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THE EFFECT OF *Glomus deserticola* ON THE MANAGEMENT OF *Alectra vogelii* IN COWPEA (*Vigna unguiculata* L. Walp) VARIETIES

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ABSTRACT

This research was conducted to evaluate the effect of *Glomus deserticola* on the management of root and shoot dry weight of four cowpea varieties in an *Alectra vogelii* inoculated soil. The four cowpea varieties used were: SAMPEA 7, IFE 82-12, IT97K-499-35 and TVX 3236. The sterilized sandy-loamy soil used for this experiment consisted of mixture of top soil and sand in ratio 1:1 (v/v). *Glomus deserticola* treatments was applied at five rates: the zero and without *Alectra*, zero and with *Alectra*, 10, 20 and 30 g/pot each with *Alectra*. A constant quantity of *Alectra* (3.3 g) was maintained where applicable. The treatments were arranged in complete randomized design. The cowpea plants were sampled for root and shoot dry weight at 5, 7 and 9 weeks after planting (WAP). The ANOVA of the three years data showed that *Glomus deserticola* treatments at different rates significantly increased cowpea root and shoot dry weights compared with the control treatments. *Glomus deserticola* at 30 g/pot resulted in the highest root and shoot dry weight of the cowpea varieties. SAMPEA 7 treated with *Glomus deserticola*, had higher values of root and shoot dry weight than the other cowpea varieties at 9 WAP. In conclusion, *Glomus deserticola* treatments significantly increased root and shoot dry weight of the four cowpea varieties on *Alectra* inoculated soil and can be recommended as a biological control agent in *Alectra vogelii* infested fields.

Keywords: *Alectra vogelii*, *Glomus deserticola*, Root and Shoot dry weights

INTRODUCTION

Cowpea is an important legume crop which is widely grown under low input production systems and in arid and semi-arid agro-ecologies of the world. It is predominantly a self-fertilizing crop. Cowpea grain contains a high proportion of protein (19 to 35 %) which is rich in two essential amino acids, lysine and tryptophan (Abadassi, 2015; Ibro *et al*., 2014). The crop has the ability to grow under harsh environmental conditions where other major crops fail to grow. Its foliage is regarded as an important source of high-quality livestock feed. In addition, cowpea has the ability to restore soil fertility through nitrogen fixation, making it a good crop to use in crop rotation with major cereal crops (Daryanto *et al*., 2015). *Alectra vogelii* which affects cowpea adversely belongs to the Orobanchaceae family (Broomrape family) or sub-family Orobanchoideae of Scrophulariaceae. It is also a serious weed of late planted groundnut and soybean in the same ecological zone (Nikcrent and Musselman, 2004). A Mycorrhiza is a symbiotic (generally mutualistic, but occasionally weakly pathogenic) association between a fungus and the roots of a vascular plants (Kirk *et al*., 2001). *Glomus* is a genus of arbuscular mycorrhizal fungi with all species forming symbiotic relationships (mycorrhizas) with plant roots. *Glomus* is the largest genus of Arbuscular mycorrhiza fungi, with 85 species described but currently defined as non-monophyletic (Kirk *et al*., 2008). *Glomus deserticola* are arbuscular mycorrhizal fungi that form symbioses with plant roots, where they obtain carbon (photosynthate) from the host plant in exchange for nutrients and other benefits. The mycorrhizae consist of arbuscules, vesicles, as well as intra and extra radical hyphae (Kirk *et al*., 2008).

The current control measures being used by some farmers to control parasites (such as cultural, mechanical, physical, chemical e.t.c) have many shortcomings. For instance, the health risks associated with chemical control method, the environmental pollution potential, the safety of the host crop and the demand for skilled application are challenges being faced by resource limited farmers. Use of pesticides can cause drastic effects on non-target species and affect animal and plant biodiversity, aquatic as well as terrestrial food webs and ecosystem (Mahmood *et al*., 2016). Pesticides residues in human body can cause headache, vomiting, abnormal births, cancer, hepatic and renal problems e.t.c (Goel and Aggarwal, 2007). Host plant resistance could be overcome by new strain of the parasite. Integrated pest management requires expertise of various fields, education and training of farmers which takes a long time (Surendra, 2019). 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. 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 and shoot dry weight of cowpea varieties. This is of importance because some farmers grow cowpea plant particularly to use it as a fodder crop.

