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Full Length Research Paper

Evaluation of cowpea lines on natural infested field of *Striga gesnerioides* in the Sahel Sudan of Southeast Niger

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Abstract

Growth and grain yields in cowpea are greatly reduced by *Striga gesnerioides* in the Sahel, like most crops. This parasitic weed negatively impacts cowpea productivity, therefore the purpose of this study was to evaluate the agronomic performance of cowpea lines under natural infestation with *Striga*. The results showed that IT 97K-106-6 recorded the highest plant height of 59 cm while IT 98D-1399 recorded 16 cm. Two cowpea lines IT97K-205-8 and IT 97K-499-38 were observed to flowering 42 days while IT 99K-721-2-2 and IT98K-311-8-2 flowered in 60 and 61days respectively. Also, the results revealed that IT 97K-205-8, IT 97K-499-38 and IT 98K-628 recorded the shortest days to reach maturity (MAT) with 59 days. According to the results, IT98K-412-13 with 903 kg/ha was the most performing line for fodder yield. IT99K-377-1 significantly recorded the highest grain yield of 279 kg/ha, whereas IT 98K-133-1-1 recorded the lowest yield of 16 kg/ha. The highly resistant cowpea to striga gesnerioides were IT 98K-1092-1, IT 99K-573-1-1, IT 98K-628, IT 99K-1122, IT 97K-205-8 and IT 97K-499-38 whereas IT 98K-311-8-2 (102) and IT 98K-497-4 (102) were the highly susceptible lines. However, IT 03K-324-9 which supported the parasitic weed with relatively 141 kg/ha and 729 kg/ha for grain and fodder yields respectively was considered as a *Striga* tolerant line. These resistant and tolerant lines could be used as potential parental lines that can be used in a cowpea breeding program for improving resistance to *Striga.*

Key words: Cowpea, growth, grain yield, parasite, resistance.

Introduction

In sub-Saharan Africa, cowpea *(Vigna unguiculata L. Walp.)* is one of the most important grain legume grown (Timko and Singh, 2008). Cowpea is the major source of dietary protein in Niger, where it is commonly cultivated as an intercrop with pearl millet and sorghum in diverse planting patterns. Also, it serves as fodder for animal feeding and a source of soil fertility improvement by fixing nitrogen biologically. The mean annual production is about 500,000 MT, with a production higher than 1 million tons in 2007 (FAOSTAT, 2012). However, the production reached 1.5 million tons in 2008. However, despite its importance the yield remains very low (less than 450 kg/ha) at farmers field level due to Striga infestation, which is a major biological constraints to increase cowpea productivity. According to certain authors, crop yield losses due to *S. gesnerioides* may be up to 70% depending on the extent of damage and level of infestation (Aggarwal and Ouedraogo, 1989; Alonge *et al.,* 2005). On susceptible cultivars, yield losses can reach 100% when *S. gesnerioides* population was over 10/plant (Kamara *et al*., 2008). Omoigui *et al.* (2009) added that yield losses caused by this witchweed in dry savanna of sub-Saharan Africa are estimated in millions of tons annually and the prevalence of *Striga* soils is steadily increasing. Recently, due to its negative effects on cowpea productivity, researchers exploit molecular approach in order to identify striga resistant cowpea genotypes (Mellor *et al.,* 2012; Ouédraogo *et al.,* 2012; Rajeev *et al.,* 2013 and Boukar *et al.,* 2016). More than 81% of the fields grown to cowpea were infested with S. gesnerioides leading to serious crop losses in northeast Nigeria was reported by Dugle *et al.,* (2006). On the other hand, race formation in cowpea-*S. gesnerioides* was largely a result of host-driving selection because the

parasite is autogamous, with a floral biology that makes any possibility of outcrossing very low (Botanga and Timko, 2005). These races were designated as follow: SG1 (Burkina Faso), SG2 (Mali), SG3 (Nigeria and Niger), SG4 and SG4z (Benin), SG5 (Cameroon) and SG6 (Senegal). Also, Tignengre *et al.,* (2013) reproted SR Kp as a new race of striga while investigating new sources of resistance to *Striga gesnerioides* in cowpea germplasm from Burkina Faso. Many strategies such as improved cultural practices, the use of chemical control, biological control, and host plant resistance have been suggested (Dube and Alain, 2000; Boukar, 2004). But, control strategies based on the use of herbicides are too expensive for low-input farming systems. Therefore, the imperative need for breeding high yielding cowpea genotypes that would withstand striga stress, in order to enhance small scale subsistent farmers' food security. The purpose of this study was to evaluate the agronomic performance of cowpea lines under natural infestation with *Striga*.

