

GENETIC PARAMETERS FOR HYDROCYANIC ACID CONTENT IN FORAGE SORGHUM (*Sorghum bicolor* L. Moench)

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ABSTRACT

Six lines (IS 1003, IS 3504, IS 3541, IS 6354, CO 27 and CO 28) and four testers (IS 0030, AKSS 5, GSSV 1 and TNS 52) were crossed in line x tester design to produce 24 hybrid combinations. These hybrids along with their ten parents were grown in a randomized block design with three replications. The samples for estimation of hydrocyanic acid content were taken 32 days after sowing. The analysis of variance indicated significant differences for HCN content in all the genotypes. It also clearly shown that, the specific combining ability (SCA) variance for HCN content was higher than general combining ability (GCA) variance indicating the trait is controlled by non additive gene action. The parents IS 3541, CO 27 and IS 0030 were found to be the best ones based on GCA effects and the hybrids IS 1003 x TNS 52, IS 6354 x IS 0030 and IS 3541 x TNS 52 were found to have maximum negative SCA effects for HCN content. Heterosis breeding, recurrent selection and other population improvement procedures were suggested for getting varieties with reduced HCN contents.

Key words: Combining ability, Hydrocyanic acid, *Sorghum bicolor*

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) plays an important role as a major grain cum fodder crop. It is extensively grown as a major source of fodder as it is preferred over Maize (*Zea mays* L.) because of its high tolerance to various stresses (Reddy *et al.* 2004). It has quick profuse tillering, more leafiness, high palatability and high dry matter content. Its leaves contain the cyanogenic glucoside dhurrin. Dhurrin and its catabolic enzymes are compartmentalized in young tissue of green seedlings. Glucosides are stored in vacuoles of epidermal cells (Saunders and Conn, 1978). Degradation of dhurrin yields equimolar amounts of hydrocyanic acid (HCN), glucose and p-hydroxy benzaldehyde (Halkier and Moller, 1991). Large amounts of dhurrin may be produced rapidly when plants are environmentally stressed (Drought,

frost) and when leaf tissues are disrupted. HCN is readily absorbed into the blood stream of grazing ruminants causing cellular asphyxiation and eventually death (Hoveland and Monson, 1980). Hence, it is essential to develop varieties/hybrids with high fodder yields and low hydrocyanic acid (HCN) content in sorghum. Before initiating any crop improvement programme, it is necessary to understand the genetic nature of the parents. Combining ability analysis helps in identifying the parents, which could be used for hybridization programme to produce superior hybrids. General Combining Ability (GCA) is the result of additive gene effects, while Specific Combining Ability (SCA) is considered to be composed of non allelic interactions (Jinks, 1954). This information on the gene action will be useful to design efficient breeding programmes. Among the various biometrical

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techniques used for genetic analysis of quantitative traits, Line x Tester analysis is widely used, which provides information on the genetic potential of parents and hybrids and nature of gene action. Hence, we studied the genetic architecture of HCN content in forage sorghum using Line x Tester analysis as suggested by Kempthorne (1957).

MATERIALS AND METHODS

The experimental material consisted of six lines *viz.*, IS 1003, IS 3504, IS 3541, IS 6354, CO 27 and CO 28 and four testers *viz.*, IS 0030, AKSS 5, GSSV 1 and TNS 52. These parents were crosses in a Line x Tester design during Rabi 2002. All the ten parents and their 24 hybrids were evaluated during Kharif 2003 under irrigated conditions in a randomized block design with three replications at the Department of Forage crops, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The samples for analysis of HCN content were taken 32 days after sowing. The HCN content was estimated following the method suggested by Hogg and Ahlgren (1942) and expressed in parts per million (ppm).