MATERIALS AND METHODS

This pot experiment was conducted on a fenced farmland at Agwa New Extension, Trikania, Kaduna (10° 31'35°N and 7°26'20°E and 601.68 m above sea level) 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 to *Alectra* (IFE 82-12 and IT97K-499-35) were obtained from the Seed Production Unit, Institute for Agricultural Research (IAR), Ahmadu Bello

University, Zaria. Also, the *Alectra* seeds and AM inoculum were gotten from IAR farms, Zaria and University of Ibadan, Ibadan respectively. The method of Heckman and Angle (1987) was used to prepare *Glomus deserticola* inoculum. Soil composed of a mixture of topsoil and sharp sand in ratio 1:1 was sieved, sterilized and placed in polythene bag. Polythene bags (1200 ml capacity equivalent to 1.5 kg of soil) were filled up to 80 % with the soil-sand mixture (approx. 1.2 kg of soil) to serve as pots for planting. Four seeds each of the different cowpea varieties were planted in each polythene bag. These pots were arranged at an intra-row spacing of 0.30 m. The cowpea plants were inoculated at the point of planting with propagules of *Glomus deserticola* depending on the treatments (control without *Alectra,* control with *Alectra*, 10, 20 and 30 g per pot) each with a constant quantity of *Alectra* (3.3 g). The AM fungal inoculum was mixed with the top 3 cm of the pot soil for the relevant treatments. Each of the five treatments was assigned eight pots in three replicates. 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 with (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. Weeds with the exception of *Alectra* were controlled by hand pulling as at when necessary from 2 WAP. At each sampling, cowpea plants were carefully uprooted from three pots per treatment and for each variety. 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. The selected cowpea plants were separated into root and shoot using a knife and each part was then put in labeled envelopes, oven dried at 70 ^{0}C and dried weight taken. Root and shoot dry weights were taken fortnightly beginning from 5 to 9 WAP.

Fractional Mycorrhizal Root Colonisation

A random sample from each washed root system was collected (approximately 2 g (fresh weight) before oven-drying the root system at 5 WAP. The root fragments were then cut into approximately 1cm pieces and cleared for 10 minutes in 10 % KOH at 121 ^{0}C in an autoclave. It was then rinsed with water, immersed in 5 % HCl and stained for 30 minutes in 0.01 % acid Fuchsin dissolved in destaining solution (14:1:1 lactic acid: glycerol: water), (Kormanik and McGraw, 1982). The stain was then drained and the root pieces washed thoroughly with water before destaining overnight. Percent colonization was then assessed using the root segment ± method where colonization was calculated as the number of root segments (1 cm in length) with any form of AMF colonization divided by the total number of segments examined (Biermann and Linderman, 1981).

Number and Fresh Weight of Parasites

On each sampling date (fortnightly beginning from 5 to 9 WAP), the roots of the plants were carefully examined (with the aid of stereo microscope during the first sampling) in order to separate plants infected by the parasite from the uninfected ones. The number of plants in each group was noted. The parasitic weed plants attached to the roots of the infected cowpea plants were detached, separated into emerged and unemerged and then counted. These were then weighed together for fresh weight. Emergent *Alectra* plants (*Alectra* incidence) were counted weekly starting from three weeks after crop emergence in relevant pots.

Analysis of Data

The data obtained on the root and shoot dry weights 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 the Duncan Multiple range test (DMRT). The three years data on each parameter were pooled and subjected to ANOVA.

RESULTS AND DISCUSSION

Glomus deserticola and Root Dry Weight: *Glomus deserticola* at 30 g/pot treatment resulted in a higher root dry weight in SAMPEA 7, IFE 82-12 and TVX 3236 at 5 and 9 WAP in 2016 compared with other treatments (Table 1). The control without *Alectra* treatment resulted in a lower root dry weight in IFE 82-12 and TVX 3236 at 5 – 9 WAP in 2017 compared with all the other treatments (Table 1). *Glomus deserticola* treatments at 10, 20 and 30g/pot resulted in comparable root dry weight in IFE 82 – 12, IT97K-499-35 and TVX 3236 at 5 – 9 WAP in 2019 (Table 1). Root dry weight due to the control without *Alectra* treatment was higher than that due to the control plus *Alectra* treatment in IFE 82 – 12 and IT97K-499-35 (Table 1). The ANOVA of the three years data based on *Glomus deserticola* treatments showed that, 30 g/pot *Glomus deserticola* treatments recorded the highest root dry weight which was significantly higher than the other treatments. The lowest root dry weight due to 20 g/pot *Glomus deserticola* treatment was only comparable with the control plus *Alectra* treatment (Fig.1). Also, *Glomus deserticola* treatments resulted in the highest root dry weight in SAMPEA 7 which was significantly higher than that observed in the other varieties. The lowest root dry weight which was observed in TVX 3236 was only comparable with that in IFE 82 – 12. (Table 3). The root dry weight recorded at various cowpea plant ages varied significantly from each other with the highest root dry weight recorded at 9 WAP significantly higher than that at 5 and 7 WAP.

