EFFECT OF *ALECTRA VOGELII* AND *STRIGA GESNERIOIDES* INFESTATIONS ON THE GRAIN MINERAL ELEMENTS' CONCENTRATION OF COWPEA VARIETIES

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Received: July 16, 2008
Accepted: February 2, 2009

Abstract: Field trials were conducted in 1999 and 2000 to investigate the effect of *Striga gesnerioides* and *Alectra vogelii* on the grain mineral elements' concentration of five cowpea varieties at harvest : IT82D-849, IT86D-534, IT89KD-245, KANO 1696 and SAMPEA7. The mineral elements analyzed were: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn) and zinc (Zn). Obtained data showed that the concentration of most elements was generally reduced in the grains of the cowpea varieties IT82D-849 and IT89KD-245 on both *Alectra* and *Striga* inoculated plots. On the other hand, cowpea varieties KANO1696 and SAMPEA 7 showed a tendency towards having increased concentration of about 50% of the element analyzed in each year on both *Alectra* and *Striga* inoculated plots. In both KANO1696 and SAMPEA 7 there was a tendency towards the increase in the grain concentration of Mg and Zn and the decrease in K and Mn on *Alectra* inoculated plots and the increase in P and Mg but the decrease in Ca and Zn on *Striga* inoculated plots. The concentration of P in all the varieties in 1999 and 2000 (except IT89KD245 in 2000) was increased on *Striga* inoculated plots. Also, the concentration of Mg and N was increased in IT82D-849 on both *Striga* and *Alectra* inoculated plots in 2000. This study showed that, *Striga* and *Alectra* infestation generally reduced the mineral elements' concentration in the grains of cowpea varieties

Key words: *Alectra vogelii*, *Striga gesnerioides*, cowpea varieties, mineral element

INTRODUCTION

A damage is inflicted on food and fodder plants by the parasitic members of family *Scrophulariaceae*. Among these are: *Striga gesnerioides* and *Alectra vogelii* which occur in West Africa, as serious pests of cowpea. These parasites divert the host nutrient into themselves through the haustorium that established contact with xylem and phloem tissues of the host (Okonkwo and Nwoke 1978; Okwonkwo 1966). Therefore, competition for water, organic ions and metabolites is the simplest explanation for losses in host production (Stewart and Press1990). The competitive success of *Striga* is usually ascribed to having a greater osmotic pressure than its host (Kuijt 1969). According to Setty and Nanjappa (1985) the osmotic potential was higher in both leaf and root of *Striga* than the leaf and root of *Sorghum*.

Hibbered *et al*. (1996) observed lower concentrations of nitrogen and phosphorus in the leaves of *Striga* infected cowpea plants compared to the control plants, although, the differences were not significant. However Stewart *et al*. (1984) reported no differences in leaf N concentration between *Striga*-infected and uninfected plants of *Sorghum*. Graves *et al*. (1992) reported that, *S. gesnerioides* was highly dependent on its host for carbon as well as for water and inorganic solutes. It was estimated that 70% of the carbon transferred from host to parasite was used in respiration of parasites. Infected cowpea had a lower photosynthetic capacity. The loss of carbon from the host by export to parasite is more important than reduced photosynthetic capacity of the host accounting for the observed growth reduction. Younis and Agabawi (1965) found that *S. hermothica* and *Sorghum* parasitized by *S. hermonthica* together accumulated less nitrogen from the soil than did non-parasitized *Sorghum*. However, they found that the parasite accumulated more N than did the host shoots per gram on dry weight basis.

Very little has been done in the tropics on the effect of *Striga* and *Alectra* infestation on cowpea seeds mineral element composition despite their devastating effects on cowpea crop production. This study was therefore conducted to provide information on the extent to which *Striga* and *Alectra* infestation can influence mineral element concentrations in cowpea seeds in the guinea savanna zone of Nigeria. The infestation affects quality of seeds produced by plants infected by these parasitic weeds.

