

## Correlations and Heritability of Morphological Characters in Grain Sorghums\*

by

D. V. NARASIMHA RAO<sup>1</sup> and K. O. RACHIE<sup>2</sup>

**Synopsis:** In this paper, the genotypic, phenotypic and environmental correlations between grain yield and nine other characters estimated to establish their potential value as indices for selection of superior genotypes in *Sorghum* have been discussed.

**Introduction:** Correlation studies in plant improvement have several important applications. The correlation co-efficient, a measure of the relationship of two varieties established for specific characters aids in determining the most effective breeding method to obtain superior genotypes based on that character. Straight selection based on phenotype may not achieve the desired advancement since phenotype results from the interaction of genotype and environment. It is therefore necessary to estimate the genotypic, phenotypic and environmental correlation co-efficients to aid in estimating the effect of environment and selecting the breeding method likely to be most effective in improving genotypes for specific character. Estimates of the three types of correlations for nine plant and earhead characters in sorghum with grain yield and the heritability of these characters were made in a study of twelve sorghum varieties.

**Review of Literature:** Several investigators have studied the relationship of certain plant characters with grain yield in sorghum in the past to aid in selecting superior genotypes in the field. Kottur and Chavan (1928) reported close relationship between plant height and grain yield. Short peduncle, thickness of earhead and weight of ear were found associated with grain yield. Patel and Patel (1928) found close positive relationships between leaf area, plant height, thickness of stem, length of rachis, density of panicle branches and grain yields; while early flowering was found negatively correlated. Ayyangar *et al* (1935) determined that diameter of peduncle, weight of ear, length and thickness of ear and straw weight were positively correlated with grain yield. Robinson *et al* (1951) obtained a high positive genotypic correlation between number of ears per plant and grain yield in maize. Plant height and ear length were also associated with yield. Swarup and Chaugale (1962) determined phenotypic, genotypic and environmental correlations for several pairs of characters in sorghum. Plant height was found positively correlated with grain yield while fodder yields were positively correlated with number of days for panicle emergence, plant height, stalk diameter and leaf number.

Burton (1951) obtained heritability values of 56% for grain yield in pearl millet. Sikka and Jain (1958) estimated heritability in the broad sense for five characters in wheat. They reported very low values for heritability of grain

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1. Assistant Millet Specialist, Chandragiri, (A. P.) 2. Indian Agricultural Research Institute, New Delhi.

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yield and number of ears per plant; while 1000 grain weight, date of earing and grain number per ear were found to be highly heritable. Swarup and Chaugale (1962 a) estimated heritability values for 15 characters in sorghum and obtained very high values of heritability for almost all characters.

**Material and Methods:** Twelve varieties of sorghum, briefly described in Table 1 were grown in single row plots replicated four times. Six varieties are of dwarf American types and six are tall Indian strains. Five random plants were selected in each varietal plots to record observations on the following characters: plant height, number of leaves, length of peduncle, length of earhead, diameter of earhead, weight of earhead (dry), weight of 100 grains, weight of dry straw, number of secondary panicle branches and yield of grain per plant. The procedure adopted by Ayyangar *et al* (1935) was adopted in recording observations on all plant characters.

TABLE 1.

*A brief description of twelve sorghum varieties used for studying correlations and heritability of some important morphological characters.*

S. No.	Pedigree	I. S. No.	Height Group	Midrib Colour	Grain Colour	Earhead Type
1.	D. D. W. Feterita	72	Combine	White	White-chalky	Semi-compact
2.	Early Hegari	106	"	Dull	" "	" "
3.	C. Kafir 60	169	"	"	" "	" "
4.	D.D.Y.S. Milo	338	"	White	Reddish-yellow	" "
5.	Redbine 58	408	"	Dull	Red	" "
6.	C. Shallu	475	"	"	White-pearly	Spreading
7.	Verawal Dholio	1038	Tall	"	" chalky	Semi-open
8.	Maldandi 35-1	1054	"	"	" pearly	Semi-compact
9.	Chhasatio 10-2	1056	"	"	" "	Compact
10.	Sheosagar *	1114	"	White	" chalky	Semi-open
11.	G. 4	1148	"	"	Yellow	Semi-compact
12.	Palapu Jonna	1469	"	"	Red	Very-compact

\* Twin-seeded variety

Phenotypic, genotypic and environmental correlations were determined by utilising the variances of different characters and their co-variances with yield. The error, phenotypic, genotypic variances and co-variances were used in calculating the three types of correlation. The general formula used is

$$V_{XY} = \frac{\text{Co-variance } XY}{\sqrt{\text{variance of } x \cdot \text{variance of } y}}$$

The correlation coefficients are estimated as below.