Glomus deserticola and Shoot Dry Weight: At 7 and 9 WAP, the control treatments resulted in a lower shoot dry weights in SAMPEA 7 in 2016 than that due to 20 and the 30 g/pot *Glomus deserticola* treatments (Table 2). In 2017, most treatments produced comparable shoot dry weight at 5 and 7 WAP in most of the varieties (except SAMPEA 7). Similar observation was made in TVX 3236 in 2016 at 5 and 7 WAP. At 5 and 9 WAP, the control without *Alectra* treatment resulted in a lower shoot dry weight in IFE 82-12 in 2017 than at 20 and 30 g/pot *Glomus deserticola* treatments (Table 2). The control without *Alectra* treatment resulted in the highest shoot dry weight in SAMPEA 7 and IFE 82-12 at 5 – 9 WAP in 2019 (Table 2). *Glomus deserticola* treatment at 20 and 30 g/pot resulted in lower shoot dry weight at 5 and 7 WAP in SAMPEA 7 and IFE 82-12, compared with the two control treatments (Table 2). The ANOVA of the three years data showed the control without *Alectra* treatment resulted in the highest shoot dry weight which was comparable with that at 10 and 30 g/pot. The control plus *Alectra* treatment resulted in significantly lower shoot dry weight than the other treatments (Table 2). Also, the highest shoot dry weight in SAMPEA 7 was significantly higher than the other varieties. The lowest shoot dry weight in TVX 3236 was only comparable with that observed in IT97K – 499-35 (Fig. 2). The shoot dry weight recorded at various cowpea plant ages varied significantly from each other with the highest shoot dry weight recorded at 9 WAP significantly higher than that at 5 and 7 WAP (Table 3).

Glomus deserticola and *Alectra* plant count: Generally, recorded cases of emerged and unemerged *Alectra* plants on cowpea varieties were under the control plus *Alectra* treatment and/ or 10 g/pot *Glomus deserticola* treatment and also from varieties SAMPEA 7 and TVX 3236. No *Alectra* shoot (emerged or unemerged) was found on IT97K-499-35 at 7 WAP and SAMPEA 7 at 9 WAP but IFE 82-12 only had one unemerged *Alectra* shoot under 10 g/pot *Glomus deserticola* treatment at 7 WAP in 2016.

Table 1: Effect of *Glomus deserticola* on root dry weight of cowpea varieties on *Alectra vogelii* inoculated soil in 2016, 2017 and 2019

Cowpea variety	Year	AMF CONC (g)	Root Dry Weight (g) at		
			5 WAP	7 WAP	9 WAP
SAMPEA 7	2016	0 – parasite	0.47^{c}	1.07^{a}	4.50^{c}
		0+ parasite	0.53^{c}	0.87^{b}	4.13^{c}
		10	0.80^{b}	1.07^{a}	3.30^{d}
		20	0.70^{b}	1.07^{a}	6.17^{b}
		30	1.53^{a}	1.20^{a}	7.23^{a}
		Mean	0.81	1.06	5.07
		SE ±	0.05	0.06	0.13
	2017	0 – parasite	0.67^{a}	0.83^{a}	0.77^{ab}
		0+ parasite	0.33^{c}	0.50^{b}	0.63^{abc}
		10	0.67^{a}	0.63^{b}	0.50^{bc}
		20	0.50^{b}	0.53^{b}	0.80^{a}
		30	0.43^{bc}	0.60^{b}	0.47^{c}
		Mean	0.52	0.62	0.63
		SE ±	0.05	0.06	0.08
	2019	0 – parasite	0.20^{b}	0.63^{a}	0.63^{a}
		0+ parasite	0.33^{a}	0.30^{b}	0.27^{b}
		10	0.03^{c}	0.37^{b}	0.70^{a}
		20	0.02^{c}	0.63^{a}	0.67^{a}
		30	0.20^{b}	0.17^{c}	0.70^{a}
		Mean	0.16	0.42	0.59
		SE ±	0.03	0.02	0.04
IFE 82 -12	2016	0 – parasite	0.33^{cd}	0.40^{b}	2.57^{ab}
		0+ parasite	0.30^{d}	0.50^{b}	2.40^{ab}
		10	0.67^{b}	0.67^{a}	2.07^{b}
		20	0.43^{c}	0.50^{b}	2.07^{b}
		30	1.87^{a}	0.67^{a}	3.13^{a}
		Mean	0.72	0.55	2.47
		SE ±	0.03	0.04	0.23
	2017	0 – parasite	0.37^{c}	0.50^{b}	0.37^{c}
		0+ parasite	0.60^{a}	0.60^{ab}	1.00^{a}
		10	0.43^{bc}	0.60^{ab}	0.73^{b}
		20	0.50^{abc}	0.60^{ab}	1.03^{a}
		30	0.57^{ab}	0.77^{a}	0.50^{c}
		Mean	0.49	0.61	0.73
		SE ±	0.05	0.05	0.06
	2019	0 – parasite	0.23^{a}	0.50^{a}	0.73^{a}
		0+ parasite	0.20^{a}	0.43^{ab}	0.47^{b}
		10	0.23^{a}	0.43^{ab}	0.67^{ab}
		20	0.23^{a}	0.33^{bc}	0.90^{a}
		30	0.23^{a}	0.23^{c}	0.70^{ab}
		Mean	0.23	0.39	0.69
		SE ±	0.03	0.03	0.07
IT97K – 499–35	2016	0 – parasite	0.50^{b}	0.57^{b}	6.53^{a}
		0+ parasite	0.17^{c}	0.40^{c}	3.53^{c}
		10	0.20^{c}	0.77^{a}	3.50^{c}
		20	0.30^{c}	0.27^{d}	2.03^{d}
		30	1.90^{a}	0.27^{d}	4.57^{b}
		Mean	0.61	0.45	4.03
		SE ±	0.05	0.03	0.12
	2017	0 – parasite	0.43^{a}	0.43^{b}	0.73^{ab}
		0+ parasite	0.40^{a}	0.70^{a}	0.70^{ab}
		10	0.37^{a}	0.77^{a}	0.67^{ab}
		20	0.37^{a}	0.53^{b}	0.53^{b}
		30	0.37^{a}	0.37^{b}	0.87^{a}
		Mean	0.39	0.56	0.70
		SE ±	0.06	0.05	0.07

