Selection Criteria for Combining High Yield and *Striga* Resistance in Sorghum

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Keywords: Sorghum- *Striga*- Heritability- Correlations- Correlated response selection

Summary

Ten genetically diverse but homozygote sorghum cultivars that are adapted to northern Guinea savanna zone of Nigeria were grown in Striga *sick-field for two years. Agronomic traits of maturity,* Striga *resistance traits and actual grain yield were quantitatively heritable. Correlation coefficients computed among these traits revealed that grain yield was positively correlated with plant vigour, stem girth, root weight, shoot weight and plant height, while* Striga *count was negative and highly significantly correlated (r= -0.86) with grain yield. Correlated response indicated that selecting for bigger stem girth, high root, good plant vigour and shoot weight, and taller plants under* Striga *infestation will lead to a corresponding increase of 1.1%, 1.4%, 2.7%, 7.8% and 14.9% respectively on grain yield, while a 52.4% reduction in grain yield is observed by selecting* Striga *encouraging traits.*

Résumé

Critères de sélection du sorgho combinant le rendement et la résistance au *Striga*

Dix cultivars de sorgho, génétiquement divers et homozygotes, bien adaptés aux conditions de la zone nord de la savane guinéenne, ont été plantés dans un champ infesté de Striga *pendant deux ans afin d'évaluer leur aptitude au rendement en grains et leur résistance au* Striga*. Les critères de sélection étudiés ont été la maturité, la résistance au* Striga *et le rendement en grains. Les résultats obtenus ont montré que ces caractères étaient quantitativement héréditaires et qu'il y'avait une corrélation positive entre le rendement en grains et la vigueur de la plante, la circonférence de la tige, le poids des racines ainsi que la hauteur de la plante. Par contre une corrélation négative (r= -0,86) fut observée entre le rendement en grains et le nombre de plantes de* Striga*. En sélectionnant les plants soumis au parasitisme du* Striga*, et en n'utilisant respectivement comme seul critère de sélection que, (la plus grande circonférence de la tige, la plus longue racine, la meilleure vigueur de la plante et le plus grand poids des tiges, et les plus grandes plantes), des augmentations du rendement en grains de 1,1%; 1,4%; 2,7%; 7,8% et 14,9%, ont été obtenues, alors qu' en considérant les caractères favorables au* Striga*, une réduction de 52,4% du rendement en grains a été observée.*

Introduction

The success of sorghum as a commercial crop and its diffusion over new region will depend largely on the amount of improvements made. This in turn depends on the selection criteria for combining high grain yield and resistance to the menace of *Striga*.

It is well known that *Striga* (*S. hermonthica* Benth), commonly referred to as 'witchweed' is the most noxious weeds in sorghum fields all over the world especially Africa and Asia. An average of 30-95% loss in sorghum due *Striga* had been reported (2, 4, 7, 8). Grain yield is complex trait that is strongly influenced negatively by pest, diseases and weeds. An ideal sorghum genotype will combine high grain yield and weed resistance especially *Striga* which is noted to be most destructive than any other parasite.

The value of relationship between heritable traits is an aid to selection in plant breeding programmes, especially relationships between desirable traits. The objective of this study was to examine the interrelationships between agronomic traits of maturity and *Striga* resistance and grain yield in order to evaluate the possibility of using these traits as selection criteria for combining high grain yield and *Striga* resistance in sorghum. The information obtained will also enhance breeding for *Striga* resistance in sorghum.

Material and methods

The experimental plant material of this investigation comprised of 10 genetically diverse but homozygote cultivars that are adapted to the northern Guinea savannah zone of Nigeria. The study was carried out in a naturally *Striga*- infested field which has been maintained as a *Striga* 'sick-field' for over 10 years at the research field of Institute for Agricultural Research, Samaru Zaria.

The experiment was conducted for two seasons 1994 and 1995 in a randomized complete block design with

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Received on 13.03.03. and accepted for publication on 22.07.03.

three replications. Each plot consist of two rows each, 5 m long with 0.75 m x 0.25 m inter and intra row spacing respectively. Prior to planting, single superphosphate fertilizer was applied at 32 kg/ha, and split application of urea fertilizer was done at 32 kg/ha as basal and 32 kg/ha as top dressing at 3 and 6 weeks after planting respectively. Weeds other than *Striga* were removed regularly.

Data were recorded on plant vigour, (1-5 visual scale), stem girth (cm), root weight (g), shoot weight (g), plant height (cm), *Striga* count (Emerged) and grain yield (t/ha). For count data, squared root transformation was done. The statistical analysis was done on mean plot basis from the means of the cultivars across years and replications, broad sense heritability phenotypic and genotypic coefficient of variation, correlation and correlated response were calculated for all the seven traits measured (1, 9).

