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Evaluation of Sweet Sorghum Genotypes for Reaction to Striga Hermonthica (Del.) in Nigeria

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ABSTRACT

Field evaluation of 91 sweet sorghum genotypes including a local check was conducted in 2014 and 2015 cropping seasons at Bida, Niger State Nigeria, with the purpose of evaluating their reaction to Striga hermonthica. Sweet sorghum is a multipurpose crop grown for food, feed and fuel due to its high sugar level in the stem. This collection of 48 sweet sorghum accessions from ICRISAT, 42 from Dutch breeding program and a local check (Kaura) from Nigeria were grown in randomized complete block design. The experimental site is known to be endemic to Striga, but in addition, prior to planting, the field was inoculated with Striga seeds to ensure homogenous infestation. Striga count on a scale for 1 to 5 was based on the number of crop stand with Striga shoots. The results from field observations showed some degree of variability in sorghum reaction to Striga and the yield with coefficient of variability of 47 – 51% for ICRISAT accessions and 31 – 36% for Dutch accessions. The overall resistance in ICRISAT accessions was found to be 33.5%, whereas the Dutch sorghum accession was 21.4% across the two years of evaluation. Based on the crop yield and the severity of infection scores, seven genotypes of ICRISAT accessions were identified to be high yielding with high to medium resistance while four genotypes of Dutch were identified to be resistant with corresponding high yields. Most of the Dutch accessions were very susceptible to Striga infestation with associated poor yields. The severity of Striga infection influences the yield performance of each sorghum genotype among the ICRISAT and Dutch accessions across the years. The Dutch accessions resistant to Striga infection were not high yielding when compared with the ICRISAT accessions. There were eleven promising sorghum genotypes among the screened materials identified to be resistant to Striga while thirteen genotypes appeared to be tolerant. The resistant genotypes may be recommended to farmers in the areas where Striga is a threat to sorghum production.

Keywords: *Accession, Genotype, Infestation, Resistance, Striga*

INTRODUCTION

Sorghum [*Sorghum bicolor (*L.) Moench] is one of the major cereals grown within the semi-arid regions of sub-Saharan Africa because it is high yielding even under poor environments. Sweet sorghum is a multipurpose crop grown for food, feed and fuel due to its high sugar level in the stem (Regassa and Wortmann, 2014).

It is similar to grain sorghum but exhibit more rapid growth, higher production, and wider adaptation. It has great potential for ethanol production (Mathur et al. 2017) and marker assisted breeding is feasible which can be shown for quantitative traits for biomass and across climatic zones (Mocoeur et al. 2015). The crop possesses various anatomical, morphological and physiological features that allow it to adapt and thrive in environments with limited water (Albuquerque et al. 2010). The crop serves as the main staple food to millions of people (Babiker 2007; Belz 2007) living in arid to semi-arid with environments with inadequate rainfall (Berner et al. 1995). It is planted either sole or in mixed cropping with soybean or other crops. There has been increase demand for sorghum to meet the human, livestock and industrial requirement. Sorghum accounts for nearly 34% of all the cereal production in West and Central Africa (Akintayo and Sedgo 2001). Nigeria produced 6.7 million metric tons of sorghum in 2014 on an area of approx. 5 million ha (FAOSTAT 2017). Nonetheless, the production of sorghum experiences various biotic and abiotic constraints. One of the major biotic constraints is caused by Striga species which as parasitic weed in the field causing significant yield loss in sorghum production.

In Nigeria, Striga infests close to 50% of the production area of sorghum which translate to about 20%yield loss (Parker, 2009). Striga is an obligate parasite of root that deprives its host from water supplies, mineral salts together with sugar for its survival so as to develop the required shoot system and for achieving normal growth (Ezeku and Gupta, 2004). Heavy infestation of the crop by Striga causes yield loss up to 100%. Other factors that contribute to low production of sorghum are use of local, susceptible cultivars, limited access to improved cultivars, use of non-optimum planting dates as well as unpredictable rainfall during the growth season. As an example, a study of farming practice in Borno State, Nigeria, showed that 92% of the 54 sorghum fields examined grew local cultivars, which furthermore are more vulnerable to Striga infestation while the remaining 4 fields grew a KSV variety which is tolerant to *Striga hermonthica* (Dugje et al. 2007).

The control of Striga has been very difficult because of its complex adaptive mechanisms. It defies the control methods generally applicable to common weeds of the field crops (Olaniyan and Iwo 1993). However, these damages caused by Striga infestation may be effectively minimized through planting Striga resistant sorghum cultivars (Carsky et al. 1996), where resistance indicate a genetic control and tolerance a mechanistic defense. Host plant resistance to Striga species parasitism is recognized as the best method of control (Iwo et al 1998) but combining sound agricultural practices with Striga-resistant cultivars gives the best control results (Wilson et al. 2000, Bayu et al. 2001, Rodenburg et al. 2006).