Material and methods

A field trail was conducted at Magaria research station (13°44' N, 9°36'E and 401 m above the sea) located in Sahel Sudan of southeast Niger. This site represents one of the striga endemic areas in the country. Thirty three (33) cowpea lines were used in this experiment and a randomized complete block design was used with three replications. The plots consisted of four rows of 4 m length each, with a spacing of 0.8 m between rows, and 0.30 m within the rows. Seeds were planted at a rate of two grains and later thinned to one per hill, resulting in a total of 52 plants per plot. The trial was hand-weeded two weeks after emergence. All other cultural practices were used in order to avoid disturbing striga emergence, which normally starts on susceptible genotypes around 30 days after planting. NPK (15, 15, 15) fertilizer was applied and mixed with soil before planting cowpea lines. Some useful agronomic traits such as PHT (plant height), FLO (days to 50% flowering), MAT (days to 50% maturity), GRY (grain yield), as well as FOY (fodder yield (kg/ha), were collected on two central rows. For striga resistance, NSP (number of striga per plot) was recorded. A scale of 0 = highly resistant, 1-5 = resistant, 6-15 = moderately resistant, 16-25 = moderately susceptible, 26-35 = susceptible, 35-100 = very susceptible, >100 = highly susceptible was used. Data were subjected to ANOVA (Analysis of Variance) using Genstat statistical package 10th edition. Individual means of cowpea lines were compared using Duncan test.

Table 1: List of cowpea lines and their sources

Line	Source	Line	Source	Line	Source
1. IT 96D-610	IITA	12. IT 97K-819-118	IITA	23. Damsa-07	IITA
2. IT 98K-133-1-1	IITA	13. IT 98K-628	IITA	24. Dadaga-07	INRAN
3. IT 03K-324-9	IITA	14. IT 03K-351-1	IITA	25. IT 98D-1399	INRAN
4. IT 98K-1092-1	IITA	15. IT 97K-390-2	IITA	26. TN 5-78	IITA
5. IT 98K-503-1	IITA	16. IT 99K-529-2	IITA	27. Damai-07	INRAN
6. IT 99K-573-1-1	IITA	17. IT 98K-497-4	IITA	28. TN 88-63	INRAN
7. IT 97K-499-35	IITA	18. IT 99K-1122	IITA	29. BT-07	INRAN
8. IT 99K-377-1	IITA	19. IT 98K-128-3	IITA	30. KVX30-309-6G	INRAN
9. IT 98K-412-13	IITA	20. IT 97K-106-6	IITA	31. IT 97K-205-8	IITA
10. IT 98K-311-8-2	IITA	21. IT 98K-166-4	IITA	32. IT 97K-449-38	IITA
11. IT 99K-721-2-2	IITA	22. IT 00K-1263	IITA	33. IT 90K-372-1-2	IITA

Results

The analysis of variance (ANOVA) revealed that all the parameters studied PHT (plant height), 50% flowering (FLO), 50% maturity (MAT), FOY (fodder yield) and NSP (number of striga per plot) were highly significant excepted grain yield (GRY) (Table 2).

Table 2: ANOVA and mean performances of six (6) parameters used in this study

Parameter	Minimum	Maximum	Mean	CV (%)	F
Plant height (PHT)	16	59	28±8.19	29	8.01*
Flowering (FLO)	42	61	50±5.14	10	12.43**
Maturity (MAT)	59	78	69±5.14	6	10.01*
Grain yield (GRY)	17	279	87±66.64	57	5.26 ns
Fodder yield (FOY)	180	903	388±190.80	49	14.05**
Number of Striga/plot (NSP)	0	120	41±37.26	49	5.21*

NB : **= significant at 1%, *= significant at 5%, ns= not significant

Nineteen (19) cowpea lines had plant height above the average (28 cm) while fourteen (14) had plant height below the average. The results showed that IT 97K-106-6 recorded the highest plant height of 59 cm whereas IT 98D-1399 recorded 16 cm. Cowpea line IT 98K-133-1-1 with 28 cm had a plant height equal to the mean. These are presented in table 3.