	2019	0 – parasite	0.07^{a}	0.27^{a}	0.40^{a}
		0+ parasite	0.04^{ab}	0.23^{a}	0.37^{a}
		10	0.03^{ab}	0.23^{a}	0.13^{b}
		20	0.03^{ab}	0.23^{a}	0.40^{a}
		30	0.02^{b}	0.30^{a}	0.43^{a}
		Mean	0.04	0.25	0.35
		SE ±	0.01	0.03	0.06
TVX 3236	2016	0 – parasite	0.53^{b}	0.37^{d}	2.97^{b}
		0+ parasite	0.20^{b}	1.00^{a}	2.20^{c}
		10	0.37^{b}	0.83^{b}	3.67^{ab}
		20	0.40^{b}	0.57^{c}	1.57^{c}
		30	1.70^{a}	0.73^{b}	3.97^{a}
		Mean	0.64	0.70	2.87
		SE ±	0.10	0.03	0.22
	2017	0 – parasite	0.33^{a}	0.47^{c}	0.53^{c}
		0+ parasite	0.33^{a}	0.67^{a}	0.80^{ab}
		10	0.43^{a}	0.53^{bc}	0.90^{a}
		20	0.23^{a}	0.53^{bc}	0.57^{c}
		30	0.37^{a}	0.63^{ab}	0.73^{b}
		Mean	0.34	0.57	0.71
		SE ±	0.06	0.03	0.05
	2019	0 – parasite	0.20^{ab}	0.27^{c}	0.20^{b}
		0+ parasite	0.13^{bc}	0.33^{bc}	0.63^{a}
		10	0.30^{a}	0.23^{c}	0.47^{a}
		20	0.09^{c}	0.47^{ab}	0.27^{b}
		30	0.20^{ab}	0.50^{a}	0.50^{a}
		Mean	0.19	0.36	0.41
		SE ±	0.03	0.04	0.06

