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SELECTION INDICES FOR THEORETICAL YIELD OF ALCOHOL IN SUGARCANE

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ABSTRACT

Selection indices were formulated using seventy seven genotypes of sugarcane in second clonal stage considering theoretical yield of alcohol and seven of its component characters which showed high correlation with it. Among eight characters that were used to formulate selection indices, theoretical yield of alcohol (X_1) was considered as dependent character while other characters viz., brix per cent (X_2), sucrose per cent (X_3), commercial cane sugar per cent (X_4), juice purity per cent (X_5), pol per cent cane (X_6), total sugars per cent (X_7) and commercial cane sugar yield (X_8) were considered as independent variables. From the results, it is evident that to increase the alcohol yield selection should be mainly based on total sugars per cent as all the selection indices showing higher relative efficiency and genetic advance involved this trait. For indirect selection, the index involving the combination of five characters viz., brix per cent (X_2), sucrose per cent (X_3), juice purity per cent (X_5), pol per cent cane (X_6) and total sugars per cent (X_7) which exhibited maximum relative efficiency of 523.98 with genetic advance of 12.14 could be considered for selection schemes to improve theoretical yield of alcohol. Inclusion of commercial cane sugar yield to this index increased the relative efficiency to 602.98 and genetic advance of 13.97.

KEY WORDS: Selection indices, Sugarcane, Theoretical yield of alcohol

INTRODUCTION

Sugarcane, which is also considered as an important bio energy crop belongs to the category of C4 plants which converts the solar energy effectively into high quality and low cost raw materials for sugar and ethanol (Bruce *et al.*, 2005). Molasses and bagasse are the byproducts of sugar industry which form the feedstock for ethanol production and cogeneration respectively. National policy on biofuels proposed to scale up the blending from 5% to 20% by 2017. The target is difficult to achieve due to limited availability of bioethanol which to a greater extent comes from sugarcane molasses apart from a smaller proportion from grains. This necessitates significant increase in domestic ethanol production by developing varieties which yield higher ethanol.

The main objective of a selection programme is to shift the mean to a new peak by directional selection. Continuous selection in one character may result in a loss or gain in the other characters, which are also of equal importance. On the other hand, if selection is made for a number of characters, the efficiency of selection would be reduced. So the plant breeder will have to base his selection on a combination of a few important characters related to the main character under consideration in the form of a selection index by appropriate weightages assigned to the phenotypic values of each character so that the genetic gain in the character under consideration will be maximum without any loss in other important characters. Selection indices provide the means for making use of correlated characters for higher efficiency in selection for characters of low heritability. Selection index is a tool, which breeder can use successfully for selection on several characters simultaneously by discriminating the desirable ones on the basis of phenotypic performance.

MATERIAL AND METHODS

The present investigation was carried out at Agricultural Research Station, Perumallapalle (Acharya N.G. Ranga Agricultural University), situated in the Southern Agro-climatic Zone of Andhra Pradesh with seventy seven genotypes of sugarcane that were planted in a randomized block design with two replications during April, 2011. Each entry was planted in 2 rows of 5 m length spaced at a distance of 80 cm between rows with 4 three budded setts per meter as seed rate.

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Observations were recorded on each entry for the traits viz., no. of tillers at 120 DAP, shoot population at 180, 240 DAP, NMC at harvest, no. of green leaves at 90, 120, 240 DAP and at maturity, biomass per cane (kg), internode number, internode length (cm), stalk length (cm), stalk diameter (cm), stalk volume (cm^3), single cane weight (kg), fibre content (%), Brix (%), sucrose (%), CCS (%), juice purity (%), pol % cane, juice extraction (%), total sugars (%), fibre yield (tha^{-1}), CCS yield ($t\ ha^{-1}$), theoretical yield of alcohol (g/100ml) and cane yield ($t\ ha^{-1}$).

The technique of Discriminant function developed by Fisher (1936) was adopted to know the true genotypic worth of yield and its components and to have computational formulae for construction of selection indices which when applied to select plants can bring about effective improvement in yield compared to straight selection for yield. Smith (1936) has illustrated the use of discriminant function in plant selection. A number of different selection indices are constructed using 2, 3,……, n combination of characters. The expected genetic advance based on the composition of characters that was included for formulation of the various selection indices was calculated as per the formula of Robinson *et al.* (1951). The relative efficiency of each selection index formulated was calculated as per the formula given by Brim *et al.* (1959).

RESULTS AND DISCUSSION

Among eight characters that were used to formulate selection indices, theoretical yield of alcohol (X_1) was considered as dependent character while other characters viz., brix per cent (X_2), sucrose per cent (X_3), commercial cane sugar per cent (X_4), juice purity per cent (X_5), pol per cent cane (X_6), total sugars per cent (X_7) and commercial cane sugar yield (X_8) were considered as independent variables. The discriminant functions and the estimated values of genetic advance and relative efficiency for each combination of characters over straight selection for theoretical yield of alcohol are presented in Table 1 and briefly discussed below.

