EVALUATION OF THE EFFICACY OF PLANT EXTRACTS (Cassia nigricans, Azadiracta indica and Carapa procera) AGAINST INSECTS (Aphis craccivora and Maruca vitrata) OF COWPEA IN A CROPPING SYSTEM IN MALI

Issa TRAORE[1], Karim DAGNO[1], Assitan DAOU[1], Abdoulaye G DIALLO[1], Bouya TRAORE[1], Amadou H BABANA[2], Amadou K COULIBALY[3], Bakary SAGARA[3], Abou TOGOLA[4], Adama DIALLO[1], Bocar DIALLO[1], Fily DEMBELE[1] and Awa BAMBA[1]

[1]Sorghum Program, Regional Center for Agronomic Research of Sotuba (CRRA/IER)

[2]Research Laboratory in Microbiology and Microbial Biotechnology, Faculty of Sciences and Techniques, University of Sciences, Techniques and Technologies of Bamako

[3]Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA) of Katibougou

[4]International Institute for Tropical Agriculture (IITA)

https://doi.org/10.35410/IJAEB.2023.5856

ABSTRACT

Cowpea Vigna unguiculata L. Walpers (Fabaceae) is one of the main seed legumes produced and consumed in the world and particularly in West Africa precisely in Mali. In Mali, the cultivation of sorghum and cowpea in association occupies an important place in agriculture and contributes to achieving food and nutritional security in the country. Cowpea is an important source of vegetable protein. This crop is faced with many biotic (insects) and abiotic (drought) problems. The attack of pests (insects) can completely reduce the production of cowpea. Most farmers use chemicals to reduce these pests. While these chemicals (insecticides) have a negative impact on human health and that of the ecosystem. Aphids (Aphis craccivora) and Marucas (Maruca vitrata) can cause yield losses of up to 80%. Finding alternatives to synthetic pesticides is therefore a major challenge for the design of cropping systems. The study was carried out at the Sotuba agronomic research station for two years. Three varieties of cowpea (Sangaranka, djiguifa and Ghana Shoba) were planted in split plot in pure culture and in association with sorghum (Tiandougou coura). Three (3) products (Azadiracta indica and Cassia nigricans leaf, Carapa procera oil) and two controls (optimal K and without treatment) were used against Aphis craccivora and Maruca vitrata of cowpea. Observations focused on the number of Maruca vitrata and Aphis craccivora colonies before and after each treatment, the weight (pod, grain, haulm). The data was analyzed with GENSTAT Release 12.1 of the 12th edition of 2012. Zarama(Cassia nigricans) extract was the most effective among the others after the first treatment on Aphis and Maruca with a count average of 1.44 and 1.33 respectively of these two insects. The best grain yield was recorded in the same Sangaraka variety (1623 kg.ha-1) by treatment with Neem extract (Azadiracta indica), i.e. an increase of 8.1%.

Keywords: Cowpea, Efficacy, Extracts, Plants, Insects.

1. INTRODUCTION

Cowpea Vigna unguiculata L. Walpers (Fabaceae) is one of the main seed legumes produced and consumed in the world and particularly in West Africa, specifically in Mali (Théodore et al. 2022). Cowpea is native to West Africa and in Mali, it occupies a prominent place in human nutrition. It contributes to improving the nutritional quality of food for the urban and rural population. Its role is known in livestock farming, from where it makes it possible to create fodder reserves for livestock during critical periods of lean season or prolonged drought in the semi-arid areas of West Africa (AGUIDI, TAMÒ, and AGBAKA 2013). Due to its role as soil fertiliser, its involvement in fodder (FOFANA, and COULIBALY, 2016). Cowpea, considered as a dual-purpose plant (grain and fodder), has significant nutritional, economic and socio-cultural importance.

It is an essential and inexpensive source of protein compared to that of animals. These young leaves, green pods and seeds are used in the preparation of a variety of foods in both rural and urban settings (Johnson et al. 2009). Recognized as the meat of the poor because its protein content (22-25%) is 2-3 times higher than cereals (Johnson et al. 2009). Globally, out of more than twenty million tons of cowpea produced, concerning Africa and mainly West Africa provides 82.3% (FAOSTAT, 2009).

