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PERFORMANCE OF PROMISING SUGARCANE CLONE FOR YIELD AND QUALITY TRAITS IN DIFFERENT ECOLOGICAL ZONES OF SINDH

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Abstract

A new sugarcane clone AEC86-347, was obtained from seed (fuzz), of a cross combination of NCo 310 x CP57-614, imported from ARS, USDA, Canal Point, Florida, USA. The genotype was evaluated for the stability of its performance for economic characters at six different locations in the Province of Sindh for the two consecutive years. Significant ($P \leq 0.01$) differences were observed in genotypes and locations x genotypes interactions for the three traits i.e., cane yield, commercial cane sugar and sugar yield. This phenomenon indicates the presence of genetic variability amongst the genotypes and their differential response to varying environments. High mean performance of AEC86-347 with 'b' values more than 1.00 for cane yield, sugar yield and CCS (%) indicated its potential to take advantage of favourable environmental conditions for yield under different locations.

Introduction

Estimation of stability of a new genotype for yield and quality traits is pre-requisite in plant breeding programme prior to its release for commercial planting. Productivity of a genotype in favourable environments does not indicate its adaptability and stability, whereas performance of a genotype in diverse environments is somehow a true evaluation practice of its inherent potential for adaptativeness (Pandey *et al*., 1981). Therefore, varietal trials are normally conducted over various locations for different years, after achieving meaningful results before deciding the release of a new cultivar in a particular region (Narendra *et al*., 1988; Bakhsh *et al*., 1991; Basford & Cooper 1998). Stability analyses of sugarcane cultivar performance tests conducted under different environments have been reported by many researcher, (Pollock 1975; Ruschel 1977; Tai *et al*., 1982; Kang & Miller 1984; Milligan *et al*., 1990; Khan *et al*., 1997).

Productivity stability is shown by some cane varieties in both predictable and unpredictable environments. In a predictable environment (i.e. climatic, soil type, day length and controllable variables such as fertilization, sowing dates and harvesting methods), a high level of genotype and environmental interaction was desirable, so as to ensure a maximum yield or financial return; whereas, in an unpredictable environment (inter and intra-season fluctuation, fluctuation in quantity and distribution of rainfall and prevailing temperature), a low level of interaction is desirable so as to ensure maximum uniformity of performance over a number of locations or seasons (Khan, 1981).

After examining the stability of standard variety in varietal trials of sugarcane Pollock (1975) and Ruschel (1977) have suggested that clone selection against the average of several standard varieties was better than against a single one as the 'b' values were more precisely estimated when several rather than one standard variety was used to measure the effects of environment. The stability-variance parameters may also be used to compare the stability character of various experimental cultivars to that of a check one. Selected cultivars should have high mean yields and low stability variance (Kang and Miller 1984).

The performance of crop plants varies in different environments, which indicates their adaptability to specific region or over wide areas. The objective of this study was, therefore, to estimate the stability and adaptability potential of new sugarcane clone AEC86-347 by its growth performance under different agroclimatic conditions in the province of Sindh, Pakistan.

Materials and Methods

True seed (fuzz) of different crosses of sugarcane was imported from USDA Canal Point, Florida, USA and grown at Experimental Farm of Nuclear Institute of Agriculture (NIA), Tandojam. The clone AEC86-347 was selected on the basis of high cane and sugar yield from the seedlings of the cross NCo 310 x CP57-614. Four sugarcane clones CP67-412, AEC82-1026, AEC86-328 and AEC86-347 along with commercial variety BL4 were evaluated at 6 locations in the Province of Sindh during 1999-00 and 2000-2001 viz., Tandojam, Nawabshah, Mir Wah, Degree, Badin and Sujawal for two consecutive years. The experimental layout was RCB design with 4 replications. The plot size was 8 x 10m, one metre apart. The sowing was done in the month of September at all locations and normal agronomic practices were followed through out the growth period. Three stools were randomly taken from each plot to determine their sugar contents according to Sugarcane Laboratory Manual for Queensland Sugar Mills (Anon., 1970), while three rows from each plot were harvested to record yield data. The data were analysed according to Steel and Torrie (1960). Stability parameters were estimated by using the methods of Eberhart & Russell (1966). Correlation studies were also carried out.

