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RESEARCH ARTICLE :

Correlation analysis for root, growth, yield and quality parameters of twelve sugarcane clones (*Saccharum officinarum* L.)

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SUMMARY : Sugarcane, an industrial crop was grown in an area of 50.32 l ha with a cane production of 356.56 mt and a productivity of 70.86 t ha^{-1} in India during 2014-15. India ranks second in terms of area and per hectare productivity. Sugarcane being a C_4 plant is distinct and more efficient converter of solar energy, thus having potential to produce huge amounts of biomass. The root system of sugarcane deserves particular attention be- cause it is essential for the regeneration of the cane. The research on sugarcane has greatly advanced in recent decades, but many aspects of sugarcane including the root-shoot relationships are still poorly understood, that ultimately affect yield. Studies on sugarcane roots lag well behind those on other crops, in part due to the large plant stature and long crop cycle. Hence, a study on root characteristics of sugarcane along with growth, quality and yield and yield attributes have been taken up for the present research. Correlation analysis for all the parameters was considered as it shows relation between the characters. A root structure experiment involving twelve sugarcane genotypes was conducted at Agricultural Research Station, Basanthpur, Medak district during 2016-2017 for correlation studies on genotypes for their root mining characteristics in relation to growth and yield. Various root parameters, Morpho- physiological, yield and yield attribute parameters was observed at different growth stages of sugarcane crop. The correlation co-efficient is an index of the proportion of causes common in the genesis of two variables to the total and not the causes themselves. Data collected were subjected to variance and cross-product analysis using the analysis of variance and covariance. Highly significant and positive correlation was observed for all the root, growth, yield and quality parameters. However, a linear negative correlation was observed between the root dry weight and shoot root ratio.

KEY WORDS:
Sugarcane, correlation analysis, Positive, Significant, Linear negative relation

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BACKGROUND AND OBJECTIVES

Sugarcane, an industrial crop was grown in an area of 49,000 ha with a cane production of and 3.67 mt a productivity of 75 t ha^{-1} in Telangana during 2014-15. Sugarcane being

a C_4 plant is distinct and more efficient converter of solar energy, thus having potential to produce huge amounts of biomass. Comparison of various parameters correlations indicates the degree of relationships between traits. In addition to this means of defining relationships among traits, path-co-efficient analysis can be used to further define the phenotypic and genotypic correlation co-efficients. Such a procedure is desirable because some traits correlate due to a common association with other traits. Therefore, it is necessary to determine the direct effect of the correlation co-efficient unbiased by its indirect effects. Direct effects delineate the relative importance of yield components to yield. Indirect effects measure the degree of independence between two traits. Many sugarcane breeders have defined relationships among traits through phenotypic path-co-efficient analysis. James (1971) and Miller and James (1974) used phenotypic path-co-efficient analysis to show stalk number, followed by stalk diameter and stalk height, as the major components of cane yield in Florida. Shih and Gascho (1980) also had reported a positive correlation between LAI and sugarcane biomass yield. Singels and Donaldson (2000) showed that higher radiation interception was linked to high LAI resulting in greater biomass production. The positive and significant correlation for cane yield and sucrose yield was also been reported in many other studies (Milligan, 1988; Milligan *et al*., 1990).

RESOURCES AND METHODS

A root structure experiment was conducted at Agricultural Research Station, Basanthpur, Medak District during 2016-2017 for correlation studies of

Fig. A : Root structure

Sugarcane genotypes for their rooting characteristics in relation to growth and yield. The data pertaining the weather details and soil physico-chemical properties were noted for the experimental period. The experiment was laid in randomized block design with 3 blocks of root structures constructed especially for root studies (as shown in fig 1 and layout of the experiment is also given). Each block consisted of 12 structures each of size 1m x 1m x 1.2m for accommodating 12 varieties in three replications. Single node seedlings @ 12 no.s were planted in each root structure. Planting, fertilization, irrigation and harvesting were done as per the recommended practices. The biometric observations were recorded on root characters, plant morphological characters, yield attributes, quality and yield. At harvest, the walls of root structure were dismantled systematically and plants along with intact root systems were excavated as shown in Fig. B. Later the roots were washed with foam water and dried to record root parameters.