Physiological parameters such as 50% flowering (FLO) was ranging between 42 days to 61 days with a mean of 50 days. IT 97K-205-8 and IT 97K-499-38 with 42 days were the early flowering lines whereas IT 98K-311-8-2 and IT 99K-721-2-2 with 61 days and 60 days respectively were late flowering cowpea lines. Also, for 50% maturity (MAT) the minimum and maximum were respectively 59 days and 78 days, with a mean of 69

days. The results revealed that IT 97K-205-8, IT 97K-499-38 and IT 98K-628 recorded the shortest days to reach maturity with 59 days, whereas cowpea line KVX30-309-6G (78 days) was the latest to reach 50% maturity. The two lines IT 98K-311-8-2 and IT 99K-721-2-2 which were late for 50% FLO, showed long time before reaching 50% MAT, with 74 days and 75 days, respectively (table 3).

Table 3: individual mean performance of thirty three (33) cowpea lines

Cowpea line	Parameters				
	Plant height (cm)	50% Flowering	50% Maturity	Grain yield (kg/ha)	Fodder yield (kg/ha)
1. IT 96D-610	37	55	69	204	278
2. IT 98K-133-1-1	28	56	72	16	389
3. IT 03K-324-9	32	50	66	141	729
4. IT 98K-1092-1	30	50	75	27	469
5. IT 98K-503-1	41	51	73	58	560
6. IT 99K-573-1-1	32	45	66	189	556
7. IT 97K-499-35	30	45	62	195	352
8. IT 99K-377-1	37	48	63	279	495
9. IT 98K-412-13	35	52	71	96	903
10. IT 98K-311-8-2	33	61	74	23	643
11. IT 99K-721-2-2	33	60	75	23	764
12. IT 97K-819-118	20	54	69	73	208
13. IT 98K-628	26	43	59	141	260
14. IT 03K-351-1	31	53	68	65	261
15. IT 97K-390-2	33	54	74	49	344
16.IT 99K-529	30	45	69	64	382
17.IT 98K-497-4	22	48	67	45	180
18. IT 99K-1122	23	55	74	41	452
19. IT 98K-128-3	30	58	74	43	469
20. IT 97K-106-6	59	54	74	47	694
21. IT 98K-166-4	29	48	73	26	295
22. IT 00K-1263	34	51	71	72	313
23. Damsa-07	18	49	70	110	267
24. Dadaga-07	21	48	64	66	191
25. IT 98D-1399	16	55	74	62	201
26. TN 5-78	21	52	74	51	295
27. Damai-07	25	45	65	181	250
28. TN 88-63	22	47	65	178	372
29. BT-07	29	48	69	52	208
30. KVX30-309-6G	24	58	78	50	208
31. IT 97K-205-8	23	42	59	97	182
32. IT 97K-449-38	24	41	59	157	330
33. IT 90K-372-1-2	19	48	67	162	208
Mean	29	51	69	93	385
CV (%)	28	10	7	57	49

Cowpea lines significantly differ for fodder yield (FOY). Table 3 shows that IT 98K-412-13 with 903 kg/ha was the most performing line for FOY. However, cowpea line IT 98K-477-4 with 180 kg/ha was the least. Although, there were no significant difference among cowpea lines for grain yield (GRY), IT 99K-377-1 recorded relatively the highest grain yield of 279 kg/ha, whereas IT 98K-133-1-1 recorded the lowest yield of 16 kg/ha. There was significant difference among cowpea lines for number of striga per plot. The count was done once before harvesting and followed the scale made in this study. Thus, several groups were distinguished according to the absence and presence of striga plant in the plot (Table 4).

