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Contrasting the Virulence of *Striga gesnerioides* (Willd.) Vatke of Cowpea (*Vigna unguiculata* L. Walp) Accessions in the Sudan Savanna Ecology

Shittu, E.A[1]., Lawan, Z.M[1]. and Abdullahi, W.M[2].

[1]Department of Agronomy, Bayero University, PMB 3011, Kano, Nigeria.
[2]International Institute of Tropical Agriculture, PMB 3112 Kano Station, Nigeria
*Corresponding Authors; Email: *seabraham.agr@buk.edu.ng*; +2348024695219

Abstract: *Striga gesnerioides, a parasitic weed which causes significant yield penalty in cowpea (Vigna unguiculata [L.] Walp) in Nigeria and also, it is one of the greatest devastating parasitic weeds in most parts of the world. A study was conducted with the aim of screening cowpea accessions for their resistance and virulence to Striga gesnerioides infection at the screen house of the International Institute of Tropical Agriculture (IITA) Kano station. Nineteen (19) cowpea accession were used which include Danila (Control), TVu-62, TVu-18, TVu-263, TVu-320, TVu-16300, TVu-16510, TVu-96, TVu-144, TVu-7585, TVu-11970, TVu-3850, TVu-4275, TVu-7605, TVu-9201, TVu-968, TVu-16616, TVu-16624, TVu-984; which were laid out in a Completely Randomized Design (CRD) and replicated three times. Data collected include, Striga count at 10 and 12 WAS, Striga attachment, Shoot weight and Root weight. Results revealed a significant variation across the accession in terms of resistance to Striga. TVu-18, Dan'ila, TVu-3850 and TVu-16616 recorded the highest striga count, striga attachment, TVu 3850 and TVu 7585 had the highest shoot and root dry weight respectively. Also, TVu-144 was observed to record taller plants at 4-10 WAS. While TVu-16616 and TVu-320 recorded taller plants at 6 and 12 WAS respectively. Striga count showed a positive relationship with Striga attachments, as the Striga count increase the Striga attachments increased. However, Striga count at 12 WAS was negativity associated with shoot weight of the cowpea accessions by -46%. Further research should be carried out in other agro ecological zone in other to ascertain the resistance of such cowpea genotypes to Striga gesneriodes infestation.*

Keywords: *Cowpea, genotypes, virulence, Striga gesnoroides, infestation*

INTRODUCTION

One of the most significant biological constraints impacting cowpea productivity in the savanna region of West Africa is Striga gesnerioides infestation (Botanga & Timko, 2005; Tignegre, 2010). The magnitude of the cowpea damage caused by *S. gesnerioides* could be up to 70% which however, depends on the type of the damage and the degree of infestation (Sponge *et al*., 2004; Omoigui et al., 2017)). The damage caused by Striga gesnerioides affects several different areas of the cowpea plant (Alonge et al., 2004). *S.gesnerioides* has the potential of interfering with the physiological processes of the cowpea plant. Alonge et al. (2004) also documented damage due to striga infestation such as reduced leaf photosynthesis, partial blooming, decreased leaf area, poor podding and seed development. In dry conditions, the parasite's transpiration generally exacerbates these effects (Alonge et al., 2004). Because of the concentration of inhibitors that diminish the canopy and plant growth, Striga infestation can also reduce the nitrogen and protein content in cowpea plants and grains, respectively (Alonge et al., 2004). When the population of *S. gesnerioides* exceeds 10 emergent shoots per plant on vulnerable cultivars, yield losses might reach up to 100% (Kamara et al., 2008). Striga is predicted to cause yield losses of millions of tons per year in the dry savannah of SSA, and the prevalence of Striga-infested soils is continuously growing. Infestation levels are frequently so high that cowpea producers may be forced to abandon their fields due to total production loss (Singh & Emechebe, 1997). Because of the shortage of a high-protein leguminous crop, this leads to food insecurity and malnutrition issues. In *Striga* species, differentiation of the radicle tip into a host attachment organ can be seen as a switch from a limited vegetative phase to an expansive parasitic and reproductive phase. The transition from a limited vegetative phase to an expanding parasitic and reproductive phase can be seen in Striga species as the radicle tip differentiates into a host attachment organ. The establishment of this attachment organ is aided by a chemical signaling mechanism between the parasite and the host (Ramaiah et al., 1991; Magnus et al., 1992; Riopel & Timko, 1992). Seeds of striga germinate when cowpea roots provide a stimulus from exudates within 2 mm (Lane et al., 1991; Dube & Olivier, 2001), with strigol being the most essential molecule (Muller et al., 1992). Agriculture intensification has resulted in an increase in the abundance and spread of parasitic plants that use crop species as their hosts, resulting in significant production losses. Although resistant crop varieties can be created or bred, some parasite plants rapidly evolve as new races to overcome resistance and establish infestations. As a result, understanding parasite plant pathogenicity mechanisms and the accompanying host plant defense responses is critical. Hence, the need to determine the differential virulence of cowpea genotypes due to *Striga gesnoroides* infestation.

