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Screening legumes for integrated management of witchweeds (*Alectra vogelii* and *Striga asiatica*) in Malawi

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In Malawi the parasitic weeds (witchweeds) for cereals and legumes exist simultaneously. The predominant species for cereals is *Striga asiatica*, while for legumes it is *Alectra vogelii*, which causes damage in groundnuts (*Arachis hypogea* L.), cowpeas (*Vigna unguiculata*) and soybeans (*Glycine max*.). Growing legumes is a control measure for *S. asiatica* in cereal crops. Studies were initiated in 2000/2001 at Chitedze Research Station to screen amongst several entries of groundnuts, pigeon peas (*Cajanus cajan*), sunhemp (*Crotalaria* spp.), soybeans, velvet beans (*Mucuna* spp) for resistance to *A. vogelii*. In 2002/2003 a similar experiment was repeated, utilizing the promising entries. In 2003/2004 a screen house pot study was conducted at Bunda College to evaluate soybean lines with and without *A. vogelii* infection. Results from the 2000/2001 screening study indicated that amongst the crops soybean are the most susceptible to *Alectra*. Within soybeans, Bossier, Ocepara-4 and 501/6/12 were the least susceptible, with < 1.0 plant m^{-2}, compared to 5.0 plants m^{-2} with 427/5/7. All pigeon peas and green manure entries had no *Alectra* emerging on them. Similar results were obtained when the study was repeated with a few entries in 2002/2003. In a screen house study of 2003/2004, soybean varieties Bossier and Ocepara-4 had the least A*lectra* on them (<0.33 plants pot^{-1}), while other entries such as Kudu had 7.0 plants pot^{-1}. There was significant ($P < 0.05$) reduction in plant dry mass, grain weight, and pod number due to *Alectra* infection). The following conclusions were drawn from these studies:- 1). *A. vogelii* significantly affects crop growth, 2). Pigeon peas and green manure crops of mucuna and crotalaria are immune to *Alectra*, 3). Farmers with *S. asiatica* and *A. vogelii* infestation in their fields should therefore use resistant soybean types (Bossier, Ocepara-4), pigeon peas or green manures as trap crops for *S. asiatica*, while avoiding damage or build of *Alectra* on their farms, 4). As is always the case, an integrated management approach should be advocated in management of the parasitic weeds.

Key words: integrated witchweed management, legumes rotations, *Alectra* resistance.

INTRODUCTION

Malawi is a south east African country occupying 11.8 million hectare of surface area, of which 9.4 M is land and the rest is water. Of the land area, 5.4 M is arable land (Mulenga, 2004). Maize (*Zea mays* L.) and legumes (Fabaceae family) are important crops amongst the smallholder farmers in Malawi. Between 1999 - 2000 and 2005/2006 seasons, the area for maize production ranged between 1.478 to 1.63 M ha while the combined area for legumes ranged between 0.794 to 0.658 M ha (FEWSNET, 2007). Maize and legumes are complimentary to each other in pest management, dietary requirements and soil fertility management. In terms of diet, legumes are rich in the amino acid lysine, which compensates the low levels from maize. There are several links between maize and legumes on pest management and soil fertility. Maize is important to legumes in that it provides a break in nematode (*Meloidogyne* spp.) build up (Javaheri and Baudoin, 2001). The legumes are important to maize in that they serve as trap crop to the parasitic weed *Striga asiatica* which causes serious yield

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losses in Malawi (Kabambe and Drennan, 2003; Kabambe et al., 2003). *Striga* is prevalent in the major maize growing areas, due to continuous cropping and poor agronomic practices such as lack of rotation and non-use of fertilizers. The use of legume crops to reduce the *Striga* seed bank through suicidal germination is one of the best components for integrated management of *Striga* (Parkinson et al., 1997; Kabambe et al., 2002, 2003) On-farm studies in Malawi showed that legumes can yield better than maize when no fertilizer is used and gave higher economic and nutritional value (MPTF Group 1, 1998). Also, legumes supply nitrogen, and increase organic matter which improves the inherent soil fertility (Kumwenda et al., 1998). Nitrogen reduces *Striga* germination and emergence through reduction of stimulant production by host (Raju et al., 1990; Okonkwo, 1991). The ammonium form of nitrogen released during plant residue decomposition is particularly injurious to *Striga* seeds and suppressive to its germination and radicle elongation (Pesch and Pieterse, 1982; Okonkwo, 1991; Chechin and Press, 1993; Eplee and Norris, 1994).

