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Root and Shoot Dry Weight Response to *Glomus Clarum* for Some Selected Cowpea (*Vigna Unguiculata* (L.) Walp) Varieties under *Alectra Vogelii* Inoculated Soil

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Abstract

This research was conducted to evaluate the effect of *Glomus clarum* on the root and shoot dry weight of four cowpea varieties on *Alectra vogelii* inoculated soil. 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 clarum* was 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. The treatments were arranged in complete randomized design. Four cowpea seeds were planted per pot but later thinned to two seedlings per pot at two weeks after planting (WAP). These cowpea plants were sampled for root and shoot dry weight at 5, 7 and 9 WAP. Most *Glomus clarum* treatments indicated a significant increase ($p \leq 0.05$) on root and shoot dry weight of cowpea varieties. *Glomus clarum* treatment at 30 g/pot resulted in the highest root and shoot dry weight which was comparable with the two control treatments and significantly higher with that due to all the other treatments respectively. Cowpea variety SAMPEA 7 mostly resulted in higher values compared with other cowpea varieties for root and shoot dry weight at 9 WAP. From this study, *Glomus clarum* treatment at 30 g/pot increased root and shoot dry weight of the cowpea varieties compared to other treatments, therefore, is recommended as a biological control agent.

Keywords: *Glomus clarum*, *Alectra vogelii*, Cowpea Varieties, Root dry weight, Shoot dry weight.

Introduction

Cowpea (*Vigna unguiculata* L. Walp. L) is an important leguminous crop largely grown by smallholder farmers in sub-Saharan Africa for food security and animal feed (Nkomo, *et al.*,2021). According to FAOSTAT (2017), over 87 % of cowpeas are produced in Africa. Nigeria is the largest producer and consumer of cowpeas and accounts for 61 % of the production in Africa and 58 % worldwide (Baysah, 2013). Fifty-two percent of Africa's production of cowpeas is used for food, 13 % as animal feed, 10 % for seeds, 9 % for other uses, and 16 % is wasted (Baysah, 2013). Cowpea has many beneficial uses as animal feed, human consumption, and income generation (IITA, 2009). The roughage is utilized as food for animals during the long dry season in the semi-arid areas and to fatten small ruminants in anticipation of different celebrations (Hall, 2012). In the agricultural system, it compensates for the loss of nitrogen absorbed by cereals, thus, it has a positive impact on soil properties. This is due to its unique capacity to fix atmospheric nitrogen and performs well even in poor soils. The crop has also weeds suppressing ability. Being a drought-tolerant and warm-weather crop, it is a promising food and forage species in a typical tropical lowland climate (Alemu *et al*., 2016; Belay *et al*., 2017; Bilatu *et al*., 2012). The cowpea root is an important organ, it supplies nutrients, moisture and other compounds needed for normal development of flowers, fruits and seed in angiosperm (El Zahar Haichar *et al*., 2014).

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. 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 (Bowles *et al*., 2016).

The yields of cowpea have generally remained below the potential of the crop due to several factors (Kebede and Bebeko, 2020; Ewansiha *et al*. 2014). A major constraint to cowpea production 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). Considering the many shortcomings of the current control measures being used by some farmers to control parasitic weed infestation on cowpea, there is still 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, the objective of this study was to evaluate the tripartite interactions between cowpea varieties, *Glomus clarum* and *Alectra vogelii* with emphasis on the role of the fungi on root and shoot dry weight 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, sterilized and placed in polythene bags (in place of pots) and 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. 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 and shoot dry weight 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 clarum* and root dry weight**: the control without *Alectra* treatments mostly resulted in lower root dry weight compared with that due to all the other treatments of the cowpea varieties at 7 WAP in 2016 (Table 1). Most *Glomus clarum* treatments resulted in root dry weight in IFE 82-12 and IT97K-499-35 at 5 – 9 WAP in 2017 comparable with the control treatments (Table 2). The control plus *Alectra* treatment resulted in the highest root dry weight in IT97K-499-35 and TVX 3236 but lowest in SAMPEA 7 at 5 and 7 WAP in 2019. Also, the control without *Alectra* treatment resulted in the lowest root dry weight in IFE 82-12 and TVX 3236 at 5 and 9 WAP in 2019 (Table 3).

