VARIABILITY AND HETEROSIS IN INTERVARIETAL HYBRIDS OF SUGARCANE [*Saccharum officinarum L.*]

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "Variability and heterosis in intervarietal hybrids of sugarcane" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "Variability and heterosis in intervarietal hybrids of sugarcane" is a record of research work done independently by Smt. ALICE ANTONY under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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ALICE ANTONY

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Introduction

INTRODUCTION

Sugarcane and sugar beet form the two major sources of commercial sugar in tropical and temperate zones of the world respectively. Sugarcane has a paramount place in the sugar industry as it contributes the lion's share of the raw material, besides being able to produce a host of bye-products. The crop is essentially a tropical one. It has however been in cultivation in subtropical India from time immemorial. Sugarcane is cultivated in India since ancient times. It is referred in Atharva veda. The use of gur in religious practices indicates the presence of sugarcane plant in India since the days of mythology.

Sugarcane is classified under the genus Saccharum and belongs to the family Gramineae. Of the cultivated species, Saccharum officnarum occupies an important niche on account of its higher yield potential and allied noble attributes.

The genus Saccharum is genetically a complex one. It is characterised by variable chromosome numbers and high polyploidy. Parthenogenesis adds to these complexities. There are two cytological types (1) officnarum type in which the chromosome number is constant, basic number is ten and meiosis regular. (ii) spontaneum type with variable chromosome number, irregular meiosis, basic number not decided (Parthasarathy, 1972). Sugarcane has been known in India long before other countries took to its cultivation. Naturally India was considered as the original home of this crop till the time of the dual origin theory according to which the Northern India region was accepted as the place of origin of the indegenous cultivated varieties grouped under *Saccharum barberi* and the polynesian islands as that of the tropically cultivated *Saccharum officinarum*. The cultivated sugarcane is not seen in the wild state anywhere and its cultivation is confined to the tropics and sub tropics roughly between 35° North and South of equator. Sugarcane occupies an area of 31,19,000 ha and 8537 ha in India and Kerala respectively.

Sugarcane breeding is confronted by countless number of problems. Flowering is confined to South Indian conditions only. Flowers are tiny and seeds are delicate in germination. Selfing in sugarcane does not seem to yield good rewards. Reciprocal recurrent selection is reported to yield greater measure of recombination. Polycross method is also recommended. In the melting pot technique adopted in Hawaii, there is economy of cost and time, but here only female parent is known.

The history of sugarcane breeding dates back to 1912, when the first cane breeding work was started at Coimbatore and the consequent production of the first hybrid Co 205.

Being a high polyploid by itself, inheritance of characters is more complex in sugarcane. Studies at Coimbatore indicated that certain characters like weight of stalks can be relied on as criteria of selection, as the variation of this character from place to place is not high indicating genetic stability. In India, the phenomenal success of the earlier Coimbatore hybrid varieties had led to an ever increasing demand for high tonnage quality canes with built-in-resistance to a wide spectrum of unfavourable environments. It is an undisputable fact that the spectacular increase in the yield of sugarcane per hectare has been mainly due to the successful production of new high yielding varieties of cane obtained by selection from the enormous number of seedlings.

The problems of sugarcane industry are well known. Though a number of varieties have been bred and cropped over large areas of land, still degeneration or reduced yields have been noticed in many cases on account of a host of reasons. The practice of monoculture is widespread in sugarcane causing problems of pests and diseases. The crushing season is limited and because of the existing policy of the mills generally to pay on quantity basis instead on quality criteria, the incentive to grow high sucrose varieties is on the decline. The failure of variety to yield takes two forms; an apparent sudden and spectacular collapse, or a more or less general decline. Regardless of cause, the threat of the yield decline can best be countered by active breeding and testing programme. Biological influences on the deterioration of cane varieties in Hawaii have been studied by Martin et al., (1959) who included cultural, environmental and genetical causes in their consideration of this problem. According to Simmonds (1967) a close adaptation will reduce the variability and thus limit long term adaptability by narrowing the genetic base.

In Kerala, the area under sugarcane has not registered an increasing trend. One of the factors which contributes towards this decline is the non-availability of high yielding cane varieties suited to local conditions. With this end in view the present investigation was taken up. The experiment was carried out at the Sugarcane Research Station, Thiruvalla. Four hundred and fifty seedlings available from the cross Co 775 x Co 453 were subjected for subsequent studies. The female parent was endowed with the qualities of resistance to water logging, high sucrose content, profuse tillering capacity and good ratooning ability, while the male parent possessed saline and drought resistance, thickness of cane and higher yield potential. The female parent had high fibre content.

Seventeen attributes were studied in the seedling population and correlations and coefficient of variation worked out. From among the seedling population, sixty five clones were selected based on the millable cane number, H.R.Brix, total weight of cane and general appearance. The selected clones were tried in an RBD with three replications along with parents and four standards prevalent in the Thiruvalla area namely Co 997, Co 449, Co 785 and Co 62175. Seventeen important economic attributes were assessed from the clonal population. The statistical studies included the estimation of coefficient of variation, correlation coefficients (both phenotypic and genotypic), heritability, genetic advance and heterosis.

The studies enabled to elucidate twenty four elite clones with higher values for millable canes, brix, pol, purity, ccs and total weight.

Review of literature

REVIEW OF LITERATURE

Saccharum officinarum, being a complex polyploid, makes it impossible to forecast the characteristics of hybrids derived by cross pollination between varieties. The progeny of one cross may number several thousands of individuals displaying wide range of variation in size, appearance, growth habit, disease susceptibility, vigour, yield and other features. Therefore, cane breeding may at first sight appear to be empirical, it depends basically for success in the inheritance of desirable characters from known parents possessing particular and desirable attributes. The great variability in hybrids is due to the unusually large number of chromosomes and genes in the species and subspecies of *Saccharum* and in the variations in these numbers not only between species but between local forms of the same species. Most of the commercial characters in sugarcane are polygenic in inheritance. The genetic stocks are maintained as clones and most of the varieties are characterised by extreme degrees of heterozygosity. Hybrid seedling population therefore display wide genetic variation and provide excellent scope for selection among the segregants.

Genotypic and phenotypic variability, heritability and genetic advance in sugarcane

(i) Quantitative traits:

Craig (1944) while studying refractometric brix and weight per stool in seedling population reported a greater coefficient of variation for weight of stool than refractometric brix. In seedling populations, Desorney (1950) emphasised that genotypic variability was a function of genetic make up and different for each of the seedlings. Burton (1952) suggested that genetic coefficient of variation along with heritability estimates would provide the best picture of the amount of advance to be expected from selection.

The heritability estimates relating to important economic traits have been studied by many workers. From a study on characters like cane thickness, length, number, brix and grade at four locations in sugarcane crosses, George (1962) observed that heritability values in the broad sense ranged from 6-82 per cent. Yang and Chu (1962) recorded heritabillties of cane yield, stalk length and tiller number to be 35 per cent, 45 per cent and 49 per cent respectively. In an observation conducted in twenty hybrid clones, Rao et al., (1966) reported that the heritability varied from 51 per cent to 91 per cent for the characters, germination percentage, height, girth, yield and sucrose percentage. Substantial genetic advance for similar characters were reported by Rao et al., (1967) and Shah et al., (1966). By employing the parent progeny regression method, Anonymous (1967) estimated heritability in narrow sense for germination at 30 days, as 0.17. High heritability values and low coefficients of genetic variation for yield components in sugarcane were reported by Mariotti (1971 c). On the basis of broad sense heritability estimates, Dayal et al., (1972) suggested that selection for yield and shoot number should be based on the phenotype while for node number and height, selection should be based on progeny performance only. In hybrid progenies of three sugarcane crosses, Mariotti (1973) observed the highest heritability value of 63 per cent for stalk diameter, followed by stalk weight (53%). High variability for cane yield, number of stalks and stalk weight were also reported by him. Allam et al., (1974) reported high heritability estimates for tons of cane per hectare, kg sugar per ton of cane, and kg sugar per hectare in plant, first ratoon and second ratoon crops of over 100 experimental clones.

High heritability values for yield and quality characters in seedlings were obtained by Cesnik (1975). Khairwal (1975) reported high estimates of broad sense heritability for leaf width, leaf length, cane thickness and number of millable canes and medium estimates for height of cane. High heritability estimates for flowering in sugarcane were obtained by Lyrene (1977a).

The variance components, broad sense heritability estimates, expected genetic advance and genetic coefficients of variation for yield characters, on the plant and ratoon crops of twenty early maturing cane varieties in two localities were studied by Sahi et al., (1977) and recorded very high heritability estimates for yield in the plant (96.24%) and ratoon (91.44%) respectively. Balasundaram and Bhagyalakshmi (1978) from varietal studies, reported high genetic variability for stalk yield and its components namely number of millable stalks per row, single stalk weight and amount of sugar produced per row. On the basis of the results from parent and progeny analysis, Hogarth et al., (1981) observed high variability for cane yield and low heritability for stalk diameter and length. High variability for yield attributes like yield per clump and number of millable canes was reported by Punia and Singh (1981). Singh (1981) obtained high variability and heritability estimates for yield in sugarcane.

(ii) Qualitative traits

In sugar industry, the total cane yield is not the ultimate objective as it is generally conceived, but the commercial cane sugar (CCS) per unit area is of paramount importance. Juiciness, brix, pol, purity and ccs are the common parameters generally employed to gauge the quality attributes. A perusal of the works done in these lines elucidate interesting trends.

In hybrid populations, Brown (1965) obtained heritability estimates for brix and fibre content as 50 per cent and 75 per cent respectively. In ten genotypes, moderate heritability for sucrose under varying heterogenity conditions, maximum heritability in different seasons and the highest heritability values under different locations were reported by Rao *et al.*, (1967). Mariotti (1971c) recorded moderate heritability values for pol, juice purity and moisture in bagasse. For these attributes, he could get only low coefficients of variation. Further, he observed a variability less than 5 per cent for quality components also. For sucrose, Khairwal and Babu (1975) recorded low broad based heritability. Amador and Galvez (1977) observed brix to be the less variable character in their studies on different families, while the progenies displayed greater variation for this character. High heritability values of brix and stalk diameter were reported by Galvez and Amador (1978). Singh et al., (1978) observed sufficient genetic variability for brix percentage, sucrose percentage, purity and ccs percentage. For refractometric brix within progenies of a single parent, Mariotti et al., (1979) reported 42 per cent heritability. Hogarth et al., (1981) observed low heritability values for sugar content on the basis of the results from parent progeny analysis. High variability and heritability values for quality attributes namely, ccs percentage and sucrose percentage were reported by Punia and Singh (1981). Singh (1981) also reported similar results for quality attributes.

CORRELATIONS

Elaborate correlation studies on quantitative and qualitative attributes have been conducted by many workers. However, the parameters available are very little to predict the quality attributes with precision. A good amount of work done in these lines helped to standardise the correlation indices with respect to many economic characters. In the past, many workers have tried to correlate the yield and quality attributes with the vegetative characters in sugarcane with an objective to find out a suitable indicator for selection.

i. Quantitative traits

The inverse relationship between tillering capacity and thickness was recorded by Wodehouse (1915). Positive correlations between yield and number of millable canes were reported by many authors. Quintus (1925) could notice proportionate increase in yield with stooling. Gill (1949) and Rattan (1951) observed highly significant positive correlation of yield with total length and number of canes per unit area. The latter also recorded high positive correlation between leaf area and yield. The total absence of correlation between juice quality and weight per stool in seedlings was reported by Desorney (1950). Dillewijn (1950) noticed an approximately linear relationship between mean plant weight and number of stalks. He observed a highly significant correlation coefficient between mean weight of the stalk and its mean length.

Within crosses, significant negative correlations for stalk diameter and number of stalks per stool were recorded by Herbert and Henderson (1959). George (1962) and Mariotti (1972*b*;1973) also obtained similar results.

Subbarao et al., (1962) reported that there was no correlation between early vigour of the seedlings and the final data on number of stalks per clump and thickness of stalk.

The positive correlation between number of millable canes with height, weight and girth have been established by many workers. Consistent positive and significant correlations with number of millable canes and cane height were obtained by Varma (1963) and Mariotti (1971a;1972a). Anon. (1965) reported the same trend with respect to cane diameter also in hybrid seedlings. But, an inverse association of number of canes per clump with thickness of cane, number of internodes per clump and yield of cane, was reported by Singh and Jain (1968). Singh and Sangha (1970) showed that cane girth, number of internodes and juice percentage had significant correlations with cane yield. High correlation of stalk number followed by stalk diameter and length with cane yield was observed by James (1971). He further concluded that stalk density had the least correlation with yield. Juang (1971) also reported same results. Low positive correlation of yield with number of internodes and girth was reported by Batcha and Sahi (1972). They also obtained highly significant positive correlations between number of canes per row and height of millable canes with cane yields. Stalk diameter was observed to be a better criterion for forecasting yield according to Miller and James (1975). Balasundaram and Bhagyalakshmi (1976), and Khairwal and Babu (1976) emphasised the maximum contribution of stalk number to yield. High positive correlation of cane weight with cane length, thickness and number of internodes was underlined by Bathila (1978). Singh et al., (1981) obtained positive genotypic and phenotypic association with number of millable canes per clump, number of internodes per stalk and number of green leaves per cane.

ii. Qualitative traits:

Correlations between morphological and anatomical characters and with other traits were investigated by Barber (1915, 1916 and 1919). According to Barber (1915) sucrose and purity of cane juice were inversely correlated with vigour. Further, he reported negative correlation between the width of the leaf and sucrose content in seedling populations. Low degrees of positive correlations between sucrose, fibre, stalk diameter and stalk weight were reported by Stokes (1934). Stevenson (1954) obtained similar results between cane weight and brix of juice. While studying correlations between juice weight and leaf characters Rao and Negi (1956), reported significant negative correlation of juice weight per stalk with number of green leaves, total area of green leaves and dry weight of green leaves.

High positive correlation between brix value and sucrose in hybrid progenies was obtained by Hebert(1957). Hebert and Henderson (1959) recorded significant negative correlation between diameter and brix within crosses. Between ten month old seedlings and settlings, non-significant correlation for canes per clump and brix in juice was reported by Bhat <u>et al</u>., (1960). High yield and high sugar were found to be negatively correlated by Rao and Narasingham (1963). Brown (1965) observed a non-significant genetic correlation and a small positive phenotypic correlation between brix in juice and fibre. In intervarietal crosses, Ethirajan (1965) obtained negative relationship between yield and juice quality. Very high correlation between stalk diameter and milling quality and low degree of negative correlation between cane yield and sucrose recovery were reported by Hebert (1965). Similar results were obtained by Batcha and Sahi (1972). Luna (1965) recorded negative correlation between brix and stalk diameter in hybrid progenies. Khapaga et al., (1966) observed that stalk weight had no correlation with brix. Inverse association of number of canes per clump with juice percentage per clump was reported by Singh and Jain (1968). Further, they reported positive significant correlations between height of the main shoot, thickness of cane, number of internodes per clump, yield of canes and juice percentage. Mariotti (1971) emphasised that juice quality was not strongly associated with fibre content or yield. Significant correlations between H.R.Brix and sucrose content and between sucrose content and purity in crosses were observed by Richard (1975).

Dosado et al., (1976) suggested that canes with long stalks and leaves had lower sugar content while freely flowering varieties had higher sugar content at harvest.

Further, they observed varieties with greater stalk diameter and wider leaves to be giving higher sugar yield.

Lyrene (1977b) reported juiciness to be an important component of yield in sugarcane. In different varieties significant positive correlations between the ccs per cent and brix value, sucrose per cent and purity coefficient were reported by Kanwar Singh _et al._, (1979). Singh _et al._, (1981) observed negative association of stalk height and stalk girth with brix value.

Heterosis

The important varieties of sugarcane available today are complex hybrids that include in their ancestry representatives of both _Saccharum officinarum_ and _Saccharum barberi_ groups of cultivated varieties together with representatives of one or both of the wild species. Thus the sugarcane breeder has been exploiting to the best of his ability the advantages that heterosis has to offer.

If heterosis is to be measured by comparing the performance of offspring with that of the parents, then higher the standing of the parents in the scale of measurement, the lower the degree of heterosis to be expected in the offspring and vice versa.

A perusal of the literature available on the studies on heterosis indicates that the information available in this aspect is scanty.

While studying the principles of breeding vegetatively propagated crops, Hebert and Henderson(1959) reported that the general performance of the progeny derived from a cross could be predicted to a reasonably relative degree from the performance of the parents. There were no instances in which inferior parents produced a superior progeny or vice versa. Further, they observed that the smaller the relationship between two parents, the greater the heterosis expressed in the mating.

Luna (1965) from his study on the progeny characters in four sugarcane crosses observed the presence of a possible negative heterotic effect especially for the stalk thickness and number of immature canes.

Anonymous (1965) reported nine per cent higher cane yields and 20 per cent higher sugar yields for the variety F 148, than the standard variety N Co 310.

While evaluating the plant attributes concerned with yield in sugarcane and assessing their behaviour in succeeding clonal population, Ethirajan (1965) observed that the progeny of the crosses Co 419 x Co 678 and Co 419 x Co 779 recorded high mean yield than the mean of the higher yielding parent Co 419.

A higher sucrose percentage and ten per cent more sugar was reported for the variety CoS 541 (Co 419 x Co 285) and the local variety CoS 510 by Singh (1965).

Shen (1967) reported three to five per cent higher sucrose content for the variety F 153 (N Co 310 x 34-136) than N Co 310. He compared varieties F 154, F 155 and F 156 with the standard N Co 310 for sugar yield and found an increase of ten per cent, 15 per cent and 15-20 per cent sugar than the standard.

Hogarth (1968) reviewed the quantitative genetics in plant breeding with particular reference to sugarcane and concluded that the theory of quantitative genetics may be inadequate when applied to a clonally propagated crop like sugarcane.

From the experiments with *Saccharum officinarum* and *Saccharum spontaneum* crosses, Roach (1969) concluded that male-female interactions are highly significant in determining sucrose yield per acre, percentage of flowering and pollen production. In the cross Korpi x 51 NG.2, features of stooling and quality exceeded the mid parent values while stalk thickness, flowering time, total sugar and sucrose approximated with mid parent values and fibre content and erectness remained below mid parental values.

Materials and methods

MATERIALS AND METHODS

The present investigation was carried out at the Sugarcane Research Station, Tiruvalla during the year 1981. Four hundred and fifty hybrid seedlings of the cross Co 775 x Co 453 which displayed remarkable morphological variation were selected for the preliminary studies. Observations on the following characters were recorded in January 1981, when the seedlings attained eight months' age.

1. Compactness of shoots

Based on the orientation of the canes, the seedlings were categorised as (a) Compact (b) Semicompact and (c) Open.

2. Rooting at nodes

The intensity of rooting at nodes were classified as (a) High (b) Medium and (c) Mild.

3. Colour of the stem

The intensity of the internodal pigmentation was recorded.

4. Colour of the leaf

Leaf colouration on either side of the midrib was noted.

5. Spines on sheath

The glaberous and pubescent sheaths were recorded separately.

6. Flowering

Flowering was recorded when the canes attained eight months' age.

7. Stem splitting

The stem splitting nature of canes was recorded when the canes were at eight months' maturity.

8. Number of shoots

Counts were taken including the number of water shoots at eight months' age.

9. Number of millable canes

Fully matured canes were reckoned as millable canes.

Three millable canes were randomly selected from each hybrid progeny and the following observations recorded.

1. Height

The height of the cane was measured from the lowest node to the uppermost node that could be seen after stripping off the leaves, averaged and expressed in centimetres.

2. Number of internodes

The total number of internodes were counted and averaged.

3. Length of internode

The length of the middle internodes were measured, averaged and expressed in centimetres.

4. Girth

Maximum girth of the middle internodes were measured, averaged and expressed in centimetres.

5. H.R.Brix

H.R.Brix values were taken from the lower fifth internode averaged and expressed as percentage.

6. Length of a three budded sett

The length of a three budded sett from the middle portion of each of the canes was measured, averaged and expressed in centimetres.

7. Weight of a three budded sett

The three budded setts were weighed, averaged and expressed in grams.

8. Weight of cane per unit length

Weight of cane per unit length was found out by dividing the mean weight of the three budded sett by its mean length.

9. Weight of canes per clump

Total weight of all canes in each clump was taken and expressed in kilograms.

Based on the above observations, progenies which exhibited higher values for height, girth, weight, H.R.Brix, number of millable canes and general vigour were selected for further studies.

The female parent, Co 775 and the male parent Co 453 were numbered as one and two respectively. The standards Co 449, Co 785, Co 997 and Co 62175 were assigned numbers from three to six and hybrid clones from seven to seventy one. From each of these progenies, setts with three viable buds were taken and planted along with parents and standards. The experiment was laid out in Randomised Block Design with three replications during February 1981.