In Mali in 2020 over an area of 406,698 ha, cowpea production was 199,763 tonnes with 491.2 kg/ha. (FAOSTAT, 2022). This production is affected by many biotic (insects) and abiotic (drought) problems. The attack of pests (insects) can totally reduce the production of cowpea. Farmers use more chemicals. While the excessive use of chemicals has negative impacts on human health and the environment. The ancestral knowledge of controlling these pests in an ecological way can be exploited to minimize the use and impact of chemicals. The use of plant extracts can be a solution to reduce the use of these chemicals in order to sustainably preserve human and environmental health. The objective was to improve grain and haulm yields under the effectiveness of plant extracts on cowpea pests in two cropping systems.

2. MATERIAL AND METHODS

2.1. Study environment

The study was conducted for two years (2021 and 2022) at the Regional Center for Agronomic Research (CRRA) in Sotuba, which is one of the six Regional Research Centers of the Institute of Rural Economy (IER). The CRRA of Sotuba is located in Commune I of the District of Bamako, about 7 km from the city center of Bamako at a latitude 12° 39' north, longitude 07° 56' west at an altitude of 320 m. It covers an area of 270 ha. It is bordered to the west by the industrial zone, to the east by the village of Sotuba, to the south by the Niger River and to the north by the Bamako-Koulikoro road which separates it from Boulkassoumbougou.

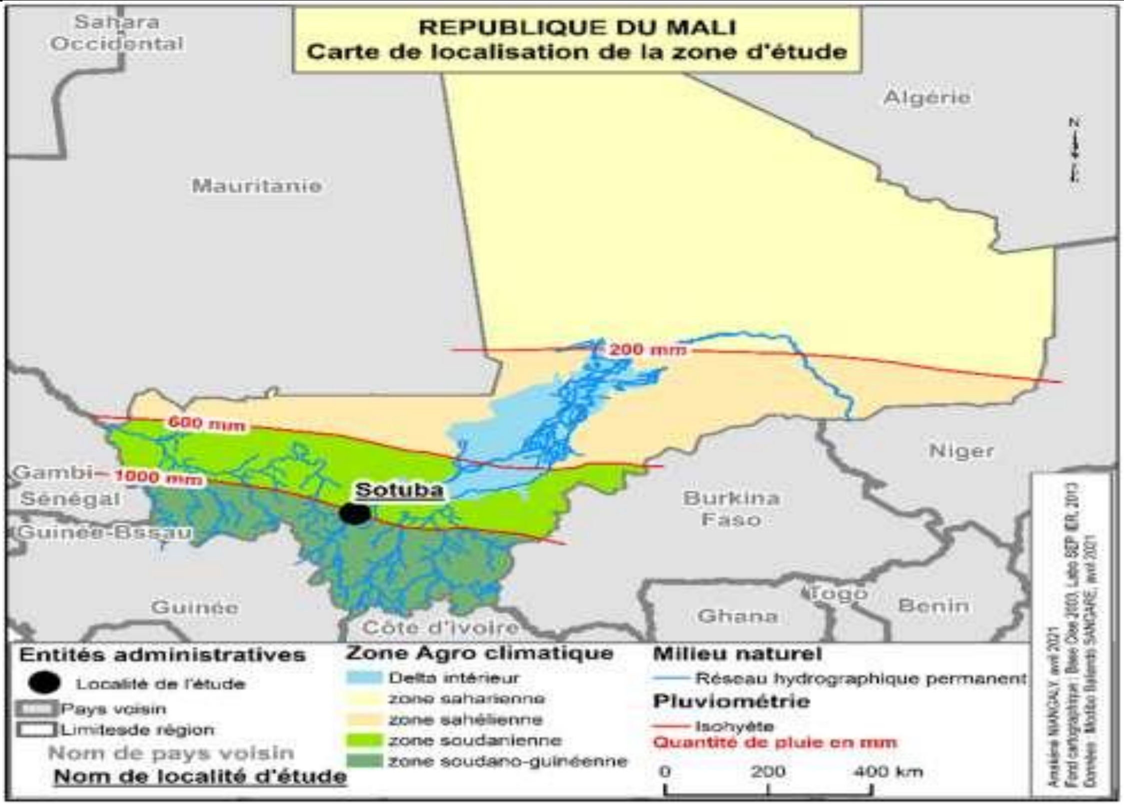

Figure 1: Map of Mali locating the CRRA site in Sotuba

2.2. plant material

Three dual-purpose cowpea varieties (Sankaraga, Djiguifa, Ghana shoba) were planted in association with the Tiandougoucoura sorghum variety. Extracts of three plants (Cassia nigricans, Carapa procera, Azadiracta indica) plus optimal K as a control were used to treat cowpeas.