Fig. B : Excavation of roots after dismantling of root structure

Data were collected on: shoot root ratio, root length (cm), root spread (cm), root volume (c.c), root dry weight (g), sucrose yield (t/ha), cane yield (t/ha), sucrose concentration (%), stalk number ('000/ha), stalk height (m), dry matter (g/structure), cane girth(cm), single cane weight (kg), LAI, SCMR, Fv/Fm, RWC, juice Brix (%) and juice purity (%). Parameters related to root, stalk number, cane height, cane girth, single cane weight, dry matter and quality readings were taken at harvest, and parameters like LAI, SCMR, Fv/Fm, and RWC were taken at formative stage of crop. Necessary techniques like polarization, saccharimeter, SPAD meter, fluorometer, leaf area meter, scales, weighing scale etc. were used for deriving the data. Data was then subjected to variance and cross-product analyses using the analyses of variance and covariance. The statistical model used to calculate the phenotypic variances and covariance was: $Y = p + R + Y + E$ where p and R were the overall mean and replication, respectively.

OBSERVATIONS AND ANALYSIS

The correlation c-oefficient is an index of the proportion of causes common in the genesis of two variables to the total and not the causes themselves (Bowley, 1920). The assessed correlation among characters revealed linear and positive significant correlation between the root spread and root volume, root volume and root length, LAI and dry matter production, Stalk number and yield, cane girth and single cane weight, cane height and yield; and sucrose and sugar yield. However, a linear negative correlation was observed between the root dry weight and shoot root ratio (Fig. 1).

The root volume of different Sugarcane varieties was found positive and significantly in relation with root spread ($r = 0.726$). Similarly, root volume and root length ($r = 0.702$) were found positive and significantly related. The magnitude of correlation indicates that the sugarcane roots are more efficient in tapping moisture from ground during water stress. The varieties showing better root spread are considered as variety likely to possess drought tolerant traits. On the other hand, the co-efficient of determination is relatively high ($r = -0.876$) and negatively correlated for shoot-root ratio and root dry weight indicating that it was highly dependable factor of ground mass for the productivity (Smith, 1998). High shoot to root ratio is desirable as partitioning of biomass occurs to shoot at the expense of root and thus more dry matter and yield is obtained. More dry weight in root is an undesirable character especially in sugarcane as stem (shoot) is of economic importance.

The number of nodes and intermodal length readings were taken at harvest stage which revealed a negative relation. The varieties which possessed high number of nodes recorded lower intermodal length which indirectly has affected the yield of crop.

Further, a linear positive and significant correlation between LAI and dry matter production ($r = 0.676$) was noticed, since, LAI is an important adjustment factor in

