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# Developing an appropriate technique for evaluating cowpea varieties' reaction to the parasitic plant *Alectra vogelii* (Benth.)

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ABSTRACT

*Objective:* To develop an appropriate technique for evaluating cowpea varieties' reaction to the parasitic plant *Alectra vogelii* (Benth).

*Methodology and results:* Screen house trials were conducted at Zaria, Nigeria in 2004. Treatments consisted of a factorial combination of eight cowpea varieties, four *Alectra* seed inoculant density (0, 5, 10, 20 c.c/pot) and three pre – conditioning periods (0, 7 and 14) and (0, 3, 7 and 14) days before crop planting in the first and second trials, respectively. Result indicated that cowpea variety B301 and the derivative of cross with IT84S – 2246 – 4 (IT90K – 76) did not have any attachment of *Alectra,* while 1T89KD – 245 – 1 had the least *Alectra* emergence in the two trials. In both trials, variety TVX3236 initiated early emergence of *Alectra* while delayed emergence was observed with 1T89KD – 245 – 1. Inoculation with 10 c.c/pot of *Alectra* seeds resulted in higher *Alectra* infection that 20 c.c/pot. In general, *Alectra* emergence was earlier in the second trial than the first trial. *Alectra* emergence increased with *Alectra* seed density in the first trial while 10 c.c/pot *Alectra* seed gave the highest number of emerged *Alectra* in the second trial. Pre – conditioning period prior to cowpea sowing for 14 days initiated early *Alectra* emergence. The crop dry matter production was negatively correlated to the number of emerged, un – emerged and total number of *Alectra* plants.

*Conclusions and application of findings:* This investigation has shown that variety B301 and derivative of its cross with IT84S – 2246 – 4 (IT90K – 76) did not support the emergence of *Alectra* thus exhibiting resistance. *Alectra* emergence increased with *Alectra* seed density up to 10 c.c/pot when compared to other *Alectra* seed density. Pre – conditioning period had no significant effect on emerged *Alectra*, but *Alectra* emergence increased with pre – conditioning period of 7 to 14 days.

Key words: Technique, cowpea varieties, evaluation, *Alectra* vogelii.

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## INTRODUCTION

*Alectra vogelii* (Benth.), is a hemiparasite belonging to the family Scrophulariaceae and is a parasitic plant of a wide range of legumes in the West, East and South Africa (Bagnall-Oakeley *et*

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*al*., 1991). Aggarwal (1985) and Emechebe *et al*. (1991) have observed that *Alectra* appears to be more destructive in the Northern Guinea and Sudan agro-ecologies, because of the marginal nutrient status of the soils and unreliable rainfall in these zones.

*Alectra* and related parasitic weeds including *Striga* are presently among the most important biological constraints to food production in Africa. Although crop attack by *Alectra* is has less sever impact than that of *Striga*, total yield loss is not uncommon in fields that are heavily infested by these parasites when susceptible varieties are planted (Emechebe *et al*., 1983). Significant crop yield losses caused by *Alectra* have been reported in legumes including cowpea, broad and velvet beans, groundnuts, bambara groundnut and grams (Riches, 1987; Lagoke *et al*., 1988). Several cultivated lands have been abandoned due to high infestations with the noxious parasitic weeds (Lagoke *et al*., 1988). Fields infested by these parasitic weeds are difficult to clean, because of the considerable amount of seeds produced and the dormancy mechanisms, which enable them to survive in the soil for several years (Emechebe *et al*., 1983). Although considerable work has been done on various control methods for parasitic weeds, *Alectra* control in cowpea has received relatively little attention. It is however apparent that no single method can adequately control this problem, and a number of methods would need to be integrated for effective control.

*Alectra* was previously not a problem of cowpea and groundnuts in Nigeria, but its importance has recently increased and it currently affects crop productivity, especially where production is intensified. This study evaluated cowpea varieties reaction to pre-conditioning treatments and inoculation with varying density of *Alectra* seed inoculant.

