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Full Length Research Article

INFLUENCE OF TWO *GLOMUS* SPECIES ON ROOT NODULE NUMBER OF COWPEA (*VIGNA UNGUICULATA* (L) WALP) VARIETIES ON *ALECTRA VOGELII* INOCULATED SOIL

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ABSTRACT
Nitrogen fixation in legumes takes place in the root nodules. This research was conducted to evaluate the effect of *Glomus* spp. on root nodule number of four cowpea varieties grown on *Alectra vogelii* inoculated soil. The heat sterilized soil used for this experiment consisted of a mixture of top soil and sand in ratio 1:1 (v/v). *Glomus deserticola* and *Glomus clarum* were applied in five rates: the control without *Alectra*, control with *Alectra*, 10, 20 and 30 g/pot. A constant quantity of *Alectra* (3.3 g/pot) was maintained. Four cowpea seeds were planted per pot but later thinned to two seedlings per pot. Cowpea plants were sampled for root nodule number at 5, 7 and 9 WAP. The ANOVA of the three years data based on *Glomus deserticola* treatments showed that the control plus *Alectra* resulted in a significantly higher root nodule number (64.50) than the other treatments. Also, 30 g/pot *Glomus clarum* treatment resulted in significantly higher root nodule number (68.98). Both *Glomus* spp. treatments resulted in higher values in cowpea variety SAMPEA 7. From this study, *Glomus clarum* treatment at 30 g/pot, is recommended for increased nodulation of cowpea varieties on an *Alectra vogelii* infested soil.

Keywords: *Glomus clarum*, *Glomus deserticola*, *Alectra vogelii*, Cowpea Varieties

INTRODUCTION
Cowpea (*Vigna unguiculata* [L.] Walp.) is an annual herb, warm season legume that serves as a major source of calories and protein for many people, especially in developing countries (Boukar *et al*., 2019). Cowpea was originally domesticated in sub-Saharan Africa but is now cultivated on every continent except Antarctica (Herniter *et al*., 2020). It demonstrates a wide range of growth habits, ranging from prostrate to erect; can be spreading, climbing, or bushy; and can be determinate or indeterminate. Cowpea is cultivated in a wide range of environments. The specific growth habits of a cultivar or landrace are generally associated with the particular environment and uses (Dugje *et al*., 2009).
As a food crop, cowpea is an excellent source of protein, fiber, and a wide range of micronutrients. Cowpea grains are 20%–30% protein by dry weight (Boukar *et al*., 2011), and the leaves have a similar protein content (Nielsen *et al*., 1997). The leaves and grain are also supplied as high protein feed and fodder to livestock. As a legume, the plants form root nodules in cooperation with nitrogen-fixing bacteria and are used as green manure (Fatokun *et al*., 2002). Symbiotic association with effective rhizobia is a prerequisite to attain maximal benefits from symbiotic N_2 fixation. Symbiotic N_2 fixation can compensate for missing soil nitrogen (N) and thus potentially save costly mineral N fertilizer (Guimarães *et al*., 2012; Rashid *et al*., 2012).
A major constraint to cowpea production in is a parasitic weed *Alectra vogelii*, which attaches to the roots of plants and diverts assimilate from roots and, hence cause the reduction in production of the total biomass of the plant and yield (Singh and Emechebe, 1997; Mbwaga *et al*., 2010). The current control measures being used by some farmers (such as cultural, mechanical, physical, chemical etc.) have many shortcomings. Considering the limitations of each control method there is need to search for an effective control measure that can be suitable for the host plant, safe for the environment, control the parasite and can be easily adopted by poor resource farmers. Arbuscular mycorrhiza fungi are ubiquitous in soil, forming symbiosis with most terrestrial plants including major crops: legumes and horticultural plants (Dalpe and Monreal, 2004; Wang and Shi, 2008). Spores of *Glomus clarum* are borne single in the soil with one subtending hypha while that of *Glomus deserticola* are found single or in loose aggregates lacking a peridium and with one subtending hypha. Germination occurs with a germ tube emerging from the lumen of a subtending hypha (Kirk *et al*., 2008). The benefit of the fungus is the receipt of carbohydrates from the host plant while the host plant obtains a larger surface area to support the uptake of nutrients from the soil as a result of the symbiotic association (John *et al*., 1983).
Therefore, this study was conducted to evaluate the tripartite interactions between cowpea varieties, Arbuscular Mycorrhizal Fungi and *Alectra vogelii* with emphasis on the role of the fungi on root nodule number of cowpea varieties.

