STUDIES ON GENETIC ENHANCEMENT OF SUGARCANE PRODUCTIVITY FOR ORGANIC JAGGERY PRODUCTION (*Saccharum officinarum* L.)

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CERTIFICATE

This is to certify that the thesis entitled "STUDIES ON GENETIC ENHANCEMENT OF SUGARCANE PRODUCTIVITY FOR ORGANIC JAGGERY PRODUCTION.(*Saccharum officinarum* L.)" submitted by Mr. VIJAY KUMAR METI for the degree of MASTER OF SCIENCE (AGRICULTURE) in GENETICS AND PLANT BREEDING to the University of Agricultural Sciences, Dharwad, is record of research work done by him during the period of his study in this University, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

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JULY, 2016

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LIST OF ABBREVIATIONS

Sl. No.	Abbreviation	Full form
1	@	At the rate of
2	%	Per cent
3	*	Significant at 5% level
4	**	Significant at 1% level
5	ANOVA	Analysis of Variance
6	CD	Critical Difference
7	cm	Centimetre
8	CV	Coefficient of Variation
9	d.f.	Degrees of freedom
10	*et al.*	And other workers
11	Fig.	Figure
12	GA	Genetic Advance
13	GAM	Genetic Advance as percent of Mean
14	*i.e.,*	That is
15	l	Litre
16	kg	Kilogram
17	TS	Total shoots
18	CFS	Cane formed shoots
19	CG	Cane girth
20	CH	Cane height
21	NMC	Number of Millable Canes
22	SCW	Single cane weight
23	CCS	Commercial Cane Sugar
24	INT	Number of inter nodes
25	IL	Inter nodal length
26	GCV	Genotypic Coefficient of Variation
27	PCV	Phenotypic Coefficient of Variation
28	h^2(b)	Heritability (broad sense)
29	*viz.,*	Namely

1. INTRODUCTION

Sugarcane (*Saccharum* spp. hybrids, 2*n* = 100–140) is native to South East Asia, with its cultivation in India since 5000 years ago, India has been the original home of sugar and sugarcane. It belongs to genus *Saccharum* L., of the tribe *Andropogoneae* in grass family *Poaceae*.

Sugarcane is an important cash and industrial crop of India. It is a domesticated tropical, perennial grass species and a source of raw material to sugar industry and generates employment for many people. It forms essential items for industries like sugar, chip board, paper, confectionary and use in chemicals, plastics, paints, synthetics, fiber, insecticides and detergents (Kazi *et al.,* 2010). Sugarcane is cultivated mainly in the tropics, though it is grown in sub tropical areas in India.

The *Saccharum* genus is characterized by clonal propagation, complex aneupolyploidy and high levels of heterozygosity. This genus traditionally comprises of six species: *S. spontaneum, S. officinarum, S. robustum, S.edule, S. barberi* and *S. sinense. S officinarum* (2n=80). The word '*saccharum*' is thought to have been derived from the Sanskrit word sharkara. It is also know by the common name of 'noble cane'.

Globally, sugarcane is cultivated over an area of 23.80 million hectare with a production of 1794.0 million tons (Anon., 2014) with a productivity of 70.54 tons per hectare. In India sugarcane occupies an area of 5.307 million hectare with a production of 366 million tones and productivity of 69.10 tons per hectare (Anon., 2015). The principal sugarcane growing states are Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Gujarat. In Karnataka, sugarcane is being cultivated in an area of 4.50 lakh hectares with a cane production of 46.7 million tons and a productivity of 94 tons per ha (Anon., 2015).

The sugar and jaggery are the two main sweetening agents which are used in beverages and foods. The increasing trend of their production particularly jaggery is of much significance, mainly due to its nutritional and medicinal values and which is rich in important minerals (Singh *et al*., 2013). Jaggery is produced in three forms *viz.,* lumps, liquid and powder or granular form.

