRODUCTION

Agriculture remains the main activity in Cameroon because it occupies 62 % of the active population. Despite this, agricultural production is insufficient because it does not meet the consumption needs of the population. In this sector, market gardening occupies an important place for human consumption (FAO, 2012). Defined as a highly specialized agriculture, market gardening is one of the most productive agricultural systems in Africa and is considered as an activity of food sovereignty (FAO, 2012). Market gardening plays a key role in most nutrition programs, combating poverty and contributing significantly to family incomes (James *et al*., 2010, Yolou *et al*., 2015). Among these vegetable crops, Okra (*Abelmoschus esculentus* (L.) Moench) is a controversial fruit vegetable grown in most tropical, subtropical and Mediterranean countries of Africa, India and America. It is an exceptional and original plant because all its parts (roots, stem, leaves, fruits, seeds) are valued in food, medicinal, artisanal and even industrial (Marius *et al.*, 1997). It grows best in deep, well-drained, light (sandyloamy) soil, rich in organic matter and has good water retention capacity. This plant is sensitive to salinity (Doumbia and Seif, 2008).

World production of okra is about 6 to 8 million tons per year, which represents about 1.5 % of vegetable production (Hamon, Charrier, 1997). India is the largest producer of okra, accounting for over 70 % of world production. In Africa production varies from 500,000 to 600,000 t per year, which represents about 5 % of the world production. The highest producers are: Nigeria, Sudan, (Anonymous, 2016).

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In Cameroon, okra is the second most important vegetable on the market after tomato with an average production of 72,661 t (Anonymous, 2015). All regions of Cameroon offer climatic conditions conducive to its cultivation.

Okra, like all other crops, faces many biotic and abiotic problems, limiting its production. Among them, light, temperature and water are the most important factors (Siemonsma, 1982). To these are added the effect of pests. The pressure of pests has been identified as the major constraint due to crop losses (Kanda *et al*., 2014, Mondédji *et al*., 2015).

Thus, to improve yields and respond to the ever-increasing market demand, producers resorted to the use of synthetic pesticides (Kanda *et al*., 2013, Mondédji *et al.*, 2015). The use of these pesticides has largely relieved this constraint. However, it now threatens the viability of production systems by the loss of effectiveness of many insecticide molecules, following the appearance of resistant insect populations and a break in biological balance. Synthetic pesticides are generally harmful to natural enemies (predators and parasitoids) of pests. Their application on crops therefore leads to a reduction in the populations of these organisms which are beneficial for cultivation. The immediate effectiveness of synthetic pesticides makes producers forget the health risks associated with their use (Ahouangninou *et al.,* 2013). Indeed, pesticides accumulate in food chains (a small concentration in water can lead to high concentrations in the fatty tissues of carnivorous and consumers in general) (Anonymous, 2006). Although the use of chemical pesticides helps to fight against diseases and pests, they remain expensive for producers and harmful for consumers and the environment. To cope with this, alternative control methods from plants are increasingly being considered. Indeed, many plants are known and used for their biocidal activities (toxic, repellent, anti-appetizing) vis-à vis a wide range of pests (Mochiah *et al*., 2011, Mondédji *et al*., 2014a). Plant extracts have the advantage of being not only cheaply available to farmers, but also non-toxic, biodegradable and environmentally friendly (Ngoh Dooh, 2014ab). This is the case for the use of *Jatropha curcas* extracts on okra cultivation in fields, which could allow us to reduce certain diseases due to the presence of pesticide residues that pollute the environment. It is in this context of economic sustainability, environmental respect for human health, integrated pest management against diseases and pests of which one part is the use of local plants with pesticidal effects appear as an alternative to the use of synthetic pesticides.

The present study had as aim to evaluate the insecticidal potential of *Jatropha curcas* seeds extracts (organic and aqueous) on the insect pests of okra (*Abelmoschus esculentus*) in situ.

More specifically:

- Determine the yield of extraction of *J. curcas* seeds;
- Evaluate the effect of different extracts on the growth parameters of okra; - evaluate the effect of the different extracts on the insect pests of okra.

MATERIAL AND METHODS

Material

Biological material

The biological material used in this experiment consisted of two varieties of okra (Clemson and Hire) and seeds of *Jatropha curcas* collected in the Centre Region of Cameroon.

Chemical material

The chemical material consisted of the synthetic insecticide LAMIDA GOLD 90EC. This insecticide is a liquid with active ingredient (30 g / l of imidacloprid + 60 g / l of lambdacyhalothrin). As other chemicals, organic solvents (ethyl acetate and acetone) were used to obtain the various extracts.