MATERIALS AND METHODS
This pot experiment was conducted on a fenced farmland at Agwa New Extension, Trikania, Kaduna, beginning from May in 2016, 2017 and 2019 wet seasons. Four cowpea varieties comprising of two susceptible varieties (SAMPEA 7 and TVX 3236) and two moderately resistant varieties (IFE 82-12 and IT97K-499-35) to *Alectra* were obtained from the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria. The method of Heckman and Angle (1987) was used to prepare *Glomus* spp inoculum. Soil composed of a mixture of topsoil and sharp sand in ratio 1:1 was sieved using 4.75mm sieve, heat sterilized and placed in low density black colored polythene bags (in place of pots) used for planting. Four seeds each of the different cowpea varieties were planted in each polythene bag. They were arranged at an intra-row spacing of 0.30 m. The cowpea plants were inoculated with

propagules of *Glomus deserticola* or *Glomus clarum* depending on the treatments (0 with absence of *Alectra* (negative control), 0 with presence of *Alectra* (positive control) 10, 20 and 30 g per pot). During planting, a constant (3.3 g) quantity of *Alectra* was added to the soil. The AM fungal inoculum was mixed with the top 3 cm of the pot soil for each treatment. Each of the treatment above had three replicates and each replicate was represented by 8 pots. The treatments were arranged in Complete Randomized Design (CRD). The plants were thinned to two plants per pot at two weeks after planting. The cowpea seedlings were sprayed with Benlate (Benomyl) and Dithane M45 (Carbendazim) at the product rate of 0.6 kg/ha and 2.5 kg/ha respectively to control fungal diseases and Rogor (dimethoate) at 0.75 L/ha at 4 WAP, to prevent viral diseases. Sherpa plus (cypermethrin + perfekthion) was applied fortnightly at the rate of 1.0 L/ha, beginning from 7 WAP until harvest, to control insect pests during flowering and pod development (Alonge, 2000; Olaofe, 2001). The sampled plants were brought to the laboratory in labeled polythene bags, washed carefully with tap water and the surface water was allowed to drain. Number of root nodules was counted fortnightly on three randomly selected plants beginning from 5 to 9 WAP.

Analysis of Data

The data obtained on the growth parameters were subjected to analysis of variance (ANOVA) as described by Lawes Agricultural Trust (1980), to compare the varietal reaction of cowpea varieties to the presence of Arbuscular mycorrhizal fungi. Significant differences between treatments means were compared using Duncan Multiple range test (DMRT). The three years data on each parameter were pooled and subjected to ANOVA.

RESULTS

***Glomus deserticola* and Root Nodule Number:**

Table 1: Effect in *G. deserticola* on Root Nodule Number of Cowpea Varieties in 2016