MATERIALS AND METHODS

Field trails were conducted in 1999 and 2000 wet seasons in the Botanical garden, Ahamdu Bello University, Samaru (11° 11′ N, 07° 38E and 686 m above sea level) Zaria, Nigeria, to study the impact of *Alectra vogelii* and

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Striga gesnerioides infestation on the mineral element concentration of cowpea varieties grains. The land was cleared manually each year before ridges spaced 75 cm apart with West African hand-held hoe were made. The physico-chemical properties of the soil in the experimental site is shown in table 1.

Table 1. Physical and chemical properties of the soil at the experimental site

Soil property	Value
Particles size	
Sand [%]	54.0
Silt [%]	38.0
Clay [%]	8.0
Textural class	Loam
pH in 1:2.5 water	5.93
pH in 1:2.5 0.01 M $CaCl_2$	5.92
Organic carbon [%]	0.27
Total nitrogen [%]	0.10
Available phosphorus [ppm]	10.55
Potassium [ppm]	71.0
Sodium [ppm]	15

The land was divided into three parts, i.e. *Alectra* and *Striga* inoculated parts and the uninoculated control section. The *Striga* infested part was artificially inoculated with *S. gesnerioides* seeds, at the approximate rate of 2,000 seeds per hole, spaced at 20 cm interval, using inoculum that filled a soft drink bottle cover. *Striga* seeds inoculum was prepared by mixing 10 g of *Striga* seeds with 250 g sieved sand (180 μm size). The mixture was shaken thoroughly in air-filled polythene bag for 5 minutes to ensure a uniform distribution of *Striga* seeds.The above procedure was also used for *Alectra.*

Each plot was represented by 3 × 3 m long ridges for each cowpea variety and the experiment was laid out in a randomized complete block design in three replications. Cowpea seeds were sown in the first week of September [for late planting trail (LPT) in 1999] and July [for early planting trial (EPT) in 2000). Three cowpea seeds dressed with metalaxyl (10%) + carboxin (60%) + furathiocarb (34%) were sown per hole (Table 2).

Table 2. Details of the chemicals applied in the study

Trade Mark	Formulation	Active substance
Apron plus	powder	metalaxyl [10%]
		carboxin [6%]
		furathiocarb [34%]
Dithane M-45	wettable powder	mancozeb (Maneb/zinc complex) [80%]
Benlate	wettable powder	benomyl [50%]
Sherpa plus	emulsifiable	cypermethrin [35g/1]
	concentrate	dimethoate [300g/1]

They were later thinned to two plants per stand at 2 weeks after planting (WAP). A compound fertiliser (NPK 15-15-15) was applied at the rate of 30 kg N/ha at 3 WAP. Cowpea seedlings were sprayed with benomyl and mancozeb (maneb/zinc complex) at the rate of 0.6 and 2.5 kg/ha respectively (to control fungal diseases) and dimethoate at 0.75 l/ha were applied at 4 WAP, to prevent viral diseases.

Cypermethrin and dimethoate (sherpa plus) were 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. These chemicals were applied using a knapsack sprayer of a spray volume 186 l/ha. Cowpea plants were sampled fortnightly from each plot beginning from 5 to 9 WAP for the determination of different parameters. At each sampling, plants were carefully uprooted from the plots with the aid of a West African hoe. Samples were brought to the laboratory in labeled polythene bags. They were washed carefully with tap water, rinsed with deionized water and spread on a table for water to drain. The roots of these plants were carefully examined (with the aid of a stereo-microscope at 5 WAP), in order to separate plants infected with *Striga* from uninfected ones. The number of plants in each group was recorded.

Dry pods of cowpea plants on each net plot were picked three times, weighed and threshed. After threshing, a certain quantity of grains for each variety was enveloped and dried to a constant weight in an oven maintained at 70°C. These dried seeds were ground with a mortar to pass through 1mm sieve and stored in airtight labeled specimen bottles.