Table 4: Number of striga/plot and reaction of 33 cowpea lines

Cowpea lines	Number of striga/plot	Reaction to striga
IT 98K-1092-1	0.00	Highly resistant
IT 99K-573-1-1	0.00	
IT 98K-628	0.00	
IT 99K-1122	0.00	
IT 97K-205-8	0.00	
IT 97K-499-38	0.00	
IT 97K-819-118	1.00	Resistant
IT97K-499-35	2.00	
BT-07	2.00	
IT 00K-1263	2.00	
IT 99K-377-1.	6.00	Moderately resistant
IT 98K-412-13	13.00	
KVX30-309-6G	23.00	Moderately susceptible
IT 99K-721-2-2	29.00	
IT 98K-128-3	29.00	
Damsa-07	30.00	
IT 98D-1399	35.00	Susceptible
IT 99K-529	36.00	Very susceptible
Damai-07	38.00	
TN 5-78	41.00	
Dadaga-07	42.00	
IT 03K-351-1	45.00	
IT 96D-610	49.00	
IT 90K-372-1-2	55.00	
IT 98K-503-1	77.00	
IT 98K-166-4	78.00	
IT 97K-106-6	83.00	
IT 98K-133-1-1	86.00	
IT 97K-390-2	89.00	
TN 88-63	95.00	
IT 98K-311-8-2	102.00	Highly susceptible
IT 98K-497-4	102.00	
IT 03K-324-9	120.00	

Discussions

Significant differences were observed among cowpea lines for number of Striga per plot. This indicates differential response of cowpea lines to *Striga*. Among cowpea lines which were free of *Striga* only IT 98K-1092-1 and IT 99K-573-1-1 recorded a plant height above the mean with 30 cm and 32 cm respectively (figure 1). On the other hand, the moderately resistant cowpea line IT 99K-377-1 recorded relatively a plant height mean of 37 cm while the highly susceptible ones IT 03K-324-9 and IT 98K-311-8-2 supported the *Striga* by recording plant height above the mean. This shows that they can tolerate the parasitic plant. Similar results were obtained by Noubissie *et al.,* (2010) and Omoigui *et al.,* (2007). The results found by Noubissie *et al.,* (2010), while screening twelve selected cowpea cultivars for their resistance to *S. gesnerioide* showed that cowpea line IT99-573-1-1 was free of striga.

