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# Genetic Variability and Character Association for Harvest Index in Sorghum under Rainfed Conditions

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## ABSTRACT

An experiment was conducted to determine the relationship of harvest index with economic yield and biological yield of seven sorghum genotypes. A significant positive correlation was observed between economic yield and biological yield. The cultivar YSS-9 gave the highest economic yield (2633 kg $ha^{-1}$) and biological yield (18370 kg $ha^{-1}$). A harmonious balance between economic yield and biological yield was observed in genotypes; YSS-89 recommended as dual-purpose candidate variety. Moreover, components of variation and heritability were on the higher side for all the characters studied.

**Key Words:** *Sorghum bicolor*; Harvest index; Variation; Association; Rainfed

## INTRODUCTION

Sorghum is one of the main staples for the worlds poorest and most food insecure people. The crop is genetically suited to hot and dry agro-ecologies, where it is difficult to grow other food grains and these are also areas subject to frequent drought. In Barani areas sorghum is truly a dual-purpose crop; both grain and stover are highly valued outputs. Therefore, it can play a vital role for the uplift of socio-economic status of the farmers of Barani areas through development of high yielding (grain) varieties along with reasonable amount of dry fodder during winter season for the livestock. Harvest index is the ratio of seed yield to total above ground plant yield and is recognized by many plant breeders as an important criterion on the search for high yielding genotypes (Donald, 1962). Appreciably high harvest index shows the efficiency of converting biological yield into economic yield (Kusalkar *et al*., 2003). Although harvest index is a very variable character, which is highly influenced by the environment yet it may be a useful selection criterion due to its significant correlation with seed yield (Shrotria & Singh, 1988).

It has been found that harvest index had a negative correlation with plant height and there is a positive correlation with grain yield, both phenotypically and genotypically (Can & Yoshida, 1999). Contrary to harvest index forage yield is positively correlated with plant height, late maturity, tiller retention and stover yield, but negatively correlated with crude protein content and harvest index (Mohammad *et al*., 1993). Performance of sorghum even under rainfed conditions is significantly associated with green leaf area retention, plant height and maturity (Habyarimana *et al*., 2004). Like harvest index, green fodder and dry matter yield are also variable characters both of them vary according to cultivars (Gampawar *et al*., 2002). Also there is a significant negative correlation between grain yield and physiological traits related to development and vegetative growth in *S. bicolor* genotypes (Soltani *et al*., 2001). However, there are significant positive correlations for growth rate, grain filling rate and harvest index. According to Briggs and Knowles (1967), the heritability of quantitative characters is usually high, because breeding behavior can be predicted. Furthermore, high heritability coupled with genetic advance indicates that additive gene effects are operating and selection for superior genotype is possible (Arunkumar *et al*., 2004). In addition to correlation and heritability the knowledge of genetic variability existing among different parameters contributing to yield is also an important criterion for yield enhancement.

It has been observed that the estimates of genetic variance were smaller than their respective phenotypic variances (Khan *et al*., 2005). Present studies were therefore conducted to estimate the genetic variability, heritability and association among harvest index, biological and economic yield in sorghum and to assess the performance of different genotypes under rain-fed conditions.

## MATERIALS AND METHODS

The experimental material comprised of seven sorghum genotypes, planted in a randomized complete block design with three replications at Millets Research Station, Rawalpindi, during Kharif 2005. YSS-98 was used as check variety. The plot size was 5 x 2.4 m. Crop was sown at row spacing of 60 cm, while plant spacing of 18 cm was maintained within a row. No irrigation was given to the crop. All the cultural practices were uniformly applied to all the experimental units. Observations in respect of economic and biological yield on a unit area (12.0 $m^2$) basis were determined. Harvest index was calculated as seed weight divided by un-thrashed plant weight x 100 (Wilcox, 1974). The data thus recorded was subjected to analysis of variance (Steel & Torrie, 1980). The genetic components of variation were estimated as outlined by Johnson *et al.* (1956). The estimates of heritability ($h^2_{bs}$) and genetic advance (GA) at 5% selection intensity (2.06) were obtained using procedure given by Allard (1960). Phenotypic correlation coefficients were worked out following Snedecor (1956).

## RESULTS AND DISCUSSION

The analysis of variance for economic yield, biological yield and harvest index indicated highly significant differences among the genotypes for these traits (Table I). Genotypic, phenotypic and environmental variances were maximum for biological yield. Phenotypic variance was higher than genotypic and environmental variances for all the traits. These results are in conformity with the findings of Khan *et al.* (2005). Genotypic and phenotypic coefficients of variance were highest for economic yield, while environmental coefficient of variance was greater for biological yield. The estimates of broad sense heritability were high for all the characters, indicating lesser influence of environment on their expression. Such characters can be improved by applying selection pressure. Harvest index (99.41%) showed maximum heritability followed by economic yield (95.18%) (Table II). These results corroborate the findings of Briggs and Knowles (1967) and Habyarimana *et al.* (2004). Higher value of heritability indicated that these traits are under the control of additive genes, as reported by Arunkumar *et al.* (2004).