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

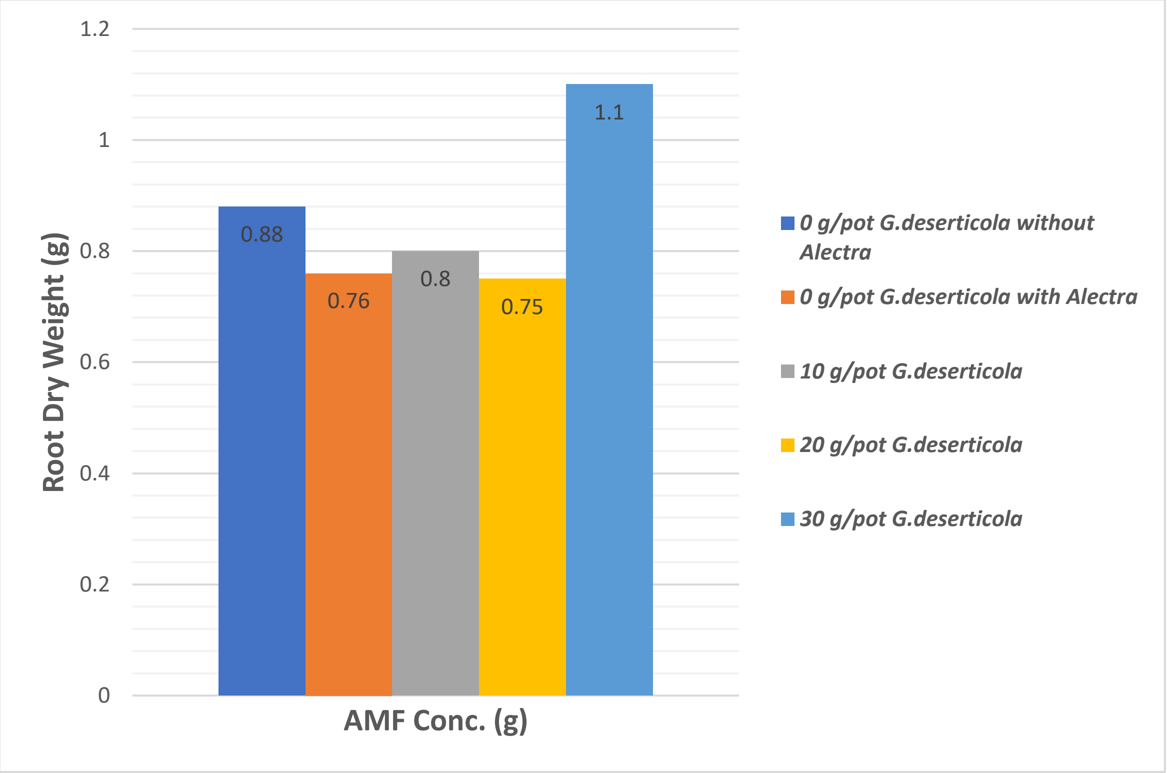

Figure 1: Effect of *Glomus deserticola* on root dry weight of cowpea varieties in 2016, 2017 and 2019 (combined data)

Table 2: Effect of *Glomus deserticola* on shoot dry weight of cowpea varieties on *Alectra vogelii* inoculated soil in 2016, 2017 and 2019

Cowpea variety	Year	AMF CONC (g)	Shoot Dry Weight (g) at:		
			5 WAP	7 WAP	9 WAP
SAMPEA 7	2016	0 – parasite	1.47^{b}	3.80^{c}	4.50^{c}
		0+ parasite	1.47^{b}	2.80^{d}	4.13^{c}
		10	2.20^{a}	4.47^{b}	3.30^{d}
		20	2.37^{a}	5.10^{a}	6.17^{b}
		30	1.53^{b}	4.30^{b}	7.20^{a}
		Mean	1.53	4.09	5.06
		SE ±	0.10	0.12	0.15
	2017	0 – parasite	1.60^{a}	1.90^{a}	3.17^{ab}
		0+ parasite	0.77^{c}	1.33^{b}	2.03^{c}
		10	1.43^{ab}	2.00^{a}	2.77^{b}
		20	1.00^{bc}	1.17^{c}	3.57^{a}
		30	1.00^{bc}	1.97^{a}	1.70^{c}
		Mean	1.16	1.67	2.65
		SE ±	0.16	0.05	0.14
	2019	0 – parasite	0.93^{a}	2.23^{a}	3.33^{a}
		0+ parasite	0.73^{b}	1.10^{b}	1.77^{bc}
		10	0.57^{c}	1.10^{b}	2.27^{b}
		20	0.47^{c}	0.87^{bc}	1.77^{bc}
		30	0.50^{c}	0.67^{c}	1.40^{c}
		Mean	0.64	1.19	2.11
		SE ±	0.05	0.08	0.22
IFE 82 -12	2016	0 – parasite	2.27^{ab}	1.40^{c}	2.57^{b}
		0+ parasite	1.33^{d}	2.53^{b}	2.40^{b}
		10	2.43^{a}	3.40^{a}	2.07^{c}
		20	1.60^{cd}	3.70^{a}	2.07^{c}
		30	1.87^{bc}	3.73^{a}	3.13^{a}
		Mean	1.90	2.95	2.45
		SE ±	0.12	0.11	0.08
	2017	0 – parasite	1.10^{b}	2.00^{a}	1.27^{c}
		0+ parasite	1.50^{ab}	2.03^{a}	3.07^{a}
		10	1.70^{a}	1.63^{b}	2.00^{bc}
		20	1.50^{ab}	2.20^{a}	2.67^{ab}
		30	1.47^{ab}	2.23^{a}	1.67^{c}
		Mean	1.45	2.02	2.14
		SE ±	0.12	0.11	0.22
	2019	0 – parasite	1.03^{a}	1.67^{a}	3.00^{a}
		0+ parasite	0.90^{b}	1.70^{a}	1.77^{b}
		10	0.70^{c}	1.50^{a}	2.63^{a}
		20	0.70^{c}	1.10^{a}	3.07^{a}
		30	0.33^{d}	1.00^{b}	1.83^{b}
		Mean	0.73	1.39	2.46
		SE ±	0.04	0.10	0.21
IT97K – 499–35	2016	0 – parasite	1.53^{b}	2.00^{a}	6.20^{a}
		0+ parasite	1.27^{b}	2.97^{a}	3.53^{c}
		10	1.43^{b}	1.50^{cd}	3.40^{c}
		20	1.37^{b}	1.20^{d}	2.03^{d}
		30	1.90^{a}	1.80^{bc}	4.57^{b}
		Mean	1.50	1.89	3.95
		SE ±	0.11	0.13	0.22
	2017	0 – parasite	1.27^{a}	1.40^{b}	2.13^{b}
		0+ parasite	1.20^{a}	2.03^{a}	2.00^{bc}
		10	1.10^{a}	2.33^{a}	1.93^{c}
		20	1.17^{a}	2.07^{a}	1.73^{d}
		30	1.07^{a}	1.50^{b}	2.93^{a}
		Mean	1.16	1.87	2.93
		SE ±	0.07	0.13	0.05
	2019	0 – parasite	0.30^{b}	0.90^{b}	3.10^{a}
		0+ parasite	0.33^{b}	0.90^{b}	2.00^{b}
		10	0.20^{c}	0.90^{b}	0.90^{c}
		20	0.53^{a}	0.97^{b}	3.03^{a}
		30	0.27^{bc}	1.50^{a}	1.83^{b}
		Mean	0.33	1.03	2.17
		SE ±	0.03	0.07	0.09

