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RESEARCH ARTICLE

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BIOCIDAL EFFECTS OF *JATROPHA CURCAS* OIL ON THE MAIN INSECT PESTS ASSOCIATED WITH COWPEA *(VIGNA UNGUICULATA)* CROPS IN SOUDANIAN SAVANNAH OF CHAD

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ABSTRACT

This study was carried out with the objective to evaluate the insecticidal effects of *Jatropha curcas* oil on three devastating insects of cowpea.A device in randomized complete blocks comprising 6 treatments and 4 repetitions was set up in field.The compound biocide of *J. curcas* oil used was an emulsifying formulation stabilized by ethanol and arabic gum.The spraying was carried out three times : at the start of the formation of flower buds corresponding to 35 Days After Sowing (35 DAS); at 50% flowering (45DAS) and early pod formation (65DAS).The biocidal effects of Jatropha oil has reduced damage with an effectiveness from 80 to 100% on aphids, thrips and bugs, the main cowpea pests in fields. It caused a highly significant ($p<0{,}001$) increase in seed yields ($kg.ha^{-1}$) compared to negative control.The yields obtained are 883,72±2,32 ; 1187,81±2,26 ; 1117,81±3,12 and 1109,82±4,11, respectively for concentrations 5, 10, 15 and 20 ml of *J. curcas* oil for 100 mL of preparation compared to the negative control (698,31±2,45).Ultimately, it emerges from these results that the use of Jatropha oil as a bioinsecticide bodes better tomorrow for the cultivation of *J. curcas* and opens up prospects for for biological and sustainable agriculture.

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INTRODUCTION

Over the past two decades, the promotion of biofuel has aroused renewed interest in planting *Jatropha curcas* so the seeds contain oil up to 40% of its total mass (Dieye, 2007). The ambitions to incorporate up to 5,75% biofuels in 2010 and 8% in 2015 in fuels from fossil sources and the fight against climate change have prompted several states around the world to develop these sectors (Tchobsala, 2013).

Besides its potential to produce biofuel, this oil has toxic substances, in particular phorbol esters, which also gives its insecticidal activity. This constitutes a second aspect of valuing the plant (Abdoul, 2013 ; Adoulaye, 2018). Food legumes are an important source of protein in the African subtropical zone. Cowpea (*Vigna unguiculata* (L.) Walp.) is a popular staple food and occupies a prominent place in the diet of rural populations. When sold, the leaves, green pods and dry seeds play a decisive role in the economy of the average peasant (Megueni, 2011). However, pest pressure damages the cowpea crop and limits its yield.

In fact, harmful insects of this species of food legumes can cause crop losses, ranging from 30% to 100% (Ngamo & Hance, 2007). To deal with these plagues, control methods have been developed for the management of its pests. The most widely used method today is chemical control. However, most of these chemical insecticides used constitute violent poisons for natural ecosystems (Abdoulaye, 2018).
To alleviate environmental problems, the use of natural pesticides extracted from plants constitutes alternatives to chemical pesticides in Central Africa. They have no negative impacts on human and animal health, and on the environment because of their rapid biodegradability. The production of these natural insecticides is within the reach of the average farmer. The insecticidal effect of Jatropha oil has been demonstrated with great success on pests of foodstuffs stored in laboratories and plants grown in fields (Abdoul *et al,*2011 ; Mazid *et al*., 2011). The general objective was to contribute to the formulation, development and application of the natural insecticide from *Jatropha curcas* oil planted in the agricultural systems of the Sudanian savannah of the province of Tandjilé in Chad. More specifically, it was to assess the insecticidal effect of the oil of this shrub on the frequency of attacks of the three most famous insect pests, on the development and production of cowpea in the field.