The magnitude of challenge is clear from the fact that a single Striga plant can produce more than thousand seeds and seeds can survive in the soil for many years (van Delft et al. 1997). Evidently, the best solution to Striga problem is the use of resistant varieties. The purpose of the study therefore is to evaluate the exotic sorghum accessions for their reaction to Striga and to identify sorghum genotypes resistant to Striga. Therefore, the study hypothesized that the use of exotic sorghum accessions would resist or tolerate Striga infestation and produce better yield.

Materials and Methods

A field trial consisting of 48 sorghum accessions obtained from ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), one of the consultative Group of International Agricultural Research (CGIAR) institutions under the UN, and 42 sorghum accessions (Dutch) obtained from sorghum breeder Walter de Milliano including a local check from Nigeria(Kaura). The trial was conducted in collaboration with the National Cereals Research Institute (NCRI) Badeggi, Niger State, Nigeria for 2014 and 2015 cropping seasons. At the NCRI Badeggi, the field trial was conducted in Bida where the field has a history of high Striga infestation. NCRI is located at 09° 04N and 06° 08E, with annual rainfall of 1,104mm, and has Ferrisol types of soil. In addition, the field was inoculated with Striga seeds before planting to ensure homogenous infestation.

In preparation of the land, a tractor was used for ploughing the soil for initial preparation for sowing. The field was cleared and large roots were stumped out from the soil while Stover from previous cropping year was properly cleared and disposed of before the soil was ploughed to turnover fresh long fertile soils as furrows. After two weeks the tractor was brought in for harrowing and breaking up large cluster of soil and loosening it for sowing of seeds.

The sorghum accessions collected were planted in a Randomized Complete Block Design (RCBD) with two replications. A single row plot of 10m x 0.75m was maintained with inter-row and intra-row spacing of 75cm and 30cm respectively. The seeds were sown at a rate of 2 to 3 seeds per hole through direct manual hand drilling with a sowing depth of 2.5 to 3cm and also 2 plants per stand were maintained after thinning with maximum of 66 plants per plot. Application of mixed inorganic fertilizers (NPK 15% nitrogen, 15% phosphorus and 15% potassium) was done at the rate of 80kg/ha to ensure top dressing at sowing and fertilizer was applied at four weeks with urea fertilizer incorporated as side dressing. Weeding was carried out every four weeks until harvest and this was done through hand pulling method and also using a simple weeding hoe.

The Striga resistance was determined by first counting the number of plant stands with Striga shoots per plot at 6 weeks after sowing, 9 weeks after sowing and at harvest. Striga count was based on the number of crop stand with Striga shoots. A scale of measurement from 1 to 5 was then used to measure the severity of Striga infestation on the field (Iwo et al.1998). From this method a crop reaction score to Striga was established and different level of sorghum resistance to Striga was measured with a scale as follows: Highly Resistant = 1.0 – 1.9, Resistant = 2 - 2.5, Moderately Resistant = 2.6 - 3.0, Moderately Susceptible 3.1 -3.5, Susceptible = 3.6 - 4.5, Highly Susceptible = 4.6 – 5.0 and above. The number of Striga at 6WAS, 9WAS and harvest were added together, and their mean value recorded. The crop yield (grain of sorghum) was determined by using a weighing balance, and the weight was recorded in grams per plot (g/plot) but later extrapolated to kilogram/hecter.

RESULTS

Field observations of the evaluated sorghum accessions showed greater degree of variations in response to Striga infestation for the two years of field evaluation irrespective of the sources of the sorghum accessions. The variations in yield and severity scores among the accessions are presented in Tables 1, 2, 3 and 4. The ICRISAT accessions tend to be more resistant/ tolerant to Striga infestation. Sixteen accessions were identified with varying degree of resistance to Striga (HR, R, MR) while four genotypes; SPV422, F5.3SSM10-21/4-1TAN, F5.3SSM10-9/1-3, and F7,5SSM09-1-1/9-2 were found to be tolerant to Striga with high seed yield regardless of the number of Striga plants per stand.

The coefficient of variability recorded for Striga mean score and seed yield among the accessions were 51% and 47% for 2014 and 50% and 51% respectively for 2015 cropping seasons. Among the Dutch sorghum accessions only nine genotypes were observed to be resistant to Striga while five genotypes; H4-2PD1-R47, H5-B1-R8-32-R2, H1-PD1-R47, H5-2-PD1-R47 and H2-PD2-R50 were tolerant to Striga. The coefficient of variability recorded for Striga mean score and the yield among the Dutch accessions for the two cropping seasons were 34% and 31% for 2014 while 31% and 36% for 2015 cropping season.