Methods Experimental design

The experimental setup used here was a completely randomized block (Lecompt, 1965). The varieties of okra were the main factor at two levels: V1 (Clemson) and V2 (Hire). The treatments represented the secondary factor at five levels: T0 (control), T1 (Insecticide), T2 (aqueous extract of *J. curcas*), T3 (ethyl acetate extract of *J. curcas*) and T4 (acetone extract of *J. curcas*).

Obtaining the different extracts of *Jatropha curcas* seeds

The extracts of *J. curcas* were obtained using the method disclosed by stoll (1994). Ripe fruits of *J. curcas* were collected in the makenene area (Centre Region of Cameroon). The collection was done by of the harvesting of the fruits on the plant and the picking of those on the ground. The fruits were pulped and dried at room temperature for 1 week. The seeds were then freed of their skin and dried. The dried seeds were ground using a mechanical machine. Subsequently, 500 g of *J. curcas* seed powder was weighed and macerated in 2 l of solvent and incubated for 72 hours. The solvent and solute assembly was transferred to the sonicator to maximize extraction. After filtration using a muslin cloth, the solution was put in a rota vapor for separating the solvent from the extractable compounds. The extracts were then stored in a refrigerator at 4 °C.

Determination of the extraction yield of *J. curcas*

The extraction yield is the ratio of the mass of the extract obtained to the mass of the powder and it is determined according to the formula cited by (Ngoh dooh; 2014).

$$R(\%)= \frac{mass\ of\ extract\ obtained}{mass\ of\ powder} \times 100$$

Preparation of the different doses of *J. curcas* extracts (aqueous and organic)

The aqueous solution of *J. curcas* was carried out according to the method disclosed by (Kumar; 2003), at a concentration of 1:10 as follows:

The fallen fruits were picked at the foot of the tree and the stones removed from the pulp. The stones were then carefully dried to prevent the development of fungi. Three days before application, the seeds were extracted from the cores (500 g), finely crushed and macerated for 12 hours minimum in 5l of water. After maceration, the solution was filtered with a muslin cloth and the collected content was poured into a 15l backpack sprayer, to which 10 g of powdered soap were added.

The solution of the organic extract was made by taking 26.5 ml of extract and introducing into 5l of water. The solution thus obtained was poured into a knapsack sprayer, to which 10 g of powdered soap were added. The mixture thus obtained was ready for the treatment of the sub-plots concerned.

The insecticide treatment was prepared respecting the dose recommended by the manufacturer is 8.3 ml of Lamida Gold 90 EC for 5l of water.

Pesticide application

The aqueous and organic extracts of *J. curcas* seeds as well as the synthetic insecticide were applied 14 days after sowing and weekly until the harvest of mature fruits.

Monitoring and data collection

Data collection was carried out on twelve okra plants sampled on the different sub-plots, avoiding the border plants that served as security cordon.

Evaluation of the growth parameters of the plant

Two main growth parameters were studied namely, the size and number of plant leaves.

Height of plants

The height measurement was evaluated weekly on the sampled plants by measuring with a graduated ruler the distance between the soil surface and the apex.

Number of leaves

The number of leaves was assessed by visual counting, which consists of counting the leaves on the sampled plants after each week.

Inventory and quantitative evaluation of pests

The observations started 14 days after sowing and repeated every week. The insect pest population was evaluated in experimental subplots on 12 core plants sampled in the field. The identification was made according to the colour, the type of insects and the vegetative parts attacked (leaves, flowers and fruits) (Aroga, 2007). Insect counting was done directly on okra leaves. It is a visual count done every week. The observations were made between 6:00 and 8:30 am as suggested by (Opareeke; 2006). This moment is favorable for counting these insects because their mobility is limited by the cool weather of the day (when the weather becomes hot, they fly away at the slightest movement). The number of insects was noted at each visit in each sub-plot.

Assessment of the severity

The severity of insect attacks on the different parts of the plant was evaluated using a 1 to 9 visual grading scale of (Fablo et *al.*, 2012) where: 1 = 0; 2 = 2.5%; 3 = 12.5%; 4 = 25%; 5 = 50%; 6 = 75%; 7 = 87.5%; 8 = 97.5%; 9 = 100% average attack percentage.

It is given by the formula:

$$S = \frac{\sum(ab)}{N} x100$$

With S = attack intensity (severity)

$\sum(ab)$ = sum of multiplications of the number of diseased plants (a) by the corresponding degree of infection (b) given in %

N = total number of plants.

Yield

The fruits were harvested from 12 plants sampled from each sub-plots and put into bags and finally weighed in the laboratory using a precision balance. Yield was estimated from the fresh weight of the fruits obtained for each sub-plot according to the treatments and estimated per hectare according to the formula of (Zakari; 2003).

$$\text{Yield (kg/ha)} = \frac{weight/plot\ (g)}{area\ of\ plot\ (\text{m}^2)} x \frac{10000\ \text{m}^2}{1\ ha} x \frac{1\ \text{kg}}{1000\ g}$$

Statistical analysis

The data obtained were subjected to analysis of the variance (ANOVA), the averages were compared using Newman-keuls method, based on the smallest significant value, realized with the XL-STAT 20.0 software. The results were considered significant when $P \leq 0.05$. The graphs were presented and the average grouping tables were produced in the Excel 2013 spreadsheet.