Modern sugarcane genome is a complex blend of aneuploidy and polyploidy. It is derived from the interspecific hybridization involving different *Saccharum* species particularly *S. officinarum* and *S. spontaneum*. The importance of the wild species *S. spontaneum* L. (2n=40-128, x=8) was realized after its successful hybridization with the domesticated sugar-producing species. It is characterized by low sugar content, thin stalks, high fiber, high ratooning ability and high resistance to biotic and abiotic stresses. Whereas *S. officinarum* (2n=80, x=10) is best represented by two commercial hybrid varieties Co205 and Co285, which replaced the indigenous cultivated varieties from northern India. *S. officinarum* represents cultivated sugarcane and is characterized by high sugar content, thick stalks, low fiber and low disease resistance. Most of the sugarcane varieties in the world are breeds of *S. spontaneum and S. officinarum*. To minimize the negative effects of *S. spontaneum* and to retain the high sucrose producing ability of *S. officinarum* during crosses, a series of backcrosses were made between the inter-specific hybrids and the *S. officinarum* parents. This led to the "Nobilization" of *Saccharum spp*. Hybrids. This was a major breakthrough in sugarcane varietal improvement programs in terms of improved sugar productivity, high disease resistance and high ratooning ability. Although nobilization was highly successful but due to limits of the gene pool exploited during traditional breeding programs, very limited progress has been achieved in increasing sugar content.

The success of a sugarcane breeding programme lies in the proper choice of rich and genetically diverse parents. The search of genetically diverse parents can be based on geographical origin, morphological traits and pedigree data or molecular markers data. Genetic variability accumulated and conserved in the form of diverse plant types is immediately valuable for shaping new varieties. Genotypic coefficient of variability gives the magnitude of genetic variance present in the population. The heritability in broad sense is a measure of proportion of total genetic variance reflecting the performance repeatability and its appropriate estimate for clonally propagated crops like sugarcane. The genetic advance as per cent mean summarizes the information contained in the heritability and genotypic coefficient of variability. Hence, the information on these parameters is of paramount importance to sugarcane breeders.

The information on the genotypic and phenotypic inter-relationship of cane yield and sugar yield with their component characters and among yield and quality components would be of immense help to the breeder. Path coefficient analysis provides direct and indirect effects of component characters thereby enhancing the better understanding of true relationship of the component characters with yield.

At present recommended varieties including newly developed clones under advanced testing are having acceptable quality but are moderate/less productive particularly under organic cultivation. Presently in the domestic market the available jaggery has been found to contain excess quantities of harmful chemicals like sulphur dioxide. Due to use of chemicals the taste and storability of such jaggery is also affected. There is scope for growing sugarcane naturally with organic sources of nutrients and use of organic clarificants during jaggery preparation which helps to produce quality jagger, for health and nutritional security.

Chemical free/organic jaggery is becoming popular and gaining lot of demand in terms of quality in domestic market and for export. It contains approximately 65 to 85 per cent sucrose, 9 to 15 per cent reducing sugars comprising of glucose and fructose. Besides sugars, jaggery contains protein (0.4 %), fat (0.7 %) and minerals/ash (0.5 to 1.0 %). The minerals include iron (110 ppm), calcium (0.4 %), magnesium (0.08 %) and phosphorus (0.045 %). It also contains traces of vitamins and amino acids (Keshavaiah, 2011). Light coloured jaggery with crystalline structure, sweet taste, good flavour and longer storage life are preferred by the consumers. On the other hand, farmers are in need of more productive varieties which are suitable for organic or chemical free jaggery production.

The use of inorganic fertilizers does not necessarily lead to better farming than the use of natural and organic methods in agriculture. Due to continuous application of only inorganic fertilizers and plant protection chemicals in agriculture, the soils have been badly degraded. It has destroyed stable traditional ecosystem of the soil (Palaniappan and Annadurai, 1999). There is need to encourage more productive, cost efficient and ecofriendly farming system (Bhattacharya and Gehlot, 2003). The use of organic manure and Biofertilizers help in increasing biological fixation of atmospheric nitrogen and enhancing native phosphorus availability to sugarcane. *Azotobacter* and phosphate solubilizing microorganisms are some biofertilizers which are useful for improving the sustainable productivity of soil.

