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RESEARCH ARTICLE

EFFICACY OF PLANTS AQUEOUS EXTRACTS FOR GREENFLIES MANAGEMENT ON SIX COWPEA CULTIVARS IN NORTHWEST OF BENIN

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ABSTRACT

The present study allowed evaluating the efficacy of five plant water extracts on aphids and the yield of six cowpea's cultivars in three villages of the northwest region of Benin. The five aqueous extracts made with *Hyptis suaveolens*, *Azadirachta indica*, *Manihot esculenta*, *Thevetia neriifolia* and *Cymbopogon nardus* have been compared to the control treatment without product with six producers in a scattered experimental randomized blocks. The number of aphids present on the cowpea plants at 27, 34, 41, 48, 55 and 62 days after sowing, and the cowpea seeds yield was estimated. Results indicated that aqueous extracts of *Thevetia neriifolia*, *Azadirachta indica*, *Hyptis suaveolens* and of cassava have very significantly ($p < 0.001$) reduced the populations of aphids. Katché péha, Kpodjiguèguè, Katché sôwôho and Toura pera are been the least attacked by pests. Aqueous extracts of *Thevetia neriifolia*, *Hyptis suaveolens*, *Azadirachta indica*, cassava, *Cymbopogon nardus* and the control led in this order, decreasing seeds yields from 886 kg/ha to 387 kg/ha. Seeds yields of cultivars Katché péha, Kpodjiguèguè, Katché sôwôho, Toura pera, Katché péha nan soorii and Katché Sénégal were very significantly ($p < 0,001$) variable in this order, from 747.50 kg/ha to 519 kg/ha. These aqueous extracts should be tested on thrips and on the bugs as well as for the future of the seeds in stock for a good protection of cowpea.

INTRODUCTION

The cowpea [*Vigna unguiculata* (L.) Walp.] is one of the world's leading food legumes (Pasquet and Baudoin, 1997). In Africa, it is a popular staple food for its leaves, green pods and dry seeds, which are marketed and consumed (ISRA et al., 2005). Described as "poor meat", cowpea plays a prominent role in the diet of rural populations (Ibro and Bokar, 2001) and is therefore an important source of protein for rural populations in South Benin (CBDD, 2000; cited by Kpatinvoh et al., 2016). Its food importance (Glitho, 1990) as fodder (Bello, 2005; Bello et al., 2016; Bello & Baco, 2015), its medicinal and aphrodisiac effects and its impact on soil fertility recovery make it a multi-purpose plant (Kossou et al., 2001). Cowpea is the best-selling food crop at about 80% of the amount produced. The income it provides to farm households represents 88% of the households' plant income, enabling them to meet the financial needs of purchasing material goods, health care, schooling for children, etc. (Kpangon, 2002).

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In Africa, cowpea is grown mainly in Nigeria, Burkina Faso, Benin, Niger, Senegal, Sudan, Uganda, Tanzania, Malawi, Zimbabwe and South Africa (Anonymous, 2003). In Benin, it is cultivated throughout the national territory, in Ouémé, Mono and Zou departments and especially in the Central and Northern regions (MAEP, 2014). Especially in the northern region, where the population is growing with an increase rate of more than 4% and a growing impoverishment of rural people (World Bank, 2003), the situation of agriculture and its biodiversity seem even more critical. Land is deteriorating, and cotton is competing with food crops (Akker van den, 1999). Under these conditions, the gradual shortening of fallow duration and long-term soil-exhausting cropping techniques lead to a significant decline in agricultural yields and the abandonment of some traditional cultivars (Zoundjihékpon et al., 1997). In this context, cowpea yield levels have remained low and do not exceed 800 kg/ha (MAEP, 2014), due to the fact that it is still highly parasitised in the field (Kossou et al., 2001; Kpangon, 2002) by pests whose management problem is undeniable. Yield losses due to the latter range from 30% to 100% in extreme cases (Singh and Allen 1979). In the face of these scourges, several methods of control have been highlighted, among which, chemical control is now the most