Results Extraction yield of extracts

The extracts showed the extraction yields according to the solvents used. For organic solvents, the yields were 39.02 % and 38.04 %, respectively for acetone and ethyl acetate. For the aqueous extract the yield was 30.04 %. The appearance and colour of the various extracts depended on the solvent used (Table I).

Table I: Extraction yield (%) and characteristics of extracts obtained

Seeds	Solvent	Yield	Colour	Product obtained
Jatropha curcas	Acetone	39.02	yellowish	oily
	Ethyl Acetate	38.04	yellowish	Oily
	Water	30.04	whitish	whitish

Evaluation of the effects of the different extracts on the growth parameters of okra Effects of the different extracts (aqueous and organic) on the number of leaves

The results obtained after analysis show that the extracts stimulated leaf production in the treated plots compared to the control plots for the Clemson variety. A significant difference is observed between the different treatments and the negative control. The T + and T-EAQ treatments record the highest average number of leaves, 6.09 and 6.01, respectively. For the other treatments the average number of leaves was 4.90; 4.76 and 4.35 respectively for T-EAE treatments; T-EAC and T0.

In the V2 variety (Hire), during the experimental phase in the field, the application of the different treatments did not lead to leaf production in the treated plots compared with the control plots. The analyzes obtained on the various treatments reveal no significant difference at the 5 % threshold for the number of leaves produced between the T + treatments; T-; T-EAC; T-EAE and T-EAQ. This number of leaves varies from 6.06 ± 0.45; 5.89 ± 0.31; 6.09 ± 0.35; 5.63 ± 0.31 and 5.52 ± 0.15 (Fig 1).

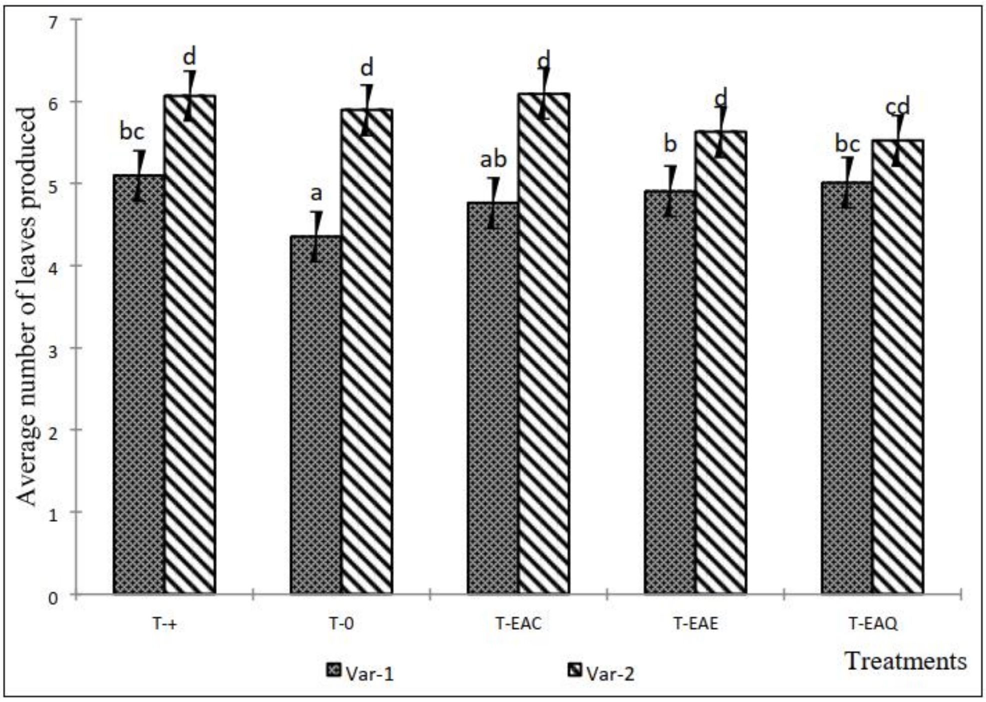

Fig 1: Effects of treatments on the number of leaves in function of varieties
T0: Control; T+: insecticide; T-EAC: acetone extact; T-EAE: ethyl acetate extract; T-EAQ: aqueous extract.
*Values with the same letter are not different significantly at 5% threshold.

