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Full Length Research Paper

Farm yard manure reduces the virulence of *Alectra vogelii* (Benth) on cowpea (*Vigna unguiculata)*

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The average productivity of cowpea in arid and semi-arid regions of Kenya is low due to a complex of biotic and abiotic stresses. Among the major biotic factors is the parasitic weed *Alectra vogelii*. Six cowpea varieties were evaluated in 2010 to determine the effect of farm yard manure on *A. vogelii* on six cowpea genotypes. Treatments consist of three tolerant (Kib-18, Kir/Nya-005 and Sia/Cia-004) and three susceptible genotypes (K80, M66 and Tra/Kir-001). Three levels of manure (0, 5 and 10 ton/ha) were applied. The experiment was conducted at Kiboko research sub-centre (37° 43' N and 2°13' E). Most of the yield and yield determining attributes recorded significant (P < 0.05) at 5 and 10 ton/ha. M66 and K80 recorded the highest *A. vogelii* count at 6, 8, 10 and 12 weeks after planting (WAP) in all treatments. Average grain yield ranged between 365 to 2276 kg/ha at 0 ton/ha, 1693 to 4042 kg/ha at 5 ton/ha and 476 to 6797 kg/ha at 10 ton/ha. Sia/cia-004 (local cultivar) recorded the highest yield of 2276 kg/ha at 0 ton/ha. On the other hand, M66 (commercial variety) recorded the lowest yields of 365 kg/ha at 0 ton/ha. Application of a handful of (5 and 10 ton/ha) farm yard manure reduced *A. vogelii* density by >50% at 6, 8, 10 and 12 WAP with increase in mean number of pods per plant and yield. Therefore, farm yard manure application is advantageous in reducing the effect of *Alectra* parasitism on cowpea.

Key words: Cowpea, farm yard manure, *Alectra vogelii.*

INTRODUCTION

Cowpea (*Vigna unguiculata* L. (Walp.) is a leguminous herbaceous warm-season annual crop that is similar in appearance to common bean except that leaves are generally darker green, shinier, and less pubescent. Early maturing cowpea varieties provide food early in the season before the late maturing crops. Cowpea flowers in 55 days after planting and is suitable for shortening the “hungry period” that often occurs just prior to harvest of the late seasonal crops. Being a fast growing crop, cowpea curbs erosion by covering the ground. In soils with adequate amounts of phosphorus it fixes atmospheric nitrogen, and its decaying shoot and root residues contributing to soil fertility (Carsky et al., 2002; Tarawali et al., 2002; Sanginga et al., 2003). The crop is also used as food and source of vegetable.

Productivity of cowpea is constrained by moisture and heat stresses, declining soil fertility and poor crop management practices all resulting to low yields. In addition, the looming climate change and variability is likely to exacerbate the effect caused by the constraints. In particular, it is likely that the biggest impacts of changes will be on agricultural and food systems (Brown and Funk, 2008). Lobell et al. (2008) reported that climate change is likely to reduce food availability because of a reduction in agricultural production. Evidence provided by the Intergovernmental Panel for Climate Change (IPCC) shows that higher frequency and diffusion of climate fluctuations is likely to produce more severe and frequent droughts leading to short-term fluctuations in food production in semi-arid and sub-humid areas. These changes are likely to reduce cowpea yields further which at the moment are 20 to 30% of the potential (Wortmann et al., 1998). In addition, a high significant drop on cowpea yield from 1500 to 234 kg/ha in Makueni district is as a result of low soil fertility, inadequate farm inputs, noxious weeds, pest and diseases and lack of seeds during planting time (Kimiti et al., 2009). With the increasing food shortage in the semi-arid areas, it has

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become urgent to develop technologies for legumes for bridging the food deficit gap. Food legumes which are well adapted for the dry areas are among the orphan crops that are being encouraged by the Kenyan government through the ministry of Agriculture for food security. Cowpea is the second most important grain legume in Kenya after common beans. The area under cowpea is estimated at 1800 ha excluding the area under the crop in home gardens (Kimiti et al., 2009). About 85% of the total area under the cowpea is in arid and semi-arid lands (ASALs) of Eastern province and 15% in the Coast, Western, and Central provinces (Kimiti et al., 2009).