2.3. Methods

The objective of this activity is to preserve the production potential of dual-purpose cowpea and sorghum in an association system. The trial was implemented in a split-split-plot in three repetitions with three factors. The main factor was the two-level cropping system (association with sorghum, pure cowpea), the second factor was the 3-level genotype (3 varieties of cowpea: Sangaraka, Djiguifa, Ghana shoba), and the third factor was is the 5-level treatment product (Cassia nigricans powder, Azadiracta indica leaves, Carapa procera oil, optimal K and without treatment).

Implementation of the tests:

The elementary plot was 5 m/ 8 lines corresponding to 30 m2. Sorghum is sown at spacings of 0.75 m x 0.50 m and cowpea 0.75 m x 1 m.

ISSN: 2456-8643

Organic manure (Profeba) was applied at a rate of 1 t ha-1 and 45 kg ha-1 at sowing and cereal complexes (17–17–17) two weeks after sowing.

• Cassia nigricans

Commonly called Zarama in the local Mianga language, the whole plant without its roots was harvested, ground, dried in the shade for a week. After drying, the ground material is crushed by a mill to make it into a powder. The preparation of the spray is made with a dose of 250g of powder per 10 L left in maceration for 24 hours before application.

• Azadiracta indica,

Five kg of fresh Neem leaves (Azadiracta indica) were chopped and soaked in 10L of water for 24 hours then filtered before application.

• Carapa procera

Called Cobi in the local Bambara language whose oil is extracted from its nuts. The traditionally refined oil was obtained from the local market. It is mixed with water (15mL/10L of water) to treat 400m2.

The optimal K control was used at a dose of 1 L.ha-1.

The different products were sprayed using the Technoma 15 device.

• Plant spraying operation:

The treatment threshold is the presence of at least one colony of 5 insects on 5 different plants on the diagonal of the plot. The spraying was done at a frequency of 15 days apart, due to 10 liters for 400m2.

• Comments

The ratings focused on the number of insects per elementary plot, insect damage to leaves, flowers and pods. The targeted insects were Aphiscraccivora, Marucavitrata.

3. RESULTS

Figure 1 shows the number of Aphis colonies was higher before the first treatment (44 DAS) in pure culture than in association, the maximum of which was recorded with Carapa procera (3.6) in the Djiguifa plot. This number of colonies fell before the second treatment (58 DAS) in pure culture than in association with all the plant extracts in the three varieties of cowpea (Sangaraka, Djiguifa, Ghana shoba).