However, *Alectra vogelii*, another parasitic weed for legumes, is also of growing concern particularly as legumes are becoming widely promoted and grown (ICRISAT/MAI, 2001). *A. vogelii* is widely seen in Lilongwe and Kasungu plains many parts of southern region (Riches and Shaxson, 1993; Mainjeni, 1999; Kabambe et al., 2005). Like *Striga*, *Alectra* may be controlled through trap crops such as dolichos bean (*Lablab purpureus* [L.] Sweet) cotton (*Gossypium hirsutum* L.), okra (*Hibiscus esculentus* L.), sunflower (*Helianthus annuus* L.) pea (*Pisum sativum* L.) and faba bean (*Vicia faba* L.) (Parker and Riches, 1993; Berner et al., 1994). There is generally greater availability of resistant genotypes against *Alectra* (Riches, 1989; Mainjeni, 1999; Rubiales et al., 2006). In Tanzania yield losses of up to 50% have been reported (Mbwaga et al., 2000). Bagnall-Oakley et al. (1991) reported total crop loss in parts of Kenya. In Botswana Riches (1989) reported that losses of 80 – 100% in a susceptible cultivar. Yield losses of up to 15% yield loss has been reported in groundnut in Nigeria (Salako, 1984), while in South Africa 30 – 50% reductions in yield of bambara were reported (Beck, 1987).

Late-sown crops of soyabean may be completely destroyed by the parasite in northern Nigeria (Lagoke, 1989). Based on the foregoing, it is clear that legume production is threatened by *Alectra* and it is important to screen for *Alectra* resistance among existing legumes crops or varieties in order to avoid working with the most susceptible varieties. This would ensure that farmers as not discouraged from using legumes trap crops for *S. asiatica* or soil fertility replenishment. The objectives of the studies in this report were to screen varieties of soybean, groundnuts and pigeon peas (*Cajanus cajan*) for resistance/susceptibility to the legume witchweed *A. vogelli*.

MATERIALS AND METHODS

General

Several varieties of released and pre-released soybean, pigeon peas (medium maturity) and green manure crops were grown at Chitedze Research Station (under infection and *A. vogelii.* In the 2000/2001 season, the main evaluation was against resistance or susceptibility to *A. vogelii.* In 2002/2003 a similar study was conducted, utilising select entries based on 2000/2001 results. In 2004/2005 another study was initiated at Bunda College to confirm these results in under artificial infection in a screen house. Both Chitedze and Bunda College are located at approximately 13° 59' S and 33° 38' E and are in the mid-altitude ecology (1100 - 1200 m above sea level) in Malawi, with a mean annual rainfall of 700 - 1200 mm.

Legume screening trials, 2000/2001

There were 4 trials, a trial each on soybean, groundnuts, pigeon peas and green manures laid out in a randomized complete block design with 4 replications for groundnuts and 3 replications for the rest. All entries were planted in two rows, 5.0 m long and 0.90m apart. Net plot sizes were 8.1 m^2 for all entries except *Canavalia* spp. which was 7.92 m^2. All plots were inoculated with *A. vogelli by* opening up a 10 cm depth grove in the centre of the ridge and infesting with a uniform drill of seed-sand mixture calibrated to deliver 1,000 seeds per meter section. There were 14 entries for soybeans, 7 entries groundnuts, 8 entries for pigeon peas and 10 for green manures (comprising 4 accessions of mucuna, 3 accessions of *Canavalia* ensiformis and 3 for Crotalaria). The full details of the entries are given in the appropriate tables in the results section.

Management of trap legumes

For soybeans, seeds were drilled in double rows, 5 cm apart. All soybeans were innoculated with Rhizobium spp., but no fertilizer was applied. Pigeon peas were planted at 45 cm apart, with 3 seeds per station. For the green manures, planting was as follows:- mucuna was planted every 15 cm, one seed per hill; *Canavalia spp.* was planted at 2 seeds per hill every 40 cm; *Crotalaria juncea* accession 52 and *Crotalaria ochroleuca* accession 55 were drilled at 4.5 g seed per 5.0 m row; *Crotalaria grahamiana* accession 57 was sown at 5 seeds/hill, 40 cm apart. No fertilizer application was made to all legumes. All trials were planted on 24th November 2000. All trials were kept free of weeds by hoe-weeding in first three weeks, then by hand weeding.