About 0.5 g of each powdered sample was wet digested in a Kjeldahl flask as described by Jackson (1972). From each sample the level of the following mineral elements: calcium, magnesium, zinc, manganese and iron was determined with the use of a Perkin-Elmer Atomic Absorption Spectrophotometer. Phosphorus was determined colorimetrically using a Spectronic 20 at 440 nm. Potassium concentration was estimated with a Flame Photometer. The obtained data from plants on *Alectra* and *Striga* inoculated plots were compared with those from the uninoculated control plots, as shown below:

Per cent (%) change in the element:

$$\frac{\text{Inoculated} - \text{Uninoculated}}{\text{Uninoculated}} \times \frac{100}{1}$$

They were subjected to analysis of variance (ANOVA) as described by Lawes Agricultural Trust (1980). Significant differences between varietal means were compared using Duncan Multiple Range Test (DMRT).

RESULTS

Cowpea variety IT86D-534 had the lowest *Alectra* shoot dry weight/sampled cowpea plant on *Alectra* inoculated plots in 1999 and 2000, while the highest was for variety IT82D-849 in 1999 and KANO 1696 in 2000 (Table 3). The difference in 1999 was significant while that in 2000 was not. However, on *Striga* inoculated plots variety IT82D-849 had no *Striga* infection in both trials, while the highest infection was obtained from SAMPEA 7 in 1999 and IT89KD-245 in 2000. The lowest *Striga* shoot dry weight/sampled cowpea plant from IT82D-849 in 1999 was only significantly lower than that on SAMPEA 7. Similarly, in 2000, the highest *Striga* infection on IT89KD-245 was significantly higher than the lowest from variety IT82D-849.

Table 3. *Alectra* and *Striga* dry weight of sampled cowpea plant in 1999 and 2000

Cowpea variety	*Alectra* dry weight [g]		*Striga* dry weight [g]	
	1999	2000	1999	2000
IT82D- 849	2.58 a	2.18 a	0.00 b	0.00 b
IT89KD-245	1.19 ab	0.56 a	2.28 a	5.00 a
KANO1696	0.41 bc	2.42 a	0.74 b	3.70 ab
IT86D-534	0.01 c	0.10 a	1.13 b	3.66 ab
SAMPEA 7	0.94 ab	2.67 a	2.73 a	2.71 ab
SE ±	0.52	1.00	0.46	1.11

Figures followed by the same letter(s) in each column are not significantly different (p = 0.05), using Duncan's Multiple Range Test

Nitrogen (N)

Alectra

Alectra infestation increased seed N concentration in all the varieties except SAMPEA 7 in 1999 (Table 4). In 2000, seed N concentration was reduced in both varieties IT89KD-245 and KANO1696 while that of the other varieties was increased due to *Alectra* infestation. The highest increase in seed N concentration was observed in variety IT86D-534 in both trials. The two-year data showed that, the highest reduction in seed N concentration was significantly lower than the highest increase in IT89KD-245.

Striga

In 1999, *Striga* infestation increased the seed N concentration in varieties IT86D-534 and KANO 1696, while that of the other varieties was reduced (Table 5). The highest reduction in SAMPEA 7 was significantly lower than the increase observed in varieties IT86D-534 and KANO1696. In 2000, the seed N concentration in cowpea varieties IT82D-849, IT86D-534 and SAMPEA 7 was increased, while it was reduced in the other varieties on *Striga* inoculated plots. Only the increase in seed N concentration in SAMPEA 7 and IT82D-849 was significantly higher than the highest reduction in variety IT89KD-245. The two-year data showed that, the highest reduction in seed N concentration in IT89KD-245 was significantly lower than that of the other varieties (p = 0.05).

Phosphorus (P)

Alectra

With the exception of variety SAMPEA 7, the seed P concentration was reduced in all the varieties on *Alectra* inoculated plots in 1999 (Table 4). The reduction was comparable among the varieties, even though the highest reduction was shown in varieties IT89KD-245 and KANO1696. In 2000, the seed P concentration in varieties IT82D-849 and IT89KD-245 was reduced while that of varieties KANO 1696 and SAMPEA 7 was increased. There was no significant difference in the per cent change in seed P concentration among the varieties in each trial. The two-year data showed that, the seed P concentration in all cowpea varieties, except SAMPEA 7, was reduced on *Alectra* inoculated plots, the difference in seed P concentration among the varieties was not significant (p = 0.05).

