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Comparative Analysis of Different Leave Powders on Root Knot Nematode *Meloidogyne incognita* Affecting Bambara Groundnut in Adamawa State

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Abstract
Field experiment was conducted in 2024 rainy season to compare the effect of different plant leaves powders on root knot nematode (*Meloidogyne incognita*) affecting Bambara groundnut (*Vigna subterranea*) in Adamawa State. Completely randomized and split-plot in randomized complete block design were used. Soil solarization was used to sterilize soil and four varieties of Bambara groundnut were used and sown two per hole at 2 cm depth of soil and thinned to one at 14 days after planting. Nematode obtained was extracted and inoculated around plant roots. Data collected on growth and yield characters were subjected to Analysis of Variance to compare differences between variables. Means were separated for significance at 95% (p=0.05) Least Significant Differences. Plants treated with leaf powders gave best measuring 300g leaf powder by increasing growth and yield compared to the untreated. Among leaf powder, *V. amygdalina* gave the best result by inhibiting nematode population in soil, roots and reducing galls formed. Among the plant cultivars, Zebra gave high yield compared to others. Among concentrations, 300g leaf powder proves more effective in reducing nematode population in the soil, roots and number of galls. The use of plant leaf powders proved effective and should be encouraged as effective nematicides against nematode.

Keywords: Galls, *incognita*, Root-knot, Varieties, Inhibition, Susceptible

Introduction

In the recent past, the application of nematicides proved to be very effective, though not attractive to farming communities due to their high costs and hazardous effects. Consequently, many nematicides have been withdrawn from the market (Jones *et al*., 2013; Mukhtar *et al*., 2013c). The presence of such pathogens as *M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla* on produce have led to the rejection of the produce at the international market (Rahma, 2003; Power *et al*., 2005 and Waiganjo *et. al.*, 2006). This has now propelled *Meloidogyne* spp. to the forefront as an important pathogen of many crops (Powers *et al*., 2005 and Jones *et al*., 2013). Bambara groundnut represents common food staple in semi-arid area of Africa and remains one of the crops less investigated but one with a great nutritional potential (Bamshaiye *et al*., 2011). Unfortunately, Bambara groundnut became less important in many parts of Africa because of the expansion of other crop productions. In the recent years, however, there has been renewed interest in the crop for cultivation, most especially in the arid savannah zones. It is the second most important food legume and the third food crop, after maize and groundnut, grown by the small-scale farmers in many African countries (Berchie *et al*., 2012 and Mabhaudhi *et al*., 2013). In Africa, there has been a great challenge on how to control nematode diseases affecting different agricultural crops particularly in Nigeria. This has been a major stumbling block to most local farmers who are largely poor and cannot afford the necessary chemicals to help control nematode from affecting our crops (Siddiqui and Shaukat, 2003; Walker, 2004).

Nematode control using different plant leaves prove to be one of the best option for Nigerian farming due to its easy accessibility by poor

farmers, cost effectiveness, abundance and availability of the required items and more importantly, the safety and method of application (Litchfield, 2005; Matthews, 2008; Oka *et al*., 2012; FAO, 2014; Singh and Kumar, 2015). Thus, Plant leave extracts are potential alternatives to the harmful chemical control against plant-parasitic nematode and have been found to reduce plant feeding nematodes and increase plant yields (Rahman 2003; Edward, 2009; Oka, 2010; Hassan *et al*., 2010).

Materials and Methods

Research areas

A field experiment was carried out during 2024 rainy season in different locations of Mubi-North, Girei and Ganye Local Government Areas of Adamawa State. The experimental fields were cleared manually using machete and spade. The method of Wilen, (2018) and Stapleton (2018) was adopted for soil solarization. Split- Split-Plot (SSP) was laid out and arranged with three treatments and replicated four (4) times. Plant seed of Nav red, Zebra, Tan 1 and Black seed were used, plant extracts of *Cassia fistula* L. (golden shower), *Calotropis procera* (Sodom apple) and *Vernonia amygdalina* (Bitter leaf) were collected and dried naturally under the shade and grinded separately using electric flour mill grinding machine suggested by Bamsida *et al*. (2016). Analysis of plant materials was carried out in the laboratory to determine the phytochemicals present in the plant extracts as reported by Auwal *et al*., (2014); Kamala *et al*., (2014); Madhu *et al*., (2016); Prabhavathi *et al*., (2016) and Rao *et al*., (2016). The leaf powders were applied in two (2) different periods, the first application of leaf powders was (150 g) which was done (one) 1 week before planting (pre-sowing) to inhibit pathogens present in the soil. Second application was same (150 g) at 14 days after sowing of seeds (post-sowing) giving the total concentrations of 300 g of leaf powders by modifying the method of Chimbekujwo and Bukar (2013).

Sample Collection and extractions

Soil samples were randomly collected and tested for pH with digital soil pH meter at 1:1 soil to water ratio using the method of Udo *et al.* (2009). Pathogen was obtained from Nduhyelya garden from a*n* infected pawpaw plants at a depth of 15 – 20 cm using shovel in a zig-zag form and was extracted in the laboratory by adopting the method of Bamsida *et al*., (2020). The plant was inoculated with nematode sample three weeks after sowing for it to be active. The treatment was replicated after 2 weeks of inoculation in each study site adopting the method of Martinez-Medina *et al.* (2017).

Data collected and analysis

Data on growth parameter were collected weekly for stem girth, height, length and width of leaves, number of flowers and branches produced using measuring tape. Data collected on yield parameters were dry pod weight, number of pods, dry seed weight, and seed yield using electronic balance. Nematode population in the soil, roots and galls formed were observed by adopting the method of Chimbekujwo and Bukar (2013). Data obtained were subjected to analysis of variance (ANOVA) to compare the relationship between variables using Statistical Analysis Software (SAS) version 9.0. Differences between treatment means was separated for significance at 95% (p= 0.05) Least Significant Differences (LSD) adopting the method of Bamsida *et al*., (2020).

Results and Discussion

The results of the tested plant leaves extracts showed the presence of some phytochemical present. In addition to these phytochemicals, *C. fistula* leaf powder showed the presence of saponin, tannin, flavonoid, alkaloid and phenol, *C. procera* showed the presence of saponin, tannin, flavonoid, alkaloid, cardiac glycoside, steroid and phenol, and *V. amygdalina*, showed presence of saponin, tannin, terpene, flavonoid, alkaloid, cardiac glycoside, steroid and phenol respectively as showed in Table 1.

