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Effects of Striga (*Striga gesnerioides* Wild V*atke)* on the Growth and Yield of some Cowpea [*Vigna unguiculata* (l.) Walp.] Varieties in Mubi, Adamawa State Nigeria

Babayola, M., Ahmed, M. and Oaya, C.S
Department of Crop Science, Adamawa State University, Mubi, Nigeria

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***Corresponding Author:**
E-mail: *muazubabayola2@gmail.com*
Phone: 07030086018

ABSTRACT

Cowpea yield loss associated with *Striga gesnerioides* have been reported to range between 83 to 100 %. For sustainable food production to meet the increasing population in developing countries like Nigeria, the production of cowpea need to be increased through proper selection of variety that can resist striga effects. The experiments was conducted at the Teaching and Research farm of the Department of Crop Science, Faculty of Agriculture, Adamawa State University Mubi, to investigate the effect of striga (*Striga gesnerioides* Wild Vatke) on the growth and yield of some cowpea (*Vigna unguiculata* L. Walp) varieties. The treatments consisted of three improved cowpea varieties and four commonly cultivated genotypes viz: T_1 = SAMPEA-14, T_2 = SAMPEA-11, T_3 = SAMPEA-8, T_4 = Iron beans, T_5 = Ife Brown ("BOSAP"), T_6 = White "kanannado" and T_7 = "kilikili" which were laid out in a Randomized Complete Block Design (RCBD) in three replicates. Data were collected on leaf area, leaf area index, fresh plant weight, shoot dry matter weight and grains yield. Data collected were subjected to analysis of variance and means were separated using Least Significant Difference (LSD) at 5 % probability level. Result shows that effect of striga was significant on leaf area, leaf area index and grains yield of cowpea while fresh plant weight and shoot dry matter weight were not significantly affected. Iron beans produced the highest leaf area while kilikili produced the highest leaf area index. SAMPEA -14 exhibited higher striga resistance with no striga emergence throughout the period of the study. In terms of yield, all the improved varieties together with Kilikili performed better than the other cultivars. SAMPEA -14 recorded the highest grains (2110.90 kg ha^{-1}) and is hereby recommended for adoption by farmers in Northern Guinea Savannah zone of Nigeria and similar areas with severe *Striga gesnerioides* infestations.

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Introduction

Cowpea (*Vigna unguiculata (L.) Walp*) is considered the most essential leguminous grain in the dry Savannahs of tropical Africa. Cowpea, also known as southern peas, is cultivated in a range of agro-ecologies and cropping systems in the tropics. It originated from the semiarid areas of West Africa, it contributes to human nutrition and generate income for farmers and food vendors (Boukar *et al.,* 2016). Cowpea is cultivated for its immature pods and mature grains and is consumed extensively in Africa and in small amount in Asia (Sreerama *et al.,* 2012). Cowpea is also called vegetable protein because it contains high amount of protein in grain with better biological value on dry weight basis. Beside its use as vegetable, pulse and fodder, cowpea can also be used as green manure, nitrogen fixer, cover crop, leafy vegetable. It forms an excellent forage and it gives a heavy vegetable growth and covers the ground so well that it checks soil erosion.

Cowpea is a crop of tremendous economic value being a major source of protein in West and Central Africa where more than 60 % of the world's cowpea is being produced by rural families as a source of their food and animal fodder (Tarawali *et al*., 1997; Asiwe and Kutu, 2007) and also as source of cash crop (Sreerama *et al.,* 2012). In many parts of West Africa including Nigeria, cowpea is a popular staple food utilized to fortify cassava, plantain, cereal-based meals and yoghurt (Henshaw *et al*., 2005). The chemical composition of cowpea is similar to that of most edible legumes. It contains about 24 % protein, 62 % soluble carbohydrate and small amount of other nutrients. Apart from its role in controlling soil erosion and fixing atmospheric nitrogen into the soil, thereby reducing nitrogen requirement for its growth (Lane *et al*., 1997), cowpea is also a food security crop in the semi-arid zone of West and Central Africa which ensures subsistence food supply even in the dry years. It is adapted to stressful environment where other crops either fail or do not perform well.

