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Effectiveness of aqueous extracts of neem seeds and deltamethrin in protection of cowpea (*Vigna unguiculata*): case of *Megalurothrips sjöstedti* (Trybom)

MBAIDIRO Taambaijim'd Josué, Armand PARAISO, Gapili NAOURA and DOYAM NODJASSE Amos

Abstract
Cowpea, is a popular seed legume in Chad. It is experiencing production losses due to insect pest attacks. The thrips of flower buds *Megalurothrips sjöstedti* is one of these pests, whose economic importance is well established. This study aims in promoting the use of neem extract as an alternative to chemical pesticides in the management of thrips. The trial was conducted at the agricultural research station in Chad. The experimental design was a Complete Randomized Block with four treatments and four replicates, including Control (no treatment), deltamethrin at normal dose (1L/ha), aqueous extract of neem seeds alone (140 g) and its combination with a low dose of the chemical insecticide (1/10 of the normal dose). The results showed that deltamethrin reduced thrips density by 79.41 % at the third application. The botanical insecticide indicated a reduction in thrips density of 44.11% at the third. Deltamethrin showed a yield increase of 463.875 kg. ha^{-1} compared to the control (P <0.05). As for the combination of the natural product with the chemical insecticide at low dose the results were similar to those of deltamethrin (67.64 % at the third application). Neem extract used alone and its combination with low dose of deltamethrin indicated yields of 253.375 kg. ha^{-1} and 312 kg. ha^{-1}, respectively (P <0.05). These results showed the opportunities of the use of alternatives to chemical control. The extract of neem can be used as an alternative for the control of cowpea insect pests in Chad.

Keywords: Efficacy, Neem extract, *Vigna Unguiculata*, Deltamethrin, *Megalurothrips sjöstedti*, Chad

Introduction
Cowpea is a world-grown legume with an estimated crop area of about 14.5 million hectares a year and an annual world production of more than 4.5 million tons (Singh *et al.*, 2002) [20]. Nigeria, the world's largest producer, provides 65% of the region's supply, and Niger (second largest producer in the region and third in the world) gives 15%. Other countries listed in order of importance are Burkina Faso, Mali, Benin, Ghana, Cameroon, Togo, Senegal, Chad, Côte d'Ivoire and Mauritania (A.S. Langyintuo et *al.*, 2003) [9].
In Chad, cowpea is the widely grown and most used vegetable after peanut. According to the Directorate of Agricultural Statistics (DSA, 2017) [3], its national average annual production for the last five years is estimated at 128,253 tons, with a peak production of 144,070 tons for the 2016-2017 crop year.
With a high nutritional value and a high protein content (22-24%), cowpea plays an important role in the nutritional balance of Sahelian populations whose diet is largely based on cereals (Atachi *et al.*, 2002) [2]. Despite its great adaptability and importance, cowpea productivity is generally very low because of numerous biotic and abiotic constraints (lshikawa *et al.*, 2013) [6]. Several insects attack the crop in the field and in storage. Flower budworm thrips (*Megalurothrips sjöstedti*) is one of the most damaging insects in Africa (Jakai and Daoust 1986, Jackai *et al.*, 1992) [7, 8].
The most common control technique against these pests is the use of chemical pesticides; if they are judged effective by their immediate action, their use and mishandling pose serious problems of water pollution, air with adverse health consequences (Singh *et al.*, 2004) [21]. However, the rapid development of insecticide resistance in thrips populations tends to render chemical treatments ineffective (Morse and Hoddle, 2006) [11]. It therefore seems necessary to develop alternative methods for the ecologically sustainable protection of cowpea.

No studies on the use of the aqueous extract of neem seeds in the control of *M. sjöstedti* have been carried out in Chad.
This work presents the results of the study, of which objective is to promote the use of neem extract *(Azadirachta indica*) as an alternative to chemical pesticides in the management of thrips.