Two metre rows of three budded setts constituted one treatment. Four numbers of three budded setts occupied one metre length, with an inter-row spacing of 90 cm. The cultural and management practices were given according to the package of practices of the Kerala Agricultural University (1979).

The following observations were recorded.

1. <u>Germination</u>

Germinated sprouts were counted on the 45th day of planting and expressed as percentage.

2. Shoot count

The total number of shoots per treatment were counted on the 90th day of planting and replication means obtained.

3. Grassy shoot count

The incidence of grassy shoots disease was recorded by counting the number of shoots affected on the 180th day after planting and replication means worked out.

4. H.R.Brix

Observations on brix percentage were taken in the tenth month by using a hand refractometer.

5. Number of water shoots

The total number of water shoots were counted in the tenth month and replication means worked out.

6. Number of arrows

The number of arrows produced were counted in the tenth month and replication means worked out.

7. Number of millable canes

From each treatment, fully matured canes were reckoned as millable canes at the time of harvest, and replication means worked out.

8. Number of internodes

(As measured in the preliminary studies)

9. Length of internode

(As measured in the preliminary studies)

10. Girth of the cane

(As measured in the preliminary studies)

11. Height of the cane

(As measured in the preliminary studies)

12. Juiciness

The total juice from a unit weight of cane (one kg) was extracted by using a power crusher. The quantity was expressed in millilitres.

13. Brix

One litre of juice was taken for brix reading. A standard brix spindle was used for taking the reading and, corrected to temperature.

14. Pol (percentage)

Pol percentage was worked out as suggested by Gupta (1977).

15. Purity (percentage)

Purity of the juice was expressed as the percentage of pol to brix.

16. Commercial cane sugar (percentage)

CCS was determined according to the scheme proposed by Mathur (1978).

$$CCS = S - \left\{ 0.4\ (B-S) \right\} F$$

where B = Brix percent

S = Pol percent

F = 0.73 - Factor relative to fibre percentage of cane

17. Total weight of cane

(As measured in the preliminary studies)

18. Weight of single cane per treatment

From the millable canes per treatment, a single cane was randomly selected, weighed, replication means worked out and expressed in grams.

As regards juiciness, brix and pol, replication means could not be worked out for want of sufficient quantity of juice from each treatment.

Statistical Analysis

The data collected in respect of the metric traits as mentioned above were tabulated and subjected to statistical analysis.

Genotypic and phenotypic correlation coefficients were estimated according to Burton (1952).

1. Genotypic correlation coefficient,

$$r\, g_1 g_2 = \frac{Cov(g_1,\ g_2)}{\sqrt{V(g_1)\ V(g_2)}}$$

where $Cov(g_1, g_2)$ = Genotypic covariance between the two traits

$V(g_1)$ = Genotypic variance of the first trait and

$V(g_2)$ = Genotypic variance of the second trait.

2. Phenotypic correlation coefficient,

$$r_{p_1p_2} = \frac{Cov(p_1, p_2)}{\sqrt{V(p_1)\ V(p_2)}}$$

where $Cov(p_1, p_2)$ = Phenotypic covariance between the two traits

$V(p_1)$ = Phenotypic variance of the first trait and

$V(p_2)$ = Phenotypic variance of the second trait.

3. Phenotypic coefficient of variation,

$$= \frac{\sqrt{V(p)}}{Mean} \times 100$$

where $V(p)$ = Phenotypic variance

4. Genotypic coefficient of variation,

$$= \frac{\sqrt{V(g)}}{Mean} \times 100$$

where $V(g)$ = Genotypic variance.

5. Heritability in the broad sense was estimated by the method proposed by Lush (1949) and Allard (1960)

$$h^2 = \frac{V(g)}{V(p)} \times 100$$

where h^2 = Heritability expressed in percentage

$V(g)$ = Genotypic variance and

$V(p)$ = Phenotypic variance

6. Expected genetic advance under selection was calculated according to Allard (1960)

$$GA = k.\ h^2.\ \sqrt{V(p)}$$

where GA = Genetic advance

h^2 = Heritability in the broad sense.

$V(p)$ = Phenotypic variance.

k = Selection differential expressed in phenotypic standard deviation

= 2.06 in the case of 5% of selection in large samples.

Estimation of heterosis

The three types of heterosis, viz., relative heterosis, heterobeltiosis and standard heterosis were estimated using the relation,

$$H = \frac{(\bar{x}F_1 - \bar{x}P)}{\bar{x}P} \times 100$$

where $\bar{x}F_1$ = Mean value of F_1

$\bar{x}P$ = Mean value of mid parent, better parent or standard variety as the case may be.

Negative heterosis expressed as the percentage decrease of the mean value of the F_1 over those of mid parent, better parent and standards was worked out with respect to the characters, number of water shoots and number of arrows.

For testing the significance of the difference between the mean values of the F_1 and those of the mid parent, better parent and standard varieties, the critical values were calculated as follows.

a) CD I (For testing the significance over mid parental value)

$$CD\ I\ (0.05) = t_e(0.05)\sqrt{\frac{3\ MSe}{2r}}$$

$$CD\ I\ (0.01) = t_e(0.01)\sqrt{\frac{3\ MSe}{2r}}$$

b) CD II (For testing the significance over the better parent and over the standard varieties)

$$\text{CD II } (0.05) = t_e\,(0.05)\sqrt{\frac{2MSe}{r}}$$

$$\text{CD II } (0.01) = t_e\,(0.01)\sqrt{\frac{2MSe}{r}}$$

where CD = Critical difference

MSe = Mean square for error

r = Number of replications,

$t_e(0.05)$ and $t_e(0.01)$ are critical values of 't' corresponding to error degrees of freedom at 0.05 and 0.01 levels respectively.

Since the data pertaining to grassy shoots, water shoots and number of arrows contained zero values, they were transformed by using square root transformation . ie. $\sqrt{x + 1}$

where x = observed value

Since the data on germination was expressed in percentage arc sin transformation was done (Panse and Sukhatme, 1954). This consisted in calculating the angle θ corresponding to the observed value of proportion P, such that $\sin \theta = \sqrt{P}$.

Results

RESULTS

i. Range, mean and coefficient of variation in the seedling population

The frequency of F_1 seedlings for the different qualitative attributes are presented in Table 1. The range, mean and coefficient of variation with respect to nine quantitative attributes of the four hundred and fifty hybrid progeny seedlings of the cross Co 775 x Co 453 are presented in Table 2. Out of the nine quantitative traits estimated, the maximum range (43.33 - 198.57) was displayed by height of cane followed by number of shoots, while girth recorded the minimum range. The coefficient of variation ranged from 10.36 to 55.18. The maximum variation in this parameter was manifested in weight of cane per stool (55.18) followed by number of shoots (51.29). The minimum coefficient of variation was observed in H.R.Brix reading (10.36).

ii. Correlation studies in the seedling population

The interrelationship among the nine metric traits estimated in the preliminary studies are presented in Table 3. Out of the thirty six correlation coefficients

Table 1

Table showing the frequency of F_1 seedlings for the qualitative attributes

Sl. No.	Character	Frequencies of F_1
1.	Compactness of shoots	
	a. Compact	143
	b. Semicompact	238
	c. Open	69
2.	Rooting at nodes	
	a. High	21
	b. Medium	31
	c. Low	129
3.	Colour of stem	
	a. Light green	27
	b. Purple	142
	c. Light purple	148
	d. Yellowish green	9
	e. Yellow with purple tint	12
	f. Green with purple tint	21
	g. Dark purple	91
4.	Colour of leaf	
	a. Light green	333
	b. Dark green	117
5.	Spines on s.	
	a. Presence	224
	b. Absence	226
6.	Stem splitting	
	a. Presence	48
	b. Absence	402

Table 2

Range, mean and coefficient of variation of hybrid seedlings

Sl. No.	Characters	Range	Mean	Coefficient of variation
1.	Weight of cane per stool	0.28- 7.76	2.21	55.18
2.	Number of shoots	2- 26	9.03	51.29
3.	Number of millable canes per stool	2- 19	5.69	44.61
4.	Height of cane	43.33-198.57	103.36	20.82
5.	Number of internodes	8- 24.67	12.63	18.61
6.	Length of internode	4.4 - 13.85	9.53	14.06
7.	Girth of cane	5.4 - 9.8	7.08	11.30
8.	H.R.Brix	11.33- 22.80	17.27	10.36
9.	Weight of cane per unit length	1.70- 7.32	3.67	24.23

twenty four were positively significant and four were negatively significant. The maximum degree of positive association was displayed between the characters, girth of cane and weight of cane per unit length (0.876). The maximum negative association was exhibited between height of cane and H.R.Brix (-0.00364).

The weight of cane per stool had positive correlation with the seven attributes except H.R.Brix. The number of shoots also displayed positive significant correlation with all the characters except girth of cane, H.R.Brix and weight of cane per unit length. The number of millable canes per stool displayed negative non-significant correlation between girth of cane, H.R. Brix and weight of cane per unit length. The height of cane at harvest displayed positive significant correlation with all the characters except H.R.Brix, where it showed a negative non-significant association. The number of internodes recorded negative significant correlation with length of internode while it displayed positive significant correlation with other characters. As regards length of internode, it exhibited positive significant association with girth of cane and weight of cane per unit length.

The H.R.Brix manifested negative correlation with characters like length of internode, number of millable canes and weight of cane per stool. Girth of cane also displayed negative association with number of millable canes per stool.

iii. Phenotypic and genotypic variability, heritability and genetic advance

The ANOVA with respect to thirteen quantitative characters studied in sixty five selected clones from the base material is presented in Table 4. The clones differed significantly for all the characters investigated. The mean values of the selected clones for all the quantitative traits are given in Appendix I. The range, mean, coefficient of variation, heritability and expected genetic advance under selection for the different characters are presented in Table 5. The maximum amount of phenotypic coefficient of variation was displayed by grassy shoot counts (119.77) followed by number of arrows (91.58). Weight of single cane displayed minimum phenotypic coefficient of variation, being 0.03. As far as genotypic coefficient of variation is concerned, the number of arrows recorded the maximum coefficient of

Table 3.

Correlations between yield and its components in seedling population

Characters	Weight of cane per stool	Number of shoots	Number of millable canes per stool	Height of cane at harvest	Number of internodes	Length of internode	Girth of cane	H.R.Brix	Weight of cane per unit length
Weight of cane per stool		0.61129**	0.71982**	0.62948**	0.49017**	0.24602**	0.405**	-0.04119	0.41920**
Number of shoots			0.62178**	0.27092**	0.19637**	0.11816*	0.05484	0.06376	0.0709
Number of millable canes per stool				0.32551**	0.20095**	0.18205**	-0.05201	-0. 06726	-0.05063
Height of cane at harvest					0.70437**	0.38162**	0.30424**	-0.00364	0.29941**
Number of internodes						-0.21332**	0.25959**	0.14524**	0.27598**
Length of internodes							0.13881**	-0.10101*	0.14078**
Girth of cane								-0.02006**	0.87602**
H.R.Brix									-0.01225**

** Significant at 1% level
* Significant at 5% level

Table 4

Analysis of variance table for the selected clones under character

Source	df	Mean square: Germination (45 DAP) @	Shoot count (90DAP)	H.R.Brix (10th month)	Total weight	No. of millable canes at harvest	Number of internodes at harvest	Length of internodes at harvest
Replication	2	190.782	131.6761	21.2515	5.0764	36.7089	24.7296	5.1884
Treatments	70	200.8158**	198.7009**	14.2978**	60.597**	68.4551**	36.6879**	3.3557**
Error	140	92.978	31.6284	5.7901	8.1559	13.2851	3.4852	1.0437

Source	df	Mean square: Girth of cane at harvest	Height of cane at harvest	Weight of single cane	Grassy shoot counts (180 DAP) @	Number of water shoots (10th month) @	Number of arrows (10th month) @
Replication	2	2.7919	1418.4903	15360.681	8.3369	2.6805	0.0732
Treatments	70	1.0291**	1598.2298**	109726.411**	3.0773**	1.2325**	2.5778**
Error	140	2.9000	245.1029	34798.419	0.9856	4.3392	1.9849

@ Transformed values

** Significant at 1% level

Table 5

Mean and genetic parameters of different characters of the clonal population

Sl. No.	Characters	Range	Mean	Coefficient of variation Phenotypic	Coefficient of variation Genotypic	Heritability in the broad sense	Expected genetic advance under selection.
1.	Germination (45 DAP)	25.02- 83.40	57.1306	29.21	13.37	20.96	7.2051
2.	Shoot count (90 DAP)	7.67- 53.33	24.4923	38.66	30.68	62.98	12.2847
3.	H.R.Brix (10th month)	12.8 - 21.8	17.9129	16.12	9.17	32.66	1.9251
4.	Total weight of cane	4.417- 18.333	9.4313	40.00	29.75	55.29	4.2973
5.	No.of millable canes at harvest	4.00- 30.67	16.1848	32.56	25.02	59.02	6.4074
6.	No. of internodes at harvest	15.11- 29.11	21.8277	16.65	14.30	73.72	5.5202
7.	Length of internodes at harvest	6.55- 12.30	9.6335	13.32	8.43	40.08	1.0592
8.	Girth of cane at harvest	6.20- 8.56	7.3158	9.72	6.37	42.84	0.6278
9.	Height of cane at harvest	134.61- 232.47	182.105	13.09	9.87	56.85	27.9191
10.	Weight of single cane	441.67-1170.00	768.8726	0.03	0.02	38.63	0.1857
11.	Grassy shoot counts (180 DAP)	0 - 23.67	6.4872	119.77	68.54	32.75	5.2417
12.	Number of water shoots	2.67- 21.33	9.3622	49.56	27.64	31.10	2.9729
13.	Number of arrows	0 - 20.67	5.3545	91.58	81.16	78.54	7.9338

variation (81.16) followed by grassy shoot counts (68.54). The minimum variation was displayed by weight of single cane (0.02).

The maximum extent of range was observed in the character weight of single cane, while the minimum degree of range was registered in girth of cane at harvest.

Heritability manifested wide variation in the thirteen characters studied. The maximum and the minimum heritability was displayed by number of arrows and germination respectively. All the characters displayed relatively high degree of heritability. High heritability was not always accompanied by higher genetic advance.

The expected genetic advance was maximum for height of cane at harvest and minimum for weight of single cane.

iv. Correlation studies in the clonal population

The phenotypic and genotypic correlations between the thirteen characters studied among the sixtyfive hybrid clones from the replicated trial are presented in Table 6. The genotypic correlations were found to be greater than the phenotypic correlations. The shoot count was found to be positively correlated with total weight of cane, number of millable canes, grassy shoots, number of water shoots and number of arrows, while this character was negatively associated with number and length of internode, height and girth of cane and weight of single cane. H.R.Brix displayed negative correlation with the characters, total weight of cane, number of millable canes, length of internode, height of cane, grassy shoot count, number of water shoots and number of arrows, while it showed positive correlation with three characters viz. number of internodes, girth of cane and weight of single cane. The total weight of cane displayed positive association with all the characters studied except grassy shoot counts. The number of millable canes was found to be negatively associated with girth, weight of single cane and grassy shoot counts, but it showed positive correlation with number and length of internode, height, number of water shoots and number of arrows. The number of internodes was positively associated with three characters, viz. girth and height of cane and weight of single cane, while it registered negative correlation with other characters. The length of internode was positively correlated with all the characters studied except shoot count, H.R.Brix and number of internodes. The girth of cane was seen positively correlated with H.R.Brix, total weight, number and length of internode, height of cane and weight of single cane. However, the girth and number of millable canes registered a negative non-significant correlation. The height of cane displayed negative correlation with H.R. Brix. At the same time it manifested positive significant correlation with total weight, number and length of internodes and weight of single cane. But this character manifested a positive non-significant correlation with number of millable canes.

Weight of single cane had positive correlation with H.R.Brix, total weight of cane, number of internodes, length of internode, girth and height of cane; while it was negatively correlated with shoot count, number of

X_1 - Germination (45 DAP)

X_2 - Shoot count (90 DAP)

X_3 -H.R.Brix (10th month)

X_4 - Total weight of cane

X_5 - Number of millable canes at harvest.

X_6 - Number of internodes at harvest.

X_7 - Length of internode at harvest.

X_8 - Girth of cane at harvest.

X_9 - Height of cane at harvest.

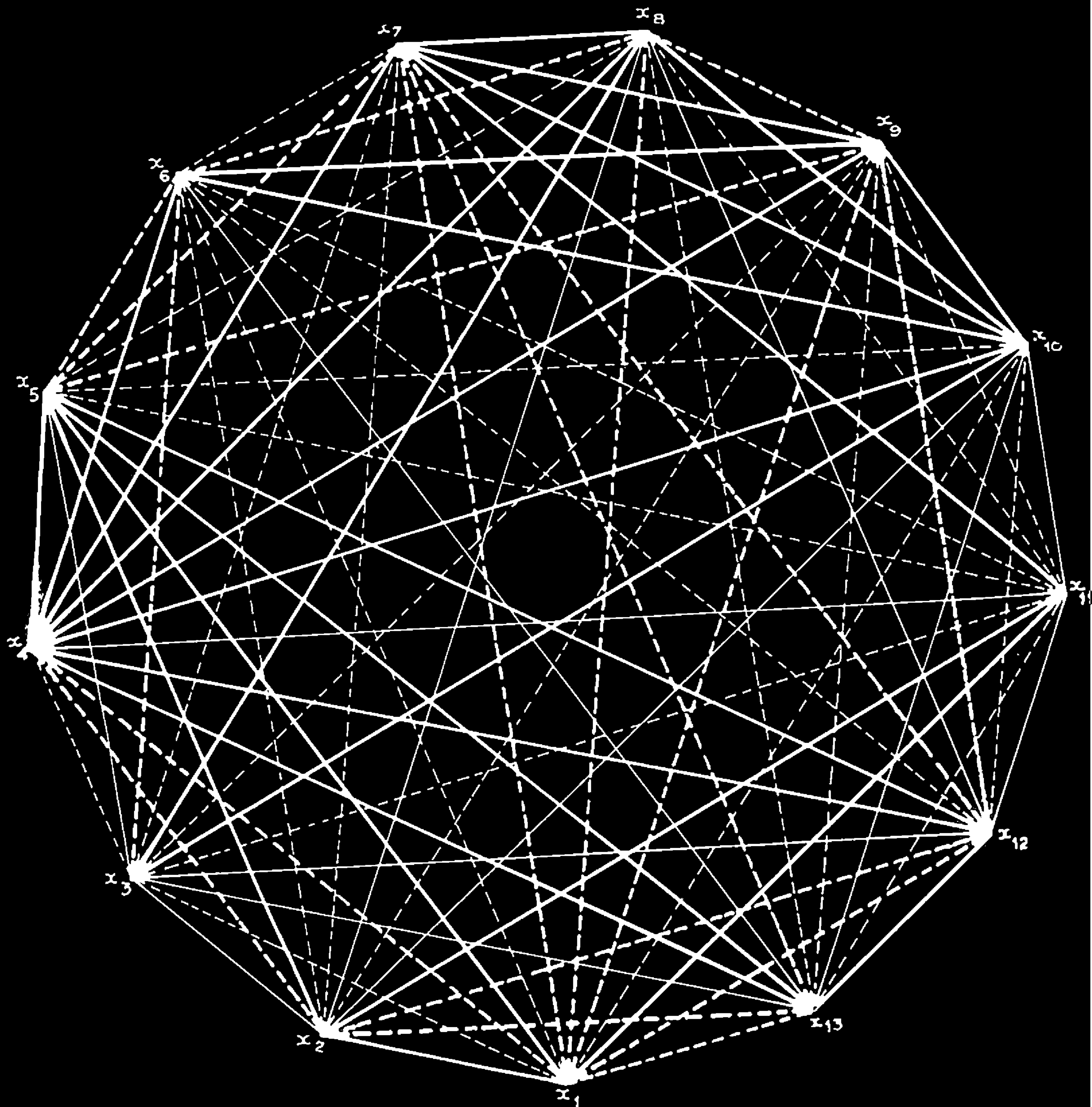
X_{10} - Weight of single cane

X_{11} - Grassy shoot counts (180 DAP)

X_{12} - Number of water shoots

X_{13} - Number of arrows.

FIG. 1. DIAGRAM SHOWING CORRELATION BETWEEN IMPORTANT ATTRIBUTES IN *Saccharum officinarum*.



millable canes, grassy shoot counts, water shoot counts and number of arrows. Grassy shoot counts were found to have negative associations with all the characters except germination, shoot count and length of internode, where it manifested positive associations. Number of water shoots had negative correlations with all the characters except total weight of cane, number of millable canes and number of arrows in which case, the correlations were positive and significant. The character, number of arrows followed a similar pattern.