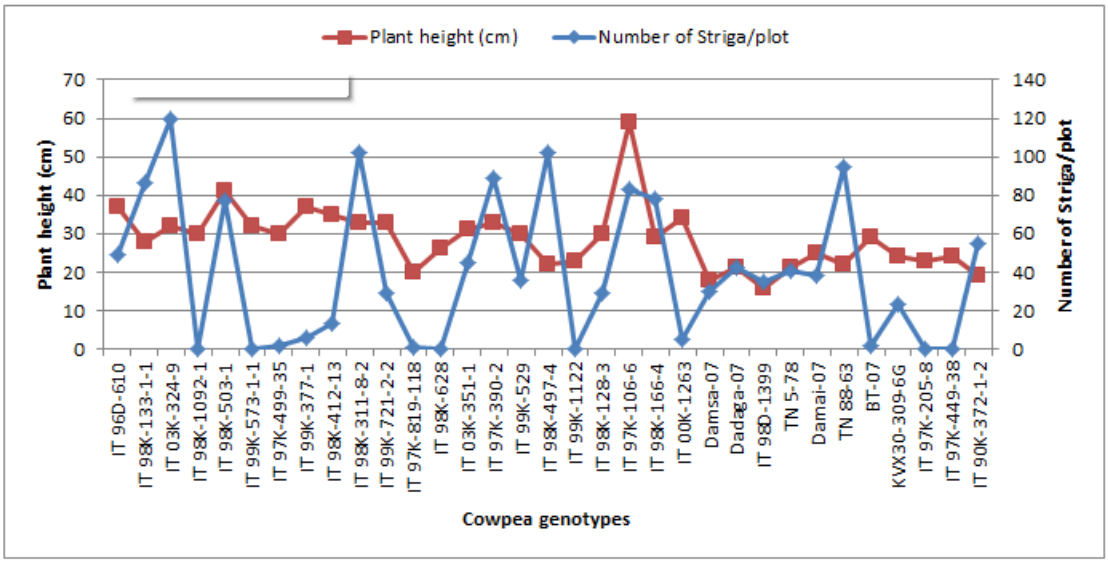

Figure 1: Effect of striga on the growth of thirty three (33) cowpea genotypes

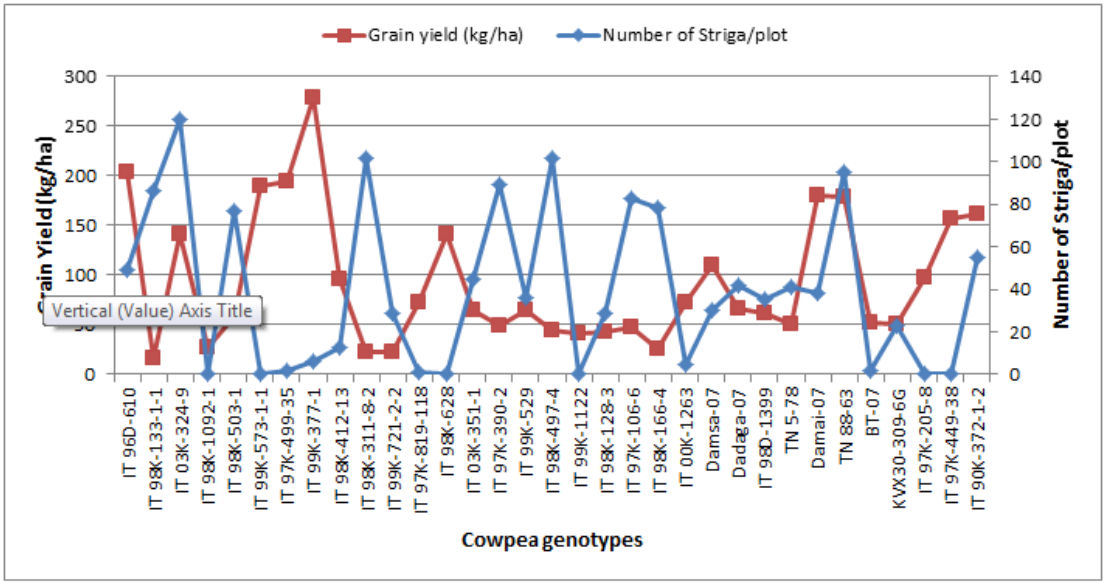

Figure 2: Effect of striga on grain yield of thirty three (33) cowpea genotypes

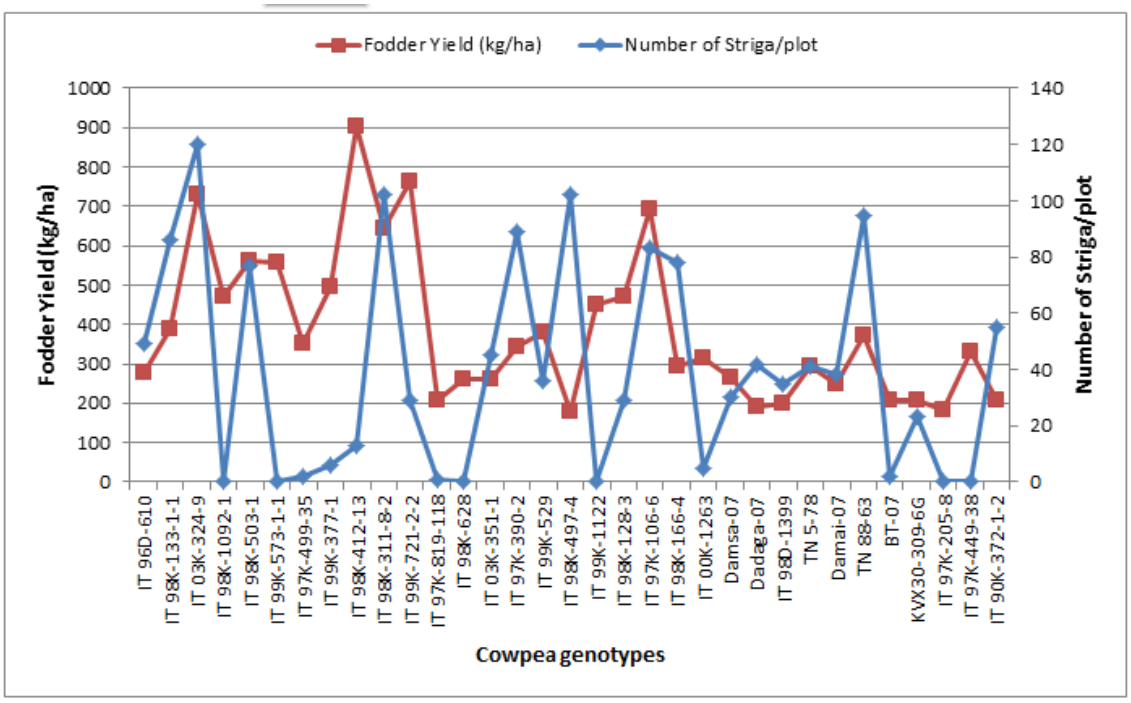

Figure 3: Effects of Striga on fodder yield of thirty three (33) cowpea lines

IT98K-412-13 which was among moderately resistant cowpea lines recorded the highest fodder yield (903 kg/ha) but with lower grain yield (71 kg/ha) (figure 3). This result can be explained by the level of the infestation during pod filling which is very critical in cowpea production. Also, it shows the negative impact of *S. gesnerioides* infestation on cowpea grain production. A similar result was reported by Omougui *et al.,* (2012), who reported that cowpea line IT97K-205-8 was completely resistant to Striga but in contrary IT99K-573-1-1 which was completely resistant in the present study, was not in their results. The results obtained for grain and fodder yields in this study were lower; this suggests variability within population of *S. gesnerioides* and level of infestations. Grain yield reduction causes by *Striga* damage was more pronounced on susceptible lines than on the moderately resistant or tolerant lines (figure 2). Among these cultivars, TN5-78 and KVX-309-6G widely grown in the country and other cowpea lines such as IT 98K-128-3, IT 98K-497-4, IT 97K-106-6, IT 97K-390-2 and IT 98K-503-1 recorded significantly high numbers of tufts of *Striga.* These lines showed severe yield losses and gave grain yields that were significantly lower than those of the resistant or the tolerant cultivars, thus, suggesting that they are susceptible to *Striga*.