The low grain yield of 0.25 - 0.3 Mt/ha (Kamara *et al.,* 2018 and Agbogidi *et al.,* 2010) observed in farmers' fields are due to a myriad of factors including Striga *gesnerioides*. Striga [*Striga generioides* (Wild) Vatke] is an obligate root-parasitic flowering plant that influence the growth of cowpea and other legumes (Thalouran and Fer, 1993). The genus *Striga* is a member of *Scrophulariaceae* which contains about 50 species (Botanga and Timko, 2005). Most members from the Scrophulariaceae are holoparasitic (without chlorophyll and absolutely reliant on the host for natural carbon, water and nitrogen), some are hemiparasitic (with chlorophyll) (Matusova *et al.,* 2005). The geographical distribution of *S. gesnerioides* comprise West and Southern Africa, India, Asia, Europe and USA. However, in West Africa *S. gesnerioides* is reported to occur in the following West African countries; Burkina Faso, Niger, Nigeria, Benin, Togo, Ghana, Mali and Cameroon with one race designated to each country (Mohammed *et al.,* 2001). Cardwell and Lane (1995) in their studies have found out that Striga infestation is more severe in Ghana and Nigeria and affect cereals and legumes. Awuku (2018): Haruna *et al.* (2018); Israel and Isaac (2013); and Alhassan (2018) in their studies stated that the parasitic weed (*S. gesnerioides)* which is also referred to as witch weeds in some localities is a destructive parasite as far as cowpea production areas is concern, adding that the seeds of the parasites can remain dormant in the soil until when a suitable host is planted. The Striga seeds are microscopic in size measuring 0.20 mm to 0.35 mm long, weighing 4 to 7µg (Dube and Oliver, 2018). Because of the miniature size of the seeds, they can be scattered by wind, water and animals. Under farming situations, the seeds can pollute harvested products. However, the major means of dispersal is through farm machineries, tools and clothing (Mohammed *et al.,* 2001). Each Striga plant can produce up to 90,000 seeds (Parker, 1991). However, adaptation and inactive nature of *S. gesnerioides* permit the seeds to remain dormant in the soil for quite a long time. This underground seed stock under suitable environmental conditions germinates and infest suitable growing hosts present in that field (Cardwell and Lane, 1995). *S. gesnerioides* thrives in areas with low precipitation and poor soil fertility conditions as found in the arid and semi-arid regions. This implies that areas with water stress and low soil fertility will continue to experience Striga invasion.

The biology of the cowpea parasites, Striga *gesnerioides* and *Alectra vogelii,* and the histology of infected cowpea plants has been extensively studied (Okonkwo, 1991; Samb and Chamel, 1992 and Dorr, 1995). Striga and *Alectra* seeds germinate when exposed to root exudates from cowpea, other hosts, and a few non-hosts. Radicles elongate, showing a chemotropic response to a concentration gradient of root exudates. Once in contact with host roots, the radicular apex develops numerous hairs, which attach to host roots. The Striga radicle penetrates and stimulates cell division in the host root. The new host cells, together with growing parasitic tissues, form a large haustorium, uniting the parasite with tissue in the host's stele which permits transfer of water and nutrients from host to parasite. *Alectra* radicles stimulate profuse root formation by the host and form a larger haustorium than Striga. Both Striga and *Alectra* shoots emerge from the haustorium about 2 weeks after infection and grow into plants which may be 15-25 cm tall. In a study (unpublished) in soils jointly infested with Striga and *Alectra* and planted with cowpea show that Striga attaches and emerges faster than *Alectra.* The plants of both parasites usually branch below ground and emerge as a bunch above the ground. Striga leaves are very small, succulent, scale-like, and oppressed to the stem; *Alectra* leaves are a bit larger and more open. Flowers are normally borne when the plants emerge above the ground and may be white, pink or purple for Striga and yellow for *Alectra.* Seeds are produced in capsules, each of which may have 400-500 seeds; over 50,000 seeds may be produced by a single plant, depending upon the branching and growth. The seeds are very small, measuring 0.15 - 0.25 mm in length (Visser, 1978), and these are dispersed over long distances by water, wind and animals (Parker and Riches, 1993), and with crop seeds (Berner *et al.*, l994b).