The reactions of ICRISAT sorghum accessions to Striga showed that 50% of the sorghum accessions were highly susceptible (HS), 6.3% susceptible (S) and 10.4% moderately susceptible (MS) while 16.7% were highly resistant (HR), 6.3% resistant(R) and 10.3% moderately resistant (MR). The genotype with the highest yield with a mean Striga count of 2.7 was F5.3SSM10-20/2-1 followed by F7.5SSM09-1-1/9-2 and F5.3SSM10-21/6-1 with corresponding Striga mean score of 3.2 and 1.5, respectively. The genotype F5.3SSM10-8/3-2 appeared to be immune to Striga but the yield was low 155g/plot. The Dutch sorghum accessions were more susceptible to Striga infestation which was evidenced with low yields ranging from 100 - 367kg/hecter. The reaction to Striga infestation showed that 52.3% was susceptible, 16.8% moderately susceptible and 9.5% highly susceptible. On the other hand 10.7% was highly resistant, 5.9% resistant and 4.8% moderately resistant **(Fig. 1**). The sorghum genotypes from the two different sources reacted differently to Striga.

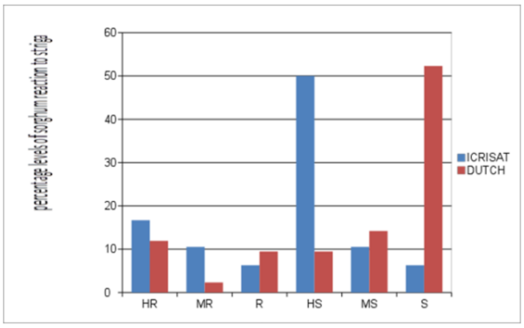

Fig1. *Average distribution pattern of Striga reactions among ICRISAT and Dutch sorghum accessions for 2014 and 2015 cropping seasons*

The infection trend and severity of attack varied with the different types of sorghum accessions. The ICRISAT sorghum accessions responded slowly to Striga infection. These are evidenced by the smaller numbers of Striga shoots that emerged on each of the sorghum stand. The frequency of resistant sorghum genotypes responding negatively to Striga infection was greater with low severity scores ranging from 0 – 2.9 while the frequency of susceptible genotypes responding positively to striga infection was low with high severity score of 3.5 – 9.9. The Dutch accessions showed higher trend of susceptibility but the frequency of occurrence for resistance to Striga attack was less with severity scores of 1-2.5. The highest frequency of occurrence for susceptibility was recorded with the severity scores of 4.0 -5.5 (Fig.2). The prevalence and the severity of infection depended on the genotype and the relationship between the parasite and the host plant. The number of Striga count influences the yield performance of the crop. Among the ICRISAT accessions, seven genotypes appeared to be best yielding with varying degree of resistance (HR, R, and MR).

Table1. *The performance and Striga count at different interval after sowing of ICRISAT sorghum accessions in 2014 cropping season*