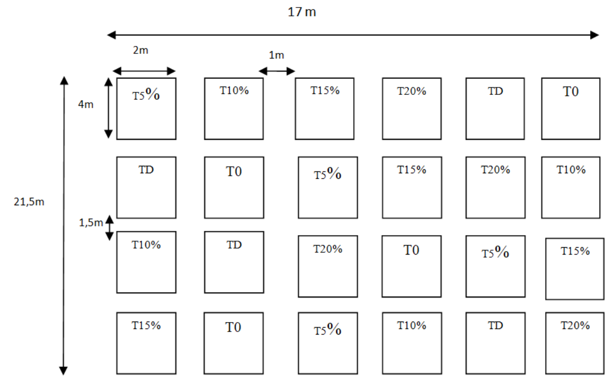
MATERIAL AND METHODS

Study site description: The trials were carried out in the field on the experimental site of the university campus of the National Higher Institute of Agronomic Sciences and Agri-Food Technologies of Laïin southwestern Chad. The locality is situated about three kilometers from Laï, the capital of the province. It is characterized by a Sudanese tropical climate with a long dry season (7 months) and a short rainy season (5 months). There is a shrub savannah so the soil has a grassy carpet in the rainy season (Anonyme, 2011a ; Kabé *et al*., 2019). The soil is sandy clay and suitable for agrosilvopastoral activities. The population mainly engages in agricultural activities and the exploitation of agricultural by-products through its marketing (Anonyme, 2011b ; Kabé *et al*., 2020). The cumulative rainfall varies between 800 mm to 1200 mm. The maximum rainfall is recorded in August-September corresponding to the high level of air humidity (80%). The absolute minimum temperatures are recorded in December-January (15°C) and the averages of the relatively high maximums (which may exceed 40°C) are found in March-April (Kabé, 2020).

Biological material : *Jatropha curcas* oil used in the insecticide formulation applied in the field in this experiment was extracted from seeds produced under the different experimental conditions. These were field-grown plants, three years old, whose pockets where the shrubs are planted are amended with mycorrhizal inocula, compost and chemical fertilizer (Kabé *et al.,* 2019). The extracted oils come from a mixture of the harvested seeds. The cowpea used in this study is the variety KVX396452D, of Burkinabé origin. It is widely popularized in the Sudano-Sahelian areas of Chad by the Chadian Institute for Agronomic Research and Development (ITRAD) through the National Rural Development Support Agency (ANADER), because of its broad adaptation. The vegetative growth habit is semi-creeping with a life cycle of 75 days. The annual yield is estimated between 1,2 to 2 tonnes per hectare.

Harvest, drying and storage of *Jatropha curcas* seeds : Ripe fruits, having a black appearance, are picked directly from the tree. They are dried in the sun until they have a constant mass and then pulped. The black seeds removed from the fruit are dried in the sun so that they have maximum moisture loss. They are kept in a permeable bag allowing air circulation in a dry place until the next use.

Extraction and preservation of*Jatropha curcas* oil : The seeds were crushed in a mechanical grinder, the paste was transferred to a cloth bag, and the whole pressed using a mechanical press. The oil obtained was decanted, filtered and stored in 200 ml bottles and wrapped in aluminum foil to avoid possible photo-oxidation, then stored until its use in the bioinsecticide formulation and spread in the field.



T5%: 5% concentration of Jatropha curcasoil ;
T10%: 10% concentration of Jatropha curcasoil ;
T15%: 15% concentration of Jatropha curcasoil ;
T20%: 20% concentration of Jatropha curcasoil ;
TD : Delthametrine (25g/L).
T0 : Control

Figure 1. Experimental design for biocidal trials of Jatropha curcasoil on pests of cowpea in the field

Formulation of bioinsecticide from *Jatropha curcas* oil : The procedure used was deduced from that established by Abdoul *et al.* (2013). It is a mixture of oil, ethanol and gum arabic (10% dissolved in water). Pure ethanol has a stabilizing role while gum arabic is an adjunct to fix active molecules on the plant. Four preparations of the bioinsecticide were made corresponding to different concentrations of oil. In these variations, the volume of ethanol was set at 30 mL/100mL of preparation; the volume of oil varied from 5, 10, 15 and 20 mL per 100 mL of prepared solution, or 5%, 10%, 15% and 20% of bioinsecticidal preparation. The negative control which was an aqueous mixture consisted only of water, alcohol and gum arabic. The positive control was a reference insecticide, deltamethrin applied at a dose of 25g/L.

