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Comparative Effect of Plant Extracts and Accession Differences on the Control of A Storage Insect Pest (*Callosobruchus maculatus*)

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ABSTRACT

Insect pests are the most important constraint limiting Bambara groundnut storage in Nigeria. Consequently, this study was conducted at the Laboratory of Pest Management Technology Department of Niger State College of Agriculture, Mokwa aimed at determining the comparative effect of organic plant extracts and accession differences on a storage insect pest of Bambara groundnut *(Vigna suberrancean* L Verdc) Mokwa is located on latitude 09° 18ᴵN and longitude 05° 04ᴵE in Southern guinea savanna agro-ecological zone of Nigeria. Med at The treatments were organic materials which consisted of garlic, white onion, violent tree root powder extracts and phostoxin as check while control had no antidote application. The trial was factorially combined in a 2×4 arrangement and fitted in to complete randomized design (CRD) with three replications. Data were collected on insect mortality rate, number of life insect pests, grain weight loss and insects damage score. The application of garlic, white onion, violent tree root powder extracts and phostoxin (check) recorded a significantly higher insect mortality rate at 14 and 28 days after storage of 3.67 and 3.00 compared to the control with no application that resulted in lowest mortality rate of 1.33. The result indicated that varieties of bambara groundnut did not differ significantly on number of life insects throughout the period of the study. The application of garlic, white onion and violent tree root powders' extract are effective for the control of *Callosobruchus maculatus*. They are suggested for optimum quality protection of bambara groundnut and as alternatives to synthetic pesticides in southern guinea savanna zone of Nigeria.

Keywords: Bambara groundnut, Organic plant extracts, Quality protection, Insect damage score, Insect mortality, Nigeria.

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1. INTRODUCTION

Bambara groundnut (*Vigna subteranea* L. Verdc.) is a plant of the family Fabaceae. It is recognised for its high nutritional value, its tolerance to poor soils, drought, salt stress and its ability to produce in conditions where peanuts completely fail (Taffouo 2010 and Tsoata et al. 2017) However, it remains unfortunately, less cultivated and poorly known in tropical Africa. Bambara groundnut is native to northeastern Nigeria and northern Cameroon (Tegemne et al. 2018).

Its seeds are used as feed for pigs and poultry and their leafy stalks are also used as livestock feed (Brink. 2006). The seeds contain on average 63% carbohydrates, 19% proteins and 6.5% fats and these values are considered sufficient to make this legume a complete food (Bamishaiye, 2011). It is also rich in calcium, potassium, iron and nitrogen (Tan et al. 2020) The highly nutritious content of Bambara groundnut and its high content of essential amino acids namely methionine, Leucine, isoleucine, lysine, phenylalanine, threonine, valine and tryptophan make it an important crop to consider for food security (Yao et al. 2015 and Tan et al. 2020).

Bambara groundnut also contains vitamin E (3.18+).15mg/100g), vitamin C (1.17+0.20 mg/100g) and vitamin A (26.05+0.14 mg/100 g). It is a medicinal plant used to treat diarrhoea, anemia, abscesses, internal injuries, ulcers, infected wounds, epilepsy, cataracts, menorrhagia during pregnancy, nausea in pregnant women, kwashiorkor and venereal diseases. It also helps to prevent heart disease, eye disease and colon cancer (Jdeani and Diedericks, 2014 and Brink, 2006). It contains kaempferol, an antioxidant polyphenol, which reduces the risk of many chronic diseases such as cancer (Jideani and Diedericks, 2014; Yao, 2015).

The known distribution of Bambara groundnut extends from west to southern Africa via Central Africa. Investigations into origin of Bambara groundnut all concluded that the crop originated from the African continent (Temegne et al. 2018). The distribution of wild Bambara groundnut is now known to extend from the Jos and Yola Peateau in Nigeria, to Garoua in Cameroon, and probably beyond (Touré et al. 2013).