widespread against pests (Adigoun, 2002). However, most of the insecticides used are violent poisons for users, treated plants and animals. Indeed, the use of pesticide plants presents itself as an alternative in terms of crop and crop protection in West Africa. These biopesticides have a real advantage because of their low remanence, their low toxicity to humans and their environment and their mode of action on pests. As a result, they are less dangerous to the environment and to humans. Most insect repellent and insecticide plants are known to local populations that traditionally use them (Alexis, 1999). More than 2,000 plant species with insecticide properties are identified (Ngamo and Hance, 2007; Benayad, 2008). It is with this in coming that the producers of the commune of Djougou, located in northwestern Benin, members of the Rural Organization for Sustainable Agriculture (ORAD), have expressed the need for a participatory development of effective alternative control methods based on botanical pesticides, which are inexpensive and environmental preservatives, such as a solution approach to the low yields of cultivated cowpea cultivars, due in part to pest attacks.The objective of this study is to evaluate the efficacy of five (05) water extracts based on *Hyptis suaveolens*, *Manihot esculenta* (manioc), *Azadirachta indica* (Neem), *Thevetia neriifolia* and *Cymbopogon nardus* (Lemongrass) for control at aphid field and cowpea yield in the commune of Djougou in northwestern Benin.

MATERIAL AND METHODOLOGY

Location and agro-ecological characteristics of the study area: This study was conducted in the municipality of Djougou, which covers an area of 3,966 km^2 and is one of the four municipalities that make up the department of Donga. It is bounded to the north by the municipalities of Kouandé and Péhunco, to the south by the municipality of Bassila, to the east by the municipalities of Sinendé, N'dali and Tchaourou, all located in the department of Borgou and to the west by the municipalities of Ouaké and Copargo (Figure 1.). The city of Djougou, the capital of the department of Donga is located about 450 km from Cotonou. In this commune, three villages namely Passari, Kpayèroun and Kpafoungou, were selected for the study. The climate is Sudanese-Guinean with a rainy season (April to October) and a dry season (October to March). The annual average rainfall is between 1200 mm and 1300 mm, with variations between 1000 mm and 1500 mm of water for 75 to 140 days of rain. At the beginning of the rainy season, the region periodically experiences hurricanes blowing from east to west. Soils, of clay-sand or latite texture (gravel or stony), are generally favourable to agriculture. The arable area represents 35.7% of the area of the commune which has a plateau relief dotted with hills of low gradients. The vegetation of the commune is dominated by treed and shrubs, including 37182 hectares of forests classified under development. Nevertheless, not insignificant relics of clear forests and dense forests can be seen in places. The commune is crossed and watered by four (04) important rivers: Donga, Affon, Momongou and Daringa over a total length of 21 km (PDC, 2003).

Cowpea cultivars tested: The agromorphological study involved six (06) of the most cultivated local cowpea cultivars in the commune of Djougou. They are called Katché péha, Katché sôwôho, Katché péha nan sôorii, Kpodjiguèguè, Toura pera and Katché Sénégal. These cultivars are owned and handled by producers in the villages of Kpayèroun, Kpafoungou and Passari, some of whom took part in the study in a participatory manner.

Insecticide plants tested: Five (05) insect repellent and insecticide plants were tested. They are *Hyptis suaveolens* (Figure 2.), *Thevetia neriifolia* (Figure 3.), *Cymbopogon nardus* or lemongrass (Figure 4.), *Manihot esculenta* or cassava (Figure 5.) and *Azadirachta indica* or neem/mangoose (Figure 6.). Cassava is a plant used as a 'trap crop' in a cowpea crop, to significantly reduce the number of flower thrips and pod-sucking insects. *Thevetia neriifolia* is a white latex plant that is considered a toxic plant whose roots, leaves, seeds and latex are used. From an ecological point of view, *Thevetia neriifolia* is considered an insecticide plant (Jackie 1983). *Hyptis suavuolens* leaf water extract has very potent insect repellent or insecticide properties (Kerharo and Adam 1974; Tchibozo, 1996; Boeke et al., 2004 cited by Guèyé et al., 2011; Ketoh et al., 2005). In Central Africa, *Cymbopogon nardus* (lemongrass) is most often planted around homes because its smell repels mosquitoes (Hmamouchi 1995; Tchibozo, 1996; Rocha et al., 2000; Boeke et al., 2004; cited by Guèyé et al., 2011; Ketoh et al., 2005).

Azadirachta indica A. Juss. called neem or mongoose has insecticide, insect repellent, repellent, nematicide, fungicide and medicinal properties (Kossou, 1989; Seck, 1993; quoted by Tchibozo, 1996, then Guèyé et al., 20Il). The producers have estimated, based on their endogenous technical knowledge, that water extracts from these plants can be used as biological pesticides of botanical origin to control cowpea pests in vegetation.