Effects of the different extracts on the height of plants

The application of the various organic and aqueous extracts of *J. curcas* seeds as a biopesticide led to a significant improvement in growth parameters for the variety V2 (Hire) compared to the variety V1 (Clemson). All treated plants had a height higher than that of the control. Indeed, a significant difference at 5% threshold according to the Newman-keuls test was observed between the different treatments. The heights of the plants in treatments T +, TEAC, T-EAE; T-EAQ were 39.87; 31.68; 34.52 and 33.52 cm, respectively.

For Variety V1, analysis of variance showed no treatment effect on plant growth compared to the control at the 5% threshold. Treatments showed average heights of 29.20; 27.66; 26.56; 27.04 and 28.61 cm, respectively for T+ treatments; T0; T-EAC, T-EAE and TEAQ. No significant difference was observed between the biological treatments and the controls according to the Newman-keuls test at 5% threshold (Fig 2).

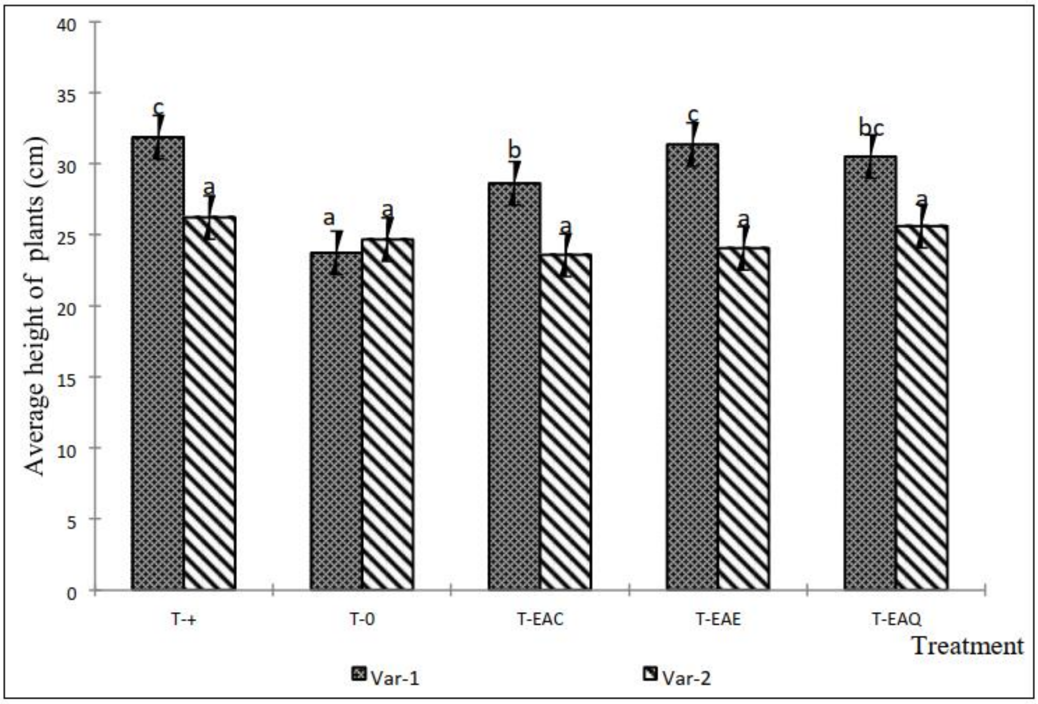

Fig 2: Effects of treatments on the height of plant in function of variety
T0: control; T+: insecticide; T-EAC: acetone extract; T-EAE: ethyl acetate extract; TEAQ: aqueous extract.
* Values with the same letter are not different significantly at 5 % threshold.

Evaluation of the influence of aqueous and organic extracts on insect pests of okra

Pest identification

During the experiment, six types of insect pests of okra were identified namely: *Aphys gossypii* glover or aphid of cotton plant; *Cheilomenes sp*; *Dydercus spp*. also called cotton bugs; *Nisotra spp*.; *Podagrica spp*. (flea beetle) and *Zonocerus variegatus* also called stinking cricket. These insects cause serious damage to the crops and the most consumed parts are the leaves. They appeared simultaneously on the plants according to the different stages of development of the crop (Table II).

Table II: Different insect pests identified and the extent of their damage according to the stage of development of the crop

Insectes	Germination and growth	Appearance of floral buds	Flowering	Fruiting and harvest
Aphys gossypii	-	+	+++	++
Dydercus spp.	-	+++	+++	+++
Cheilomenes sp	+	+	-	-
Nisotra spp.	+++	+++	+	+
Podagrica spp.	++	++	+	+
Zonocerus variegatus	++	++	-	-

+ low importance ++ average importance +++ very important – absent

Influence of aqueous and organic extracts on the number of insects

Figure 3 shows the effect of the different treatments on the average number of insects on both varieties of okra in the field. It appears that for the two varieties, the number of insects increased gradually over time and reached a maximum at the fourth week after treatment for the negative control and 20.66 and 16.91 for the varieties V1 and V2, respectively. For the other extracts, the average number of insects decreased over time and attained a relatively low number by the fourth week after treatment. A significant difference was observed between the different extracts and the control ($p < 0.05$).

