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Effect of nitrogen and phosphorus application on the reaction of cowpea to the parasitic plant *Alectra vogelii*

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ABSTRACT
Objective: To study the effect of nitrogen and phosphorus application on the reaction of cowpea varieties to *Alectra vogelii*.
Methodology and results: Three cowpea varieties (B301, TN93 – 80, VITA – 3) and four varieties (IT89KD – 245 – 1, TN93 – 80, VITA – 3 and SAMPEA – 7) were used in the two years respectively, with three levels each of N and P. Cowpea varieties TN93 – 80 and IT89KD – 245 – 1 delayed *Alectra* emergence. The highest N rate (60kg P/ha) consistently reduced *Alectra* shoot count, but depressed cowpea yield; while moderate P rate (20kg/ha) increased cowpea grain yield without any apparent effect on *Alectra* incidence.
Conclusions and application of findings: The study demonstrate that cowpea variety VITA – 3 has potential to tolerate *Alectra*; while higher doses of N (60kg/ha) and P (40kg/ha) delay *Alectra* emergence. Combination of suitable cowpea variety with appropriate fertilizer level could therefore be used as a management measure for *Alectra vogelii*.

Keywords: Cowpea, reaction, Alectra, nitrogen, phosphorus.

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INTRODUCTION

Alectra vogelii (Benth) is a parasitic plant belonging to the family *Scrophulariaceae*, a hemi-parasite which derives its water and nutrients from the roots of its host plant. It is a major constraint to cowpea production in the Nigerian Savanna, especially in the Northern Guinea Savanna (Emechebe *et al*.., 1983). The parasite is so wide-spread and severe that susceptible cowpea varieties can be wiped out completely and fields may become so heavily infested with its seeds that farmers cannot grow cowpea.

Alectra has a similar life-cycle to that of *Striga* sp. Seed germination occurs in response to the root exudates of potential hosts and a hemi-parasitic phase after emergence follows the holo-parasitic development of the plant on the host roots (Botha, 1984). Control measures proposed for *Striga* sp. are therefore generally applicable for *Alectra* management. The most effective method of controlling the weed is through host-plant resistance or tolerance. The other control methods including hand pulling, fertilizers and herbicide application have not been sufficiently effective, and therefore can only serve as supplements to the use of resistant or tolerant varieties.

Although there has been no reported studies on the effect of nitrogen fertilizer on the incidence of cowpea infection by *Alectra*, application of nitrogen at rates of up to 60kg N/ha reduce the incidence of cowpea attack by *Striga gesnerioides* without necessarily affecting grain yield (Adu *et al.*., 1989). In the tropics, phosphorus deficiency and soil acidity are the major factors limiting legume growth and nitrogen fixation (Whitney, 1975). Thus application of phosphate would be expected to benefit establishment, nodulation and yield of legumes.

Cowpea is the most important grain legume in the semi – arid regions of West Africa, and Nigeria is the largest producer. The dry seed of cowpea is primarily cooked as a pulse in a large variety of dishes while the tender green leaves and pods are cooked as vegetables. The ability of cowpea to fix atmospheric nitrogen (60 – 70 kg N/ha) which is utilized by the following crop makes it an important crop as replinisher of soil nitrogen especially in traditional farming systems (Rachie, 1985). The major constrains to cowpea production in Nigeria are insect pests, diseases and the parasitic plants *A. vogelii* and *S. gesnerioides*.

The trials reported here were carried out with the main objective of evaluating the effect of nitrogen and phosphorus application on the reaction of several cowpea varieties to *Alectra vogelii*.

MATERIALS AND METHODS

The trials were conducted during the 2003 and 2004 wet seasons in Samaru (11° 11'N, 7° 38'E) in the Northern Guinea Savanna ecological zone of Nigeria. Three cowpea varieties (B301, TN93 – 80, VITA – 3) were used in 2003 and four varieties (IT89KD – 245 – 1, TN93 – 80, VITA – 3 and SAMPEA – 7) were used in 2004. Varieties formed the main plot treatment while three levels each of nitrogen (0, 30 and 60kg N/ha) and Phosphorus (0, 20 and 40kg P/ha) fertilizers, in factorial combinations, all applied at planting, were the sub-plot treatments. The trial was laid out in a split-plot design and replicated three times in each block. Variety B301 was replaced in the investigation in 2004, since B301 did not support *Alectra* emergence at all in 2003. The gross and the net plot sizes in both trial years were 12 and 6 m^2, respectively. Two seeds of cowpea dressed with Benlate were planted per hole on 75cm wide ridges at an intra-row spacing of 30cm. Bentlate and Dithane M45 were used for the control of fungal pathogens while insects pests were controlled using cypermethrine and dimethoate.