Sorghum Accessions	Mean value for Striga count			Total grain yield	Mean Striga Score	Crop RXN
Name	**NS6WAS**	**NS9WAS**	**NStr_har**	**Kg/hecter**	**Scale 1-5**	
F5.3SSM10-20/2-1	2.0	3.0	4.0	598	3.0	MR
F5.3SSM10-8/3-2	0.0	0.0	0.0	216	0.0	HR
TIEBLE	0.0	3.0	3.5	286	2.2	HR
F5.3SSM10-1/6-1	1.0	1.5	2.5	392	1.6	HR
F5.3SSM10-31/6-5	0.5	2.0	2.5	105	1.6	HR
F7.5SS9-1-1/7-1	0.5	1.5	2.5	220	1.5	HR
F5.3SSM10-4/4-1	2.5	6.5	6.5	101	5.1	HS
F5.3SSM10-16/1-1	1.0	2.5	4.5	230	2.7	MR
F5.3SSM10-1/5-1	3.0	4.0	6.5	155	4.5	S
IS23555	6.0	12.5	14.0	139	10.8	HS
F7.5SSM09-1-1/9-2	1.5	3.5	6.0	523	3.6	MS
F5.3SSM10-13/7-1	4.0	5.0	5.5	295	4.8	S
F7.5SSM09-5-3/3-2-3-3	5.5	5.5	6.5	155	5.8	HS
F5.3SSM10-12/2-3	3.0	7.5	8.0	210	6.1	HS
F7.5SSM09-5-3/4-1-2-2	0.0	2.5	5.0	300	2.5	R
F60	2.5	7.5	7.5	200	5.8	HS
F5.3SSM10-33/3-1	0.5	3.5	4.5	237	2.8	MR
Local Variety (CSR-01)	3.0	4.0	5.0	120	4.0	S
F7.5SSM09-6-2/3-1-2-PL	2.5	2.5	3.7	236	2.9	R
F5.3SSM10-8/1-5	3.5	7.0	8.5	220	6.3	HS
LINA 3	4.5	4.0	7.0	220	5.2	HS
F7.5SSM09/4-1-1-3	6.0	5.0	6.5	113	5.8	HS
F5.3SSM10-4/4-1	2.5	6.5	6.5	215	5.2	HS
447(471)496	3.0	6.0	7.5	160	5.5	HS
F5.3SSM10-9/1-3	1.5	3.5	5.5	446	3.5	MS
F7.3SSM09-1-1/6-1	5.0	4.5	5.5	278	3.0	MR
F7.3SSM09-5-3/3-2-1-1	4.5	7.0	9.5	255	7.0	HS
F5.3SSM10-21/6-1	1.5	2.0	3.0	490	2.2	R
F5.3SSM10-14/1-1	4.5	8.0	10.0	275	7.5	HS
IS23561	6.5	7.5	10	225	8.0	HS
IS23519	4.5	11.0	14.0	132	9.8	HS
F5.3SSM10-24/2-1	2.0	3.0	4.5	217	3.2	MS
SPV422	1.5	4.0	5.0	400	3.5	MS
F5.3SS10-21/10-1	1.0	1.5	1.5	300	1.3	HR
F5.3SSM10-/6-6	0.5	1.5	2.0	256	1.3	HR
IS23574	3.0	4.5	6.0	121	4.5	S
F7.5SSM09-1-1/2-1	4.0	7.5	8.0	101	6.5	HS
F221	0.1	1.5	3.0	286	1.5	HR
F5.3SSM10-1/1-8	5.5	6.5	8.5	145	6.8	HS
F5.3SSM10-15/5-1	4.5	5.0	8.0	154	5.8	HS
F5.3SSM10-21/4-1TAN	2.0	3.0	4.5	401	3.2	MS
IS23525	2.0	5.0	6.5	150	4.5	HS
ICSR93034	7.0	8.0	8.5	160	7.8	HS
F7.5SSM09-1-1/4-1	4.5	6.0	8.0	245	6.1	HS
MULT-11-36461-2-1	3.5	6.0	10.0	217	6.5	HS
F7.5SSM09-5-3/4-1-1-1	3.5	5.0	7.0	207	5.2	HS
IS23541	2.0	3.0	4.0	300	3.0	MR
F5.3SSM10-18/2-1	3.0	6.5	9.5	135	6.3	HS
Kaura (Local check)	3.5	6.5	7.5	260	5.8	HS
MEAN	**2.89**	**4.79**	**6.35**	**236.36**	**4.55**	
SEM	**0.26**	**0.35**	**0.40**	**16.01**	**3.25**	
CV (%)	**64**	**52**	**45**	**47**	**51**	

Where

Entries = Accession names

NS6WAS = Mean Value for Number of Striga at 6 weeks after sowing

NS9WAS = Mean Value for Number of Striga at 9 weeks after sowing

NStr_har = Mean Value for Number of Striga at harvest

Mean Striga Score = Mean Score of Striga at 6WAS, 9WAS and Harvested

CROP RXN = Crop reaction score to Striga resistance (HR= Highly Resistant, R = Resistant, MR = Moderately Resistant, MS = Moderately Susceptible, S = Susceptible, HS = Highly Susceptible)

Table2. *The performance and Striga count at different interval after sowing of Dutch sorghum accessions in 2014 cropping season*