**Environmental correlations:** The mean sum of squares for error in variance and co-variance analysis was used.

*Phenotypic correlation:* The mean sum of squares for varieties in variance and co-variance analysis were taken.

*Genotypic correlation:* Genotypic variance was obtained by deducting the mean sum of squares for error from the mean sum of squares for varieties and dividing the difference by number of replications.

Heritability was estimated in the broad sense in ten characters. The following formula was used:

$$\text{Heritability} = \frac{O^2g}{O^2p} \times 100 \text{ where } \begin{array}{l} O^2g \text{ is genetic variance} \\ O^2p \text{ is phenotypic variance} \end{array}$$

$$O^2g = \frac{O^2p - O^2e}{R}; \quad O^2p = O^2g + O^2e \quad \begin{array}{l} O^2e \text{ environmental variance} \\ R = \text{No. of replications} \end{array}$$

**Experimental Results:** The association between grain yield and nine other components of yield was assessed by estimating the genotypic, phenotypic and environmental correlation co-efficients in twelve varieties of Sorghum. The results are presented in Table 2.

TABLE 2.

*Correlations between grain yield and nine morphological characters in twelve sorghum varieties.*

Character	Correlation co-efficient		
	Genotypic	Phenotypic	Environmental
Plant height	- 0.19	- 0.17	+ 0.18
Number of leaves	+ 0.11	+ 0.11	+ 0.14
Length of peduncle	+ 0.29	+ 0.26	+ 0.12
Length of earhead	+ 0.44 *	+ 0.41 *	+ 0.61 *
Diameter of earhead	+ 0.04	+ 0.11	+ 0.07
Weight of earhead	+ 0.98 **	+ 0.97 **	+ 0.96 *
Weight of 100 grains	+ 0.27	+ 0.23	- 0.07
Number of secondary branches	+ 0.04	+ 0.12	+ 0.52
Dry straw yield	+ 0.01	+ 0.02	+ 0.08

\* Exceeds 5% level of significance

\*\* Exceeds 1% level of significance

Grain yields were found positively and closely correlated with weight of earhead being significant at 1% level while length of earhead was significant at 5% level for genotypic, phenotypic and environmental correlations. Weight of ear, length of peduncle, length of earhead and weight of 100 grains were positively correlated with grain yield for genotypic correlations. Plant height was negatively correlated with grain yield. Weight of ear, length of ear, length of peduncle and

weight of 100 grains were positively correlated (phenotypically) with grain yield. The other characters, however, failed to exhibit appreciable phenotypic association with yield. All characters studied with the exception of weight of 100 grains were associated positively with grain yield for environmental correlations. Relationships between weight of ear, length of ear and number of secondary branches and grain yield were particularly close. Plant height, leaf number and length of peduncle were likewise positively associated with grain yield but at a lower level.

*Heritability:* The measure of transmission of characters from generation to generation is termed heritability. In the present investigations heritability in the broad sense for ten characters was estimated from a varietal trial and the results are presented in Table 3.

TABLE 3

*Heritability Estimates of Characters Contributing to Yield in Sorghum.*

Character	Heritability in percent		
Plant height	...	...	96.6
Number of leaves	...	...	86.9
Length of peduncle	...	...	77.6
Length of earhead	...	...	95.5
Diameter of earhead	...	...	61.8
Weight of earhead	...	...	43.3
Weight of 100 grains	...	...	90.5
Number of secondary branches	...	...	64.4
Weight of dry straw	...	...	76.7
Grain yield per plant	...	...	43.4

On the basis of the above results it is concluded that among the characters studied plant height, number of leaves, length of earhead and weight of 100 grains are highly heritable characters while weight of earhead and grain yield are comparatively less heritable. The higher level of heritability of characters indicates that selection can be exercised directly on phenotypic basis. It appears that length of earhead has a good correlation with grain yield in addition to being highly heritable. Selection for this character might be helpful in increasing the yielding potential of genotypes.