Cowpea variety	VAM CONC (g)	PLANT'S AGE (WAP) Root Fresh Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	53.67^{ab}	120.33^{a}	94.33^{a}
	0+ parasite	46.33^{b}	87.33^{ab}	124.00^{a}
	10	46.67^{ab}	80.00^{ab}	130.33^{a}
	20	56.33^{a}	75.33^{b}	152.67^{a}
	30	51.00^{ab}	53.00^{b}	115.67^{a}
	Mean	50.8	83.20	123.40
	SE ±	2.80	12.57	19.96
IFE 82 -12	0-Parasite	24.67^{a}	88.00^{a}	70.00^{ab}
	0+ parasite	17.67^{a}	73.33^{ab}	90.00^{a}
	10	19.33^{a}	58.00^{ab}	52.67^{b}
	20	19.67^{a}	45.00^{b}	71.33^{ab}
	30	28.00^{a}	51.33^{ab}	85.67^{a}
	Mean	21.87	63.13	73.93
	SE ±	3.76	11.23	8.97
IT97K – 499 – 35	0- parasite	53.67^{a}	53.00^{ab}	119.67^{a}
	0+ parasite	7.67^{c}	28.67^{b}	89.00^{a}
	10	16.00^{bc}	62.67^{a}	122.67^{a}
	20	28.00^{b}	38.67^{ab}	32.00^{b}
	30	27.00^{b}	62.67^{a}	39.00^{b}
	Mean	26.47	49.14	80.47
	SE ±	4.33	9.18	14.54
TVX – 3236	0-parasite	51.67^{a}	63.00^{bc}	72.00^{c}
	0+ parasite	22.67^{c}	125.67^{a}	118.67^{b}
	10	33.67^{bc}	86.33^{b}	31.67^{d}
	20	41.67^{ab}	72.33^{bc}	183.00^{a}
	30	30.67^{bc}	54.00^{c}	72.67^{c}
	Mean	36.07	80.27	95.60
	SE ±	4.77	8.52	11.25

NB: Means followed by the same letter(s) in each column, under each variety are not significantly different ($P \leq 0.05$), using DMRT.
WAP- Weeks after Planting

At 5 WAP, the control plus *Alectra* treatment resulted in the lowest root nodule number in the cowpea varieties compared with other treatments in 2016 (Table 1). At 9 WAP, most *Glomus deserticola* treatments resulted in comparable root nodule number compared with the controls in 2016 (Table 1).

Table 2: Effect in *G. deserticola* on Root Nodule Number of Cowpea Varieties in 2017

Cowpea variety	VAM CONC (g)	PLANT'S AGE (WAP) Root Fresh Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	145.67^{a}	47.00^{b}	87.67^{a}
	0+ parasite	125.00^{ab}	87.00^{a}	80.00^{a}
	10	114.00^{bc}	89.33^{a}	82.00^{a}
	20	79.33^{d}	78.00^{ab}	91.00^{a}
	30	97.67^{cd}	67.00^{ab}	48.33^{b}
	Mean	112.33	73.67	77.80
	SE ±	7.37	9.73	5.14
IFE 82 -12	0-Parasite	83.67^{a}	41.67^{c}	55.00^{bc}
	0+ parasite	45.67^{b}	225.00^{a}	86.67^{a}
	10	61.00^{ab}	77.67^{bc}	87.67^{a}
	20	86.00^{a}	88.67^{b}	70.00^{ab}
	30	77.67^{ab}	247.00^{a}	34.33^{c}
	Mean	70.80	136.00	77.80
	SE ±	9.81	11.67	5.14
IT97K – 499 – 35	0- parasite	35.67^{b}	65.33^{a}	34.00^{c}
	0+ parasite	38.67^{b}	88.00^{a}	32.33^{c}
	10	8.00^{b}	76.67^{a}	55.67^{b}
	20	82.00^{a}	35.67^{b}	95.00^{a}
	30	107.33^{a}	28.67^{b}	55.67^{b}
	Mean	54.33	58.87	54.53
	SE ±	13.11	6.90	4.98
TVX – 3236	0-parasite	39.67^{c}	62.00^{c}	90.00^{b}
	0+ parasite	102.67^{a}	183.67^{b}	149.67^{a}
	10	42.00^{c}	81.67^{c}	57.00^{b}
	20	40.67^{c}	250.00^{a}	58.67^{b}
	30	74.00^{b}	78.00^{c}	72.00^{b}
	Mean	59.80	131.07	85.47
	SE ±	7.74	7.17	9.98

NB: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≤ 0.05), using DMRT. WAP- Weeks after Planting

At 7 WAP, most *Glomus deserticola* treatments mostly resulted in significantly higher root nodule number than the control without *Alectra* treatments in 2017 (Table 2). On the other hand, the control plus *Alectra* treatment resulted in higher root nodule number in most varieties at 7 WAP, compared with most *Glomus deserticola* treatments. At 9 WAP, most *Glomus deserticola* treatments resulted in comparable root nodule number compared with the controls in 2017 (Table 2).