Materials and methods

Study area

The present study was conducted at the Institute of Agronomic Research Institute for Development located in Bébédjia in the Southern zone of Chad. It is located at the geographic coordinates of: 8 ° 40'34 ' North latitude, 16 ° 33'58 " East longitude and 397 m altitude (NGIA, 2015). Bébédjia has a tropical Sudanese climate characterized by the alternation of rainy season (7 to 8 months) which extends from April to October and a dry season (4 to 5 months) from November to March (Medards and Ozias, 2007, Nadjiam *et al.*, 2015) [10, 12].

Plant material

The plant material used in this study was cowpea (*Vigna unguiculata* L. Walp), the variety IT81D985 of Nigeria origin (IITA, 1981). It has a cycle between 75-80 days, a height up to 35 cm, a medium seed, white and hilum spotted with red.

Weather condition

During the year experiment rainfall was 823 mm and August was most wet with 314.1 mm (figure 1). Rain stopped in September and for October, November and December there was not rained anymore. Maximal air temperature average ranged from 41.45 °C (in March) to 31.9 °C (in August) and the minimal air temperature average varied from 25.07 °C (in April) to 14.51 °C (in January).

Method of preparation of the products

Aqueous extract of neem seeds

The collected neem seed were washed, dried, sorted and prepared according to the following steps: the seeds were peeled to remove the almonds. The almonds were weighted using electronic balance and pounded thoroughly using mortar and pestle to produce a fine crushed material. The powder was left for maceration overnight, then filtered the next day using a muslin cloth. A solution of soapy water was prepared with 30 g of "azur" soap and added to the extract at a rate of 1 L per 9 L of the extract, in order to allow the formulation to be fixed on the leaves.

Solutions based on Deltamethrin 12.5 EC

According to the Practical Manual for the Protection of Food Crops in West and Central Africa (Theissen and Pierrot, 1994), deltamethrin 12.5 EC is used at a dose of 1L / ha.
The deltamethrin solution used was Deltox 12.5 EC, manufactured by an Indian firm (Tagros Chemicals India Ltd) with 12.5 g of deltamethrin per liter; the recommended dosage is 1 L / ha.

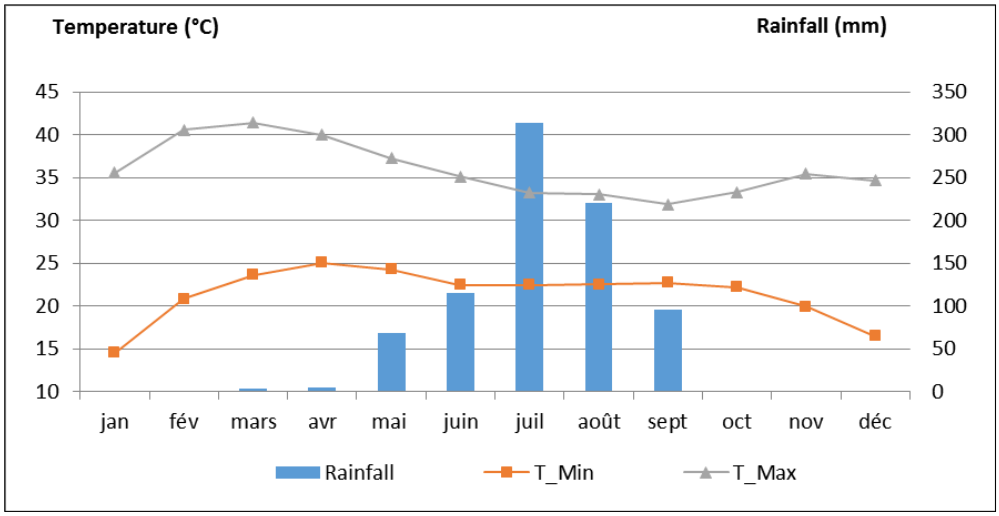


Fig 1: Weather condition during the experiment in 2018

Experimental design

The experiment was laid out in a Randomized Complete Block design consisting of four treatments, each replicated four times. The experimental plots measured 7 x 4 m. Plots were separated by 2 m and blocks by 3 m. The cowpea (variety IT81D985) was sown on August 04, 2018. Three seeds were planted per hole and planting space was 0.5x 0.8 m^2. Thinning to two plants per stand took place on August 18, 2018. Each plot consisted of 6 rows of 10 cowpea stands. Weeding was carried out twice with a hoe during the vegetative stage of the crop.
The treatments consisted of four modalities, including:

- T1: Control (no treatment);
- T2: Aqueous extract of neem seeds: 140 g of neem seed powder + 2.8 liters of water + 24 hours' maceration;
- T3: Deltamethrin 12.5 EC (at the recommended dose 1L / ha): 11.2 ml + 2.24 liters of water;
- T4: Deltamethrin 12.5 EC (1/10 recommended dose (1.12 ml + 0.224 l of water) + Aqueous extract of neem seeds (140 g of neem seed powder + 2.8 liters of water) + maceration 24 h).

Three applications were made in each plot every seven days from the 35th day after sowing. The products were applied using a battery powered ULV sprayer.
Data collection was carried out on the four central lines as follows:

- Two lines were used for observations on insect pests;
- The other two were devoted to the estimates of production.

The following parameters have been studied.

Efficacy of the aqueous extract of neem and deltamethrin on *M. sjöstedti*.

Five flowers were collected from 5 plants randomly per plot, on both edge rows of the useful plot and placed in 70-degree alcohol to facilitate counting of the thrips using a binocular. Counting was done one day before treatment and on days 1, 3, 5 and 7 after treatment.

Effects of aqueous extract of neem seed and deltamethrin on cowpea yield.

At the mature stage, five plants selected at random from the two central rows of the useful plot were harvested. The pods were dried and shelled for yield estimation.

- The yield in kilograms per hectare of each plot has been determined using the following formula:

Yield (kg / ha) = WSP x TNP

With:
WSP = Average weight of seeds per pocket and,
TNP = Total number of cowpeas per hectare.

Statistical analyzes

The descriptive and variance analyzes of the data collected were performed using the software version 2016. When it revealed significant differences, the Newman-Keuls test at the 5% probability threshold was performed to separate the averages. Treatment control efficacy on thrips was calculated after 3rd application using the following formula (Kondap and Upadyayi, 1985):

TCE% = (a-b) / a x 100

Where: TCE = treatment control efficacy, a = Number of thrips in the control plot, b = Number of thrips in the treated plot

Results

Efficacy of the aqueous extract of neem seeds and deltamethrin on the thrips population

No presence of thrips was observed before and after the first application of the products.

The analysis of variance showed a significant difference at the second application. The density of thrips population after application decreased significantly at day 1, day 5 and day 7. A significant difference was observed between the mean of treatments T3 and T1 at day 1 and between the treatments T1, T3 and T4 at day 5 (P <0.05) after application (Table 1).

The comparison of averages at the 3rd application indicated a decrease in thrips density at days 3, 5 and 7. The mean of treatments T3 and T4 were significantly different at Day 5 and T3 and T2 at Day 7 (P <0.05) after application (Table 2).

The maximum reduction in the thrips population was observed in T3-Deltamethrin treatment (79.41%) followed by T4 treatments (Neem aqueous extract of seeds + Deltamethrin 1/10 of the recommended dose) with 67.64% and T2 aqueous extract of neem seeds 44.11% (Table 3).

Effect of aqueous extract of neem seeds and deltamethrin on the yield of cowpea variety IT81D985

The chemical pesticide treatment gave a yield 5.93 times higher than that of the control treatment. The other two treatments (neem extract / low dose chemical mix and neem extract alone) indicated an increase in yield more than 3 times greater than the control treatment. Chart 3 below shows the different yields obtained by treatment.

Table 1: Mean density of the *M. sjöstedti* thrips population observed by treatments after 2nd application

Treatment	1er day before treatment (DBT)	1er day after application (DAS)	3e DAS	5e DAS	7e DAS
T1	44.500 a	18.000 a	12.000 a	9.250 a	7.500 a
T2	38.000 a	13.750 a	12.500 a	6.750 ab	6.250 a
T3	18.250 a	1.500 b	3.250 a	2.500 b	2.250 b
T4	29.000 a	8.500 ab	4.250 a	2.250 b	2.500 b
Pr > F	0.479	0.009	0.133	0.013	0.005

The affected averages of the same letters and in the same column were not significantly different at the 5% threshold (Student Newman-Keuls).