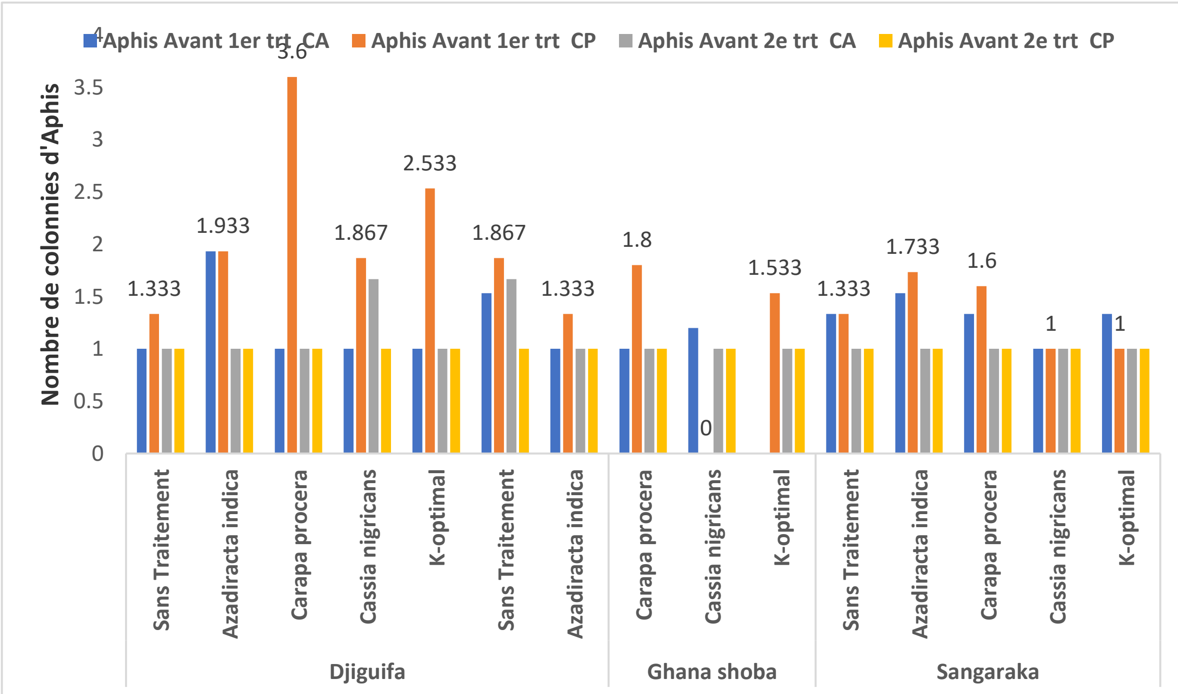

Figure 1: Number of colonies of Aphis craccivora in the first year (2021) before the first (44 DAS) and the second treatment (58 DAS)

NB: CA: culture in association. CP: pure cowpea crop.

The maximum number(4) of colonies of Aphis craccivora recorded after the first treatment (48 DAS) in the control plot without treatment in intercropping with the Ghana shoba variety against 3.67 in pure cowpea culture treated with C. procera in the Djiguifa variety. The presence of Aphids was almost zero after the second treatment (Figure 2).

Vol. 08, No. 04; 2023

ISSN: 2456-8643

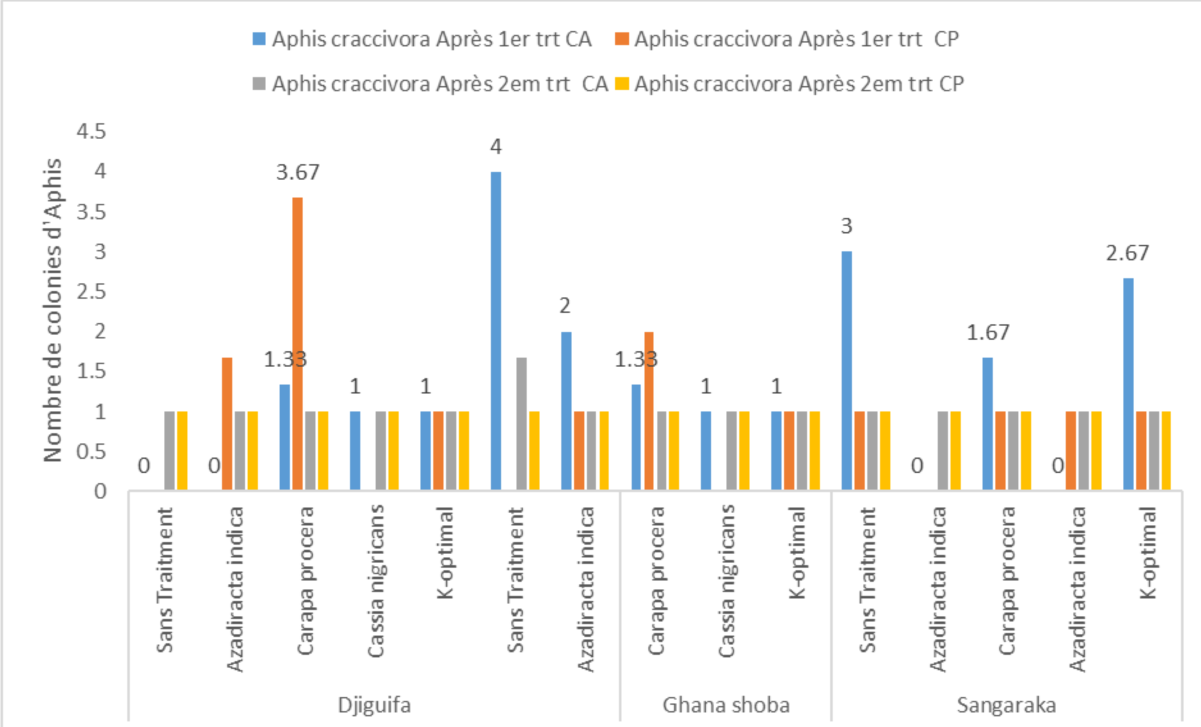

Figure 2: Number of colonies of Aphis craccivora in the first year (2021) after the first (48 DAS) and the second treatment (62 DAS).