Technical materials: The various materials used are a tape meter and strings to measure the dimensions of experimental sites and blocks, stakes to delineate, a marker, labels to identify cultivars, working tools such as hoe and cutting to install plots and maintain crops, a sprayer of plant protection products, a digital photography camera for taking pictures, a scale (Figure 7.), a mortar (Figure 8.), plastic buckets and a maintained pressure back sprayer (Figure 9.) for the preparation and use of plant extract solutions, a magnifying glass for aphid observation (Figure 10.) and a four-digit manual counter.

Methods

Sample and choice of villages: The study was conducted in the three above-mentioned villages that were selected on the basis of the participation of some households in the activities of the peasant organization "ORAD", the Organization of Rural for Sustainable Agriculture, which works in synergy with the Out-of-Wall Laboratories and the Laboratory of Ecological Genetics for a few years. In each of the villages, two producers from this organization were chosen to host the trials.

Experimental design: An experimental design of fisher has been adopted with six treatments representing the water extracts of the five plant species mentioned above and a control treatment without product, for each of the six (06) cowpea cultivars. Five (05) repeats of the trial were installed with six producers in the three villages in the form of broken blocks. The elementary plots are 24 m² long and 8 m wide. In each block, treatments including cultivars and oil extracts are separated by a 2 m aisle.

Conduct of cowpea cultivation: The cowpea was sown on May 28, 2015 following a rain the day before, after clearing the experimental plots with a cutting cutter, followed by manual ploughing with the daba. The line sowing was carried out at the 0.80 m gap between lines and 0.60 m between poquets or plants. Two to three seeds were sown per poquet and unmarried to one plant per poquet. During the demarriage, the missing plants were replaced. The weedings were carried out on June 22, 2015 with hoe, on the 25th Day After Sowing (DAS).

Preparing water extract solutions : The leaves of these plants are harvested from the fields of cowpea growers who have proposed testing their insect repellent and insecticide effects. The water extracts were made the day before the cowpea plots were sprayed. For each plant species, 10 liters of water combined with five (05) times the weight equivalent of leaves was used to obtain water extract formulations. The amount of neem, cassava, *Thevetia neriifolia* and *Hyptis suaveolens* leaves and stems was agreed with the producers for 24 m^2 representing the surface of each elemental plot (Table 1). The weighing leaves were then crushed in a mortar until a more or less homogeneous paste was placed in a container. The mortar is rinsed and the residual dough solution is poured over the dough. The contents of the container are well stirred after adding to it for the five repetitions of water extract treatments spread over 120 m^2; 62.5 g of palmida soap as an adhesive. The resulting mixture is covered and deposited in a fairly shady area. On the day of treatment, 24 hours later, the mixture is stirred before being filtered and used. The resulting solution is divided into five (05) equal parts to treat each 24 m^2 plot when spraying. This dose is applied for each cultivar. For each plant species, the applied doses were diluted in 833 l of water per hectare.

Application of plants water extracts: Applications of water extracts from insecticide plants were made six times during the cowpea vegetative cycle. Plant health treatments began in the vegetative growth phase of cowpea, after the emission of a large amount of leaves observed at 28 DAS. From that date, the applications were carried out on a weekly basis at 28, 35, 42, 49, 56 and 63 DAS. Sprays were sprayed early in the morning from 10 a.m. to enhance the effect of morning dew on the absorption of porridge through the stomata of cowpea plants and to prevent degradation of the product during the hot hours of the day.

Sample plants observed: In the experimental device, each elementary plot has 5 lines. To avoid border effects, one line is left on either side for each parcel and the remaining three (03) lines are lines of observation for the measured parameters. All sample takes are taken at random on the diagonals and medians, and then at the intersection of the medians and diagonals in order to exploit in a representative way, the parcel surface concerned. Sampling began as soon as a large number of leaves appeared. A magnifying glass was also used to directly observe aphids in the field and a four-digit manual counter was also used to count aphids. Observations are made at a regular frequency of seven (07) days apart.