TVX 3236	2016	0 – parasite	1.70[a]	1.80[c]	2.97[b]
		0+ parasite	0.70[b]	3.93[a]	2.30[c]
		10	1.67[a]	3.93[a]	3.67[a]
		20	1.53[a]	3.10[b]	1.57[d]
		30	1.77[a]	3.80[a]	3.30[ab]
		Mean	1.47	3.13	2.76
		SE ±	0.14	0.11	0.20
	2017	0 – parasite	0.97[b]	1.57[ab]	1.67[c]
		0+ parasite	0.97[b]	1.93[a]	2.73[a]
		10	1.23[a]	1.50[ab]	2.73[a]
		20	0.53[d]	1.50[ab]	1.70[c]
		30	0.77[c]	1.43[b]	2.13[b]
		Mean	0.89	1.59	2.19
		SE ±	0.05	0.14	0.07
	2019	0 – parasite	0.53[ab]	0.97[a]	1.60[b]
		0+ parasite	0.50[ab]	1.10[a]	2.13[a]
		10	0.63[a]	1.27[a]	2.27[a]
		20	0.37[b]	1.23[a]	1.63[b]
		30	0.47[ab]	1.23[a]	1.10[c]
		Mean	0.50	1.16	1.75
		SE ±	0.05	0.10	0.12