Observations made included number of cowpea plants infected by *Alectra*, *Alectra* shoot count per unit area, days to first *Alectra* emergence, number and weight of cowpea pods and grain yield. The data collected were subjected to analysis of variance. Treatment means were compared using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

In the two trials, cowpea varieties differed significantly in their reaction to *Alectra*. In 2003, the number of plants infected with *Alectra* was significantly higher for VITA – 3 than TN93 – 80. In 2004, SAMPEA – 7 had the highest number of plants infected, while the least was obtained with cv. IT89KD – 245 - 1 (Table1). Varieties differed in the number of plants infected by *Alectra* following the order SAMPEA – 7 > VITA – 3 > TN93 – 80 > 1789KD – 245 – 1.

In 2003, *Alectra* did not emerge at all in the plots planted with variety B301 which confirmed the high level of resistance reported earlier (Riches, 1987; Emechebe & Singh, 1990). Variety B301 was therefore not included in the repeat trial carried out in 2004.

The number of days to *Alectra* emergence also differed significantly among cowpea varieties in the two years (Table 1). Generally, Alectra emergence was delayed in 2003 than 2004 in all the cowpea varieties that supported *Alectra* emergence. Nitrogen only had significant effect on the days to *Alectra* emergence only in 2004 when earlier germination was realized with 30Kg N/ha.In spite of having a higher number of infected plants, cowpea variety VITA – 3 produced comparable grain yield to the maximum realized with variety IT89KD – 245 – 1. This could be attributed to higher tolerance by the variety to *Alectra*.

Table 1: Effect of nitrogen and phosphorus on number of plants infected, the time of emergence and crop damage score at Samaru, 2003 and 2004 wet season.

Treatments	Number of Plants Infected/6m^2 at 9WAS		Number of days to first Alectra Emergence		Crop Damage Symptoms Score at 9WAS	
Variety (V)	2003	2004	2003	Variety (V)	2003	2004
B. 301	0.0c	-	-	B. 301	0.0c	-
(IT89KD-245-1)	-	2.0d[3]	-	(IT89KD-245-1)	-	2.0d[3]
TN 93 – 80	6.5b	4.4c	57	TN 93 – 80	6.5b	4.4c
VITA – 3	10.4a	7.1b	56	VITA – 3	10.4a	7.1b
(SAMPEA – 7)	-	9.4b	-	(SAMPEA – 7)	-	9.4b
S.E ±	0.58	0.56	0.35	S.E ±	0.58	0.56
Phosphorus (Kg /ha)				Phosphorus (Kg/ha)		
0	5.9	5.1	38	0	5.9	5.1
20	5.3	5.9	38	20	5.3	5.9
40	5.7	6.1	38	40	5.7	6.1
S.E ±	0.58	0.44	0.68	S.E ±	0.58	0.44
Nitrogen (Kg N/ha)				Nitrogen (Kg N/ha)		
0	7.7a	6.5	37	0	7.7a	6.5
30	5.8b	5.9	38	30	5.8b	5.9
60	3.5c	4.7	37	60	3.5c	4.7
S.E ±	0.58	0.44	0.68	S.E ±	0.58	0.44
Interactions				Interactions		
V X P	NS	NS	NS	V X P	NS	NS
V X N	NS	NS	NS	V X N	NS	NS
N X P	NS	NS	NS	N X P	NS	NS
V X N X P	NS	**	**	V X N X P	NS	**

WAS = weeks after sowing; Crop damage symptom score scale (1 – 5) where 1 = normal crop plant growth; 2 = no chlorosis; 3 = no blotching; 4 = no leaf scorching; and 5 = total scorching or and obviously stunted or dead plants. Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

In the two trial years, the number of infected plants were consistently reduced by 60Kg N/ha, although this rate depressed cowpea grain yield compared with 0 and 30Kg N/ha. In a similar study in sand culture (Emechebe *et al*., 1991) showed that 140ppm N applied as sodium nitrate ($NaNo_3$) solution completely reduced the incidence of *S. gesnerioides* with a concomitant decrease in nodule numbers. However, (Adu *et al*., 1989) reported that lower levels of N in combination with some host resistance would be appropriate to reduce *Striga* infection. The influence of N – fertilization and manuring as farm practices in the management of *Striga* are generally not consistent and repeatable. The use of N in controlling *S. gesnerioides* in cowpea seems to be limited due to its detrimental effect of high rates on nodulation with consequent yield reduction. In field studies in the USA, significant control of *Striga asiatica* was obtained by using high rates of N as ammonium sulfate (Shaw *et al*., 1962). Similarly, in India N applied to heavily infested *Striga* fields grown with pearl – millet reduced the incidence of *Striga* and doubled crop yields (Marthur & Marthur, 1967). In Sudan, application of 90Kg N/ha on soil that was lightly infested with *S. hermonthica* trebled grain yields from 1278 to 3957 Kg1/ha while the relative effect was greater in highly infested soil with severe attack (Last, 1960). In Nigeria, Mansfield (1982) showed that up to 150Kg/ha may be needed to reduce *Striga* infestation effectively. The mechanism by which high N reduced *Striga* infestation could be attributed to the production of low germination stimulant by sorghum under high N (Parker, 1984; Adeosun, 1990; Ngawa, 1992). This was confirmed Gworgwor (1993) who reported that under high N, low stimulate was produced during the first three weeks.