Measured parameters

Evaluation of the aphids' population: Aphid observation and counting was conducted on the leaves, at the regular frequency of seven (07) days apart at 27, 34, 41, 48, 55 and 62 DAS. Visual observation of aphids was conducted on the three central lines of each observation square on twenty (20) plants per parcel unit and cultivar. Each 1 m serving is spaced so that on all three lines, the observation sites do not coincide in parallel.

Fragmentary seed weight and 1000 cowpea seeds at harvest: The performance assessment is done on a 1 m^2 density square located between the three central lines of each parcel. The harvest of all useful plants was carried out on the central yield lines. After harvest, the seeds were dried and dumbed down in the sun until the humidity had decreased sufficiently. Finally, the seed weight of each sample was measured.

Data analysis: The aphids number and weight parameters of the cowpea seeds used to calculate seed yield per hectare and the weight of 1000 seeds were subjected to statistical analysis according to the general linear model for a single-variance of three factors namely (i) cultivar, (ii) water extract and (iii) observation period and to the two paired comparison of means with the Tukey test at the 5% threshold using the statistical software Minitab 16 and Statistix 8.0.

RESULTS

Effectiveness of aqueous plant extracts on the aphid population: The results of the variance analysis (Tables 2. and Table 3.) reveal a very highly significant difference ($p < 0.001$) between treatments and cultivars. Significant differences has been observed between aphid populations counted by cultivar, treatment and period (DAS) of observation. Average discrimination shows that extracts from Thevetia nerrifolia, neem, cassava and Hyptis suaveolens have significantly reduced the aphid population (Figure 10.), and have therefore better controlled the population of this kind of pests.

Effects of watery plant extracts on cowpea seed yield: The results of variance analysis of treatment factors (water extract and cultivar) and their interaction are presented in Table 4. Analysis of the data in this table shows a strong significance of the treatment factors ($p < 0.001$) and cultivar ($p < 0.001$) and a strong interaction of the two factors ($p < 0.01$) for average cowpea yield. Very significant differences were observed between the treatments ($p < 0.001$) and between cultivars ($p < 0.001$). These results indicate that water extracts did not have the same effectiveness in controlling aphids and that cultivars did not have the same behavior with aphids controlled by water extracts. A significant effect of bio-pesticides is therefore observed on the control of aphids, and therefore on the seed yield of different cultivars. The cultivars Katche péha, Kpodjiguèguè, Katché sôwôho, and Toura pera, had relatively higher seed yields, from 723.46 kg/ha to 747.5 kg/ha. They are followed by the cultivar Katche péha nan sôorii which has a lower seed yield of 646.45 t/ha. The cultivar Katché Senegal has the lowest seed yield of 519.1 kg/ha.

Effects of water plant extracts on the weight of 1000 cowpea seeds of different cultivars Figure 2 illustrates the graphic representation of the weights of a thousand seeds of the six cultivars. Significant differences were observed between cultivars for this variable. Thus, the Tukey test allowed a ranking of the averages of this variable.