Touré et al. (2013) reported that Bambara groundnut is the third most widely grown legume in the plains of tropical Africa after groundnut and cowpea. The authors said that the legume is used in crop rotation to improve soil properties through its ability to fix atmospheric nitrogen and provide it to the soil. According to Anchirinah (2001) and Azam-Ali et al.(2001) the crop is mainly grown by farmers because it has several organic benefits including high nutritional value, drought tolerance and ability to thrive in poor soils compared to other preferred species such as common bean, peanut and groundnut.

The seeds and leaves of Bambara groundnut are used in traditional medicine. In Senegal, Leaf preparations are reported to be used in treating abscesses and infected wounds (Brink et al. 2006). The workers also reported that the juice extracted from the leaves is applied to the eyes to treat epilepsy and the roots are sometimes used as an aphrodisiac.

The increasingly serious problem of resistance and residue to pesticides and contamination of the biosphere associated with large-scale use of broad-spectrum synthetic pesticides have led to the need for effective bio-degradable pesticides with greater selectivity. This awareness has created a worldwide interest in the development of alternative strategies including the discovery of newer insecticides (Yallapa et al. 2012).

The present study was, therefore, aimed at determining the effect of organic plant extracts on the control of *C. maculatus* on Bambara groundnut accessions and to assess the reactions of different bambara groundnut accessions to the pest as well as the interactive effects between the organic plant extracts and the accessions. The result of the present work will enable Bambara groundnut growers especially those within the study area to indentify the most effective botanical (s) for use as safe and effective control options against *C. maculatus* in place of synthetic pesticides for increased Bambara groundnut production.

MATERIALS AND METHODS

The experiment was carried out in the Pest Management Technology Laboratory at College of Agriculture Mokwa, Niger State. Mokwa is located on latitude 09^{o} 18^{1}N and Longitude 05^{o} 04^{1}E southern guinea savanna agro ecological zone of Nigeria.

Materials used

The research materials used during the work include:

Bambara groundnut gain, Garlic, White onion, Violent tree root, Phostoxin tablet, Plastic containers, Rubber band, Sieve, Pestle and mortar, Digital weighing balance, petri dish, Knife, Moslem Cloth, and live insects (*C. maculatus*).

Samples and preparation

The garlic and white onion was bought at Mokwa market and violet tree roots were collected from a violet tree in the bush along Ja'agi Eppa road at distance of 10km and all were cut in to small pieces separately and were air dried separately for three weeks. Mortar and pestle were use to pound the garlic, white onion and violet tree root separately and were sieved and stored for use as well as phostoxin tablet as check.

Treatments and Experimental Design

The trial was laid out in a 2x5 factorially combined arrangement and fitted into a complete ramdomized design (CRD) with three replications. The main treatments were organic plant extracts which included, garlic powder (GP) White onion powder (WOP) violet tree root powder (VTRP) 40g of phostoxin tablet (PT), and the control (C) without any application. The sub-treatment was two accessions of Bambara groundnut consisting of A1 = Black Accession, A2 = Cream Accession. The 400g of Bambara groundnut were weighed into plastic containers and covered with Muslim cloth tied with rubber bands. Ten (10) live adult weevils were introduced into plastic containers to ascertain the antidote effectiveness.

Parameters Measured

- Insect mortality rate in days at 14, 28 and 42 days after storage (DAS)
- Number of life insect at 14, 28 and 42 days after storage (DAS)
- Grain weight loss at 30, 60 and 90 days after storage (DAS)
- Percentage weight loss at 30, 60 and 90 (DAS)

Insect damage score

The insect damage score was observed at 60 and 90 DAS using a scale of 1-5 by visual estimation as described by Ayala *et al*. (2013).. Where, 1 = No damage, 2 =1- 25% damage, 3 = 26-50% damage, 4 =51-75% damage and 5 = 75% and above damage.

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using the statistical package GENSTAT release 12.1 (McDonald, 2014) means were partitioned where significant differences exist between the means at (P≤0.05).

