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# Genotype-Environment Interactions on Yield and Yield Contributing Characters in Sugarcane

**M.A. Miah, B.P. Podder and S.M.N. Nahar**
Bangladesh Sugarcane Research Institute,
Ishurdi, Pabna, Bangladesh.

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## ABSTRACT

An experiment was conducted with five genotypes in consecutive three years to find out the genotype × year interactions on yield and yield contributing characters of sugarcane. The characters considered were germination per cent, number of tillers, number of millable canes, cane height, cane diameter, cane yield, sucrose recovery per cent and sugar yield. It was observed that all characters except diameter and cane yield were significantly influenced by genotype × year interactions. Diameter showed significant variation at genotypic level while cane yield did not show any variation either at genotypic level or at year level.

**Key words :** Sugarcane, genotype-environment interaction, yield contributing characters.

## INTRODUCTION

The characters of economic importance in sugarcane, as in most crops, are mainly quantitative. Characters such as yield of cane are usually continuous in expression under normal environmental conditions. A knowledge of the genetic variability and type of gene action controlling the yield contributing characters and expression over various environmental conditions for response to select biological populations is a pre-requisite in formulating more efficient breeding programme. There are reports that it is needed to emphasize the significance of varietal test to ascertain information on the magnitude of genotype × location, genotype × year and genotype × location × year interactions. If a varietal trial is conducted in several seasons, the yield of all varieties at a site (general mean) can be used to provide a measure of that environment (Skinner, 1971). However, information on genotype - environment interactions in sugarcane is scanty. This study was, therefore, undertaken to estimate genotype × year interaction components of variance for yield and some yield contributing characters in five genotypes of sugarcane.

## MATERIALS AND METHODS

The experiment was conducted with five genotypes during 1990-91, 1991-92 and 1992-93 cropping seasons. The genotypes were I 49-84, I 68-84, I 95-84, I 154-84 and Isd 16. In each season three budded setts were planted in last week of November and harvested in last week of December of the following season. Every year the experiment was laid out in randomized block design with four replications at Regional Sugarcane Research Station (RSRS), Thakurgaon. Normal cultural practices were done as per

requirement. Data were recorded on germination (GM), number of tillers (NT), number of millable canes (NM), cane height (CH), cane diameter (CD), cane yield (CY), sucrose recovery (SR) and sugar yield (SY) for consecutive three years. Data were collected from middle four lines of a plot having six lines. Sucrose content was chemically analysed at the Thakurgaon Sugar Mills Laboratory at harvest in each season. Cane height and diameter were recorded from 10 randomly selected stalks and sugar yield was calculated from the cane yield and sucrose recovery of each genotype. However, all parameters were statistically analysed and mean values were evaluated by DNMR test.

## RESULTS AND DISCUSSION

Analysis of variance showed significant variations among the genotypes, years (seasons) and their interactions in germination, number of tillers, number of millable canes, height and sucrose recovery per cent (Table 1). The analysis of variance also showed significant variation in diameter at genotypic level and in sugar yield at year and interaction (genotype × year) level. No significant effects were observed for cane yield. It indicates that seasonal variation might have some effects on some characters in sugarcane. Such significant difference among the characters was also reported by Mian and Awal (1979).

Table 1. Analysis of variance for different characters of sugarcane in different years.

| Source of variation | df | Values of mean sum of square with level of significance | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | GM (%) | NT (000) | NM (000) | CH (m) | CD (cm) | CY (TCH) | SR (%) | SY (TSH) |
| Genotype | 4 | 509.660** | 8261.590** | 694.140** | 0.240** | 0.450** | 88.770 | 2.640** | 0.380 |
| Year | 2 | 450.930** | 3389.360** | 401.820** | 0.250* | 0.010 | 197.570 | 7.970** | 3.260** |
| Genotype × Year | 8 | 125.010** | 1660.880** | 226.560** | 0.150* | 0.006 | 151.340 | 0.790* | 1.670** |
| Between block within year | 9 | 34.580* | 969.090* | 1121.350* | 0.040 | 0.030 | 47.080 | 0.280 | 0.570 |
| Pooled error | 36 | 12.600 | 386.640 | 46.390 | 0.060 | 0.020 | 60.840 | 0.280 | 0.540 |