The current problem of indiscriminate usage of inorganic chemicals for juice clarification and getting light color jaggery is highly health hazardous. The organic jaggery producers need suitable productive varieties which can fit well both for organic cultivation and organic jaggery processing. Considering the limitations like moderate productivity and profuse flowering of present commercial varieties, concerted efforts were made to identify clones which combine both productivity and quality under organic cultivation. Further, for longer and extended crushing, non/late flowering feature was also considered during identification of clones for better fodder security.

Hence, there is a need to popularize scientific and eco-friendly methods of sugarcane cultivation and jaggery production, where in adoption of suitable varieties is an essential requirement in the context of developing/ identifying suitable genotypes for organic/ chemical free jaggery production the present study is planned with following objectives.

1. Assessment of genetic variability parameters in selected early clonal populations.
2. To study Inter and intra stage repeatability/association for various productivity traits in the population.
3. Identification of suitable genotypes for organic/chemical free jaggery production.

2. REVIEW OF LITERATURE

Genetic improvement for yield in crop plants frequently utilizes the selection and hybridization techniques. The success in the approach needs the basic information on the extent of genetic variability and the extent to which the desired characters are heritable. Improvement of both quantitative and qualitative characters is the main interest of any plant breeder for which adequate knowledge on genetics of yield and its component characters is very much essential. This has in turn attracted the attention of plant breeders to study genetic aspects of economically important characters such as yield and its component traits.

Scientific literature which deals with reports on genetic variability studies, estimates of heritability and genetic advance as well as nature and extent of association between different traits studies is reviewed in this chapter. Keeping in view the objectives of the present investigation, the literature on genetic studies in sugarcane has been reviewed and presented under following headings.

2.1 To assess the genetic variability parameters in selected early clonal populations.

2.2 To study Inter and intra stage repeatability/association for various productivity traits in the population.

2.3 Identification of suitable genotypes for organic/chemical free jaggery production.

2.1 To assess the genetic variability parameters in selected early clonal populations

2.1.1 Studies on genetic variability parameters

Sugarcane varieties in commercial cultivation are complex polyploidy. The heterozygous and polyploidy nature of this crop has resulted in generation of greater genetic variability. The information on the nature and the magnitude of variability present in the genetic material is of prime importance for a breeder to initiate any effective selection program. The existence of high variability for the parameters indicates the possibility of a higher response through selection. Genotypic coefficient (GCV) and phenotypic coefficient (PCV) of variation along with heritability are very essential to improve any trait of sugarcane.

High magnitude of coefficient of variations, high heritability and maximum genetic gain for number of millable canes, cane weight and cane height have emphatic role in clonal selection for improvement in cane and sugar yield. Variance analysis indicates the significant genetic differences among the varieties for all characters. High phenotypic and genotypic variations for cane weight, cane yield and sugar yield.

The ratio of additive genetic variance to the total phenotypic variance is narrow sense heritability (Lush, 1949). Hansen *et al.* (1956) proposed the ratio of genotypic variance to phenotypic variance as broad sense heritability. Because of the genotypic variance includes additive, dominance and epistatic gene effects, the latter one does not give a proper idea of heritability from one generation to next generation.

According to Allard (1956) heritability of yield alone is less and that of yield component is more. However, the gain from selection for a particular character is the function of its heritability, selection pressure and the variance existing in the base population.

Johnson (1909), Nilson Ehle (1909) and East (1916) described the heritable and environmental components of variance in the early part of the century. The calculation of phenotypic and genotypic coefficient of variability (PCV, GCV) was suggested by Burton (1952).

Charles and Smith (1939), Powar (1942) separated the genotypic variance from the total variance, using estimate of environmental variance in non-segregating populations. Since then the studies on heritability, genetic advance and their variance components have been estimated for most of the yield contributing characters in several crops.

Lush (1949) defined heritability as the ratio of additive genetic variance to the total phenotypic variance in a narrow sense. The heritability in broad sense was proposed by Hansen *et al.* (1956) as the ratio between the genotypic variance as whole and phenotypic variance. But this does not give a clear picture of transmissibility of variation from one generation to next generation, because the genotypic variance includes additive, dominance and epistatic gene effects.

The genetic advance is more useful in predicting the actual value of selection than heritability, according to Johnson *et al.* (1955) although the later value indicates the relative effectiveness of selection based on phenotypic expression of the character.

