CORRELATION AND PATH ANALYSIS OF YIELD AND ITS COMPONENT IN SUGARCANE

M. S. Yahaya ; A .M. Falaki; E.B. Amans and L.D. Busari

Abstract

Correlations and path coefficients were used to determine the interrelationship and importance of various characters as components of yield in sugarcane in 2002-03 and 2003-04 growing seasons. Generally, correlation coefficients among the yield component characters were similar in both seasons, however path coefficients show variation from seasons to season. In both seasons, number of millable canes, stalk length, stalk girth and number of internodes per stalk had high positive correlation with cane yield and with each other. The path coefficient analysis revealed that stalk length made the highest direct contribution (0.653 in 2003-04) to cane yield followed by number of millable canes with a direct contribution of 0.4290 in 2002-03 season. The path analyses further showed these characters to be the most important components of cane yield. Both correlation and path coefficient analyses have established stalk diameter as a less reliable component character than the other three variables included in the yield component analysis.

Introduction

Yield in sugarcane is dependent on a number of factors. Agronomist and breeders have adopted yield component studies through correlation and path coefficient analysis, as a crop improvement strategy. The concept of correlation is used to explore and reveal the relationship between yield and its components. It has also proved valuable in determining the association of quantitative attributes with yield for selecting characters that influence the yield. Several studies (Brown *et al*., 1968; Hebert and Henderson, 1959) have been carried out to assess the relationship between different cane crop characters. Hebert (1967) observed a significant positive association between cane yield and stalk weight but not between cane yield and stalk girth of sugarcane varieties in Louisiana. Legendre (1970) found a positive association for cane yield with stalk number, stalk diameter, stalk length and stalk weight, but did not ranked these attributes in order of importance for determining cane yield. Phenotypic correlation analysis conducted by Singh (1985) reveal that cane yield, commercial cane sugar, millable cane, and stalk height had a highly significant association with each other. Thakur *et al*., (1989) and Yahaya, *et al*., (2007) have reported the existence of a positive and significant correlation between cane yield with cane diameter and number of millable canes per hectare.

Correlation study alone is not likely to give correct appraisal of yield associations. Therefore, path coefficient analysis has been a very important tool for interpreting and predicting ultimate plant yield. According to Prabhakaran Nair and Singh (1974), path analysis is an effective means of disentangling the

direct and in direct causes of association between yield component and yield. Salih and Khadir (1975) have noted that while correlation simply measures the apparent mutual association between two variables without regard to the cause, path analysis specifies the causes and measure their relative importance. Path-coefficient analysis studies conducted by Gravious (1991) show that stalk number increased cane yield directly, while stalk length and stalk density exerted moderate negative direct effect on cane yield. Yahaya *et al*., (2007) have established through path analysis that stalk length and number of millable canes were the important component characters of cane and sugar yields, while polarity and fibre percentages ware the most important characters of sucrose content.

This paper reports the analysis of the relationship between certain important yield components and cane yield and how changes in yield patterns could be predicted through them.

Materials and Methods

The data used for the study were from two experiments conducted during 2002-03 and 2003-04 seasons at the National Cereals Research Institute Badeggi (9^0 45' N and 06 07 E). The investigation was carried out to evaluate the response of sugarcane to nitrogen level (0, 120 and 240 kg ha^{-1}) and irrigation applied at 1-, 2-, 3- and 4- week intervals. The field plot design each season was a randomized complete block with three replications. Plots were 5 m x 10 m (50 m^2) with six rows of cane plants spaced 1.0 m apart.

All data were taken on individual plot at harvest. Stalks were cut level with the ground, topped through the apex, stripped of leaf material, bundled and tagged. The number of millable stalks was counted for each plot. Stalk diameter (cm) was obtained at the midpoint of the stalk by measuring the diameter perpendicular to the bud halfway between two nodes. Stalk diameter, stalk length and internodes per stalk were obtained as an average of five random stalks. Cane yield (t/ha) was obtained by weighing all stalks of millable size.

All simple correlations were calculated among characters for each season. Path coefficient analysis as described by Ahmed (1995) was used to partition the correlation coefficients between cane yield and other characters into direct and indirect effect. Path analysis was applied to the data for the two seasons and only characters showing significant positive correlation with cane yield were included in the path coefficient analysis.

Results

Correlations

Correlations among the five characters in 2002-03 and 2003-04 seasons are shown in Table 1 and 2 respectively. In all the seasons, a positive and highly significant correlation was found between cane yield and all the characters. The correlation coefficients of stalk length, internode per stalk and millable cane with cane yield were about equal in magnitude in 2002-03 (0.770**, 0.790** and 0.784** respectively). However in 2003 -04 season, the correlation between stalk

length and cane yield was the highest (0.907**) followed by the association of internode per stalk and millable cane with cane yield having r values of 0.727** and 0.758** respectively. Stalk diameter had the lowest correlation with cane yield in both season. The results also show that the correlation between each yield component character was positive and highly significant in the two seasons. The correlation existing for stalk diameter and cane yield was lower than that between cane yield and any other attribute in 2002-03 and 2003-04 seasons being 0.400** and 0.442** respectively.