Table 4. Effect of *Alectra vogelii* on seed mineral elements' concentration of cowpea varieties in 1999 and 2000

Cowpea variety Percentage [%] change in mineral element						
Element	IT82D-849	IT86D-534	IT89KD-245	KANO1696	SAMPEA 7	SE±
1999						
N	08.5 a	12.7 a	07.3 a	19.1 a	–01.5 a	11.99
P	–03.5 a	–09.0 a	–13.7 a	–13.7 a	20.1 a	16.70
K	–92.68 a	–92.40 a	–92.19 a	–91.26 a	–90.17 a	0.86
Mg	–21.4 c	–07.0 a	–09.2 b	06.9 a	00.3 ab	4.33
Ca	–53.1 b	–34.8 b	24.7 a	–28.4 b	–28.2 b	12.28
Fe	–58.0 b	–97.0 b	–08.0 ab	119.3 a	–50.0 b	10.76
Mn	–92.2 b	–87.7 b	–26.1 a	–04.4 a	–87.7 b	6.82
Zn	–56.0 b	03.0 ab	59.0 a	62.0 a	82.0 a	23.48
2000						
N	4.5 ab	60.8 a	–11.4 b	–21.3 b	05.7 ab	18.87
P	–02.5 a	00.0 a	–13.7 a	11.8 a	02.3 a	18.79
K	–92.21 a	–92.12 a	–93.52 a	–92.24 a	–94.27 a	0.82
Mg	00.2 a	–13.5 a	00.1 a	00.7 a	01.1 a	9.55
Ca	75.5 ab	05.6 c	136.2 a	66.0 bc	–00.1 c	20.12
Fe	–96.2 c	–85.7 c	–96.1c	–57.2 b	–21.7 a	6.73
Mn	00.0 a	–87.7 b	–89.8 b	–84.3 b	–82.7 b	1.91
Zn	–19.6 b	–68.9 b	26.1 a	02.7 a	57.8 a	17.76

Means followed by the same letter (s) in each row, in each year, are not significantly different (p = 0.05),using Duncan's Multiple Range Test

Table 5. Effect of *Striga gesnerioides* on seed mineral element concentration of cowpea varieties in 1999 and 2000

Element	IT82D-849	IT86D-534	IT89KD-245	KANO1696	SAMPEA 7	SE±
	Cowpea variety Percentage [%] change in mineral element					
1999						
N	–17.2 ab	09.9 a	–26.5 ab	16.7 a	–34.6 b	12.75
P	22.0 a	18.0 a	01.0 a	12.0 a	26.0 a	29.84
K	00.0 a	00.2 a	–02.3 a	13.6 a	13.0 a	5.38
Mg	–16.6 bc	–24..5 c	–24.1 c	–00.1 ab	12.4 a	5.92
Ca	–56.6 b	–52.8 b	–41.8 ab	–41.8 ab	–27.6 a	7.28
Fe	–20.6 b	–08.8 b	50.8 a	11.8 ab	00.0 b	14.50
Mn	–50.0 a	–18.9 a	–17.2 a	07.2 a	–16.7 a	20.78
Zn	–74.0 b	04.0 b	–69.0 b	–41.0 b	222.0 b	64.49
2000						
N	08.2 ab	4.8 abc	–27.5 c	–19.8 bc	28.7 a	10.23
P	06.0 a	17.0 a	–06.0 a	14.0 a	21.0 a	25.03
K	–01.5 a	–08.8 a	–13.8 a	–92.0 b	–93.3 b	6.23
Mg	00.2 ab	12.5 a	–10.5 b	11.9 a	12.6 a	5.95
Ca	–24.8 bc	–38.6 c	01.1 b	67.6 a	–19.8 bc	8.90
Fe	–50.0 b	–86.0 b	–96.0 b	–77.0 b	115.0 a	23.19
Mn	–50.0 a	–18.9 a	–17.2 a	07.2 a	–16.2 a	20.78
Zn	–76.0 b	–68.9b	–68.9 b	–80.4 b	–00.2 a	5.40

Means followed by the same letter(s) in each row, in each year, are not significantly different (p = 0.05), using Duncan's Multiple Range Test

Striga

The seed P concentration in cowpea varieties (except IT89KD-245 in 2000) was increased on *Striga* inoculated plots in both trials (Table 5). The highest increase in cowpea seed P concentration was observed in variety SAMPEA 7 in each trial. However, there was no significant difference in the changes in seed P concentration observed among the cowpea varieties in each trial and when the two-year data were combined (p = 0.05).