Table 2: Effect of nitrogen and phosphorus on number, weight of pods and grain yield at Samaru, 2003 wet seasons.

Treatments	Number of pods/6m2	Weight of pods (Kg/ha)	Grain yield (Kg/ha)
Variety (V)			
B. 301	5.75 a	943.3 a	64.1
TN 93 – 80	3.36 b	688.3 b	53.2
VITA – 3	2.53 c	881.7 a	66.0
S.E ±	12.73	60.7	44.20
Phosphorus (Kg P/ha)			
0	272 b	533.3 b	390 b
20	415 a	925.0 a	685 a
40	477 a	1055.0 a	759 a
S.E ±	25.53	57.52	45.76
Nitrogen (Kg N/ha)			
0	359	833.3	613 a
30	425	945.0	694 a
60	370	743.3	526 b
S. E ±	25.53	57.52	45.76
Interactions			
V X P	NS	NS	NS
V X N	NS	NS	NS
N X P	NS	NS	NS
V X N X P	NS	NS	NS

Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT)

Earlier works (Parker, 1984; Sharif & Parker, 1986; Raju *et al.*, 1990) have shown that high N reduces stimulant production from sorghum and can delay *Striga* emergence and reduce its infestation. This might be through physiological changes in the growth rate of the cell tissues in the active stimulant producing area of the sorghum roots. High N could also reduce radicle elongation of the few germinated *Striga* seeds (Perch & Pieterse, 1982) and thus provide an escape mechanism effect on the attachment of the *Striga* seedlings to the host.

Although not significant, *Alectra* infection depressed yield in 2004. In the two years cowpea varieties differed significantly with respect to pod weight (Tables 2 and 3) with variety VITA-3 producing significantly higher pod yield than TN93 – 80. In the two trials, 20Kg P/ha significantly increased pod weight compared with no phosphorus application.

The significant increase in weight of pods per unit area and grain yield with P – application has earlier been attributed to the fact that P promotes good establishment, nodulation and yield of legumes (Whitney, 1975). Phosphorus application however, did not have any effect on *Alectra* parameters while the damage symptoms on crop plants was more intense at 40Kg P/ha compared with 0 and 20Kg P/ha . This may be attributed to better establishment and increased number of nodules and lateral roots which could serve as haustorial attachment points for the parasite.

In 2004, although not significant, un-infested plots had more grain yield than the infected (Table 3). *Alectra* infection only reduced grain yield of VITA – 3 by 0.9% compared with 21.5, 13.5 and 11.7% for varieties SAMPEA – 7, TN93 – 80 and IT89KD – 245 – 1, respectively. With the low pod number, the acceptable yield of VITA – 3 in 2003 and low reduction in yield in 2004 in-spite of moderate infestation respectively could be attributed to some degree of tolerance. The higher yield is probably through increased seed size to compensate for reduced pod number. Being a late maturing variety, it would still have adequate photosynthetic apparatus for the production of assimilates for grain filling at the later stages of life cycle. In the two trials, grain yield was significantly increased by phosphorus application at 20Kg P/ha. In 2004, under artificial infestation, *Alectra* caused 16.7% reduction in cowpea compared to 7.9 and 8.0% reduction obtained with 0 and 40Kg p/ha, respectively.

Application of 30Kg N/ha resulted in significantly higher cowpea grain yield compared with 60Kg N/ha in 2004. In 2004, under artificial infestation, *Alectra* only caused 2.9% reduction in cowpea grain yield with application of 30Kg N/ha compared with 18.0% and 13.3% obtained with 0 and 60Kg N/ha, respectively.

Table 3: Effect of nitrogen and phosphorus on number of days to crop flowering, weight of pods and grain yield under *Alectra* infestation at Samaru, 2004 wet season.