The quantitative analysis of plant leaves powders used showed different level of phytochemicals present. The leaf powder of *C. fistula* was tested and found to contain 5.82% of saponin, 8.16% of tannin, 11.35% of flavonoid, 1.97% of alkaloid and 10.61% of phenol per gram of leaf powder. In the leaf powder of *C. procera*, when tested found to contain 7.19% of saponin, 4.72% of tannin, 8.60%

of flavonoid, 2.46% of alkaloid, 0.51% of glycoside, 1.60% steroid and 8.99% of phenol per gram of leaf powder. In the test for *V. amygdalina* leaf powder, when tested found to contain 12.47% of saponin, 3.55% of tannin, 1.02% of terpene, 17.63% of flavonoid, 5.70% of alkaloid, 1.39% of steroid and 6.73% of phenol per gram of leaf powder as shown in Table 2. This is in accordance with the work of Saravanapriya and Sivakumar (2005) Khan *et al*. (2017) and Akinsanya *et al.* (2020) who compared the nematicidal tendency of different leaves extracts used to inhibit the growth of nematodes which was found to effective in reducing the population of nematode and improve yield in tomato.

Comparative Analysis on the Effect of Leaf Powder on Growth Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

The result of field experiment carried out on growth and reproductive characters of bambara groundnut showed that there is significant difference P≤ 0.05 among the treatments and between the treated and untreated cultivars as showed in Table 3. In stem girth, Zebra seed bambara groundnut had significant increase in stem girth with 1.875 cm, followed by Black (1.612 cm), while Nav-red had lowest (1.325 cm). Between the treated and untreated plants in the stem girth, the treated plants had significant increase in stem girth with 1.612 cm, while the untreated plants significantly reduced plant girth with 1.001 cm. Among plants treated with plant extracts, *C. fistula* had increase in stem girth with 1.637 cm, followed by *V. amygdalina* with 1.600 cm and *C. procera* had lowest with 1.587 cm. Between concentrations and untreated, leaves powder at 300 g effectively increased plant stem girth with 1.410 cm, while untreated recorded lowest with 1.365 cm. In length of leaves, Black seed of bambara groundnut seed had higher length of leaves with 4.825 cm, followed by Zebra (4.700 cm), while Tan 1 had lowest (3.775 cm). Between the treated and untreated plants in the length of leaves, the treated plants had significant increase in the length of leaves with 4.825 cm, while the untreated plants significantly a reduced length of leaves with 4.825 cm. Among extracts, there was no significant difference observed. Between concentration and untreated, the treated at 300g effectively increased the length of leaves with 3.980 cm as compared to the untreated plants with 3.121 cm.

In the number of branches produced, Black seed bambara groundnut had significant increase in the number of branches produced of 42.00, followed by Nav-red (27.75), while Zebra had lowest (34.75). Between the treated and untreated plants in the number of branches produced, the treated plants had significant increase in the number of branches produced with 42.00, while the untreated plants significantly a reduced number of branches produced with 22.31. Among plants treated with plant extracts, it was observed that there was no significant difference among extracts in the number of branches produced.

Table 1: Comparative Analysis on the Qualitative Phytochemistry of Leave Extracts of *C. fistula*, *C. procera and V. amygdalina*

		Chemical Component							
S/N	Plant Extracts	Sap.	Tan.	Terp.	Flav.	Alk.	Glyco.	Ster.	Phen.
1.	*C. fistula*	+	+	-	+	+	-	-	+
2.	*C. procera*	+	+	-	+	+	+	+	+
3.	*V. amygdalina*	+	+	+	+	+	-	+	+

Keys

Plant Extracts
1. *Cassia fistula* (*C. fistula*)
2. *Calotropis procera* (*C. procera*)
3. *Vernonia amygdalina* (*V. amygdalina*)

Chemical Compounds
Saponin (Sap.) Alkaloid (Alk.)
Tanin (Tan.) Glycoside (Glyco.)
Terpenoid (Terp.) Steroid (Ster.)
Flavonoid (Flav.) Phenol (Phen)

Table 2: Comparative Analysis on the Quantitative Phytochemistry of Leave Extracts of *C. fistula, C. procera and V. amygdalina*

		Chemical Component (%)							
S/N	Plant Extracts	Sap.	Tan.	Terp.	Flav.	Alk.	Glyco.	Ster.	Phen.
1.	*C. fistula*	5.82	8.16	-	11.35	1.97	-	-	10.61
2.	*C. procera*	7.19	4.72	-	8.60	2.46	0.51	1.60	8.99
3.	*V. amygdalina*	12.47	3.55	1.02	17.63	5.70	-	1.39	6.73

Keys

Plant Extracts
1. *Cassia fistula* (*C. fistula*)
2. *Calotropis procera* (*C. procera*)
3. *Vernonia amygdalina* (*V. amygdalina*)

Chemical Compounds
Saponin (Sap.) Alkaloid (Alk.)
Tanin (Tan.) Glycoside (Glyco.)
Terpenoid (Terp.) Steroid (Ster.)
Flavonoid (Flav.) Phenol (Phen.)

Between concentration and untreated, 300 g leaves powder was more effective in the number of branches produced with 38.243 while untreated recorded lower with 30.140. In the number of flowers produced, Tan 1 seed cultivar of bambara groundnut significantly increased in reproduction of flowers produced with 2.562, followed by Black (2.375), while Nav-red had lowest (1.250). Between the treated and untreated plants in the number of flowers produced, the treated plants had significant increase in the number of flowers reproduced with 2.562, while the untreated plants significantly reduced number of flowers reproduced with 2.056. It was observed that untreated had higher number of flowers produced than the treated Nav-red. Among plants treated with plant extracts, *C. procera* leaves powder significantly increased reproductive character of flowers 2.375, while *C. fistula* and *V. amygdalina* had lowest with 2.250. Between concentration and untreated, 300 g had significant increase in flowers produced with 2.532 while untreated had lowest with 2.032.

In the number of leaves produced, Zebra seed cultivar of bambara groundnut had significant increase in the number of leaves produced with 46.75, followed by Tan 1 (44.50), while Black had lowest (36.00). Between the treated and untreated plants in the number of leaves produced, the treated plants had significant increase in the number of leaves produced with 46.75, while the untreated plants significantly a reduced number of leaves produced with 32.49. Among plants treated with plant extracts, *C. fistula* and *V. amygdalina* had significant increase in number of leaves produced with 46.75, while *C. procera* with 45.25. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded higher number of leaves with 39.321, while untreated recorded lowest with 30.000.

In plant height, Zebra seed cultivar of bambara groundnut had significant increase in plant height with 12.156 cm, followed by Nav-red and Black (11.475 cm), while Tan 1 had lowest (10.375 cm). Between the treated and untreated plants in the plant height, the treated plants had significant increase in the plant height with 12.156 cm, while the untreated plants significantly a reduced plant height with 10.012. Among plants treated with plant extracts, *V. amygdalina* had significant increase in the plant height with 13.100 cm, followed by *C. fistula* with 12.100 cm and *C. procera* had lowest with 10.550 cm. Between plants treated with 300 g leaves powder and untreated, the treated plants had significant increase in plant height with 12.135, compared to untreated with 8.210. The result in width of leaves showed that Zebra seed cultivar of bambara groundnut had significant increase in the width of leaves with 2.875 cm, followed by Black (2.850 cm), while Tan 1 had lowest (2.600 cm). Between the treated and untreated plants in the width of leaves, the treated plants had significant increase in the width of leaves with 2.875 cm, while the untreated plants significantly a reduced width of leaves with 2.384. Among plants treated with plant extracts, there was no significant difference among the extracts. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded to be more effective with 2.416, while untreated recorded lowest with 2.045. This is in line with the work of

Olabiyi and Ayeni 2016 and Bamsida *et al*., 2016 who observed the significant increase in plant root length of treated eggplant which improved the growth character of the plant.