RESULTS

Effect of Organic Plant Extracts and Accessions of Bambara Groundnut on Number of Life Insects at 14, 28, 42 Days after Storage (DAS)

Throughout the period of the study, insect mortality rates did not differ significantly among the different accessions of Bambara groundnut. However, the organic plant extracts consistently recorded a significant effect on insect mortality rate throughout the period of the study except at 42 DAS. The treatment applied with garlic, white onion, violent tree root powder and phostoxin (check) recorded significantly higher insects mortality rate at 14, 28, DAS of 3.67, and 3.00, compared to the control with no application which resulted in the lowest insects mortality rate of 1.33 (Table 1).

Effect of Organic Plant Materials and Accessions of Bambara Groundnut on Number of Life Insects at 14, 28, 42 (DAS)

Results presented in Table 2 show that there were no significant differences in the number of life insects among the Bambara groundnut accessions.

However, the organic plant extracts consistently recorded significant differences in the number of life insects found among the test Bambara groundnut accessions. The test accessions treated with garlic, violet tree powder extracts and phostoxin (check), recorded significantly lower numbers of life insects at 14, 28, and 42 DAS of 3.71, 2.57, 2.50 respectively compared to the control which recorded the highest number of life insects of 27.50 (Table 2).

Table 1: Effect of organic plant extracts and accessions of Bambara groundnut on Insects mortality rate at 14, 28 and 42 days after storage (DAS)

Treatments	Insect mortality rate		
Accessions of Bambara groundnut (A)	Days after storage (DAS)		
	14	28	42
Creamy accession	2.47	2.20	1.67
Black accession	2.27	2.40	1.73
S E ± (0.05)	NS	NS	NS
Organic plant extracts (0)			
Grarlic powder	3.67a	3.00a	2.17
White onion powder	3.00ab	2.00ab	1.67
Violent tree root powder	1.50c	2.50ab	1.50
Phostoxin (Check)	2.33bc	2.50ab	1.83
Control (No application)	1.33c	1.50b	1.33
S E ± (0.05)	0.51*	0.49**	NS
Interaction (AxO)	NS	NS	NS

Interaction (AxO) = Organic plant extracts (0) x Accessions of Bambara groundnut (A), NS = No Significant difference, S. E. ± = Standard error of difference of means, * = Significant difference, and ** = Highly significant and Means with same letter(s) within the columns are not significantly different at (P ≤ 0.05).

Table 2: Effect of Organic Plant Extracts and Accessions of Bambara groundnut on the Number of life Insects at 14, 28 and 42 days after storage (DAS)

Treatments	Number of Insects Alive at		
Accessions of Bambara groundnut (A)	Days after Storage (DAS)		
	14	28	42
Creamy accession	6.000	7.33	7.47
Black accession	6.067	7.40	7.47
S E ± (0.05)	NS	NS	NS
Organic plant extracts (0)			
Grarlic powder	5.500b	4.33b	3.17b
White onion powder	5.667b	4.50b	2.67b
Violent tree root powder	5.000b	3.83b	2.50b
Phostoxin (Check)	5.500b	2.17b	1.50b
Control (No application)	8.500a	22.00a	27.50a
S E ± (0.05)	0.31**	2.10**	1.94**
Interaction (A x O)	NS	NS	NS

Interaction (AxO) = Organic plant materials (0) x Accessions of Bambara groundnut (A), NS = No Significant difference, S. E. ± = Standard error of difference of means, * = Significant difference, ** = Highly significant and Means with same letter (s) within the columns are not significantly different at (P ≤ 0.05).

Effect of Organic Plant Extracts and Accessions of Bambara groundnut on Weight Loss at 30, 60, 90, days after storage (DAS)

Results presented in Table 3 show that there were no significant differences in weight loss among the varieties of Bambara groundnut throughout the period of the study.

The organic plant extracts consistently recorded significant differences in weight loss of the test accessions treated with garlic, white onion violent tree root powder extracts and phostoxin (check) recorded significantly lower weight loss at 30, 60 and 90 DAS of 227.8, 218.3, 209.7 respectively compared

to the control with no application that recorded higher weight loss of 138.7 (Table 3).