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

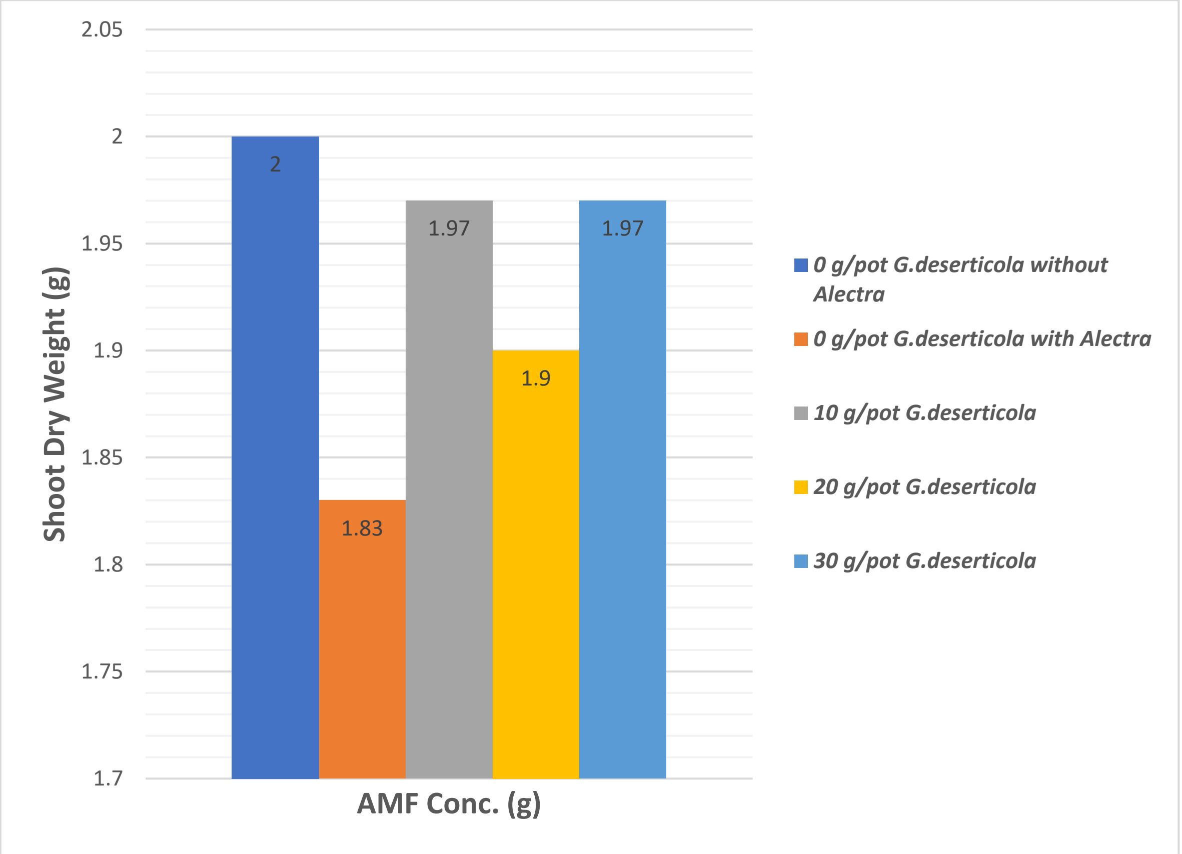

Figure 2: Effect of *Glomus deserticola* on shoot dry weight of cowpea varieties in 2016, 2017 and 2019 (combined data)

Table 3: Effect of *Glomus deserticola* on Root and Shoot dry weight of cowpea varieties in 2016-2019 (combined data)

Treatment	Root dry weight (g)	Shoot dry weight (g)
Variety		
SAMPEA 7	1.10a	2.26a
IFE 82-12	0.76c	1.94b
IT97K-499-35	0.82b	1.78c
TVX 3236	0.75c	1.74c
Mean	0.86	1.93
SE±	0.01	0.02
Age		
Week 5	0.43c	1.13c
Week 7	0.54b	2.02b
Week 9	1.60a	2.65a
Mean	0.86	1.93
SE±	0.01	0.02
Year		
2016	1.66a.	2.76a
2017	0.57b	1.74a
2019	0.31c	1.29c
Mean	0.86	1.93
SE±	0.001	0.001

NB: Means followed by the same letter(s) on each column, under each parameter are not significantly different (P≤ 0.05), using DMRT. NS = Not Significant, *= Significant

Table 4: Effect of *Glomus deserticola* on *Alectra vogelii* growth parameters at 7 and 9 WAP in 2016

Cowpea Variety	VAM CONC (g)	*Glomus deserticola*					
		7 WAP			9 WAP		
		No. of emerged plants	No. of unemerged plants	Fresh weight (g)	No. of emerged plants	No. of unemerged plants	Fresh weight (g)
SAMPEA 7	0 – parasite	-	-	-	-	-	-
	0+ parasite	10	10	8.7	-	-	-
	10	-	9	13.7	-	-	-
	20	-	3	0.5	-	-	-
	30	-	4	0.7	-	-	-
IFE 82 -12	0 – parasite	-	-	-	-	-	-
	0+ parasite	-	-	-	-	-	-
	10	-	1	1.4	-	-	-
	20	-	-	-	-	-	-
	30	-	-	-	-	1	0.8
IT97K – 499 – 35	0 – parasite	-	-	-	-	-	-
	0+ parasite	-	-	-	-	-	-
	10	-	-	-	5	5	17.4
	20	-	-	-	-	-	-
	30	-	-	-	-	-	-
TVX 3236	0	-	-	-	-	-	-
	0+ parasite	-	3	1.2	3	4	14.5
	10	-	1	0.1	-	-	-
	20	-	2	1.0	-	-	-
	30	-	1	1.7	-	-	-

Table 5: Effect of *Glomus deserticola* on *Alectra vogelii* growth parameters at 7 and 9 WAP in 2017

Cowpea Variety	VAM CONC (g)	*Glomus deserticola*					
		7 WAP			9 WAP		
		No. of emerged plants	No. of unemerged plants	Fresh weight (g)	No. of emerged plants	No. of unemerged plants	Fresh weight (g)
SAMPEA 7	0 – parasite	-	-	-	-	-	-
	0+ parasite	-	5	0.9	-	1	0.2
	10	-	-	-	-	-	-
	20	-	-	-	-	-	-
	30	-	-	-	-	-	-