For the variety V1 (Clemson), the number of insects in the first week after applying the different treatments was 16.52; 17.64; 15.37; 13.66 and 12.94 respectively for T+; T0; T-EAC; T-EAE and T-EAQ. On the other hand, this number decreased progressively with the application of extracts as a bio-pesticide and became almost nil at the fourth week after treatment, ie 1.72; 3.45; 3.45 and 1.00, respectively for T+ treatments; T0; T-EAC; T-EAE and T-EAQ, while this number increased in the negative control. A significant difference was observed between the different treatments and the negative control (Fig 3A).

For the variety V2 (Hire) the number of insects observed in the first week after treatment was relatively small compared to the variety V1, ie 10.95; 13.89; 12.20; 12.54 and 9.83, respectively. Nevertheless, for the extracts tested, the number of insects decreased with time while in the negative control the number increase was 3.14; 16.91; 4,5; 4,39 and 1.31 respectively, for T+ treatments; T0; T-EAC; T-EAE; T-QAR. A significant difference was observed between the different treatments tested and the negative control at the 5% threshold (Fig 3B).

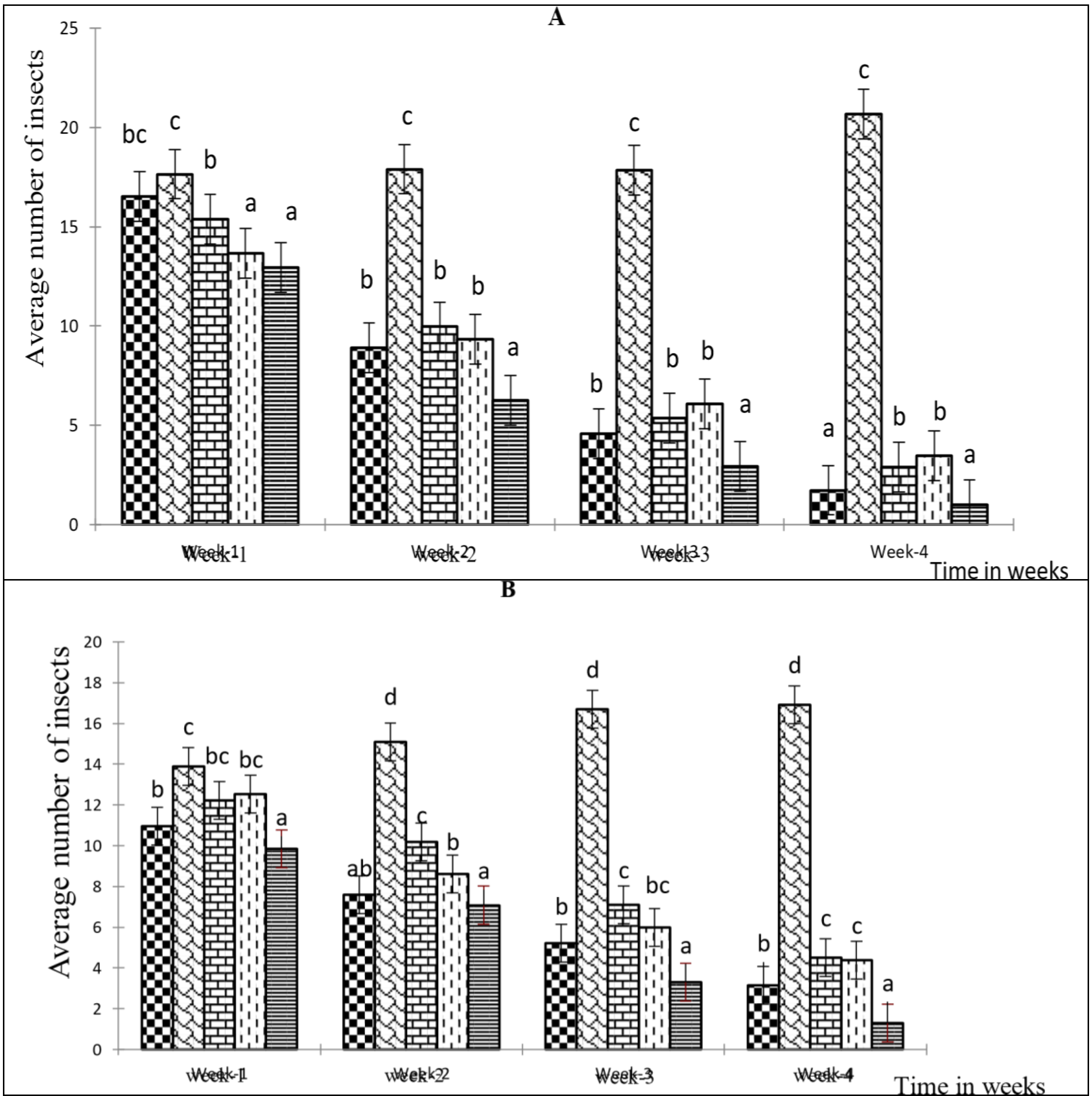

Fig 3: Effect of treatments on the density of insects in function of time: A= Variety V1; B= Variety V2