Comparative Analysis on Yield Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

The result of field experiment showed that there is significant difference P≤ 0.05 among the treatments and between treated and untreated bambara groundnut seed cultivars as showed in Table 4. Among the treated bambara groundnut in the nematode population in the root, Nav-red seed cultivar of bambara groundnut significantly increase the nematode population of 42.063, followed by Black with 36.250, while Zebra had lowest with 28.875. Between the treated and untreated plants in the nematode population in the roots, the untreated plants had significant increase in the population of nematodes in the roots with 53.219, while the untreated plants significantly reduced the population of nematodes with 28.875.

Among plants treated with plant extracts, *C. procera* had significant increase of nematode in the roots with 38.750, followed by *C. fistula* with 33.313 and *V. amygdalina* had lowest with 32.938. Between plants treated with 300 g concentration of leaves powder and the untreated, the treated plants reduced the population of nematode with 25.341, while untreated recorded higher with 39.628. Among cultivars in the nematode population in the soil, Nav-red seed cultivar of bambara groundnut had higher nematode population in the soil with 34.500, followed by Tan 1 with 30.375 and Zebra had lowest with 17.125. Between the treated and untreated plants in the nematode population in the soil, the untreated plants had significant increase in the population of nematodes in the soil with 41.628, while the untreated plants significantly reduced the population with 17.125. Among extracts, *C. procera* leaves powder had nematode increase in the soil with 30.500, followed by *C. fistula* with 22.688 and *V. amygdalina* had lowest with 21.438. Between plants treated with 300 g concentration of leaves powder and the untreated, the treated plant significantly reduced the population of nematode with 28.315, while untreated recorded higher with 40.079.

In galls produced, Nav-red seed of bambara groundnut had higher galls produced with 26.313, followed by Tan 1 (23.625), while Zebra had lowest (15.563). Between the treated and untreated plants in the number of galls produced, the untreated plants had significant increase in number of galls produced with 33.338, while the untreated plants significantly reduced in the number of galls formed with 15.563. Among plants treated with plant extracts, *C. procera* had higher galls formed with 27.000, followed by *C. fistula* with 17.188 and *V. amygdalina* had the lowest with 16.250. Between plants treated with 300 g leaves powder and the untreated plants, the untreated plants had significant increase in number of galls produced with 31.251, while untreated reduced the galls formed with 27.132. In dry pod weight, Zebra bambara groundnut had higher dry pod weight with 33.831 g, followed by Nav-red (28.856 g), while Tan 1 had lowest (26.238 g). Between treated and untreated plants, treated plants had increase in dry pod weight with 33.831 g, while untreated plants significantly reduced the pod weight with 21.132 g. Among plants treated with plant extracts, *V. amygdalina* had increase in pod weight (32.481), followed by *C. fistula* with 31.850 and *C. procera* had lowest with 28.575. In the pods produced, Zebra seed cultivar of bambara groundnut had higher number of pods produced with 21.312, followed by Black (17.125), while Nav-red had lowest (13.062). Between the treated and untreated plants in the number of pods produced, the untreated plants had significant increase in the number of pods produced with 21.312, while the untreated plants significantly reduced the number of pods with 11.100. Among plants treated with plant extracts, *V. amygdalina* had significant increase in the pods produced with 22.062, followed by *C. fistula* with 21.562 and *C. procera* had lowest with 11.937. Between treated and untreated in concentration, treated plants at 300 g of leaves powder increased pods produced of 30.123 as compared to the untreated with 25.214. In dry seed weight, Zebra cultivar of bambara groundnut had higher dry seed weight with 28.056 g, followed by Black (24.669 g), while Nav-red had

lowest seed weight (22.063 g). Between the treated and untreated plants in the dry seed weight, the untreated plants had significant increase in the dry seed weight with 28.056 g, while the untreated plants significantly reduced the weight with 20.221 g. Among plants treated with plant extracts, *V. amygdalina* was more effective in seed weight with 26.838 g, followed by *C. fistula* with 26.222 g and *C. procera* had the lowest with 24.019 g. Between treated and untreated in concentration, treated plants at 300 g of leaves powder had significant increase in dry seed weight produced with 23.021 cm as compared to the untreated with 21.568 cm.

In plant seed yield, Zebra cultivar of bambara groundnut gave higher yield with 20.813, followed by Tan 1 (18.875), while Nav-red had lowest with 12.375. Between treated and untreated plants in seed yield, untreated plants had significant increase in seed yield with 20.813, while the untreated plants significantly reduced the yield with 15.505. Among plants treated with plant extracts, *V. amygdalina* improved the seed yield (21.250), followed by *C. fistula* 20.375 and *C. procera* had lowest 14.250. Between plants treatment at 300 g and the untreated, treated plant had better seed yield of 21.364 while untreated produced low yield with 21.222. The finding of the research is in line with the works of Adenawoola *et al.,* (2005); Olabiyi *et al*., (2007); Chimbeujwo and Bukar (2013) on the significant increase in growth of groundnut observed which may be due to the fact that addition of organic matter to the soil increases soil nutrient status and plant growth.

Table 3: Comparative Analysis on the Effect of Leaf Powder on Growth Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

	Stem girth (cm)	Length of leaves (cm)	No. of branches	No. of flowers produced	No. of leaves produced	Plant height	Width of leaves (cm)
Cultivar							
Zebra	1.875^{a}	4.700^{b}	34.75^{b}	2.187^{b}	46.75^{a}	12.156^{a}	2.875^{a}
Nav-red	1.325^{c}	3.850^{c}	27.75^{c}	1.250^{c}	38.50^{c}	11.475^{b}	2.825^{c}
Tan 1	1.343^{c}	3.775^{d}	27.00^{d}	2.562^{a}	44.50^{b}	10.375^{c}	2.600^{d}
Black	1.612^{b}	4.825^{a}	42.00^{a}	2.375^{a}	36.00^{d}	11.475^{b}	2.850^{b}
Control	1.001^{d}	2.346^{c}	22.31^{e}	2.056^{d}	32.49^{e}	10.012^{d}	2.284^{e}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	0.111	0.000	0.000	0.338	0.000	0.118	0.000
Extracts							
C. fistula	1.637^{a}	4.350^{a}	35.00^{a}	2.250^{a}	46.75^{a}	12.100^{b}	2.750^{b}
C. procera	1.587^{a}	4.350^{a}	35.00^{a}	2.375^{a}	45.25^{b}	10.550^{c}	2.750^{b}
V. amyg.	1.600^{a}	4.350^{a}	35.00^{a}	2.250^{a}	46.75^{a}	13.100^{a}	2.750^{b}
P < f	0.000	0.000	0.000	0.099	0.000	0.000	0.000
LSD	0.000	0.000	0.000	0.357	0.000	0.118	0.000
Concentrations							
300g	1.410^{a}	3.980^{a}	38.243^{a}	2.532^{a}	39.321^{a}	12.135^{a}	2.416^{a}
Control	1.365^{a}	3.121^{b}	30.140^{b}	2.032^{b}	30.000^{b}	8.210^{b}	2.045^{b}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	1.239	0.15	1.111	0.140	1.575	0.110	0.102
Interactions							
Cultivar x Conc	*	ns	**	**	**	**	ns
Extract x Conc	ns	ns	ns	ns	ns	**	**
Cultivar x Extract	ns	ns	ns	ns	ns	*	**
Cult x Extr x Conc.	ns	ns	ns	ns	ns	**	*