Cowpea yield loss associated with *S. gesnerioides* have been reported to range between 83 to 100 % (Cardwell and Lane, 1995). Kamara *et al.* (2008) in their study stated that. *S. gesnerioides* population of over 10 /plant on a genotype can result to 100 % yield loss. This implies that as population keeps on increasing and pressure on available land continuous, and soil fertility reduces, Striga multiplies at a faster rate. Striga harm happens at different parts of cowpea plants which influence the physiological and biological processes of the crop. Different control measures have been suggested including cultural practices, chemical and biological controls (Dubè and Oliver, 2018). Nevertheless, no single strategy seems to be fully adequate in the control of this parasite. The most effective way to control the parasites could be the use of host plant resistance, which is economically affordable to resource-poor farmers.

The production could not meet up with their demand for food, animal feed, industrial uses and for export as a result of ever increase in population coupled with the impact of climate change. Information regarding the use resistant varieties of cowpea that can give maximum yield are limited or scarce in literature. For sustainable food production to meet the increasing population in developing countries like Nigeria, the production of cowpea need to be increased through proper choice of varieties that can resist Striga and give maximum yield. The objectives of the study are to evaluate the effect of *Striga gesnerioides* on the growth and yield of the selected cowpea varieties and determine the best cowpea varieties that can give maximum growth and yield of under *Striga gesnerioides* infestation.

Materials and Methods

Experimental Site

Field experiments was carried out under rain fed condition at the Teaching and Research farm of the Department of Crop Science Adamawa University, Mubi, located in the Northern Guinea Savannah agro – ecological zone of Nigeria. Mubi lies between latitude 10^0 11” and 10^0 30” North of the equator and longitude 13^0 10” and 13^0 30” East of the Greenwich meridian and on an altitude of 969 m above mean sea level (Zemba *et al*., 2020).

Treatments and Experimental Design

The treatments consisted of three improved cowpea varieties and four commonly cultivated genotypes: T_1 = SAMPEA-14, T_2 = SAMPEA-11, T_3 = SAMPEA-8, T_4 = Iron beans, T_5 = Ife brown (“BOSAP”), T_6 = white “kanannado” and T_7 “kilikili” which were laid out in a Randomized Complete Block Design (RCBD) replicated three times. The gross plot size was 4 m x 3 m and the net plot size was 2 m x 1.8 m. Two (2) meters were left between replicates and 1 m between plots.

Seed Treatment and Sowing Method

The seeds were soaked in a gibberellins acid (G_3) solution of 100 ml to 1000 ml of water to improve its germination, and seed dressing chemical (apron star) was also used at one sachet (10 g) to 3 kg of seed to control the effect of soil pathogens on the germination and early growth of cowpea seedlings. The seeds were sown by dibbling with three to four seeds per hill and later thinned to 2 plants per stand at 2 weeks after sowing (WAS). SAMPEA -14, SAMPEA-11, SAMPEA -8 (semi-erect types) and “kilikili” (erect type) were spaced at 60 cm x 25 cm while the remaining genotypes (spreading type) were spaced at 100 cm x 60 cm. Striga seeds was sown by dibbling at the same time with cowpea seeds after mixing the striga seed with grinded corn.

Data Collection

Observations on various biometric characters were recorded at 3, 6 and 9 weeks after sowing (WAS) by randomly selecting five plants in each plot which were tagged properly. The border plants were excluded while selecting the sample plants. Data were collected on:

1. **Leaf area per plant:** Leaf area of the whole sampled plants were determined by measuring the individual length (L) and width (W) and multiplied by factor (0.9915) i.e. LA= L x W x 0.9915 as suggested by Oliveira *et al*. (2008).
2. **Leaf area index per plant:** Leaf area index of the sampled plants was determined by dividing the leaves area to the ground area occupied by the crop as suggested by Forbes and Watson (1992). Thus, LAI was determined as: LAI = $\frac{LA}{GA}$ Where LA = leaf area

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and GA = ground area. And their mean calculated and recorded.

3. **Fresh plant weight:** Destructive sample was carried out to determine the fresh plant weight by measuring the shoot of the uprooted plant using electronic (sensitive) scale and means computed and expressed in grams.
4. **Shoot dry matter weight:** The shoots from the uprooted plants were oven dried at 65^0C in an air dry oven until constant weight obtained. Average dry weight of shoots per plant was computed and expressed in grams.
5. **Grains yield:** Grains yield was determined by harvesting and threshing of pods from the whole net plot of each treatment. First, grain weight per net plot were calculated. The grain weight were then converted to grains yield per hectare. (Weight of the grains divided by net plot and multiplied by 10,000 m^2).