Effect of Organic Plant Extracts and Accessions of Bambara groundnut on Percentage Weight Loss at 30, 60, 90, days after storage (DAS)

Results presented in Table 4 show that the Bambara ground accessions did not differ significantly between themselves in percentage weight loss. However, the organic plant extracts consistently had a significant effect on the percentage weight loss of Bambara groundnut varieties throughout the period of study. The test Bambara groundnut varieties treated with garlic, white onion, violent tree root powder extracts and phostoxin (check) recorded significantly lower percentage weight loss at 30, 60, 90 DAS respectively of 9.13, 12.67, 6.13 compared to the control which recorded the highest percentage weight loss of 44.53 (Table 4).

Table 3: Effect of Organic Plants Extracts and Accessions of Bambara groundnut on Weight Loss at 30, 60 and 90 days after storage (DAS)

Treatments	**Weight Loss at**		
Accessions of Bambara groundnut (A)	Days after Storage (DAS)		
	30	60	90
Creamy accession	236.87	224.07	204.1
Black accession	236.67	224.60	211.2
S E ± (0.05)	NS	NS	NS
Organic plant extracts (0)			
Grarlic Powder	245.83a	236.50b	227.8b
White onion powder	238.67b	230.33c	218.3bc
Violent tree root powder	230.00c	223.00d	209.7c
Phostoxin (Check)	249.67a	247.50a	243.8a
Control (No application)	219.67d	184.33e	138.7d
S E ± (0.05)	1.88**	143.49**	6.22**
Interaction (AxO)	NS	NS	8.79*

Interaction (AxO) = Organic plant materials (0) x Accessions of Bambara groundnut (A), NS = No Significant difference, S. E. ± = Standard error of the difference of means, * = Significant difference, ** = Highly significant and Means with the same letter(s) within the columns are not significantly different at (P ≤ 0.05).

Interaction Effects between Organic Plant Extracts and Accessions of Bambara groundnut on Percentage Weight Loss at 90 (DAS)

The interaction effect of organic plant extracts and accessions of Bambara groundnut was significant at 90 (DAS). The two accessions recorded similar lower percentage weight loss under garlic, white onion, violent tree root powder extracts and phostoxin (check) while they recorded higher % weight loss with the control with no treatment (Table 5).

Effect of Organic Plant Extracts and Accessions of Bambara Groundnut on Insects Damage Score at 28 and 42 days after storage (DAS) Using Scale 1-5

Results presented in Table 6 show that the Bambara groundnut accessions under evaluation did not differ significantly among themselves on insect damage score.

However, the organic plant extracts recorded significantly different effect on insect damage score throughout the period of the study. The treatments applied with garlic, white onion, violent tree root powder extracts and phostoxin (check) recorded significantly lower insect damage score at 28 and 42 DAS of 2.56, 2.00, 2.56 respectively compared to the control treatment which recorded the highest insect damage score of 4.23 (Table 6).

Table 4: Effect of Organic Plant Extracts and Accessions of Bambara Groundnut on Percentage (%) Weight Loss of Bambara Groundnut at 30, 60, and 90 days after storage (DAS)

Treatments	**Percentage (%) Weight Loss at**		
Accessions of Bambara groundnut (V)	Days after Storage (DAS)		
	30	60	90
Creamy accession	5.72	10.37	18.91
Black accession	5.47	9.68	16.29
S E ± (0.05)	NS	NS	NS
Organic plant extracts (0)			
Grarlic powder	1.67d	5.80c	9.13cd
White onion powder	4.53c	7.73bc	12.67bc
Violent tree root powder	8.00b	9.30b	16.13b
Phostoxin (Check)	1.63d	1.00d	5.53d
Control (No application)	12.13a	26.30a	44.53a
S E ± (0.05)	0.92**	1.20**	NS
Interaction (AxO)	NS	NS	*

Interaction (AxO) = Organic plant extracts (0) x Accessions of Bambara groundnut (A), NS = Not Significant, S. E. ± = Standard error of difference of means, * = Significant difference, ** = Highly significant and Means with same letter(s) within the columns are not significantly different at (P ≤ 0.05).