Recent efforts to improve cowpea yields in Kenya have been hampered by the presence of *Alectra vogelii*, a parasitic weed that has now established itself in most of the farmers' fields in Eastern province. The menace of *Alectra* invasion on cowpea is on the increase in Mbeere, Makueni, Kibwezi, Kitui, Yatta, Mwala and the neighbouring districts where farmers know little or are not aware of its existence and damage (Karanja et al., 2009). The *Alectra* weed present in these regions has multiple stem branching at the base; subsoil plant parts have a deep orange colour, yellow flowers and leaves are light green (Karanja et al., 2009). *A. vogelii* effect on cowpea was first recognized in Kenya in the 1920, where 20% yield loss was estimated in Embu district (Bagnall-Oakley et al., 1991). Fields infested by this parasitic weed were difficult to clean, due to their enormous reproductive capacity. *Alectra* is very prolific producing 10 times more seeds than Striga, *Striga hermonthica,* which produces 50,000–250,000 seeds per plant. The seeds of *A. vogelii* persist in the soil for up to 15 years waiting for the host plant (Kroschel, 1998). Thus, growing a susceptible cowpea variety in an infested field in one season increase immensely the soil seed bank and can be a cause of lowering cowpea yield. For instance, in South-east of Botswana an improved variety (Black-eyed) yielded 602 kg/ha without the parasitic weed compared to 100 kg/ha in heavily infested sites (Riches, 1989a). In addition, experiment carried at KARI-Kiboko research farm recorded a yield loss of 80% in Ken-Kunde in *Alectra* infested plots (Karanja et al., 2011). Studies also show that *Alectra* infection reduces shoot dry matter by over 50% (Alonge et al., 2002). Serious crop yield losses, caused by *A. vogelii*, have also been reported in cowpea and groundnut (Atokple et al., 1995; Riches, 1990; Singh et al., 1991, 1993).

Cowpea plants that are infested by *A.vogelii* often appear wilted prior to *Alectra* emergence. Infection also results in delayed onset of flowering, reduced number on flowers and pods, and hence a reduced yield of cowpea seed even when soil moisture is not limiting (Magani and Lagoke, 2009). *Alectra* can only grow by attaching itself to the roots of the host plant. The negative effect of *Alectra* in reducing the vegetative and grain yield of cowpea is due to competition for growth factors. The effect is more pronounced where it involves high nutrients and water from the host plant. It can reduce the yield of host crop by >50% and even cause complete crop failure (100% yield loss) under severe infestation.
Hence, the weed does not only deprive the host of nutrients, but it also wastes the energy utilized for their uptake (Singh et al., 2002).

A. vogelii pose a serious threat to cowpea production in Eastern Kenyan. The weed has also been observed infest Kenyan local beans (Mwetemania) and a wild species Arachis in Mbeere and Narok district (Karanja et al., 2009). In Mbeere district where the weed has been in existence for more than 50 years (reports from farmers), the common control method used by farmers is hand pulling. This has not been effective because the weed re-emerge from its underground growth to form more *Alectra* shoots. According to farmers, infested fields by this parasitic weed are difficult to clean, due to their enormous re-emergence capacity which most farmers attribute to the weed underground root tuberous structure (Karanja et al., 2009).

For effective management in the fields, the survey carried out by Karanja et al. (2009) indicates that a combined use of host plant resistance/tolerance and crop rotation with non-host nitrogen fixing legumes, increase of soil fertility and proper seed management may not only stop further spread of the weed, but also reduce soil seed bank for *Alectra*. Although several authors have reported improved, high yielding striga/*Alectra* resistant cowpea genotypes which are becoming popular with farmers in West African Savanna (Singh et al., 2002; Kamara et al., 2008), the same cannot be said in Kenya. In addition, no known use of integrated approaches involving the combination of susceptible cowpea varieties with crop management to increase their yields. This calls need to source for effective control method(s) to combat the devastating effect of *Alectra* on cowpea. Increase of soil fertility has been reported to suppress virulence of *Striga* weed and increase grain yield in maize (Kamara et al., 2007). Therefore, this study was undertaken to assess the effect of farm yard manure on *A. vogelii* parasitism on six cowpea cultivars.

MATERIALS AND METHODS

A field trial was conducted to assess the use of farm yard manure for the control of *A. vogelii* in different cowpea cultivars at Kenya Agricultural Research Institute (KARI) Kiboko research farm located at latitude 37° 43'N and longitude 2°13'E, 686 m above sea level. The site where the experiment was conducted has a bimodal rainfall which range between 223 to 290 mm per year. It has a mean minimum temperature of 28°C and maximum of 37°C. The chemical properties of the soil in the experimental site and manure applied are shown in Table 1.