Table 3: Effect in *G. deserticola* on Root Nodule Number in cowpea varieties in 2019

Year	Cowpea variety	VAM Conc.(g)	Plant's age(WAP) Root Nodule Number		
			5	7	9
2019	**SAMPEA 7**	0-	18.00^{a}	14.00^{c}	25.00^{a}
		0+	17.00^{a}	38.33^{a}	23.33^{a}
		10	13.67^{a}	25.67^{b}	34.00^{a}
		20	11.67^{a}	26.00^{b}	24.00^{a}
		30	9.67^{a}	35.33^{ab}	28.00^{a}
		Mean	14.00	27.87	26.87
		SE ±	3.82	3.37	4.02
	IFE 82-12	0-	9.67^{ab}	21.00^{ab}	36.00^{a}
		0+	7.67^{b}	25.00^{a}	14.67^{b}
		10	7.00^{b}	26.67^{a}	17.33^{ab}
		20	16.67^{a}	12.00^{b}	30.67^{ab}
		30	10.33^{ab}	12.00^{b}	28.67^{ab}
		Mean	10.27	19.33	25.47
		SE ±	2.59	2.73	5.91
	IT97K-499-35	0-	14.00^{a}	20.67^{a}	25.33^{a}
		0+	11.67^{ab}	15.33^{a}	36.00^{a}
		10	8.33^{b}	18.33^{a}	9.00^{b}
		20	10.00^{ab}	21.00^{a}	40.67^{a}
		30	11.33^{ab}	18.00^{a}	29.00^{a}
		Mean	11.07	18.67	28.00
		SE ±	1.45	2.50	4.89
	TVX 3236	0-	15.67^{a}	9.67^{c}	21.00^{ab}
		0+	14.00^{a}	17.33^{abc}	26.33^{ab}
		10	14.00^{a}	12.33^{bc}	32.67^{a}
		20	3.33^{b}	24.00^{a}	15.67^{b}
		30	3.67^{b}	20.33^{ab}	21.33^{ab}
		Mean	10.13	16.73	23.40
		SE ±	1.26	2.47	4.74

NB: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≤ 0.05), using DMRT. WAP- Weeks after Planting

At 5 WAP, the control without *Alectra* treatment resulted in the highest root nodule number in SAMPEA 7, IT97K-499-35 and TVX 3236 in 2019 (Table 3). Most treatments resulted in comparable root nodule number in the cowpea varieties at 5 – 9 WAP in 2019 with that due to the control treatments (Table 3).

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***Glomus clarum* and Root Nodule Number:**

Table 4: Effect in *G. clarum* on Root Nodule Number of Cowpea Varieties in 2016

Cowpea variety	VAM CONC (g)	PLANT'S AGE (WAP) Root Fresh Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	49.00ab	112.67b	70.00a
	0+ parasite	51.00a	107.67bc	69.33a
	10	38.67b	87.67c	70.00a
	20	48.67ab	109.33bc	45.00a
	30	41.67ab	137.67a	74.00a
	Mean	45.80	111.00	65.67
	SE ±	3.47	6.84	11.01
IFE 82 -12	0-Parasite	22.00b	73.00a	67.67a
	0+ parasite	15.33b	74.00a	62.00a
	10	19.00b	74.67a	76.33a
	20	50.00a	96.33a	50.00a
	30	42.67a	67.67a	49.00a
	Mean	29.80	77.13	61.00
	SE ±	5.74	10.46	15.55
IT97K – 499 – 35	0- parasite	40.00ab	71.00a	64.67a
	0+ parasite	33.67ab	72.67a	55.67ab
	10	32.00ab	36.33b	61.33a
	20	18.00b	38.00b	30.33ab
	30	42.67a	95.00a	21.33b
	Mean	33.27	62.60	46.67
	SE ±	6.70	9.24	10.27
TVX – 3236	0-parasite	32.33b	131.67a	44.00c
	0+ parasite	18.00c	100.67ab	72.33b
	10	47.00a	122.33a	125.00a
	20	51.67a	74.67b	35.67c
	30	46.00a	112.67ab	125.00a
	Mean	39.00	108.40	80.40
	SE ±	3.12	12.10	8.58

NB: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≤ 0.05), using DMRT.
WAP- Weeks after Planting

Most *Glomus clarum* treatments produced comparable root nodule numbers with that due to the control treatments in SAMPEA 7, 1FE 82–12 and IT97K-499-35 in 2016 (Table 4).