Out of two hundred and fifty five different selection indices formulated higher relative efficiency of 744.59 coupled with high genetic advance (17.25) was observed in the combination involving all the eight traits followed by the index based on seven characters excluding commercial cane sugar per cent (X_4) with a relative efficiency of 687.77 and genetic advance of 15.72.

Among single characters, total sugars per cent (X_7) was highly efficient with relative efficiency of 170.65 and high genetic advance of 3.95, compared to the direct selection based on theoretical yield of alcohol (X_1). Whereas among two character combinations, maximum relative efficiency of 268.97 was observed for the combination of juice purity per cent (X_5) and total sugars per cent (X_7) with a genetic advance of 6.23. However, in case of three character combinations, the combination involving sucrose per cent (X_3), juice purity per cent (X_5) and total sugars per cent (X_7) exhibited higher relative efficiency of 360.64 coupled with a genetic advance of 8.35.

Among four character combinations, theoretical yield of alcohol (X_1), sucrose per cent (X_3), juice purity per cent (X_5) and total sugars per cent (X_7) exhibited high relative efficiency of 445.34 coupled with a genetic advance of 10.32.

When indirect selection scheme excluding theoretical yield of alcohol is to be followed, the index involving the combination of five characters viz., brix per cent (X_2), sucrose per cent (X_3), juice purity per cent (X_5), pol per cent cane (X_6) and total sugars per cent (X_7) which exhibited maximum relative efficiency of 523.98 with genetic advance of 12.14 could be considered for selection schemes to improve theoretical yield of alcohol. Inclusion of commercial cane sugar yield to this index increased the relative efficiency to 602.98 and genetic advance of 13.97.

From the results it is evident that to increase the alcohol yield selection should be mainly based on total sugars per cent as all the selection indices showing higher relative efficiency and genetic advance involved this trait.

Scoring of sugarcane genotypes for theoretical yield of alcohol based on the best selection index is depicted in Figure 1. Selection of top ten percent of the genotypes (Table 2) based on the best selection index has shown 136.19% gain over population mean.

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Table 1. Discriminant functions, their Genetic Advance (GA) and Relative Efficiency (RE) over straight selection for Theoretical yield of alcohol

S. No.	Discriminant function	GA	RE
1	$Y = 0.92\ X_1$	2.32	100.00
2	$Y = 0.81\ X_5$	3.37	145.52
3	$Y = 0.92\ X_7$	3.95	170.65
4	$Y = 1.03\ X_1 + 0.87\ X_7$	6.21	268.15
5	$Y = 0.78\ X_5 + 0.97\ X_7$	6.23	268.97
6	$Y = 0.94\ X_7 + 0.96\ X_8$	6.00	259.00
7	$Y = 1.20\ X_1 + 0.78\ X_5 + 0.83\ X_7$	8.31	358.81
8	$Y = 1.55\ X_3 + 0.62\ X_5 + 0.92\ X_7$	8.35	360.64
9	$Y = 0.78\ X_5 + 0.98\ X_7 + 1.01\ X_8$	8.13	350.83
10	$Y = 0.99\ X_1 + 1.63\ X_3 + 0.59\ X_5 + 0.88\ X_7$	10.32	445.34
11	$Y = -0.17\ X_2 + 2.71\ X_3 + 0.50\ X_5 + 0.94\ X_7$	10.24	442.11
12	$Y = 1.60\ X_3 + 0.62\ X_5 + 0.94\ X_7 + 0.89\ X_8$	10.20	440.59
13	$Y = 0.96\ X_1 + -0.45\ X_2 + 3.10\ X_3 + 0.43\ X_5 + 0.91\ X_7$	12.12	523.10
14	$Y = 0.93\ X_1 + 1.68\ X_3 + 0.59\ X_5 + 0.94\ X_7 + 0.89\ X_8$	12.08	521.72
15	$Y = -0.33\ X_2 + 2.77\ X_3 + 0.50\ X_5 + 1.07\ X_6 + 0.96\ X_7$	12.14	523.98
16	$Y = 0.95\ X_1 + -0.64\ X_2 + 3.18\ X_3 + 0.42\ X_5 + 1.10\ X_6 + 0.94\ X_7$	13.93	601.58
17	$Y = 0.91\ X_1 + 0.68\ X_2 + 1.88\ X_3 + 0.63\ X_5 + 0.97\ X_7 + 0.90\ X_8$	13.90	600.09
18	$Y = 0.80\ X_2 + 1.43\ X_3 + 0.70\ X_5 + 1.22\ X_6 + 0.99\ X_7 + 0.89\ X_8$	13.97	602.98
19	$Y = 0.92\ X_1 + 0.64\ X_2 + 1.41\ X_3 + 1.50\ X_4 + 0.62\ X_5 + 1.12\ X_6 + 0.97\ X_7$	15.49	668.74
20	$Y = 0.89\ X_1 + 0.41\ X_2 + 1.92\ X_3 + 0.61\ X_5 + 1.26\ X_6 + 1.00\ X_7 + 0.89\ X_8$	15.72	678.77
21	$Y = 2.12\ X_2 - -0.38\ X_3 + 1.49\ X_4 + 0.92\ X_5 + 1.25\ X_6 + 1.01\ X_7 + 0.88\ X_8$	15.53	670.30
22	$Y = 0.86\ X_1 + 1.88\ X_2 + -0.11\ X_3 + 1.57\ X_4 + 0.84\ X_5 + 1.30\ X_6 + 1.04\ X_7 + 0.88\ X_8$	17.25	744.59