Data evaluated was grain yield, periodic *Alectra* emergence counts starting 6 weeks after planting, crop plant heights, *Alectra* height (mean of 5 tallest plans) canopy width at six weeks and 12 weeks.

Repeat study of select entries 2002/2003

In 2002/2003 season, some select entries of soybean, groundnuts, pigeon peas and green manures were planted under field conditions at Chitedze Research Station, also under *Alectra* infestation, as in the first season. The entries were all included in one trial as follows: 7 entries for soybean, 2 entries for groundnut, 5 entries for pigeon peas, and 2 for green manures. The full details of the entries are given in the appropriate tables in the results section. In addition, new entries comprising cowpeas (2 entries) silver leaf (*Desmodium* spp., local accession) and sesame were also included. Cowpeas were planted at 20 cm apart, two seeds per station.

Table 1. Effect of soybean entries on grain mass (kg ha^{-1}) and *Alectra* counts (AC) m^{-2} at 90, 109 and 128 various days after planting (DAP) at Chitedze, 2000/2001 season.

Entry	Grain mass	AC 90 DAP	AC109 DAP	AC 128 DAP
1 = Bossier	2355	0.0	0.07	0.04
2 = 427/5/7	2319	0.62	5.20	1.93
3 = Santarosa	2541	0.08	1.20	0.16
4 = Kudu	1117	0.29	2.73	0.74
5 = 501/6/12	2506	0.12	0.83	0.00
6 = Ocepara-4	2639	0.08	0.20	0.00
7 = 491/5/6	2141	0.16	1.40	0.33
8 = Duocrop	1026	0.12	3.03	1.52
9 = Impala	2509	0.08	0.26	0.16
10 = TGx1649-11F	1840	0.00	0.03	0.04
11 = TGx1681-3F	1292	0.16	0.56	0.24
12 = TGx1448-2E	1454	0.08	2.20	1.19
Mean	1944	0.15	1.33	0.53
P	0.004	0.097	0.0001	0.001
SED	392	0.17	0.75	0.44
CV	24	139	69	103

Silverleaf was sown by drilling 1.4 g of seed per 5 m row. Sesame was planted at 30 cm apart, one seed per station.

Screen house pot study, 2003/2004

A screen house study was planted in November 2005 in pots at Bunda College. The study was 2 x 7 factorial. The treatments were 2 levels of *Alectra* infestation (without *Alectra* or with *Alectra* infestation at 0.02 g of seeds per pot) and 7 levels of soybean (Ocepara-4, Kudu, Bossier, TGX1649-11F, TGX1681-3F, Magoye, and Santarosa). The experiment was a randomized complete block design with three replications. Pots were fertilized with 2 g of 23:21:0+4S at planting. Data collected was days to first *Alectra* emergence, periodic *Alectra* emergence and soybean dry mass, grain and *Alectra* dry mass matter after 118 days after planting DAP). Data evaluated was grain yield, periodic *Alectra* emergence counts starting 6 weeks after planting, crop plant heights, *Alectra* height (mean of 5 tallest plans) canopy width at six weeks and 12 weeks.

Data analysis

The analysis of variance was performed on all data. Mean comparisons were made using the least significant difference. Statistical significance is quoted at the 5% level unless otherwise stated.

RESULTS

First season of screening for A. vogelii resistance

Soybean

Soybean yield, canopy width and *Alectra* counts are presented in Table 1. Entries that had poor germination were eliminated from the analysis. There were no significant entry differences in canopy width at 6 and 12 weeks after planting with a mean 40 and 79 cm, respectively (data not shown). There were significant differences for grain yield, *Alectra* counts and height. *Alectra* counts were quite low and peaked at 109 DAP with a mean of 1.3 plants m^{-2}. For all the *Alectra* count data, several entries had consistently quite low emergence of less than 0.5 plants m^{-2}. These were Bossier, Ocepara-4, TGx1649-11F and Impala. Bossier, Ocepara-4 and Impala also gave the best yields of over 2.2 t ha^{-1}, while some entries had just 1.0 t ha^{-1}. The entries Kudu, Duocrop, 427/5/7 were quite susceptible. Potential yields of soybean yields range between 2000 - 4500 kg/ha (Ministry of Agriculture, Irrigation and Food Security, MoAIFS, 2005).