Table 5: Effect in *G. clarum* on Root Nodule Number of Cowpea Varieties in 2017

Cowpea variety	VAM CONC (g)	PLANT'S AGE (WAP) Root Fresh Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	132.00a	209.67b	64.67b
	0+ parasite	42.67b	184.00b	44.67c
	10	114.00a	77.67c	60.00bc
	20	125.00a	268.67a	74.67b
	30	108.00a	113.00c	98.33a
	Mean	104.33	170.60	68.47
	SE ±	9.65	14.50	5.76
IFE 82 -12	0-Parasite	126.00a	80.00c	53.67c
	0+ parasite	105.67b	33.00c	31.00c
	10	44.67d	54.00c	91.00ab
	20	79.67c	132.67b	57.67c
	30	117.67ab	195.67a	98.00a
	Mean	94.74	99.07	66.27
	SE ±	4.00	15.76	10.33
IT97K – 499 – 35	0- parasite	90.00a	60.00a	59.00c
	0+ parasite	62.67b	33.00a	83.00ab
	10	31.33c	50.00a	67.67bc
	20	91.00a	62.00a	93.33a
	30	68.33ab	53.33a	92.67a
	Mean	68.67	51.67	79.13
	SE ±	7.74	12.45	5.00
TVX – 3236	0-parasite	58.00c	196.00a	87.00a
	0+ parasite	123.00a	61.67b	40.67e
	10	100.67ab	69.67b	14.67e
	20	87.67bc	224.00a	58.00c
	30	89.00bc	187.67a	73.00b
	Mean	91.67	147.80	54.67
	SE ±	9.48	2.79	2.02

NB: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≤ 0.05), using DMRT.
WAP- Weeks after Planting

At 7 WAP, 20 g/pot *Glomus deserticola* treatment mostly resulted in the highest root nodule number of the cowpea varieties in 2017 (Table 5).

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Table 6: Effect in *G. clarum* on Root Nodule number in cowpea varieties in 2019

Cowpea variety	VAM Conc.(g)	Plant's age(WAP) Root Nodule Number		
		5	7	9
SAMPEA 7	0-	21.67^{a}	29.00^{a}	28.00^{a}
	0+	9.00^{b}	31.00^{a}	26.67^{a}
	10	16.67^{ab}	11.67^{b}	29.00^{a}
	20	10.67^{b}	26.33^{a}	41.00^{a}
	30	17.33^{ab}	35.33^{a}	28.67^{a}
	Mean	15.07	26.67	30.67
	SE ±	2.84	4.07	7.79
IFE 82-12	0-	2.67^{c}	18.00^{b}	12.67^{b}
	0+	7.33^{c}	19.33^{b}	26.33^{ab}
	10	8.33^{bc}	12.67^{b}	17.00^{b}
	20	26.00^{a}	19.00^{b}	30.33^{ab}
	30	16.33^{b}	34.67^{a}	38.00^{a}
	Mean	12.13	20.73	24.87
	SE ±	2.58	3.03	5.24
IT97K-499-35	0-	17.67^{ab}	15.67^{a}	11.00^{a}
	0+	18.33^{ab}	14.33^{a}	19.00^{a}
	10	15.00^{ab}	17.33^{a}	26.00^{a}
	20	10.00^{b}	13.67^{a}	12.00^{a}
	30	21.67^{a}	25.00^{a}	19.33^{a}
	Mean	16.53	17.20	17.47
	SE ±	2.88	4.04	4.27
TVX 3236	0-	11.00^{c}	26.00^{b}	9.33^{c}
	0+	16.33^{c}	17.67^{c}	47.67^{a}
	10	41.67^{a}	10.67^{d}	30.67^{b}
	20	11.67^{c}	20.33^{c}	26.67^{b}
	30	27.33^{b}	39.00^{a}	30.67^{b}
	Mean	21.60	22.73	29.00
	SE ±	1.94	1.31	1.48

NB: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≤ 0.05), using DMRT. WAP- Weeks after Planting

At 7 WAP, 30 g/pot *Glomus clarum* resulted in the highest root nodule number in the cowpea varieties in 2019 (Table 6). Most treatments resulted in comparable root nodule number at 7 and 9 WAP in most cowpea varieties (Table 6).