*Discussion:* The estimation of genetic correlations from varietal trials, although having limitations, is of interest where the characters involved have a high level of heritability. The genotypic, phenotypic and environmental correlations of yield with nine other characters were estimated to establish their potential value as indices for selection in the field. The data indicated that none of the characters except length of earhead and weight of earhead were correlated with yield at a level high enough to permit their use as indirect measures of yield. The genotypic correlation for length of earhead with yield was + 0.44 and the heritability of this character was high enough to use in eliminating poor genotypes.

Weight of earhead was highly correlated with yield but its heritability was not high. Therefore, as an index of yield this character may have limited application. The high environmental correlations for length and weight of earhead suggests caution in emphasising their utility for selection purposes. The results of these investigations in respect of plant height and fodder yield are in agreement with the environmental correlations reported by Swarup and Chaugale (1962 b). The positive environmental correlations for number of leaves, length of peduncle, number of secondary branches are in line with those reported by Kottur and Chavan (1928), Patel and Patel (1928) and Ayyangar *et al* (1935). Correlations for plant height and grain yield in genotypic and phenotypic categories are negative and this is understandable since the American sorghums included in the trial are dwarf in height and high grain yielders.

The heritabilities of yield components such as weight of earhead, number of secondary branches, length of peduncle and thickness of earhead is low compared to the high heritabilities obtained for vegetative characters like plant height, and number of leaves. The lower estimates of heritability for grain yield are in agreement with those reported by Burton (1951) in pearl millet and Sikka and Jain (1958) in wheat.

**Summary:** The genotypic, phenotypic and environmental correlations between grain yield and nine other characters were estimated to establish their potential value as indices for selection of superior genotypes in sorghums. Only earhead length and weight were positively correlated with grain yield. The absence of significant correlations between yield and vegetative characters like plant height, number of leaves, length of peduncle, diameter of earhead and grain size suggests the possibility for independent improvement of these characters. Heritability studies of ten characters in sorghum revealed that with the exception of grain yield and earhead weight all other characters were highly heritable. Vegetative characters such as plant height and leaf number have relatively higher heritability values than the earhead components.

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## REFERENCES

- Ayyangar, G. N. R.,  
M. P. Sankara Ayyar,  
P. V. Hariharan, and  
D. S. Rajabhooshanam
- Burton, G. W.
- Kettur G. L. and V. M. Chavan
- Patel, M. L. and G. B. Patel
- Robinson, N. F.,  
R. E. Cerstock, and  
P. H. Harvey
- Sikka, S. M. and K. B. L. Jain
- Swarup, S. and D. S. Chavale
- and —
- 1935 The relations of some plant characters to yield in sorghum. *Indian J. Agric. Sci.*, 5: 75-100.
- 1951 Quantitative inheritance in Pearl Millet. *Pennisetum glaucum*. *Agric. J.* 43: 409-17.
- 1928 Selection in the Jowars of Bombay Karnatak. *Bombay Dent. Agric. Bull.* 151: 1-24.
- 1928 Studies in Jowars of Gujarat. *Mem. Dept. Agric. India (Bot. - Ser)* 16: 1-57.
- 1951 Genotypic and phenotypic correlations in Corn and their implications in selection. *Agron. J.* 43: 382-87.
- 1958 Correlation studies and the application of discriminant function in aestivum wheats for varietal selection under rainfed condition. *Indian J. Genet.*, 18: 178-86.
- 1962 (a) Studies on genetic variability in Sorghum I. Phenotypic variation and its Heritable components in some important quantitative characters contributing towards yield. *Indian J. Genet.* 22: 31-36.
- 1962 (b) Studies on Genetic variability in Sorghum II. Correlation of some important quantitative characters contributing towards yield and application of some selection indices varietal selection. *Indian J. Genet.* 22: 37-44.

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