Groundnuts

Alectra emergence and height, and groundnut kernel yield, stover weight, canopy width are shown in Table 2. There were significant differences due to entry on canopy width at 12 weeks after planting, groundnut stover weight and *Alectra* height. *Alectra* emergence was low and late, and only one recording was made at 109 DAP, with no significant differences detected. The entries CG7, JL24, P49-6, C851/7 had high *Alectra* height greater than 28 cm, compared to less than 10 cm for the rest. The highest stover weight was recorded with the entry D27/3 which also gave the highest kernel yield. Potential yields of groundnuts in Malawi are 1 - 2 t/ha (MoAIFS, 2005).

Pigeon peas

No *Alectra* emergence was recorded in all plots throughout the season. There were significant differences for canopy width and grain yield (Table 3). The entry QP38

Table 2. Effect of groundnut entries on canopy width (CW), grain mass and *Alectra* counts (AC) m^{-2} and height at Chitedze in 2000/2001 season

Entry	CW (cm) 6 weeks	CW (cm) 12 weeks	Grain mass Kg ha^{-1}	AC128 DAP	AH 128 DAP
1 = CG7	40	72	958	0.37	29.0
2 = JL24	38	64	852	0.21	26.2
3 = P49-6	41	73	1033	0.24	28.0
4 = C851/7	39	72	1064	0.19	8.0
5 = D27/3	42	78	1097	0.46	13.0
6 = ICG7-SM9074	42	79	880	0.21	8.5
9 = ICG7-SM9074	38	73	789	0.18	5.5
Mean	40	73	953	0.23	14.8
P	0.15	0.01	0.88	0.20	0.016
SED	2	3.5	311	0.18	10
CV	7	7	40	93	84

Table 3. Canopy width (CW) at 6 and 12 weeks, grain yield, *Alectra* counts (AC) at different days after planting (DAP) for various pigeon peas entries at Chitedze, 2000/2001 season

Entry	Cw 6 wks cm	Cw 12 wks Cm	Grain yield kg ha^{-1}	AC at 60, 90, 100 and 133 DAP
1 = ICP 9145	35	80	181	0.0
2 = QP 38	37	88	696	0.0
3 = ROYES	38	89	351	0.0
4 = ICEAPOOO 20	39	75	64	0.0
5 = ICPL 87105	35	68	357	0.0
6 = ICEAPOOO 40	39	82	96	0.0
7 = ICPL 86012	30	50	243	0.0
8 = ICPL 87091	30	85	88	0.0
Mean	37	77	259	0.0
P	0.02	0.001	0.02	0.0
SED	2	7	155	0.0
CV, %	7	11	73	0.0

gave the highest yield of 696 kg/ha while ICP9145, which is widely grown in Malawi gave 181 kg/ha. Potential yields of pigeon peas are 2500 kg/ha (MoAIFS, 2005).

Green manures

There was no *Alectra* emergence recorded in all plots throughout the season, as was the case with pigeon peas. There were significant differences for canopy width and grain yield (Table 4). *Crotalaria* spp. were generally slow growing, recording lower canopy width at 6 and 12 weeks.

Repeat evaluation on elite varieties, 2002/2003

The grain yield and *Alectra* counts for the entries evaluated in this season are shown in Table 5. For the second season of testing, pigeon peas and the green manures sustained no *Alectra* parasites through out the season. For soybean, TGX1649-11F sustained no emergence, while Ocepara-4 was recorded a maximum of 0.12 plants recorded late in the season at 118 days. Kudu was most susceptible with a maximum of 1.98 plants per pot. The results are consistent with those of the first evaluation in which Kudu was amongst the most susceptible and TGX1649-11F amongst the least. The two entries of groundnuts tested showed moderate susceptibility. For the first, two cowpea lines, all released varieties, were tested. The entry IT82E-16 was more resistant than Sudan. There was also one entry each of sesame and silverleaf tested and they all had no *Alectra* emerging on them.

Evaluation of soybean varieties at Bunda College, 2002/2003

Results of *Alectra* emergence on soybean (Table 6)

Table 4. Canopy width (CW), grain yield and *Alectra* counts (AC) at different days after planting (DAP) for green manure species at Chitedze, 2000/2001 season.