Thulijaram Rao *et al*. (1966) reported the high heritability for the characters like cane weight and number of millable stalks. Thus, the direct selection of these characters for improvement of cane yield will be very effective.

Khairwal *et al.* (1978) recorded high broad sense heritability for thickness as well as the number of stalk but moderate heritability for stalk height and weight. Contrastingly sucrose per cent had low heritability.

Balasundaram and Bhagyalakshmi (1978) reported that the stalk yield as well as its components with high degree of genetic variability and broad sense heritability was highly amenable to selection where as stalk thickness and quality attributes with low variability and high heritability had lower level of genetic advance.

High genotypic coefficient of variation was reported for stalk weight, number of stalks, stalk girth and brix. Heritability was high for number of internodes, stalk height and brix, while it was moderate for number of stalk and lowest for stalk weight reported by Nair *et al.* (1980) and Singh *et al.* (1981a).

Singh *et al.* (1981b) observed high phenotypic and genotypic coefficient of variation was noticed for stalk followed by stalk weight. On the other hand, number of internodes, length of internodes and sucrose per cent exhibited low genotypic coefficient of variation. Heritability was high for sucrose per cent followed by internodal length.

Sharma and Singh (1984) observed high genetic variability and heritability for quality traits. They further reported high genetic advance at 11th month for stalk girth and stalk height. In another study, Punia *et al.* (1987) observed maximum heritability of 98.22 per cent for cane thickness. Cane yield per clump recorded high estimates of GCV, heritability and expected genetic gain

Reddy and Reddi (1985) reported high genotypic coefficients of variation (29.31) and high genetic heritability (98.98 %) coupled with high genetic advance (60.32 %) for stalk weight, while low GCV and GA for stalk diameter, stalk number and brix.

Punia *et al.* (1987) observed maximum heritability of 98.22 per cent for cane thickness. Cane yield per clump recorded high estimates of GCV, heritability and expected genetic gain.

Ram and Hemaprabha (1991) observed maximum genetic variability among progenies of mating group involving *S. spontaneum* for all the characters except cane length and cane yield. The mean performance of progenies involving commercial hybrids was the best for cane diameter, single cane weight, quality character and sugar yield. The *S. officinarum* x commercial hybrids mating group was found advantageous for obtaining promising clones as compared to other groups. The values of correlation coefficients between various characters of cane yield and quality characters varied among the four mating groups.

Reddy and Somarajan (1994) reported in an interspecific hybrid population of 46 clones derived from crosses of various *Saccharum* spp. that the, number of millable canes, sugar yield and single cane weight recorded high genotypic coefficient of variation. High heritability coupled with high genetic advance was recorded for CCS, sucrose content, and number of millable canes. Cane yield recorded low heritability and low genetic advance. sucrose, brix, CCS and sugar yield were positively interrelated. Cane yield did not have significant positive association with any of the yield attributes except number of millable canes.

Ram (1994) reported that high genotypic coefficient of variation for germination per cent, sugar yield, cane yield, number of millable canes and single cane weight.

Ram and Hemaprabha (1995) noticed high heritability for number of millable canes, stalk diameter, stalk height, stalk yield, sucrose per cent, purity per cent and sugar yield in the interspecific hybrids of *Saccharum* species.

Sharma *et al.* (1998) observed that high coefficient of variation and moderate heritability was found for stalk weight, height, girth, number and length of internodes. Low coefficient of variation and high heritability were also noticed for brix.

Singh and Singh (1999) noticed that the GCV, PVC, heritability, genetic advance in per cent of mean was higher for stalk weight, NMC and yield in both plant and ratoon crops. The genetic associations among characters were relatively low. Stalk diameter was the most predictable characters followed by stalk number, stalk height, juice brix and sucrose per cent at grand growth stage for yield potential of genotypes in plant crop as well as ratoon.

Tippeswamy *et al.* (2001) recorded a good amount of variability for at least eleven morphological characters and maximum heritability for germination percentage, number of internodes and cane yield. Quantitative characters like number of shoots, LAI, cane height, number of millable canes, single cane weight and cane yield recorded moderate to high coefficient of variation, heritability and genetic advance. The numerical estimation of genetic parameters for cane diameter and sucrose per cent juice were comparatively low (Kamat and Singh, 2001).