The ANOVA of the three years data based on *Glomus clarum* treatments showed that, 30 g/pot *Glomus clarum* treatment resulted in the highest root dry weight which was comparable with the two control treatments. This was followed by that due to 10 g/pot *Glomus clarum* treatment. The lowest root dry weight due to 20 g/pot *Glomus clarum* treatment was only significantly lower than that due to all the other treatments (Table 7). The root dry weight varied significantly among cowpea varieties with the highest root dry weight recorded in SAMPEA 7 significantly higher than that observed in all the other varieties. This was followed by that produced in TVX 3236. The lowest root dry weight in

IT97K – 499 – 35 was significantly lower than that observed in the other varieties. The root dry weight recorded at various cowpea plant ages varied significantly from each other with the highest at 9 WAP significantly higher than that at 5 and 7 WAP. The lowest root dry weight at 5 WAP was significantly lower than that at 7 and 9 WAP (Table 7).

***Glomus clarum* and shoot dry weight**: the control treatments mostly resulted in lower shoot dry weight in IFE 82-12 and IT97K-499-35 at 5 and 7 WAP in 2016 compared with that due to the other treatments (Table 4). The control without *Alectra* treatment mostly resulted in the highest shoot dry weight in 1FE 82 – 12, IT97K-499-35 and TVX 3236 at 5 and 7 WAP in 2017 (Table 5). At 7 and 9 WAP, the control plus *Alectra* treatment mostly resulted in the lowest shoot dry weight in SAMPEA 7, IFE 82-12 and TVX 3236 in 2019 (Table 6). Similar observation was also made for most varieties at 5 WAP. *Glomus clarum* at 30 g/pot treatment mostly resulted in the highest shoot dry weight in IFE 82 – 12, IT97K-499-35 and TVX 3236 at 9 WAP in 2019 (Table 6). Most of the *Glomus clarum* treatments resulted in higher shoot dry weight than the two control treatments especially at 7 and 9 WAP.

The ANOVA of the three years data based on *Glomus clarum* treatments showed that, 30 g/pot *Glomus clarum* treatment resulted in significantly higher shoot dry weight compared with that due to all the other treatments. This was followed by that due to the control without *Alectra* treatment. The control plus *Alectra* treatment resulted in significantly lower shoot dry weight compared with that due to all the other treatments (Table 7). The shoot dry weight varied significantly among cowpea varieties with the highest shoot dry weight recorded in SAMPEA 7 significantly higher than that due to all the other varieties. This was followed by that produced in TVX 3236.The lowest shoot dry weight in IT97K – 499 – 35 was significantly lower than that observed in the other varieties (Table 7). The shoot dry weight recorded at various cowpea plant ages varied significantly from each other with the highest shoot dry weight at 9 WAP significantly higher than that at 5 and 7 WAP. The lowest shoot dry weight at 5 WAP was significantly lower than that at 7 and 9 WAP (Table 7).

Table 1: Effect in *G. clarum* on Root Dry Weight of Cowpea Varieties in 2016

Cowpea variety	**VAM CONC (g)**	**PLANT'S AGE (WAP)**		
		Root Dry Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	0.47^{b}	0.93^{b}	7.20^{a}
	0+ parasite	0.33^{cd}	1.07^{ab}	5.57^{b}
	10	0.40^{bc}	1.07^{ab}	5.87^{b}
	20	0.63^{a}	0.90^{b}	3.13^{c}
	30	0.27^{d}	1.33^{a}	5.87^{b}
	Mean	0.42	1.06	5.53
	SE ±	0.02	0.10	0.12

IFE 82 -12	0-Parasite	0.13^{b}	0.57^{c}	1.83^{c}
	0+ parasite	0.17^{b}	0.77^{a}	3.60^{a}
	10	0.40^{a}	0.73^{ab}	2.07^{bc}
	20	0.30^{a}	0.63^{bc}	2.40^{b}
	30	0.33^{a}	0.60^{c}	3.43^{a}
	Mean	0.27	0.66	2.67
	SE ±	0.04	0.03	0.12
IT97K – 499 – 35	0- parasite	0.33^{b}	0.33^{d}	2.40^{b}
	0+ parasite	0.23^{bc}	0.67^{b}	2.73^{a}
	10	0.20^{c}	0.50^{c}	2.40^{b}
	20	0.27^{bc}	0.47^{c}	1.20^{d}
	30	0.53^{a}	1.07^{a}	1.57^{c}
	Mean	0.31	0.61	2.06
	SE ±	0.03	0.03	0.10
TVX – 3236	0-parasite	0.27^{b}	0.80^{ab}	3.47^{b}
	0+ parasite	0.20^{b}	0.90^{a}	3.60^{b}
	10	0.23^{b}	0.97^{a}	2.60^{c}
	20	0.40^{a}	0.67^{b}	4.30^{a}
	30	0.23^{b}	0.67^{b}	3.33^{b}
	Mean	0.27	0.80	3.46
	SE ±	0.02	0.05	0.18