Results and discussion

The analysis of variance (data not shown) revealed that sorghum cultivars differed significantly for all the traits studied, thus these traits can be improved through genetic selection among the cultivars.

Range, means, standard errors of the means, broad sense heritability, phenotypic and genotypic coefficient of variation of the 10 cultivars, for seven traits are shown in table 1. Broad sense heritability was high for all the traits studied, plant height was the most heritable (H= 97%) and stem girth is the least heritable (H= 57%) traits, therefore, indicating that these traits are quantitatively inherited with high degree of repeatability of result. In all cases the phenotypic coefficient of variability was higher than the genotypic coefficient of variability with less than 4% difference between them similarly low SE of means for all the traits was obtained, thereby, indicating that these traits are less influenced by the environment. Hence, these traits are amenable to improvement through selection. The maximum phenotypic and genotypic coefficient of variability was obtained for root weight (PCV= 24.91% and GCV= 23.61% and the least was for plant height (PCV= 2.79% and GCV= 1.88). High heritability estimates and coefficient of variability for agronomic traits of sorghum had been reported by Obilana (5) and Obilana and El-Rouby (6).

Table 2 shows phenotypic correlation coefficients computed among agronomic traits of maturity (stem girth, root weight, shoot weight and plant height),

Table 1
Range, mean, heritability (H %) and coefficient of variability (CV %) for some agronomic and *Striga* resistance traits in sorghum

Traits	Range	Mean ± SE	H (%)	CV (%)	
				Phenotypic	Genotypic
Plant vigour	2.5-4.2	3.32 ± 0.41	70	23.98	20.87
Stem girth (cm)	2.2-2.9	2.70 ± 0.09	57	22.89	19.96
Root weight (g)	3.0-6.5	4.74 ± 0.79	74	24.91	23.61
Shoot weight (g)	14.8-32.4	23.34 ± 2.1	72	11.44	9.72
Plant height (cm)	93.0-115.7	104.1 ± 16.98	97	2.79	1.88
Striga count	12.0-25.0	17.5 ± 1.37	95	12.94	9.93
Grain yield (t/ha)	0.51-3.6	2.9 ± 0.15	71	24.70	22.74

Table 2
Phenotypic correlation and correlated response among some agronomic and *Striga* resistance traits in sorghum

Traits	Plant Vigour	Stem girth	Root weight	Shoot weight	Plant height	Striga count	Grain yield
Plant vigour	1.00						
Stem girth	-0.98**	1.00					
Root weight	0.64**	-0.61**	1.00				
Shoot weight	-0.17	0.25	-0.07	1.00			
Plant height	-0.32	0.27	-0.47*	0.56*	1.00		
Striga count	-0.12	-0.22	-0.20	-0.95**	-0.42*	1.00	
Grain yield	0.06	0.03	0.03	0.17	0.24	0.86**	1.00
Correlated Response (CR)	0.027	0.011	0.014	0.078	0.149	-0.524	–

*, ** Significant at 5% and 1% probability levels.

Striga resistance (plant vigour and *Striga* count) and actual grain yield. The traits correlated response to grain yield is also presented. All the traits studied were low and positively correlated with grain yield except *Striga* count (r= -0.86) which is negative, and highly significant, similar negative and highly significant correlation was recorded between plant vigour and stem girth (r= - 0.98), shoot weight and *Striga* count (r= - 0.95), stem girth and root weight (r= - 0.61). *Striga* count had negative correlation with all other traits such negative association arises primarily from developmentally induced relationships, since they compete for a common nutrient supply and if one structure is more favoured than the other a negative correlation arises. Another reason is due to the activities of *Striga* that limits proper functioning of these traits. This result conforms to those of Kim *et al.* (3) in maize; Stewart *et al.* (10) in sorghum. The positive correlations obtained in this result indicates that selection for high yield and *Striga* resistance must include vigourous plant since good plant vigour discourages early *Striga* infestation which in most cases lead to severe crop loss. Increased stem girth, high root and shoot weight, and taller plant are important selection criteria in reducing the menace of *Striga*. A change in trait due to selection will definitely cause an associated change in another trait, therefore, correlated response (CR) in this study measure the associated change expected when selecting for high grain yield and *Striga* resistance. In table 2 selecting cultivars based on stem girth, root weight, plant vigour, shoot weight and plant height under *Striga* infestation will give an increase of 1.1%, 1.4%, 2.7%, 7.8% and 14.9% in grain yield. While *Striga* count or *Striga* activities leads to 52.4% reduction of grain yield.

In conclusion, all the traits studied under *Striga* infestation are quantitatively heritable with minimal environmental influence. These traits are easily improved through selection for total grain yield combining *Striga* resistance.

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