In contrast, the highly susceptible cowpea line IT03-324-9 was among the early maturing lines and recorded a relatively higher grain and fodder yields while IT98K-311-8-2 and IT98-497-4 recorded lower grain yield and poor growth development. This indicates that susceptible cowpea lines develop poor growth because the infestation of the parasitic weed occurs at early stage, and greatly reduces cowpea growth and grain yields. IT03-324-9 which supported the parasitic weed was tolerant and its counterparts were susceptible.

Yield loss in grain yield and large number of *Striga* observed in IT98K-311-8-2 (highly susceptible cowpea line) was an indicator of severity of the infestation on the genotype. This result confirms the findings of Kamara *et al.,* (2007) and Omoigui *et al.,* (2007), who reported that cowpea yield loss, can range from 30 to 100% for a highly susceptible line to *Striga.*

The result suggests that resistance to *Striga* does not imply high yield and this is clearly demonstrated by IT99K-1122 and BT-07 with respectively 0 and 2 tufts of *Striga* but recorded a yield lower than some of the tolerant lines. These findings indicate that some of cowpea lines (IT 99K-573-1-1, IT 97K-205-8, IT 97K-499-38 and IT03-324-9) could be used as potential parental lines that can be used in a cowpea breeding program for improving resistance to *Striga.*

Conclusion

According to the results obtained in this study, these lines IT 99K-573-1-1, IT 97K-499-38 and IT03-324-9 could be recommended as source of resistance to *Striga*. But in the dry area like Sahel where like most crops, cowpea growth and grain yield production are greatly reduced by some biotic and abiotic constraints which occur sometimes together. Therefore, it would better in combination of resistance to *Striga*, to include other constraints such as insect pests, severe drought, salinity and heat etc., in the breeding programme so as to ensure sustainable food security.

References

Aggarwal VD, Ouédraogo JT (1989). Estimation of cowpea yield loss from S. gesnerioides infestation. Trop Agric 66:91–92.

Alonge SO, Lagoke STO, Ajakaiye CO (2005). Cowpea reactions to Striga gesnerioides: I. Effects on growth. Crop Protection 24:565-573.