*, ** indicates significance at 5 and 1% level respectively. GM, NT, NM, CH, CD, CY, SR and SY represent germination, no. of tillers/ha, no. of millable canes/ha, cane height, cane diameter, cane yield, sucrose recovery and sugar yield respectively.

The mean values on germination revealed that all genotypes differed significantly from one another except Isd 16 and I 68-84 showing the highest germination in I 95-84 (Table 2). On the other hand, germination per cent was significantly higher in 3rd year than that of the 1st and 2nd year. The genotype × year interactions effects showed that germination per cent was significantly higher in 3rd year, except Isd 16 and I 154-84, from that of 1st and 2nd year in each of the remaining three genotypes. The interaction effects showed significantly higher per cent of germination in I 95-84 in the 1st and 2nd year while in 3rd year higher germination was found in I 49-84 compared to other genotypes. The results indicate that genotypes give differential responses when grown in different environment. The results were in support with the findings of Chowdhuri *et al* (1977).

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**Table 2 Mean values for different characters of five genotypes of sugarcane in different years**

| Germination | Year | Genotypes | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | | I 49-84 | I 68-84 | I 95-84 | I 154-84 | lsd 16 | |
| Germination (%) | 1st | 26.11 bc B | 23.90 bc B | 36.51 a B | 20.79 c A | 27.44 b A | 26.95 b |
| | 2nd | 29.86 a B | 21.11 b B | 32.99 a B | 24.38 b A | 22.78 b A | 26.22 b |
| | 3rd | 48.33 a A | 35.83 c A | 42.70 b A | 20.41 c A | 26.66 d A | 34.78 a |
| | Mean | 34.76 b | 26.94 c | 37.40 a | 21.86 d | 25.62 c | |
| No. of Tillers/ha x (000) | 1st | 144.00 b B | 129.38b c A | 177.94 a A | 102.00 c A | 146.38 b A | 149.94 a |
| | 2nd | 160.56 a AB | 89.38 b B | 108.81 b B | 98.63 b A | 117.81 b AB | 115.03 b |
| | 3rd | 188.69 a A | 120.38 c A | 152.94 b A | 94.94 c A | 113.44 c B | 134.07 a |
| | Mean | 164.41 a | 113.04 d | 146.56 b | 98.52 e | 125.87 c | |
| No. of millable canes/ha x (000) | 1st | 68.44 a B | 59.81a b A | 66.75 a A | 55.62 b B | 63.13a b B | 62.75 b |
| | 2nd | 82.18 a A | 66.25 b A | 62.50 b A | 66.25 b A | 78.50 a A | 71.13 a |
| | 3rd | 85.00 a A | 69.31 b A | 61.25b c A | 51.44 c B | 53.50 c C | 64.10 b |
| | Mean | 78.54 a | 65.12 b | 63.50 b | 57.77 c | 65.04 b | |
| Cane height (m) | 1st | 2.38 a A | 2.25 a A | 2.36 a A | 2.29 a B | 2.62 a A | 2.38 b |
| | 2nd | 2.50 a A | 2.46 a A | 2.09 b A | 2.60a A | 2.79 a A | 2.48 ab |
| | 3rd | 2.48 a A | 2.45 a A | 2.65 a A | 2.69 a A | 2.75 a A | 2.60 a |
| | Mean | 2.45 b | 2.38 b | 2.36 b | 2.52 b | 2.72 a | |
| Cane diameter (cm) | 1st | 2.24 a A | 1.86 b A | 1.84 b A | 2.15 a A | 2.25 a A | 2.06 a |
| | 2nd | 2.25 a A | 1.87 b A | 1.87 b A | 2.16 a A | 2.27 a A | 2.08 a |
| | 3rd | 2.27 a A | 1.85 b A | 1.99 b A | 2.20 a A | 2.25 a A | 2.11 a |
| | Mean | 2.25 a | 1.86 b | 1.90 b | 2.17 a | 2.26 a | |
| Cane yield/ha (TCH) | 1st | 48.56 a A | 46.44 a A | 58.38 a A | 46.56 a A | 51.13 a A | 50.21 a |
| | 2nd | 58.38 a A | 51.76 a A | 47.25 a A | 56.94 a A | 55.00 a A | 53.86 a |
| | 3rd | 55.69 a A | 47.98 a A | 47.40 a A | 45.10 a A | 43.13 a A | 46.97 a |
| | Mean | 54.21 a | 48.72 a | 51.01 a | 49.53 a | 52.08 a | |
| Sucrose recovery (%) | 1st | 8.40 a A | 7.42 b A | 8.45 a A | 8.30 a A | 8.24 a A | 8.16 b |
| | 2nd | 8.38 b A | 8.97 ab A | 8.56 ab A | 8.38 b A | 9.30 a A | 8.71 a |
| | 3rd | 8.17 c A | 8.52 bc A | 9.51 a A | 9.24 ab A | 9.88 abc B | 8.86 a |
| | Mean | 8.31 b | 8.30 b | 8.84 a | 8.64 ab | 8.80 a | |
| Sugar yield/ha (TSH) | 1st | 4.07 a A | 3.45 a A | 4.93 a A | 3.86 a A | 4.21 a A | 4.10 b |
| | 2nd | 4.89 a A | 4.64 a A | 4.04 a A | 4.82 a A | 5.33 a A | 4.74 a |
| | 3rd | 4.56 a A | 4.09 a A | 4.50 a A | 4.16 a A | 3.82 a B | 4.22 a |
| | Mean | 4.51 a | 4.06 a | 4.49 a | 4.28 a | 4.45 a | |