Entry	Cw 6 wks Cm	Cw 12 wks Cm	Grain yield kg ha^{-1}	AC at 60, 90 and 133 DAP
1 = Mucuna puriens (local) accn 56	77	139	1623	0.00
2 = Mucuna puriens accn 33	74	145	1331	0.00
3 = Mucuna puriens accn 34	92	163	1450	0.00
4 = Mucuna puriens accn 35	74	162	1919	0.00
5 = Canavalia ensiformis accn 21	61	126	2742	0.00
6 = Canavalia ensiformis accn 22	59	158	2437	0.00
7 = Canavalia ensiformis accn 58	66	135	1511	0.00
8 = Crotalia ochroleuca accn 52	54	78	1521	0.00
9 = Crotalaria juncea accn 55	37	79	1423	0.00
10 = Crotalaria grahamiana	36	118	653	0.00
Mean	63	130	1661	0.0
P	0.0001	0.001	0.024	0.0
SED	5	19	484	0.0
CV, %	10	18	35	0.0

Table 5. Effect of selected soybean, groundnuts, pigeon pea, cowpeas, silverleaf, sesame mucuna and Crotalaria on grain yield and *Alectra* count at Chitedze Research Station, in 2002/2003

Entries	grain yield kg/ ha^{-1}	Alectra no. m^{-2} 61 days	Alectra no. m^{-2} 75 days	Alectra no. m^{-2} 91 days
Soybeans				
1 = Ocepara-4	1416	0.00	0.04	0.12
2 = TGX1649-11F	805	0.00	0.00	0.00
3 = TGX1448-2E	650	0.08	0.28	1.03
4 = Kudu	1191	0.12	0.82	1.98
5 = Santarosa	1074	0.04	0.24	0.98
Groundnuts				
1 = CG7	1512	0.04	0.33	0.86
2 = ICG7-SM9704	818	0.00	0.37	0.04
Pigeon peas				
1 = ICP9145	0	0.00	0.00	0.00
2 = QP38	0	0.00	0.00	0.00
3 = ICEAP0040	0	0.00	0.00	0.00
4 = ICPL903015	406	0.00	0.00	0.00
5 = ICPL903015	638	0.00	0.00	0.00
Cowpeas and others				
1 = Sudan	1571	0.53	0.70	1.39
2 = IT82E-16	1287	0.74	0.45	0.54
3 = Silver leaf local collection	0	0.00	0.00	0.00
4 = Sesame accession 31	581	0.00	0.00	0.00
Green manure				
5 = Mucuna	1912	0.00	0.00	0.00
6 = Crotalaria juncea	1317	0.00	0.00	0.00
Mean	-	0.08	0.21	0.35
F prob	-	0.001	0.51	0.0001
SED	-	0.11	0.38	0.37
CV	-	173	227	131

Table 6. Average number of days to first *Alectra* emergence (DFE), periodic *Alectra* counts and dry mass of *Alectra* (ADM) at harvest (118 days) per pot on soybean entries in a green house study at Bunda College, 2003/2004 season

Soybean entry	DFE	Alectra counts per pot				ADM g/pot
		Day 55	Day 75	Day 95	Day 118	
Bossier	118.0b	0.00a	0.00a	0.00a	0.00a	0.00a
Kudu	64.7a	0.00a	3.33b	5.67b	7.00b	1.51a
Magoye	90.0a	0.00a	1.00a	1.00a	2.33a	0.76a
Ocepara-4	105.3b	0.00a	0.33a	0.33a	0.33a	0.08a
Santarosa	109.3b	0.00a	0.00a	0.67a	2.67a	0.73a
TGX1649-11F	94.7a	0.00a	0.67a	1.33a	1.67a	0.52a
TGX1681-3F	118.0b	0.00a	0.00a	0.00a	0.00a	0.00a
LSD (0.05)	32.2	0.00a	1.52	1.89	2.51	0.70
SED	14.56	0.00a	0.70	0.61	1.17	0.33
CV%	17.9	0.00a	12.20	12.20	71.50	77.20

Table 7. Effect of *Alectra* infection on plant dry mass, grain mass and number o f plants per pot on soybean varieties

Alectra level	Plant Dry mass	% Alectra effect	Grain Mass	% Alectra effect	No. pod/plant	% Alectra effect
None	8.08	-	5.14	-	29.38	-
Infested	7.08	12.3	4.48	12.8	26.67	0.09
F prop	0.03		0.002		0.025	

showed Bossier was completely resistance with no emergence up to end of study (118 days). Ocepara -4 was the next best resistant with a peak emergence of 0.33 plants at 75 days. Although Santarosa refused emergence until 105 days, by 118 it had an emergence of 2.67 plants. The entry TGX1681-3F also had no *Alectra* emergence till maturity. The entry was supplied by International Institute of Tropical Agriculture (IITA) on the basis that it very good as a trap crop for *Striga hermothica*. *Striga* emergence at these sites was quite high, reaching 21 plants per pot. Infection by *Alectra* gave small but significant reduction in plant dry mass, grain mass and pod number per plant (Table 7).

