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# PHENOTYPIC STABILITY FOR GRAIN YIELD IN CERTAIN BREEDING LINES AND VARIETIES OF GRAIN-CUM-FODDER SORGHUM

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## ABSTRACT

Genotype X environment interaction was investigated for grain yield in 18 genotypes and varieties of fodder-cum-grain sorghum in six environments during 1985-'87 rabi and summer seasons. There was a significant variation for genotype and genotype X environment interaction for grain yield. Both linear and non-linear components were significant and between the two, the linear component was higher in magnitude. Rabi season characterised by the highest mean maximum temperature of 32°C was congenial for sorghum production. Summer season with a mean maximum temperature above 32°C (with a mean of about 38°C) resulted in reduced grain yield and was found unsuitable for sorghum cultivation. KS 7631, KS 7634 and KS 7637 were found to be most stable with wide adaptability. Tenkasi local and KS 6317 were found to be useful and potential parents for transferring the stability attributes. K 4 was found to be the best performer under unfavourable conditions.

KEY WORDS : Sorghum, Genotype Environment interaction, stability.

Sorghum (*Sorghum bicolor* L. Moench) is next in importance to rice as a valuable food-cum-fodder crop in Tamil Nadu. It is grown under widely different edaphic and environmental conditions and it is known to exhibit a high degree of genotype environment interactions. There is, therefore, a need to develop varieties with stability in performance over a wide range of environmental conditions. The present study was taken up to evaluate promising breeding lines and varieties of grain-cum-fodder sorghum in multi-environmental tests in order to identify high yielding and stable genotypes.

## MATERIALS AND METHODS

A total of 18 genotypes that included 11 breeding lines and seven popular and improved varieties of grain-cum-fodder

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sorghum formed the materials for the present study. The experiment was conducted in the Agricultural Research Station, Kovilpatti during the years 1985-'87 in black soil. The crop was raised in both rabi and summer seasons, each crop in the respective season being considered as one environment and there were six environments *viz.,* (1) $E_1$ - 1985 rabi, (2) $E_2$ - 1986 rabi, (3) $E_3$ - 1985 late rabi (Nov - Feb), (4) $E_4$ - 1985 summer, (5) $E_5$ - 1986 summer and (6) $E_6$ - 1987 summer. For rabi crop, pre-monsoon sowing was done during last week of September and irrigation was given to facilitate germination in the event of delayed pre-monsoon showers and after germination the crop was treated as a rainfed crop benefitted by the North-east monsoon. Summer crop was raised during April every year under irrigated conditions. A completely randomized block design with three replications was adopted. The plot size was 5.0 x 2.7 m. with a spacing of 45 x 15 cm. Stability parameters were worked out using the mean plot yield obtained over seasons and the statistical model as suggested by Eberhart and Russel (1966).

## RESULTS AND DISCUSSION

The individual environmental mean along with range and environmental index for grain yield are given in Table 1. The environments were diverse as shown by the range of ej values (Table 1). Analysis of variance showed that the mean squares due to genotypes, environment (linear) and genotype x environment were highly significant when tested against pooled error (Table 2). The linear component of genotype X environment interaction was significant indicating that the genotypes differed in their regression on the environmental index. The non-linear component was also significant and this showed that the genotypes differed in their stability for grain yield.

It further revealed that the genotypes reacted considerably with the environmental conditions that existed in different years of testing. A major portion of these interactions was accounted for by the presence of linear component although non-linear component was also significant. Palanisamy *et al.* (1978) observed that a large portion of the genotype X environment interaction in sorghum was accounted by the linear component and the non-linear component was comparatively small.

Mean grain yield and the two stability parameters viz., regression co-efficient (bi) and deviation from regression ($S^2$di) for 18 genotypes are given in Table 1. The mean yield of the genotypes was for higher in rabi than in summer season, as also reflected by positive and higher magnitude of environmental index (ej). This would indicate that rabi season in which the weather conditions are optimum (particularly the temperature) is ideally suited for growing sorghum under Kovilpatti conditions. It has been observed by Downes (1972) that temperature above 32° / 38° C caused floret abortion and that even moderately high temperature at anthesis resulted in embryo abortion. The maximum temperature that prevailed during the 7 week period covering 2 weeks before and 5 weeks after 50% flowering was within the tolerable limit of 32° c in rabi seasons, particularly in $E_1$ and $E_2$ (32.7°c in $E_1$ and 31.3° c in $E_2$) and this would have been helpful in normal flowering and grain set with no unfavourable effect on yield. In $E_3$ rabi, which experienced a mean maximum temperature of 32.8° c, during the flowering and ripening phases, the mean yield was very low possibly due to influence of high temperature causing spikelet sterility. Regarding summer seasons, the maximum temperature that prevailed during the flowering phase and thereafter was observed to be well above 37° c (37.3° c in $E_4$, 37.1° c in $E_5$ and ble 1. Mean, grain yield, environmental index (ej) and temperature during flowering and ripening phases in different environments.