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

Table 2: Effect in *G. clarum* on Root Dry Weight of Cowpea Varieties in 2017

Cowpea variety	**VAM CONC (g)**	**PLANT'S AGE (WAP)** Root Dry Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	0.63^{a}	0.93^{a}	1.13^{a}
	0+ parasite	0.47^{b}	0.57^{b}	0.67^{c}
	10	0.37^{bc}	0.60^{b}	0.53^{c}
	20	0.30^{c}	1.03^{a}	0.60^{c}
	30	0.47^{b}	0.67^{a}	0.87^{b}
	Mean	0.45	0.76	0.76
	SE ±	0.04	0.03	0.05
IFE 82 -12	0-Parasite	0.23^{b}	0.53^{b}	0.67^{a}
	0+ parasite	0.47^{a}	0.63^{ab}	0.63^{a}
	10	0.43^{a}	0.47^{b}	0.60^{a}

	20	0.53^{a}	0.77^{a}	0.50^{a}
	30	0.53^{a}	0.63^{ab}	0.53^{a}
	Mean	0.44	0.61	0.59
	SE ±	0.04	0.05	0.06
IT97K – 499 – 35	0- parasite	0.50^{a}	0.60^{ab}	0.80^{a}
	0+ parasite	0.37^{a}	0.57^{ab}	0.70^{a}
	10	0.37^{a}	0.63^{a}	0.70^{a}
	20	0.37^{a}	0.40^{b}	0.73^{a}
	30	0.37^{a}	0.73^{a}	0.83^{a}
	Mean	0.40	0.59	0.75
	SE ±	0.05	0.06	0.07
TVX – 3236	0-parasite	0.50^{a}	0.73^{ab}	0.80^{a}
	0+ parasite	0.30^{b}	0.47^{c}	0.20^{c}
	10	0.33^{a}	0.43^{c}	0.53^{b}
	20	0.13^{c}	0.57^{bc}	0.63^{b}
	30	0.33^{a}	0.83^{a}	0.50^{b}
	Mean	0.32	0.61	0.50
	SE ±	0.05	0.05	0.04

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

Table 3: Effect in *G. clarum* on Root Dry Weight of Cowpea Varieties in 2019

Cowpea variety	**VAM CONC (g)**	**PLANT'S AGE (WAP)** Root Dry Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	0.63^{a}	0.93^{a}	1.13^{a}
	0+ parasite	0.47^{b}	0.57^{b}	0.67^{c}
	10	0.37^{bc}	0.60^{b}	0.53^{c}
	20	0.30^{c}	1.03^{a}	0.60^{c}
	30	0.47^{b}	0.67^{a}	0.87^{b}
	Mean	0.45	0.76	0.76
	SE ±	0.04	0.03	0.05
IFE 82 -12	0-Parasite	0.23^{b}	0.53^{b}	0.67^{a}
	0+ parasite	0.47^{a}	0.63^{ab}	0.63^{a}
	10	0.43^{a}	0.47^{b}	0.60^{a}
	20	0.53^{a}	0.77^{a}	0.50^{a}
	30	0.53^{a}	0.63^{ab}	0.53^{a}
	Mean	0.44	0.61	0.59

	SE ±	0.04	0.05	0.06
IT97K – 499 – 35	0- parasite	0.50^{a}	0.60^{ab}	0.80^{a}
	0+ parasite	0.37^{a}	0.57^{ab}	0.70^{a}
	10	0.37^{a}	0.63^{a}	0.70^{a}
	20	0.37^{a}	0.40^{b}	0.73^{a}
	30	0.37^{a}	0.73^{a}	0.83^{a}
	Mean	0.40	0.59	0.75
	SE ±	0.05	0.06	0.07
TVX – 3236	0-parasite	0.50^{a}	0.73^{ab}	0.80^{a}
	0+ parasite	0.30^{b}	0.47^{c}	0.20^{c}
	10	0.33^{a}	0.43^{c}	0.53^{b}
	20	0.13^{c}	0.57^{bc}	0.63^{b}
	30	0.33^{a}	0.83^{a}	0.50^{b}
	Mean	0.32	0.61	0.50
	SE ±	0.05	0.05	0.04