The genotypic correlations among the thirteen characters of the hybrid clones studied in the replicated trial are diagramatically represented in Figure (1).

v. <u>Heterosis</u>

The mean values of parents, standards and F_1 hybrids and their heterobeltiosis, relative heterosis and standard heterosis in percentage are presented in Tables 7 to 18. Table 19 represents the percentage of hybrids displaying significant positive and negative heterosis, which is diagramatically represented in Figure (6).

1. Germination (45 DAP)

The mean values of the hybrids were found to be ranging from 25.02 to 83.40. The maximum and the minimum values were recorded by hybrid clone numbers sixty nine and thirty nine respectively. The hybrids displayed significant positive heterosis over the better parental and midparental values and a slight enhancement over the fourth standard, namely Co 62175.

Heterobeltiosis was positive and significant in three of the hybrids (4.6%) and the values ranged from 35.14% to 39.78%. The maximum value was recorded by clone number twenty one and the minimum by fifty one. The number of individuals displaying significant positive relative heterosis was much higher (12). The highest value of 67.83% was recorded by clone number twenty and the lowest value of 34.03 per cent by clone number eleven.

Significant negative heterobeltiosis was displayed by two out of the total sixty five hybrids (3.08%) and the values ranged from 33.71 per cent to 39.84 per cent. Relative heterosis was significant and negative only in

Table 7

The mean values of parents standards and F_1 hybrids and their heterosis in percentage

Germination (45 DAP)

Parents, standards and hybrids	Mean	Heterobeltiosis	Relative Heterosis	Standard Heterosis			
				1	2	3	4
1	2	3	4	5	6	7	8
1	71.14						
2	56.65						
3	57.92						
4	49.86						
5	32.69						
6	49.12						
7	45.80	- 6.75	11.95	-35.62*	-19.15	-20.93	- 8.14
8	49.92	1.63	22.02	-29.83*	-11.88	-13.81	12.03
9	44.20	-10.016	8.04	-37.87**	-21.98	-23.69	-11.35
10	55.21	12.398	34.95*	-22.39*	- 2.54	- 4.68	10.73
11	54.83	11.62	34.03*	-22.93*	- 3.21	- 5.33	9.97
12	47.41	- 3.48	15.89	-33.36**	-16.31	-18.15	- 4.9
13	59.38	20.89	45.15**	-16.53	4.82	2.52	19.09
14	47.75	- 2.79	16.72	-32.88**	-15.71	-17.56	- 4.23
15	52.55	6.98	28.45	-26.13*	- 7.24	- 9.27	5.40
16	32.56	-33.71*	20.41	-54.23**	-42.52**	-43.78**	-34.7*
17	36.60	-25.49	-10.54	-48.55**	-35.39*	-36.81*	-26.59

(Table contd..)

(Table 7 contd.)

1	2	3	4	5	6	7	8
18	48.31	- 1.65	18.09	-32.09*	-14.72	-16.59	- 3.11
19	49.04	- 0.0016	19.87	-31.07	-13.43	-15.33	- 1.64
20	45.00	- 0.084	9.99	-36.74**	-20.56	-22.31	- 9.75
21	68.66	39.78*	67.83**	- 3.49	21.2	18.54	37.71
22	64.35	31.01	57.3	- 9.54	13.59	11.10	29.06
23	51.59	5.03	26.11	-27.48*	- 8.93	-10.92	3.47
24	45.00	- 8.39	9.99	-36.74**	-20.56	-22.31	- 9.75
25	42.60	-13.27	4.13	-40.12**	-24.80	-26.45	-14.56
26	35.96	-26.79	-12.09	-49.45**	-36.52**	-37.91**	-27.88
27	52.45	6.78	28.21	-26.27*	- 7.41	- 9.44	5.19
28	49.9	1.59	21.98	-29.86	-11.92	-13.85	0.80
29	57.55	17.16	40.67*	-19.10	1.59	- 0.64	15.42
30	49.57	0.79	21.02	-30.40**	-12.60	-14.52	- 0.70
31	50.95	3.73	24.54	-28.38*	-10.06	-12.03	2.19
32	44.99	- 8.41	9.97	-36.76**	-20.58	-22.32	- 9.77
33	29.55	-39.84*	-27.77*	-58.46**	-47.84**	-48.98**	-40.73**
34	59.51	21.15	45.47**	-16.35	5.04	2.75	19.35
35	44.11	-10.2	7.82	-37.99**	-22.13	-23.84	-11.53
36	45.00	- 8.39	9.99	-36.74**	-20.56	-22.31	- 9.75
37	40.60	-17.35	-0.76	-42.93**	-28.33	-29.90*	-18.57
38	49.81	1.40	21.76	-29.98*	-12.07	-14.00	- 0.1
39	49.17	0.102	20.19	-30.88*	-13.20	-15.11	- 1.38
40	38.46	-21.70	-5.99	-45.94**	-32.11	-33.60*	-22.86
41	66.52	35.42*	62.60**	- 6.49	17.42	14.85	33.41

(Table contd.)

(Table 7 contd.)

1	2	3	4	5	6	7	8
42	45.82	- 6.72	12.00	-35.59**	-19.12	-20.89	- 8.10
43	50.70	3.22	23.93	-28.73*	-10.50	-12.47	1.68
44	51.69	5.23	26.35	-27.34*	- 8.76	-10.76	3.67
45	46.65	- 5.03	14.03	-34.43*	-17.65	-19.46	- 6.43
46	43.40	-11.64	6.09	-38.99**	-23.39	-25.07	-12.96
47	64.17	30.64	56.86**	- 9.79	13.27	10.79	28.7
48	46.59	- 5.15	13.88	-34.51**	-17.76	-19.56	- 6.56
49	48.24	- 1.79	17.92	-32.19*	-14.85	-16.71	- 3.25
50	63.10	28.46	54.24**	-11.30	11.39	8.94	26.55
51	53.09	8.08	29.77	-25.37*	- 6.28	- 8.34	6.48
52	44.96	-8.47	9.90	-36.80*	-20.64	-22.38	- 9.83
53	46.60	- 5.13	13.91	-34.50	-17.74	-19.54	- 6.54
54	43.38	-11.69	6.04	-39.02	-23.42	-25.10	-12.99
55	53.34	8.59	30.38	-25.02	- 5.84	- 7.91	6.98
56	48.19	1.89	17.80	-32.26	-14.93	-16.8	- 3.35
57	66.38	35.14*	62.26**	- 6.69	17.18	14.61	33.13*
58	47.41	- 3.48	15.89	-33.36	-16.31	-18.15	- 4.91
59	44.31	- 9.79	8.31	-37.71	-21.78	-23.50	-11.13
60	50.66	3.14	23.83	-28.79	-10.57	-12.53	1.60

(Table contd..)

(Table 7 contd.)

1	2	3	4	5	6	7	8
61	48.35	- 1.57	18.19	-32.04	-14.65	-16.52	- 3.03
62	55.22	12.42	34.98*	-22.38	- 2.52	- 4.66	10.75
63	46.60	- 5.13	13.91	-34.5	-17.74	-19.54	- 6.54
64	58.42	18.93	42.80*	-17.88	- 3.12	- 0.86	17.17
65	42.59	-13.29	4.11	-40.13	-24.82	-26.46	-14.58
66	54.01	9.95	32.02	-24.08	- 4.66	- 6.75	8.32
67	51.45	4.74	25.76	-27.68	- 9.18	-11.17	3.19
68	49.92	1.63	2.20	-29.83	-11.88	-13.81	- 0.12
69	57.63	17.32	40.87*	-18.99	1.73	- 0.50	15.58
70	47.41	- 3.48	15.89	-33.36	-16.31	-18.15	- 4.91
71	49.10	- 0.041	20.02	-30.98	-13.33	-15.23	- 1.52

C.D. I (0.05) - 13.5

C.D. I (0.01) - 17.79

C.D.II (0.05) - 15.59

C.D.II (0.01) - 20.55

one hybrid. Significant negative standard heterosis was registered by the hybrids over all the four standards and the maximum over the first standard ie. Co 449. The number of hybrids in each comparison were fifty seven (87.69%), four (6.15%), six (9.23%) and two (3.08%) respectively.

2. Shoot count (90 DAP)

The hybrids were found to have a range of mean values from 7.67 to 53.33. The maximum and the minimum values were displayed by clone numbers thirteen and seventeen respectively. Among the six comparisons, significant positive heterosis was observed in all. None of the hybrids exhibited significant negative heterosis over the mid parental values. But this trend was observed in all other comparisons.

Among the sixty five hybrids, sixteen (24.62%) exhibited significant positive heterosis over the better parent. Clone number thirteen displayed the maximum value of 190.94 per cent, while clone number thirty eight recorded the minimum value of 60.01 per cent. There was pronounced enhancement in the number of clones (33) displaying heterosis over the mid parental value. The values ranged from

Table 8

The mean values of parents standards and F_1 hybrids and their heterosis in percentage

Shoot count (90 DAP)

Parents, standards and hybrids	Mean	Heterobeltiosis	Relative Heterosis	Standard Heterosis 1	Standard Heterosis 2	Standard Heterosis 3	Standard Heterosis 4
1	2	3	4	5	6	7	8
1	18.33						
2	15.50						
3	30.67						
4	23.67						
5	34.33						
6	23.33						
7	24.33	32.73	56.97*	-20.67	2.79	-29.13*	4.29
8	18.67	1.85	20.45	-39.13	-21.12*	-45.62*	-19.97*
9	25.67	40.04	65.61*	-16.30	8.45	-25.23	10.03
10	33.00	80.03**	112.90**	7.60	39.42*	- 3.87	41.45*
11	36.33	98.20**	134.39**	18.45	53.49**	5.83	55.7**
12	32.00	74.58**	106.45**	4.34	35.19	- 6.79	37.16
13	53.33	190.94**	244.06**	73.88**	125.31**	55.35**	128.5**
14	24.00	30.93	54.84*	-21.75	1.39	-30.09*	2.87
15	37.00	101.85**	138.71**	20.64	56.32**	7.78	58.5**
16	17.67	-3.60	14.00	-42.39	-25.35	-48.53**	-24.26

(Table contd.)

(Table 8 contd.)

1	2	3	4	5	6	7	8
17	7.67	-58.16**	-50.52	- 0.75	-67.60**	-77.66**	-67.12**
18	23.00	25.48	48.39	-25.01	- 2.83	-33.00*	- 1.41
19	19.67	7.31	26.90	-35.87*	-16.90	-42.70**	-15.69
20	25.00	36.39	61.29*	-18.49	5.62	-27.18*	7.16
21	23.33	27.28	50.52	-23.93	- 1.44	-32.04*	-
22	35.33	92.74**	127.94**	15.19	49.26*	2.91	51.44**
23	24.00	30.93	54.84*	-21.75	1.39	-30.09*	2.87
24	17.33	- 5.46	11.81	-43.50*	-25.35	-49.52**	-25.72
25	21.00	14.57	35.48	-31.53*	-11.28	-38.83*	- 9.99
26	13.67	-25.42	-11.81	-55.43**	-42.25*	-60.18**	-41.41*
27	29.00	58.21*	87.10**	- 5.45	22.52	-15.53	24.30
28	23.00	25.48	48.39	-25.01	- 2.83	-33.00*	- 1.41
29	36.00	96.40**	132.26**	17.38	52.09**	4.86	54.31**
30	27.00	47.30	74.19**	-11.97	14.07	-21.35	15.73
31	27.33	49.10	76.32**	-10.89	15.46	-20.39	17.15
32	23.67	29.13	52.71*	-22.83	-	-31.05*	1.46
33	9.33	-49.10	-39.81	-69.58**	-60.58	-72.82**	-60.01
34	23.67	29.13	39.81*	- 7.00	-	-10.66	1.46
35	18.00	- 1.80	16.13	-41.31**	-23.95	-47.57**	-22.85
36	21.67	18.22	39.81	-29.84	- 8.45	-36.88**	-38.58

(Table contd.)

(Table 8 contd.)

1	2	3	4	5	6	7	8
37	14.33	-21.82	- 7.55	-53.28*	-39.46*	-58.26**	-38.58
38	29.33	60.01*	89.23**	- 4.37	23.91	-14.56	25.72
39	22.00	20.02	41.94	-28.27	- 7.06	-35.92*	- 5.70
40	11.33	-38.19	-26.90	-63.06**	-52.13**	-66.99**	-51.44**
41	36.00	96.40**	132.26**	17.38	52.69**	4.86	54.31**
42	29.33	60.01*	89.23**	- 4.37	23.91	-14.56	25.72
43	22.67	23.68	46.26	-26.08	- 4.22	-33.96*	- 2.83
44	20.00	9.11	29.03	-34.79*	-15.50	-41.74**	-14.27
45	17.67	- 3.60	14.00	-42.39**	-25.35	-48.53**	-24.26
46	16.00	-12.71	3.23	-47.83**	-35.19	-53.39**	-31.42
47	32.00	74.58**	106.45**	4.34	35.19	- 6.79	37.16
48	23.67	29.13	39.81*	-22.83	-	-31.05*	1.46
49	18.33	-	18.26	-40.23**	-22.56	-46.61**	-21.43
50	25.67	40.04	65.61*	-16.30	8.45	-25.23	10.83
51	26.33	43.64	69.87**	-14.16	11.24	-23.30	12.86
52	20.00	9.11	29.03	-34.79*	-15.50	-41.74**	-14.27
53	21.33	16.37	37.61	-30.45*	- 9.89	-37.87*	- 8.57
54	20.00	9.11	29.03	-34.79*	-15.50	-41.74**	-14.27
55	26.67	45.50	72.06**	-13.04	12.67	-22.31	14.32
56	30.33	65.47**	95.68**	- 1.11	28.14	-11.65	30.00
57	30.33	65.47**	95.28**	- 1.11	28.14	-11.65	3.00

(Table contd.)

(Table 8 contd.)

1	2	3	4	5	6	7	8
58	44.00	140.04**	183.87**	43.46**	65.89**	28.17*	88.60**
59	14.00	-23.62	- 9.68	-54.35**	-40.85*	-59.22**	-40.00*
60	25.00	36.39	61.29*	-18.49	5.62	-27.18*	7.16
61	14.00	-23.62	- 9.68	-54.35**	-40.85*	-59.22**	-40.00*
62	23.00	25.48	48.39	-25.01	- 2.83	-33.00*	- 1.41
63	26.33	43.64	69.87**	-14.15	11.24	-23.30	12.86
64	28.00	52.76*	80.65**	- 8.71	18.29	-18.44	20.02
65	21.00	14.57	35.48	-31.53*	-11.28	-35.83**	9.99
66	16.67	9.06	75.48	-45.65	-29.57	-51.44	-28.55
67	24.33	32.73	56.97*	-20.67	2.79	-29.13*	4.29
68	26.67	45.50	72.06**	-13.04	12.67	-22.31	14.32
69	43.67	138.24**	101.74**	42.39**	84.50**	27.21*	87.18**
70	19.67	7.31	26.90	-35.87*	-16.90	-42.70**	-15.69
71	21.67	18.22	39.81	-29.34	- 8.45	-36.89**	- 7.12

C.D. I (0.05) - 7.87

C.D. I (0.01) -10.37

C.D. II (0.05) - 9.09

C.D. II (0.01)-11.98

52.71 per cent to 183.87 per cent. The clone numbers forty eight and thirty two recorded maximum and minimum values respectively. Among the four standards, the maximum range of positive heterosis was displayed over the fourth standard, ie. Co 62175. The range varied from 41.45 per cent to 128.5 per cent. Three hybrids each manifested positive heterosis over the first and third standards, eight numbers over the second and seven numbers over the fourth.

When compared to the standards, more number of hybrids displayed significant negative heterosis. The highest number was with respect to the third standard, Co 997. In this aspect the values were found to be ranging from 29.13 per cent to 77.66 per cent.

3. <u>H.R.Brix</u>

The mean values of the hybrids for this character were found to be ranging from 12.8 per cent to 21.8 per cent. The maximum value was recorded by clone number forty two and the minimum by clone number twenty two. The hybrids displayed significant positive heterosis over the better parental and midparental means only. Heterosis was negative and significant over the four standards. Thirty nine

Table 9

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage

H.R.Brix

Parents, standards and hybrids	Mean	Hetero-beltiosis	Relative Heterosis	Standard Heterosis 1	2	3	4
1	2	3	4	5	6	7	8
1	15.93						
2	14.47						
3	18.27						
4	18.53						
5	21.20						
6	19.00						
7	17.40	9.23	20.25	- 4.76	- 6.10	-17.92	- 8.42
8	16.53	3.77	14.24	- 9.52	-10.79	-22.03*	-13.00
9	14.27	-10.42	1.38	-21.89*	-22.99*	-32.69**	-24.89*
10	18.67	17.20	29.03*	2.19	0.76	-11.93	- 1.74
11	18.07	13.43	24.88*	- 1.09	- 2.48	-14.76	- 4.89
12	18.27	14.69	26.26*	-	-12.20	-13.82	- 3.84
13	16.33	2.51	12.85	-10.62	-11.87	-22.97*	-14.05
14	14.33	-10.04	- 0.97	-21.57*	-22.67*	-32.41**	-24.58*
15	13.20	-17.14	- 8.78	-27.75*	-28.76**	-37.74**	-30.53**
16	16.40	2.95	13.34	-10.24	-11.49	-22.64*	-13.68
17	20.13	23.37*	39.12**	10.18	8.63	- 5.05	5.95
18	16.80	5.46	16.10	- 8.05	- 9.34	-20.75*	-11.58

(Table contd.)

(Table 9 contd.)

1	2	3	4	5	6	7	8
19	18.80	18.02	29.92*	2.90	1.46	-11.32	- 1.05
20	19.40	21.78	34.07**	6.19	4.70	- 8.49	0.21
21	19.40	21.78	34.07**	6.19	4.70	- 8.49	0.21
22	12.80	-19.65	-11.54	-29.94**	-30.92**	-39.62**	-32.63**
23	18.87	18.46	30.41*	3.28	1.83	-10.99	- 0.68
24	19.27	20.97	33.17**	5.47	3.99	- 9.10	1.42
25	20.60	29.32*	42.36**	12.75	11.17	- 2.83	8.40
26	17.07	7.16	17.97	6.57	- 7.88	-19.48	-10.16
27	21.27	33.52**	46.99**	16.42	14.79	0.33	11.95
28	16.53	3.77	14.24	- 9.52	-10.79	-22.03*	-13.00
29	20.13	26.37*	39.12**	10.18	8.63	- 5.05	5.95
30	17.93	12.55	23.91*	- 1.86	3.24	-15.42	- 5.63
31	20.60	29.32*	42.36**	12.75	11.17	- 2.83	8.42
32	14.80	- 7.09	2.28	-18.99	-20.13	-30.19	-22.11
33	21.13	32.64**	46.03**	15.65	14.03	- 0.33	11.21
34	17.13	7.53	18.38	- 6.24	- 7.56	-19.20*	- 9.84
35	18.93	18.83	30.82**	3.61	2.16	-10.71	- 0.37
36	16.87	5.90	16.59	- 7.66	- 8.96	-20.42*	-11.21
37	19.07	19.71	31.79**	4.38	2.91	-10.05	0.37
38	16.93	6.28	17.00	- 7.33	- 8.63	-20.14*	-10.89
39	18.67	17.20	29.03*	2.19	0.76	-11.93	- 1.74
40	20.00	25.55*	38.22**	9.47	7.93	- 5.66	5.26

(Table contd.)

(Table 9 contd.)

1	2	3	4	5	6	7	8
41	18.40	15.51	27.16*	0.71	- 0.70	-13.21	- 3.16
42	19.27	20.97	33.17**	5.47	3.99	- 9.10	1.42
43	18.73	17.58	29.44*	2.52	1.08	-11.65	- 1.42
44	19.73	23.85	36.35**	7.99	6.48	- 6.93	- 3.84
45	16.60	4.21	14.72	- 9.14	-10.42	-21.70*	-12.63
46	16.00	0.44	10.57	-12.42	-13.65	-24.53**	-15.79
47	17.67	10.92	22.11	- 3.28	- 4.64	-16.65	- 7.00
48	21.80	36.85**	50.66**	19.32	17.65	2.83	14.74
49	18.73	17.58	29.44*	2.52	1.08	-11.65	- 1.42
50	18.20	14.25	25.78*	- 0.38	- 1.78	-14.15	- 4.21
51	17.53	10.04	21.15	- 4.05	- 5.40	-17.13	- 7.74
52	20.00	25.55*	38.22**	9.47	7.93	- 5.66	5.26
53	13.20	-17.14	- 8.78	-27.75*	-28.76**	-37.74**	-30.53**
54	19.00	19.27	31.31**	3.40	2.54	-10.38	-
55	19.07	19.71	31.79**	4.38	2.91	-10.05	0.37
56	18.73	17.58	29.44*	2.52	1.08	-11.65	- 1.42
57	17.67	10.92	22.14	- 3.28	- 4.64	-16.65	- 7.0
58	15.60	- 2.07	7.81	14.61	-15.81	-26.42**	-17.89
59	21.07	32.27**	45.61**	15.33	13.71	- 0.61	10.89
60	18.67	17.20	29.03*	2.19	0.76	-11.93	- 1.74

(Table contd.)