The experiment was on a randomised complete block design laid as split-plot with six cowpea cultivars. Of the six cultivars, three; K80, Tra/Kir-001 and M66 are susceptible while the other three, Kir/Nya-005, Kib-18 and Sia/Cia-004 are tolerant to *A. vogelii*. The cowpea cultivars were the main plots, while the sub-plots consisted of three manure rates (0, 5 and 10 $tonha^{-1}$). Farm yard manure

Table 1. Chemical properties of the experimental site soil and farm yard manure before planting.

Fertility	Soil	Manure
pH	6.79	9
Total nitrogen %	0.08	1
Organic Carbon	0.55	NA
Phosphorus ppm	22.89	2.62
Potassium me %	1.27	2.39
Calcium me %	3.32	1.46
Magnesium me%	2.36	0.12
Manganese me %	0.48	401 mg/kg
Copper ppm	3.04	21 mg/kg
Iron ppm	23.9	572 mg/kg
Zinc ppm	1.86	112.35 mg/kg
Sodium me %	0.17	NA

NA-not analysed.

Table 2. Combined effect of genotype on the number of *A. vogelii* shoots in cowpea grown under infestation at KARI-Kiboko.

Varieties	Number of *Alectra* shoots/7.5 m^2 at											
	6 WAP			8 WAP			10 WAP			12 WAP		
	0	5	10	0	5	10	0	5	10	0	5	10
K80	27	8	4	38	15	11	41	22	17	41	24	20
M66	19	8	3	32	23	13	39	24	15	41	27	20
Tra/Kir-001	9	3	1	19	6	5	24	9	7	27	10	8
Kir/Nya-005	2	2	1	8	12	8	12	15	10	14	17	10
Kib-18	3	2	2	8	4	6	13	6	9	14	7	10
Sia/Cia-004	1	1	1	8	5	2	9	8	2	9	9	3
SE	2.942			5.526			5.397			5.321		

WAP= weeks after planting.

(cow) was weighed and applied in the hills at the rate of 0, 5 and 10 ton/ha and mixed thoroughly with the soil. *A.vogelii* inoculum was prepared by mixing 30 g of *Alectra* seeds collected from infested fields at Kiboko to 500 g of sieved sand (2 mm sieve). The *Alectra* and the sieved sand were thoroughly mixed for 10 min to ensure a uniform distribution of *Alectra* seeds in the inoculum stock. Suffiecient quantities of this inoculum were prepared for the experiment. Each hill was inoculated using 10 g of *Alectra* mixture (about 6800 *Alectra* seeds) from the stock.

Two seeds of each of the cowpea cultivars were sown per hill at the spacing of 75 by 20 cm. These were thinned to one plant per hill 2 weeks after planting. All the weeds other than *A.vogelii* were controlled by hoe-weeding 2 weeks after planting (WAP) followed by hand weeding at 5 and 8 WAP. Greater care was taken by hand pulling to avoid tampering with the un-emerged and emerged *Alectra* shoots. Cyper-methrin and dimethoate was applied using a knapsack sprayer fortnightly at the rate of 1.01/ha beginning from 4 weeks after planting until harvest, to control insect pests during flowering and pod development. Data collected included; days to cowpea flowering, number of pods per plant (10 random plants per plot), pod length and number of seeds per plant, 100 seed weight and grain yield. For the parasitic weed the data collected included; days to *A.vogelii* emergence, *A. vogelii* count at 6, 8, 10 and 12 week after planting (WAP) from the two middle rows (7.5 m^2) of each plot.

All data were subjected to an ANOVA with the general linear model (GLM) procedure of SAS (version 8.0; SAS Institute, Cary, NC). The GLM procedure of SAS uses the method of least squares to fit data to a general linear model. The cowpea genotypes were analyzed as subplot and manure levels as main plot.

RESULTS

Results of the effect of farm yard manure on the germination of *A. vogelii* at different times on the six cowpea cultivars are shown in Table 2. *A. vogelii* shoot count differed significantly ($p<0.005$) among cowpea genotypes and fertility levels during the growth period (Figure 1). Crops injury sustained by Sia/Cia-004 was lowest at 8, 10 and 12 WAP in all treatments (Figure 2). However, K80 and M66 sustained highest crop injury throughout the growth period in the three manure treatments (Table 2 and Figure 2).