Potassium (K)

Alectra

The cowpea seed K concentration in all the varieties was greatly reduced on *Alectra* inoculated plots in both trials and when the two-year data were combined (Table 4). However, the change in seed K concentration among the varieties was not significant in each trial and when the two-year data was combined.

In 1999, *Alectra* infestation resulted in the lowest reduction in seed K concentration in variety SAMPEA 7 and the highest reduction in IT82D-849, while in 2000, the lowest reduction occurred in IT86D-534 and the highest in SAMPEA 7.

Striga

In comparison with *Alectra,* there was very low per cent reduction in seed K concentration of IT89KD-245 while that of the other varieties was reduced on *Striga* inoculated plots in 1999 (Table 5). This difference in seed K concentration among the varieties due to *Striga* infestation was not significant. However, in 2000 and when the two-year data were combined, *Striga* infestation reduced the seed K concentration of all the cowpea varieties with significantly lower reduction in varieties IT82D-849, IT86D-534 and IT89KD-245, compared with the other varieties.

Magnesium (Mg)

Alectra

Alectra infestation resulted in a slight increase in seed Mg concentration in varieties KANO1696 and SAMPEA 7 in 1999 and also when the two-year data were combined. The highest reduction in seed Mg concentration in IT82D-849 was significantly lower than the change in the other varieties (Table 4).

However in 2000, seed Mg concentration was slightly increased in all the cowpea varieties, except IT86D-534 on *Alectra* inoculated plots. The highest increase observed in SAMPEA 7 was similar to the change in the other varieties. The two-year data showed that, there was no significant difference in the percentage change in seed Mg concentration of the cowpea varieties on *Alectra* inoculated plots.

Striga

Striga infestation resulted in the highest increase in seed Mg concentration in SAMPEA 7 in each trial (Table 5). All the other varieties had a reduced Mg concentration on *Striga* inoculated plots in 1999. The highest reduction in seed Mg concentration in IT89KD-245 was significantly lower than the change in KANO 1696 and SAMPEA 7. In 2000, only varieties IT89KD-245 showed the reduction in seed Mg concentration due to *Striga* infestation and this was comparable with the increase in variety IT82D-849.

All the other varieties had seed Mg concentration that was significantly comparable with the highest increase observed in variety SAMPEA 7 on *Striga* inoculated plots. The two-year data revealed that, only varieties SAMPEA 7 and KANO 1696 showed the increase in seed Mg concentration while the other varieties showed comparable reduction due to *Striga* infestation.

Calcium (Ca)

Alectra

In 1999, the seed Ca concentration was reduced in all the cowpea varieties, except IT89KD-245, on *Alectra* inoculated plots (Table 4). The highest reduction in seed Ca concentration in IT82D-849 was significantly lower than the increase observed in IT89KD-245. In 2000, seed Ca concentration was increased in all the cowpea varieties (except SAMPEA 7), on *Alectra* inoculated plots.

The highest reduction in seed Ca concentration in SAMPEA 7 was significantly lower than the increase in IT89KD-245 and IT82D-849. Similarly, the two-year data showed that, with the exception of the highest increase in seed Ca concentration in IT89KD-245, the change in the other varieties was similar to the highest reduction in IT86D-534 ($p = 0.05$).

Striga

In 1999, the seed Ca concentration was reduced in all the cowpea varieties on *Striga* inoculated plots (Table 5). The highest reduction in IT82D-849 was comparable with that of the other varieties, except the lowest reduction in variety SAMPEA 7.In 2000, seed Ca concentration was increased in varieties KANO 1696 and IT89KD-245 but reduced in the other varieties on *Striga* inoculated plots. The highest reduction in Ca concentration in varieties IT86D-534 was similar to that observed in varieties IT82D-849 and SAMPEA 7. The two-year data showed that, the highest increase in seed Ca concentration in KANO1696 and the highest reduction in that of IT86D-534 were each significantly different from the other varieties.