Means with the same letter in the same column are not significantly different at (P≤ 0.05) level of significance

Comparative Analysis on the Effect of Leaf Powder on Growth Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

The result of field experiment carried out on growth/reproductive characters of bambara groundnut showed that there is significant difference P≤ 0.05 among the treatments and between the treated and untreated cultivars as shown in Table 5. In stem girth, Zebra seed bambara groundnut had significant increase in stem girth of 2.100 cm, followed by Black (1.750 cm), while Nav-red had lowest (1.300 cm). Between the treated and untreated plants in the stem girth, the treated plants had significant increase in stem girth with 2.100 cm, while the untreated plants significantly a reduced the girth with 1.011 cm. Among plants treated with plant extracts, it was

observed that there was no significant difference observed among the plant extracts. Between concentrations and untreated, leaves powder at 300 g was recorded higher increase in plant stem girth with 1.486 cm, while untreated recorded lowest with 1.322 cm. In length of leaves, Zebra seed of bambara groundnut seed had significant increase in length of leaves with 4.425 cm, followed by Black (4.275 cm), while Tan 1 had lowest (3.625 cm). Between the treated and untreated plants in the length of leaves, the treated plants had significant increase in the plant leaves length with 4.425 cm, while the untreated plants significantly reduced leaves length with 2.678 cm. Among extracts in the length of leaves, it was observed that there was no significance. Between concentration and untreated, the treated at 300g had significant increase in plant length of leaves with 3.580 cm than the untreated with 3.377 cm.

In the number of branches produced, Zebra seed bambara groundnut had significant increase in number of branches produced with 35.00, followed by Black (34.50), while Tan 1 had lowest (29.50). Between the treated and untreated plants in the number of branches produced, the treated plants had significant increase in the number of branches produced with 35.00 cm, while the untreated plants significantly a reduced leaves length with 26.404. Among plants treated with plant extracts, it was observed that there was no significant difference among extracts. Between concentration and untreated, 300 g leaves powder had significant increase in the branches produced with 34.472 while untreated recorded lower with 28.400.

Table 4: Effect of Leaf Powder on Yield Characters among Four Cultivars of Bambara groundnut Infected with Root Knot Nematode

Cultivar	Nematode pop. in the roots	Nematode pop. in sample soil	Galls produced per plant	Dry pod weight (g)	No. of pods per plant	Dry seed weight (g)	Seed yield per plant
Zebra	28.875^{d}	17.125^{e}	15.563^{d}	33.831^{a}	21.312^{a}	28.056^{a}	20.813^{a}
Nav-red	42.063^{b}	34.500^{b}	26.313^{b}	28.856^{b}	13.062^{c}	22.063^{b}	12.375^{b}
Tan 1	33.875^{c}	30.375^{c}	23.625^{b}	26.238^{b}	15.750^{b}	23.125^{b}	18.875^{a}
Black	36.250^{c}	22.563^{d}	22.063^{c}	28.744^{b}	17.125^{b}	24.669^{b}	18.750^{a}
Control	53.219^{a}	41.628^{a}	33.338^{a}	21.132^{c}	11.100^{d}	20.221^{c}	15.505^{c}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	4.278	3.589	3.645	2.285	1.483	2.520	2.246
Extracts							
C. fistula	33.313^{b}	22.688^{b}	17.188^{b}	31.850^{a}	21.562^{a}	26.225^{a}	20.375^{a}
C. procera	38.750^{a}	30.500^{a}	27.000^{a}	28.475^{b}	11.937^{b}	24.019^{b}	14.250^{b}
V. amyg.	32.938^{b}	21.438^{b}	16.250^{b}	32.481^{a}	22.062^{a}	26.838^{a}	21.250^{a}
P < f	0.117	0.000	0.000	0.000	0.000	0.000	0.000
LSD	5.359	3.746	3.717	2.941	1.760	2.702	2.159
Concentrations							
300g	25.341^{a}	28.315^{a}	27.132^{a}	33.491^{a}	30.123^{a}	23.021^{a}	26.364^{a}
Control	39.628^{b}	40.079^{b}	31.251^{b}	27.326^{b}	25.214^{b}	21.568^{b}	21.222^{b}
P < f	0.001	0.000	0.011	0.001	0.000	0.000	0.020
LSD	1.026	2.000	1.133	1.044	1.032	2.026	2.232
Interactions							
Cultivar x Conc	**	**	**	**	**	**	ns
Extract x Conc	ns	**	**	**	**	**	**
Cultivar x Extract	**	**	**	**	**	**	**
Cult x Extr x Conc.	ns	ns	ns	ns	**	ns	**

Means with the same letter in the same column are not significantly different at (P≤ 0.05) level of significance

In the number of flowers produced, Nav-red seed cultivar of bambara groundnut had significant increase in the flowers reproduced with 2.500, followed by Zebra (2.312), while Tan 1 had lowest (1.687). Between the treated and untreated plants in the number of flowers produced, the treated plants had significant increase in the plant number of flowers produced with 2.500, while the untreated plants significantly a reduced the number of flowers with 2.000. It was observed that the untreated had significant increase in the number of flowers reproduced than Tan 1 treated plants. There was significant difference observed between the untreated and Tan 1 seed cultivars of bambara groundnut. Among plants treated with plant extracts, *V. amygdalina* had increase in branches

produced with 2.375, followed by *C. fistula* with 2.125 and *C. procera* had lowest with 2.062. Between concentration and untreated, 300 g recorded higher in the number of branches produced with 2.182 while untreated had lowest with 1.101. In the number of leaves produced, Zebra seed cultivar of bambara groundnut recorded significant increase in number of leaves produced with 49.25, followed by Tan 1 (32.25), while Black had lowest (28.50). Between the treated and untreated plants in the number of leaves produced, the treated plants had significant increase in the number of leaves with 49.25, while the untreated plants significantly a reduced number of leaves produced with 25.846. Among plants treated with plant extracts, it was observed that there was no significant difference among extracts in the number of leaves produced. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded to improve significantly in number of leaves produced with 32.001, while untreated recorded lowest with 28.458.