## MATERIALS AND METHODS

Two screen house trials were conducted at Samaru (11° 11'N, 7° 36'E) in the Northern Guinea Savannah agro-ecology of Nigeria from February to May and July to September, respectively in 2004. Treatments consisted of a factorial combination of eight cowpea varieties, four *Alectra* seed inoculant density (0, 5, 10, 20, c.c/pot) and three pre-conditioning periods (0,7 and 14 days before crop planting) in the first trial and four pre-conditioning periods (0, 3, 7 and 14 days) in the second trial arranged on the screen house bench in a completely randomized design. Different density (5 – 20 c.c) of *Alectra* seeds were measured and mixed with sieved dry sand (< 180 µm particle size) in an air filled polythene bag and shaken thoroughly for five minutes to ensure uniform distribution of *Alectra* seeds. This was followed by addition of 20, 40, 100, 200 or 400 cc sieved sand to finally give 1,000 cc *Alectra* seeds/sieved sand mixture, which formed the inoculant stock. Each time sieved sand was added to the *Alectra* seeds/sieved sand mixture, the shaking process was repeated to ensure homogeneity. Based on enumeration by Emechebe (personal communication) the original 5cc, 10cc and 20cc *Alectra* inoculant contained approximately 1000, 2000 and 4000 seeds, respectively. From the 1000cc *Alectra* inoculant, 100 cc was taken and used to inoculate a plastic pot (2.16 litres) containing 2/3 soil - sand mixture (1:1,v/v). Thus ten plastic pots were inoculated for every 1000cc *Alectra* inoculant stock.

After inoculation, the *Alectra* seeds were pre-conditioned for the required period by irrigating the soil in the pots to field capacity daily. After the pre-conditioning of *Alectra* seeds, six seeds of cowpea were planted per pot. At two weeks after sowing, the cowpea plants were thinned to two plants per pot. The experimental pots were subsequently irrigated to field capacity until the trials were terminated at 65 days after sowing. At the end of the trial, roots of cowpea plants were freed from soil by immersing each pot in a 20 litre bucket of water for five minutes. The pot was then inverted to release the ball of soil and the roots were then carefully freed of adhering soil in such a way that there was no loss of both emerged and un-emerged *Alectra* plants.

Observations made included number of days to *Alectra* emergence, number of emerged and un-emerged *Alectra* at the end of experiments, number of nodules/plant, crop damage symptom rating and cowpea shoot dry weight at harvest. The data collected were subjected to analysis of variance and the treatments means were compared using Duncan Multiple Range Test (Duncan, 1955). Coefficient of correlation (r) between *Alectra* infestation and other parameters were also determined.

RESULTS AND DISCUSSION

Generally, *Alectra* emergence was earlier in the second trial than the first trial (Table 1), which could be attributed to the favourable temperature for *Alectra* seed germination between July-September as compared to that between February-May when the first trial was done. In the two trials, cowpea variety TVX3236 had the highest *Alectra* infestation. *Alectra* inoculation suppressed shoot dry matter production in TVX3236 especially at the higher inoculation levels in the second trial. Among the varieties evaluated, B301 and the derivative of its cross with 1T84S-2246-4 (1T90K-76) did not have any attachment of *Alectra* while 1T89KD-245-1 had the least emergence in the two trials. Similar levels of resistance have been reported for variety 301 to *Striga gesnerioies* (Emechebe & Singh, 1991; Lagoke *et al*., 1991) and to *Alectra vogelii* (Magani *et al*., 1991).

Table 1: Number of days to *Alectra* emergence and crop damage score as influenced by *Alectra* seed density, pre – conditioning period and cowpea variety in the green house at Samaru, 2004.

| Treatments | Number of days to *Alectra* emergence | | Crop Damage Score3 (50 DAS) |
|---|---|---|---|
| Varieties | 1st Trial | 2nd Trial | 2nd Trial |
| IT90K – 76 | - | - | 0.0 e |
| TVX 3236 | 46 b[1] | 34 d | 1.9 a |
| IT89KD – 245 – 1 | -2 | - | 1.0 e |
| TN 93 – 80 | 47 a | 36 b | 1.4 c |
| VITA – 3 | 46 b | 35 c | 1.7 b |
| B 301 | - | - | 1.0 e |
| IT846 – 2246 – 4 | 47 a | 36b | 1.4 c |
| IT810 – 985 | 47 a | 38 a | 1.1 d |
| B. E ± | 0.02 | 0.04 | 0.03 |
| *Alectra* Seed Density (c.c./pot) | | | |
| 0 | - | - | 1.0 e |
| 5 | 38 b | 29 c | 1.5 a |
| 10 | 39 a | 30 b | 1.4 b |
| 20 | 39 a | 31 a | 1.4 b |
| S. E ± | 0.02 | 0.03 | 0.02 |
| Pre – conditioning Period (DAS) | | | |
| 0 | 29 b | 23 | 1.4 a |
| 3 | | 23 | 1.3 b |
| 7 | 30 a | 22 | 1.3 b |
| 14 | 29 b | 22 | 1.4 a |
| S. E ± | 0.01 | 0.03 | 0.02 |
| Interactions | | | |
| C x V | NS | NS | NS |
| P x V | NS | NS | NS |
| P x C | NS | NS | NS |
| P x C x V | NS | NS | NS |