Results and Discussion

Cane yield and its components: Clone AEC86-347 maintained its superiority at all locations. It showed increase of 15.01, 28.13, 48.61, 19.63, 30.41 and 27.63% over BL4 at Tando Jam, Degree, Mir Wah, Badin, Sajawal and Nawabshah, respectively (Table 1). Significant ($P \leq 0.05$) differences were observed for cane yield and its other yield components amongst clone under study. Highest cane yield (t/ha) was produced by AEC86-347 (174.40) followed by BL4 (136.13) and CP67-412 (129.74) (Table 3). Yield differences close to or higher than 10% value reflect its impact on the economic benefit (Khan *et al*., 2000; Khan *et al*., 2002). Significant difference in plant height was observed among the clones. Highest plant height was observed in AEC86-347 (249.79 cm), followed by BL4 (203.09 cm) and CP67-412 (202.93 cm) (Table 3). Clone AEC86-347 kept its dominance for plant height at all locations and overall showed 22.99% increase over BL4 in cane length (Table 1 & 3). The cane girth of AEC86-347 was comparable to check BL4 (Table 1). The plant height and cane girth are the major contributing factors for high cane yield (Rehman *et al*., 1992). The high cane yield of AEC86-347 may be due to high number of stalks per stool (7.15) as compared with the commercial variety BL4 (5.41) (Table 3). Singh *et al*., (1985) and Raman *et al*., (1985) regarded the number of canes (stalks/stool) as the most important character contributing directly to higher yield.

Quebedeadux & Martin (1986) proposed that both the stalk number and weight should be assessed to have an accurate yield potential of the variety. Similar findings were also reported by Khan *et al*., (1997 and 2000). Our results are fully in agreement with the finding of these researchers.

Commercial cane sugar: (CCS% and CCS t/ha): Significant ($P \leq 0.05$) differences were recorded for CCS% amongst all the entries under trials at different locations. Clone AEC86-347 showed the highest CCS% (12.52%), followed by clone AEC86-328 (11.31%) and AEC82-1026 (10.69%) (Table 3). The highest CCS% of AEC86-347 was observed at Tando Jam (15.14%) and lowest at Mir Wah (11.31%) (Table 1). The maximum sugar (CCS t/ha), was produced by AEC86-347 (21.83) followed by BL4 (13.98) whereas, the lowest sugar yield was recorded in AEC86-328 (12.94) (Table 3). Highest sugar yield (t/ha) was recorded at Nawabshah (29.02) and lowest yield by AEC82-1026 at Sujawal (07.07) (Table 1). Clone AEC86-347 showed 21.90% and 56.15% increase over BL4 in CCS% and sugar yield, respectively (Table 3).

Genotype - environments interaction analysis: The mean squares (MS) for genotypes, locations and locations x genotypes interaction were significant ($P \leq 0.01$) and years, years x locations, years x genotypes and locations x years x genotypes interactions were non-significant for cane yield (t/ha), commercial cane sugar (CCS%) and sugar yield (t/ha). This indicated the presence of genetic variability in the genotypes and varied response of the genotypes to locations for the traits under study. The mean squares for locations, genotypes, and locations x genotypes interaction were significant, which reflected the presence of variability among genotypes and differential response of genotypes to various environments for these characters (Table 2). Tai *et al.*, (1982) reported that mean square for cultivars x locations and cultivars x years were significant but were very much smaller than the mean squares for cultivars for all the seven traits. The cultivars x locations interactions mean square greatly exceeded the three factors i.e., cultivars x locations x years mean squares indicating that the differential response of the cultivars may be permanent characteristics for the locations.

Correlation studies: The cane yield was highly positively correlated with cane length (0.957**), and weight per stool (0.988**) (Table 5). Sugar contents and sugar yield were positively correlated with each other. The cane and sugar yields were positively correlated with each other at 1% level of significance (0.961**).

Table 2. Pooled analysis of variance for 3 traits of 5 sugarcane clones grown at 6 locations for 2 years (1999-2000 and 2000-2001).