MATERIALS AND METHODS

The experiment was conducted at the screen house of the International Institute for Tropical Agriculture (IITA) Kano station, situated within Sudan savanna agro ecological zone involving nineteen (19) cowpea accessions which were laid out in a Complete Randomize Design (CRD) with three replicates. Plastic pots, each measuring 15cm in diameter and 18cm in depth were each filled with sterilized sieved sand and top soil (sandy loam) by ratio; 2:1 (mixture of river sand and top soil). This was inoculated with 0.025 g of *Striga gesnerioides* seeds. The pots were clearly labeled and arranged based on allocated

treatments. Prior to sowing, the pots were irrigated with water to field capacity. SSP fertilizer was applied at 1g pot^{-1}. Two cowpea seeds were sown per pot at depth of 3 cm and later thinned to one stand per pot after 7 days after sowing (DAS). Data on recovered lines were recorded. Hand weeding, pest and disease control were carried out as at when due. Data were collected on some growth parameters such as plant height, shoot weight and root weight. Similarly, Striga count and striga attachment were equally determined at 12 WAS. Data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis Software (SAS Version 9.3) and means were separated using Student Newman Keuls (SNK) test at 0.05. Correlation analysis was carried out to know the association between the characters measured.

RESULTS AND DISCUSSION

Days to emergence ranges from 1-5 days with a mean value of 3.32 days (Table 1). However, TVu-9201, TVu-16300, TVu-11970, TVu-16616, TVu-16624 took more days to emerged while accessions TVu-18, TVu-62 and TVu-144 emerged early (1day). This variation observed in terms of number of days to emergence may be due to environment and or genetic difference of the cowpea accession This is in line with the findings of Onyishi et al. (2013) who reported that cowpea genotypes differ in days to emergence due to the differences in the thickness of the seed coat and tissue layers among the genotypes. Cowpea height at 4 WAS ranges from 4-6.5 cm with a mean value of 5.095. Accession TVu-144 recorded the tallest plant (6.5 cm) while Dan'ila and TVu-7585 recorded the lowest height (4.0 cm). TVu-16616 recorded the tallest plant (11.50 cm) while genotype TVu-16300 recorded the lowest (5.75 cm). Cowpea height at 8 WAS indicated that accession TVu-16300 recorded the lowest height of 7.6cm while TVu-144 recorded the highest at 15.75 cm. At 10 WAS, accession TVu-144 recorded taller plants (20.50 cm) while TVu-16300 had shorter plants (9.0 cm). Cowpea height at 12 WAS ranges between 9.75 cm to 35.5 cm for lowest and highest, ascribing to TVu-7585 and TVu-320 accessions, respectively. The stunted growth of some cowpea accessions like TVu-7585, TVu-16300, TVu-16624, TVu-18, TVu-7598, can be attributed to severe *Striga* infestation which resulted into low shoot and root weight. Due to insufficient water, the vulnerable cultivars' vegetative growth was stunted, resulting in a reduction in leaf area and photosynthetic capacity, affecting flowering, podding, and seed output (Alonge, 1999). Press (1995) reported decreased biomass buildup by the susceptible genotypes due to competition between the host and the weed for solutes, as well as carbon, water, and a lesser rate of photosynthesis in the leaves of Striga afflicted plants. Reduced photosynthesis may have resulted in fewer pods per plant and the transport of photosynthate from the source to the sink.