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

Table 4: Effect in *G. clarum* on Shoot Dry Weight of Cowpea Varieties in 2016

Cowpea variety	**VAM CONC (g)**	**PLANT'S AGE (WAP)** Shoot Dry Weight (g)		
		5	7	9
SAMPEA 7	0 – parasite	2.33^{a}	3.00^{c}	7.20^{a}
	0+ parasite	1.17^{b}	3.67^{b}	5.60^{b}
	10	2.10^{a}	4.60^{a}	5.87^{b}
	20	2.27^{a}	3.60^{b}	3.13^{c}
	30	1.47^{b}	4.40^{a}	5.87^{b}
	Mean	0.15	3.85	5.53
	SE ±	1.87	0.10	0.12
IFE 82 -12	0-Parasite	1.23^{ab}	3.10^{cd}	1.83^{b}
	0+ parasite	1.20^{b}	2.77^{d}	3.60^{a}
	10	1.60^{ab}	4.30^{a}	2.07^{b}
	20	1.57^{ab}	3.60^{b}	2.40^{b}
	30	1.67^{a}	3.33^{bc}	3.33^{a}
	Mean	1.45	3.42	2.65
	SE ±	0.13	0.12	0.25
IT97K – 499 – 35	0- parasite	1.57^{c}	1.97^{c}	2.40^{a}
	0+ parasite	1.37^{c}	1.93^{c}	2.73^{a}

	10	1.47^{c}	2.13^{c}	2.40^{a}
	20	2.17^{b}	2.73^{b}	1.20^{b}
	30	2.57^{a}	3.43^{a}	1.57^{b}
	Mean	1.83	2.44	2.06
	SE ±	1.00	0.18	0.19
TVX – 3236	o-parasite	1.40^{b}	4.33^{a}	3.47^{b}
	o+ parasite	1.53^{b}	3.33^{b}	3.60^{ab}
	10	1.87^{a}	4.37^{a}	2.60^{c}
	20	2.07^{a}	3.37^{b}	4.30^{a}
	30	1.43^{b}	3.10^{b}	3.33^{b}
	Mean	1.66	3.70	3.46
	SE ±	0.07	0.16	0.22

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

Table 5: Effect in *G. clarum* on Shoot Dry Weight of Cowpea Varieties in 2017

Cowpea variety	**VAM CONC (g)**	**PLANT'S AGE (WAP)** Shoot Dry Weight (g)		
		5	7	9
SAMPEA 7	o – parasite	1.77^{a}	2.40^{b}	2.13^{bc}
	o+ parasite	1.07^{b}	1.63^{c}	1.47^{c}
	10	1.20^{b}	1.63^{c}	0.60^{d}
	20	1.07^{b}	2.67^{a}	2.67^{ab}
	30	0.73^{c}	1.67^{c}	3.13^{a}
	Mean	1.17	0.08	2.00
	SE ±	0.04	2.00	0.23
IFE 82 -12	o-Parasite	1.57^{a}	2.10^{b}	2.60^{a}
	o+ parasite	0.83^{b}	2.60^{a}	2.03^{b}
	10	1.47^{a}	1.37^{c}	1.97^{bc}
	20	1.47^{a}	2.27^{ab}	1.57^{c}
	30	1.37^{a}	2.03^{b}	1.60^{c}
	Mean	1.34	2.07	1.95
	SE ±	0.12	0.13	0.12
IT97K – 499 – 35	o- parasite	1.73^{a}	2.33^{a}	2.67^{a}
	o+ parasite	1.57^{ab}	1.93^{b}	1.90^{b}
	10	1.17^{b}	2.13^{ab}	2.00^{b}
	20	1.13^{b}	1.40^{c}	2.10^{a}
	30	1.30^{ab}	2.30^{a}	1.63^{b}

	Mean	1.38	2.02	2.06
	SE ±	0.15	0.07	0.19
TVX – 3236	0-parasite	3.00^{a}	2.57^{a}	2.57^{a}
	0+ parasite	0.73^{c}	1.77^{bc}	0.57^{d}
	10	1.43^{b}	2.10^{abc}	1.77^{b}
	20	0.63^{c}	1.70^{c}	1.57^{bc}
	30	1.30^{b}	2.40^{ab}	1.20^{c}
	Mean	1.42	2.11	1.54
	SE ±	0.10	0.19	0.11