Sorghum Accessions	Mean value for Striga count			Total grain yield	Mean Striga Score	Crop RXN
Name	**NS6WAS**	**NS9WAS**	**NStr_har**	**Kg/hecter**	**Scale 1-5**	
R12-23-IR	4.0	5.0	6.5	120	5.2	S
H8-R9-29/SN	3.5	4.5	7.2	135	5.1	S
H5-1-PDI-R47	2.0	6.0	9.0	100	5.7	S
H4-2-PD1-R47	2.5	3.0	5.5	236	3.7	MS
H4-1-PD1-R47	3.5	6.0	6.5	135	5.3	S
H3-2-PDI-R47	2.4	5.0	5.5	186	4.3	S
H3-1-PD1-R47	1.0	2.1	4.5	291	2.5	R
H3-R9-32/SN	4.0	4.1	5.0	195	4.4	S
H5-B1-R8-32-R2	2.0	5.0	7.0	255	4.6	S
H3-R9-33/SN	3.5	6.5	13.0	136	7.6	HS
H5-2-PD1-R47	1.5	4.0	5.0	280	3.5	MS
H2-14-B1-W1	4.0	4.0	7.5	155	5.1	S
H18-1-PD1-R47	2.1	2.5	4.0	247	2.9	R
H8-2-PD1-R47	3.6	5.0	6.0	179	4.9	S
H8-1-PD1-R47	2.2	6.5	11.0	168	6.5	HS
H1/SN-PD1-R47	2.7	4.0	9.0	182	5.2	S
H1-PD1-R47	1.0	4.3	5.5	253	3.6	MS
H18-PD3-R51	2.0	2.1	4.0	216	2.7	R
H8-PD3-R51	1.4	2.0	2.5	115	2.0	R
H5-PD3-R51	1.3	4.5	6.0	259	3.9	MS
R2-14-B1-W1	2.3	5.6	7.0	186	5.0	S
R2-14-B1-W4	1.5	3.0	6.5	261	3.7	MS
R2-14-B1-W5	3.0	5.5	7.0	155	5.2	HS
R2-8-2B/W	2.3	5.1	7.0	200	4.8	S
H4-PD2-R50	3.0	3.8	6.5	191	4.4	S
H3-PD2-R50	2.5	4.0	6.0	187	4.2	S
H2-17-2B/W	3.0	3.0	5.5	220	3.8	MS
H1-PD2-R50	2.2	4.0	6.0	178	4.1	S
H3-PD3-R51	1.0	1.5	2.5	235	1.7	HR
H1-PD3-R51	2.3	4.0	6.0	153	4.1	S
H18-PD2-R50	3.0	5.5	2.5	148	3.7	S
H2-PD2-R50	2.0	3.5	10.0	311	5.2	HS
H5-PD2-R50	2.1	4.5	6.5	195	4.0	S
H100-5	1.1	1.5	2.8	246	1.8	HR
H7	1.0	1.0	2.5	300	1.3	HR
H4-1	0.0	0.0	2.5	370	0.8	HR
S4-28-4	2.0	4.5	6.5	221	4.2	S
H100-1	3.5	5.6	2.5	86	3.9	S
H7-R9-17/SN	3.0	4.5	6.0	116	4.5	S
H5-B2-R8-33/SN	1.5	3.1	3.7	198	2.8	R
R2-14-B1-W/6	3-5	5.2	8.5	180	5.7	S
H3-R8-10/SN	3.3	5.0	7.1	166	5.1	HS
MEAN	**2.4**	**4.0**	**6.2**	**199**	**4.2**	
SEM	**1.39**	**2.52**	**4.07**	**9.1**	**2.18**	
CV (%)	**41**	**38**	**35**	**31**	**34**	

Where

Entries = Accession names

NS6WAS = Mean Value for Number of Striga at 6 weeks after sowing

NS9WAS = Mean Value for Number of Striga at 9 weeks after sowing

NStr_har = Mean Value for Number of Striga at harvest

Mean Striga Score = Mean Score of Striga at 6WAS, 9WAS and Harvested

CROP RXN = Crop reaction score to Striga resistance (HR= Highly Resistant, R = Resistant, MR = Moderately Resistant, MS = Moderately Susceptible, S = Susceptible, HS = Highly Susceptible)

Table3. *The performance and Striga count at different interval after sowing of ICRISAT sorghum accessions in 2015 cropping season*