In plant height, Zebra seed cultivar of bambara groundnut had higher plant height with 11.35 cm, followed by Black (11.20 cm), while Tan 1 had lowest (10.67 cm). Between the treated and untreated plants in the plant height, the treated plants had significant increase in the plant height with 11.35 cm, while the untreated plants significantly a reduced plant height with 10.00 cm. Among plants treated with plant extracts, *V. amygdalina* was recorded to improve plant height with 11.55 cm, followed by *C. fistula* with 11.45 cm and *C. procera* had lowest with 10.85 cm. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded higher plant height with 12.183, while untreated recorded lowest with 8.215.

The result in width of leaves showed that Zebra seed cultivar of bambara groundnut had significant increase in width of leaves with 2.775 cm, followed by Black (2.725 cm), while Nav-red had lowest (2.275 cm). Between the treated and untreated plants in the width of leaves, the treated plants had significant increase in the width of leaves with 2.775 cm, while the untreated plants significantly a reduced width of leaves with 2.010 cm. Among plants treated with plant extracts, there was no significant difference observed among the extracts in the width of leaves. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded higher in width of leaves with 2.400 cm, while untreated recorded lowest with 1.860 cm. This is in concordance with the report of Kumar and Singh (2011); Izuogu *et al*., (2016) and Bamsida *et al*., (2020) who reported on the treatment of cowpea with aqueous leaf extracts of *H. suaveolens* to improve the vegetative growth of the cowpea varieties and possibly to improve their photosynthetic ability in respect to the number of leaves produced.

Comparative Analysis on Yield Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

The result of field experiment showed a significant difference P≤ 0.05 among the treatments and between treated and untreated bambara groundnut cultivars as showed in Table 6. Among the treated bambara groundnut in the nematode population in the root, Nav-red seed cultivar of bambara groundnut had higher population of 41.000, followed by Black with 36.563, while Zebra had lowest with 27.750. Between the treated and untreated plants in the nematode population in the roots, the untreated plants had significant increase in the population of nematodes in the roots with 56.241, while the treated plants significantly reduced the population of nematodes with 27.750. Among plants treated with plant extracts, *C. procera* had significant increase of nematode population in the plant roots with 38.188, followed by *C. fistula* with 33.688 cm and *V. amygdalina* had lowest with 33.250. Between plants treated with 300 g concentration of leaves powder and the untreated, the treated plants reduced the nematode with 23.481, while untreated recorded higher with 29.412.

Among cultivars in the nematode population in the soil, Nav-red seed cultivar of bambara groundnut had higher nematode population in the soil with 33.813, followed by Tan 1 with 31.500 and Zebra had lowest with 18.188. Between the treated and untreated plants in the nematode population in the soil, the untreated plants had significant increase in

the population of nematodes in the soil with 71.285, while the treated plants significantly reduced the population of nematodes with 18.188. Between plants treated with leaves extracts and the untreated, it was observed that the untreated plants had higher increase of nematode in the soil with 30.625 as compared to treated as low as 22.313. Between plants treated with 300 g concentration of leaves powder and the untreated, the untreated plants gave higher nematode increase with 44.232, while plants treated with leaves powders reduced the nematode in the soil with 30.248.

In the number of galls produced, Nav-red seed of bambara groundnut had higher number of galls produced with 27.500, followed by Tan 1 (26.313), while Zebra had lowest (17.625). Between the treated and untreated plants in the number of galls produced, the untreated plants had significant increase in the number of galls with 32.570, while the untreated plants significantly reduced the galls formed with 17.625. Among plants treated with plant extracts, *C. procera* had increase in galls formed with 28.688, followed by *C. fistula* with 19.000 and *V. amygdalina* had lowest with 17.875. Between plants treated with 300 g concentration of leaves powder and the untreated, the untreated plant recorded higher number of galls produced with 29.842, while treated reduced the galls formed with 25.252. In dry pod weight, Zebra bambara groundnut had higher dry pod weight with 33.119 g, followed by Black (28.681 g), while Tan 1 had lowest (25.481 g). Between the treated and untreated plants in the dry pod weight, the treated plants had significant increase in the pod weight with 33.119 g, while the untreated plants significantly reduced the weight with 21.121 g. Among plants treated with plant extracts, *V. amygdalina* had increase in dry pod weight (30.419 g) g, followed by *C. fistula* with 30.194 g and *C. procera* had lowest with 27.650 g. Between treated and untreated, treated plants at 300 g of leaves powder had higher dry pod weight of 31.360 g while untreated was recorded low with 29.117 g.

Table 5: Comparative Analysis on the Effect of Leaf Powder on Growth Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

Cultivar	Stem girth (cm)	Length of leaves (cm)	No. of branches	No. of flowers produced	No. of leaves produced	Plant height (cm)	Width of leaves (cm)
Zebra	2.100^{a}	4.425^{a}	35.00^{a}	2.312^{a}	49.25^{a}	11.35^{a}	2.775^{a}
Nav-red	1.300^{d}	3.425^{d}	32.00^{c}	2.500^{a}	29.00^{c}	10.73^{c}	2.275^{d}
Tan 1	1.437^{c}	3.625^{c}	29.50^{d}	1.687^{c}	32.25^{b}	10.67^{d}	2.500^{c}
Black	1.750^{b}	4.275^{b}	34.50^{b}	2.062^{b}	28.50^{d}	11.20^{b}	2.725^{b}
Control	1.011^{e}	2.678^{e}	26.404^{e}	2.000^{c}	25.846^{e}	10.00^{e}	2.010^{e}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	0.023	0.000	0.000	0.259	0.000	0.000	0.000
Extracts							
C. fistula	1.650^{a}	3.975^{a}	33.25^{a}	2.125^{a}	36.75^{a}	11.45^{b}	2.550^{b}
C. procera	1.650^{a}	3.975^{a}	33.25^{a}	2.062^{b}	36.75^{a}	10.85^{c}	2.550^{b}
V. amyg.	1.650^{a}	3.975^{a}	33.25^{a}	2.375^{a}	36.75^{a}	11.55^{a}	2.550^{b}
P < f	0.618	0.000	0.000	0.000	0.000	0.000	0.000
LSD	0.023	0.000	0.000	0.259	0.000	0.000	0.000
Concentrations							
300g	1.486^{a}	3.580^{a}	34.472^{a}	2.182^{a}	32.001^{a}	12.183^{a}	2.400^{a}
Control	1.322^{b}	3.377^{b}	28.400^{b}	1.101^{b}	28.458^{a}	8.215^{b}	1.860^{b}
P < f	0.000	0.133	0.000	0.000	0.000	0.000	0.000
LSD	0.140	1.64	0.564	0.240	1.545	0.149	0.011
Interactions							
Cultivar x Conc	*	**	**	**	**	**	ns
Extract x Conc	ns	ns	ns	ns	**	**	**
Cultivar x Extract	ns	ns	ns	ns	*	**	**
Cult x Extr x Conc.	ns	ns	ns	ns	**	**	*

Means with the same letter in the same column are not significantly different at (P≤ 0.05) level of significance

In the number of pods produced, Zebra seed cultivar of bambara groundnut had higher number of pods produced with 20.937 cm, followed by Black (16.937), while Nav-red had lowest (12.812). There was no significant difference observed between the treated cultivars of Tan 1 and black. Between the treated and untreated plants in the number of pods, the treated plants had significant increase in the number of pods with 20.937, while the untreated plants significantly reduced the number of pods with 24.831. It was observed that untreated recorded higher than Nav-red, Tan 1 and Black plant seed cultivars in the treated. Among plants treated with plant extracts, *V. amygdalina* had significant increase in the pods produced with 21.125, followed by *C. fistula* with 21.062 and *C. procera* had lowest with 12.125. Between treated and untreated in concentration, treated plants at 300 g of leaves powder had higher number of pods produced of 28.489 as compared to the untreated with 26.246.