T1-Control untreated; T2- Aqueous extract of neem seeds; T3-deltamethrin; T4: Aqueous extract of neem seeds + 1/10 of the recommended dose of Deltamethrin.

Table 2: Mean density of the *M. sjöstedti* thrips population observed by treatments after the 3rd application

Treatment	1er day after treatment	1er day after application (DAS)	3e DAS	5e DAS	7e DAS
T1	29.500 a	17.000 a	37.000 a	9.500 a	8.500 ab
T2	14.500 a	16.500 a	15.250 b	11.750 a	4.750 a
T3	16.000 a	4.000 a	4.000 b	3.250 b	1.750 b
T4	12.750 a	3.000 a	4.000 b	3.250 b	2.750 ab
Pr > F	0.521	0.071	0.010	0.004	0.034

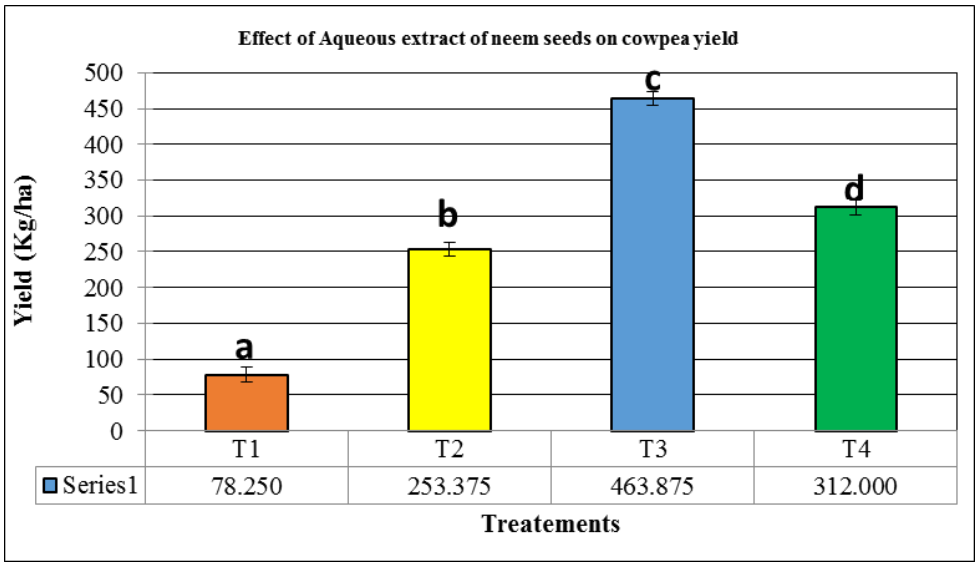
The affected averages of the same letters and in the same column were not significantly different at the 5% threshold (Student Newman-Keuls).

DBT: Day before treatment; DAS: Day after Spraying; T1-Control untreated; T2- Aqueous extract of neem seeds; T3-deltamethrin; T4: Aqueous extract of neem seeds + 1/10 of the recommended dose of Deltamethrin.

Table 3: Treatment control efficacy on *M. sjöstedti* thrips population after 3rd application

Treatments	Number of thrips per 5 flowers					Reduction of population (%)
	1er DBT	1er DAS	3e DAS	5e DAS	7e DAS	
T1 : Control untreated	29.5	17	37	9.5	8.5	-
T2 : Aqueous extract of neem seeds	14.5	13.75	15.25	11.75	4.75	44.11
T3 : Deltamethrin	16	4	4	3.25	1.75	79.41
T4 : Aqueous extract of neem seeds + 1/10 of the recommended dose of Deltamethrin	12.75	3	4	3,25	2,75	67.64

DBT: Day before treatment; DAS: Day after spraying



T1-Control untreated; T2- Aqueous extract of neem seeds; T3-deltamethrin;
T4: Aqueous extract of neem seeds + 1/10 of the recommended dose of deltamethrin.