The cultivar YSS-9 gave the highest economic and biological yield (2633 kg ha$^{-1}$ & 18370 kg ha$^{-1}$) respectively, but low harvest index (14.36%), whereas the genotype YSS-89 ranked second in economic and biological yield (2452 kg ha$^{-1}$& 13560 kg ha$^{-1}$) respectively with maximum harvest index (18.16%) (Table III). This genotype displayed plenty of potential according to Kusalkar *et al.* (2003). The genotype YSS-89 can be recommended as dual purpose candidate variety. Minimum economic and biological yield (1393 kg ha$^{-1}$ & 11460 kg ha$^{-1}$), respectively was produced by the genotype YSS-3.

Correlation analysis provides the information of interrelationship of important plant characters and hence, leads to a directional model for direct and/or indirect improvement in grain yield (Khan *et al*., 2004). Although direct selection for various parameters could be misleading, indirect selection via related parameters with high heritability might be more effective than direct selection (Toker *et al.,* 2004). All possible correlations were worked out to determine the relationship of harvest index with economic yield and biological yield (Table IV). Positive correlations were observed between economic yield, biological yield and harvest index, while no correlation was observed among biological yield and harvest index. These findings are inline with those of Shrotria and Singh (1988), Mohammad *et al.* (1993), Can and Yoshida (1999), Gampawar *et al*. (2002) and Kusalkar *et al*. (2003).

It is concluded from the above that the genotypes showed greater magnitude of variability for all the traits indicating ample scope for selection of these traits. Heritability was also on the higher side for all the traits indicating that these traits are controlled by additive genes and it can be assumed that they will remain stable under varied environmental conditions. Regarding the performance of genotypes a harmonious balance between economic yield and biological yield was observed in genotypes YSS-89 along with the highest value of harvest index exhibiting the efficiency of the genotype in converting biological yield into economic yield. A positive correlation was observed among economic yield and biological yield suggesting direct and/or indirect ways to deal with them. As

**Table I. Analysis of variance for economic and biological yield and harvest index in sorghum**

| Source of variation | d.f | Economic yield MS | Economic yield F-value | Biological yield MS | Biological yield F-value | Harvest Index MS | Harvest Index F-value |
|---|---|---|---|---|---|---|---|
| Genotypes | 6 | 704336.87 | 60.23** | 15247895.32 | 17.001** | 20.39 | 477.68** |
| Replications | 2 | 1312.71 | 0.11 | 67212.05 | 0.07 | 0.05 | 1.31 |
| Error | 12 | 11694.16 | | 986879.77 | | 0.04 | |

**Significant at 1% level

**Table II. Genotypic, ($\sigma g^2$) phenotypic ($\sigma p2$) and environmental variability ($\sigma e^2$), Genotypic, (GCV) phenotypic (PCV) and environmental coefficient of variation (ECV), heritability ($h^2$) and in sorghum**

| | Economic yield | Biological yield | Harvest Index |
|---|---|---|---|
| $\sigma g^2$ | 230880.90 | 4753671.85 | 6.78 |
| $\sigma p^2$ | 242575.06 | 5740551.62 | 6.82 |
| $\sigma e^2$ | 11694.16 | 986879.77 | 0.04 |
| GCV | 24.59 | 16.05 | 18.14 |
| PCV | 25.21 | 17.64 | 18.19 |
| ECV | 5.53 | 7.31 | 1.39 |
| $h^2$ (bs) % | 95.18 | 82.81 | 99.41 |

**Table III. Economic yield, biological yield and harvest index Sorghum**

| Genotypes | Economic Yield (kg ha$^{-1}$) | Biological Yield (kg ha$^{-1}$) | Harvest Index (%) |
|---|---|---|---|
| YSS-3 | 1393 | 11460 | 12.15 |
| YSS-9 | 2633 | 18370 | 14.36 |
| YSS-16 | 1711 | 12890 | 13.27 |
| YSS-17 | 1967 | 12000 | 16.40 |
| YSS-18 | 1407 | 13330 | 10.55 |
| YSS-89 | 2452 | 13560 | 18.16 |
| YSS-98 (Check) | 2115 | 13540 | 15.63 |
| Cd-1 | 192.4 | 1767 | 0.3689 |
| CV | 5.53 | 6.97 | 1.44 |

**Table IV. Correlation Coefficient between Economic yield, Biological yield and Harvest index in Sorghum**

| | Biological Yield | Harvest Index |
|---|---|---|
| Economic Yield | 0.72* | 0.73* |
| Biological Yield | | 0.060 $^{N.S}$ |

*Significant at 5 % level $^{N.S}$ Non-significant all the parameters were highly heritable and strongly correlated, it is suggested that indirect selection via related parameters might be more effective than direct selection.

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