Table 7: Effect of *Glomus deserticola* and *Glomus clarum* on Root Nodule Number of Cowpea Varieties in 2016-2019 (combined data)

Treatment	*Glomus deserticola*	*Glomus clarum*
VAM (Conc.) g/pot		
0-	52.26^{c}	61.02^{b}
0+	64.50^{a}	50.84^{c}
10	49.77^{c}	50.07^{c}
20	58.52^{b}	62.49^{b}
30	52.39^{c}	68.98^{a}
Mean	55.49	58.68
SE±	1.43	1.35
Variety		
SAMPEA 7	65.55^{a}	70.92^{a}
IFE 82-12	54.17^{c}	53.97^{c}
IT97K-499-35	42.39^{d}	43.69^{d}
TVX 3236	59.84^{b}	66.14^{b}
Mean	59.49	58.68
SE±	1.28	1.35
Age		
Week 5	39.83^{b}	47.72^{c}
Week 7	63.16^{a}	76.30^{a}
Week 9	63.47^{a}	52.02^{b}
Mean	59.49	58.68
SE±	1.10	1.17
Year		
2016	65.36^{b}	63.39^{b}
2017	81.78^{a}	91.42^{a}
2019	19.32^{c}	21.22^{c}
Mean	59.49	58.68
SE±	0.08	0.09
Interactions		
Var*Conc.	*	*
Var*Age	*	*
Var*Year	*	*
Conc.*Age	*	*
Conc.*Year	*	*
Age*Year	*	*
Var*Conc.*Age*Year	*	*

NB: Means followed by the same letter(s) in each column, under each treatment are not significantly different (P≤ 0.05), using DMRT. WAP- Weeks After Planting

The ANOVA of the three years data based on *Glomus deserticola* treatments showed that, the control plus *Alectra* resulted in the highest root nodule number which was significantly higher than that due to all the other treatments. This was followed by that due to 20 g/pot *Glomus deserticola* treatment. The lowest root nodule number due to the control without *Alectra* was comparable with that due to 10 and 30 g/pot *Glomus deserticola* treatments (Table 7). The root nodule number varied significantly among the cowpea varieties. *Glomus deserticola* treatments resulted in the highest root nodule number in SAMPEA 7 which was significantly higher than that observed in the other varieties. This was followed by that

produced in TVX 3236. The lowest root nodule number in IT97K – 499 -35 was significantly lower than that of other varieties (Table 7). The highest root nodule number in cowpea varieties at 9 WAP was only comparable with that observed at 7 WAP. The lowest root nodule number in cowpea varieties at 5 WAP was significantly lower than that at 7 and 9 WAP (Table 7).
The ANOVA of the three years data based on *Glomus clarum* treatment showed that, 30 g/pot *Glomus clarum* treatment resulted in significantly higher root nodule number than that due to all the other treatments. This was followed by that due to 20 g/pot *Glomus clarum* treatment. The lowest root nodule number due to 10 g/pot *Glomus clarum* treatment was only comparable with that due to the control plus *Alectra* treatment. (Table 7). The root nodule number varied significantly among cowpea varieties with the highest root nodule number in SAMPEA 7 significantly higher than that observed in the other varieties. This was followed by that produced in TVX 3236. The lowest root nodule number in IT97K – 499 – 35 was significantly lower than that observed in all the other varieties (Table 7). The highest root nodule number in cowpea varieties at 7 WAP under the influence of *Glomus clarum* was significantly higher than that at 5 and 9 WAP. The lowest root nodule number at 5 WAP was significantly lower than at 7 and 9 WAP (Table 7).