Fig 2: Effect of aqueous extract of neem seeds and deltamethrin on cowpea yield.

Discussion

Neem extract contains insecticidal properties that are lethal to a wide range of insects, including *M. sjöstedti* thrips (Ostermanni 1979, Stoll 1988, Oparaeke 2007) [17, 22, 16]. The results of this study showed the effectiveness of neem extract on the thrips population. The application of the extract resulted in decrease in thrips density compared to the control. The efficacy of the treatment based on the aqueous extract of neem seeds allowed a significant reduction of thrips (44.11%) compared to the control. Our results confirmed those of Panhwar, (2002) [19] who also reported the effectiveness of the aqueous extract of neem against cowpea worms, beetles and thrips.

This study showed that the synthetic insecticide was effective on *M. sjöstedti* since the unprotected plots showed greater damage than the plots protected by the insecticide. The efficacy of control of the Treatment showed a significant reduction in thrips (79.41%). These results corroborate with the findings of many other authors who reported a very low population of thrips in plots treated with chlorpyrifos, cypermethrin, lambda-cyhalothrin and dimethoate + deltamethrin. (Omongo *et al.*, (1998); Egho *et al.*, (2010); Dzemo *et al.*, (2010) and Yusuf *et al.*, 2012,) [15, 5, 4, 25]

Nderitu *et al.*, 2010 [13] have reported that significant low densities of *M. sjöstedti* in plots treated with 0.15% azadirachtin in combination with a chemical insecticide (Thiacloprid). Our results are consistent those of Nderitu *et al.*, 2010 [13], for the application of aqueous neem seed extract and deltamethrin low dose also allowed a significant decrease in the density of thrips on the treated plots. The control efficacy of the treatment indicated a significant reduction of thrips (67.64%). These results also correspond with that of Ouma *et al.*, 2014 [18], which indicated the effectiveness of integrate pest management in cowpea protection.

With respect to yields, the findings of our study indicated that yields obtained on neem extract treated plots were significantly (p <0.05) higher (253.375 kg. ha^{-1}) than yields on the control plots. These results are consistent with previous work by (William and Ambridge, 1996, Panhwar, 2002) [24, 19], which showed that neem extract increased the yield of legumes and peas by protecting them from pests. However, these observation differs from the findings of Olaifa and Adenuga (1988) [14] who, claimed that neem products caused chlorosis making cowpea leaves to fall.

Our results showed that the yield recorded on plots treated with deltamethrin was higher (463.875 kg. ha^{-1}) compared to the yield of the control plots (p <0.05). Tanzubil (1991) [23] and Dzemo *et al.* (2010) [4] similarly reported a higher grain yield in the insecticide treated plots (lambda-cyhalothrin) compared to control plots.

The study indicated that the treatment based on the combination of the synthetic product and the natural product provided a high yield (312 kg. ha^{-1}) compared to untreated plots (p <0.05). These results showed that the association of low-dose synthetic pesticide with the aqueous neem seed extract probably contributed to the increase in yields. These findings are consistent with observations reported by Ouma *et al.*, 2014 [18]; Abudulai *et al.*, 2016 [1].

Control plots showed a lower seed yield of 78.25 kg. ha^{-1} compared with 463, 875, 312 and 253.375 kg. ha^{-1} for deltamethrin, neem extract and the combination of natural product and the synthetic product respectively. These

observations are consistent with those of Jackai and Daoust (1986) [7] who reported that, without pest control, a reasonable grain yield of cowpea cannot be obtained.

Conclusion

The present study showed the effectiveness of the aqueous extract of neem seeds alone and in combination with low dose deltamethrin on the M. sjöstedti thrips population. A small reduction in thrips density was observed in the neem extract alone, compared with deltamethrin and the combination of low dose deltamethrin-associated neem extract, which showed a higher rate during the study. The aqueous extract of neem seeds alone and its combination with low dose deltamethrin proved more effective for the control of thrips. The results are promising and suggest prospects for the use of this botanical insecticide as alternatives to chemical pesticides for the control of cowpea pests in Chad.

Conflict of interest

The authors state that there is no conflict of interest.

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