Table 1. Correlation Coefficients Between Different Pairs of Characters Studied for 2002-03 Growing Season

Characters	Stalk length	Internodes stalk^{-1}	Stalk diameter	Millable cane	Cane Yield
Stalk length	1.000**				
Internodes stalk^{-1}	0.744**	1.000**			
Stalk diameter	0.560**	0.602**	1.000**		
Millable canes	0.680**	0.624**	0.400**	1.000**	
Cane yield	0.770**	0.790**	0.634**	0.784**	1.000**

** indicates significant correlation between two variables at 1% level of significance (df =n-2)

Table 2. Correlation Coefficients Between Different Pairs of Characters Studied for 2003-04 Growing Season

Characters	Stalk length	Internodes stalk^{-1}	Stalk diameter	Millable cane	Cane yield
Stalk length	1.000**				
Internodes stalk^{-1}	0.718**	1.000**			
Stalk diameter	0.703**	0.664**	1.000**		
Millable canes	0.782**	0.606**	0.442**	1.000**	
Cane yield	0.907**	0.727**	0.687**	0.758**	1.000**

** indicates significant correlation between two variables at 1% level of significance (df =n-2)

Path Analysis

Path coefficient analysis was used to determine the direct and indirect contributions to cane yield of the stalk length, internodes per stalk, stalk diameter and number of millable cane in the two seasons. From these relations (Table 3) it

is clear that stalk length had the highest direct contribution to cane yield (0.6536) in 2003-04 season. This was followed by number of millable cane, with direct contribution of 0.4129 in 2002-03 season. The magnitude of the direct contributions of stalk diameter and internodes per stalk in the two seasons was very small. The data also disclose that stalk diameter, internodes per stalk and number of millable canes made their highest indirect contribution to yield through stalk length in 2003-04 compared to any other paired contribution in this study. The indirect contribution of these variables via stalk length was mainly responsible for the total contributions of the characters to yield in the season. Further more, the indirect contribution of stalk length through number of millable canes (0.3179) in 2002-03season was the fourth largest indirect contribution to yield. It is noteworthy that the indirect contribution of any yield component character through its association with stalk diameter was very small in both seasons.

Table 3: Path Coefficient Analysis of Cane Yield and its Components in 2002-3 and 2003-04 Growing Seasons

PATH – WAY		PATH – COEFFICIENT	
Characters analyzed	**Code**	**Growing season**	
		2002-03	**2003-04**
Stalk length and Cane yield			
Direct contribution	P_1	0.1572	0.6536
Indirect via stalk diameter	$r_{12} P_2$	0.1183	0.0640
Indirect via internodes stalk^{-1}	$r_{13} P_3$	0.2172	0.0817
Indirect via millable canes	$r_{14} P_4$	0.3179	0.1077
Total contribution	$\mathbf{r_{18}}$	**0.7700**	**0.9070**
Stalk diameter and Cane yield			
Direct contribution	P_2	0.2051	0.0911
Indirect via stalk length	$r_{12} P_1$	0.0881	0.4595
Indirect via internodes stalk^{-1}	$r_{23} P_3$	0.1758	0.0756
Indirect via millable canes	$r_{24} P_4$	0.1652	0.0609
Total contribution	$\mathbf{r_{28}}$	**0.6340**	**0.6870**
Internodes stalk-1 and Cane yield			
Direct contribution	P_3	0.2919	0.1138
Indirect via stalk length	$r_{13} P_1$	0.1168	0.4693
Indirect via stalk diameter	$r_{23} P_2$	0.1234	0.0605
Indirect via millable canes	$r_{34} P_4$	0.2577	0.0834
Total contribution	$\mathbf{r_{38}}$	**0.7900**	**0.7270**
Millable canes and Cane yield			
Direct contribution	P_4	0.4129	0.1377
Indirect via stalk length	$r_{14} P_1$	0.1069	0.5111
Indirect via stalk diameter	$r_{24} P_2$	0.0820	0.0403
Indirect via internodes stalk^{-1}	$r_{34} P_3$	0.1822	0.0690
Total contribution	$\mathbf{r_{48}}$	**0.7840**	**0.7580**

Discussion

The correlation between cane yield and all the yield component characters was positive and highly significant. This suggests that selection for these components would be effective in yield improvement. Stalk length had about the highest positive coefficient in all seasons. This may imply that stalk length was more important than any other character in determining cane yield.

Number of millable canes ranked second, while stalk diameter was the least important component of cane yield ranking fourth in both seasons. In general, the order of importance for components of cane yield was stalk length, number of millable canes, internode per stalk and stalk diameter. Miller and James (1974) reported stalk number, stalk diameter and stalk length in order of importance for determining cane yield.