Estimation of Hydrocyanic Acid Content

One gram of the leaf sample was homogenized in 25 ml distilled water with 3-4 drops of chloroform. The homogenate was placed in 500 ml conical flask. The filter paper strip saturated with alkaline picrate solution was placed in the hanging position with the help of a cork stopper inside the conical flask. The mixture was incubated at room temperature (20 °C) for 20 – 24 hrs. The sodium picrate present in the filter paper was reduced

to reddish compound in proportion to the amount of hydrocyanic acid evolved. The colour was eluted using 10 ml distilled water and it was compared with standard at 625 nm. Standard hydrogen cyanide solutions were prepared using KCN as standard.

Data Analysis

The Line x Tester analysis was done as per the method suggested by Kempthorne (1957). The data were analyzed statistically using the software WINDOSTAT, developed by INDOSTAT services Ltd. Hyderabad, India.

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) showed that the variance due to genotypes was highly significant for HCN content indicating significant differences among the parents and hybrids. The variance due to line x tester interaction was also highly significant indicating the presence of inter-allelic interaction (Rao *et al.*, 1981, Manickam and Vijendra Das, 1994). From the analysis of variance, it was clearly shown that the HCN content was predominantly controlled by non additive gene action because of higher Specific Combining Ability (SCA) variance over General Combining Ability (GCA) variance. Similar findings were also reported by Khatri *et al.*, 1997. On the other hand, Iyanar (2001) reported additive gene action in the expression of this trait.

The GCA effects of parents and SCA effects of hybrids were presented in the table 2. The parents with negative GCA effects and hybrids with negative SCA effects were preferred since low HCN content is desirable in forage sorghum. Among the lines, IS 3541, CO 27 and CO 28 and among the

testers IS 0030 and AKSS 5 were adjudged as best parents since they recorded negative GCA effects and

these can be utilized to develop varieties with low HCN content.

Table 01: Analysis of Variance for Combining Ability for HCN Content in Sorghum

Source of variation	df	MSS
Genotypes	33	310.62**
Crosses	23	980.66**
Parents	9	250.87**
Lines	5	1030.30
Testers	3	149.70
Line x Tester	15	1130.20**
Error	96	4.89
GCA variance		3.77
SCA variance		375.15
GCA/SCA		0.01

Table 02: General Combining Ability Effects of Parents and Specific Combining Ability Effects of Hybrids for HCN Content in Sorghum

Parents/ Hybrids	IS 1003	IS 3504	IS 3541	IS 6354	CO 27	CO 28	GCA testers
	SCA effects						
IS 0030	-1.83ns	-13.62**	26.76**	-25.89**	21.43**	-6.79**	-3.09**
AKSS 5	16.28**	-1.52ns	3.67**	-7.57**	0.60ns	-11.46**	-1.53**
GSSV 1	13.55**	-4.24**	-10.39**	14.43**	-11.13**	-2.22ns	1.20*
TNS 52	-28.00**	19.38**	-19.97**	19.02**	-10.90**	20.47**	3.41**
GCA lines	11.04**	2.16**	-6.82**	8.55**	-13.46**	-1.46*	
SE of lines :0.638					SE of testers: 0.521	SE of	
hybrids : 1.277							
**-. Significant at 1 % level					*- Significant at 5 % level		

The evaluation of hybrids became necessary to consider whether a hybrid might be used as a commercial hybrid or further utilized in breeding programme. The SCA effects were one of the important criteria that could be used to evaluate the hybrids. Among the hybrids, IS 1003 x TNS 52, IS 6354 x IS 0030 and IS 3541 x TNS 52 were found to have negative SCA effects. Since non-additive gene action played major role in controlling HCN content, exploiting heterosis by crossing two parents with desirable GCA may help to develop varieties

with low HCN content. Being an often cross-pollinated crop, sorghum can also improved through recurrent selection and other population improvement procedures. Segregants with high green fodder yields and low HCN may be selected and converted to inbreds for further use in breeding programmes.

CONCLUSIONS

The results of this experiment indicated that preponderance of SCA variance over GCA variance indicating

the role of non additive gene action in the expression of HCN content in Sorghum. The study also revealed the promising parents (CO 27, IS 3541) which could be used in heterosis breeding programmes or their crosses could be exploited in subsequent generations to isolate desirable

segregants for developing varieties with low HCN content.

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