Severity of pests

The severity of insect attack on different varieties of okra is a function of time and treatment. In the first week after treatment, for variety V1, the percentages of severity were:
55.87; 41.08; 52.39; 52.43 and 47.56 %, respectively for T + treatments; T0; T-EAC; T-EAE; T-QAR. A significant difference was observed at the 5 % threshold between the treatments and the negative control. During the second, third, and fourth week after planting, the severity of attacks decreased for all treatments and increased in the negative treatment. At the fourth week of treatment the percentages of severity were 13.70; 67.58; 14.35; 17.81 and 10.08%, respectively for T +; T0; T-EAC; T-EAE; T-QAR treatments. A significant difference was observed between the biological treatments and the different controls. The smallest severity was obtained with the aqueous extract (Fig 4A).

For the V2 variety, the percentage severity of insect attack increased over time in the control from 35.89% in the first week after treatment to 62.27% in the fourth week after treatment. On the other hand, in other treatments, the percentage severity of insect attack decreased from the first to the last week after treatment passing from 50,70; 35.89; 47.25; 47.35; 42.50 to 8.66; 62.27; 9.31; 12.77; 5.64, respectively for T +; T0; T-EAC; T-EAE; T-QAR treatments. A significant difference is observed between the different treatments and the negative control (Fig 4B).