(Table 9 contd.)

1	2	3	4	5	6	7	8
61	13.87	-12.93	- 4.15	-24.08*	-25.15*	-34.58**	-27.00*
62	19.93	25.11**	37.73**	9.09	7.56	- 5.99	4.89
63	16.93	6.28	17.00	- 7.33	- 8.63	-20.14*	-10.89
64	14.47	- 9.17	-	-20.80	-21.91*	-31.75**	-23.84*
65	20.27	27.24*	40.08**	10.95	9.39	- 4.39	6.68
66	19.67	23.48	35.74**	7.66	6.15	- 7.22	3.53
67	14.80	- 7.09	2.28	-18.99	-20.13	-30.19**	-22.11
68	19.33	21.34	33.59**	5.80	4.32	- 8.82	1.74
69	18.67	17.20	29.03*	2.19	0.76	-11.93	- 1.74
70	18.53	16.32	28.06*	1.42	-	-12.59	- 2.47
71	15.60	- 2.07	7.81	-14.61	-15.81	-26.42*	-17.89

C.D. I (0.05) = 3.37

C.D. I (0.01) = 4.44

C.D. II (0.05) = 3.89

C.D. II (0.01) = 5.13

hybrids displayed significant positive heterosis over the midparental value and twelve numbers over the better parental value. The corresponding values expressed in percentage were 18.46 and 60 respectively. In the former comparison, the maximum heterosis of 50.66 per cent was registered by clone number fortyeight and the minimum of 23.91 per cent by clone number thirty. In the latter case, the range was very little (25.11 % to 36.95%). The clones displaying the maximum and the minimum values were forty eight and sixty two respectively. But none of the hybrids manifested positive heterosis over the standards.

As regards negative heterosis, it was significant only over the standards. Maximum number of hybrids were found to follow this trend over the third standard ie, Co 997. The range of heterosis in this respect was from 19.2 per cent to 39.62 per cent. The maximum range of negative heterosis was found to be over the same standard.

4. <u>Total weight of cane</u>

For this attribute, the hybrids displayed mean values ranging from 4.417 to 18.333. The hybrid clones which recorded the maximum and the minimum mean values were clone

Table 10

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage.

Total weight of cane

Parents, Standards and hybrids	Mean	Hetero-beltio-sis	Rela-tive Hetero-sis.	Standard Heterosis			
				1	2	3	4
1	2	3	4	5	6	7	8
1	16.483						
2	12.817						
3	23.217						
4	23.417						
5	19.817						
6	26.383						
7	12.908	-21.689	0.71	-44.40**	-44.48**	-34.86**	-51.07**
8	8.458	-48.687**	-34.01*	-63.57**	-63.88**	-57.32**	-67.94**
9	6.825	-58.59*	-46.75**	-70.60**	-70.85**	-65.56**	-74.13**
10	12.800	-22.34	- 0.13	-44.87**	-45.34**	-35.41**	-51.48**
11	7.817	-52.58**	-39.01*	-66.33**	-66.62**	-60.55**	-70.37**
12	7.550	-54.20**	-41.09**	-67.48**	-67.76**	-61.90**	-71.38**
13	5.400	-67.24**	-57.87**	-76.74**	-76.94**	-72.75**	-89.74**
14	9.983	-39.43**	-22.11	-57.00**	-57.37**	-49.62**	-62.16**
15	14.950	- 9.30	16.64	-35.61**	-36.16**	-24.56*	-43.33**
16	11.333	-31.24*	-11.58	-51.19**	-51.60**	-42.81**	-57.04**
17	6.283	-61.88**	-50.98**	-72.94**	-73.17**	-68.29**	-76.19**

(Table contd.)

(Table 10 contd.)

1	2	3	4	5	6	7	8
18	13.317	-19.21	3.90	-42.64**	-43.13**	-32.80**	-49.52**
19	9.983	-39.43**	-22.11	-57.00**	-57.37**	-49.62**	-62.16**
20	6.533	-60.37**	-49.03**	-71.86**	-72.10**	-67.03**	-75.24**
21	10.200	-38.12**	-20.42	-56.07**	-56.44**	-48.53**	-61.34**
22	7.500	-54.50**	-41.48**	-67.70**	-67.97**	-62.15**	71.57**
23	6.867	-58.34**	-46.42**	-70.42	-70.68**	-65.35**	-73.97**
24	10.200	-38.12**	-20.42	-56.07	-56.44**	-48.53**	-61.34**
25	6.717	-59.25**	-47.59**	-71.07	-71.32**	-66.10**	-74.54**
26	8.500	-48.43**	-33.68*	-63.39	-63.70**	-57.11**	-67.78**
27	13.367	-18.90	4.29	-42.43	-42.92**	-32.55**	-49.33**
28	9.567	-41.96**	-25.36	-58.79	-59.15**	-51.72**	-63.74**
29	5.967	-63.80**	-53.44**	-74.30	-74.52**	-69.89**	-77.38**
30	9.433	-42.77**	-26.40	-59.37	-59.72**	-52.40**	-64.25**
31	14.300	-13.24	11.57	-38.41	-38.93**	-27.84*	-45.80**
32	14.383	-12.74	12.22	-38.05**	-38.58**	-27.42*	-45.48**
33	9.383	-43.07*	-26.79	-59.59**	-59.93**	-52.65**	-64.44**
34	9.800	-40.54**	-23.54	-57.79**	-58.15**	-50.55**	-62.85**
35	11.733	-28.82*	- 8.46	-49.46**	-49.89**	-40.79**	-55.53**
36	6.650	-59.66**	-48.12**	-71.36**	-71.60**	-66.44**	-74.79**
37	4.533	-72.50**	-64.63**	-80.48**	-80.64**	-77.13**	-82.82**
38	7.350	-55.41**	-42.65**	-68.34**	-68.61**	-62.91**	-72.14**
39	11.133	-32.46*	-13.14	-52.05**	-52.46**	-43.82**	-57.80**

(Table contd.)

(Table 10 contd.)

1	2	3	4	5	6	7	8
40	5.600	-66.03**	-56.31**	-75.88**	-76.09**	-71.74**	-78.77**
41	16.567	0.51	29.26	-28.64**	-29.25**	-16.40	-37.21**
42	14.833	-10.01	15.73	-36.11**	-36.66**	-25.15*	-43.78**
43	9.350	-43.27**	-27.05	-59.73**	-60.07**	-52.82**	-64.56**
44	8.658	-47.47**	-32.45*	-62.71**	-63.03**	-56.31**	-67.18**
45	8.150	-50.56**	-36.41*	-64.90**	-65.20**	-58.87**	-69.11**
46	6.383	-61.28**	-50.20**	-72.51**	-72.74**	-67.79**	-75.81**
47	6.483	-60.67**	-49.42**	-72.08**	-72.31**	-67.29**	-75.43**
48	6.317	-61.68**	-50.71**	-72.79**	-73.02**	-68.12**	-76.06**
49	6.167	-62.59**	-51.88**	-73.44**	-73.66**	-67.86**	-76.63**
50	4.417	-73.20**	-65.54**	-80.98**	-81.14**	-77.71**	-83.26**
51	13.360	-18.95	4.24	-42.46**	-42.95**	-32.58**	-49.36**
52	9.800	-40.54**	-23.54	-57.79**	-58.15**	-50.55**	-62.85**
53	7.400	-55.10**	-42.26**	-68.13**	-68.40**	-62.66**	-71.95**
54	10.650	-35.39**	-16.91	-54.13**	-54.52**	-46.26**	-59.63**
55	7.067	-57.13**	-44.86**	-69.56**	-69.82**	-64.34**	-73.21**
56	7.267	-55.91**	-43.30**	-68.70**	-68.97**	-63.33**	-72.46**
57	18.333	11.22	43.04**	-21.04*	-21.71	- 7.49	-30.51**
58	5.700	-65.42**	-55.53**	-77.45**	-75.66**	-71.24**	-78.40**
59	7.817	-52.58**	-39.01**	-66.33**	-66.62**	-60.55**	-70.37**
60	12.183	-26.09	- 4.95	-47.53**	-47.97**	-38.52**	-53.82**

(Table contd.)

(Table 10 contd.)

1	2	3	4	5	6	7	8
61	9.922	-39.80**	-22.59	-57.26**	-57.63**	-49.93**	-62.39**
62	5.167	-68.65**	-59.69**	-77.74**	-77.93**	-73.93**	-80.42**
63	7.550	-54.20**	-41.09**	-67.48**	-67.76**	-61.90**	-71.38**
64	11.250	-31.75*	-12.23	-51.54**	-51.96**	-43.23**	-57.36**
65	10.650	-35.39**	-16.91	-54.13**	-54.52**	-46.26**	-59.82**
66	12.367	-24.97	- 3.51	-46.73**	-47.19**	-37.59**	-53.13**
67	9.117	-44.69**	-28.87	-60.73**	-61.07**	-53.99**	-65.44**
68	13.433	-18.50	- 4.81	-42.14**	-42.64**	-32.21**	-49.08**
69	8.683	-47.32*	-32.25**	-62.60**	-62.92**	-56.18**	-67.09**
70	12.283	-25.48	- 4.17	-47.09**	-47.55**	-38.02**	-53.44**
71	8.383	-49.14**	-34.59**	-63.89**	-64.20**	-57.70**	-68.23**

C.D. I (0.05) - 3.99

C.D. I (0.01) - 5.27

C.D. II (0.05) - 4.62

C.D. II (0.01) - 6.09

number fifty seven and fifty respectively. Positive significant heterosis (43.04%) was observed in one hybrid only over the mid parental value, while significant negative heterosis was observed in all the six comparisons ie. over the better and mid parental values and over the four standards.

All the sixty five hybrid clones recorded significant negative heterosis over three standards; ie. first, second and fourth standards. The range of values with respect to the above standards were almost the same. Fifty hybrids exhibited significant negative heterosis over better parent and thirty three numbers followed the same pattern for comparisons with mid parent.

5. Number of millable canes at harvest

The mean values of hybrids for this character ranged from 4.00 to 30.67. Clone number fifteen registered the maximum value and clone number seventeen, the minimum value.

Comparatively lesser number of clones manifested significant positive heterosis than significant negative heterosis.

Table 11

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage

Number of millable canes at harvest

Parents, standards and hybrids	Mean	Heterobeltiosis	Relative Heterosis	Standard Heterosis 1	Standard Heterosis 2	Standard Heterosis 3	Standard Heterosis 4
1	19.00						
2	14.67						
3	29.00						
4	21.67						
5	21.67						
6	23.00						
7	23.33	22.79	59.03**	-19.55	7.66	7.66	1.43
8	13.67	-28.05	- 6.82	-52.86**	-36.92**	-36.92**	-40.57**
9	13.67	-28.05	- 6.82	-52.86**	-36.92**	-36.92**	-40.57**
10	20.00	- 5.26	-36.33	-31.03**	- 7.71	- 7.71	-13.04
11	16.00	-15.79	- 9.07	-44.83**	-26.17	-26.17	-30.43*
12	13.67	-28.05	- 6.82	-52.86**	-36.92**	-36.92**	-40.57**
13	13.33	-29.84	- 9.13	-54.03**	-38.49**	-34.49**	-42.04**
14	15.00	-21.05	2.25	-48.28**	-30.78*	-30.78*	-34.78**
15	30.67	61.42**	109.07**	5.76	41.53**	41.53**	33.35**
16	13.0	-31.58*	-11.38	-55.17**	-40.01**	-40.01**	-43.48**
17	4.0	-78.95**	-72.73**	-86.21**	-81.54**	-81.54**	-82.61**
18	16.33	-14.05	11.32	43.69**	-24.64	-24.64	-29.00*

(Table contd.)

(Table 11 contd.)

1	2	3	4	5	6	7	8
19	15.33	-19.32	4.50	-47.14**	-29.26*	-29.26*	-33.35**
20	12.67	-33.32*	-13.63	-56.31**	-41.53**	-41.53**	-44.91**
21	18.33	- 3.53	24.95	-36.79**	-15.41	-15.41	-20.30
22	18.33	- 3.53	24.95	-36.79**	-15.41	-15.41	-20.30
23	10.00	-47.37**	-31.83	-65.52**	-53.85**	-53.85**	-56.52**
24	16.33	-14.05	11.32	-43.69**	-24.64	-24.64	-29.00*
25	14.00	-26.32	- 4.57	-51.72**	-35.39*	-35.39*	-39.13**
26	10.67	-43.84**	-27.27	-63.21**	-50.76**	-50.76**	-53.61**
27	18.33	- 3.53	24.95	-36.79**	-15.41	-15.41	-20.30
28	16.67	-12.26	13.63	-42.52**	-23.07	-23.07	-27.52*
29	18.67	- 1.74	27.27	-35.62**	-13.84	-13.84	-18.83
30	17.67	- 7.00	20.45	-39.07**	-18.46	-18.46	-23.17
31	20.00	5.26	36.33*	-27.59**	- 7.71	- 7.71	-13.04
32	24.67	29.84*	68.17**	-14.93	13.84	13.84	7.26
33	9.00	-52.63**	-38.65*	-68.97**	-58.47**	-58.47**	-60.87**
34	18.00	- 5.26	22.70	-37.93**	-16.94	-16.94	-21.74
35	17.67	- 7.00	20.45	-39.07**	-18.46	-18.46	-23.17
36	18.00	- 5.26	22.70	-37.93**	-16.94	-16.94	-21.74
37	9.67	-49.11**	-34.08	-66.66**	-55.38**	-55.38**	-57.96**
38	18.67	- 1.74	27.27	-35.62**	-13.84	-13.84	-18.83
39	21.0	10.53	43.15*	-27.59**	- 3.09	- 3.09	- 8.70
40	9.33	-50.89**	-36.40*	-67.83**	-56.95**	-56.95**	-59.43**
41	25.33	33.32*	72.67**	-12.66	16.89	16.89	10.13

(Table contd..)

(Table 11 contd.)

1	2	3	4	5	6	7	8
42	18.00	- 5.26	22.70	-37.93**	-16.94	-16.94	-21.74
43	17.67	- 7.00	20.45	-39.07**	-18.46	-18.46	-23.17
44	18.33	- 3.53	24.95	-36.79**	-15.41	-15.41	-20.30
45	14.33	-24.58	- 2.32	-50.59**	-33.87*	-33.87*	-37.70**
46	10.67	-43.84**	-27.27	-63.21**	-50.76**	-50.76**	-53.61**
47	16.00	-15.79	9.07	-44.83**	-26.17	-26.17	-30.43*
48	13.33	-29.84	- 9.13	-54.03**	-38.49**	-38.49**	-42.04**
49	10.33	-45.63**	-29.58	-64.38**	-52.33**	-52.33**	-55.09
50	9.67	-49.11**	-34.08	-66.66**	-55.38**	-55.38**	-57.96
51	14.33	-24.58	- 2.32	-50.59**	-33.87*	-33.87*	-37.70
52	15.33	-19.31	4.50	-47.14**	-29.26*	-29.26*	-33.35*
53	21.00	10.53	43.15*	-27.59**	- 3.09	- 3.09	- 8.70
54	18.00	- 5.26	22.70	-37.93**	-16.94	-16.94	-21.74
55	11.67	-38.58*	13.63	-59.76**	-46.15**	-46.15**	-49.26**
56	16.67	-12.26	13.63	-42.52**	-23.07	-23.07	-27.52*
57	24.33	28.05	65.85**	-16-10	12.28	12.28	5.78
58	10.00	-47.37**	-31.83	-65.52**	-53.85**	-53.85**	-56.52**
59	11.67	-38.58	-20.45	-59.76**	-46.15**	-46.15**	-49.26**
60	22.67	19.32	54.53**	-21.83*	4.61	4.61	- 1.43
61	16.00	-15.79	9.07	-44.83**	-26.17	-26.17	-30.43*
62	15.00	-21.05	2.25	-48.28**	-30.78*	-30.78*	-34.78**

(Table contd.)

(Table 11 contd.)

1	2	3	4	5	6	7	8
63	18.00	- 5.26	22.70	-37.90**	-16.94	-16.94	-21.74
64	18.00	- 5.26	22.70	-37.90**	-16.94	-16.94	-21.74
65	16.00	-15.79	9.07	-44.83**	-26.17	-26.17	-30.43*
66	15.33	-19.32	4.50	-47.14**	-29.26*	-29.26*	-33.35*
67	12.67	-33.32	-13.63	-56.31**	-41.53**	-41.53**	-44.91**
68	23.67	24.58	61.35**	-18.78	9.23	9.23	2.91
69	20.67	8.79	40.90*	-28.72**	- 4.61	- 4.61	-10.13
70	15.33	-19.32	4.50	-47.14**	-29.26*	-29.26*	-33.35*
71	15.00	-21.05	2.25	-48.28**	-30.78*	-30.78*	-34.78**

C.D. I (0.05) = 5.10

C.D. I (0.01) = 6.73

C.D. II (0.05) = 5.89

C.D. II (0.01) = 7.77

Out of the sixty five hybrid clones, heterobeltiosis was positive and significant only in three clones (4.62%). The values of heterosis ranged from 29.84 per cent to 61.42 per cent. The maximum and minimum values were displayed by clone number fifteen and thirty two respectively. Relative heterosis was significant and positive in comparatively higher number of clones (11). The figure expressed in percentage was 16.92. The maximum value (109.07%) for relative heterosis was recorded by clone number fifteen and the minimum value (36.33%) by clone number ten. Standard heterosis was very low and one clone each manifested this phenomenon over the second, third and fourth standards.

Heterobeltiosis was significant and negative in fifteen clones (23.08%) only. The heterotic values were found to be ranging from 31.58 per cent to 78.95 per cent. The maximum value was displayed by clone number seventeen and the minimum by sixteen. Relative heterosis was negative and significant only in three out of sixty five clones. The maximum number of hybrids (59) displaying standard heterosis was observed with respect to the first standard ie. Co 449. The maximum value in this aspect was 86.21 per cent which was recorded by hybrid clone number seventeen and the minimum value 21.83 per cent by clone number sixty.

The number of hybrids with respect to other standards were thirty each for the second and third standards and thirty-five for the fourth standard. Among the standards maximum range of heterosis was observed with respect to the first standard.

6. <u>Number of internodes at harvest</u>

The maximum mean value of 29.11 was recorded by clone number sixty seven and the minimum value of 15.11 by clone number thirty seven.

The number of hybrids manifesting significant positive heterosis over the better and mid parental values were found to be equal (forty three each) for this character. The hybrids displayed an almost equal range of heterotic values. The ranges were 15.05 per cent to 64.74 per cent and 16.91 per cent to 67.4 per cent respectively. The maximum values were recorded by clone number sixty seven and the minimum values by clone number sixty one, in both respects. Five hybrids each manifested significant positive heterosis over the second and third standards. Here also almost equal ranges of values were observed (10.34 per cent to 18.00 per cent and 10.83 per cent to 18.53 per cent).

Table 12

The mean values of parents, standard and F_1 hybrids and their heterosis in percentage

Number of internodes at harvest

Parents, Standards and hybrids	Mean	Hetero-beltio-sis	Relative hetero-sis	Standard Heterosis 1	Standard Heterosis 2	Standard Heterosis 3	Standard Heterosis 4
1	2	3	4	5	6	7	8
1	17.67						
2	17.39						
3	26.78						
4	24.67						
5	24.56						
6	30.89						
7	16.44	- 6.96	- 5.46	-38.61**	-33.36**	-33.06**	-46.78**
8	27.33	54.67**	57.16**	2.05	10.78**	11.28**	-11.52
9	18.44	4.36	6.04	-31.14**	-25.25**	-24.92**	-40.30**
10	17.55	- 0.68	0.92	-34.47**	-28.86**	-28.54**	-43.19**
11	19.33	9.39	11.16	-27.82**	-21.65**	-21.29**	-37.42**
12	19.22	8.77	10.52	-28.23**	-22.09**	-21.74**	-37.78**
13	17.22	- 2.55	- 0.98	-35.70**	-30.20**	-29.89**	-44.25**
14	20.78	17.60*	19.49*	-22.40**	-15.77**	-15.39**	-32.73**
15	17.67	-	16.10	-34.02**	-28.37**	-28.05**	-42.80**
16	18.89	6.90	8.63	-29.46**	-23.43**	-23.09**	-38.85**
17	20.92	18.39*	20.30*	-21.88**	-15.20**	-14.82**	-32.28**
18	26.78	51.56**	53.99**	-	8.55	9.04	-13.31

(Table contd.)