Sia/Cia-004 recorded the highest pod numbers in the three treatments. The six evaluated genotypes did not vary significantly in their pod length, number of seeds per

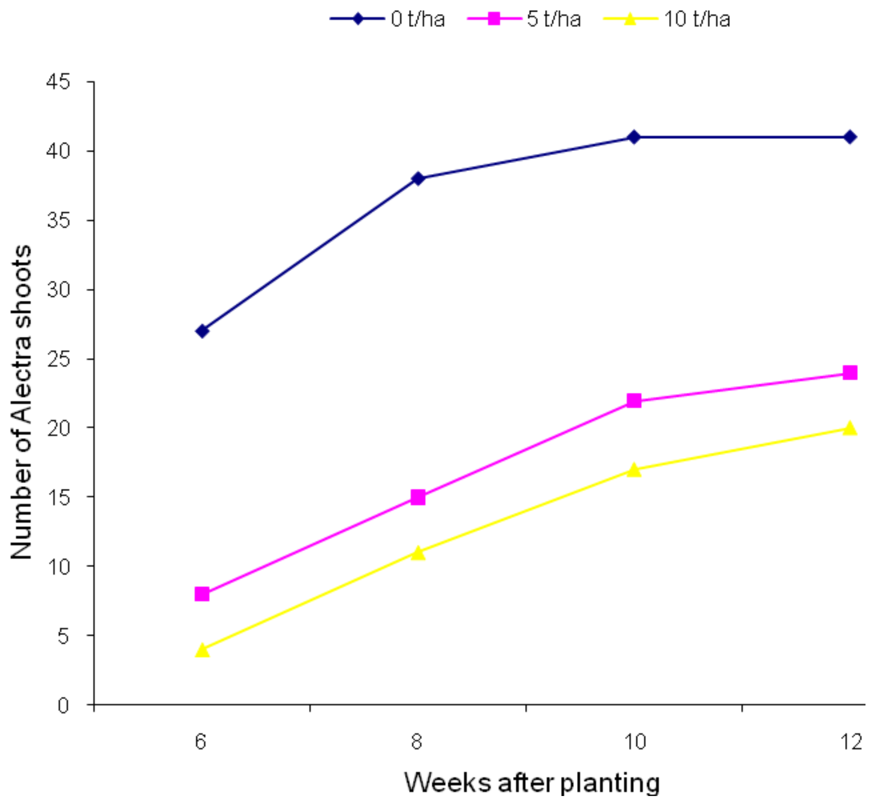

Figure 1. Cowpea growth period against *A. vogelii* shoot counts.

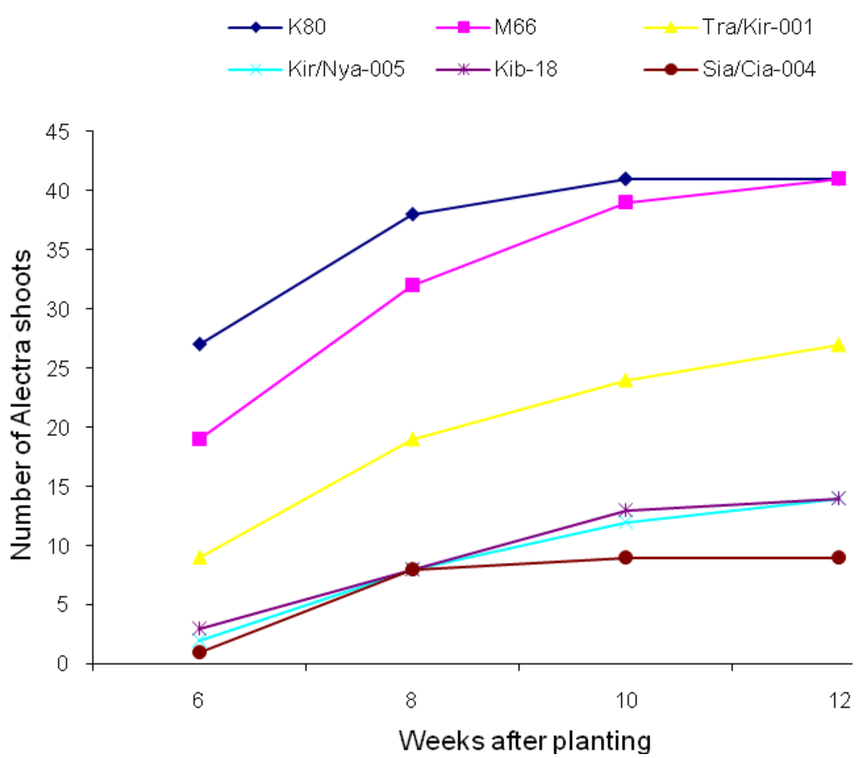

Figure 2. Growth period against *A. vogelii* shoots count for six cowpea genotypes.