The high correlation coefficient between stalk length, internodes per stalk and number of millable canes may suggest that canes with long stalks will consequently have high number of internodes per stalk and more cane number. The relatively low significant positive correlation obtained between millable cane and stalk diameter in both seasons indicates that selection for one character may not be strongly connected to the other in determining final yield as observed by Yahaya, *et al*., (2007). Correlation between stalk number and stalk diameter were reported to be negative in the studies by James and Falgout (1969), Smith and James (1969), and Kang *et al.*, (1983). From a practical point of view, increasing the level of millable cane or stalk diameter would naturally be expected to increase cane yield.

The relative influence of the characters on cane yield within each season is shown by the direct contribution component of the partitioned total correlations. The results of the path analysis show that the direct effect of stalk length on yield was the highest. Similarly, the indirect effect of other characters through association with stalk length was high. This finding emphasizes the role of stalk length in determining cane yield, as was indicated by the correlation studies. Millable canes also gave high correlation coefficient being (0.7840 and 0.7580 in 2002-03 and 2003-04 seasons). However, the high correlation was largely due to its direct effect on 2002-04 season and indirect effect through stalk length in 2003-04 season. This qualifies millable cane as second in importance for determining cane yield, as demonstrated by the correlation analysis. James (1971), from phenotypic path analysis reported stalk number to be the most important component of cane yield followed by stalk diameter and stalk length. However, similar studies conducted by Miller and James (1974) and Kang *et al*., (1983) indicated that stalk number and stalk diameter were of about equal in important in determining cane yield.

Further more, number of millable cane was about twice as important as stalk diameter and internode per stalks and approximately three times as important as stalk length in determining cane yield in 2002-03 season. Never the less, in 2003-04, the relative importance of stalk length was greater than other characters in determining cane yield. Thus, it appears that, seasonal variation can alter the relative importance of characters in determining yield.

Conclusion

Yield component studies through path analysis have shown that number of millable canes and stalk length are the most important characters directly contributing to yield. However, correlation analysis have place stalk length,

number of internodes per stalk and number of millable canes (with about equal coefficient value in the two season) on the same pedestal in terms of contribution to yield. The study show that for breeding purpose, improvement in cane yield would be best accomplished by emphasizing high stalk length and number of millable canes compared to other yield components.

References

Ahmed, M.K., (1997). Yield analysis via path coefficients. *Special seminar on Statistics*. Department of agronomy, ABU Zaria, Nigeria. p. 1-2.

Brown, A. H. D., Daniel, J. & Latter, B. D. H. (1968). Quantitative genetics of sugarcane I. Analysis of variation in a commercial hybrid sugarcane population. *Theoret. applied genet* 38: 361-369.

Gravois, K.A. (1991). Additive genetic effects for sugarcane yield components and implications for hybridization. *Tropical agriculture (Trinidad)*. 68(4): 376-380.

Hebert, L. P. (1967). Association between yield components and yield of sugarcane varieties in Lousiana. *International Society of sugarcane technologies. 5th Congress proceedings*, p 760-763.

Hebert, L. P. & Henderson M. T. (1959). Breeding behavior of certain agronomic characters in progenies of sugarcane crosses. *USDA Technical Bulletin No*. 1194: 54pp.

James, N. I. & Falgout, R. N. (1969). Association of five characters in progenies of four sugar cane crosses. *Crop science* 9: 88-91.

James, N. I (1971). Yield components in random and selected sugarcane populations. *crop science*, 10: 906-908.

Kang, M.S., Miller, J.D., & Tai, P.Y.P., (1983). Genetic and phenotypic path analyses and habitability in sugarcane. *Crop science* 23: 643-647.

Legendre, B. L, (1970). Association involving yield of sugar per acre and its component in sugarcane *Ph. D thesis, Louisiana state university, Baton Range,* La. 170 pp.

Miller, J. D. & James, N. I. (1974). The influence of stalk density on cane yields P. 177-184. *In*: Proceedings of the 15th International Society of Sugar Cane technologies Congress. Hayne and Gibbon Limited, Durban, South Africa.

Prabhakaran Nair, K.P., & Singh, R.P. (1974). Correlative analysis of yield and its components in maize. *Experimental agriculture.* 10: 81-86.

Salih, S.H., & Khadir, M.O. (1975). Correlations, path analysis and selection Indices for castorbean [*Ricinus communis* L.]. *Experimental agriculture.* 11: 145-154.

Singh. N.B., (1985) Response of sugarcane to foliar fertilization of nitrogen at different moisture stress. *Indian journal of agricultural. Science.* 55: 582-585.

Smith, G. A. & James, N. I. (1969). Association of characters within and repeatability between years in progenies of four sugarcane crosses. *Crop Science*. 9: 819-821.

Thakur, R., Jain, R.C., Thakur, G.L., & Sharma, S.R., (1989). Correlation and regression studies on yield and quality parameters as affected by N levels in sugarcane. Co-operative sugar. 21(4): p. 257-261. *Abstr. Field Crop*. No. 9070. 44(11): 1991.

Yahaya, M.S., Falaki, A.M., Ahmed, M.K., Amans, E.B. & Busari, L.D. (2007). Response of sugarcane (*Sacchrum officinarum* L) to nitrogen levels and irrigation frequency. *Unpublished PhD dissertation*, department of agronomy, ABU Zaria, Nigeria.