Table 5: Interaction Effect between Organic Plant Extracts and Accessions of Bambara groundnut on Percentage Weight Loss of Bambara groundnut at 90 days after storage (DAS)

Organic extracts (O)	**V1**		**V2**
Garlic powder	8.53de		9.73e
White onion powder	13.07d		12.27d
Violent tree root powder	16.00c		16.27c
Phostoxin (Check)	5.74f		5.60f
Control (No application)	51.47a		37.60b
S E ± (0.05)	3.93		

Interaction (AxO) = Organic plant extracts (0) x Accessions of Bambara groundnut (A), NS = No Significant difference, S. E. ± = Standard error of difference of means, * = Significant difference and Means with same letter(s) within the columns are not significantly different at (P ≤ 0.05) and V1 = Cream Accession and V2 = Black Accession.

Table 6: Effect of Organic Plant Extracts and Accessions of Bambara Groundnut on Insects Damage Score at 28 and 42 days after storage (DAS) Using a Scale 1-5

Treatments	**Insect Damage Score at**	
Accessions of Bambara groundnut (V)	Days after Storage (DAS)	
	28	42
Creamy accession	2.58	2.64
Black accession	2.69	2.62
S E ± (0.05)	NS	NS
Organic plant extracts (0)		
Grarlic powder	2.56	2.56
White onion powder	2.61	2.00
Violent tree root powder	2.67	2.56
Phostoxin (Check)	2.67	2.56
Control (No application)	3.67	4.23
S E ± (0.05)	0.99**	1.22**
Interaction (AxO)	NS	NS Interaction

(VxO) = Organic plant materials (0) x Varieties of Bambara groundnut (V), NS = Not Significant, S.E. ± = Standard error of difference of means, * = Significant difference, ** = Highly significant and Means with same letter(s) within the columns are not significantly different at (P ≤ 0.05).

DISCUSSION

In the present report, the two different accessions of Bambara groundnut studied did not differ significantly in insect's mortality of *C. maculatus* rate throughout the periods they were stored until towards the end of the study. Furthermore, the organic plant extracts were found to be consistently and significantly effective in the control of *C. maculatus*.

The treatments with garlic, white onion and violent tree roots powder extracts were comparable to phostoxin used as check in the study. The differences in the performances of the organic plant extracts could be due to their possessing organic repellants and the toxic effects of their antidotes that prevented or reduced the activities of *C. maculatus* in causing damage to the two test bambara groundnut accessions. This is in agreement with the report by Tripathi et al.(2014) who pointed out that some organic plant extracts are effective and perform better in the management of storage insect pests of Bambara groundnut as well as being safer for consumption after using them as organic storage materials in controlling weevils especially *C. maculatus*.

This study further shows that entries not treated with either the organic plant extracts or phostoxin recorded colossal damage or losses. This agrees with the report of Colazza et al. (2017) who stated that the quality of Bambara groundnut reduces or deteriorates if storage insects are not controlled thereby causing total loss of the infested grains. The implication of the present study is that Bambara groundnut can be stored with any of the test plant extracts investigated.

CONCLUSIONS

1. Throughout the study period the creamy and black varieties tested consistently did not differ significantly in insect's mortality rate between themselves.
2. The organic plant extracts recorded significantly higher insect pest control of the stored bambara groundnut compared to the control without any application.
3. For effective insect pest control and maintenance of Bambara groundnut quality in storage it should be treated with garlic, white onion and violent tree root powder extracts.
4. Checked insect pests' infestation resulted in higher number of live insect of 27.5 at 42 DAS compared to treated samples which recorded lower number of live insects of 3.17, 2.67, 2.50 and 1.50 at 42 DAS.

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