Parameters	d.f	Cane yield (t/h)	CCS (%)	CCS (t/h)
		MS	MS	MS
Locations (L)	5	400093.547**	110.760**	341.604**
Error (a)	6	5528.447**	59.047**	104.427**
Year (Y)	2	164.463ns	0.451ns	4.782ns
Y x L	10	692.960ns	0.279ns	10.791ns
Error (b)	12	497.031ns	0.647ns	9.291ns
Genotype (G)	4	18882.863**	48.506**	546.031**
L x G	20	1736.282**	9.231**	33.226**
Y x G	8	185.366ns	0.168ns	3.611ns
L x Y x G	40	349.444ns	0.195ns	5.660ns
Error (c)	48	310.483ns	0.201ns	6.061ns

CCS= Commercial Cane Sugar, MS = Mean square; ** = Significance at 1% level

Table 4. Regression coefficient 'b' and variance due to deviation from regression for 3 traits of 5 sugarcane clones grown at 6 locations for 2 years.

Clone	Cane yield (t/h)		C.C.S.(%)		CCS (t/h)	
	S^2d	b	S^2d	b	S^2d	b
AEC86-347	0.011	1.090	0.022	1.204	0.012	1.011
CP67-412	0.030	0.982	0.023	0.882	0.033	0.858
AEC86-328	0.048	0.663	0.114	0.823	0.163	0.869
AEC82-1026	0.050	1.108	0.019	1.122	0.088	1.022
BL 4	0.014	0.969	0.180	0.975	0.014	0.839

Stability studies: Regression coefficient 'b' is a measure of stability in crop plants (Finlay & Wilkinson, 1963). Other researchers (Eberhart & Russel, 1966; Paroda & Hayes, 1971; Ali *et al*., 2002) suggested that both regression coefficient 'b' and deviation from regression coefficient 'S^2d' may be taken into consideration in identifying a stable genotype. Regression coefficient 'b' values for cane yield, CCS and sugar yield were 1.090, 1.204 and 1.011, respectively while, deviation from regression coefficient 'S^2d' values were 0.011, 0.022 and 0.012 for the above mentioned three characters respectively for clone AEC86-347 (Table 4). A cultivar with 'b' value less than 1.0 has above average stability and is specially adapted to low-performing environments, a cultivar with 'b' value greater than 1.0 has below average stability and is specially adapted to high performing environments and a cultivar with 'b' value equal to 1.0 has average stability and is well or poorly adapted to all environments depending on having a high or low mean performance (Finlay & Wilkinson 1963) but a cultivar with b = 1.00 and $S^2d = 0.00$ may be defined as stable (Eberhart & Russell 1966), The 'b' value being greater than 1.00 for cane yield, sugar yield and CCS percentage indicated the potential of AEC86-347 to take advantage of favourable environments. Tai *et al*., (1982) reported that the cultivar CP70-1133 had the highest means of tonnes cane per hectare (TCH) and tonnes sugar per hectare (TSH) and was found relatively stable for these two characters as both the characters have b=1.05 and 'S^2d' = 0.12. This cultivar, however, had 'b' values less than 1.00 for brix (%), sucrose (%), purity (%) and sugar per tonne. Though, this cultivar did not produce high sugar content, yet the stability parameters and mean performance for TCH and TSH indicated as the best choice for its release to the sugar industry.

Sugar yield per unit area can be increased only, if there is a break through, in the production of sugarcane and the recovery of sugar. There is lack of good varieties and absence of mechanisms to carry out the package of technology and inputs to the farmers. The share of improved variety in the enhancement of cane yield and sugar recovery is about 20-25%, while rest is contributed by production technology (Javed *et al*., 2001). Since the increase in cane and sugar yield in our country has mainly been due to an increase in the acreage (Hashmi, 1995), therefore, the evolution of high yielding clones is urgently needed, which could increase the cane and sugar yield per unit area.

The studies indicated that of all the clones under evaluation, AEC86-347 showed its potential for higher cane and sugar yields under prevailing agroclimatic conditions of Sindh, Pakistan. Moreover, on the basis of estimates of stability parameters, it may be concluded that the clone AEC86-347 has good adaptation potential under favourable as well as unfavourable environmental growing conditions in the Province of Sindh.

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