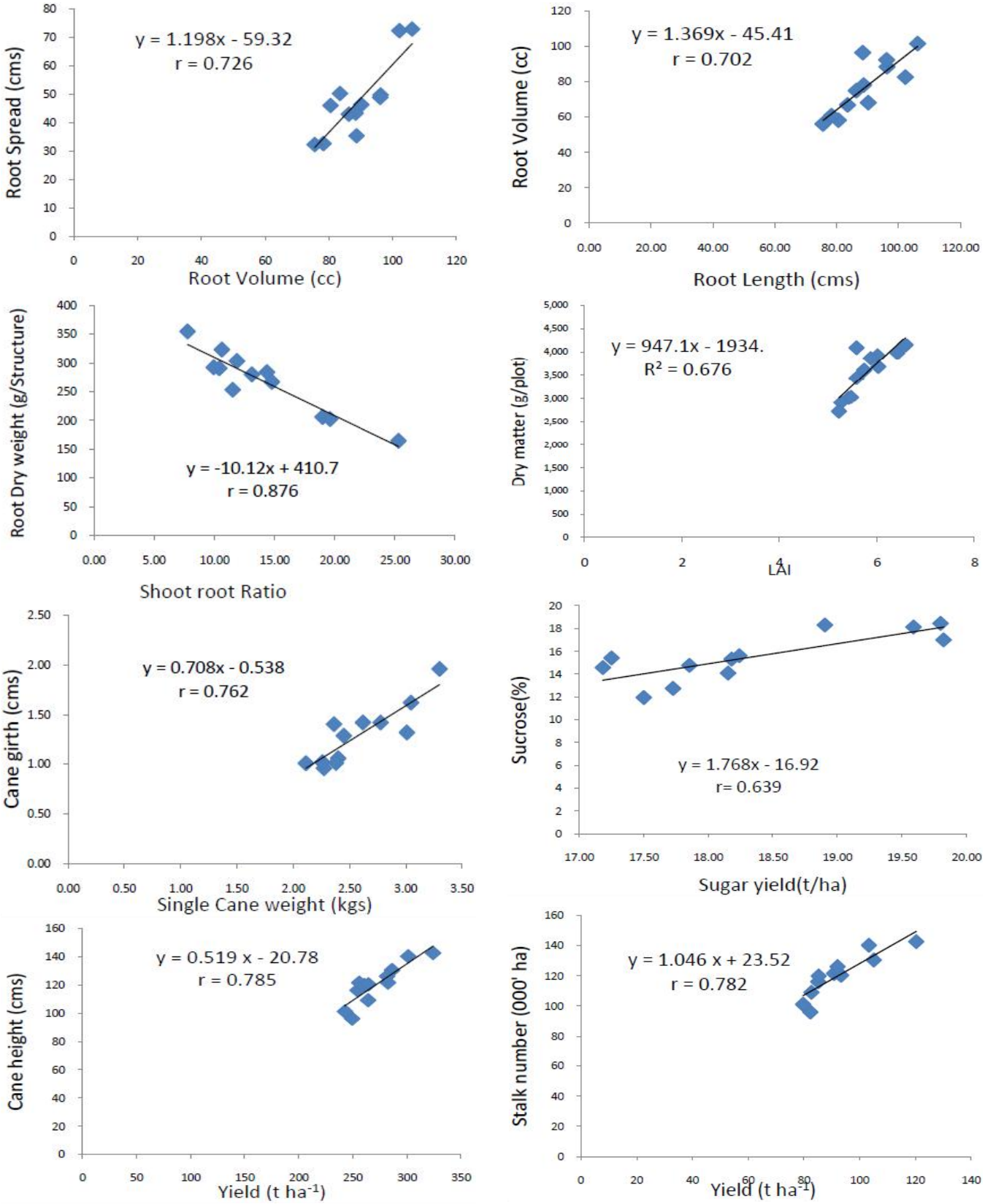

Fig. 1 : Interrelationship between root, growth, and yirld attributes in sugarcane

sugarcane for growth and biomass yield. Shih and Gascho (1980) also had reported a positive correlation between LAI and sugarcane biomass yield. Sucrose yields in sugarcane could be increased through increased radiation use efficiency (Robertson *et al.*, 1996). Singels and Donaldson (2000) showed that higher radiation interception was linked to high LAI resulting in greater biomass production. While sugarcane LAI is directly related to yield, there are fewer studies regarding the trend in this relationship through growth stage and crop cycles. In case of physiological parameters *i.e.* SCMR, Fv/Fm and RWC a relation was observed. The higher SCMR values had shown positive reflectance on chlorophyll fluorescence and relative water content. Conversely, lowest SPAD values were noted in some varieties, the same trend was not reflected with chlorophyll fluorescence, relative water content and leaf area index.

There was linear positive and significant correlation between cane girth and single cane weight (r = 0.762), stalk number and yield (r = 0.782), cane height and yield (r = 0.785); and sucrose and sugar yield (r = 0.639). The varieties which showed high values for morphological and yield attributes has shown high yielding ability. The positive and significant correlation for cane yield and sucrose yield was also been reported in many other studies (Gravois, 1988; Milligan, 1988; Kang *et al*., 1983; 1989; Milligan *et al*., 1990), and cane yield was generally found to be the primary determinant and sugar content the secondary determinant of sugar yield. Higher sucrose and CCS percentages had registered higher sugar yields and were noted as best quality varieties.

Conclusion :

Correlation is of the statistical analysis which determines relationship between two parameters. Positive and highly significant correlation between two characters states that one parameter has positive affect over the other while; contrast is seen for negative correlation. The present correlation analysis study has helped to determine which morphological, yield and yield attributes and root parameters are positively related and thus affect the yield.

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