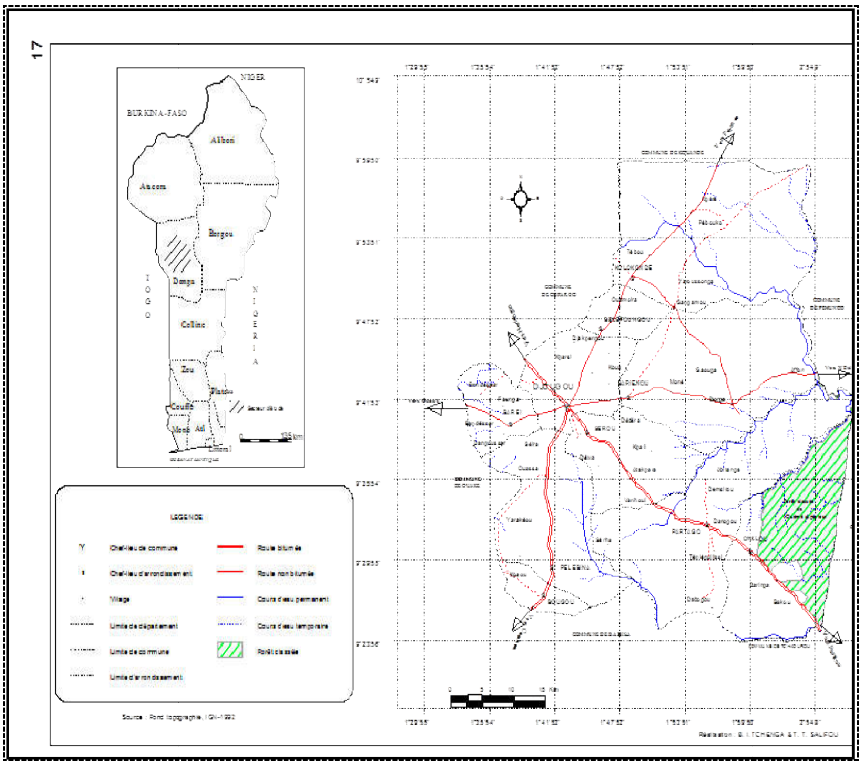

Figure 1. Benin's administrative map showing the geographical location of the municipality of Djougou (Source: IGN Topography Background, 1992)

Figure 2. Plant of *Hyptis suaveolens*

Figure 3. Plant of *Thevetia Neriifolia*

Figure 4. Plant of *Cymbopogon nardus* (lemongrass)

Figure 5. Plant of *Manihot esculenta* (cassava)

Figure 6. Plant of *Azadirachta indica* (neem/mangoose)

Figure 7. Electrical scale used to weigh the leaves of tested plant species and the weight of cowpea seeds at harvest

Figure 8. Mortar piling of the leaves and stems of the five plant species tested

Figure 9. Maintained pressure sprayer used for plant health treatments

Figure 10. Three-enlargement manual magnifying glass used for aphids observation and counting.

Tableau 1. Amounts of leaves and stems used to prepare water extracts from the five plant species

Plants tested	Amount (g) of leaves used to process 24 m^2	Dose (kg/ha)
Hyptis suaveolens	400 (with stems)	167
Manihot esculenta	400	167
Azadirachta indica	300	125
Thevetia neriifolia	250	104
Cymbopogon nardus	300	125

Table 2. Populations of aphids counted by treatments of water extracts from plants for each cowpea cultivar

Cultivars / Treatments	Katché péha	Katché sôwôho	Katché péha nan sôorii	Kpodjiguèguè	Toura pera	Katché sénégal
Témoin	36.31ijkl	61.05B	55.83c	55.87c	60.57b	67.21a
Hyptis suaveolens	28.52pq	33.12lmno	38.41ghijk	27.82qr	30.32nopq	40.11efgh
Manihot esculenta	23.44st	27.87qr	39.12fghij	22.35st	33.16lmno	44.75d
Azadirachta indica	23.17st	30.08opq	35.77jkl	33.67lmn	34.94klm	37.81hijk
Thevetia neriifolia	21.17st	24.41rs	29.57opq	19.92t	31.26nopq	32.02mnop
Cymbopogon nardus	29.38pq	42.97de	42.50def	39.84efghi	41.74defg	58.37bc
Great mean = 37,07 CV (%) = 19,55						

Source of variation	DAS	Treatment	Cultivar	DAS* Treatment	DAS* Cultivar	Treatment* Cultivar	DAS*Treatment Cultivar
df	5	5	5	25	25	25	125
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 3. Populations of aphids counted by cowpea cultivar during observation periods (DAS)

Cultivars / DAS	Katché péha	Katché sôwôho	Katché péha nan sôorii	Kpodjiguèguè	Toura pera	Katché sénégal	Means of DAS
27	42.99DE	56.82B	47.26C	41.65E	57.97B	62.88A	51.59a
34	28.24JKL	34.38FG	33.17GH	30.38HIJ	35.60FG	43.57DE	34.22d
41	34.66FG	44.45CDE	54.85B	44.11CDE	45.60CD	43.93CDE	44.60b
48	24.21MN	32.69GHI	43.71CDE	30.56HIJ	36.87F	44.12CDE	35.36c
55	17.88O	27.79JKLM	3713F	27.56JKLM	2957IJK	43,32DE	30,54e
62	14.03P	23.36N	25.07LMN	25.22LMN	26.37KLMN	42.43DE	2607f
Means of cultivars	27.00f	36.58d	40.20b	33.24e	36,66c	46,71a	37.07
Great mean = 37,067M CV (%) = 19,55							

Source of variation	DAS	Treatment	Cultivar	DAS* Treatment	DAS* Cultivar	Treatment* Cultivar	DAS* Treatment* Cultivar
df	5	5	5	25	25	25	125
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 4. Average yields in cowpea seeds (kg/ha) obtained for different cultivars based on water extract treatments for plants