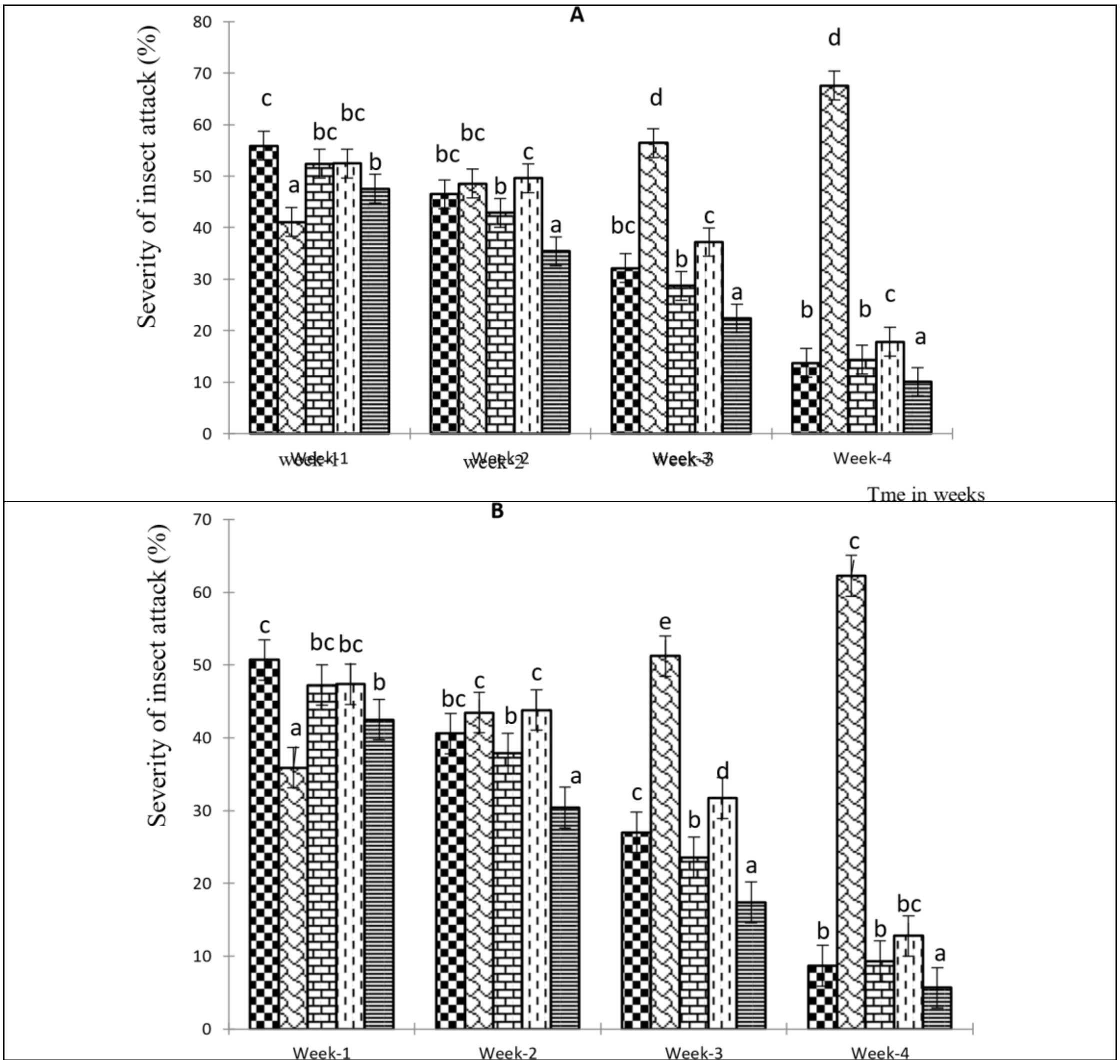

Fig 4: Effect of treatment on the severity of insect attack in function of time: A= Var 1; B=Var2

T-+ T-0 T-EAC T-EAE T-EAQ

Yields

Yields in number of fresh fruits per plant and in weight of these fruits expressed in kg per ha were determined in order to evaluate the effect of *J. curcas* seed extracts on the yield gain compared to that of the synthetic insecticide and the absolute control. This parameter was assessed on 12 plants of okra per sub-plot. The results obtained show a difference between the varieties and between the treatments. A comparison of yield averages by variety shows that the V2 variety was more productive with a yield of 8093.79 kg/ha compared with 6486.78 kg / ha for the V1 variety. In terms of treatments, the highest yield in kg / ha was recorded with the aqueous extract for both varieties. Respectively (8684.73 and 11206.17) for variety V1 and V2; follow-up of T + treatments (8088 and 9742.62); T-AEA (6040, 8 and 7285.11); T-EAC (5260.8 and 7039.08) and T0 (4359.6 and 5223) with the lowest yield in both varieties (Table III).

Table III: Yield (kg / ha) of okra varieties according to different treatments

Treatment		Yield (kg/ha)
	V1(Clemson)	V2 (Hire)
T0	4359,6 a	5223 a
T+	8088 c	9742,62 c
T-EAQ	8684,73 c	11206,17 c
T-EAC	5260,8 a	7039,08 b
T-EAE	6040,8b	7285,11b

DISCUSSION

Pesticide plants are a promising alternative in the agricultural sector to address the problems resulting from the use of synthetic pesticides. The objective of the present investigation was to evaluate the insecticidal potential of organic and aqueous extracts of *J. curcas* seeds on pests of okra in the field.

The extraction yields varied according to the solvents used. This variation could be attributed on the one hand to the extrinsic factors of the plant and on the other hand to the state of the plant material at the time of collection. In effect, Svoboda and (Hampson; 1999) and (Smallfield; 2001) report that environmental conditions, harvest period and age of plant material can influence extraction yields. In addition, the polarity of the extraction solvents used would play a role in the extraction of many compounds (Muhammad *et al.*, 2013).

The application of the extracts various (organic and aqueous) of *Jatropha curcas* seeds as a biopesticide induced a significant improvement on the growth parameters of the cultivar variety V1 (Clemson). These effects of seed extracts would be due to the presence of secondary metabolites such as saponins, phenols and phorbolesters (Makun *et al.*, 2011) as these bioactive compounds would influence the metabolism of the plant and allow for an improvement in plant growth. The same result was obtained by (Ndogho *et al.*, 2018) when evaluating the effectiveness of aqueous extracts of neem seeds on Asian soybean rust who observed improved growth for treated plants compared to control plots. Similarly, (Aghofack *et al.*, 2015) demonstrated that the *J. curcas* seed extract used as a biopesticide would stimulate tomato growth. For the variety V2 (Hire), the application of the different extracts had no effect on the growth parameters throughout the experiment. This permits us to suggest that it could depend on the intrinsic factors (genetic character) of the plant.

With regard to the number of leaves produced, it appears, the different treatments stimulated the production of leaves regardless of the variety. These results are similar to those of (Sahu *et al.*, 2012), who showed the stimulatory effects of several medicinal plants on leaf production in tomato.

Treatments based on *J. curcas* seed extracts resulted in a considerable drop in the number of insects on the treated plots, contrary to the control plots, thus confirming the bioinsecticide activity of these extracts. These results are confirmed by those obtained by (Habou *et al*., 2011), which in natural conditions (open field) significantly reduced the number of insect pests of cowpea at 45 and 60 days after planting using *J. curcas* oil extracts. Similar results were obtained by (Adesina *et al.*, 2016) when they used extracts of *Dalbergia lactea* Vatke for the control of insect pests of okra.