Table 1: Mean performance of quantitative trait of cowpea accession evaluated at IITA Kano during 2020 raining season under screen house.

S/N	Accession	Days to Emergence	Plant height (cm) Weeks after sowing (WAS) 4	6	8	10	12
1	TVu-18	1.00	5.50	7.75	10.00	11.00	12.25
2	TVu-62	1.00	5.50	9.25	10.50	12.50	14.30
3	Dan'ila	2.00	4.00	9.50	11.50	13.00	16.40
4	TVu-96	2.00	5.50	9.00	9.75	11.50	14.75
5	TVu-144	1.00	6.50	11.00	15.75	20.50	23.75
6	TVu-263	3.00	4.75	10.00	11.25	12.75	17.40
7	TVu-320	3.00	5.50	9.75	13.10	15.25	35.50
8	TVu-968	3.00	5.00	8.75	10.50	12.50	21.50
9	TVu-984	3.00	5.00	10.55	14.50	18.75	24.25
10	TVu-3850	3.00	6.20	10.75	12.80	16.75	47.50
11	TVu-7585	4.00	4.00	7.55	8.35	10.00	9.75
12	TVu-7588	4.00	5.50	7.75	9.65	12.25	14.50
13	TVu-7598	4.00	4.30	8.55	8.65	10.00	12.75
14	TVu-7605	4.00	5.00	7.05	10.00	11.95	14.10
15	TVu-9201	5.00	5.10	9.75	12.75	17.50	30.50
16	TVu-11970	5.00	5.05	9.50	11.30	15.00	18.65
17	TVu-16300	5.00	4.75	5.75	7.60	9.00	11.00
18	TVu-16616	5.00	5.15	11.50	14.75	19.00	25.95
19	TVu-16624	5.00	4.50	8.00	10.20	11.00	12.00
	Mean	3.316	5.095	9.029	11.205	13.695	19.832
	SE±	0.325	0.150	0.339	0.512	0.776	2.220

The *Striga* count at 12 WAS was highest (50.0) with TVu-18 followed by TVu-96 and TVu-7588 (33.0) while TVu-144, TVu-11970, TVu-3850, TVu-4275, TVu-7605, TVu-9201 and TVu-968 recorded no *Striga* count (Table 2). *Striga* attachments ranged from 1 to 69 with a mean value of 14.947. Dan'ila recorded the highest (69) striga attachment followed by Tvu-62, Tvu-18, TVu-263, TVu-320 (60 > 50 > 43 > 22) while TVu-16616, TVu-16624 and TVu-984 recorded zero (0) *Striga* attachment on them. Shoot weight value ranges between 3-41g with a mean value of 15.68. Tvu-3850 recorded the highest (41.0 g) shoot weight followed by TVu-984, TVu-144, TVu-968, TVu-4275 (29 > 23 > 20 >19) in that order while TVu-62 and TVu-18 recorded the lowest (3.0 g) shoot weight each. Root weight range from 0.16 to 9 g with a mean value of 1.944. TVu-16616 recorded the highest (9.0 g) followed by TVu-96, TVu-7585, TVu-16300 (7.4, 6.0, 4.68) while TVu-3850 recorded the lowest (0.16) shoot weight. The haustorium is used by *Striga gesnerioides* to channel host resources into themselves, allowing them to make contact with host tissues (xylem and phloem) (Okonkwo & Nwoke, 1978; Okwonkwo, 1966). As a result, according to Stewart and Press (1990), the battle between host and parasite for water and critical metabolites may be the cause of yield loss on susceptible genotypes. According to Setty & Nanjapp