Means followed by the same letter(s) ate not significantly different at 5% level of probability (DMRT); - indicates no *Alectra* emergence; Damage symptoms on crop plans using scale (1 – 5), where 1 = normal crop plant growth; 2 = no chlorosis; 3 = no blotching; 4 = leaf scorching; and 5 = total leaf scorching or/and obviously stunted or dead plants.

The local variety B301, which was initially identified for resistance to *Alectra vogelii* in Botswana has been observed to exhibit multigenic resistance to both strains of *Striga* and *Alectra* at various locations in West and Central Africa, including Nigeria (Riches, 1987; Emechebe & Singh, 1991). Resistance to *Striga* sp. in the genotype B 301 has been reported to be controlled by one dominant gene and resistance to *Alectra* by two dominant genes (Singh & Emechebe, 1990a,b). Lane and Bailey (1989) have however attributed the resistance in B 301 to its low production of stimulants for the germination of *Striga* seeds as well as attachment and prevention of haustorial formation and subsequent development of the seedling of the parasite through antibiosis.

The anatomical studies revealed that the haustorium remains in the endodermis without further development and penetration. The fact that no Striga attachment occurred in cv. 1T90K-76 further indicates the compatibility of relevant genes in the two parents i.e. (B 301 and 1T84S-2246-4). In the two trials, variety TVX3236 initiated early emergence of *Alectra*, while delayed *Alectra* emergence was observed on 1T89KD-245-1 as previously reported by Magani *et al*. (1992).

Table 2: Nodulation (as percentage of the control) as influenced by *Alectra* seed density, pre – conditioning period and cowpea variety in the green house at Samaru, 2004.

| Treatments | Percentage nodulation (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Density (c.c/pot) | | | 1st Trail | | | | 2nd Trail | |
| 0 | | | 100 | | | | 100 | |
| 5 | | | 94.1 | | | | 82.3 | |
| 10 | | | 102.6 | | | | 2.6 | |
| 20 | | | 106.2 | | | | 82.7 | |
| Pre – Conditioning Period | 0 | 5 | 10 | 20 | 0 | 5 | 10 | 20 |
| 0 | 100 | 102.5 | 108.6 | 101.0 | 100 | 97.4 | 111.6 | 113.7 |
| 3 | - | - | - | - | 100 | 101.6 | 103.3 | 81.6 |
| 7 | 100 | 95.2 | 103.5 | 87.8 | 100 | 78.3 | 64.6 | 74.8 |
| Varieties | | | | | | | | |
| IT90K – 76 | 100 | 135.1 | 109.6 | 113.3 | 100 | 114.9 | | |
| TVX 3236 | 100 | 84.4 | 119.1 | 69.6 | 100 | 48.9 | 52.9 | 59.6 |
| IT89KD – 245 – 1 | 100 | 64.4 | 59.9 | 94.7 | 100 | 99.9 | 82.0 | 107.3 |
| TN93 – 80 | 100 | 86.4 | 85.1 | 84.7 | 100 | 86.6 | 69.6 | 108.2 |
| VITA – 3 | 100 | 101.4 | 113.8 | 81.3 | 100 | 66.2 | 44.6 | 54.8 |
| B 301 | 100 | 127.1 | 138.1 | 151.4 | 100 | 89.2 | 107.6 | 88.6 |
| IT845 – 2246 – 4 | 100 | 91.7 | 92.8 | 102.9 | 100 | 65.1 | 79.5 | 81.9 |
| IT81D – 985 | 100 | 67.8 | 84.1 | 185.8 | 100 | 59.4 | 80.1 | 71.8 |

Means following by the same letter(s) are not significantly different at 5% level of probability (DMRT); DAS=Days after sowing;

Nodulation as percentage of the control was only suppressed in 1T89KD-245-1 at 5 and 10 c.c/pot *Alectra* seed density in the first trial. In the second trial only cv. TVX3236 and VITA-3 at all *Alectra* seed *Alectra* density had suppressed nodulation as percentage of the control (Table 2). Similarly shoot dry matter production as percentage of the control was suppressed in the susceptible variety TVX3236. The resulst indicated that prior to emergence, *Alectra* entirely depended on its host for carbon but after emergence only about two-third of its carbon requirements is obtained from the host.