Sorghum Accessions	Mean value for Striga count			Total grain yield	Mean Striga Score	Crop RXN
Name	**NS6WAS**	**NS9WAS**	**NStr_har**	**Kg/hecter**	**Scale 1-5**	
F5.3SSM10-20/2-1	2.0	3.0	3.0	695	2.7	MR
F5.3SSM10-8/3-2	0.0	0.0	0.0	155	0.0	HR
TIEBLE	0.0	3.0	4.5	275	1.5	HR
F5.3SSM10-1/6-1	1.0	1.5	1.5	375	1.3	HR
F5.3SSM10-31/6-5	0.5	2.0	2.5	90	1.7	HR
F7.5SS9-1-1/7-1	0.5	1.5	2.5	120	1.5	HR
F5.3SSM10-4/4-1	2.5	6.5	6.5	215	5.1	HS
F5.3SSM10-16/1-1	1.0	2.5	4.5	237	2.7	MR
F5.3SSM10-1/5-1	3.0	4.0	4.5	155	3.8	S
IS23555	6.0	10	12	150	9.3	HS
F7.5SSM09-1-1/9-2	1.5	3.5	4.5	500	3.2	MS
F5.3SSM10-13/7-1	4.0	5.0	4.5	295	4.5	S
F7.5SSM09-5-3/3-2-3-3	5.5	5.5	6.5	155	5.8	HS
F5.3SSM10-12/2-3	3.0	7.5	8.0	310	6.2	HS
F7.5SSM09-5-3/4-1-2-2	0.0	2.5	5.0	295	2.5	R
F60	2.5	7.5	7.5	190	5.8	HS
F5.3SSM10-33/3-1	0.5	3.5	4.5	230	2.8	MR
Local Variety (CSR-01)	3.0	4.0	5.5	120	4.2	S
F7.5SSM09-6-2/3-1-2-PL	2.5	2.5	5.0	140	3.3	R
F5.3SSM10-8/1-5	3.5	6.0	7.5	220	5.7	HS
LINA 3	4.5	5.0	7.0	220	5.5	HS
F7.5SSM09/4-1-1-3	4.0	5.0	6.5	80	5.1	HS
F5.3SSM10-4/4-1	2.5	6.5	6.5	215	5.2	HS
447(471)496	3.0	6.0	7.5	165	5.5	HS
F5.3SSM10-9/1-3	1.5	3.5	5.5	488	3.5	MS
F7.3SSM09-1-1/6-1	5.0	4.5	5.5	250	5.0	HS
F7.3SSM09-5-3/3-2-1-1	4.5	7.0	9.5	260	7.0	HS
F5.3SSM10-21/6-1	1.5	2.0	2.0	490	1.5	HR
F5.3SSM10-14/1-1	4.5	8.0	10.0	375	7.5	HS
IS23561	6.5	7.5	10	275	8.0	HS
IS23519	4.5	11.0	14.0	252	9.8	HS
F5.3SSM10-24/2-1	2.0	3.0	4.5	117	3.2	MS
SPV422	1.5	4.0	5.0	405	3.5	MS
F5.3SS10-21/10-1	1.0	1.5	1.5	160	1.3	HR
F5.3SSM10-/6-6	0.5	1.5	2.0	155	1.3	HR
IS23574	3.0	4.5	6.0	135	4.5	S
F7.5SSM09-1-1/2-1	4.0	7.5	8.0	140	6.5	HS
F221	0.1	1.5	3.0	80	1.5	HR
F5.3SSM10-1/1-8	5.5	6.5	7.5	145	6.5	HS
F5.3SSM10-15/5-1	4.5	5.0	8.0	180	5.8	HS
F5.3SSM10-21/4-1TAN	2.0	3.0	4.5	405	3.2	MS
IS23525	2.0	4.0	5.5	150	3.8	S
ICSR93034	7.0	8.0	8.5	260	7.8	HS
F7.5SSM09-1-1/4-1	4.5	6.0	8.0	240	6.1	HS
MULT-11-36461-2-1	3.5	6.0	10.0	315	6.7	HS
F7.5SSM09-5-3/4-1-1-1	3.5	5.0	7.0	247	5.2	HS
IS23541	2.0	3.0	4.0	290	3.0	MR
F5.3SSM10-18/2-1	3.0	6.5	9.5	140	6.3	HS
Kaura (Local check)	4.5	7.0	9.0	245	6.8	HS
MEAN	**2.767**	**4.606**	**5.961**	**240.8**	**4.49**	
SEM	**0.246**	**0.328**	**0.396**	**17.6**	**3.25**	
CV (%)	**63**	**50**	**46**	**51**	**50**	

Where

Entries = Accession names

NS6WAS = Mean Value for Number of Striga at 6 weeks after sowing

NS9WAS = Mean Value for Number of Striga at 9 weeks after sowing

NStr_har = Mean Value for Number of Striga at harvest

Mean Striga Score = Mean Score of Striga at 6WAS, 9WAS and Harvested

CROP RXN = Crop reaction score to Striga resistance (HR= Highly Resistant, R = Resistant, MR = Moderately Resistant, MS = Moderately Susceptible, S = Susceptible, HS = Highly Susceptible)

Table4. *The performance and Striga count at different interval after sowing of Dutch sorghum accessions in 2015 cropping season*