In dry seed weight, Zebra cultivar of bambara groundnut had higher dry seed with 28.306 g, followed by Black (25.918 g), while Nav-red had lowest seed weight (22.006 g). Among plants treated with plant extracts, *V. amygdalina* had higher increased in seed weight with 26.156 g, followed by *C. fistula* with 25.768 g and *C. procera* had the lowest with 23.387 g. Between the treated and untreated plants in dry seed weight, the treated plants had significant increase in dry seed weight with 28.306 g, while the untreated plants significantly reduced the seed weight with 21.015 g. Between plants treated with plant extracts and the untreated, treated plants had higher increase in weight with 26.156 g compared to the untreated with 23.681 g. It was observed that the untreated had higher dry seed weight than *C. procera* leaf powder. Between treated and untreated in concentration, treated plants at 300 g of leaves powder had higher dry seed weight produced with 24.133 g as compared to the untreated with 22.487g.

In plant seed yield, Zebra cultivar of bambara groundnut gave higher yield with 20.938, followed by Black (19.813), while Nav-red had lowest with 11.688. Between the treated and untreated plants in plant seed yield, the treated plants had significant increase in seed yield with 20.938, while the untreated plants significantly reduced plant seed yield with 14.443. It was observed that the untreated plants had significant increase in yield than Nav-red. Among plants treated with plant extracts, *C. fistula* had significant increase in seed yield (20.750), followed by *V. amygdalina* with 20.500 and *C. procera* had lowest with 14.375. Between plant treatment at 300 g and the untreated, the treated plant had higher seed yield produced of 24.416 while the untreated produced low yield with 19.562. This supports the findings of Saravanapriya and Sivakumar (2005); Izuogu (2016) and William *et al*., (2024) on the use of plant powder to reduce nematode activities and allowing the general increase in all growth characters.

Comparative Analysis on the Effect of Leaf Powder on Growth Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

The result of field experiment carried out on growth/reproductive characters of bambara groundnut showed that there is significant difference P≤ 0.05 among the treatments and between the treated and untreated cultivars as showed in Table 7. In stem girth, Zebra seed bambara groundnut significantly increase stem girth of 1.456 cm, followed by Black (1.412 cm), while Tan 1 had lowest (1.318 cm). Between the treated and untreated plants in the stem girth, the treated plants had significant increase in the stem girth with 1.456 cm, while the untreated plants significantly a reduced stem girth with 1.112 cm. Among plants treated with plant extracts, it was observed that there was no significant difference observed among the plant extracts. Between concentrations and untreated, leaves powder at 300 g was more effective in stem girth with 1.516 cm, while untreated recorded lowest with 1.121 cm.

In length of leaves, Nav-red seed of bambara groundnut seed had higher length of leaves with 7.025 cm, followed by Black (4.019 cm), while Tan 1 had lowest (3.875 cm). Between the treated and untreated plants in the length of leaves, the treated plants had significant increase in the plant leaves length with 7.025 cm, while the untreated

plants significantly a reduced leaves length with 3.021. Among extracts, there was no significant difference observed. Between concentration and untreated, the treated plants at 300g was recorded higher in length of leaves with 3.001 cm than the untreated with 2.100 cm. In the number of branches produced, Nav-red seed bambara groundnut had higher number of branches produced of 29.500, followed by Zebra (29.125), while Tan 1 had lowest (24.750). Between the treated and untreated plants in the number of branches produced, the treated plants had significant increase in the number of branches produced with 29.500, while the untreated plants significantly a reduced number of branches produced with 23.920. Among plants treated with plant extracts, it was observed that there was no significant difference among extracts. Between concentration and untreated, 300 g leaves powder had higher increase in branches produced with 31.333 while untreated recorded lower with 20.458.

Table 6: Effect of Leaf Powder on Yield Characters among Four Cultivars of Bambara groundnut Infected with Root Knot Nematode

Cultivar	Nematode pop. in the roots	Nematode pop. in sample soil	Galls produced per plant	Dry pod weight (g)	No. of pods per plant	Dry seed weight (g)	Seed yield per plant
Zebra	27.750^{d}	18.188^{d}	17.625^{c}	33.119^{a}	20.937^{a}	28.306^{a}	20.938^{a}
Nav-red	41.000^{b}	33.813^{b}	27.500^{b}	28.631^{b}	12.812^{c}	22.006^{c}	11.688^{c}
Tan 1	35.750^{c}	31.500^{b}	26.313^{b}	25.481^{c}	16.375^{b}	22.762^{c}	18.188^{b}
Black	36.563^{b}	23.438^{c}	21.938^{b}	28.681^{b}	16.937^{b}	25.918^{b}	19.813^{a}
Control	56.241^{a}	71.285^{a}	32.570^{a}	21.121^{d}	24.831^{d}	21.015^{d}	14.443^{d}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	4. 822	3.726	3.77	2.213	1. 805	0.000	2.585
Extracts							
C. fistula	33.688^{a}	23.625^{b}	19.000^{b}	30.194^{a}	21.062^{a}	25.768^{a}	20.750^{a}
C. procera	38.188^{a}	30.375^{a}	28.688^{a}	27.650^{b}	12.125^{b}	23.387^{b}	14.375^{b}
V. amyg.	33.250^{b}	22.313^{b}	17.875^{b}	30.419^{a}	21.125^{a}	26.156^{a}	20.500^{a}
P < f	0.159	0.000	0.000	0.014	0.000	0.002	0.000
LSD	4.822	3.726	3.77	2.213	1.805	1.686	2.585
Concentrations							
300g	23.481^{b}	30.248^{b}	25.252^{b}	31.360^{a}	28.489^{a}	24.133^{a}	24.416^{a}
Control	29.412^{a}	44.232^{a}	29.842^{a}	29.117^{b}	26.264^{b}	22.487^{a}	19.562^{b}
P < f	0.001	0.000	0.011	0.000	0.000	0.000	0.020
LSD	1.011	2.002	1.131	1.031	1.018	2.012	2.123
Interactions							
Cultivar x Conc	*	**	**	**	**	**	**
Extract x Conc	ns	**	**	*	**	**	**
Cultivar x Extract	**	**	**	**	**	**	*
Cult x Extr x Conc.	ns	ns	ns	ns	**	ns	**

Means with the same letter in the same column are not significantly different at (P≤ 0.05) level of significance

In the number of flowers produced, Zebra seed cultivar of bambara groundnut had significantly increase in reproductive growth with 2.687, followed by Black (2.562), while Nav-red had lowest (1.625). Between the treated and untreated plants in the number of flowers produced, the treated plants had significant increase in the number of flowers with 2.687, while the untreated plants significantly a reduced number of flowers produced with 2.006. It was observed that the untreated plants had significant increase in number of flowers reproduced than the plant treated with Nav-red**.** Among plants treated with plant extracts, *V. amygdalina* had significant increase in the number of branches produced with 2.437, followed by *C. procera* with 2.375 and *C. fistula* had lowest with 2.312. Between concentration and untreated, 300 g recorded higher in the number of branches produced with 2.162 while untreated had lowest with 2.120.