In the two experiments, inoculation with 10 c.c/pot of *Alectra*_seeds resulted in higher *Alectra* infection than when 20 c.c./pot was used, probably due to competition among the attached parasite seedlings for the host resources. In effect it may not be necessary to increase the level of inoculation from 10 c.c/pot to 20 c.c./pot in order to induce reaction in cowpea in the green house. The result confirmed the reports of Emechebe *et al*. (1991) on cowpea *Alectra* relationships. This indicated that adequate exposure of plants to *Alectra* in pots could be achieved by inoculation with about 10 c.c/pot seeds of the parasites.

Pre-conditioning period only had significant effect in the first trial. Pre-conditioning period needs further investigation under controlled environment as *Alectra* infection seems to be related to environmental conditions, which tended to vary even in the green house. With cowpea *Striga* (Emechebe *et al*. 1991) observed that *Striga* symptom expression was related to environmental condition which varies even in the screen house and that the number of *Striga* shoots that emerged often vary greatly for replicates of the same cowpea lines grown during the same period in the screen house.

Table 3: Interaction between cowpea varieties and *Alectra* seed density on number of emerged *Alectra* in the first green house trial at Samaru, 2004.

| | *Alectra* Seed Density (c.c/pot) | | | |
|---|---|---|---|---|
| Varieties | 0 | 5 | 10 | 20 |
| IT90K – 76 | 0.0 g | 0.0 g | 0.0 g | 0.0 g |
| TVX 3236 | 0.0 g | 0.9 b[1] | 0.1 fg | 1.4 a |
| IT89KD – 245 – 1 | 0.0 g | 0.0 g | 0.1 fg | 0.2 efg |
| TN 93 – 80 | 0.0 g | 0.4 de | 1.2 a | 0.8 bc |
| VITA 3 | 0.0 g | 0.1 fg | 0.0 g | 0.7 bc |
| B 301 | 0.0 g | 0.0 g | 0.0 g | 0.0 g |
| IT84S – 2246 – 4 | 0.0 g | 0.4 de | 0.1 fg | 0.3 ef |
| IT81D – 985 | 0.0 g | 0.3 ef | 0.2 efg | 0.6 cd |
| S. E (±) | 0.08 | | | |

Table 4: Interaction of *Alectra* seed density and pre – conditioning period on number of un – emerged *Alectra* in the second green house trial at Samaru, 2004.

| | Pre – conditioning (DAS) | | | |
|---|---|---|---|---|
| Density (c.c/pot) | 0 | 3 | 7 | 14 |
| 0 | 0.0 g1 | 0.0 g | 0.0 g | 0.0 g |
| 5 | 0.7 ab | 0.3 ef | 0.3 ef | 0.5 cd |
| 10 | 0.4 de | 0.7 ab | 0.5 cd | 0.6 bc |
| 20 | 0.8 a | 0.3 ef | 0.8 a | 0.2 f |
| S. E (±) | 0.06 | | | |

Means followed by the same letter(s) are not significantly different at 5% of probability (DMRT)
DAS = Days after sowing.

However, in this study although only significant in the first trial, pre-conditioning period prior to cowpea sowing of 14 days stimulated early *Alectra* emergence. In a study of the role of ethylene in germination of *Striga asiatica* in response to Strigol, Babiker *et al*., (1993) reported that unconditioned seeds and those conditioned for 3 days produced negligible amounts of ethylene response to Strigol. However, extending the conditioning period to 5 and 8 days increased ethylene evolution by more than 10-fold. Thus it would appear that conditioning resulted in partial release of the ethylene biosynthetic pathway.