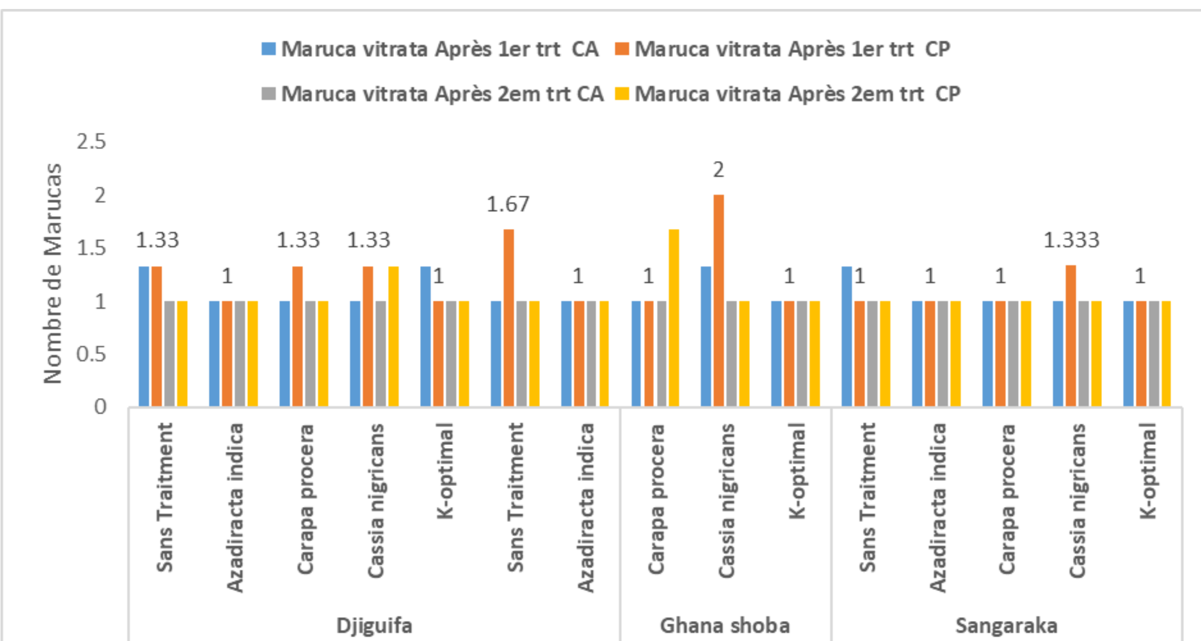

Figure 3: Number of Maruca vitrata in the first year (2021) after the first (48 DAS) and the second treatment (62 DAS)

Before the first treatment (44 DAS) and the second treatment (58 DAS), there was no significant difference for the parameters studied in relation to the number of Aphis; the Maruca was only seen before the second treatment. (Table 1)

Table 1: Averages and probabilities of parameters in 2021

Treatments	**Aphids**		**Maruca**
	Avt 1st stroke	Avt 2nd stroke	**Avt 2nd stroke**
Cultivation system	-	-	-
Associated culture	1,307	1,089	1
Culture pure	1,778	1	1,067
Probability	0.346	0,423	0,225
Genotype niébe	-	-	-
Djiguifa	1,72	1,067	1,033
Sangaraka	1,32	1	**1**
Ghana shoba	1,587	1,067	1,067
Probability	0,491	0,41	**0,624**
Pesticide treatment	-	-	-
Without treatment	1,4	1,111	**1**
A.indica	1,578	1	1
C.nigricans	1,378	1,111	1,056
Carapa procera	1,722	1	1,111
K-optimal	1,633	1	1
Probability	0,445	0,563	0,531
Interactions			
Sc x GNi	0,312	0,41	0,624
Sc x TraitP	0,073	0,563	0,531
GNi x TraitP	0,066	0,364	**0,38**
Sc x GNi x TraitP	0,106	0,364	0,38
Overall average	1.542	1.044	**1.033**
HERSELF	0,6512	0,2981	**0,2357**
CV %	42,2	28,5	22,8

NB: Before: before Line: treatment

After the first treatment (48 DAS), the difference was significant (P 0.03 and 0.02) between the treatment products on Aphis and Marucas. On the other hand, not significant between the culture systems and the interactions after the first and the second treatment (62 DAS) (Table No 2).

ISSN: 2456-8643

Cassia nigricans extract was the best among the others after the first treatment on Aphis and Maruca with an average of 1.44 and 1.33 respectively of the two insects.