Chaudhary (2001) study revealed highly significant differences between genotypes for all the seven stalk characters studied. Genotypic variance was higher than environmental one for cane yield, millable cane number, and single cane weight, stalk diameter and stalk length. Single cane weight, germination at 45 days after planting and millable cane number had high genotypic and phenotypic coefficients of variation. High heritability estimates were recorded for millable cane number, stalk diameter and single cane weight. Maximum genetic gain as per cent of mean was observed for single cane weight and millable cane number.

Twelve sugarcane accessions were sown in the field following randomized complete block design. Data were collected on different characters, and analyzed by step-wise regression and correlation analysis for the estimation of factor-wise contribution toward total cane yield, cane height, leaf area, juice content, brix value and commercial cane sugar. The varieties showed that the characters studied were the best variables and had potential for selection (Khan *et al*. 2001).

Gupta *et al.* (2002) studied some genetic parameters in sugarcane and observed highly significant differences for all the characters tested except purity per cent age at 360 days. They further recorded maximum phenotypic coefficient of variation for number of tillers per plot, followed by millable canes per plot, cane yield and commercial cane sugar.

Chaudhary *et al.* (2003) reported high heritability (h^2) for stalk weight, stalk length, internodes length, cane yield, millable cane number, germination, and stalk diameter, whereas moderate values were obtained for internodes number, germination, and stalk diameter.

Ravishankar *et al.* (2003) reported that high broad sense heritability was observed for cane yield, commercial cane sugar per plot, internodes number, juice brix and commercial cane sugar per cent in studies involving sugarcane germplasm.

Punia (2003) conducted correlation and path analysis on 41 genotypes of sugarcane. Cane yield/clump was significantly associated with the number of tillers/clump, the number of millable canes/clump, cane thickness and cane weight. There was no significant correlation between cane yield and sucrose per cent. Path-coefficient analysis further revealed that the number of millable canes/clump and cane weight were the most important components of cane yield/clump.

Thippeswamy *et al.* (2003) conducted experiment to know the character association and path coefficient analysis in sixty sugarcane (*Saccharum officinarum* L.) genotypes. Among twenty characters, single cane weight, number of millable canes per plot, leaf area and germination percent had positive and highly significant association with cane yield as well as with commercial cane sugar yield. Path coefficient analysis of cane yield per plot revealed that commercial cane sugar per plot and commercial cane sugar percent at harvest along with dry matter and number of internodes were the major contributors to cane yield per plot, where as sugar yield was largely depended on both cane yield and sucrose percent.

Patel *et al.* (2006) in their variability study among 40 diverse sugarcane cultivars, reported high heritability coupled with high genetic advance for single cane weight and CCS indicating the presence of additive gene action as well as effectiveness of direct selection for both traits.

Kadian and Mehla (2006) reported estimates of direct and indirect effects and correlation coefficients were computed among cane yield and its component traits for 32 sugarcane genotypes grown in three environments. Cane yield was found significantly correlated with single cane weight and cane thickness. Positive and highly significant correlations were observed amongst four juice quality traits. High direct effect of cane thickness and internodes length were observed for cane yield. Cane thickness and single cane weight emerged as the most important traits influencing cane yield

Khaled and Ahmed (2008) reported broad sense heritability was high for cane yield and millable cane diameter to medium for number of millable cane. The genetic variance ranged from 0.2 for and millable cane diameter to 82.91 for millable cane highest. The genotypic coefficient of variation (GCV %) for the studied less for millable cane highest for sugar yield. The phenotypic coefficient of variations (PCV %) ranged from 4.72 % for millable cane highest to 31.8 for sugar yield.

Yahaya *et al.* (2009) found the number of millable canes; stalk length, stalk girth and number of internodes per stalk had high positive correlation with cane yield and with each other. The path coefficient analysis revealed that stalk length made the highest direct contribution (0.653) to cane yield followed by number of millable canes with a contribution of 0.4290. The path analyses further showed these characters to be the most important components of cane yield.