Experimental device and sowing : After clearing and cleaning the experimental site, the soil is plowed by the harness oxen. The plots are maintained by manual weeding once a month. Barriers are erected to prevent destruction of the field by herbivorous animals. Four seeds impregnated with water for 6 hours were put in a pocket. This method accelerates germination and rapid emergence of seedlings. It is often recommended when the soil is not sufficiently watered (Kabé *et al.,* 2019). Upon emergence, only two seedlings are left per pocket to allow the plants to take advantage of climatic and soil conditions for their development. The device consisted of 6 treatments (T5%: 5% concentration of Jatropha oil ; T10%: 10% concentration of Jatropha oil ; T15%: 15% concentration of Jatropha oil ; T20%: 20% concentration of Jatropha oil ; TD : Delthametrine and T0 : Control) organized in 4 completely randomized blocks with 4 repetitions (Figure 1). Cowpea plants in the field were 40 x 40 cm between pockets and between rows. The elementary plots had a dimension of 4 m long and 2 m wide spaced 1 m apart. The blocks were spaced 1,5 m apart. The total area of the experimental field was 365,5m^2. The application of the bioinsecticide consisted of spraying, using a constant pressure sprayer, 50 mL of bioinsecticide on 8 m^2 of plots. The spraying was carried out three times at different stages of plant development : start of formation of flower buds corresponding to 35 Days After Sowing (35DAS) ; at 50% flowering (45DAS) ; at 100% flowering and early pod formation (65DAS).

Ten (10) plants per experimental unit were used, in all 40 plants per treatment. The parameters of growth, development and production were determined according to the classical methods defined in agricultural sciences. The emergence rate is a quotient obtained from the number of seedlings in the pockets divided by the total number of seeds placed in the pockets multiplied by one hundred (100). The rod length is measured using a decameter. The number of branches and fruits is determined by simply counting plant by plant and pocket by pocket. The date of flowering and pod formation is also carried out by counting the days since the day of sowing. The dry biomass is determined at harvest. The plants were first dug up, packed in labeled plastic bags and then brought to the laboratory where they were dried for 48 hours in an oven set at 105°C. After cooling in a desiccator at the exit of the oven, the weight gain was carried out thus giving the value of the dry biomass of the plant in question. The carbon stock is calculated by multiplying the biomass value by 47,5 (corresponds to the average value of the carbon content in green plants) multiplied by one hundred (100) (Mugnier *et al*., 2006). Fruit and seed yield is an estimate of the production of fruit and seeds per plant relative to an effective density per hectare (ha). The variables measured for cowpea insect pests in this study were the frequency of insect attacks on plants. The frequency of aphid attacks (*Aphis craccivora*) observed at the start of flower bud initiation and early flowering. It was determined for thrips (*Megalurothrips sjöstedti*) at 50% and 100% flowering while that of bedbugs (*Anoplocnemis curvipes*) was performed at pod formation. It should be remembered that these three insects are the main pests of cowpea in the field and the periods of observation are associated with their abundance. Aphids (*Aphis craccivora* Koch (Homoptera: Aphididae) were counted on 3 leaves of each plant; for thrips (*Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae)), three flowers were collected per plant and placed in a flask containing the ethanol at 70° and the enumeration was carried out under a binocular magnifying glass. For bedbugs (*Clavigralla tomentosicollis* Stal (Hemiptera: Coreidae); *Riptortus dentipes* Fabricius (Hemiptera: Alydidae) and *Anoplocnemis curvipes* Fabricius (Hemiptera: Coreidae)), they were counted directly on plants. The plants were monitored by simple observations with the naked eye, in the morning from 7 to 9 a.m. and in the evening from 3 to 5 p.m., to observe the death of the insects, the decrease in infestations after application of the treatments the day before, on the 3rd, 6th and 9th day. The number of infected or healthy pods was determined at harvest**.**

Statistical analyzes : The results were statistically analyzed using the Statgraphic plus version 5.0 program. Multiple analysis of variance was performed to identify the effect of different factors and blocks on the parameters studied. Duncan's test was applied for a multiple classification of the means of the different treatments. Pearson's correlation test was used to study the relationship between different dependent variables.