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

Table 6: Effect in *G. clarum* on shoot dry weight in cowpea varieties in 2019

Year	**Cowpea variety**	**VAM Conc.(g)**	**PLANT'S AGE (WAP)** Shoot Dry Weight		
			5	7	9
2019	**SAMPEA 7**	0-	0.57^{b}	1.20^{a}	1.70^{b}
		0+	0.43^{c}	1.00^{a}	1.43^{b}
		10	0.60^{b}	1.07^{a}	1.50^{b}
		20	0.73^{a}	1.37^{a}	2.30^{a}
		30	0.53^{b}	1.30^{a}	1.83^{b}
		Mean	0.57	1.19	1.75
		SE ±	0.03	0.16	0.13
	IFE 82-12	0-	0.37^{d}	1.00^{b}	1.37^{c}
		0+	0.20^{c}	0.97^{b}	1.37^{c}
		10	1.00^{a}	1.07^{b}	2.63^{b}
		20	0.83^{b}	2.07^{a}	1.60^{c}
		30	0.53^{c}	2.07^{a}	2.97^{a}
		Mean	0.59	1.43	1.99
		SE ±	0.03	0.09	0.08
	IT97K-499-35	0-	0.50^{b}	1.47^{ab}	1.03^{c}
		0+	0.13^{c}	0.90^{b}	1.47^{b}
		10	0.43^{b}	0.83^{b}	2.10^{a}
		20	0.50^{b}	1.80^{a}	2.27^{a}
		30	1.00^{a}	2.13^{a}	2.40^{a}
		Mean	0.51	1.43	1.85
		SE ±	0.04	0.24	0.11

TVX 3236	0-	0.17^{c}	1.27^{b}	1.00^{d}
	0+	0.57^{b}	0.93^{b}	1.33^{cd}
	10	0.63^{b}	1.23^{b}	1.77^{bc}
	20	0.47^{b}	2.47^{a}	2.13^{b}
	30	0.90^{a}	2.17^{a}	5.73^{a}
	Mean	0.55	1.61	2.39
	SE ±	0.05	0.20	0.13

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

Table 7: Effect of *Glomus clarum* on Root and Shoot Dry weight of Cowpea Varieties in 2016-2019 (combined data)

Treatment	Root Dry weight	Shoot Dry weight
VAM (Conc.) g/pot		
0-	0.84^{a}	2.03^{b}
0+	0.85^{a}	1.70^{d}
10	0.76^{b}	1.92^{c}
20	0.73^{c}	1.98^{bc}
30	0.87^{a}	2.21^{a}
Mean	0.81	1.97
SE±	0.01	0.02
Variety		
SAMPEA 7	1.15^{a}	2.22^{a}
IFE 82-12	0.70^{c}	1.88^{c}
IT97K-499-35	0.62^{d}	1.73^{d}
TVX 3236	0.77^{b}	2.05^{b}
Mean	0.81	1.97
SE±	0.01	0.02
Age		
Week 5	0.29^{c}	1.19^{c}
Week 7	0.61^{b}	2.27^{b}
Week 9	1.52^{a}	2.44^{a}
Mean	0.81	1.97
SE±	0.09	0.02
Year		
2016	1.51^{a}	2.83^{a}
2017	0.57^{b}	1.76^{b}

2019	0.35[c]	1.32[c]
Mean	0.81	1.97
SE±	0.001	0.001
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

Discussion

The higher values of root and shoot dry weights mostly observed in *Glomus clarum* 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 values of root and shoot dry weights at 30 g/pot *Glomus clarum* treatment might be due to host root systems been extended by widespread extraradical mycelia (due to AMF inoculation) enabling colonized roots to reach more water and nutrient pools unavailable to uncolonized roots (Katalin and Nguyen, 2019). Also, the lower values of root and shoot dry weights recorded in the control plus *Alectra* treatment might have been due to the parasitic effect of *Alectra* in the treatments. This suggest that, the influence of mycorrhization might have reduced or minimized the effect of the parasite. This is in agreement with the reports of Lendzemo *et al*. (2009), that mycorrhization reduced the impact of *Striga* on crop plants when soils infested with *Striga* were inoculated with AMF and used for crop cultivation.

The highest root and shoot dry weights observed in SAMPEA 7 compared with other cowpea varieties might have been due to the fact that the cowpea variety had ensured adequate biomass accumulation with a higher level of photosynthesis. 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.

The highest root and shoot dry weight at 9 WAP which 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 affect the rapid vegetative growth (Alonge, 2000). The lowest shoot dry weight at 5 WAP might have been due to the early stages of crop growth characterized by an initial stage of vegetative development. 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.

Conclusion

The result of this work shows that *Glomus clarum* at 30 g/pot treatment resulted in significant increase in root and shoot dry weights compared with the control with *Alectra* treatment in the cowpea varieties considered.

Recommendations

Based on the research findings, the following are being recommended:

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

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