IRON (Fe)

Alectra

Cowpea seed Fe concentration was reduced in both years in all the cowpea varieties (except in KANO1696 in 1999) due to *Alectra* infestation (Table 4). In 1999, *Alectra* infestation resulted in the lowest reduction of seed Fe in variety IT89KD-245 and the highest reduction in variety IT86D-534. The change in seed Fe concentration in all the cowpea varieties due to *Alectra* infestation was comparable, except the increase in that of KANO1696. However, in 2000, the highest reduction in seed Fe concentration of variety IT82D-849 was comparable with the reduction in that of varieties IT86D-534 and IT89D-245, while the reduction in that of SAMPEA 7 was significantly lower than that of the other varieties. The two-year data showed that, significantly higher reduction in seed Fe occurred in IT82D-849 and IT86D-534 than the other varieties which in turn had comparable change in seed Fe concentration due to *Alectra* infestation.

Striga

Striga infestation reduced the seed Fe concentration in IT82D-849 and IT86D-534 (Table 5). With the exception of the increase in the seed Fe concentration of variety IT89KD-245, the change in the other cowpea varieties was similar in 1999. The highest decrease in seed Fe concentration in variety IT89KD-245 in 2000 was similar to the decrease in other varieties, except the highest increase in that of variety SAMPEA 7.

The data in 2000 and the two-year data combined showed that, the highest increase in seed Fe concentration in SAMPEA 7 was significantly higher than the reduction in the other varieties, which was also comparable.

Manganese (Mn)

Alectra

Alectra infestation resulted in reduction in seed Mn concentration in all cowpea varieties except in IT82D-849 in both years, with the lowest reduction in KANO 1696 and the highest reduction in IT82D-849 in 1999 (Table 4). However, in 2000 the highest reduction in seed Mn concentration in IT89KD-245 was significantly lower than the zero percentage change observed in that of IT82D-849. The two-year data showed that, all the varieties showed the reduction in the seed Mn concentration due to *Alectra* infestation.The highest reduction in seed Mn concentration in IT86D-534 was only comparable with that of SAMPEA7.

Striga

The seed Mn concentration of all the cowpea varieties (except KANO1696) was reduced due to *Striga* infestation in both years and when the two-year data were combined (Table 5). However, the difference in seed Mn concentration among the varieties was not significant.

Zinc (Zn)

Alectra

There was a comparable increase in the seed Zn concentration of varieties IT89KD-245, KANO1696 and SAMPEA7 in each year and when the two-year data were combined (Table 4). However, the seed Zn concentration of variety IT82D-849 was reduced in both years due to *Alectra* infestation, cowpea variety SAMPEA 7 showed the highest increase in seed Zn concentration in each year due to *Alectra* infestation. The obtained data showed that, the decrease in seed Zn concentration of IT82D-849 and IT86D-534 due to *Alectra* infestation in 2000 and when the 2-year data were combined were comparable.

Striga

With the exception of the increase in varieties SAMPEA 7 and IT86D-534 in 1999, *Striga* infestation resulted in the reduction of the seed Zn concentration in the other varieties (Table 5). In 2000, the seed Zn concentration of all the cowpea varieties was reduced on *Striga* inoculated plots. The highest reduction occurred in IT82D-849 in 1999 and in KANO 1696 in 2000. Cowpea variety SAMPEA 7 exhibited a significantly higher increase in 1999 and a significantly lower reduction in seed Zn concentration in 2000 as compared to that of the other varieties. The change in seed Zn concentration of the other varieties was comparable in each year and when the two-year data were combined.