Treatments	Cultivars of cowpea						Means of treatments
	Katché péha	Katché péha nan soorii	Katché Sénégal	Katché sôwôho	Kpodjiguèguè	Toura pera	
Control	435.9 ± 146.2	368.9 ± 126,7	255.0 ± 139.0	381.0 ± 170.9	467.5 ± 89.8	415.7 ± 159.3	387.28d
Hyptis s.	847.9 ± 119.0	859.6 ± 330.7	652.6 ± 172.1	743.8 ± 152.2	719.9 ± 142.7	936.6 ± 115.8	793.36ab
Azadirachta i.	829.0 ± 152.8	659.0 ± 336.0	522.5 ± 137.5	780.9 ± 134.2	698.9 ± 168.1	773.0 ± 150.0	710.51b
Thevetia n.	1015.0 ± 155.2	779.0 ± 243.8	684.5 ± 176.8	935.4 ± 148.7	946.1 ± 120.1	955.9 ± 91.5	885.76a
Cymbopogon n.	596.9 ± 100.9	542.1 ± 191.8	495.5 ± 118.5	705.3 ± 243.3	611.3 ± 138.1	572.1 ± 91.1	587.06c
Manihot e.	760.5 ± 113.8	670.9 ± 279.6	505.7 ± 186.8	849.5 ± 134.0	972.5 ± 92.0	687.7 ± 204.7	740.88b
Means of cultivars	747.50a	646.45b	519.10c	732.49ab	735.85ab	723.46ab	684.14
Source of variation	Cultivar	Treatment	Cultivar* Treatment				
df	5	5	25				
Probability	0.000***	0.000***	0.0076**				

The cultivars Katché sôwôho, Katche péha nan sôorii, Toura pera and Katché Senegal are not significantly different.

The Katche péha and Kpodjiguèguè cultivars gave the lowest weight of one thousand seeds of 115 g, and the highest weight of thousand seeds of 152.5 g, respectively. These differences in weight are relatively proportional to the seed size of the different cultivars.

DISCUSSION

Effectiveness of water extracts on the control of cowpea aphids: An abundance of aphids was observed at the 41st DAS in all cultivars. This abundance is due to the fact that all the plants at this time produced many leaves. In addition, their high abundance at the level of some cultivars is due to the proximity of the natural vegetation of the plots and the microclimate created by this vegetation.