Table 2: Effect of pesticide products on the presence of insects after treatments in 2021

Treatments	Aphis		Ling	
	Apr 1er trait	Apr 2e trait	Apr 1er trait	Apr 2e trait
Cultivation system	-	-	-	-
Associated culture	1.73	1.044	1.089	1
Culture pure	1.84	1	1.200	1.067
Probability	0.652	0.423	0.199	0.225
Genotype niébe	-	-	-	-
Djiguifa	1.80	1	1.167	1.033
Sangaraka	1.67	1	1.067	1
Ghana shoba	1.90	1.067	1.200	1.067
Probability	0.916	0.410	0.477	0.624
Pesticide treatment	-	-	-	-
Without treatment	2.78 b	1.111	1.278 bc	1
A.indica	1.61 a	1	1 a	1
C.nigricans	1.44 a	1	1.333 c	1.056
Carapa procera	1.83 a	1	1.056 from	1.111
K-optimal	1.28 a	1	1.056 from	1
Probability	**0.003**	1.417	**0.022**	0.531
Interactions				
PSc x GNi	0.300	0.410	0.477	0.624
Sc x TraitP	0.460	0.417	0.211	0.531
GNi x TraitP	0.206	0.448	0.433	0.380
Sc x GNi x TraitP	0.224	0.448	0.602	0.380
Overall average	1.79	1.022	1.144	1.033
HERSELF	1.165	0.2108	0.3575	0.2357
CV %	65,2	20,6	31,2	22.8

NB: Apr: after

With a significant difference ($P< 0.05$) between the treatments and an average of 5362 kg ha-1 for the fresh haulm yield, the A.indica extract recorded the highest yield (9574 kg ha-1) at Sangaraka in pure culture. On the other hand, in combination, the control without treatment at Djiguifa recorded the highest fresh haulm yield (3474 kg ha-1) compared to the other treatments (Table 3).

Table 3: Cowpea grain and haulm yield in 2021

Treatments			Cowpea yield kg/ha			
Cultivation system	**genotype**	**Pesticide treatment**	**Pod**	**Grain**	**Fresh fane**	**Fane sec**
Associated culture	Djiguifa	Without treatment	252	105	3474	1217
		C.nigricans	198	89	2452	778
		C. procera	517	253	3243	1044
		A.indica	311	182	2133	685
		K-Optimal	485	142	3080	1165
	Ghana shôba	Without treatment	404	298	1117	800
		C.nigricans	678	369	3104	1115
		C procera	809	550	3085	1019
		A.indica	846	423	1783	776
		K-Optimal	843	575	2115	878
	Sangaraka	Without treatment	298	142	2281	894
		C.nigricans	620	217	504	857
		C. procera	449	269	370	824
		A.indica	265	124	311	2028
		K-Optimal	476	334	1075	1176
Culture pure	Djiguifa	Without treatment	406	219	9789	2615
		C.nigricans	730	429	8222	2359
		C. procera	507	252	6213	2048
		A.indica	604	329	5187	1389
		K-Optimal	1322	708	6987	1959
	Ghana shôba	Without treatment	615	203	6798	1711
		C.nigricans	894	374	9130	1856
		C. procera	969	550	9157	2920
		A.indica	1104	596	9233	2948
		K-Optimal	1554	992	8259	2607
	Sangaraka	Without treatment	613	311	9231	3046
		C.nigricans	948	504	8313	2104
		C. procera	713	370	1054	2644
		A.indica	600	311	9574	2704
		K-Optimal	1656	1075	4728	1261
Overall average			686	371	5362	1649
Probability			**0.050**	**0.118**	**0.018**	**0.084**
CV%			32.7	41.1	33.3	38.8

Statistical analysis showed highly significant differences ($P<0.01$) in 2022 between treatments for pod and grain yield. It was significant for dry and fresh haulm yield (table 4). In association, the Sangaraka variety recorded the grain yield (1645 kg.ha-1) with the treatment of the K-optimal control followed by the treatment of the Cassia nigricans extract (987 kg.ha-1). On the other hand in culture pure the best grain yield was recorded in the same variety Sangaraka (1623

Vol. 08, No. 04; 2023

ISSN: 2456-8643

kg.ha-1) by treatment with the extract of Azadiracta indica, the general average of which for the two cropping systems was 593 kg.ha-1 (Table #4).