(Table 12 contd.)

1	2	3	4	5	6	7	8
19	24.22	37.07**	39.28**	- 9.56	- 1.82	- 1.38	-21.59
20	18.44	4.36	6.04	-31.14**	-25.25**	-24.92**	-40.30**
21	19.78	11.94	13.74	-26.14**	-19.82**	-19.46**	-35.97**
22	23.22	31.41**	33.53**	-13.29**	- 5.88	- 5.46	-24.83**
23	21.78	23.26**	25.24**	-18.67**	-11.71*	-11.32*	-29.49**
24	28.66	62.20**	64.81**	7.02	16.17**	16.69**	7.22
25	20.89	18.22*	20.13*	21.99**	-15.32**	-14.94**	-32.37**
26	27.22	54.05**	56.53**	1.64	10.34**	10.83*	-11.88
27	23.44	32.65**	34.79**	-12.47	- 4.99	-4.56	-24.12**
28	25.00	41.48**	43.76**	- 6.65	1.34	1.79	-19.07**
29	26.00	47.44**	49.51**	- 2.91	5.39	5.86	-15.83**
30	24.00	35.82**	38.01**	-10.38	- 2.72	-2.28	-22.30**
31	25.22	42.73**	45.03**	-5.83	2.23	2.69	-18.36
32	20.44	15.68*	17.54*	-23.67**	-17.15**	-16.78**	-33.83**
33	23.18	23.77**	33.29**	-13.44	-6.04	-5.62	-24.96**
34	20.44	15.68*	17.54*	-23.67**	-17.15**	-16.78**	-33.83**
35	21.00	18.85*	20.76*	-21.58**	-14.88**	-14.50**	-32.02**
36	20.00	13.19	15.01	-25.32**	-18.93**	-18.57**	-35.25**
37	15.11	-14.49	-13.11	-43.58**	-38.75**	-38.48**	-51.08**

(Table contd.)

(Table 12 contd.)

1	2	3	4	5	6	7	8
38	24.11	36.45**	38.64**	-9.97	-2.27	-1.83	-21.95**
39	23.89	35.20**	37.38**	-10.79	-3.16	-2.73	-22.66**
40	18.56	5.04	6.73	-30.69**	-24.77**	-24.43**	-39.92**
41	26.56	50.31**	52.73**	-0.82	7.66	8.14	-14.02
42	24.33	37.69**	39.91**	-9.15	-1.38	-0.94	-21.24**
43	21.44	21.34**	23.29**	-19.94**	-13.09**	-12.70**	-30.59**
44	22.22	25.75**	27.77**	-17.03**	-9.93	-9.53	-28.07**
45	23.44	32.65**	34.79**	-12.47*	-4.99	-4.56	-24.12**
46	21.11	19.47*	21.39*	-21.17**	-14.43**	-14.05**	-31.66**
47	22.33	26.37**	28.41**	-16.62**	- 9.49	-9.08	-27.71**
48	21.00	18.85*	20.76*	-21.58**	-14.88**	-14.50*	-32.02**
49	21.11	19.47*	21.39*	-21.17**	-14.43**	-14.05**	-31.66**
50	18.33	3.74	5.41	-31.55**	-25.70**	-25.37**	-40.66**
51	22.00	24.50**	26.51**	-17.85**	-10.82	-10.42	-28.78**
52	22.11	25.13**	27.14**	-17.44**	-10.38	-9.98	-28.42**
53	18.78	6.28	7.99	-29.81**	-23.88**	-23.53**	-39.20**
54	22.22	25.75**	27.77**	-17.03**	-9.93	-9.53	-28.07**
55	23.55	33.28**	35.42**	-12.06	-4.54	-4.11	-23.76**
56	25.33	43.35**	45.66**	-5.41	2.68	3.14	-18.00
57	19.00	7.53	9.26	-29.05**	-22.98**	-22.64**	-38.49**

(Table contd.)

(Table 12 contd)

1	2	3	4	5	6	7	8
58	22.78	28.92**	30.99**	-14.94**	- 7.66	- 7.25	-26.25**
59	18.89	6.90	8.63	-29.46**	-23.43**	-23.09**	-38.85**
60	23.11	30.79**	32.89**	-13.70**	- 6.32	- 5.90	-25.19**
61	20.33	15.05	16.91*	-24.09**	-17.59**	-17.22**	-34.19**
62	18.11	2.49	4.14	-32.37**	-26.59**	-26.26**	-41.37**
63	17.00	-3.79	-2.24	-36.52**	-31.09**	-30.78**	-44.97**
64	19.33	9.39	11.16	-27.82**	-21.65**	-21.29**	-37.42**
65	23.11	30.79**	32.89**	-13.70**	- 6.32	-59.04	-25.19**
66	28.44	60.95**	63.54**	6.20	15.28**	15.80**	- 7.93
67	29.11	64.74**	67.40**	8.70	18.00**	18.53**	- 5.76
68	18.67	5.66	7.36	-30.28**	-24.32**	-23.98**	-39.56**
69	23.34	32.09**	33.64**	-12.85*	- 5.39	- 4.97	-24.44**
70	25.11	42.11**	44.39**	- 6.24	1.78	2.24	-18.71**
71	21.44	21.34**	23.29**	-19.94**	-13.09**	-12.70**	-30.59**

C.D. I (0.05) - 2.61
C.D. I (0.01) - 3.45
C.D. II(0.05) - 3.02
C.D.II (0.01) - 3.98

As regards significant negative heterosis, the hybrids followed this trend only over the standards. None of them manifested negative significant heterosis over the better or mid parental values. The maximum number of hybrids (60) displaying negative heterosis was observed with respect to the fourth standard. The maximum range of values were observed with regard to the fourth standard. The figures being 11.52 per cent and 46.78 per cent. In short, higher percentages of hybrids were found to be manifesting negative heterosis over the standards.

7. Length of internode at harvest

The range of means with respect to this character was from 6.55 to 12.3. The hybrid clones which recorded the maximum and minimum values were clone numbers forty seven and seventeen respectively.

None of the hybrids displayed positive significant heterobeltiosis or relative heterosis. But positive significant standard heterosis over the third and fourth standards was manifested by some of the hybrids. Among the sixty five clones, eight numbers displayed significant positive standard heterosis over the third standard. The heterotic values ranged from 15.76 per cent to 33.70 per cent.

Table 13

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage

Length of internode at harvest

Parents, Standards and hybrids	Mean	Hetero-beltiosis	Relative Heterosis	Standard Heterosis 1	Standard Heterosis 2	Standard Heterosis 3	Standard Heterosis 4
1	2	3	4	5	6	7	8
1	11.94						
2	10.99						
3	10.86						
4	12.56						
5	9.20						
6	9.71						
7	10.22	-14.41*	- 7.01	- 5.89	-18.63**	11.09	5.25
8	10.66	-10.72	- 3.00	- 1.84	-15.13**	15.87*	9.78
9	9.54	-20.10**	-13.19	-12.15	-24.04**	3.70	-1.75
10	9.45	-20.85**	-14.01*	-12.98	-24.76**	2.72	-2.68
11	8.24	-30.99**	-25.02**	-24.13**	-34.39**	-10.43	-15.14*
12	10.30	-13.74*	- 6.28	- 5.16	-17.99**	11.96	6.08
13	8.16	-31.66**	-25.75**	-24.86**	-35.03**	-11.30	-15.96*
14	8.27	-30.74**	-24.75**	-23.85**	-34.16**	-10.11	-14.83*
15	11.07	- 7.29	0.73	1.93	11.86	20.33*	14.01*
16	10.66	-10.72	- 3.00	- 1.84	-15.13**	15.87*	9.78
17	6.55	-45.14**	-40.40**	-39.69**	-47.85**	-28.80**	-32.54**

(Table contd.)

(Table 13 contd.)

1	2	3	4	5	6	7	8
18	8.37	-29.80**	-23.84**	-22.93**	-33.36**	- 9.02	-13.80
19	10.27	-13.99*	- 6.55	- 5.43	-18.23**	11.63	5.77
20	10.23	-14.32*	- 6.92	- 5.80	-18.55**	11.20	5.36
21	11.12	- 6.87	1.18	2.39	-11.46	20.87**	14.52
22	9.35	-21.69**	-14.92	-13.90*	-25.56**	1.63	- 3.71
23	10.14	-15.08*	- 7.73	- 6.63	-19.27**	10.22	4.43
24	9.16	-23.28**	-16.65	-15.65*	-27.07**	- 0.43	- 5.66
25	9.22	-22.78**	-16.11	-15.10*	-26.59**	0.22	- 5.05
26	10.81	- 9.46	- 1.64	- 0.46	-13.93	17.50*	11.33
27	10.41	-12.81*	- 5.28	- 4.14	-17.12**	13.15	7.21
28	10.22	-14.41*	- 7.01	- 5.89	-18.63**	11.09	5.25
29	9.06	-24.12**	-17.56*	-16.57*	-27.87**	- 1.52	- 6.69
30	9.86	-17.42**	-10.28	- 9.21	-21.50**	7.17	1.54
31	8.78	26.47**	-20.11**	-19.15**	-30.10**	- 4.57	- 9.58
32	10.02	-16.08**	- 8.83	- 7.73	-20.22**	8.91	3.19
33	9.72	-18.59**	-11.56	-10.50	-22.61	5.65	0.10
34	9.21	-22.86**	-16.20*	-15.19*	-26.67	- 0.11	- 5.15
35	10.37	-13.15*	- 5.64	- 4.51	-17.44	12.72	6.80
36	9.88	-17.25**	-10.10	- 9.02	-21.34	7.39	1.75
37	9.33	-21.86**	-15.10*	-14.09*	-25.72	1.41	- 3.91
38	9.89	-17.17**	-10.01	- 8.93	-21.26	7.50	1.85

(Table contd.)

(Table 13 contd.)

1	2	3	4	5	6	7	8
39	9.07	-24.04**	-17.47*	-16.48*	-27.79	- 1.41	- 6.59
40	10.95	- 8.29	0.36	0.83	12.82	19.02	12.77
41	8.14	-31.83**	-25.93**	-25.05**	-35.19	-11.52	-16.17
42	10.44	-12.56*	- 5.00	- 3.87	-16.88	13.48	7.52
43	10.18	-14.74*	- 7.37	- 6.26	-18.95**	10.65	4.84
44	8.62	-27.81**	-21.57**	-20.63**	-31.37**	- 6.33	-11.23
45	8.70	-27.14**	-20.84**	-19.89**	-30.73**	- 5.43	-11.23
46	8.53	-28.56**	-22.38**	-21.45**	-32.09**	- 7.28	12.15
47	12.30	3.02	11.92	13.26	- 2.07	33.70**	26.67**
48	7.81	-34.59**	-28.94**	-28.08**	-37.82**	-15.11	-19.57**
49	8.30	-30.49**	-24.48**	-23.57**	-33.92**	- 9.78	-14.52
50	9.23	-22.70**	-16.01*	-15.01*	-26.51**	0.33	- 4.94
51	9.42	-21.11**	-14.29	-13.26*	-25.00**	2.39	- 2.99
52	9.28	-22.28**	-15.56*	-14.55*	-26.11**	0.87	- 4.43
53	9.48	-20.60**	-13.74	-12.71	-24.52**	3.04	- 2.37
54	9.69	-18.84**	-11.83	-10.77	-22.85**	5.33	- 0.21
55	8.18	-31.49**	-25.57**	-24.68**	-34.87**	-11.09	-15.76*
56	8.55	-28.39**	-22.20**	-21.27**	-31.93**	- 7.07	-11.95
57	10.78	- 9.72	- 1.91	- 0.74	-14.17*	17.17*	11.02
58	9.43	-21.02**	-14.19	-13.17	-24.92**	2.50	- 2.88
59	10.65	-10.80	- 3.09	- 1.93	-15.21**	15.76*	9.68

(Table contd.)

(Table 13 contd)

1	2	3	4	5	6	7	8
60	9.02	-24.46**	-17.93*	-16.94*	-28.18**	- 1.96	- 7.11
61	9.37	-21.52**	-14.74	-13.72*	-25.40**	1.85	- 3.50
62	10.42	-12.73*	- 5.19	- 4.05	-17.04	13.26	7.31
63	9.38	-21.44**	-14.65	-13.63*	-25.32**	1.96	- 3.40
64	10.05	-15.83*	- 8.55	- 7.46	-19.93**	9.24	3.50
65	10.92	- 8.54	- 0.64	0.55	-13.06	18.70*	12.46
66	10.01	-16.16**	- 8.92	- 7.83	-20.30**	8.80	3.09
67	10.37	-13.15*	- 5.64	- 4.51	-17.44*	12.72	6.80
68	10.77	9.80	- 2.00	- 0.83	-14.25*	17.07	10.92
69	9.10	-23.79**	-17.20*	-16.21*	-27.55**	- 1.09	- 6.28
70	10.62	-11.06	- 3.37	- 2.21	-15.45*	15.43	9.37
71	9.88	-17.25**	-10.10	- 9.02	-21.34	7.39	1.75

C.D I (0.05) - 1.43

C.D. I (0.01) - 1.89

C.D. II (0.05) - 1.65

C.D. II (0.01) - 2.18

The maximum and the minimum values were recorded by clone numbers forty seven and fifty nine respectively. Only one clone (Clone number forty seven) manifested positive and significant heterosis (26.67%) over the fourth standard.

The number of hybrids displaying significant negative heterosis was much higher compared to positive heterosis. Out of the total sixty five hybrids, fifty two of them (80%) manifested significant negative heterobeltiosis. The range of values was from 12.73 per cent to 45.14 per cent. The maximum and the minimum values were displayed by clone numbers seventeen and sixty two respectively. With regard to relative heterosis, twenty two (33.85%) of them recorded significant values. The maximum and the minimum number of hybrids which registered significant negative values were observed in the comparison with the second and third standards respectively.

8. Girth of cane at harvest

The mean values ranged from 6.2 to 8.56. The maximum and the minimum values were recorded by clone numbers seventy and twenty nine respectively. The hybrids displaying negative heterosis were comparatively much higher than those registering positive heterosis.

Table 14

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage.

Girth of cane at harvest

Parents, standards and hybrids.	Mean	Hetero-beltio sis	Relative hetero-sis	Standard Heterosis			
				1	2	3	4
1	2	3	4	5	6	7	8
1	8.04						
2	8.00						
3.	7.57						
4	7.68						
5	7.14						
6	9.06						
7	6.81	-15.30**	-14.88**	-10.04	-11.33	- 4.62	-24.83**
8	6.86	-14.68**	-14.25**	- 9.38	-10.68	- 3.92	-24.28**
9	7.58	- 5.72	- 5.25	0.13	1.30	6.16	-16.34
10	7.98	- 0.75	- 0.25	5.42	3.91	11.76	-11.92
11	6.80	-15.42**	-15.00**	-10.17	-11.46	- 4.76	-24.94**
12	7.05	-12.31*	-11.88*	- 6.87	- 8.20	- 1.26	-22.19**
13	7.12	-11.44*	-11.00*	- 5.94	- 7.29	- 0.28	-21.41**
14	7.84	- 2.49	- 2.00	3.57	2.08	9.80	-13.47**
15	6.99	-13.06*	-12.63**	- 7.66	- 8.98	- 2.10	-22.85**
16	7.01	-12.81*	-12.38**	- 7.40	- 8.72	- 1.82	-22.63**

(Table contd.)

(Table 14 contd.)

1	2	3	4	5	6	7	8
17	7.38	- 8.21	- 7.75	- 2.51	- 3.91	3.36	-18.54**
18	7.59	- 5.60	- 5.13	- 0.26	-1.17	6.30	-16.23**
19	7.26	- 9.70	- 9.25	- 4.10	- 5.47	1.68	-19.87**
20	6.95	-13.56	-13.13*	- 8.19	- 9.51	- 2.66	23.29**
21	7.60	- 5.47	5.00	0.40	- 1.04	6.44	-16.11**
22	7.35	- 8.58	-8.13	- 2.91	- 4.30	2.94	-18.87**
23	7.28	- 9.45	- 9.00	- 3.83	- 5.21	1.96	-19.65**
24	7.87	- 2.11	- 1.63	3.96	2.47	10.22	-13.13**
25	7.38	- 8.21	- 7.75	- 2.51	- 3.91	3.36	-18.54**
26	8.03	- 0.12	0.38	6.08	4.56	12.46	-11.37*
27	7.98	- 0.75	- 0.25	5.42	3.91	11.76	-11.92*
28	6.67	-17.04**	-16.63**	-11.89	-13.15*	-6.58	-26.38**
29	6.20	-22.89**	-22.50**	-18.10**	-19.27**	-13.17**	-31.57**
30	6.93	-13.81	-13.38**	- 8.45	- 9.77	- 2.94	-23.51**
31	7.39	- 8.08	- 7.63	- 2.38	- 3.78	3.50	-18.43**
32	7.22	-10.20	- 9.75	- 4.62	- 5.99	1.12	-20.31**
33	6.75	-16.04**	-15.63**	-10.83	-12.11*	- 5.46	-25.50**
34	7.82	- 2.74	- 2.25	3.30	1.82	9.52	-13.69**
35	8.11	0.87	1.38	7.13	5.60	13.59*	-10.49*
36	8.03	0.12	0.38	6.08	4.56	12.46*	-11.37*

(Table contd.)

(Table 14 contd.)

1	2	3	4	5	6	7	8
37	7.70	- 4.23	- 3.75	1.72	0.26	7.84	-15.01**
38	6.45	-19.78**	-19.38**	-14.88*	-16.02**	- 9.66	-28.81**
39	6.84	-14.93**	-14.50**	- 9.64	-10.94	- 4.20	-24.50**
40	7.32	- 8.96	- 8.50	- 3.30	- 4.69	2.52	-19.21**
41	7.41	- 7.84	- 7.38	- 2.11	- 3.52	3.78	-18.21**
42	7.30	- 9.20	- 8.75	- 3.57	- 4.95	2.24	-19.43**
43	6.88	-14.43*	-14.00**	- 9.11	-10.42	- 3.64	-24.06**
44	7.18	-10.70	-10.25	- 5.15	- 6.51	0.56	-20.75**
45	6.96	-13.43*	-13.00**	- 8.06	- 9.38	- 2.52	-23.18**
46	6.89	-14.30*	-13.88**	-8.98	-10.29	-3.50	-23.95**
47	7.96	-1.00	-0.50	5.15	3.65	11.48*	-12.14*
48	7.31	- 9.08	-8.63	-3.43	-4.82	2.38	-19.32**
49	7.70	-4.23	-3.75	1.72	0.26	7.84	-15.01**
50	6.49	-19.28**	-18.88**	-14.27*	-15.49**	-9.10	-28.37**
51	7.60	- 5.47	5.00	0.40	1.04	6.44	-16.11**
52	7.59	-5.60	-5.13	0.26	-1.17	6.30	-16.23**
53	6.27	-22.01**	-21.63**	-17.17**	-18.36**	-12.18*	-30.79**
54	7.50	- 6.72	- 6.25	-0.92	-2.34	5.04	-17.22**
55	7.58	- 5.72	- 5.25	0.13	-1.30	6.16	-16.34**
56	6.92	-13.93*	-13.50**	-8.59	-9.90	-3.08	-23.62**
57	8.03	- 0.12	0.38	6.08	4.56	12.46	-11.37*

(Table contd.)

(Table 14 contd.)

1	2	3	4	5	6	7	8
58	7.11	-11.57*	-11.13*	-6.08	-7.42	-0.42	-21.52**
59	7.98	-0.75	-0.25	5.42	3.91	11.76*	-11.92*
60	6.61	-17.79**	-17.38**	-12.68*	-13.93*	-7.42	-27.04**
61	7.10	-11.69*	-11.25*	-6.21	-7.55	-0.55	-21.63**
62	7.39	-8.08	-7.53	-2.38	-3.78	3.50	-18.43**
63	6.72	-16.42**	-16.00**	-11.23*	-12.50*	-5.88	-25.83**
64	7.39	- 8.08	- 7.63	-2.38	-3.78	3.50	-18.43**
65	8.27	2.86	3.38	9.25	7.68	15.83*	-8.72
66	8.23	2.36	2.88	8.72	7.16	15.27*	- 9.16
67	8.38	4.23	4.75	10.70	9.11	17.37**	-7.51
68	7.27	-9.58	-9.13	-3.96	-5.34	1.82	-19.76**
69	5.83	-27.49**	-27.13**	-22.99**	-24.09**	-18.35**	-35.65**
70	8.56	6.47	7.00	13.08*	11.46*	19.89**	-5.52
71	6.98	-13.18**	-12.75*	-7.79	- 9.11	-2.24	-22.96**

C.D. I (0.05) - 0.75

C.D. I (0.01) - 0.99

C.D.II (0.05) - 0.87

C.D.II (0.01) - 1.15

The hybrids recorded significant positive heterosis over the first, second and third standards only. Nine of them registered significant values over the better parent and mid parental means. Maximum number of hybrids (7) displaying significant positive heterosis was found to be over the third standard. The values ranged from 12.46 per cent to 19.89 per cent. The maximum and the minimum values were recorded by clone numbers seventy and thirty six respectively. With respect to the other two standards, one hybrid each recorded significant positive heterosis.