DISCUSSION

The highest root nodule number observed in the control plus *Alectra* treatment compared with that in all the other *Glomus deserticola* treatments could be due to the attack of *Alectra* which might have stimulated root development and nodulation in the cowpea varieties. Tarfa *et al*. (1999) attributed increase in the number of root nodules produced by Soybean under *Alectra* infestation to hypersensitive reaction of the crop. In addition, the higher values of root nodule number in cowpea varieties due to *Glomus clarum* treatments compared with the control plus *Alectra* treatment could be due to the potency of the VAM to limit the reduction in cowpea growth under *Alectra* infestation compared with the control plus *Alectra* on the cowpea varieties. Many scientists have reported the role of AMF in uptake of soil nutrients, especially Nitrogen and Phosphorus, which can effectively promote the growth of host plants (Smith *et al*., 2011). Rajapakse and Miller (1987) observed that, inoculation with VAM fungi significantly increased the percentage of colonized roots, plant height and percentage nitrogen (N) of two cowpea (*Vigna unguiculata* (L) Walp.) cultivars.
The higher values of root nodule number observed in Cowpea variety SAMPEA 7 and/or TVX 3236 compared with the other varieties under each of the *Glomus* species might be due to the extent of the AM fungi colonization in the cowpea varieties which enhanced nutrient uptake and in turn supports plant growth. This agrees with the observation of Fidelibus *et al*. (2000) that, AMF has been shown to differentially colonize plant roots, thereby enhancing plant growth, biomass allocation and photosynthesis. This can also be attributed to the genetic make-up of the host plants. The cowpea varieties genetic make-up enables variation in their responses to AMF causing differences in the degree of the fine root development (Lebron *et al*., 2012). Also, it may be due to the preference of association between these cowpea varieties and the AM fungi species. AMF mycorrhization aids water and mineral elements uptake especially Phosphorus, which facilitates photosynthesis resulting into improved growth or development (Isobe *et al*., 2014; Katalin and Nguyen, 2019). Rolden-Fajardo (1994) and Guo *et al*. (2022) posited that, each plant has a specific reaction to certain associated mycorrhizal fungal strain. The influence of mycorrhization might have reduced or minimized the effect of the parasite. The findings of Klironomos (2003) and Scheublin *et al*. (2004) showed that, AMF and the composition of AMF communities regulate plant interactions and influence the structure of plants. This is similar to the findings of Salahedin *et al*. (2013) that, mycorrhizal treatments significantly increased the shoot and root lengths of chickpea in a calcareous soil.
Root nodule number in cowpea varieties under *Glomus deserticola* treatments had the highest values at 9 WAP while under *Glomus clarum* treatments, root nodule number had the highest values at 7 WAP. This might be due to an indication of the peak period of rapid vegetative growth or crop level of maturity involving the synthesizing of growth stimulating hormones and an increased rate of photosynthesis. The rapidly growing shoot produced more assimilate that supported its further growth, synthesize higher level of growth stimulating hormones to effect the rapid vegetative growth (Alonge, 2000).

Conclusion and Recommendations

The result of this work shows that *Glomus clarum* at 20 and 30 g/pot treatment resulted in significant increase in root nodule number compared with the control with *Alectra* treatment in the four cowpea varieties considered. Therefore, the following are being recommended:

1. Cowpea variety SAMPEA 7 can be cultivated on soils infected with *Alectra*, if *Glomus deserticola* or *Glomus clarum* treatments are applied in order to obtain higher values for root nodule number.
2. The use of each *Glomus* species at 20 and 30 g/pot treatment in soils, with *Alectra* is recommended to obtain higher values for root nodule number.
3. Further research work is needed to determine the interactions between the root nodule number of cowpea varieties, other strains of AMF, on *Alectra* inoculated soil, under sterilized and unsterilized conditions.

Further research work is needed to determine the interactions between the root nodule number of cowpea varieties, fertilizer application, AMF with *Alectra* under sterilized and unsterilized conditions.

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