Table 3. Effect of farm yard manure and *Alectra* on number of pods, pod length and number of seeds per pod.

Variety	Number of pods per plant			Pod length (cm)			Number of seeds per pod		
	0ton/ha	5ton/ha	10ton/ha	0ton/ha	5ton/ha	10ton/ha	0ton/ha	5ton/ha	10ton/ha
K80	22	36	44	17.03	16.92	15.8	13	14	14
M66	34	32	33	15.48	16.35	16.18	12	13	13
Tra/Kir-001	63	36	39	14.67	16.76	16.48	12	14	14
Kir/Nya-005	38	44	37	13.92	17.45	17.44	13	14	13
Kib-18	29	71	42	16.2	14.96	15.46	13	12	13
Sia/Cia-004	78	63	64	15.41	15.43	15.28	13	13	12
				ns	ns	ns	ns	ns	ns

Ns= not significant.

Table 4. Effect of farm yard manure and Alectra on 100 seed weight and grain yield.

Variety	100 seed weight (g)			Grain yield (kg/ha)		
	0ton/ha	5ton/ha	10ton/ha	0ton/ha	5ton/ha	10ton/ha
K80	14.57	15.99	16.27	906.05	1712.48	1746.05
M66	15.17	14.97	14.67	364.72	476.38	1211.25
Tra/Kir-001	11.42	12.59	12.02	1084.14	1692.59	1680.56
Kir/Nya-005	14.25	15.41	16.34	1674.6	1911.01	2088.47
Kib-18	15.05	13.31	13.66	1341.27	4757.81	4042.24
Sia/Cia-004	15.79	13.71	15.17	2275.72	6797.06	3306.74

pod and 100 seeds weight at 0, 5 and 10 ton/ha (Tables 3 and 4). Grain yield (kg/ha) was significantly ($p < 0.05$) superior across the manure treatment, 2276 kg/ha with Sia/Cia-004 at 0 tons, 4042 kg/ha with Kib-18 at 5 tons and 6797 kg/ha with Sia/Cia-004 at 10 tons. M66 was the most affected genotype recording the lowest yield of 365 kg/ha, 476 and 1211 kg/ha at 0, 5 and 10 tons respectively (Table 4 and Figure 3).

DISCUSSION

The results showed that despite the manure rates, there was lower *Alectra* weed count more pods per plant; more number of seeds per plant and grain yield was increased. The study has also shown that Sia/Cia-004 has exhibiting the highest tolerance to *Alectra* having shown the lowest *Alectra* incidence as observed earlier by Karanja et al. (2009). This could be attributed to the possibility of it producing the least germination stimulant (Kwaga et al., 2010). However, M66 and K80 were found to support the highest number of *Alectra* shoots throughout the growth period in all treatments which significantly contributed to their low grain yield. This indicates that M66 and K80 as the most susceptible to *Alectra*. The two (K80 and M66) are early maturing and the most preferred commercial varieties that are highly adopted in the semi-arid regions of Kenya. *Alectra* was found to reduce pod number per plant which resulted to low yield especially at 0 ton/ha manure. However, 5 and 10 tons of manure increased grain yield by 30 and 60% in K80 and M66 respectively.