X_1 : Theoretical yield of alcohol X_2 : Brix percent X_3 : Sucrose percent
X_4 : Commercial cane sugar percent X_5 : Juice purity percent X_6 : Pol % cane
X_7 : Total sugars percent X_8 : Commercial cane sugar yield

Table 2. Top ranking genotypes (10%) based on the best selection index for Theoretical yield of alcohol in sugarcane

Rank	Theoretical yield of alcohol (g/100 ml)		
	Genotype	Mean	Index score
1	2010T-88	13.93	216
2	2010T-53	10.23	211
3	2010T-239	13.19	207
4	2010T-4	10.83	204
5	2010T-18	13.65	203
6	2010T-16	14.01	203
7	2010T-82	11.47	203
Mean of the above seven genotypes		12.47	
Population mean		9.16	
% gain over Population mean		136.19	

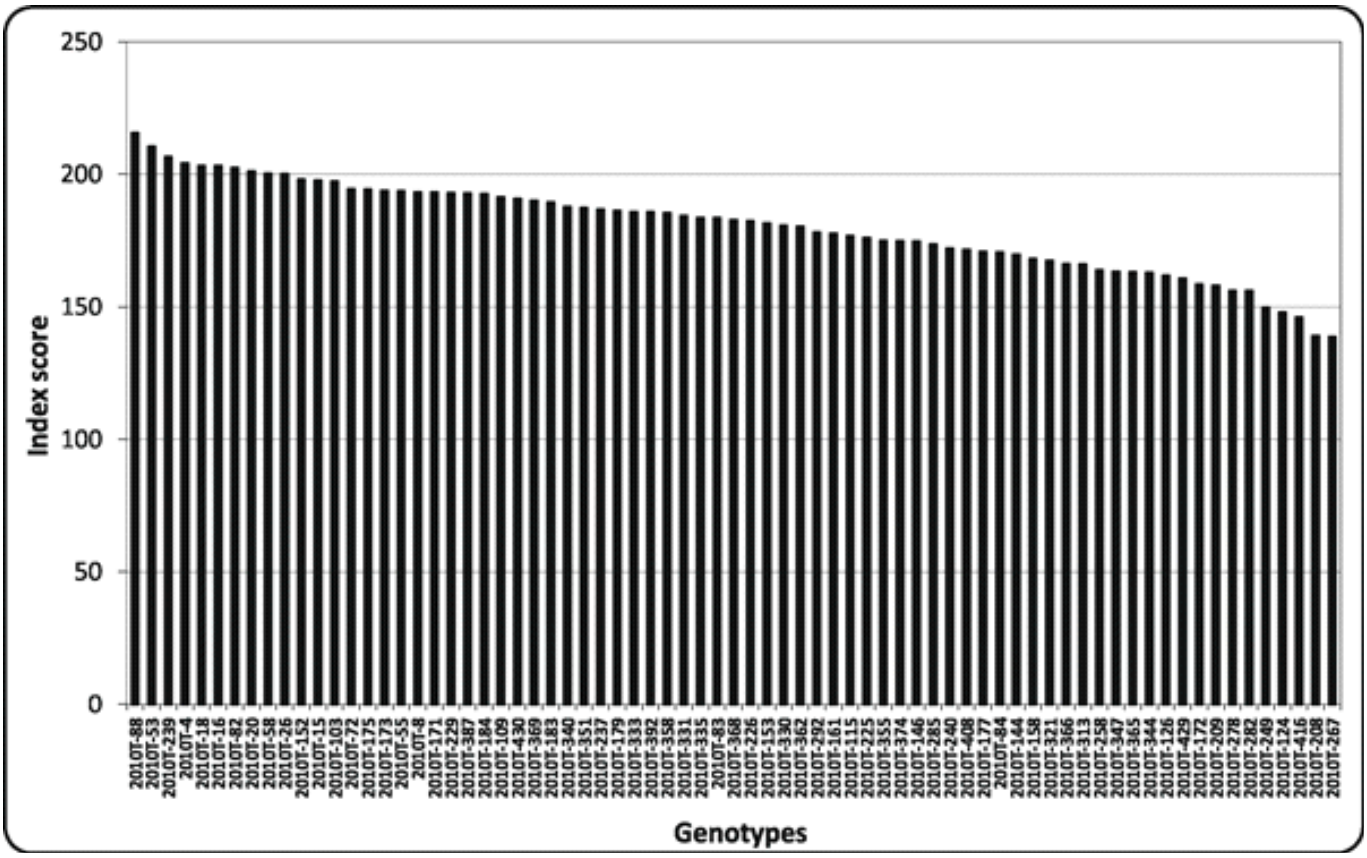

Fig. 1. Selection index score of sugarcane genotypes of theoretical yield of alcohol

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