DISCUSSION AND CONCLUSION

Resistance to *A. vogelii*

The field emergence of *Alectra* was low in these studies, probably due to low inoculation levels. However, since artificial inoculation was used and the study repeated for some entries, results can be regarded fairly conclusive. These results could be used as a preliminary basis for choosing varieties for rotation and in assembling a management package for *S. asiatica*, to ensure reduced risk to farmers. Regarding *Alectra* resistance, the results on soybean are the most conclusive. The entries Bossier, Ocepara-4) have given the least *Alectra* emergence in three separate studies. The two year results for pigeon peas and green manure entries were in agreement. Pigeon peas are generally free from *Alectr*a attack (Parker and Riches, 1993). For groundnuts the results are inconclusive. Variability in parasitic weed susceptibility between or within species can be due to differential ability of host roots to stimulate weed seed germination (Bebawi and Michael, 1991; Dejong et al., 1993; Kabambe, 1997). In some cases some genotypes may refuse parasite attachment or some varieties there could be a case of low support. Low support varieties would normally directly suffer from parasitism. In West Africa *A. vogelii* resistant cowpea resistant cultivars have been released (Rubiales et al., 2006). Variability for *A. vogelii* resistance has been widely reported (Riches, 2001; Mainjeni, 1999) and it is recommended that routine screening against the parasite is conducted so that choices of varieties to farmers may include *Alectra* resistance.

In the screen house study, significant reduction in grain weight and cowpea biomass was detected. This is an import observation. The magnitude of the growth or yield reduction may not reflect real life situation, but potential impact has been demonstrated. Field studies to determine the actual impact of parasitic weeds are usually difficult to conduct due to inability to create witchweed free plots in a field situation. It is possible to do so using some herbicides that may completely suppress attachment to host. In Tanzania, yield losses due to *A. vogelii* on cowpea were estimated at 50% (Mbwaga et al., 2000).

Canopy width and crop yields

Canopy width is indicative of ability of the crop to cover the ground. As the row spacing in these studies was 90 cm, a canopy width of the same would indicate complete ground cover. Earlier ground cover is associated with reduced temperature, high relative humidity and reduced solar radiation to crops or plants under the canopy. Higher humidity may reduce photosynthetic capacity of leaves due to restricted gaseous exchange and cooling effect of evapo-transpiration. As an example, Kabambe and Drennan (2003) showed that temperature in maize plots intercropped with cowpea at full canopy cover (61 days after planting) was 30.5℃ compared to 35℃ of pure maize crop. Photosynthetically active and direct (sunfleck) radiation interception was less in the intercrop than pure stand. The intercropping treatment significantly reduced *S. asiatica* emergence. These results indicate that groundnuts, pigeon peas and the green manures varieties or accessions would differ in their ability to suppress under growth of weeds compared to soybeans. However, both groundnuts and soybeans did not develop full canopy cover. Good crop cover also depends on good crop stands. The green manure crops gave canopy width of greater than 90 cm, meaning that there were overlaps in the canopy, as was expected. The essence of green manures is that they produce a lot of forage and biomass. For example, Kumwenda et al. (1998) reported biomass of 6.6 t/ha for mucuna and 14 t/ha for crotalaria.

Conclusions

The studies in this report confirm that *A. vogelii* is a threat to the food legumes in Malawi, mainly soybeans, groundnuts and cowpeas. The studies also confirm that *A. vogelii* significantly affects crop growth. In agreement with other reports, the studies confirm that pigeon peas and green manure crops of mucuna and crotalia are immune to *A. vogelii.* Based on the findings from the studies, it is recommended that farmers with *S. asiatica* and *A. vogelii* infestation in their fields should therefore use resistant soybean types, pigeon peas or green manures as trap crops for *S. asiatica*, while avoiding damage or build of *Alectra* on their farms. As is always the case, an integrated management approach should be advocated in management of the both parasitic weeds.

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