RESULTS

Biocidal effects of *Jatropha curcas* oil on three cowpea pests : Analysis of the data showed a significant difference (p<0,05) between the concentrations applied to the various cowpea pests. The biocidal effect increased within hours of applying the Jatropha oil, reaching a maximum level after 4 days (within a week). The phytotoxic effect of the concentration of Jatropha oil was seen at a high dose**.**

Biocidal effects of *Jatropha curcas* oil on aphids : The biocidal effect of Jatropha oil evaluated on the level of aphid infestation as a function of the days observed before and after treatment (3rd, 6th and 9th days after treatments) was noted (Table 1). The level of aphid infestation before the treatments varied on average from 50±3 to 82±3 individuals on the plants of the elementary plots to be observed per treatment. A decrease in the level of aphid infestation was observed for the treatments applied compared to the negative control. The level of infestation was zero for all concentrations of Jatropha oil from the 6th day after treatment. The 20% concentration of Jatropha oil, corresponding to 4 liters/ha (T20%), had an effect identical to Decis (Deltamethrin) from the 3rd day after treatments (100% aphid mortality). The 5% concentration of Jatropha oil, corresponding to 1 liter/ha (T5%), was the lowest but effective concentration on the 6th day after treatment. It was less toxic and more environmentally friendly. It could be recommended to the small producer for the control of aphids on cowpeas.

Table 1. Biocidal effect of Jatropha curcas oil on the change in the number of aphids according to days of observation

Treatments	Before treatments	Number of days after treatments		
		3rd	6th	9th
T0%	50±3[a]	90±3[d]	96±2[b]	40±2[b]
T5%	60±3[b]	25±2[c]	00±0[a]	00±0[a]
T10%	60±3[b]	25±3[c]	00±0[a]	00±0[a]
T15%	70±2[c]	15±2[b]	00±0[a]	00±0[a]
T20%	76±2[d]	00±0[a]	00±0[a]	00±0[a]
Decis or Deltamethrin	82±3[e]	00±0[a]	00±0[a]	00±0[a]

Values in the same column followed by the same letter are not significantly different at the 0,05 level. T0%: negative control ; T5%: 5% concentration of Jatropha oil ; T10%: 10% concentration of Jatropha oil ; T15%: 15% concentration of Jatropha oil ; T20%: 20% concentration of Jatropha oil.

Biocidal effects of *Jatropha curcas* oil on thrips : The effects of the different treatments on the average number of thrips per cowpea flower before and after treatment (3rd, 6th and 9th day) were determined and recorded (Table 2).

Table 2 : Biocidal effects of Jatropha oil on the change in the number of thrips per cowpea flower before and after the treatments (3rd, 6th and 9th days)

Treatments	Before treatments	Number of days after treatments		
		3rd	6th	9th
T0%	4±2[a]	5±2[b]	6±2[b]	4±2[b]
T5%	3±2[a]	2±1[a]	1±0,1[a]	00±0[a]
T10%	4±2[a]	1±0,1[a]	00±0[a]	00±0[a]
T15%	4±3[a]	1±0,1[a]	00±0[a]	00±0[a]
T20%	5±3[a]	00±0[a]	00±0[a]	00±0[a]
Decis or Deltamethrin	4±2[a]	00±0[a]	00±0[a]	00±0[a]

Values in the same column followed by the same letter are not significantly different at the 0,05 level. T0%: negative control ; T5%: 5% concentration of Jatropha oil ; T10%: 10% concentration of Jatropha oil ; T15%: 15% concentration of Jatropha oil ; T20%: 20% concentration of Jatropha oil.

The treatments were applied at the 50% flowering stage, corresponding to 45 days after sowing, the time of massive appearance of thrips. Before the treatments, the average number of thrips per cowpea flower varied from 3±2 to 5±3 individuals. This value decreased on the 3rd day and reached the zero level on the 6th day for all the treatments except for the negative control. The 20% concentration of Jatropha oil, corresponding to 4 liters/ha (T20%), had an effect identical to Décis (Deltamethrin) from the 3rd day after treatment (100% thrips mortality). The 5% concentration of Jatropha oil, corresponding to 1 liter/ha (T5%), was the lowest concentration but effective and the most economical. It can therefore be recommended to small producers against thrips on cowpeas.