There was significant interaction between *Alectra* seed density and cowpea varieties on number of emerged, un – emerged and total number of *Alectra* per pot in the two trials (Tables 3, other data not shown). In the first trial, among the varieties, TVX3236 supported the highest emergence in *Alectra* seed density of 5cc and 20 cc while TN 93 – 80 had highest emergence at seed density of 10cc. However, in the second trial, TVX3236 had the highest emergence in *Alectra* seed density 10cc and 20cc while VITA – 3 had highest emergence at seed density of 10cc. Among the varieties evaluated, B 301 and IT90K – 76 did not support any un – emerged *Alectra*. The highest number was recorded with TN 93 – 80 and TVX3236 in the first and second trials, respectively. In the second trial IT89KD – 245 – 1, IT84S – 2246 – 4 and IT81D – 985 had the least while in the first trial VITA – 3 and IT84S – 2246 – 4 had the least number of un – emerged

*Alectra*. Generally, increasing the *Alectra* seed density increased the number of un – emerged *Alectra* in the two trials.

Interaction of *Alectra* seed density and varities on total *Alectra* at harvest was significant in the two trials. In the first trial, cowpea variety TN 93 – 80 at the highest *Alectra* seed density had significantly higher total *Alectra* than all the other varieties, this was followed by TVX3236 also at the highest level of *Alectra* seed density. All the varieties that supported *Alectra* has the maximum number at 20cc *Alectra* seed density with the exception of IT819 – 985 which had the highest at 10cc. At all *Alectra* seed density, TVX3236 supported the highest *Alectra* infection in the second trial, among all varieties.

Interaction between pre – conditioning period x *Alectra* seed density on un – emerged *Alectra* in the second trial indicated that the highest *Alectra* seed level at the control and 7 days pre – conditioning period had the highest un – emerged *Alectra* which was comparable to 5cc/pot at control pre – conditioning period (Table 4). The 3 – way interaction of variety x pre – conditioning period x *Alectra* seed density indicated that TVX3236 at 10cc pre – conditioned for 14 days gave the highest number of un – emerged *Alectra*. This indicates the need for further investigation in order to have the appropriate pre – conditioning periods.

Interaction of cowpea varieties and pre – conditioning period on number of un – emerged *Alectra* was significant in the two trials. In the first trial, TN 93 – 80 that was not pre – conditioned prior to sowing had significantly more un – emerged *Alectra* than all the other varieties at all periods in the trial. In the second trial, TVX3236 pre – conditioned for 14 days had the highest number of un – emerged *Alectra*. All other varieties except IT89KD – 245 – 1 and VITA – 3 had their maximum emergence without pre – conditioning, as IT89KD – 245 – 1 and VITA – 3 required 3 and 7 DAS, respectively for maximum emergence.

Crop dry matter production was negatively correlated to number of emerged, un-emerged and total number of *Alectra* plants. This confirms the high vulnerability of cowpea to *Alectra* with consequent yield reduction. Similar observation has been reported by Kureh *et al* (1994) in soybean.

This investigation has shown that variety B301 and the derivative of its cross with IT84S – 2246 – 4 (IT90K – 76) did not support the emergence of *Alectra* thus exhibiting resistance. *Alectra* emergence increased with *Alectra* seed density up to 10c.c/pot when compared to other *Alectra* seed density Pre – conditioning period had no significant effect on emerged *Alectra*, but *Alectra* emergence increased with pre – conditioning of 7 and 14 days.

Table 5: Correlation between cowpea shoot dry weight and various parameters in the evaluation of *Alectra* seed density and pre – conditioning periods on cowpea varieties in the green house at Samaru, 2004.

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 1 – 0 | | | | | |
| 2 | - 0.08 | 1.0 | | | | |
| 3 | - 0.11 | 0.26 ** | 1.0 | | | |
| 4 | - 0.12 | 0.61 ** | 0.69 ** | 1.0 | | |
| 5 | - 0.20 * | 0.41 ** | - 0.26 | 0.73 ** | 1.0 | |
| 6 | 0.17 | - 0.13 | - 0.11 | - 0.26 * | 0.36 ** | 1.0 |

*= Significant at 5% level of probability (r = 0.10); **= Significant at 1% level of probability (r = 0.25)

Parameters: 1= Shoot dry weight; 2= Number of un – emerged *Alectra* at termination of experiment; 3= Number of emerged *Alectra* at termination of experiment; 4= Total number of *Alectra* at termination of experiment; 5=Crop damage score; 6= Average number of nodules/plant.

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