Treatments	Number of days to crop flowering	Weight of pods (Kg/ha)	Grain yield (Kg/ha)	% Yield reduction
Infection (I)				
Infected	51 b	1200	1029	
Un – infected	52 a	1450	1155	11.1
S. E ±	0.20	270.0	197.28	
Variety (V)				
IT89KD – 245 – 1	52 a	1400 ab	1275 a	11.7
TN93 – 80	53 a	1030 c	849 b	13.5
VITA – 3	52 a	1620 a	1345 a	0.6
SAMPEA – 7	49 b	1270 bc	895 a	21.5
S. E ±	0.52	100.0	58.76	
Phosphorus (Kg/ha)				
0	52 a	1220 b	990 b	7.9
20	51 b	1420 a	1131 a	16.7
40	51 b	1350 ab	1152 a	8.0
S. E±	0.23	50.0	39.25	
Nitrogen (Kg/ha)				
0	52 a	1300 ab	1011 b	18.0
30	51 b	1420 a	1239 a	2.9
60	51 b	1230 b	993 b	13.3
S. E ±	0.23	50.0	39.25	
Interactions				
V X I	NS	NS	NS	NS
V X N	NS	NS	NS	NS
I X N	NS	NS	NS	NS
V X P	NS	NS	NS	NS
V X I X N	NS	NS	NS	NS
V X P X N	NS	NS	NS	NS
I X P X N	NS	NS	NS	NS

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

The interactions of variety x phosphorus x nitrogen on number of days to first *Alectra* emergence were significant in the two years (Tables 4). In 2003, the highest levels of N and P increased days to *Alectra* emergence in cv. TN 93 – 80, compared with combination involving the same rate of P and zero or 30Kg N/ha. The use of either 30Kg N/ha, 20Kg P/ha or 40Kg P/ha alone in VITA – 3 reduced days to *Alectra* emergence compared with the maximum in TN 93 – 80. In 2004, the 3 – way interactions indicates that maximum number of days to first *Alectra* emergence was obtained with IT89KD – 245 – 1 given 40Kg P/ha only. The same variety given 60Kg N/ha only and combination of the 60Kg N/ha and 40Kg P/ha also resulted in days comparable to the maximum. Among all varieties tested, *Alectra* emergence was only delayed in IT89KD – 245 – 1 by P at 40Kg P/ha alone or in combination with 30Kg N/ha compared with 0 and 20Kg P/ha. It is apparent that varieties which exhibited moderate (TN 93 – 80 in 2003) to high (IT89KD – 245 – 1 in 2004) levels of resistance responded to high doses of N (60Kg N/ha) and P (40Kg P/ha) by delaying the emergence of *Alectra*. However, the high rate of N was detrimental to cowpea.

The interaction of variety x phosphorus x nitrogen was only significant on number of plants infected with Alectra at 9 WAS in 2004 (Table 5). It was highest in cv. SAMPEA – 7 treated with 40Kg P/ha alone. Only combination of 30Kg N and 20Kg P/ha in the same variety was comparable to the maximum.

Based on the findings of this investigation, it is concluded that a combination of cowpea variety VITA – 3 with N and P at 60kg /ha and 40kg /ha, respectively, can be used as a management measure for *Alectra vogelii*.

Table 4: Interaction of, Phosphorus, nitrogen and variety on number of days to *Alectra* emergence at Samaru, 2004 wet season.

Varieties	Nitrogen (Kg N/ha)	Phosphorus (Kg P/ha)		
		0	20	40
	0	50 bcd	51 bcde[1]	61 a
IT89KD – 245 – 1	30	46 cde	43 de	53 bc
	60	60 a	50 bcd	54 ab
	0	43 de	43 de	44 de
TN 93 – 80	30	46 cd	43 de	41 e
	60	48 b-e	39 e	46 cde
	0	44 de	43 de	44 de
VITA – 3	30	44 de	44 de	44 de
	60	44 de	44 de	44 de
	0	48 b-e	43 de	44 de
SAMPEA – 7	30	46 cde	45 de	43 de
	60	44 de	41 e	45 debc
S. E ±	2.38			

Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

Table 5: Interaction of phosphorus, nitrogen and variety on number of plants infected with *Alectra* at 9 Weeks after sowing (WAS) at Samaru, 2004 wet season.

Varieties	NUMBER OF PLANTS INFECTED WITH *Alectra*/ $6M^2$ AT 9 WAS Nitrogen (Kg N/ha)	Phosphorus (Kg P/ha)		
		0	20	40
	0	3.0 e – i	2.7 f – i	1.0 I
IT89KD – 245 – 1	30	0.7 i	2.7 f – i	3.0 e – i
	60	1.7 hi	1.7 hi	1.7 hi
	0	8.7 cd	4.0 d – i	5.0 c – i
TN 93 – 80	30	2.7 f – i	3.7 d – i	6.3 c – h
	60	2.3 ghi	4.0 d – i	2.7 f – I
	0	5.7 c – i	9.3 bc	6.7 c – h
VITA – 3	30	7.7 c – f	8.3 cd	7.3 c – g
	60	8.0 cde	5.0 c – I	5.7 c – i
	0	7.0 c – g	8.7 cd	16.7 a
SAMPEA – 7	30	7.3 c – g	13 3 ab	7.7 c – f
	60	6.3 c – h	8.0 cde	9.3 bc
S. E ±	1.55			

Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

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