Table 3. Biocidal effects of Jatropha oil on the change in the number of bugs per cowpea plant (pod formation stage)

Treatments	Before treatments	Number of days after treatments		
		3rd	6th	9th
T0%	4±1[a]	4±2 [b]	6±2 [b]	7±2 [b]
T5%	2±2[a]	1±0,1 [a]	00±0 [a]	00±0 [a]
T10%	3±2[a]	00±0 [a]	00±0 [a]	00±0 [a]
T15%	4±2[a]	00±0 [a]	00±0 [a]	00±0 [a]
T20%	3±2[a]	00±0 [a]	00±0 [a]	00±0 [a]
Decis or Deltamethrin	3±2[a]	00±0 [a]	00±0 [a]	00±0 [a]

Values in the same column followed by the same letter are not significantly different at the 0,05 level. T0%: negative control ; T5%: 5% concentration of Jatropha oil ; T10%: 10% concentration of Jatropha oil ; T15%: 15% concentration of Jatropha oil ; T20%: 20% concentration of Jatropha oil.

Biocidal effects of Jatropha oil on bugs: The biocidal effects of Jatropha oil on the change in the number of bugs per cowpea plant (pod formation stage) before and after the treatments (3rd, 6th and 9th days) were recorded (Table 3). It appears that the number of bugs per plant was between 2±2 and 4±1 individuals. Bugs usually appear at the pod-forming stage in cowpeas.

A significant reduction in the level of bedbug infestation was observed on the 3rd day after application of the products. The absence of bedbugs had reached the 6th day. The level of infestation in the control increased on day 6th and 9th day. The concentration at 5% of Jatropha oil, corresponding to 1 liter/ha (T5%) was the lowest concentration, effective on the 3rd day after treatments and the most economical. It can be recommended to the small producer against bugs for cowpea cultivation.

Table 4. Biocidal effects of Jatropha oil on growth characteristics

Treatments	Germination rate	Rod length (m)	Number of ramifications
T0%	96,32±5,11[a]	0,92±4,31[a]	4±3,23[a]
T5%	94,21±4,13[a]	0,98±3,61[b]	7±4,11[b]
T10%	98,52±2,41[a]	1,02±7,43[b]	8±6,32[b]
T15%	95,25±2,22[a]	0,98±2,21[b]	8±3,35[b]
T20%	96,13±1,12[a]	0,99±4,32[a]	7±2,32[b]
Decis (Deltamethrin)	93,32±4,31[a]	1,15±5,26[c]	8±4,31[b]

Values in the same column followed by the same letter are not significantly different at the 0,05 level. T0%: negative control ; T5%: 5% concentration of Jatropha oil ; T10%: 10% concentration of Jatropha oil ; T15%: 15% concentration of Jatropha oil ; T20%: 20% concentration of Jatropha oil.

Effect of treatments on cowpeas growth and development parameters : The treatment effects on cowpea stem length and branching was noted (Table 4). It appeared that the germination rates on the plots labeled and primed to receive the treatments were not statistically different from each other. The seeds were of good quality, last season and carefully stored. For the development characteristics related to the length of the stem and the number of branches, the values obtained are statistically higher than those of the negative control. The attack of insects affects the physiological activity of the plant and reduces the vegetative development of cowpeas.

Table 5. Biocidal effects of Jatropha oil on cowpea production and yield (pod harvest stage)

Treatments	Number of pods/plant	Average weight seeds/plant (g)	Seed yield (kg.ha^{-1})
T0%	37±0,2[a]	45,97±2,14[a]	698,31±2,45[a]
T5%	62±1[b]	55,29±2,32[b]	883,72±2,32[b]
T10%	72±2[d]	71,71±1,23[c]	1187,81±2,26[d]
T15%	71±1[d]	69,96±2,31[c]	1117,81±3 ,12[c]
T20%	67±1[c]	66,24±2,22[c]	1109,82±4,11[c]
Decis or Deltamethrin	97±2[e]	79,49±2,32[d]	1212,31±2,46[e]

Values in the same column followed by the same letter are not significantly different at the 0,05 level. T0%: negative control ; T5%: 5% concentration of Jatropha oil ; T10%: 10% concentration of Jatropha oil ; T15%: 15% concentration of Jatropha oil ; T20%: 20% concentration of Jatropha oil.