Heterosis was negative and significant in all the six comparisons. Among this, maximum number of hybrids which recorded significant negative heterosis was with respect to the fourth standard. In this regard, sixty one hybrids, out of the total sixty five registered significant values. When the better parent was compared, twenty two clones (33.85%) recorded significant negative heterosis. The values ranged from 11.44 per cent to 27.49 per cent. A still more number of hybrids (27) manifested significant heterosis over the mid parental value. In the comparison with the standards, the maximum number of hybrids (47) displaying significant negative heterosis was found in relation to the second standard. The values ranged from

12.11 per cent to 24.09 per cent. The maximum range of values were observed with regard to the fourth standard. The hybrid clones displaying significant negative heterosis with respect to the first, third and fourth standards were twenty eight, one and six respectively.

9. <u>Height of the cane at harvest</u>

The hybrids recorded mean values ranging from 134.61 to 232.47. Clone number thirty six registered the maximum value and clone number thirty seven, the minimum value. Comparatively much lesser number of hybrids displayed significant positive heterosis.

Out of the total sixty five hybrids, only three of them recorded significant positive heterobeltiosis. The values ranged from 14.09 per cent to 20.24 per cent. The number of hybrids displaying relative heterosis was much higher compared to those manifesting heterobeltiosis. As regards relative heterosis, the maximum value of 30.07 per cent was recorded by hybrid clone number thirty six and the minimum value of 14.08 per cent by hybrid clone number eight. Only two hybrids displayed positive standard heterosis over the third standard.

Table 15

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage

Height of cane at Harvest

Parents, standards and hybrids	Mean	Hetero-belitosis	Relative heterosis	Standard Heterosis 1	Standard Heterosis 2	Standard Heterosis 3	Standard Heterosis 4
1	193.34						
2	178.73						
3	241.89						
4	255.89						
5	195.72						
6	229.72						
7	157.67	-18.45**	-11.78	-34.82*	-38.38**	-19.44**	-31.36**
8	203.89	5.46	14.08*	-15.71**	-20.32**	4.17	-11.24*
9	161.72	-16.35*	- 9.52	-33.14**	-36.80**	-17.37**	-29.60**
10	173.00	-10.52	- 3.21	-28.48**	-32.39**	-11.61*	-24.69**
11	158.94	-17.79**	-11.07	-34.29**	-37.89**	-18.79**	-30.81**
12	164.56	-14.89*	-7.93	-31.97**	-35.69**	-15.92*	-28.36**
13	149.83	-22.50**	-16.17**	-38.06**	-41.45**	-23.45**	-34.78**
14	179.67	-7.07	0.53	-25.72**	-29.79**	-8.20	-21.79**
15	195.67	1.21	9.48	-19.11**	-23.53**	-0.03	-14.82**
16	179.11	-7.36	0.21	-25.95**	-30.01**	-8.49	-22.03**
17	136.47	-29.41**	-23.64*	-43.58**	-46.67**	-30.27**	-40.59**
18	205.61	6.35	15.04*	-15.00**	-19.65**	5.05	-10.50
19	192.17	-0.61	7.52	-20.55**	-24.90**	-1.81	-16.35**

(Table contd.)

(Table 15 contd.)

1	2	3	4	5	6	7	8
20	156.89	-18.85**	-12.22	-35.14**	-38.69**	19.84**	-31.70**
21	220.58	14.09*	23.42**	-8.81	-13.80*	12.70*	-3.98
22	168.22	-12.99	- 5.88	-30.46**	-34.26**	-14.05*	-26.77**
23	208.43	7.80	16.62**	13.83*	-18.55**	6.49	- 9.27
24	184.67	- 4.48	3.32	-23.66**	-27.83**	- 5.65	-19.61**
25	171.11	-11.50	- 4.26	-29.26**	-33.13**	-12.57*	-25.51**
26	206.17	6.64	15.35*	-14.77**	-19.43**	5.34	-10.25
27	214.11	10.74	19.80**	-11.48*	-16.33**	9.40	- 6.80
28	193.61	0.14	8.33	-19.96**	-24.34**	- 1.08	-15.72**
29	168.17	-13.02	- 5.91	-30.48**	-34.28**	-14.08*	-26.79**
30	185.44	- 4.09	3.75	-23.34**	-27.53**	- 5.25	-19.28**
31	209.56	8.39	17.25**	-13.37*	-18.11**	7.07	- 8.78
32	192.39	-0.49	7.64	-20.46**	-24.82**	- 1.70	-16.25**
33	223.19	15.44**	24.88**	- 7.73	-12.78*	-14.04*	- 2.84
34	175.61	- 9.17	- 1.75	-27.40**	-31.37**	-10.27	-23.55**
35	187.00	- 3.28	4.63	-22.69**	-26.92**	- 4.46	-18.60**
36	232.47	20.24**	30.07**	-3.89	-9.15	18.78**	1.20
37	134.61	-30.38**	-24.69**	-44.35**	-47.40**	-31.22**	-41.40**
38	186.83	- 3.37	4.53	-22.78**	-26.99**	-4.54	-18.67**

(Table contd.)

(Table contd)

1	2	3	4	5	6	7	8
39	194.33	0.51	8.73	-19.66**	-24.06**	- 0.71	-15.41**
40	173.33	-10.35	- 3.02	-28.34**	-32.26**	-11.44	-24.55**
41	177.39	- 8.25	- 0.75	-26.67**	-30.68**	- 9.37	-22.78**
42	216.11	11.78	20.91**	-10.66	-15.55**	10.42	- 5.92
43	199.35	3.11	11.54	-17.59**	-22.10**	1.85	-13.22*
44	168.34	-12.93	- 5.81	-30.41**	-34.21**	-13.99*	-26.72**
45	190.89	- 1.27	6.80	-21.08**	-25.40**	- 2.47	-16.90**
46	160.33	-17.07*	-10.29	-33.72**	-37.34**	-18.08**	-30.21**
47	188.05	- 2.74	5.21	-22.26**	-26.51**	- 3.92	-18.14**
48	164.00	-15.18*	- 8.24	32.20**	-35.91**	-16.21*	-28.61**
49	162.80	-15.80*	- 8.91	-32.70**	-36.38**	-16.82*	-29.13**
50	162.72	-15.84*	- 8.95	-32.73**	-36.41**	-16.86*	-29.17**
51	211.61	9.45	18.40**	-12.52*	-17.30**	8.12	- 7.88
52	116.61	-13.83*	- 6.78	-31.12**	-34.89**	-14.87*	-27.47**
53	168.75	-12.72	- 5.58	-30.24**	-34.05**	-13.78*	-26.54**
54	188.89	- 2.30	5.68	-21.91**	-26.18**	- 3.49	-17.77**
55	172.28	-10.89	- 3.61	-28.78**	-32.67**	-11.99	-25.00**
56	181.61	- 6.07	1.61	-24.92**	-29.03**	- 7.21	-20.94**
57	180.67	- 6.55	1.09	-25.31**	-29.40**	- 7.69	-21.35**
58	193.67	0.17	8.36	-19.93**	-24.32**	- 1.05	-15.69**
59	164.28	-15.03	- 8.08	-32.08**	-35.80**	-16.06*	-28.49**
60	187.75	- 2.89	5.05	-22.38**	-26.62**	- 4.07	-18.27**

(Table contd.)

(Table 15 contd.)

1	2	3	4	5	6	7	8
61	185.11	- 4.26	3.57	-23.47**	-27.66**	- 5.42	-19.42**
62	156.49	-19.06**	-12.44*	-35.31**	-38.84**	-20.04**	-31.88**
63	152.78	-20.98**	-14.52*	-36.84**	-40.29**	-21.94**	-33.49**
64	197.85	2.33	10.70	-18.21**	-22.68**	1.09	-13.87*
65	184.56	- 4.54	3.26	-23.70**	-27.88**	- 5.70	-19.66**
66	114.38	-25.32**	-19.22**	-40.31**	-43.58**	-26.23**	-37.15**
67	215.45	11.44	20.54**	-11.34	-15.80**	10.08	- 6.21
68	179.11	- 7.36	0.21	-25.95**	-30.01**	- 8.49	- 22.03**
69	177.83	- 8.02	- 0.50	-26.48**	-30.51**	- 9.14	- 22.59**
70	207.89	7.53	16.32**	-14.06*	-18.76**	6.22	- 9.50
71	184.37	- 4.74	3.04	-23.86**	-28.03**	- 5.90	-19.83**

C.D. I (0.05) - 21.92

C.D. I (0.01) - 28.89

C.D.II (0.05) - 25.31

C.D.II (0.01) - 33.36

The number of hybrids displaying significant negative heterosis was more with respect to the standards than with the better or mid parental means. Heterobeltiosis was negative and significant in seventeen (26.15%) out of the total number of hybrids. The values ranged from 13.83 per cent to 29.41 per cent. The highest and the lowest values were recorded by clone numbers seventeen and fifty two respectively. Only six hybrids followed this trend for negative heterosis. Among the standards, with respect to the second standard, the maximum number of hybrids displayed negative significant heterosis. The range of values was from 12.78 per cent to 47.4 per cent. The figures corresponding to the first, third and fourth standards were forty seven (72.31%) twenty one (32.31%) and thirty eight (58.46%) respectively. The maximum range of values was displayed by the second standard.

10. Weight of single cane

The mean values of the hybrids were found to be ranging from 441.67 to 1170.00. Hybrid clones, sixty six and thirteen registered the maximum and the minimum values respectively. For this attribute also, hybrids displaying significant negative heterosis were much higher than significant positive heterosis.

Table 16

The mean values of parents, stanards and F_1 hybrids and their heterosis in percentage

Weight of single cane

Parents standards and hybrids	Mean	Hetero-beltiosis	Relative Heterosis	Standard Heterosis			
				1	2	3	4
1	2	3	4	5	6	7	8
1	906.67						
2	870.84						
3	1030.00						
4	993.23						
5	846.67						
6	1398.33						
7	596.67	-34.19*	-31.48*	-42.07**	-39.93*	-29.53	-57.33**
8	815.00	-10.11	-6.41	-20.87	-17.94	- 3.74	-41.72**
9	765.00	-15.63	-12.15	-25.73	-22.98	-9.65	-45.29**
10	701.67	-22.61	-19.43	-31.88*	-29.35	-17.13	-49.82**
11	621.67	-31.43	-28.61	-39.64**	-37.41*	-26.57	-55.54**
12	551.67	-39.15*	-36.65*	-46.44**	-44.46**	-34.84*	-60.55**
13	441.67	-51.29**	-49.28**	-57.12**	-55.53**	-47.83**	-68.41**
14	970.00	6.98	11.39	-5.83	2.34	14.57	-30.63
15	550.00	-39.34*	-36.84*	-46.60**	-44.63**	-35.04*	-60.67**
16	695.00	-23.35	-20.19	-32.52*	-30.03	-17.91	-50.30**
17	546.67	-39.71*	-37.22*	-46.93**	-44.96**	-35.43*	-60.91**

(Table contd.)

(Table 16 contd.)

1	2	3	4	5	6	7	8
18	935.00	3.12	7.37	- 9.22	- 5.86	10.43	-33.13**
19	596.67	-34.19*	-31.48*	-42.07**	-39.93*	-29.53	-57.33**
20	678.33	-25.18	-22.11	-34.14*	-31.70*	-19.88	-51.49**
21	601.67	-33.64*	-30.91*	-41.59**	-39.42*	-28.94	-56.97**
22	760.00	-16.18	-12.73	-26.21	-23.48	-10.24	-45.65**
23	911.67	0.55	4.69	-11.49	- 8.21	7.68	-34.80**
24	1156.67	27.57	32.82*	12.30	16.46	36.61*	-17.28
25	870.00	- 4.04	- 0.10	-15.53	-12.41	2.76	-37.78**
26	1043.33	15.07	19.81	1.29	5.04	23.19	-25.39
27	1166.67	28.68	33.97*	13.27	17.46	37.80*	-16.57
28	705.00	-22.24	-19.04	-31.55*	-29.02	-16.73	-49.58**
29	653.33	-27.94	-24.98	-36.57*	-34.22*	-22.84	-53.28**
30	811.67	-10.48	- 6.79	-21.20	-18.28	- 4.13	-41.95**
31	1045.00	15.26	20.00	1.46	5.21	23.42	-25.27
32	816.67	- 9.93	- 6.22	-20.71	-17.78	- 3.54	41.60**
33	991.67	9.37	13.88	- 3.72	- 0.16	17.13	-29.08
34	875.00	- 3.49	0.48	15.05	-11.90	3.35	-37.43**
35	846.67	- 6.62	-2.78	-17.80	-14.76	-	-39.45**
36	840.00	- 7.35	-3.54	-18.45	-15.43	-0.79	-39.93**
37	525.00	-42.10**	-39.71**	-49.03**	-47.14**	-37.99*	-62.46**
38	548.33	-39.52*	-37.03*	-46.76**	-44.79**	-35.24*	-60.79**

(Table contd.)

(Table 16 contd.)

1	2	3	4	5	6	7	8
39	773.33	-14.71	-11.20	-24.92	-22.14	- 8.66	-44.70**
40	875.00	- 3.49	0.48	-15.05	-11.90	3.35	-37.43**
41	790.00	-12.87	- 9.28	-23.30	-20.46	- 6.69	-43.50**
42	920.00	1.47	5.65	-10.68	- 7.37	8.66	-34.21*
43	595.00	-34.38*	-31.68*	-42.23**	-40.09**	-29.72	-57.45**
44	660.00	-27.21	-24.21	-35.92*	-33.55*	-22.05	-52.80**
45	718.33	-20.77	-17.51	-30.26	-27.68	-15.16	-48.63**
46	636.67	-29.78	-26.89	-38.19*	-35.90*	-24.80	-54.47**
47	910.00	0.37	4.50	-11.65	- 8.38	7.48	-34.92*
48	776.67	-14.34	-10.81	-24.60	-21.80	- 8.27	-44.46**
49	573.33	-36.77*	-34.16*	-44.34**	-42.28**	-32.28*	-59.00**
50	616.67	-31.99	-29.19	-40.13**	-37.91*	-27.17	-55.90**
51	1090.00	20.22	25.17	5.83	9.74	28.74	-22.05
52	801.67	-11.58	- 7.94	-22.17	-19.29	- 5.31	-42.67**
53	551.67	-39.15*	-36.65*	-46.44**	-44.46**	-34.84*	-60.55**
54	823.33	- 9.19	- 5.46	-20.07	-17.11	- 2.76	-41.12**
55	711.67	-21.51	-18.28	-30.91	-28.35	-15.94	-49.11**
56	831.67	- 8.27	- 4.50	-19.26	-16.27	-1.77	-40.52**
57	835.00	- 7.90	- 4.12	-18.93	-15.93	- 1.38	-40.29**
58	798.33	-11.95	- 8.33	-22.49	-19.63	- 5.71	-42.91**
59	818.33	- 9.74	- 6.03	-20.55	-17.61	- 3.35	-41.48**
60	751.67	-17.10	-13.68	-27.02	-24.32	-11.22	-46.25**

(Table contd.)

(Table 16 contd.)

1	2	3	4	5	6	7	8
61	611.67	-32.54	-29.76	-40.61**	-38.42**	-27.76	-56.25**
62	550.00	-39.34*	-36.84*	-46.60**	-44.63**	-35.04*	-60.67**
63	581.67	-35.85*	-33.21*	-43.53**	-41.44**	-31.30	-58.40**
64	651.67	-28.12	-25.17	-36.73*	-34.39*	-23.03	-53.40**
65	1050.00	15.81	20.57	1.94	5.72	24.02	-24.91
66	1170.00	29.04	34.35*	13.59	17.80	38.19*	-16.33
67	970.00	6.98	11.39	5.83	2.34	14.57	30.63
68	723.33	-20.22	-16.94	-28.77	-27.17	-14.57	-48.27**
69	461.67	-49.08**	-46.99**	-55.18**	-53.52**	-45.67**	-66.98**
70	1000.00	10.29	14.83	- 2.91	0.68	18.11	-28.49
71	715.00	-21.14	-17.90	-30.58	-28.01	-15.55	-48.87**

C.D. I (0.05) - 260.95

C.D.I (0.01) - 343.98

C.D.II (0.05) - 301.32

C.D.I(0.01) - 397.19

Positive significant heterosis was observed only with respect to the mid parental value and the third standard. In all other aspects, none of the hybrids displayed significant positive heterosis.

Among the total sixty five hybrids, only three recorded significant positive heterosis over the mid parental value and over the third standard. The hybrids displayed similar range of values in the two cases. The ranges were 32.82 per cent to 34.35 per cent and 36.61 per cent to 38.19 per cent. The maximum values were recorded by clone number sixty six and the minimum values, by clone number twenty four.

Significant negative heterosis was manifested by fifteen hybrids each with regard to the better and mid parental values. The range of values was slightly higher in the latter. The corresponding values were from 33.64 per cent to 51.29 per cent and from 30.91 per cent to 49.28 per cent respectively. The maximum number of hybrids displaying standard heterosis was observed with respect to the fourth standard, followed by the first, second and third standards. The number of hybrids in each comparison were fifty nine (90.77%), twenty seven (41.54%), twenty three (35.38%) and three (4.62%) respectively. The hybrids displayed maximum range of values (29.08% to 68.41%) when compared to the fourth standard.

11. Number of water shoots

For this attribute the hybrid means ranged from 2.67 to 21.33. Clone numbers fifteen and seventeen recorded the maximum and the minimum values respectively. But none of the hybrids displayed significant positive heterosis or significant negative heterosis over the better parent, mid parent and the standards.

12. Number of arrows

The hybrids recorded mean values ranging from 0-20.67 for this trait. Though the minimum value was recorded by more than one clone, the maximum value was recorded by clone number fifteen only. The hybrids displayed positive significant heterosis over the standards and negative significant heterosis over the better and mid parental means.

The maximum number of hybrids displaying significant positive heterosis was observed in the comparison with the second standard followed by the third and fourth standards. In this regard, eleven hybrids manifested heterosis ranging from 241 per cent to 364 per cent. Clone numbers fifteen

Table 17

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage

Number of water shoots

Parents, stand-ards and hybrids	Mean	Hetero-beltio-sis	Relative Hetero-sis	Standard Heterosis			
				1	2	3	4
1	2	3	4	5	6	7	8
1	4.61						
2	3.99						
3	4.56						
4	3.73						
5	3.33						
6	3.67						
7	2.97	-19.07	-15.14	-35.57	-20.38	-10.81	-19.07
8	2.76	-24.80	-21.14	-40.13	-26.01	-17.12	-24.80
9	2.43	-33.78	-30.57	-47.29	-34.85	-27.03	-33.79
10	3.56	- 2.99	1.71	-22.78	- 4.56	6.91	- 2.99
11	3.07	-16.35	-12.29	-33.41	-17.69	- 7.81	-16.35
12	2.51	-31.61	-28.29	-45.55	-32.71	-24.62	-31.61
13	2.17	-40.87	-38.00	-52.93	-41.82	-34.83	-40.87
14	3.59	- 2.18	2.57	-22.13	- 3.75	7.81	- 2.18
15	4.62	25.89	32.00	0.22	23.86	38.74	25.89
16	3.43	- 6.54	- 2.00	-25.60	- 8.04	3.00	- 6.54
17	1.82	-50.41	-48.00	-60.52	-54.39	-60.09	-51.21

(Table contd.)

(Table 17 contd.)