In the number of leaves produced, Zebra seed cultivar of bambara groundnut had an increase in number of leaves produced with 41.250, followed

by Nav-red (40.062), while Black had lowest (38.812). Between the treated and untreated plants in the number of leaves produced, the treated plants had significant increase in the number of leaves produced with 41.250, while the untreated plants significantly a reduced the number of leaves with 36.100. Among plants treated with plant extracts, *C. fistula* recorded higher in number of leaves produced with 40.563, followed by *V. amygdalina* (33.125) while *C. procera* had lowest with 32.500. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded higher number of leaves produced with 39.604, while untreated recorded lowest with 22.382.

In plant height, Zebra seed cultivar of bambara groundnut had a significant increase in the plant height with 13.10 cm, followed by Black (13.08 cm), while Nav-red had lowest (10.10 cm). Between the treated and untreated plants in the plant height, the treated plants had significant increase in the plant height with 13.10 cm, while the untreated plants significantly a reduced plant height with 9.10 cm. Among plants treated with plant extracts, *C. fistula* and *V. amygdalina* leaves powder was recorded to be more effective in plant height with 12.28 cm, while *C. procera* had lowest with 11.98 cm. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded higher in plant height with 11.101, while untreated recorded lowest with 8.432.

The result in width of leaves showed that Zebra seed cultivar of bambara groundnut had an increase in plant height with 2.875 cm, followed by Tan 1 with 2.650 cm, while Nav-red and Black had lowest (2.575 cm). Between the treated and untreated plants in the width of leaves, the treated plants had significant increase in the width of leaves with 2.875 cm, while the untreated plants significantly a reduced width of leaves with 2.213 cm. Among plants treated with plant extracts, there was no significant difference observed among the extracts in the width of plant. Between plants treated with 300 g leaves powder and untreated, the treated plant recorded significantly higher with 2.414, while untreated recorded lowest with 2.268. This result agrees with the findings of Khan *et al*., (2008); Izuogu (2016) and Bamsida (2020) who reported on the use of different plant extracts at higher concentrations producing more leaves than other dilutions which may probably reduce nematode activities and allowing the general increase in all growth characters.

Comparative Analysis on Yield Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

The result of the study for field experiment showed a significant difference P≤ 0.05 among the treatments and between treated and untreated bambara groundnut cultivars as shown in Table 8. Among the treated bambara groundnut in the nematode population in the root, Nav-red seed cultivar of bambara groundnut had higher nematode increase of 43.020, followed by Black with 36.563, while Zebra had lowest with 28.670. Between the treated and untreated plants in the nematode population in the roots, the untreated plants had significant increase in the nematodes in the roots with 49.003, while the treated plants significantly reduced the nematodes with 28.670. Among plants treated with plant extracts, *C. procera* had increased nematode with 37.812, followed by *V. amygdalina* with 31.180 and *C. fistula* had lowest with 32.741. Between plants treated with 300 g concentration of leaves powder and the untreated, the treated plants reduced the nematode to 16.321, while untreated had higher with 28.411.

Among cultivars in the nematode population in the soil, Nav-red seed cultivar of bambara groundnut had higher nematode population in the soil with 33.943, followed by Tan 1 with 31.804 and Zebra had lowest with 19.035. Between the treated and untreated plants in the nematode population in the soil, the untreated plants had significant increase in the population of nematodes in the soil with 68.200, while the treated plants significantly reduced the population of nematodes with 19.035. Among extracts, *C. procera* leaves powder had increase in nematode in the soil with 31.410, followed by *V. amygdalina* with 23.471 and *C. fistula* had lowest with 23.266. Between plants treated with 300 g concentration of leaves powder and the untreated, the untreated plant gave higher population of nematode with 44.392, while plants

treated with 300 g leaves powders reduced the population of nematode with 22.020. In the number of galls produced, Nav-red seed of bambara groundnut had higher number of galls produced with 28.360, followed by Tan 1 (25.521), while Zebra had lowest (18.585). Between the treated and untreated plants in the number of galls produced, the untreated plants had significant increase in the number of galls produced with 39.980, while the treated plants significantly reduced the number of galls produced with 18.585.

Table 7: Comparative Analysis on the Effect of Leaf Powder on Growth Characters among Bambara groundnut Varieties Infected with Root Knot Nematode

Cultivar	Stem girth (cm)	Length of Leaves (cm)	No. of branches	No. of flowers produced	No. of leaves produced	Plant height (cm)	Width of leaves (cm)
Zebra	1.456^{a}	3.963^{b}	29.125^{a}	2.687^{a}	41.250^{a}	13.10^{a}	2.875^{a}
Nav-red	1.318^{b}	3.875^{b}	24.750^{b}	2.062^{b}	39.062^{b}	10.58^{c}	2.650^{b}
Tan 1	1.368^{a}	7.025^{a}	29.500^{a}	1.625^{c}	40.062^{a}	10.10^{d}	2.575^{d}
Black	1.412^{a}	4.019^{b}	28.375^{a}	2.562^{a}	38.812^{b}	13.08^{b}	2.575^{c}
Control	1.112^{c}	3.021^{b}	23.920^{c}	2.006^{d}	36.100^{c}	9.10^{e}	2.213^{e}
P < f	0.036	0.025	0.061	0.061	0.023	0.000	0.000
LSD	0.095	4. 845	3. 824	0.496	1.696	0.000	0.000
Extracts							
C. fistula	1.406^{a}	6.081^{a}	28.750^{a}	2.312^{a}	40.563^{a}	12.28^{a}	2.675^{a}
C. procera	1.406^{a}	6.081^{a}	28.750^{a}	2.375^{a}	32.500^{a}	11.98^{b}	2.675^{a}
V. amyg.	1.406^{a}	6.081^{a}	28.750^{a}	2.437^{a}	33.125^{a}	12.28^{a}	2.675^{a}
P < f	0.379	0.729	0.236	0.005	0.950	0.000	0.000
LSD	0.095	4. 845	3. 824	0.370	3.674	0.000	0.000
Concentrations							
300g	1.516^{a}	3.001^{a}	31.333^{a}	2.162^{a}	39.604^{a}	11.101^{a}	2.414^{a}
Control	1.121^{b}	2.100^{b}	20.458^{b}	2.120^{b}	22.382^{b}	8.432^{b}	2.268^{b}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	0.040	1.314	0.731	0.103	1.463	0.166	0.004
Interactions							
Cultivar x Conc	*	**	**	**	**	**	ns
Extract x Conc	ns	ns	ns	ns	**	**	**
Cultivar x Extract	ns	ns	ns	ns	*	**	**
Cult x Extr x Conc.	ns	ns	ns	ns	**	**	*

Means with the same letter in the same column are not significantly different at (P≤ 0.05) level of significance

Among plants treated with plant extracts, *C. procera* had significant increase in galls formed with 30.329, followed by *V. amygdalina* with 23.050 and *C. fistula* had lowest with 19.030. Between plants treated with 300 g concentration of leaves powder and the untreated, the untreated plant recorded higher number of galls produced with 34.002, while treated plant reduced the galls formed with 16.227.