Effect of treatments on cowpea production parameters depending on the treatments applied: The biocidal effects of different treatments of Jatropha oil on cowpea production and yield were recorded (Table 5). The analysis of variance showed that there was a difference at the threshold of 5% for the different concentrations compared to the negative control. Decis has a superior protective effects on pod/plant number and average grain/plant weight compared to other concentrations of Jatropha oil. Concentrations of 10%, 15% and 20% of Jatropha oil showed toxic effects similar to those of the standard insecticide on cowpea seed yield per hectare. Compared to the three observations of the biocidal effects of oils in the field, the elimination of insects was progressive to reach the disappearance of insects on the plants on the 6th day after application of treatments. The effect of Décis (Deltamethrin) was immediate. Complete disappearance of the insects was observed on the 2nd day after treatments (Table 1 ; 2 and 3). A decrease in cowpea pests compared to the control was accompanied by a net increase in the average weight of seeds produced by cowpea plants (Table 5). The concentrations of T5% and T10% are well indicated for biological control of cowpea pests.

They have allowed a reduction of more than 80% of thrips, aphids, and bugs. They favored a significant increase in cowpea seed yield compared to the control. The concentration of 15% and 20% of Jatropha oil gave spots on the leaves ; which proves the phytotoxicity of these concentrations. Despite these drawbacks, these concentrations proved an insecticidal effect comparable to the positive control or to the reference product (deltamethrin). The plots treated with the synthetic products gave higher yields.

DISCUSSION

The treatments applied have a biocidal effect on the three main cowpea pests observed in fields. The results obtained on the efficacy of plant extracts, here oil extracted from *J. curcas*seeds, are similar to what has been reported in the literature (Mazid *et al.,* 2011; Abdoul *et al.,* 2013). The nuisance of insect pests of legumes which can cause crop losses ranging from 30% to 100% is greatly reduced (Ngamo & Hance, 2007). Control methods, especially chemical, are topical to control pests of food plants in fields and in stock (Ogbebor *et al.,* 2007; Solsoloy *et al.,* 1997). Unfortunately, the use of chemical insecticides always results in food poisoning and environmental pollution (Abdoulaye, 2018 ; Derogoh *et al.,* 2018). That is why, in order not to arrive at unfortunate and irreversible consequences, the use of natural insecticides extracted from plants are recommended because of its production which can be within the reach of the average farmer and its rapid biodegradability in the natural environment (Abdoul *et al*., 2011). The 5% concentration of Jatropha oil is the lowest of the concentrations applied but effective and the most economical for the average farmer against the main pests of cowpea. Natural plant-based insecticides have progressive effects on pests while conventional or chemical insecticides have direct impacts (Mahaela, 2008). Solsoloy & Solsoloy (2000) found that the synthetic insecticide has a faster effect than Jatropha oil which acts slowly on insect growth.

The maximum of its effectiveness is after a week. Although effective compared to Jatropha oil, synthetic insecticides have a detrimental effect on beneficial insects as well as target insect pests, human health, animal health and the environment. Biopesticides are simple for producers to use, effective and economically profitable (Nwaga, 2000). Observations have shown a significant negative effect of deltamethrin on beneficial insects, while Jatropha oil products have maintained these populations at a sufficient level. According to Isman (2006) and Abdoulaye (2018) plant biopesticides are recommended as an alternative to chemical pesticides for crops protection with minimal negative risks (Mazid *et al.,* 2011).