1	2	3	4	5	6	7	8
18	3.10	-15.53	-11.43	-32.75	-22.31	-32.02	-16.89
19	2.97	-19.07	-15.14	-35.57	-25.56	-34.87	-20.38
20	2.10	-42.78	-40.00	-54.45	-47.37	-53.95	-43.70
21	2.35	-35.97	-32.86	-49.02	-41.10	-48.46	-36.99
22	2.05	-44.14	-41.43	-55.53	-48.62	-55.04	-45.04
23	2.65	-27.79	-24.29	-42.52	-33.58	-41.89	-28.95
24	2.41	-34.33	-31.14	-47.72	-39.59	-47.15	-35.39
25	2.08	-43.32	-40.57	-54.88	-47.87	-54.39	-44.24
26	2.14	-41.69	-38.86	-53.58	-46.37	-53.07	-42.63
27	2.74	-25.34	-21.71	-40.56	-31.33	-39.91	-26.54
28	3.08	-16.08	-12.00	-33.19	-22.81	-32.46	-17.43
29	3.01	-17.98	-14.00	-34.71	-24.56	-33.99	-19.30
30	3.14	-14.44	-10.29	-31.89	-21.30	-31.14	-15.82
31	2.10	-42.78	-40.00	-54.45	-47.37	-53.95	-43.70
32	3.53	- 3.81	0.86	-23.43	-11.53	-22.59	- 5.36
33	2.73	-25.61	-22.00	-40.78	-31.58	-40.13	-26.81
34	2.48	-32.43	-29.14	-46.20	-37.84	-45.61	-33.51
35	3.31	- 9.81	- 5.43	-28.20	-17.04	-27.41	-11.26
36	2.46	-32.97	-29.71	-46.64	-38.35	-46.05	-34.05
37	2.03	-44.69	-42.00	-55.97	-49.12	-55.48	-45.58
38	2.81	-23.43	-19.71	-39.05	-29.57	-38.38	-24.66
39	3.23	-11.99	- 7.71	-29.93	-19.05	-29.17	-13.40
40	1.97	-46.32	-43.71	-57.27	-50.63	-56.80	-47.18

(Table contd.)

(Table 17 contd.)

1	2	3	4	5	6	7	8
41	3.39	- 7.63	- 3.14	-26.46	-15.04	-25.66	- 9.12
42	3.46	- 5.72	- 1.14	-24.95	-13.28	-24.12	- 7.24
43	2.54	-30.79	-27.43	-44.90	-36.34	-44.30	-31.90
44	3.66	- 0.27	4.57	-20.61	- 8.27	-19.74	-1.88
45	3.41	- 7.08	- 2.57	-26.03	-14.54	-25.22	- 8.58
46	2.58	-29.70	-26.29	-44.03	-35.34	-43.42	-30.83
47	2.44	-33.51	-30.29	-47.07	-38.85	-46.49	-34.58
48	2.62	-28.61	-25.14	-43.17	-34.34	-42.54	-28.76
49	2.00	-45.50	-42.86	-56.62	-49.87	-56.14	-46.38
50	2.24	-38.96	-36.00	-51.41	-43.86	-50.88	-39.95
51	3.41	7.08	- 2.57	-26.03	-14.54	-25.22	- 8.58
52	3.29	-10.35	- 6.00	-28.63	-17.54	-27.85	-11.80
53	3.51	- 4.36	0.29	-23.86	-12.03	-23.03	- 5.90
54	2.64	-28.07	-24.57	-42.73	-33.83	-42.11	-29.22
55	2.65	-27.79	-24.29	-42.52	-33.58	-41.89	-28.95
56	2.64	-28.07	-24.57	-42.73	-33.83	-42.11	-29.22
57	3.87	- 5.45	-10.57	-16.05	- 3.00	-15.13	3.75
58	2.49	-32.15	-28.86	-45.99	-37.59	-45.39	-33.24
59	2.56	-30.25	-26.86	-44.47	-35.84	-43.86	-31.37
60	3.36	- 8.45	- 4.00	-27.11	-15.79	-26.32	- 9.92
61	3.85	- 4.90	10.00	-16.49	- 3.51	-15.57	3.22

(Table contd.)

(Table 17 contd.)

1	2	3	4	5	6	7	8
62	3.15	-14.17	-10.00	-31.67	-21.05	-30.92	-15.55
63	3.36	- 8.45	4.00	-27.11	-15.79	-26.32	- 9.92
64	2.46	-32.97	-29.71	-46.64	-38.35	-46.05	-34.05
65	2.86	-22.07	-18.29	-37.96	-28.32	-37.28	-23.32
66	2.88	-21.53	-17.71	-37.53	-27.82	-36.84	-22.79
67	3.15	-14.17	-10.00	-31.67	-21.05	-30.92	-15.55
68	3.63	- 1.09	3.71	-21.26	- 9.02	-20.39	- 2.68
69	3.24	-11.72	- 7.43	-29.72	-18.80	-28.95	-13.14
70	2.21	-39.78	-36.86	-52.06	-44.61	-51.54	-40.75
71	2.48	-32.43	-29.14	-46.20	-37.84	-45.61	-33.51

C.D. I (0.05) - 2.92

C.D. I (0.01) - 3.84

C.D.II (0.05) - 3.37

C.D.II (0.01) - 4.44

Table 18

The mean values of parents, standards and F_1 hybrids and their heterosis in percentage

Number of arrows

Parents, standards and hybrids	Mean	Hetero-beltiosis	Relative Heterosis	Standard Heterosis 1	Standard Heterosis 2	Standard Heterosis 3	Standard Heterosis 4
1	2	3	4	5	6	7	8
1	2.16						
2	1.00						
3	1.14						
4	1.14						
5	2.85						
6	3.73						
7	3.74	0.27	13.68	73.15	274*	228.07*	228.07*
8	1.14	-69.44*	-65.35	47.22	14	-	-
9	2.92	-21.72	-11.25	35.19	192	156.14	156.14
10	3.78	1.34	14.89	75.00	278*	231.58*	231.58*
11	3.46	7.24	5.17	60.19	246*	203.51*	203.51*
12	1.88	-49.59	-42.86	-12.96	88	64.91	64.91
13	2.29	-38.61	-30.39	6.02	129*	100.88	100.88
14	3.04	-18.49	- 7.59	40.74	204*	166.67*	166.67*
15	4.64	24.40	41.03	114.81	364*	307.02**	307.02**
16	2.43	-34.85	-26.14	12.50	143	113.16	113.16
17	1.66	-55.50	-49.54	-23.15	66	45.61	45.61

(Table contd..)

(Table 18 contd.)

1	2	3	4	5	6	7	8
18	1.14	-69.44*	-65.35*	-47.22	14	-	-
19	2.88	-22.79	-12.46	33.33	188	152.63	152.63
20	1.87	-49.87	-43.16	-13.43	87	64.04	64.04
21	2.93	-21.48	-10.94	35.65	193	157.02	157.02
22	1.28	-66.68*	-61.09*	-40.74	28	12.28	12.28
23	1.79	-52.01	-45.59	-17.13	79	57.02	57.02
24	1.00	-73.19*	-69.60*	-53.70	-	-12.28	-12.28
25	2.77	-25.74	-15.81	28.24	177	142.98	142.98
26	1.00	-73.19*	-69.60*	-53.70	-	-12.28	-12.28
27	2.49	-33.24	-24.32	15.28	149	118.42	118.42
28	1.88	-49.60	-42.86	-12.96	88	64.91	64.91
29	2.28	-65.68*	-61.09*	-40.74	28	12.28	12.28
30	1.00	-73.19*	-69.60*	-53.70	-	-12.28	-12.28
31	1.99	-46.65	-39.51	-7.87	99	74.56	74.56
32	3.25	-12.87	- 1.22	50.46	225*	185.09	185.09
33	1.38	-63.00*	-58.05	-36.11	38	21.05	21.05
34	2.67	-28.42	-18.84	23.61	167	134.21	134.21
35	2.37	-36.46	-27.96	9.72	137	107.89	107.89
36	3.60	-3.49	9.42	66.67	260*	215.79*	215.79*
37	2.85	-23.59	-13.37	31.94	185	150.00	150.00
38	1.73	-53.62	-47.42	-	73	51.75	51.75
39	2.82	-24.40	-14.29	30.56	182	147.37	147.37

(Table contd.)

(Table 18 contd.)

1	2	3	4	5	6	7	8
40	1.66	-55.50	-49.54	-23.15	66	45.61	45.61
41	1.14	-69.44*	-65.35*	-47.22	14	-	-
42	1.14	-69.44*	-65.35*	-47.22	14	-	-
43	3.09	-17.16	- 6.08	43.06	209	171.05	171.05
44	3.36	- 9.92	- 2.13	55.56	236*	194.74	194.74
45	3.01	-19.30	- 8.51	39.35	201	164.04	164.04
46	2.34	-37.27	-28.88	8.33	134	105.26	105.26
47	1.82	-51.21	-44.68	-15.74	82	59.65	59.65
48	1.28	-65.68*	-61.09*	-40.74	28	12.28	12.28
49	2.13	-42.90	-35.26	- 1.39	113	86.84	86.84
50	1.91	-48.79	-41.95	-11.57	93	67.54	67.54
51	3.50	- 6.17	6.38	62.04	250*	207.12*	207.12*
52	1.63	-56.30	-50.46	-24.54	63	42.98	42.98
53	3.93	5.36	19.45	81.94	293*	244.74*	244.74*
54	2.76	-26.01	-16.11	-27.78	176	142.11	142.11
55	2.05	-45.04	-37.69	- 5.09	105	79.82	79.82
56	1.28	-65.68	-61.09	-40.74	28	12.28	12.28
57	3.41	- 8.58	3.65	57.87	241*	199.12	199.12
58	1.00	-73.19*	-69.60*	-53.70	-	-12.28	-12.28
59	1.72	-53.89	-47.72	-20.37	72	50.88	50.88
60	2.59	-30.56	-21.28	19.91	159	127.19	127.19
61	2.68	-28.15	-18.54	24.07	168	135.09	135.09

(Table contd.)

(Table 18 contd.)

1	2	3	4	5	6	7	8
62	2.91	-21.98	-11.55	34.72	191	155.26	155.26
63	3.78	- 1.34	14.89	75.00	278*	231.58*	231.58*
64	3.27	-12.33	- 0.61	51.39	227	186.84	186.84
65	1.28	-65.68	-61.09	-40.74	28	12.28	12.28
66	1.55	-58.45	-52.89	-28.24	55	35.96	35.96
67	1.00	-73.19*	-69.60*	-53.70	-	-12.28	-12.28
68	3.54	- 5.09	7.60	63.89	254*	210.53*	210.53*
69	2.37	-36.46	-27.96	9.72	137	107.89	107.89
70	2.56	-31.37	-22.19	18.52	156	124.56	124.56
71	2.57	-31.10	-21.88	18.98	157	125.44	125.44

C.D. I (0.05) - 1.97

C.D. I (0.01) - 2.6

C.D. II (0.05) - 2.28

C.D. II (0.01) - 3.00

Table 19

Percentage of hybrids displaying significant positive and negative heterosis in different comparisons

Sl. No.	Characters		Hetero-beltio sis	Relative Heterosis	Standard Heterosis			
					1	2	3	4
1	2		3	4	5	6	7	8
1.	Germination	(P)	4.6	18.46	-	-	-	1.54
		(N)	3.08	1.54	87.69	6.15	9.23	3.08
2.	Shootcount	(P)	24.62	50.77	4.62	12.31	4.62	10.77
		(N)	1.54	-	33.85	10.77	61.54	12.31
3.	H.R.Brix	(P)	18.46	60.00	-	-	-	-
		(N)	-	-	9.23	10.77	29.23	10.77
4.	Total weight of cane	(P)	-	1.54	-	-	-	-
		(N)	76.92	50.77	100	100	98.46	100
5.	Number of millable canes at harvest	(P)	4.62	16.92	-	1.54	1.54	1.54
		(N)	23.08	4.62	90.77	46.15	46.15	53.85

(Table 19 contd.)

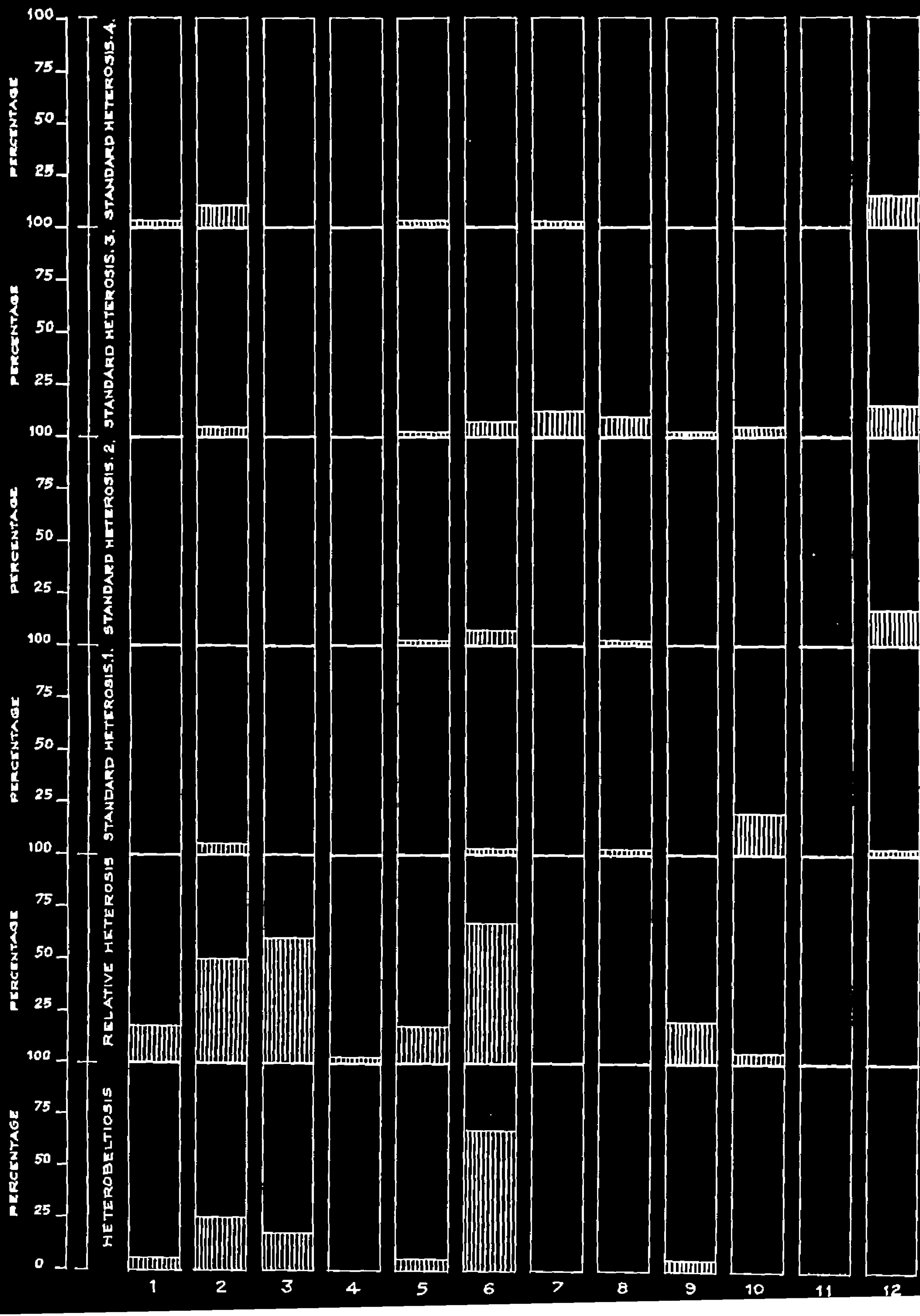
(Table 19 contd.)

1	2		3	4	5	6	7	8
6.	Number of internodes at harvest	(P)	66.15	66.15	3.08	7.69	7.69	-
		(N)	-	-	75.38	52.31	52.31	92.31
7.	Length of internodes at harvest	(P)	-	-	-	-	12.31	1.54
		(N)	80.00	33.85	43.08	72.31	1.54	9.23
8.	Girth of cane at harvest	(P)	-	-	1.54	1.54	10.77	-
		(N)	33.85	41.54	9.23	12.31	3.08	93.85
9.	Height of cane at harvest	(P)	4.62	20.0	-	-	3.08	-
		(N)	26.15	9.23	72.31	73.85	32.31	58.46
10.	Weight of single cane	(P)	-	4.62	-	-	4.62	-
		(N)	23.08	23.08	41.54	35.38	4.62	90.77
11.	Number of water shoots	(P)	-	-	-	-	-	-
		(N)	-	-	-	-	-	-
12.	Number of arrows	(P)	-	-	1.54	16.92	13.85	13.85
		(N)	23.08	21.54	-	-	-	-

P - Positive significant

N - Negative significant

FIG. 6. PERCENTAGE OF HYBRIDS DISPLAYING SIGNIFICANT POSITIVE HETEROSIS IN DIFFERENT COMPARISONS.



and fifty seven recorded the maximum and the minimum values. In comparison with the third and fourth standards, nine clones each displayed significant values ranging from 203.51 per cent to 307.02 per cent.

The mean values of brix, pol, purity and ccs of the hybrids and parents are presented in Figures 2,3, 4 and 5 respectively.

Twenty four elite clones were selected based on the number of millable canes, total weight of cane, brix, pol, purity and ccs. The details of which are presented in Appendix II.

Discussion

DISCUSSION

Although sugarcane (*Saccharum officinarum*) occupies a paramount place in the sugar industry, with its noble attributes, the diminishing vigour and yield of cane varieties after they have been in commercial cultivation for some years has been a characteristic of the cane sugar industry, since the era of expansion began about a century ago. It is an obscure and puzzling problem of the highest importance to growers and processors on one hand, the scientists associated with the industry on the other. Some of the factors contributing to varietal yield were described in papers presented at the 10th Congress of the International Society of Sugarcane Technologists in 1959. The genetic aspects were critically described by Mangelsdorf (1959).

Barnes (1974) has attributed the essential qualities of the canes, as :

1. Profitable yield of sucrose over the crop cycle or productivity.

2. Immunity or high resistance to diseases and insect pests of local importance.

3. Millability.

These features are associated with a number of contributory factors and all these are interrelated. Profitable yield is not necessarily synonymous with highest yield. Sugarcane, like other crops possess agroclimatic adaptations, for unveiling the yield potential of the variety concerned. The practice of monoculture has stemmed the canes from being able to express themselves in terms of their genetic potentiality.

Since sugarcane being a complex polyploid which is commonly propagated vegetatively, the broad spectrum of recombinants resulting from intervarietal hybridisation provide ample scope for elucidating elite clones possessing positive heterosis and adaptability to varied environmental conditions.

With an objective to study the genetic variability and to assess the extent and magnitude of heterosis pertaining to important economic attributes, the hybrid progenies of the cross Co 775 x Co 453 were selected. The female parent was endowed with the qualities of resistance to water-logging, high sucrose content, profuse tillering capacity and high ratooning ability while the male parent possessed saline and drought resistance, thickness of cane and higher yield potential. The female parent had high fibre content. The experiment was conducted at Sugarcane Research Station, Tiruvalla during 1981. Four hundred and fifty seedlings were screened for further studies. Seventeen important economic traits including quality aspects were assessed. The correlations between characters and coefficient of variation were also studied.

Based on the general performance, number of millable canes, weight per stool and brix value, sixty five clones were selected for further studies. The selected clones were put under replicated trial. The two parents and four standards which were popular in the locality namely Co 449, Co 785, Co 997 and Co 62175 were also included in the treatments. Seventeen important economic traits including four quality attributes were assessed. The quality attributes being juiciness, brix, pol and purity. Besides the estimation of relative heterosis, heterobeltiosis and standard heterosis, phenotypic and genotypic correlations were worked out. The genetic parameters like coefficients of variation, heritability in the broad sense and genetic advance were also assessed.

Based on millable cane number, total weight, brix, pol, purity and ccs, twenty four elite clones were selected for subsequent studies. The results obtained are discussed in the succeeding pages.

(a) <u>Studies on variability</u>

(i) <u>Biometric studies in seedling population</u>

The maximum coefficient of variation was observed for the character, weight of cane per stool, followed by number of shoots and number of millable canes per stool. This suggests the scope for selection of superior canes based on these attributes. The minimum coefficient of variation was recorded by H.R. Brix. The results were in confirmity with the findings of Craig (1944), who observed a higher coefficient of variation for weight of stool than refractometric brix. Mariotti (1971c) also recorded observations in the same line. He could observe low coefficients of genetic variation for pol and juice purity. However, majority of the workers reported high variability for quality components in sugarcane. Singh et al., (1978) and Punia and Singh (1981) registered the same observations.

(ii) Genotypic and phenotypic variability, heritability and genetic advance in clonal population

A perusal of the results on the population mean and genetic parameters revealed that the heritability was maximum for arrowing followed by number of internodes at harvest, and shoot count at ninety days. The results were in agreement with the observations of Lyrene (1977a). All the characters except germination percentage, H.R.Brix, grassy shoot counts, and number of water shoots displayed higher heritability. The findings indicate that these characters are less influenced by environment. High heritability for yield and its components were reported by Mariotti (1971c and 1973), Cesnik (1975), Balasundaram and Bhagyalakshmi (1978) and Singh (1981). As regards H.R.Brix, heritability was comparatively low. This observation was in disagreement with the findings of Galvez and Amador (1978).