DISCUSSION

A general reduction in the seed concentration of most mineral elements in cowpea grains in each trial showed that, *Alectra* and *Striga* infestation invariably limited the quantity of the mineral elements translocated to cowpea grains. This reduction in the elements' concentration in cowpea seeds could be due to the fact that, *Alectra* and *Striga* infestation reduced the concentration of these elements in the leaves during the vegetative growth stage (Alonge *et al.* 2004). Also, Hibberd *et al*. (1996) observed a lower concentration of nitrogen and phosphorus in the leaves of *Striga* infected cowpea plants compared with the control plants. However, it has long been observed that, mineral elements are usually concentrated in plant leaves following absorption before being translocated to the seeds (Jones *et al*. 1977; Alonge *et al*. 1995). Therefore, the factor that affects the concentration of these elements in the leaves can invariably affect it in the seeds apart from the factors influencing the absorption and translocation of these elements during pod-filling stage of the plant (Ohlrogge 1963; Alonge *et al*. 1995). Secondly, observation showed that, *Striga* and *Alectra* infestation resulted in the accumulation of mineral elements in the host roots, instead of being translocated into the parasites' shoots via haustoria. The analysis of the exuded sap obtained from cut stumps of Striga shoots shows the presence of a number of organic nitrogen compounds, but very little nitrate. The major compounds present are glutamate, and glutamine, which account for up to 85% of xylem nitrogen (Raven and Smith 1976)

Alonge *et al*. (2004) observed that, a resistant cowpea variety B301 showed on *Striga* inoculated plots a less frequent increase in the root mineral element concentration compared with varieties SAMPEA 7 and VITA3 with heavy *Striga* infestation exhibiting the increase in concentration of most elements in the infected cowpea roots. Cowpea varieties KANO 1696 and SAMPEA 7 in contrast to the other varieties showed a tendency toward the increase in about 50% of the elements in the grains in each trial. This was possibly an indication of concentration effect since these varieties supported high population of these parasitic weeds with a consequent reduction in the growth and grain yield. This reduction was higher in the LPT than EPT. Our observations showed that, the degree of infestation by these parasites determines their effect on the host growth, development and chemical composition (Alonge 2000). In conclusion, this study showed that studied parasitic weeds generally reduced the grain nutrient concentration of cowpea varieties.

REFERENCES

Alonge S.O. 2000. Effect of *Alectra vogelii* Benth. and *Striga gesnerioides* Vatkes on the growth, yield and grain chemical composition of cowpea (*Vigna unguiculata* (L) Walp) varieties. Unpublished Ph. D. Thesis submitted to the Department of Biological Sciences, A.B.U. Zaria, 321 pp.

Alonge S.O., Ajakaiye C.O., Olufajo O.O., Lagoke S. T. O. 1995. Effect of metolachlor plus metrobromuron on mineral element composition of soyabeans seeds. Trop. Oilseeds J. 2: 88–101.

Alonge S.O., Oladipo M.O.A., Dim L.A., Ewa I.O.B. 2004. Effect of *Alectra vogelii* on the mineral element concentration of tolerant cowpea varieties in guinea savanna zone of Nigeria. Zuma J. Basic Appl. Sci. 6: 103–108.

Graves J.D., Press M.C., Smith S., Stewart G.R. 1992. The carbon canopy economy of the association between cowpea and the parasitic angiosperm *Striga gesnerioides*. Plant, Cell Environ.15: 283–288.

Hibberd J.M., Quick W.P., Press M.C., Scholes J.D. 1996. The influence of the parasitic angiosperm *Striga gesnerioides* on the growth and photosynthesis of its host *Vigna unguiculata*. J. Exp. Bot. 47: 507–512.

Jackson M.L. 1972. Soil Chemical Analysis. Prentice Hall Inc., New Jersey, 488 pp.

Jones G.D., Lutz J.A., Smith T.J. 1977. Effect of phosphorus and potassium on soybean nodules and seed yield. Agron. J. 69: 1003–1006.

Kuijt J.1969. The Biology of Parasitic Flowering Plants. University of California Press, Berkley, 246 pp.

Lawes Agriculture Trust 1980.Genstat –A generalized statistical programme. The Numerical Algorithms Group Ltd, Oxford.

Ohlrogge A.J. 1963. Mineral Nutrition of Soybeans: Genetics, Breeding, Physiology, Nutrition, Management. Academic Press, New York, 239 pp.