Sorghum Accessions	Mean value for Striga count			Total grain yield	Mean Striga Score	Crop RXN
Name	**NS6WAS**	**NS9WAS**	**NStr_har**	**Kg/hecter**	**Scale 1-5**	
R12-23-IR	3.5	4.0	6.0	125	4.5	S
H8-R9-29/SN	2.0	4.0	7.0	137	4.3	S
H5-1-PDI-R47	2.0	6.2	9.0	77	5.7	HS
H4-2-PD1-R47	2.0	3.0	5.0	225	3.3	MS
H4-1-PD1-R47	3.5	6.5	7.0	137	5.7	HS
H3-2-PDI-R47	3.0	4.5	5.5	180	4.6	HS
H3-1-PD1-R47	1.5	2.5	4.0	189	2.7	MR
H3-R9-32/SN	2.0	4.0	5.0	187	3.6	S
H5-B1-R8-32-R2	1.5	5.5	7.0	230	4.7	HS
H3-R9-33/SN	4.0	7.0	11.0	130	7.3	HS
H5-2-PD1-R47	2.0	4.0	4.0	260	3.3	MS
H2-14-B1-W1	3.0	4.5	7.5	152	5.0	HS
H18-1-PD1-R47	1.0	3.0	5.0	187	3.0	MR
H8-2-PD1-R47	3.5	5.0	7.0	152	5.1	HS
H8-1-PD1-R47	2.0	5.0	11.5	150	6.2	HS
H1/SN-PD1-R47	3.5	6.5	8.0	197	6.0	HS
H1-PD1-R47	2.0	3.5	6.0	250	3.8	S
H18-PD3-R51	1.5	3.5	4.0	112	3.0	MR
H8-PD3-R51	1.2	2.0	3.0	100	2.0	R
H5-PD3-R51	2.0	5.0	6.5	250	4.3	S
R2-14-B1-W1	1.5	5.0	7.0	187	4.5	S
R2-14-B1-W4	3.0	4.5	8.5	210	5.3	HS
R2-14-B1-W5	2.5	5.5	8.0	150	5.3	HS
R2-8-2B/W	2.5	3.5	7.0	251	4.3	S
H4-PD2-R50	3.5	5.5	10	185	6.3	HS
H3-PD2-R50	3.0	5.0	8.0	125	5.3	HS
H2-17-2B/W	3.5	3.6	6.5	250	4.5	S
H1-PD2-R50	2.0	4.3	6.5	112	4.3	S
H3-PD3-R51	1.5	2.0	3.0	212	2.0	R
H1-PD3-R51	2.5	4.5	11.0	140	6.0	HS
H18-PD2-R50	3.0	5.5	7.0	367	5.2	HS
H2-PD2-R50	2.5	3.5	3.5	245	3.1	MS
H5-PD2-R50	2.0	4.0	4.5	250	3.5	MS
H100-5	1.5	1.5	4.0	262	2.3	R
H7	1.0	2.0	4.0	220	2.3	R
H4-1	0.5	1.5	3.5	230	1.6	HR
S4-28-4	2.5	4.0	5.5	240	4.0	S
H100-1	3.0	5.0	6.5	200	4.8	HS
H7-R9-17/SN	2.5	4.5	8.5	112	5.1	HS
H5-B2-R8-33/SN	1.5	3.0	4.5	162	3.0	MR
R2-14-B1-W/6	2.0	4.5	5.0	112	3.8	S
H3-R8-10/SN	1.5	5.0	6.0	192	4.1	S
MEAN	**2.3**	**4.2**	**6.3**	**181**	**4.2**	
SEM	**1.43**	**2.86**	**4.14**	**9.5**	**2.07**	
CV (%)	**37**	**32**	**34**	**36**	**31**	

Where

Entries = Accession names

NS6WAS = Mean Value for Number of Striga at 6 weeks after sowing

NS9WAS = Mean Value for Number of Striga at 9 weeks after sowing

NStr_har = Mean Value for Number of Striga at harvest

Mean Striga Score = Mean Score of Striga at 6WAS, 9WAS and Harvested

CROP RXN = Crop reaction score to Striga resistance (HR= Highly Resistant, R = Resistant, MR = Moderately Resistant, MS = Moderately Susceptible, S = Susceptible, HS = Highly Susceptible)

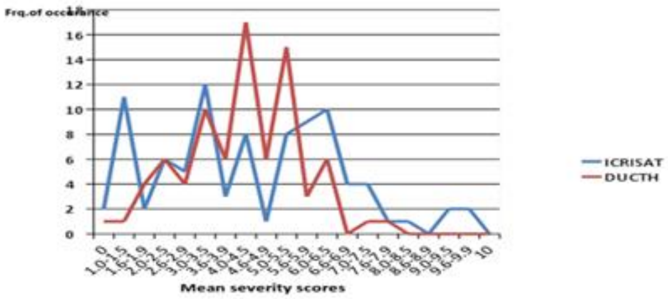

Fig2. *The frequency and severity of infestation of Striga on ICRISAT and Dutch accessions for 2014 and 2015 cropping seasons*

These included F5.3SSM10-20/2-1(695kg), F7.5SSM09-1-1/9-2(500kg), F5.3SSM10-9/1-3(488kg), F5.3SSM10-21/6-1(490kg), SPV422 (405kg), F5.3SSM10-21/4-1/TAN (405kg) and F5.3SSM10-1/6-1(375kg). The promising genotypes among the Dutch accessions with corresponding resistance to Striga included H4-7(370kg), H7 (300kg), H2-PD2-R50 (311kg) and H3-1-PD1-R47 (291kg).