Data Analysis

Analysis of variance (ANOVA) was carried out on each of the observation recorded as described by Gomez and Gomez (1984) using SAS version 9.2 (2008). Mean values were subjected to Least Significant Differences at 0.05 level of probability.

Results

Leaf Area (LA) per Plant

From Table 1, the results of leaf area per plant of cowpea at 3, 6 and 9 WAS shows a highly significant ($P \leq 0.01$) effect of striga on LA at 9 WAS but no significant ($P > 0.05$) affect at 3 and 6 WAS. The mean values show that 'Iron beans' recorded the highest leaf area (6027.50 cm^2) which is statistically the same with 'Ife brown' (4758.50 cm^2), 'Kanannado (4270.25 cm^2) and with SAMPEA-8 (3740.25 cm^2), while 'Kilikili' recorded the least leaf area (2317.50 cm^2) which was also statistically similar with SAMPEA-11 (2401.00 cm^2) and SAMPEA-14 (2427.50 cm^2).

Leaf Area Index (LAI) per Plant

Results of the effect of striga on LAI per plant of cowpea at 3, 6 and 9 WAS in Mubi for the year 2024 growing season is presented on Table 1. The results show that LAI per plant of cowpea was highly significant ($P \leq 0.001$) at 3 and 6 WAS but not significantly ($P > 0.05$) affected by striga at 9 WAS. At both 3 and 6 WAS, 'Kilikili' exhibited the highest LAI (0.3683 and 1.9255) which is statistically similar with SAMPEA – 8 (0.3239 and 1.5288), SAMPEA – 11 (0.3046 and 1.5848) and SAMPEA –14 (0.3031 and 1.6695) respectively. 'Ife brown' recorded the least LAI at 3 WAS (0.0752) and 'Kanannado' recorded the least at 6 WAS (0.4503), which were statistically similar with the other varieties.

Fresh Plant Weight per Plant

Results of the effect of striga on fresh plant weight per plant of cowpea at 3, 6 and 9 WAS in Mubi for the year 2024 growing season are also presented on Table 1. There was no significant ($P > 0.05$) effect of striga on fresh plant weight per plant of cowpea at both 3, 6 and 9 WAS during the period of the research.

Shoot Dry Matter Weight per Plant

Results of the effect of striga on dry matter weight per plant of cowpea at 3, 6 and 9 WAS in Mubi for the year 2024 growing season are also presented on Table 1. Effect of striga on shoot dry matter weight per plant of cowpea varieties at both 3, 6 and 9 WAS were not significant ($P > 0.05$) during the period of the research.

Grains Yield

Result on the effect of striga on grains yield of cowpea at harvest in Mubi during 2024 growing season is presented in Table 1. Effect of striga on grains yield of cowpea varieties was highly significant ($P \leq 0.001$) during the period of the study. The result of mean values shows that SAMPEA – 14 recorded the highest grains yield (2110.10 kg ha^{-1}) which is statistically the same with SAMPEA – 8 (1826.60 kg ha^{-1}), SAMPEA – 11 (1797.40 kg ha^{-1}) and Kilikili (1689.80 kg ha^{-1}), while Kanannado recorded the least grains yield (920.90 kg ha^{-1}) which is statistically similar to Ife brown (1419.40 kg ha^{-1}) and with Iron beans (1362.30 kg ha^{-1}).

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Table 1: Effect of Striga (*Striga gesnerioides* Wild Vatke) on the Growth and Yield of Some Cowpea (*Vigna unguiculata* L. Walp) Varieties in Mubi during 2024 Growing Season