Okonkwo S.N. C. 1966.Studies on *Striga senegalensis* II. Translocation of C-14 labelled photosynthate. Urea C-14 and sulphur-35 between host and parasite. Amer. J. Bot. 53: 142–148.

Okonkwo S.N.C., Nwoke F.I.O. 1978. Initiation, development and structure of the primary haustorium in *Striga gesnesrioides* (Scrophulariaceae). Ann. Bot. 42: 455–463.

Raven J. A., Smith F. A. 1976. Nitrogen assimilation and transport in vascular land plants in relation to intracellular pH regulation. New Phytol.76: 415–431.

Setty T. K. P., Nanjappa H. V. 1985. Studies on analysis of root exudates of *Sorghum* and osmotic potential of *Sorghum* and *Striga.* Abstracts of Papers, Annual Conference of India Society of Weed Science, 47 pp.

Stewart G. R., Nour J., MacQueen M., Shah N. 1984. Aspects of the Biochemistry of Striga. International Workshop on *Striga* Biology and Control. International Development Research Centre, Dakar, Senegal, 14–17 November, 1983: 161–178.

Stewart G. R., Press M. C. 1990. The physiology and biochemistry of parasitic angiosperms. Ann. Rev. Plant Physiol. and Plant Molec. Biol. 41 : 127–151.

Younis A. E., Agabawi K. A. 1965. Effect of *Striga hermonthica* Benth. and nitrogen application on the growth and nitrogen concentration of *Sorghum vulgare* L. Acta Biol. 15: 361–369.

POLISH SUMMARY

WPŁYW ZAKAŻENIA PRZEZ *ALECTRA VOGELII* I *STRIGA GESNERIOIDES* NA KONCENTRACJĘ MINERALNYCH SKŁADNIKÓW W NASIONACH ODMIAN WSPIĘGI

W latach 1999 i 2000 przeprowadzono doświadczenia polowe w celu zbadania działania *Alectra vogelii i Striga gesnerioidesna* na koncentrację w ziarnie składników mineralnych w czasie zbioru, w pięciu odmianach wspięgi: : IT82D-849, IT86D-534, IT89KD-245, KANO 1696 i SAMPEA7. Analizowano zawartość azotu (N), fosforu (P), potasu (K), wapnia (Ca), magnezu (Mg), żelaza (Fe), manganu (Mn) i cynku (Zn). Uzyskane wyniki wykazały, że koncentracja większości składników była na ogół zmniejszona w ziarnie odmian wspięgi IT82D-849 i IT89KD245 zarówno na poletkach inokulowanych *Alectra*, jak i *Striga.* Z drugiej strony odmiany wspięgi KANO 1696 i SAMPEA 7 wykazywały tendencję wzrostu koncentracji o około 50% analizowanego w każdym roku składnika, zarówno na poletkach inokulowanych *Alectra* i *Striga*. U odmian wspięgi KANO 1696 i SAMPEA 7 była tendencja wzrostu koncentracji w ziarnie magnezu (Mg), cynku (Zn) i spadku potasu (K) oraz manganu (Mn) na pletkach inokulowanych przy użyciu *Alectra* i wzrost fosforu (P) oraz magnezu (Mg), lecz też tendencja spadku potasu (K) i manganu (Mn) na tych poletkach, a także wzrost fosforu (P) i magnezu (Mg), ale spadek zawartości Ca i Zn na poletkach inokulowanych przy użyciu *Striga*. Koncentracja P we wszystkich odmianach wspięgi w latach 1999 i 2000 (z wyjątkiem IT89KD245 w roku 2000) była zwiększona na poletkach inokulowanych przy wykorzystaniu *Striga*. Także koncentracja Mg i N była zwiększona w roku 2000 w odmianie IT82D-849, na poletkach inokulowanych *Striga* jak i *Alectra.*

Przeprowadzone badania wykazały, że zakażenie wspięgi przez *Alectra i Strga* na ogół zmniejszało zawartość składników mineralnych w ziarnie odmian wspięgi.