(1985) & Kuijt (1969), the parasite's osmotic pressure in both leaf and root is higher than that of its host, making the Striga more competitive thereby depriving the crop from accessing the critical growth resources. This effect is also translated into low shoot to root weight of the susceptible cultivars. Using high-yielding Striga-resistant cultivars in conjunction with sound agronomic methods can thus help to minimize yield losses in Striga-infested soil in the trado-farming system of the Sub-Saharan Africa which is endemic to striga infestation. The significant difference exhibited at 12 WAS showed the variation among the tested cowpea in susceptible lines with Striga emergence and attachment, the appearance of attached Striga in some lines without emergence is showing some level of tolerance in them which can be a good breeding line for improvement with an adapted cultivar. Complete resistance found in some showed no emergence and attachment. This was corroborated by Ba (1983), who stated that some cowpea genotypes stimulate the *Striga* to germinate and the plants were allowed to penetrate the cowpea root tissues, but failed to grow further. The use of crop varieties that combine resistance with high tolerance levels is presently suggested among the most promising and easy to adopt control options against the weed Striga, particularly when combined also with other management practices (Rodenburg et al., 2006, 2017).

Table 2: Mean performance of some cowpea accession on *Striga* traits evaluated at IITA during 2020 raining season

S/N	Accession	Striga count at 12 WAS	Striga attachment at 12 WAS	Shoot dry weight (g)	Root dry weight (g)
1	Dan'ila	7.00	69.00	16.00	0.82
2	TVu-62	22.00	63.00	3.00	0.45
3	TVu-18	50.00	50.00	3.00	0.56
4	TVu-263	24.00	43.00	14.00	0.51
5	TVu-320	9.00	22.00	10.00	0.98
6	TVu-16300	7.00	7.00	16.00	4.68
7	TVu-16510	5.00	7.00	19.00	0.38
8	TVu-96	33.00	7.00	15.00	7.40
9	TVu-144	0.00	5.00	23.00	0.99
10	TVu-7585	33.00	5.00	10.00	6.00
11	TVu-11970	0.00	1.00	6.00	0.98
12	TVu-3850	0.00	1.00	41.00	0.16
13	TVu-4275	0.00	1.00	19.00	0.89
14	TVu-7605	0.00	1.00	17.00	1.05
15	TVu-9201	0.00	1.00	8.00	0.51
16	TVu-968	0.00	1.00	20.00	0.72
17	TVu-16616	17.00	0.00	14.00	9.00
18	TVu-16624	14.00	0.00	15.00	0.48
19	TVu-984	15.00	0.00	29.00	0.38
	Mean	12.421	14.947	15.684	1.944
	SE±	3.298	5.276	2.066	0.615

A positive and significant relationship was observed between *Striga* counts at 12 WAS was positive with *Striga* attachments (Table 3). Significant inverse relationship was also observed between Striga count at 12 weeks and shoot dry weight causing loss of up to 46%. The association between shoot and root dry weight was positive with 15% increase.

Table 3: Some correlation coefficient of cowpea and s*triga* traits evaluated at evaluated at IITA during 2020 raining season.

	Striga count	Striga attachment	Shoot dry weight	Root dry weight
Striga count	0.00			
Striga attachment	0.44	0.00		
Shoot weight	-0.46	-0.43	0.00	
Root weight	0.37	-0.23	0.15	0.00

CONCLUSION

Based on these findings accession TVu-144, TVu-16616 and TVu-320 resulted in taller plants at different intervals owing to *Striga gesnerioides* resistance. TVu 3850 had lowest Striga and highest shoot dry weight showing resistance to the parasite, whereas TVu 7585 and TVu 16300 had the root dry weight. Hence, genes from these accessions can be utilized as primers towards developing more resistant genotypes to *Striga gesnoroides* infestation.

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