Table 4: Average cowpea grain and haulm yields with extract treatments in 2022

Cultivation system	Treatments genotype	Pesticide treatment	Cowpea yield kg/ha Pod	Grain	Fresh fane	Fane sec
Associated culture	Djiguifa	Without treatment	347	156	10876	3748
		C.nigricans	67	36	15980	4924
		C. procera	193	36	17159	5378
		A.indica	292	197	16475	6313
		K-Optimal	286	161	12547	4111
	Ghana shôba	Without treatment	268	154	6928	1793
		C.nigricans	314	258	5528	3152
		C. procera	663	470	12760	4658
		A.indica	481	239	16459	5537
		K-Optimal	411	249	11353	3848
	Sangaraka	Without treatment	1315	706	16503	5360
		C.nigricans	2100	987	32129	**9266**
		C. procera	818	434	25122	7489
		A.indica	1560	828	17303	5824
		K-Optimal	2572	1645	17186	6513
Culture pure	Djiguifa	Without treatment	533	209	14807	3831
		C.nigricans	435	348	11891	2344
		C. procera	405	265	17953	5455
		A.indica	651	404	19579	11053
		K-Optimal	1267	557	18567	4180
	Ghana shôba	Without treatment	1135	609	12569	4562
		C.nigricans	1410	770	34841	**22245**
		C. procera	1358	803	24319	6140
		A.indica	1541	737	20260	6519
		K-Optimal	2621	1512	12226	2663
	Sangaraka	Without treatment	1633	1064	40495	14676
		C.nigricans	1224	541	10442	3477
		C. procera	2155	1013	15544	5018
		A.indica	2693	**1623**	**20240**	6734
		K-Optimal	1342	774	10545	1881
	Overall average		1070	593	17286	5956
	Probability		**<.001**	**<.001**	**0.001**	**0.002**
	CV%		37.1	44.3	48.5	72.9

ISSN: 2456-8643

With a highly significant difference between the genotypes, Sangaraka recorded the best pod and grain yield with 1741 kg ha-1 and 961 kg ha-1 respectively (Table 5). Between the treatment products also including the Neem extract after the optimal K control recorded an average of 1203 kg ha-1 and 671 kg ha-1 for the pod and grain yield. The interaction of the three studied factors recorded a highly significant difference for pod and grain yield.

Table 5: Overall averages and probabilities of cropping system, genotypes, treatments and interactions in 2022

Treatments	***Cowpea yield kg/ha***			
	Pod	***Grain***	***Fresh fane***	***Fane sec***
Cultivation system	-	-	-	-
Associated culture	*779*	*437*	*15620*	*5194*
Culture pure	*1360*	*749*	*18952*	*6719*
Probability	*0.095*	*0.089*	*0.095*	*0.308*
Genotype niébe				
Djiguifa	*448 a*	*237 a*	*15583*	*5134*
Sangaraka	***1741 c***	***961 c***	*20551*	*6624*
Ghana shoba	*1020 b*	*580 b*	*15724*	*6112*
Probability	***<.001***	***0.001***	*0.525*	*0.693*
Pesticide treatment				
Without treatment	*872 a*	*483 a*	*17030*	*5661*
A.indica	***1203 bd***	***671 from***	*18386*	*6997*
C.nigricans	*925 from*	*490 a*	*18468*	*7568*
C. procera	*932 abc*	*503 a*	*18809*	*5690*
K-optimal	***1417 d***	***817 b***	*13737*	*3866*
Probability	***<.001***	***<.001***	*0.356*	*0.116*
Interactions		**Probabilities**		
Sc x GNi	*0.066*	*0.161*	*0.453*	*0.336*
Sc x TraitP	*0.120*	*0.298*	*0.275*	*0.199*
GNi x TraitP	*0.386*	*0.143*	*0.109*	***0.011***
Sc x GNi x Trait	***<.001***	***<.001***	***0.001***	***0.002***
Overall average	*1070*	*593*	*17286*	*5956*
CV %	*37.1*	*44.3*	*48.5*	*72.9*

4. DISCUSSION

Plant extracts revealed a different effect on cowpea arthropods in association with sorghum and in pure culture. (AKOUDJIN, DABIRE, and SOMDA 2023) demonstrated that the abundance of insects was higher in untreated control plots compared to plots treated with Neem extracts (A. indica).

ISSN: 2456-8643

Treatment with plant extracts can increase the yield of cowpea while reducing the number of insects depending on the year, which has been demonstrated by (Abdoulaye Zakari 2020) who confirms that the Neem extract at a dose of 5% had a increase of 985 Kg/ha.

Association cowpea/sorghum reduces the number of Aphis craccivora and Maruca vitrata compared to the pure culture of cowpea. This was justified by (Corre-Hellou et al. 2014) in a plot, the diversity of cultivated plants can significantly influence the abundance of phytophagous crop pests, compared to a single specific crop.

Dual-purpose cowpea and sorghum in combination improve soil fertility while increasing production as demonstrated by Obulbiga et al, 2015). The grain yield of dual-purpose cowpea varieties varied according to the varieties tested, which was confirmed by Saidou et al. 2018.