In respect of tillers, mean values of all genotypes differed significantly showing higher number in I 49-84 while insignificant number of tillers were produced in 1st and 3rd year from that of 2nd year (Table 2). The genotype × year interactions revealed significant difference in tiller production in all the genotypes except I 154-84 for all three years. The genotypes I 68-84 and I 95-84 produced statistically identical number of tillers in 1st and 3rd years but were higher than 2nd year. The genotype I 49-84 produced significantly higher number of tillers in 3rd year while Isd 16 produced higher number in 1st year but both the genotypes showed insignificant difference with tiller production of 2nd year. The interaction effects also showed significantly higher number of tiller production in I 95-84 in 1st year and I 49-84 in 2nd and 3rd years over other genotypes. Results were partially corroborated with the findings of Espinosa and Galvez (1980) who found significant interactions of planting season and genotype for all characters of sugarcane. In finger-millet, genotype-environment interactions showed non-significant productive tillers which also partially supports the present results (Chawdhuri *et al.*,1977).

Regarding millable canes, mean values show that I 49-84 produced significantly higher number than all other genotypes (Table 2). The genotypes I 68-84, I 95-84 and Isd 16 were insignificant in millable canes production. The average value on year reveals that the number of millable canes in 2nd year was significantly higher over the number of 1st and 3rd year both of which differed insignificantly. The genotype × year interactions show significant variations for millable canes production for different years in I 49-84, I 154-84 and Isd 16, while no significant difference was observed for I 68-84 and I 95-84 genotypes. The interaction effects on genotypes indicate that clones I 49-84 and I 95-84 were significantly superior over I 154-84 in 1st year, I 49-84 and Isd 16 over remaining genotypes in 2nd year and again I 49-84 over other genotypes in 3rd year in millable canes production. It is observed that the tiller production in 2nd year was lower but millable canes production was found higher in the same year which might be due to lower mortality of tiller i.e., for environmental effects. However, results were partially supported by the findings of Espinosa and Galvez (1980) who observed significant genotype-environment interactions effects on all characters of sugarcane. George (1962) reported that many of the characters in *Saccharum* progenies were influenced by genotype - environment interactions which also partially support the present findings.