This study shows that the devastation of cowpea grain yield at 0 ton/ha by *Alectra* could be attributed to the reduced root nodulation, root and shoot growth and nutrients uptake exhibited by susceptible varieties (K80 and M66) at stages of vegetative growth as compared to 5 and 10 $toha^{-1}$ where there was more supply of nutrients. Alonge (2001) reported that *Alectra* infestation reduce leaf area and inhibit nodules formation. The mean performance has shown that application of manure both at 5 and 10 ton/ha reduced *Alectra* incidence throughout the growth period of the crop. This could be attributed to the high nitrogen (16%) and phosphorus (3%) present in the manure. The efficacy of nitrogen in reducing number of *Alectra* shoot in soya been has been reported by Tarfa et al. (1996). Similar effect of the nutrient was observed on cowpea by Magani (1994), Parker (1978) and Alonge et al. (2002). In addition, Egley (1971) observed that mineral nutrients exhibit toxicity to parasitic weed once the minerals exceed certain threshold level. It appears that the level of nitrogen and phosphorous has to be high enough in the tissues of the host plant to be able to suppress *Alectra.*

Therefore, in this study nitrogen and phosphorus in 5

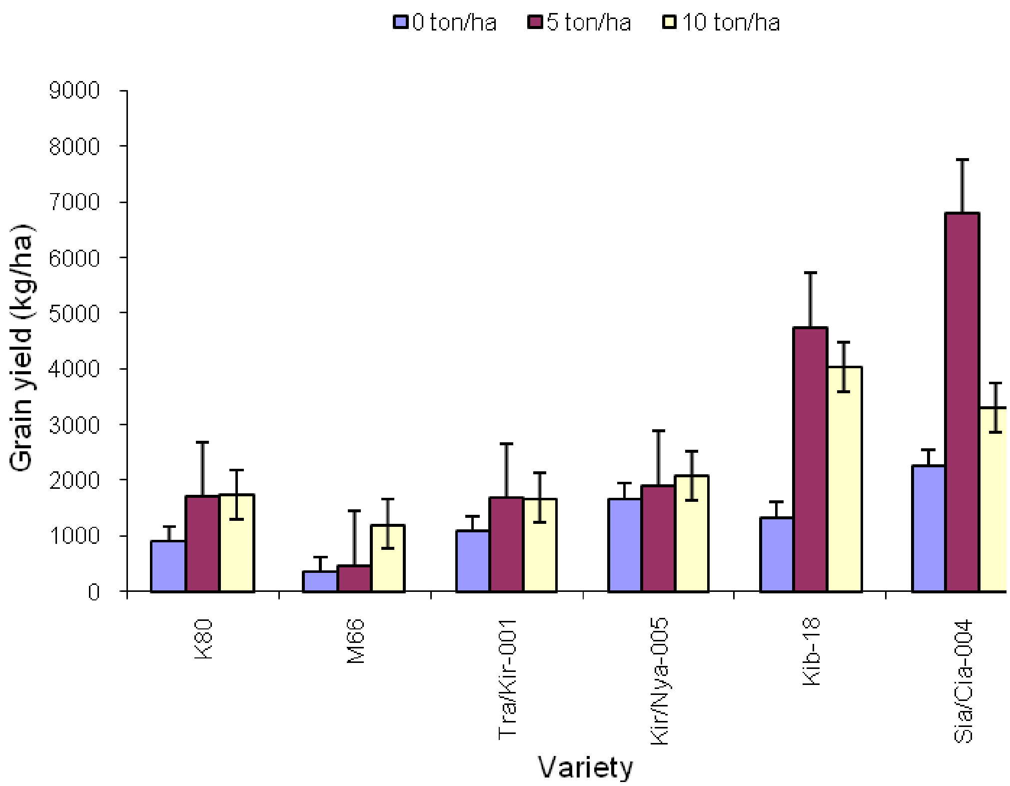

Figure 3. Six cowpea cultivars at different manure rate against yield.

and 10 tonha^{-1} of manure might have been high enough to have suppressed *Alectra* incidence and increased yield by 30 to 60%. Furthermore, the nitrogen and phosphorus status of the soil of the experimental site were 0.09% and less than 10 mg kg^{-1} (Olsen) which are considered low according to the classification by Kenya soil survey. This might have contributed to 5 and 10 tonha^{-1} of farm yard manure to have not only reduced *Alectra* virulence in cowpea but also enhanced grain yield. This study has shown that farm yard manure is beneficial in improving cowpea yield even under *Alectra* infestation.

Conclusion

This study has shown that application of 5 and 10 tonha^{-1} of farm yard manure not only reduced *Alectra* incidence during the growth period, but also increased grain yield of the susceptible cowpea varieties. Therefore, farm yard manure application is advantageous in reducing the effect of *Alectra* parasitism in cowpea and can be used as a preliminary measure in reducing *Alectra* seed bank in the soil.

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