Regarding the severity of attack of borers, the results obtained after applying the treatments show that *J. curcas* seed extracts and Lamida gold insecticide (active ingredient: Imidachloprid + Lambdacyhalothrin) significantly reduced the degree of severity of leaf borers compared to the control during both campaigns. Plots treated with these products (seed extracts, Lamida gold) reduced the number of insects, thus reducing the degree of severity rate. This low degree of severity is attributed to the effectiveness of these products in the control of okra pests. Decreasing insect density resulted in fewer attacks on the leaves. Similar results were reported by (Mochiah *et al.*, 2011; Asare-Bediako *et al.*, 2014) who emphasized the ability of extracts from *A. indica*, *Carica papaya* and *Capsicum sp*. in minimizing the severity of attacks from whiteflies on plots treated with different extracts. Similarly, (Gnago *et al.*, 2010) found that in crop plots (cabbage and okra) treated with *Azadirachta indica* seed extract, severity, caterpillars and aphid populations were less compared to plots without these treatments.

The insecticidal effect of the aqueous and organic extracts of *J. curcas* seeds is due to the presence of curcine and lectin which are toxic proteins, close to ricin that blocks the activity of ribonucleic synthesis of pests. The different varieties tested (V1 and V2) showed different levels of susceptibility to pest attack. The variety V1 compared to the variety V2 was much infected by insects. This could be justified by the selective and improved nature of the V2 variety, thus conferring resistance to pests of okra leaves.

In contrast, all treatments-controlled okra pests. Pest were lower on the treated plots and abundant on the untreated plots, thus reducing the production on the latter because of the defoliation thus causing the weakening of the plants and a decrease of the photosynthetic activity. The best yield was obtained with the aqueous extracts of *J.curcas* which improved the production of okra compared to Lamida gold and the control. These results could probably be due to the efficacy that aqueous extracts showed as an insecticide in our experiment. The extracts better protected the leaves against phyllophages compared to the control because they are the organ par excellence of photosynthesis. These results are in line with those of (Ndogho *et al.*, 2018) who tested the effectiveness of aqueous extracts of neem seeds on the development of Asian soybean rust and showed that the decrease in the severity of borers leads to improved yield. Variety V2 registered a high yield compared to variety V1. This could be attributed to the effectiveness of the aqueous and organic extracts combined with the genetic capabilities of the V2 variety to produce high yield by its ability to adapt to environmental conditions.

The results obtained during this study on okra cultivation showed that the aqueous extract of *J.curcas* seeds was the best product of the phytosanitary treatment. Organic extracts and Lamida gold insecticide have also been proven to manage insect pests by reducing the severity of okra leaf drillers and improving yield. This could be due to the bioactive substances present in extracts of *J. curcas* which could have an efficiency comparable to those present in Lamida gold (Imidachloprid and Lambdacyhaloerythrin). Similar results have been reported by (Diabaté *et al.*, 2014) on *Jatropha curcas* extract compared to pyrethroids (deltamethrin, cypermethrin) for the control of tomato pests. Similarly, other studies comparing plant extracts with conventional insecticides have shown that certain extracts may be as effective as synthetic insecticides. Thus, *Nicotiana tabacum* extracts, *Cassia sophera* L. (Fabaceae), *Jatropha curcas* L., *R. communis*, *Ageratum conyzoides* (L.) L. (Asteraceae), *Chromolaena. odorata* and *Synedrella nodiflora* (L.) Gaertn. (Asteraceae) would be as effective as emamectin benzoate and lambda-cyhalothrin for the control of *P. xylostella* and *B. brassicae* on cabbage (Amoabeng *et al.*, 2013).

CONCLUSION

At the end of this study, whose objective was to evaluate the insecticidal potential of *J. curcas* seeds aqueous and organic extracts on pests of okra in situ, several results were obtained. The nature of the extraction solvent has a direct impact on the amount and quality of *Jatropha curcas* extracts for use as insecticide. The aqueous and organic extracts of *Jatropha curcas* and the synthetic insecticide reacted positively on the growth parameters (number of leaves, plant height) of the Clemson variety and no effect on the Hire variety.

Common okra has been attacked by six phytophagous insects such as: *Aphis gossypii*; *Cheilomenes sp*; *Dydercus spp*.; *Nisotra spp*.; *Podagrica spp.*; and *Zonocerus variegatus*. All applied extracts (aqueous and organic) acted in the same way as the synthetic insecticide Lamida gold 90EC on the number of insects and on their severity. Among these different extracts applied, the aqueous extract proved to be the most effective. Although undergoing the same pest attack, the highest yield was obtained with the Hire variety because it was more resistant than the Clemson variety. Aqueous and organic extracts of *J. curcas* seeds appear to be a promising means in integrated pest management against okra insect pests; given that their seeds are available to all and can save the environment compared to synthetic insecticides. They can therefore be valorized.

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