It is observed that the mean values on plant height of Isd 16 was significantly taller than all other genotypes, while among three years plant height in 3rd year was significantly taller than 1st year (Table 2). It is observed that there was no significant genotype × year interaction effects on plant height on any genotype except I 154-84 whose plant height of 1st year was significantly smaller than 2nd and 3rd year. No significant interaction influence was also marked for plant height among the five genotypes except I 95-84 in 2nd year. Chawdhuri *et al.* (1977) reported that they found small and non-significant length of main ear in finger-millet which partially supports the present results.

In case of diameter, mean values of I 49-84, I 154-84 and Isd 16 were statistically superior over I 68-84 and I 95-84 both of which showed insignificant difference (Table 2). On the contrary, no significant difference on mean values was

marked among three years for diameter. The genotype × year interactions also revealed no significant difference in diameter among genotypes in different years. At genotypic level, I 49-84, I 154-84 and lsd 16 showed insignificant difference but they were statistically superior over diameter of I 68-84 and I 95-84 in all three years. It indicates that diameter was not influenced by environment of different years.

The mean values of different genotypes showed no significant difference in cane yield neither at genotypic level nor at environmental level (Table 2). The genotype X year interactions also showed no significant difference in cane yield among genotypes and years. It is observed that inspite of comparatively more number of millable canes in I 68-84 cane yield was lower which may be due to shorter stalk and less diameter of the genotype. However, unusual stability of genotypes on cane yield over environment of three years indicates higher capacity of homeostasis (Ruschel, 1977). Chawdhuri *et al.* (1977) found non-significant variation in grain yield among genotypes of finger-millet in genotype × year interactions which partially supported by present findings.

In respect of sucrose recovery per cent, mean values of genotypes proved superiority of I 95-84 and lsd 16 over I 49-84 and I 68-84 significantly (Table 2). At year's level, statistically higher per cent of recovery was produced by 2nd and 3rd years. The genotype X year interactions revealed significantly higher recovery of I 68-84 in 2nd and 3rd year over 1st year, I 95-84 and I 154-84 in 3rd year over 1st and 2nd year, and lsd 16 in 2nd year over 1st and 3rd year. Sucrose recovery per cent was non-significant for I 49-84 in all three years. At genotypic level, interaction effect showed significant superiority of I 49-84, I 95-84, I 154-84 and lsd 16 over I 68-84 in 1st year; of lsd 16 over I 49-84 and I 154-84 in 2nd year; and of I 95-84 over I 49-84 and I 68-84 in 3rd year in sucrose recovery. Results were in partial agreement with the findings of Espinosa and Galvez (1980) who reported that due to genotype-environment interaction, pol per cent in cane was highly significant among genotypes.

Regarding sugar yield, statistically no variation among means of genotypes was observed while significant difference was marked among the means of 2nd and 3rd years with mean of 1st year (Table 2). The genotype × year interactions showed statistically significant variation on sugar yield only in lsd 16 where yield of 2nd year was highly significant over 1st and 3rd years yield. The combined effects revealed no significant difference in sugar yield among genotypes. The non-significant difference of most of genotypes might be due to non- significant difference of cane yield. The lower sugar yield in lsd 16 in 1st and 3rd years might be due to lower sucrose recovery in those years. Results were partially corroborated with the findings of Espinosa and Galvez (1980) who found significant differences in pol in genotype-environment interactions in sugarcane. Therefore, it may be concluded that the genotype × year interactions influence most of the characters in sugarcane.

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