For a long time in Italy (Dayan *et al.,* 2009), ancient China (Long *et al.,* 2006), Egypt, Greece and India (Isman, 2006), bioinsecticides extracted from plants have been the subject of research with the aim of developing alternatives to conventional insecticides. In fact, plant biopesticides, which constitute an important group of plant protection products of natural origin, are mixtures of biologically active substances, so that pests and pathogens cannot develop resistance (Saxena, 1983; Chandler *et al.,* 2011; Leng *et al.,* 2011). The reduction in cowpea insect populations could also be influenced by biological and physical factors such as ladybugs as well as heavy rainfall which can drastically reduce aphids. Mylabers are predators of thrips (Solsoloy *et al.,* 1997; Abdoul *et al.,* 2011). The results obtained on the phytotoxicity of *J. curcas* oil are similar to those of Abdoul (2013). He reported this toxic effects of Jatropha oil used as a bioinsecticide at a high concentration (20%) and spots are observed on the leaves of cultivated plants. The laboratory tests conducted by Abdoulaye (2018) on the biocidal properties of waxes extracted from the seeds of the Jatropha, at a concentration of 20%, induced a 100% mortality of the larvae of *Choristoneura fumiferana* (Lepidoptera), a budworm of the spruce. It is an insect native to North America where it is considered the worst plague of fir and spruce forests (Martineau, 1985). He also confirmed that the waxy extracts of the Jatropha seeds have repellent effects on the larvae of this Lepidoptera. King (2009) found that waxes are generally removed by refining processes before the oils are marketed and are considered to be by-products or wastes. According to Lecomte (2009) and Orwa *et al.* (2009) cited by Abdoulaye (2018), it is a mixture of melissyl alcohol and melissimic acid ester found in the bark of the nuts of the Jatropha, the role of which is to control the transfers of mass and attack of plant pests. The toxicity of Jatropha oil is mostly attributed to phorbol esters. It is an organic compound from the family of terpenes, non-thermobile substances (Makkar *et al.,* 1997). Solsoloy and Solosoy (2000) tested two levels of Jatropha oil concentration (800 and 1250 ml / ha), on cotton pests, by spraying compared to frequently used commercial insecticides (profenofos at 400 g/ha and deltamethrin at 12,5 g/ha) and gave effects comparable to the results obtained in this study. At the start of the treatments, synthetic insecticides were more effective than Jatropha oil on the predators concerned : a grasshopper (*Amrarsca biguttula*), an aphid (*Aphid gossypii*) and a caterpillar (*Helicoverpa armigera*). In the end, *A. gossypii* was controlled better with Jatropha oil than with deltametrin, which was not the case with *A. biguttula*. Abdoul *et al.* (2011) proved in the field and in the laboratory that a 5% concentration of Jatropha oil was necessary to reduce in 24 hours 50% of *Aphis fabae*, aphids pests of bean and on insect pests of cowpea. Biocidal trials of Jatropha oil have also been carried out with great success on pests of maize (*Sitophilus zeamais*) and cowpea (*Callosobruchus chinensis*) in stock by Solsoloy *et al.* (1997). The seeds were pulverized and then dried. The dilutions tested were 0,5 ; 1,0 ; 2.5 and 10%. The direct toxicity of the treatment was low, but the efficacy of the product increased over time (Solsoloy & Solosoy, 2000). Seed damage was only 10% with a dosage of 10% for *Sitophilus zeamays* and a dosage of 5% for *Callosobruchus chinensis* after 2 months. The authors found that the number of eggs laid decreased due to a decrease in the reproductive capacity of these insects. The product also had a repellent effect on pregnant females who could no longer lay their eggs. Adebowale & Adedire (2006) also revealed the insecticidal activity of Jatropha oil in the laboratory on *Callosobruchus maculatus*, an insect pest of cowpea seeds, with dosages of 0,5 ; 1,0 ; 1,5 and 2,0%.

CONCLUSION

The results of this work show that Jatropha oil has a biocidal activity on the development of insects (aphids, thrips, bugs) pests of cowpea tested in the field. The standard insecticide has a faster effect while the Jatropha oil works slowly to reach maximum. At concentrations of 5% (1 L. ha^{-1}) and 10% (2 L. ha^{-1}), Jatropha oil allows a reduction of more than 80% of thrips, aphids and bugs compared to the control. At a concentration of 15% (3 L. ha^{-1}) and 20% (4 L. ha^{-1}) a phytotoxicity effect is observed on the leaves of cowpea. This observed toxicity has an impact on the development and production of cowpea. However, these doses of Jatropha oil have a pest infestation reduction effect comparable to the reference insecticide (Decis : deltamethrin 25g/L). A significant increase in seed yield per plant compared to the control is observed for all the treatments.
The concentrations of 5% (1 L. ha^{-1}) and 10% (2 L. ha^{-1}) of the Jatropha oil can be recommended as an insecticide application against the various cowpea pests in the field. They bode well for a better future for the use of natural biopesticides in biological farming.

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