Figure 10. Colony of aphids observed on cowpea leaves

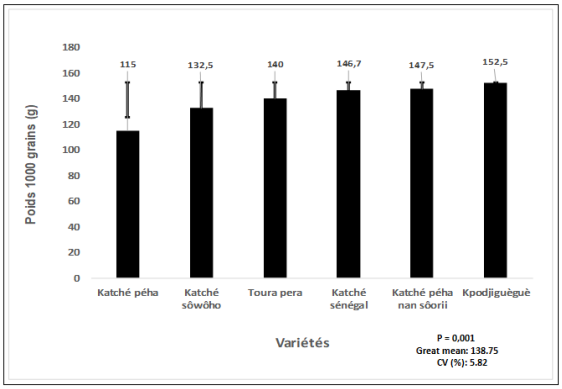

Figure 2. Weight (g) of 1000 cowpea seeds measured for different cultivars

This finding corroborates the results of Kossou et al. (2000) which reported that extracts from *Thevetia neriifolia*, *Azadirachta indica*, *Manihot esculenta* and *Hyptis suaveolens* better controlled the aphid population. Bachabi (2003) achieved the same results with water extracts of *Azadirachta indica*, *Hyptis suaveolens* and *Carica papaya*. The results of this study on the efficacy of water extracts tested against cowpea aphids corroborate those of many authors in the control of several insects in West Africa. As illustrations, the effectiveness of watery extracts of *Azadirachta indica* leaves and seeds on insects in West Africa was reported by Seck (1993) quoted by Tchibozo (1996), then by Guèyé et al. (2011). The watery extract of *Cymbopogon nardus* leaves sp. is effective against insects according to Tchibozo (1996), Boeke et al. (2004) cited by Guèyé et al. (2011), and Ketoh et al. (2005). The effectiveness of the leaves and essential oil of *Hyptis suaveolens* against insects is reported by Tchibozo (1996), Boeke et al. (2004), cited by Guèyé et al. (20Il), then Ketoh et al. (2005). The insect repellent and even insecticide activity of the leaves and flowers of *Hyptis suaveolens* was reported by Kerharo and Adam (1974). However, results contrary to those of these authors were found by Mukendi et al. (2014) in cowpea culture with *Azadirachta indica* water extract on another pest, *Ootheca mutabilis*. These authors reported that "the plant extract of *Azadirachta indica* did not significantly reduce ($P < 0.05$) the leaf damage of *Ootheca mutabilis* during the development of cowpea cultivars, of which 50% of leaf losses before flowering is due to this pest and attacks during flowering and fruiting lead to a loss of seed production of more than 50%. The number of leaves attacked does not depend on the spray dose applied. Considering that for all cultivars tested with sprays at 14; 28; 35 and 42 days, the insect's mortality remained at less than 10%, this author concluded that neem extract cannot effectively control the attacks of this pest at field.

Effectiveness of water extracts on cowpea seed yield: The effects of treatments with aqueous extracts were significantly remarkable on aphid populations, whose control had a positive impact on cowpea seed yield. For all cultivars, the best levels of cowpea seed yield, in decreasing order of importance, were obtained with treatments of aqueous extracts based on *Thevetia neriifolia*, *Hyptis suaveolens*, *Azadirachta indica* and *Manihot esculenta*, unlike the untreated plots and the plots treated with the aqueous extract based on *Cymbopogon nardus* which presented significantly the lowest seed yields, the lemongrass being more effective than the control. The cultivars Katché peha, Katché péha nan soorii and Katché sôwôho produced in this order, more seeds than the cultivars Toura pera and Kpodjiguèguè which showed the same performances, and finally Katché Senegal. These first three cultivars as the best and secondarily the following two, like the dozens identified by Baco et al. (2003), Bello (2005), Baco et al. (2008), Bello and Baco (2015), Bello et al. (2016), then Bello et al. (2017), can therefore be used in a varietal improvement program oriented towards the control of pod insects.

These results of efficacy of aqueous extracts confirm the observations of Hammond et al. (1995) who expressed the wish that "several farming methods used by farmers be improved for better integration into an ecologically sustainable protection system". They highlight the experiences of producers in the study area in varietal selection and biological control, although these deserve to be scientifically demonstrated. The test farmers are clearly correct in requesting research support for the implementation of this study. They complete and deepen the achievements of the PRONAF and Niébé projects in Benin, relating to the integrated management approach for cowpea pests in the context of Farm Field Schools (PRONAF, 2000; PRONAF SENEGAL, 2002). The approach proposed by PRONAF (2000) which consists in extracting and applying the solution of neem seeds at the frequency of four treatments at the rate of one treatment per week during the flowering-fruiting of cowpea, tomato, pepper and spinach against insects must be promoted for these crops as far as for cowpea. As cowpea agroecosystems are full of numerous parasitoids and predators (Bello et al., 2018), the use of botanical pesticides ensures the conservation of natural enemies through the management of crop habitats as specified by PRONAF (2000). These results of this study relating to methods of cowpea protection based on the least harmful pesticides possible for human health and the environment, are within the reach of small producers. They contribute to the integrated pest management system which integrates different compatible agronomic, ecological and biological control methods as confirmed by Sinzogan (2002), and which aims to reduce the negative impact of pests including aphids among others at an economic level which is not harmful to the crop.

Conclusion

The study made it possible to assess the phytosanitary behavior of cowpea cultivars cultivated in north-eastern Benin, faced with the pressure of aphids and the effectiveness of aqueous extracts from plants tested for the control of this type of pest.

The results obtained within the framework of this study complement on the one hand those of previous studies carried out within the framework of varietal diversity and cowpea management practices. They also complement the description of cowpea entomofauna. Finally, they lay the foundations for the biological protection of this crop in Benin in general and specially in North-West Benin. They give indications of avenues for the promotion of plant species with insect repellent and or insecticide effect available in cowpea agro-ecosystems for the purpose of agro-bio-ecological protection of cowpea, as alternative methods of controlling cowpea aphids and by assault against pests of this crop. The effectiveness of aqueous extracts can also be tested on thrips and bedbugs and the fate of seeds in storage.

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