IFE 82 -12	0 – parasite	-	-	-	-	-	-
	0+ parasite	-	-	-	-	-	-
	10	-	1	0.5	-	-	-
	20	-	-	-	-	-	-
	30	-	-	-	-	-	-
IT97K – 499 – 35	0 – parasite	-	-	-	-	-	-
	0+ parasite	-	-	-	-	-	-
	10	-	-	-	-	-	-
	20	-	-	-	-	-	-
	30	-	-	-	-	-	-
TVX 3236	0	-	-	-	-	-	-
	0+ parasite	-	2	1.3	-	2	1.5
	10	-	-	-	-	-	-
	20	-	-	-	-	-	-
	30	-	-	-	-	-	-

Table 6: Percentage Colonization for Cowpea Variety Sampled at 5 WAP

	Percentage Colonization (%)
Cowpea variety	*Glomus deserticola*
SAMPEA 7	77.27
IFE 82-12	64.29
IT97K-499-35	52.94
TVX 3236	60.00

Discussion

The higher values of root and shoot dry weights observed in the *Glomus deserticola* treatments compared with the control plus *Alectra* treatment suggests that, AMF concentration supports to a high degree increase in the fresh and dry weights. The highest root and shoot dry weight was at 30 g/pot *Glomus deserticola* treatment. The increase observed in the root and shoot dry weights might be due to the extent of the AM fungi colonization of the plant which could be associated with the level of the affinity of the symbiosis between them. This in turn might have altered the mycorrhizospere, AM fungi symbiosis with cowpea and other microbes' interactions favouring more root system formation. The fine hyphal structure in this region provides a large surface area to support the uptake of nutrients from the soil (John *et al*., 1983). The extra radical mycelium (ERM) can effectively improve nutrient uptake, thereby improving plant growth and development (Lehmann and Rillig, 2015). This is in agreement with the findings of Mohammed *et al*. (2001) that, the percent reduction (82 %) of *Striga* emergence after AM inoculation resulted in about 28 % increase in total dry matter of *Sorghum* over control. Also, it might be due to the efficient compensatory effect of AM fungi in the presence of the parasite thereby minimizing the *Alectra* effect on the host plant hence its being reflected in the dry weights of the root and shoot. Haro *et al.* (2016) also reported that the inoculation of cowpea varieties with AMF resulted in significant increase in shoot and root biomass compared with the control plants.

The highest root and shoot dry weight for the *Glomus deserticola* treatments as well as the highest percentage of mycorrhizal colonization observed in cowpea variety SAMPEA 7 may be attributed to the genetic make-up of the host plants. The cowpea varieties genetic make-up enables variation in AMF responses causing differences in the degree of the fine root development (Lebr on *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 P, which might facilitate photosynthesis resulting into improved growth or development (Isobe *et al*., 2014). Rolden-Fajardo (1994) 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. Root dry weight and shoot dry weight having their highest values at 9 WAP may probably be due to the crop level of maturity. This is in agreement with Das *et al*. (2008) that dry matter production in plant gradually increases with crop age and attain maximum at maturity. Also, this may be due to AMF mycorrhization which brings about an increase in nutrient uptake through exploitation of a larger soil volume by the AMF fungal hyphae (as the roots elongate) which in turn enhances plant growth and nitrogen fixation (Abbott and Robson, 1984).

Most recorded cases of emerged and unemerged *Alectra* plants on cowpea varieties was at the control plus *Alectra* treatment and/ or 10 g/pot *Glomus* spp. treatment which suggests the potency of the *Glomus* spp. at higher concentrations of 20 and 30 g/pot *Glomus* spp. treatments to limit the growth of emerged and unemerged *Alectra* plants. This is similar to the findings of Lendzemo (2009) who reported a reduction in the performance of *Striga* in terms of numbers attached to the root systems, relative time of emergence, numbers emerged and total dry weight of the emerged *Striga* shoots at harvest of *Sorghum*.

CONCLUSION

The result of this work shows that *Glomus deserticola* at different concentrations resulted in significant increase in root and shoot dry weight compared with the control with *Alectra* treatment in the four cowpea varieties considered.

RECOMMENDATIONS

Therefore, the following are being recommended:

i. Cowpea varieties SAMPEA 7 on soils infected with *Alectra* is recommended, if *Glomus deserticola* treatments are applied in order to obtain higher values for root and shoot dry weight.
ii. The use of *Glomus deserticola* at 30 g/pot treatment in soils, with *Alectra* is recommended to obtain higher values for root and shoot dry weight.

iii. For a higher value of root and shoot dry weight of cowpea, 9 WAP should be considered for its collection time.
iv. Further research work is needed to determine the interactions between the root and shoot fresh weights of cowpea varieties, other strains of AMF, on *Alectra* inoculated soil, under sterilized and unsterilized conditions.

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