| Genotype | Parentage | Mean plot yield (Kg) | | | | | | Stability parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | E1 | E2 | E3 | E4 | E5 | E6 | Over all mean (Kg) | bi | $s^2di$ |
| 6312 | IS 12611C X SC 108 | 4.13 | 2.70 | 1.27 | 0.11 | 0.23 | 0.28 | 1.45 | 1.251 | 0.259 |
| 6317 | M 90360 | 1.83 | 2.03 | 1.27 | 0.06 | 0.34 | 0.26 | 0.97 | 0.670 | 0.029 |
| 7078 | (148 X E35-1)X CS 3541 | 4.00 | 2.90 | 1.30 | 0.06 | 0.39 | 0.39 | 1.56 | 1.176 | 0.168 |
| 7631 | SPV 100 X K4 | 3.37 | 2.90 | 1.50 | 0.15 | 0.41 | 0.29 | 1.44 | 1.113 | 0.022 |
| 7632 | SPV 107 X K4 | 3.80 | 3.10 | 1.30 | 0.09 | 0.31 | 0.19 | 1.47 | 1.268 | 0.066 |
| 7633 | SPV 107 X K4 | 3.20 | 2.80 | 1.27 | 0.10 | 0.38 | 0.17 | 1.32 | 1.086 | 0.018 |
| 7634 | Tenkasi Local X A 6552 | 1.83 | 3.20 | 1.60 | 0.05 | 0.60 | 0.41 | 1.28 | 0.848 | 0.278 |
| 7635 | -do- | 2.90 | 2.57 | 0.87 | 0.05 | 0.49 | 0.21 | 1.18 | 0.979 | 0.091 |
| 7636 | -do- | 2.43 | 3.60 | 1.07 | 0.04 | 0.27 | 0.19 | 1.27 | 1.107 | 0.194 |
| 7637 | -do- | 3.03 | 2.47 | 1.67 | 0.12 | 0.45 | 0.29 | 1.34 | 0.965 | 0.061 |
| 7638 | K4 X A 3647 | 2.83 | 2.90 | 1.10 | 0.12 | 0.20 | 0.21 | 1.23 | 1.045 | 0.011 |
| 7639 | K4 X 3647 | 2.50 | 2.83 | 1.03 | 0.10 | 0.50 | 0.19 | 1.19 | 0.938 | 0.030 |
| nkasi Local | Local | 2.37 | 2.33 | 1.30 | 0.07 | 0.22 | 0.17 | 1.08 | 0.856 | 0.010 |
| | K2 X Co 18 | 1.37 | 3.10 | 1.50 | 0.14 | 0.69 | 0.41 | 1.20 | 0.733 | 0.367 |
| | Selection from IS 3541 | 4.10 | 2.07 | 1.47 | 0.06 | 0.25 | 0.29 | 1.21 | 1.129 | 0.498 |
| 23 | 2077A, MS 3660A, 2219A and CS 3541 | 4.23 | 2.97 | 1.30 | 0.06 | 0.39 | 0.39 | 1.56 | 1.298 | 0.208 |
| 25 | (IS 4283 X 699 T) X CS 3541 | 1.63 | 2.90 | 1.23 | 0.04 | 0.28 | 0.31 | 1.07 | 0.801 | 0.214 |
| 26 | MS 8271 X IS 3691 | 1.37 | 3.00 | 1.33 | 0.09 | 0.21 | 0.48 | 1.08 | 0.749 | 0.368 |
| vironment mean | | 2.82 | 2.80 | 1.31 | 0.09 | 0.38 | 0.28 | 1.27 | | |
| vironment index (ej) | | 1.55 | 1.51 | 0.02 | -1.19 | -0.91 | -0.98 | | | |
| mperature °C Maximum | | 31.7 | 31.3 | 32.8 | 37.3 | 37.0 | 38.5 | | | |

able 2. Analysis of variance for phenotypic stability in grain - cum - fodder sorghum genotypes

| Source | Geno types | Environment + (Genotype X Environment) | Environment (Linear) | Genotype X Environment (Linear) | Pooled deviation (Non linear) | Pooled error |
|---|---|---|---|---|---|---|
| )egree of freedom | 17 | 90 | 1 | 17 | 72 | 216 |
| Aean sums of iquares | 0.576 | 5.312 | 142.256 | 0.319 | 0.133 | 0.010 |
| F (against pooled rror mean squares) | 55.39** | 510.72** | 13678.44** | 30.68** | 2.40** | |
| F (against pooled leviation mean squares) | 4.34** | 8.52** | 1072.82** | 2.40** | | |

* Significant at 1% level.

18.5° c in $E_6$) which would have caused normous amount of spikelet sterility (due to he abortion of florets and embryos) ultimately esulting in the lowest yield. Since the revalence of high temperature during ummer seasons proved to be highly letrimental to sorghum production, cultivation of sorghum during April should be liscouraged.

The linear regression analysis facilitates dentification of genotypes with wider adaptability over a range of environments. A genotype with high mean, unit regression coefficient (bi = 1.0) and least deviation rom regression ($s^2di = 0$) is considered as an ideal, widely adapted and stable genotype (Eberhart and Russel, 1966). According to these criteria, three genotypes *viz.*, KS 7631, KS 7634 and KS 7637 that had above mean yield, unit regression co-efficient and least deviation from regression could be considered as those with wider adaptability and high stability. It has, however, been emphasised by Jatasara and Paroda (1979) that linear regression could be considered as a measure of stability, the genotype with least deviation around the regression being the most stable and *vice versa*. Four highest yielding genotypes *Viz.*, KS 6312, KS 7078, KS 7623 and Co 23 had more than unit regression suggesting that these would be suitable for growing under favourable environments. Tenkasi local and KS 6317 had less than unit regression and least deviation from regression and these two would be preferred for growing under unfavourable environments. Further, the exploitation of these genotypes noted for their stability would be thought of for use in the breeding programme for transferring the stability attribute and thereby improve the productivity of sorghum.

From out of the five improved varieties viz., K4, K5, Co 23 and Co 26 that were included in the study, Co 23 recorded the highest grain yield. The regression co-efficient of this variety was more than unity and this would suggest that this variety would perform well under favourable environments. K4 with the regression co-efficient being less than unity was found to be the best for the unfavourable environments as this was found to have yielded more than the individual environment mean yield in E4, E5 and E6. K5 was found to respond well to favourable environments.

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