Treatment with plant extracts in the field can increase the yield of cowpea (985 Kg.ha-1) while reducing the number of insects depending on the year, which has been demonstrated by (Abdoulaye Zakari 2020) who confirms that the extract of Neem (A.indica) at 5% dose had a considerable increase in cowpea yield. This was confirmed by (Harouna et al. 2019) who found a yield increase ranging from 811 to 1233 kg.ha-1.

5. CONCLUSION

An improvement in grain and haulm yields was observed through the use of plant extracts, particularly Neem leaves (Azadiracta indica) during the two years of study.

The use of plant extracts on cowpea pests in both cropping systems was effective while reducing their number. The effects and abundance of insects can vary according to the years of culture of cowpea in association than in pure culture.

The number of insect populations is generally higher in pure cowpea culture than in combination, this demonstrates the positive effect of biopesticide products and the sorghum/cowpea cropping system on the insect populations observed. These numbers generally decrease as the treatment progresses with the products.

REFERENCE

Abdoulaye Zakari, O. 2020. “Contribution to the agroecological management of Maruca vitrata Fab. and other major insect pests of cowpea (Vigna unguiculata L. Walp.) crops in the Zinder and Maradi regions of Niger”.

AGUIDI, A Blèwussi, Manuele TAMÒ, and Alphonse AGBAKA. 2013. “Comparative study of the mass production of Clavigralla tomentosicollisbv Stål, a pest of cowpea and its parasitoid Gryon fulviventris Crawford on two legumes”. EPAC/UAC.

AKOUDJIN, Massouroudini, Kounbo DABIRE, and Martin Bienvenu SOMDA. 2023. “Effect of neem (azadirachta indica (a.) Juss.) extracts as biopesticides on insect pests of cowpea (Vigna unguiculata (L.) Walp.) in the Ampo/Tond-Tenga center, peri-urban area of Ouagadougou, Burkina Faso”. International Journal of Current Research 15 (01): 23365-71.

Constant, KONAN K, Ibrahim FOFANA, and Adama COULIBALY. 2016. “Optimization of storage methods of cowpea (Vigna Unguiculata L. Walp) bagged pics containing biopesticide (Lippia multiflora) By central composite experimental design in Cote D’ivoire”. International Journal of Environmental & Agriculture Research (IJOEAR) 2 (7): 46-56.

ISSN: 2456-8643

Corre-Hellou, Guenaelle, Alain Baranger, Laurent Bedoussac, Nathalie Cassagne, Mario Cannavacciuolo, J Joëlle, Elise Pelzer, and Guillaume Piva. 2014. "Interactions between biotic factors and the functioning of plant associations". Agronomic Innovations 40: 25-42.

FAOSTAT. 2022. "www.faostat.org".

Harouna, Maimouna Abdourahamane, Ibrahim Baoua, Sitou Lawali, Manuele Tamò, Laouali Amadou, Saadou Mahamane, and Barry Pittendrigh. 2019. "Comparative trial of the use of Neem extracts and the entomopathogenic virus MaviNPV in the management of insect pests of cowpea in rural areas in Niger". International Journal of Biological and Chemical Sciences 13 (2): 950-61.

Johnson, F, B Seri-Kouassi, Lr Aboua, and K Foua-Bi. 2009. "Use of powders and total extracts from local plants of the genera Ocimum sp. and Mentha sp. as biopesticides in the control of Callosobruchus maculatus FAB". African Agronomy 18 (3): 221-33. https://doi.org/10.4314/aga.v18i3.1694.

Obulbiga, MF, V Bougouma, and HO Sanon. 2015. "Improvement of the fodder supply by the dual-use cereal-legume crop association in the northern Sudanian zone of Burkina Faso". International Journal of Biological and Chemical Sciences 9(3): 1431-39.

Saidou, Abdoul-Aziz, Bil-Assanou Issoufou Hassane, Nouhou Salifou Jangorzo, Aminou Ali, Sanoussi Hassane, Saadou Souley, Mahamane Nourou, and Mahamane Saadou. 2018. "Multilocal participatory assessment of the grain-fodder trade-off of dual-purpose cowpea varieties in the Centre-South and West zones of Niger". In . INRA.

Théodore, Ouédraogo Y, Yamkoulga Marcelin, Waongo Antoine, Traoré Fousséni, and Sanon Antoine. 2022. "Perception of the impact of insect pests on cowpea production among producers in the communes of Korsimoro and Boussouma in the Centre-Nord region of Burkina Faso".