Discussion

The two years evaluation of the sorghum accessions of both Dutch and ICRISAT origin showed that Dutch accessions were more prone to striga infection. It recorded the highest susceptibility value of 78.6% and resistance value of 21.4% among the population. On the other hand, the ICRISAT accessions showed lower susceptibility value of 66.8% and higher resistance value of 33.2% among the evaluated population. Some of the sorghum accessions of both ICRISAT and Dutch origin were found to be tolerant to striga infestation. These genotypes were able to produce high seed yield regardless of the striga infestation. These findings conformed with previous studies that reported various sorghum cultivars that are resistant to Striga infestation, including SRN 4841, ICSV 1007 BF and SAR 16 (Ramaiah 1986; Carson 1988; Anaso 1990; Obilana 1990; Dembeélé and Konateé, 1991; Olivier et al. 1991; Carsky et al. 1996). There is also evidence of resistant wild relatives of Sorghum versicolor (Lane et al. 1995) as well as Sorghum drummondii (Ejeta 2000). Quantitative inheritance of grain yield has been reported by Showemimo and Kimbeng (2005) in the study of genetics of sorghum cultivars under Striga infestation. These findings suggest that sorghum accessions could be selected on the basis of highly resistant traits to achieve effective control of Striga infestation.

The fewer Striga emergences reported in resistant ICRISAT accessions and Dutch accessions support findings by Showemimo and Kimbeng (2005) that the observed resistance in Sorghum could be under genetic control. . There was also slow to delayed emergence of the parasite in resistant cultivars of both ICRISAT and Dutch. These findings are consistent with what was reported by Gebremedhin et al. (2000) on two contrasting sorghum varieties. Ezeaku and Gupta (2004) stated that the time of attachment by the parasite was affected by genetic variations across the sorghum cultivars, and therefore the tolerant varieties showed later attachment as well as later parasite emergence compared to susceptible cultivars. This reduction and delayed Striga emergence is likely to be due to reduced germination and reduced initiation of haustoria and attachment (Reda, Dierick and Verkleij, 2010). It is well established that host resistance significantly predicts Striga reproduction (Rodenburg et al. 2006). This suggests that Striga resistant Sorghum cultivars could resist the parasite through reduction of its growth, development as well as through survival or tolerance to parasitic effects associated with numerous attachments to their roots.

Among the ICRISAT accessions, this study showed that the genotype F5.3SSM10-20/2-1 had the highest yield of 695g with mean Striga count of 2.7 compared to the genotypes F221 with a yield of 80g and striga means score of 1.5. On the other hand the genotype F7.5SSM09/4-1-1-3 was the least yielder with yield of 80g/plot with a corresponding striga count of 5.2 indicating high level of susceptibility. Among the Dutch accessions, the results showed that the genotype H18-PD2-R50 had the highest yield of 367g and mean Striga count of 3.1 compared to the lowest yielding genotype H8-PD3-R51 with a yield of 100g and mean Striga count of 2.0. The reduction in yield was attributed to striga infestation. According to Mohamed et al. (2003), Striga infestation on sorghum may lead to yield losses from 10 to 70% depending on cultivar including the sweet sorghum. There is much evidence that Striga plant vigour commonly measured based on biomass and height contributed to above ground mortality as well as the capacity to produce seeds (Olivier et al. 1991; Rodenburg et al. 2006). It was also observed that the intensity of infestation by Striga per host together with their emergence pattern differed based on individual sorghum cultivars. This is in agreement with previous studies on the genetic resistance of sorghum to S. hermonthica (Kenga 2006; Ezeaku and Gupta 2004; Hess and Ejeta 1992; Showemimo 2006) as well as *S. asiatica* (Haussmann et al. 2000) in host plant. It is evident that resistance is likely attributable to varied virulence across Striga strains (Hess and Ejeta 1992; Reda et al., 2010).

CONCLUSION

Sorghum accessions responded differently to Striga infestation. This was seen by varying resistance to Striga due to mechanisms like low germination stimulation and low initiation of haustoria against *S. hermonthica*. In overall, there were 11 promising sweet sorghum accessions among the evaluated materials identified to be resistant to striga with corresponding high yield. Since sweet sorghum is a versatile crop grown for food, feed and fuel due to its high sugar level, the resistant genotypes identified will serve as potential raw material for ethanol production. The sorghum farmers in Nigeria will now take advantage of this crop to extend its production to areas where Striga is a bane to sorghum production. In view of these potentials, the identified genotypes may be recommended to farmers in Striga prone areas.

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