In dry pod weight, Zebra bambara groundnut had higher dry pod weight with 35.211 g, followed by Black (28.681 g), while Tan 1 had lowest (25.481 g). Between the treated and untreated plants in the dry pod weight, the treated plants had significant increase in dry pod weight with 35.211, while the untreated plants significantly reduced the pod weight with 22.127. Among plants treated with plant extracts, *V. amygdalina* had high increase in dry pod weight (31.224) g, followed by *C. fistula* with 28.478 g and *C. procera* had lowest with 26.032 g. Between treated and untreated, treated plants at 300 g of leaves powder had higher dry pod weight of 33.112 g while untreated was recorded low with 22.041 g.

In the number of pods produced, Zebra seed cultivar of bambara groundnut had higher number of pods produced with 22.643, followed by Black (17.700), while Nav-red had lowest (12.290). Between the treated and untreated plants in the number of pods produced, the treated plants had significant increase in the number of pods produced with 22.643, while the treated plants significantly

reduced the number of pods with 12.128. There was no significant difference between the treated plants and Nav-red seed cultivar of bambara groundnut. Among plants treated with plant extracts, *C. fistula* was recorded higher in the number of pods produced with 21.122 cm, followed by *V. amygdalina* with 21.011 and *C. procera* had lowest with 13.502. Between treated and untreated, treated plants at 300 g of leaves powder had higher number of pods produced of 31.315 as compared to the untreated with 19.234.

In dry seed weight, Zebra cultivar of bambara groundnut had higher dry seed with 28.411 g, followed by Black (23.710 g), while Nav-red had lowest seed weight (22.061 g). Between the treated and untreated plants in the dry seed weight, the treated plants had significant increase in the dry seed weight with 28.411 g, while the untreated plants significantly reduced the dry seed weight with 20.101 g. Among plants treated with plant extracts, *C. fistula* and *V. amygdalina* had increase in seed weight with 25.301 g, while *C. procera* had the lowest with 23.101 g. Between treated and untreated in concentration, treated plants at 300 g of leaves powder had higher dry seed weight produced with 26.023 g as compared to the untreated with 20.303 g.

In plant seed yield, Zebra cultivar of bambara groundnut gave higher yield with 19.994, followed by Black (19.721), while Nav-red had lowest with 12.336. Between the treated and untreated plants in the seed yield, the treated plants had significant increase in the seed yield with 19.994, while the untreated plants significantly reduced the yield with 13.435. Among plants treated with plant extracts, *C. fistula* was recorded with higher seed yield (20.529), followed by *V. amygdalina* with 20.021 and *C. procera* had lowest with 13.245. Between plant treatment at 300 g and the untreated, treated plant had higher seed yield produced of 33.212 while the untreated produced low yield with 21.222. There was no significant difference between the untreated and the treated plants in the plant seed yield. This is in support of the work of Chimbekujwo and Bukar (2013), Singh (2015) and Bamsida *et al.* (2020) on the use of leave powders at different concentrations to control nematode population.

Table 8: Effect of Leaf Powder on Yield Characters Among Four Cultivars of Bambara groundnut Infected with Root Knot Nematode

Cultivar	Nematode pop. in the roots	Nematode pop. in sample soil	Galls produced per plant	Dry pod weight (g)	No. of pods per plant	Dry seed weight (g)	Seed yield per plant
Zebra	28.670^{d}	19.035^{d}	18.585^{c}	35.211^{a}	22.643^{a}	28.411^{a}	19.994^{a}
Nav-red	43.020^{b}	33.943^{b}	28.360^{b}	28.351^{b}	12.290^{c}	22.061^{c}	12.336^{c}
Tan 1	36.552^{c}	31.804^{b}	25.521^{b}	25.481^{c}	17.700^{b}	23.602^{c}	18.066^{b}
Black	36.563^{c}	24.377^{c}	23.855^{b}	28.681^{b}	16.032^{b}	23.710^{b}	19.721^{a}
Control	49.003^{a}	68.200^{a}	39.980^{a}	22.127^{d}	12.128^{c}	20.101^{d}	13.435^{c}
P < f	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LSD	4.533	3.318	2.140	2.213	1.721	1.394	2.296
Extracts							
C. fistula	32.741^{b}	23.266^{b}	19.030^{c}	28.478^{b}	21.122^{a}	25.301^{a}	20.529^{a}
C. procera	37.812^{a}	31.410^{a}	30.329^{a}	26.032^{c}	13.502^{b}	23.101^{b}	13.245^{b}
V. amyg.	33.180^{b}	23.471^{b}	23.050^{b}	31.224^{a}	21.011^{a}	25.301^{a}	20.021^{a}
P < f	0.064	0.000	0.000	0.000	0.000	0.000	0.000
LSD	3.624	3.258	3.044	2.037	1.051	1.511	2.248
Concentrations							
300g	16.321^{b}	22.020^{b}	16.227^{b}	33.112^{a}	31.315^{a}	26.023^{a}	33.212^{a}
Control	28.411^{a}	44.392^{a}	34.002^{a}	22.041^{b}	19.234^{b}	20.303^{b}	21.222^{b}
P < f	0.001	0.010	0.000	0.002	0.000	0.004	0.030
LSD	3.243	3.100	1.222	1.058	1.312	1.421	2.022
Interactions							
Cultivar x Conc	**	**	**	**	**	**	**
Extract x Conc	*	**	**	**	**	**	**
Cultivar x Extract	**	**	**	**	**	**	**
Cult x Extr x Conc.	ns	ns	ns	ns	**	ns	**

Means with the same letter in the same column are not significantly different at (P≤ 0.05) level of significance

Conclusion

Based on the findings on the comparative analysis of different leaf powders of *Cassia fistula*, *Calotropis procera* and *Vernonia amygdalina* on root-knot nematode affecting bambara nut in the selected local government areas have significant control on the nematode population. The presence of chemical compositions and toxicity found in the leaves extracts tends to suppress the growth of nematodes and help in improving the growth and yield of bambara nut. It is, therefore, concluded that the plant extracts are viable alternatives to chemical nematicides in the control of root-knot nematodes and are recommended for use as bio-pesticides.

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