Boukar O, Kong L, Singh BB, Murdock I & Ohm HW (2004). AFLP and AFLP-derived SCAR markers associated with

Striga gesnerioides resistance in cowpea [*Vigna Unguiculata*]. Crop science 44: 1259-1264.
Boukar O, Fatokun CA, Huynh BL, Roberts PA and Close TJ (2016). Genomic Tools in Cowpea Breeding Programs: Status and Perspectives. Front. Plant Sci. 7:757. doi: 10.3389/fpls.2016.00757
Botanga CJ and Timko MP (2005). Genetic structure and analysis of host and non-host interactions of Striga gesnerioides (witchweed) from Central Florida. Phytopathology 95:1166-1173.
Dube MP & Alain O (2001). Le Striga gesnerioides et son hôte, le niebe : interaction et methodes de lutte. Canadian Journal of Botany, 79(10) : 1225-1228.
Dugje IY, Kamara AY & Omoigui LO (2006). Infestation of crop fields by *Striga* species in the savannas of northeast Nigeria. Agriculture, Ecosystem, and Environment. 116:251-254.
Food and Agriculture Organization of the United Nations, Statistics Division, FAOSTAT, 2012. http://faostat3.fao.org.
Kamara AY, Chikoye D, Ekeleme F, Omoigui LO and Dugje IY (2008). Field performance of improved cowpea varieties under conditions of natural infestation by parasitic weed Striga gesnerioides. Int J. Pest Management 54(3):189-195.
Kamara AY, Chikoye D, Ekeleme F, Omoigui LO, Dugje IY (2007). Field performance of cowpea varieties under natural infestation with the parasitic weed, Striga gesnerioides. Intern. J. Pest Mangt., 54 (3): 189-195.
Mellor KE, Ava MH and Timko M.P (2012). Use of ex vitro composite plants to study the interaction of cowpea (Vigna unguiculata L.) with the root parasitic angiosperm Striga gesnerioides . Plant Methods, 8:22.
Noubissie Tchiagam JB, Joseph MB, Sirina GB, Sodea G, Emmanuel Y (2010). Varietal Response of Cowpea (*Vigna unguiculata* (L.) Walp.) to *Striga gesnerioides* (Willd.) Vatke Race SG5 Infestation. Not. Bot. Hort. Agrobot. Cluj 38 (2) : 33-41.
Omoigui LO, Kamara AY, Massawe FS, Ishiyaku MF, Boukar O, Alabi SO and Ekeleme F (2007). Evaluation of cowpea genotypes for their reactions to Striga gesnerioides in the dry savanna of northern Nigeria. African Crop Science Conference Proceedings, 8: 273-278.
Omoigui LO, Timko MP, Ishiyaku FS, Ousmane B, Muranaka BS, Kamara AY and Yeye MY (2009). Molecular characterization of cowpea breeding line for Striga resistance using FTA technology. African Crop Science Conference, Uganda 9:527-530.
Omoigui LO, Kamara AY, Ishiyaku MF, Boukar O (2012). Comparative responses of cowpea breeding lines to Striga and Alectra in the dry savanna of northeast Nigeria. African Journal of Agricultural Research Vol. 7(5), pp. 747-754.
Ouedraogo J.T., Mahama O., Gowda B.S., Timko M.P. (2012). Development of sequence characterized amplified region (SCAR) markers linked to race-specific resistance to *Striga gesnerioides* in cowpea (*Vigna unguiculata* L.). African Journal of Biotechnology Vol. 11(62), pp. 12555-12562.
Rajeev KV, Himabindu K, Abirami R, Swapna N, Chen X, Zhuang WJ, Liang X, Kahl G and David E (2013). Functional genomics to study stress responses in crop legumes: progress and prospects. Functional Plant Biology, 40:1221–1233.
Tignegre JB, Jeremy TO, Melis R, Tongoona P, Sibiya J, Makanda I, Drabo I (2013). Identification of new sources of resistance to Striga gesnerioides in cowpea germplasm. Plant Breeding 132:330–336.
Timko MP and Singh BB (2008). Cowpea, A Multifunctional Legume. In: Genomics of Tropical Crop Plants (Moore PH and Ming R, eds.). Springer Science+Business Media, New York, 227-258.