Treatments	**Leaf Area**			**Leaf Area Index**			**Fresh Plant Weight**			**Shoot Weight**	**Dry**	**Matter**	**Grains Yield**
	3 WAS	**6 WAS**	**9 WAS**	**3 WAS**	**6 WAS**	**9 WAS**	**3 WAS**	**6 WAS**	**9 WAS**	**3 WAS**	**6 WAS**	**9 WAS**	2110.90
SAMPEA-14	227.35	1252.00	2427.50	0.3031	1.6695	3.0078	11.07	52.27	145.10	2.13	8.83	25.10	1797.40
SAMPEA-11	228.40	1188.50	2401.00	0.3046	1.5848	3.2015	11.70	42.67	224.30	1.87	6.34	30.67	1826.60
SAMPEA-8	242.86	1340.25	3740.25	0.3239	1.5288	4.9868	14.37	50.50	296.30	2.57	8.20	32.97	1362.30
IRON Beans	285.11	2103.50	6027.50	0.0950	0.7013	4.0183	12.20	82.87	183.00	2.10	14.30	27.10	1419.40
IFE Brown	225.67	1451.75	4758.50	0.0752	0.4838	3.1725	12.63	61.03	410.70	2.33	9.47	51.37	920.90
Kanannado	233.75	1350.00	4270.25	0.0780	0.4503	2.8468	7.83	54.87	261.70	1.47	8.47	31.87	1689.80
Kilikili	276.37	1453.25	2317.50	0.3685	1.9255	3.0900	7.23	74.70	248.30	0.93	10.76	43.97	≤0.01
P of F	0.2096	0.0477	0.0121	<.001	<.001	0.1344	0.3813	0.5622	0.3731	0.1779	0.4338	0.4448	537.44
LSD	112.95	706.23	2535.50	0.1033	0.5987	2.4805	7.2919	46.065	240.14	1.2663	7.3986	25.672	2110.90

LSD = Least significant difference, WAS = Weeks after sowing

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Discussion

Effect of Striga (*Striga gesnerioides* Wild Vatke) on the Growth of and Yield of Cowpea (*Vigna unguiculata* L. Walp) Varieties in Mubi

The significant differences on leaf area of cowpea varieties at 9 WAS with the prostrated types (Kanannado, Ife brown and Iron beans) having higher leaf area over the erect and semi erect types could be due to its significant effects on primary vine length and number of leaves which are the indicators of the leaf area of a plant. Babayola *et al*. (2021) also reported a significant differences on leaf area of cowpea and obtained higher leaf area from the prostrated genotypes over the erect and semi erect types. Bawa *et al*. (2025) also reported significant differences on leaf area of cowpea as a result of *Striga gesnerioides* infestation.

The significant differences on leaf area index of cowpea varieties recorded in this research with the erect and semi erect (Kilikili, SAMPEA- 14, SAMPEA-11 and SAMPEA-8) varieties having higher leaf area index than the prostrated genotypes could be due to their genetic makeup which allowed for closer spacing compared to prostrated genotypes than has wider spacing. Agbogidi and Ofuoku (2005) also confirmed that cowpea plants responded differently with the environmental factors on the basis of their genetic makeup and adaptability. Babayola *et al*. (2021) also obtained higher LAI from the erect and semi erect improved varieties (SAMPEA-7 and SAMPEA-14) when compared to the prostrated genotypes.

The significantly higher grains yield obtained from SAMPEA – 14 though statistically similar with the other SAMPEAS could be linked to its genetic makeup which proved to have a superiors tolerance to *Striga gesnerioides* because it could not allowed the attachments of *Striga gesnerioides* hosarios/radicles to its roots system. Another reason could be due to its semi erect growth habit which allows for closer spacing as a result, higher number of pod and number seeds were obtained per unit area when compared with the prostrated genotypes. This aligned the findings of Bawa *et al*. (2025) who also reported a significant differences on seed yield of cowpea due to *Striga gesnerioides* and obtained higher yield from “Pudi–tuya” (a resistance variety) due to higher number of pods per plant, higher number of seeds per pods and higher weight of 100 grains when compared to the susceptible genotypes. Timko and Singh (2008) also reported a significant differences on seed yield of cowpea due to *Striga gesnerioides* and obtained higher yield from resistance variety over the susceptible genotypes which was due to compounding yield lost as a result of few pods, few number of seeds per pod and smaller seed sizes.

Conclusion and Recommendations

From the result obtained, it could be concluded that striga (*Striga gesnerioides* Wild Vatke) significantly affects the growth and yield of cowpea. Each variety performed differently based on its genetic makeup and environmental conditions. The prostrated types (Kanannado, Ife brown and Iron beans) had higher leaf area over the erect and semi erect while the erect and semi erect (Kilikili, SAMPEA- 8, SAMPEA-11 and SAMPEA-14) varieties had higher leaf area index than the prostrated genotypes. In term of yield, SAMPEA – 14 recorded the highest grains yield (2110.90 kg ha^{-1}). This study recommended that farmers should adopt the use of SAMPEA-14 for its maximum grains yield (2110.90 kg ha^{-1}) in the study area especially in an areas that are prompt to *Striga gesnerioides* Wild Vatke infestation.

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