The phenotypic coefficient of variation was greater than the genotypic coefficient of variation for all the characters studied. The maximum genotypic coefficient of variation was observed for number of arrows followed by grassy shoot counts. Cane yield and its components namely number of millable canes, number and length of internode, girth and height of cane manifested low co-efficient of variation. Contrary to these observations, Mariotti (1973) and Balasundaram and Bhagyalakshmi (1978) observed high variability for cane yield and its components. Punia and Singh (1981) also reported similar results. High variability was reported by Hogarth et al., (1981) and Singh (1981), for yield.

Johnson et al., (1955) in their studies with soybean have reported that heritability estimates along with genetic advance is more useful than heritability alone in predicting the resultant effect of selection. Since heritability determines the component of heritable variation and genetic advance measures the extent of its stability under selection, these two parameters should be considered together, so as to bring effective improvement in economic yield and other complex characters. In the present study, the maximum genetic advance was obtained for height of cane at harvest, followed by shoot count at ninety days after planting. In general, this parameter was not high for most of the attributes studied except for height of cane. Substantial genetic advance for yield and its components were obtained by Rao et al., (1966) and Shah et al., (1966).

The different clones selected from the base population differed significantly for all the characters studied. This trend along with high heritability estimates for the characters offered considerable scope for selection within the population.

(b) Correlations

The genotypic correlations were higher than the phenotypic correlations. In cases where both phenotypic and genotypic correlations were significant, the sign was same, either positive or negative.

(i) Seedling population

Cane yield was observed to be positively correlated with all the yield components except H.R.Brix where a negative non-significant correlation was observed. Yield registered high positive correlations with number of shoots, number of millable canes per stool and height of cane at harvest. Cane yield had the closest association with number of millable canes at harvest.

The positive correlation of number of millable canes with height, weight, girth and number of internodes had been established by many workers (Gill, 1949; Rattan, 1951; Dillewijn, 1950; Varma, 1963; Anonymous, 1965, Singh and Sangha 1970; James, 1971; Juang, 1971; Batcha and Sahi, 1972; Mariotti, 1972b, Balasundaram and Bhagyalakshmi, 1976 and 1978 and Bathila, 1978).

Number of millable canes and girth had an inverse relationship. But the same attribute had positive correlation with height of cane, and number and length of internode. Height of cane had significant positive associations with number and length of internode, girth of cane and number of millable canes. Hence the contribution of number of millable canes to yield was presumed to be through height of cane. Khairwal and Babu (1976) also opined this fact.

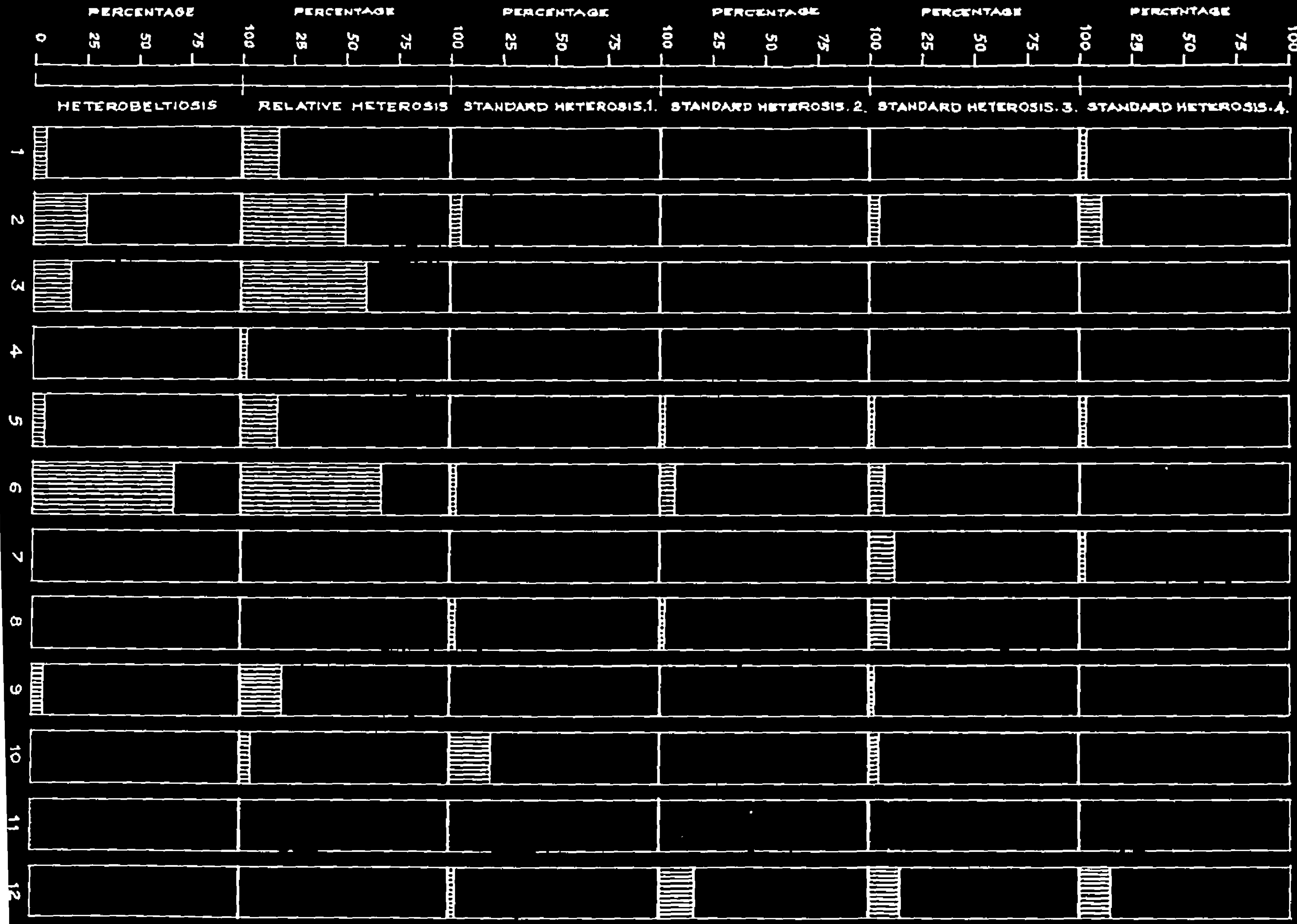


FIG. 6. PERCENTAGE OF HYBRIDS DISPLAYING SIGNIFICANT POSITIVE HETEROSIS IN DIFFERENT COMPARISONS.

The negative non-significant correlation of brix with cane yield had been established by Stevenson (1954). Ethirajan (1965) reported negative relationship between yield and juice quality in crosses.

(ii) Clonal population

The association between cane yield and its important components namely number of millable canes, number of internodes, length of internode, girth of cane, height of cane and weight of single cane were positive and significant. Yield of cane had the maximum positive significant correlation with number of millable canes followed by height of cane and weight of single cane.

Studies conducted by various workers (Quintus, 1925; Gill, 1949; Dillewijn, 1950; Anon., 1965; James, 1971; Juang 1971; Mariotti, 1971b and 1972b; Balasundaram and Bhagyalakshmi, 1976; and Bathila, 1978) and also from the results of the present study, the maximum contribution of number of millable canes to cane yield had been well established.

Number of millable canes being the most important component of cane yield, recorded positive non-significant correlations with number and length of internode and height of cane. However, this attribute registered negative non-significant correlations with girth and weight of single cane.

According to Singh and Jain (1968) number of canes per clump had inverse association with yield per clump.

Although there were difference of opinion regarding the correlation of number of millable canes and girth, the results obtained in the present study were in confirmity with the observations of Hebert and Henderson, 1959; George, 1962; Singh and Jain, 1968; and Mariotti, 1972 and 1973.

High positive correlation of stalk number with height had been reported by Varma, 1963; Anonymous, 1965; James, 1971; and Mariotti 1971 and 1972. In the present investigation also positive correlations were observed between stalk number and height of cane.

In the present investigation, number of millable canes and number of internodes were observed to have non-significant positive correlation. However, Singh et al., (1981) reported significant positive genotypic and phenotypic association between these two traits.

Height of cane was observed to have significant positive correlation with total weight of cane. However, with number of millable canes, this attribute established positive non-significant correlation. Positive association of yield with height of cane had been reported by Gill, 1949; Rattan, 1951; James, 1971; Batcha and Sahi, 1972; and Mariotti, 1972a.

Weight of single cane had positive significant correlation with cane yield. The results unveiled that single cane weight had high positive correlation with cane girth and height and both inturn possessed positive correlations with yield. Hence it is inferred that the contribution of single cane weight to cane yield may be through girth and height of cane. This observation was supported by the findings of Khairwal and Babu (1976). Hebert (1965) and Mariotti (1971b and 1972b) also opined that the single cane weight had positive correlation with cane yield.

Number of internodes and length of internode also displayed positive correlation with cane yield. These two attributes contributed to cane height and were positively correlated with cane height. Since the number and length of internodes had a positive bearing on the height of cane, which inturn contributed to yield, the former two traits were believed to be indirectly influencing the yield. Positive correlation of yield with number of internodes was emphasised by Singh and Sangha (1970). However, low positive correlation between these two traits was reported by Batcha and Sahi (1972).

H.R.Brix had negative significant correlation with number of millable canes and positive significant correlation with girth of canes and weight of single cane. However, purity registered significant positive correlation with yield.

Total cane yield appeared to have negative correlation with H.R.Brix. The results were in confirmity with the findings of Desorney (1950), who reported total absence of correlation between yield and quality. The present findings point towards the fact that as the total yield enhances, the water content also get enhances. Consequently, the quality components get decreased.

Negative correlations of yield with juice quality was already reported by Stevenson (1954), Ethirajan (1965) and Mariotti _et al._, (1971). Hence it may be presumed that the probability of varieties combining high yield potential and quality attributes are remote. Hebert (1965) emphasised that there was low negative correlation between yield and sucrose recovery.

(c) Heterosis

Although all the characters except 'water shoot counts' manifested positive heterosis, the number of hybrids displaying this phenomenon was relatively less. Comparatively lesser number of clones displayed significant positive heterosis than significant negative heterosis. Consequently, the percentage of hybrids manifesting positive heterosis became less, and accounted a higher proportion of negative heterosis in seven out of the twelve characters investigated. The shoot count alone displayed positive heterosis in all comparisons. The percentage of hybrid clones displaying positive and negative values in heterobeltiosis, relative heterosis and standard heterosis were compared.

As regards H.R.Brix 18.46 per cent of the hybrids were found superior to the better parent. The comparison with the mid parental value revealed the superiority of 60 per cent hybrids for this quality attribute. The decline for heterosis in quality attribute like brix can be ascribed to the fact that the standards incorporated in the investigation were highly stabilised ones.

Number of millable canes is the principal yield objective of the cane cultivator. Out of the total sixty five hybrid clones 4.62 per cent, 16.92 per cent and 1.54 per cent each displayed heterobeltiosis, relative heterosis and standard heterosis except with respect to the first standard, ie. Co 449. Eventhough the figures are relatively not high, the information provide ample testimony for the superiority of the hybrids with respect to this prime yield component.

Number of internodes directly influence the height of the cane and consequently its contribution to the yield is indirect. Fairly higher percentage of the hybrid clones registered heterobeltiosis and relative heterosis. Eventhough the percentages of hybrid clones registering standard heterosis with respect to the first three standards were low, the superiority of the hybrids over the stabilised varieties provide scope for improvement among the hybrid clones.

A few of the hybrids manifested significant positive heterosis in the comparison with the third and fourth standards, for the character, length of internode. In this regard, the trend of the hybrids was to manifest negative heterosis than positive heterosis. Higher percentages of hybrids recorded negative heterosis with respect to the better and mid parental values and also with the first and second standards.

Positive relative heterosis was manifested by 20 per cent of the hybrids for height of the cane, being an important component for total yield. Heterobeltiosis was positive and significant in 4.62 per cent of the hybrids. Compared to the third standard, 3.08 per cent of the hybrids displayed positive heterosis. It can be seen that 3.08 per cent of the hybrid clones registered standard heterosis over an established high yielding cane Co 997 besides being able to provide appreciable percentages of heterobeltiosis and relative heterosis. This in fact point towards a promising trend of the hybrid clones investigated.

The presence of water shoots and arrows are undesirable characters from the economic point of view. Hence for these characters inverse relationship was taken into account.

Water shoots being an undesirable attribute, registered relatively less positive or negative heterosis in all the comparisons. So it can be safely presumed that this attribute may not deter the sugarcane breeder from being able to select elite clones.

Arrowing eventhough is desirable from the breeder's point of view, is undesirable as far as the farmers are concerned, as the vegetative phase ceases during arrowing. Small percentages of hybrids manifested positive standard heterosis for this attribute. But the heterobeltiosis and relative heterosis were negative.

When the yield potential of the clones was considered, except for relative heterosis, no positive significant values were registered by the hybrids. A similar trend was observed in single cane weight also. But in this respect, standard heterosis was displayed by few hybrids.

In general, the performance of the hybrids was promising. All the characters except water shoot counts manifested positive heterosis. Relatively small decline of heterosis in brix can be attributed to the fact that the standards included were highly stabilized ones. As regards number of millable canes which is the prime yield objective, the performance of the hybrids were encouraging. The superiority of the hybrids over the stabilized varieties with respect to number of internodes provide scope for further selection in the clonal population. Consequently based on the present investigation including variability and heterosis studies, twenty four elite clones could be identified.

Summary

SUMMARY

The progeny of the intervarietal cross Co 775 x Co 453 constituting 450 hybrid seedlings available at Sugarcane Research Station, Tiruvalla were the material for the investigation. The study was aimed at selecting superior hybrids with economic attributes from the variable progeny by evaluating genetic variability and heterosis. A preliminary study was conducted on the seedling population for seventeen economic attributes including qualitative aspects. From the base population, sixty five clones were selected on the basis of number of millable canes, H.R.Brix, weight of cane per stool and general appearance. These clones along with their parents and four popular varieties of the locality namely Co 449, Co 785, Co 997 and Co 62175 were tried in an RBD with three replications at Sugarcane Research Station, Tiruvalla during 1981, and assessed seventeen important economic attributes.

The statistical studies included coefficient of variation and correlations in both the seedling and clonal populations. Besides these, in the clonal population

heritability in the broad sense, genetic advance and heterosis were also studied.

The highlights of the investigation are summarised below:

i. Seedling population

The preliminary study revealed that the weight of cane per stool displayed the maximum coefficient of variation followed by number of shoots and number of millable canes per stool.

The correlations between the quantitative traits indicated that cane yield (weight of cane per stool) had positive correlations with all the yield components except H.R.Brix. The closest association of cane yield with number of millable canes was also established. The inverse relationship of number of millable canes and girth was also brought to light, and presumed that the number of millable canes contributed to cane yield through height of cane, since height of cane and its components had positive correlation with number of millable canes.

ii. Clonal population

The results on the population mean and genetic parameters revealed that the heritability was maximum for arrowing followed by number of internodes at harvest and shoot count at ninety days. High heritability was displayed by all the characters except germination percentage, H.R. Brix, grassy shoot counts and number of water shoots, suggesting that these characters were less influenced by environment.

Regarding the coefficients of variation, the maximum values was accounted by number of arrows followed by grassy shoot counts. However, cane yield and its components, namely number of millable canes, number and length of internode, girth and height of cane manifested low coefficients of variation. Genetic advance was maximum for height of cane at harvest followed by shoot count. In the clonal population significant difference was noted for the different characters studied. High heritability estimates for the characters along with this trend offer considerable scope for selection within the population.

Correlation between the economic attributes revealed that yield of cane had positive significant correlation with number of millable canes, number and length of internodes, height and girth of cane and weight of single cane. In the clonal population also, positive correlation of number of millable canes to yield was unveiled. Stalk number had positive correlation with height while it registered negative correlation with girth. Cane yield was observed to have positive correlation with the components of cane height also, namely number and length of internodes. Single cane weight being one of the components of cane yield, contributed to yield through height and girth of cane. Total cane yield appeared to have negative correlation with H.R.Brix although purity registered significant positive correlation with yield. It was presumed that as the total yield enhances, the water content also enhanced, consequently the quality components get decreased. The present study suggests that probabilities of varieties combining higher yield potential with quality attributes are remote.

In general, the performance of the hybrids was promising. All the characters except water shoot counts manifested positive heterosis. Relatively small decline of heterosis in H.R.Brix can be attributed to the fact that the standards included were highly stabilized ones. As regards number of millable canes which is the prime yield objective, the performance of the hybrids were encouraging. The superiority of the hybrids over the stabilized varieties with respect to number of internodes provide scope for further selection in the clonal population. Consequently, based on the present investigation including variability and heterosis studies twenty four elite clones possessing higher values for number of millable canes, weight, brix, pol, purity and ccs could be identified.

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Appendices

APPENDIX II

Details showing the characteristics of the finally selected clones

Sl. No.	Clone number	Number of millable canes	Total weight of cane	Brix	Pol	Purity	CCS
1	7	23.33	12.908	16.28	13.55	83.23	9.094
2	9	13.67	8.458	18.07	14.71	81.41	9.757
3	12	20.0	12.800	17.88	15.44	86.35	9.008
4	15	13.67	7.550	16.98	13.35	78.62	11.335
5	26	18.33	10.200	18.98	17.11	90.15	13.309
6	28	10.00	6.867	18.81	15.97	84.90	10.829
7	29	16.33	10.200	17.84	15.49	86.83	10.622
8	31	14.00	6.717	18.31	14.93	81.54	9.912
9	33	18.33	13.367	18.41	15.83	85.99	10.803
10	36	17.67	9.433	18.51	15.69	84.76	10.630
11	37	20.00	14.300	19.01	17.93	94.32	12.774
12	39	9.00	9.383	19.31	18.25	94.51	13.013
13	47	21.00	11.133	18.71	14.31	76.48	9.162
14	49	25.33	16.567	17.21	14.54	84.49	9.835
15	52	18.00	14.833	17.74	14.44	81.40	9.578
16	53	17.67	9.350	19.01	17.20	90.48	12.027
17	61	10.33	6.167	20.11	16.32	81.15	10.807
18	64	15.33	9.80	16.84	12.86	76.37	8.226
19	66	18.00	10.650	18.54	15.95	86.03	10.887
20	69	24.33	18.333	16.44	13.95	84.85	9.456
21	71	11.67	7.817	19.16	17.23	89.93	12.014
22	78	16.00	10.65	18.04	16.69	92.52	11.790
23	79	15.33	12.367	19.56	17.44	89.16	12.112
24	83	15.33	12.283	16.04	13.00	81.05	8.602

VARIABILITY AND HETEROSIS IN INTERVARIETAL HYBRIDS OF SUGARCANE [*Saccharum officinarum L.*]

BY

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ABSTRACT OF THE THESIS

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ABSTRACT

A field trial was conducted at Sugarcane Research Station, Tiruvalla, during 1981 with selected clones after screening the hybrid progeny of the intervarietal cross Co 775 x Co 453. The investigation was conducted with the object of selecting superior hybrids with economic attributes from the progeny possessing wide spectrum of variability by evaluating genetic variability and assessing the extent and magnitude of heterosis.

The preliminary studies on the seedling progeny proved its variability for economic attributes. Weight of cane per stool recorded the maximum coefficient of variation followed by number of shoots and number of millable canes per stool. This attribute had positive correlation with all the yield components studied except H.R.Brix. Among the yield components, number of millable canes established the closest association with cane yield.

High heritability was displayed by almost all the attributes assessed in the clonal population, the maximum being recorded by arrowing and as such these characters were less influenced by environmental variations.

Further, the maximum coefficient of variation was also registered by the same attribute. The presence of sufficient amount of variability in the clonal population offered scope for exercising subsequent selection. Cane yield and its components manifested low coefficients of variation. Maximum genetic advance was accounted by height of cane. The clones selected from the base population displayed significant difference for the characters studied. Along with this, the high heritability estimates for the characters added considerable scope for selection within the population.

Correlation studies between the economic attributes indicated that cane yield had positive correlation with all the yield components and with the components of height, although the character registered negative correlation with H.R.Brix. Among the yield components, number of millable canes contributed the maximum to yield. From the present investigation, the contribution of number of millable canes to yield was presumed to be through height of cane on account of its positive association with height and its components. Single cane weight being another component of cane yield contributed to cane yield on account of girth and height.

Cane yield recorded negative correlation with H.R.Brix and the results point towards the fact that as the yield increased, the quality components get decreased. This may be ascribed to the enhanced water content in the juice and consequent dilution of the quality components.

Heterosis studies revealed that the performance of the hybrids was promising. The hybrids manifested positive heterosis for all the characters studied except water shoot counts. Since the standards included in the trial were highly stabilized clones, a decline in heterosis for H.R.Brix was observed in the population. The hybrids displayed an encouraging trend for number of millable canes. In the clonal population the superiority displayed by them for number of internodes in the comparison with the stabilised varieties provide potentialities for subsequent improvement. Twenty four elite clones with economic attributes could be identified for further genetic improvement based on the present investigation.