Berding and Pendrigh (2009) reported in a variability studies among twenty one phenotypically diverse genotypes of sugarcane that the broad sense heritability values were high for fiber, brix, CCS and dry matter.

High heritability with high genetic advance as percentage of mean was observed for number of tillers per hectare and single stalk weight (Rahman and Bhuiyan, 2009; Mali *et al.,* 2009). They also noticed high genotypic coefficient of variation for mean number of tillers per hectare, cane yield per hectare and single cane weight.

Mali *et al.* (2009) reported highly significant differences among the 21 genotypes for all the characters studied. All the characters under study indicated the ample variation of these characters. High heritability coupled with high genetic advance observed for number of tillers and single cane weight indicated the presence of additive gene action and direct selection may be highly effective.

Rahman and Bhuiyan (2009) in a study on twenty five promisingclones and twostandard sugarcane cultivars noticed high genotypiccoefficient of variation for mean number of tillers per hectare, cane yield per hectare and single cane weight. High heritability with high genetic advance as percentage of mean was observed for number of tillers per hectare and single stalk weight.

Ahmed (2010) evaluated sugarcane clones regarding cane yield characters namely; yield of cane, number of millable cane, stalk height, stalk diameter, single stalk weight and juice quality traits in terms of juice brix , juice pol (%), juice purity (%) and cane fiber (%). Among the eight clones genotypes R 579, SP 718210 and Co 6806 had shown superiority for yield of cane per ha where as genotype Co 527 followed by Co 997 were the best for juice pol per cent. Characters association results showed a positive correlation between cane yield in one hand and number of millable stalks, stalk height, internodal number per stalk, single stalks weight which indicated improvement of one of these character may resulted in positive response of the other character. Negative association of cane yield with stalk diameter, juice pol and purity (%) was noticed

Krishna *et al.* (2011) evaluated nineteen sugarcane clones in second plant crop and ratoon crop and observed that the estimates of variability, heritability and genetic advance as per cent of mean were high for cane length, internodal length, single cane weight, number of millable canes, commercial cane sugar yield and cane yield in both plant and ratoon crops and for sucrose per cent and CCS per cent in plant crop suggesting the effectiveness of simple selection procedures for improving morphological characters in plant crop or ratoon crop and quality characters in plant crop.

Mancini *et al*. (2012) reported progeny clones differed significantly for the traits measures indicating the existence of significant amount of variability among them as also as the presence of transgressive clones. Broad-sense heritabilities values were generally high for stalk diameter, stalk weight, stalk height, brix and pol per cent cane in plant cane and ratoon cane.

Ahmed and Obeid (2012) reported that number of tillers at 60 days plant age showed positive association with number of millable cane at harvest and cane yield. It was found that cane yield had non-significant positive association with juice pol and purity. The association among tiller counts, cane formed tillers at 180 days and number of millable cane at harvest was found positive and the strength of correlation was higher when the time interval between any of the two stages was less. Stalk height showed positive association with cane yield and number of internode per stalk, where it's association with juice brix and juice pole percentages was negative

Priyanka (2013) reported that the GCV and PCV for cane yield and juice brix (%) were higher. Similarly, Guddadamath (2013b) also reported the GCV and PCV for cane yield and HR brix (%) were higher.

Khan *et al.* (2013) conducted experiment consisting of five genetically diversified sugarcane clones to evaluate variability, effect of environmental factors and their relationship between the various quantitative and qualitative traits. Significant differences were observed between clones for all traits. The correlation coefficients revealed that the important yield components like stalk weight, stalk height, number of stalks per stool and sugar percentage were the major traits contributing to cane and sugar yields. Path analysis of sugar yield exhibited maximum direct effect of cane yield followed by sugar recovery.

Smiullah *et al*. (2013) reported that among the traits studied leaf area, number of tillers, cane thickness and cane yield had the positive and significant correlation with brix value at both genotypic and phenotypic levels. Cane height had negative but non-significant correlation with brix value at genotypic and phenotypic level. Similarly cane weight had positive correlation both at genotypic and phenotypic level with cane height, number of tillers per plant and brix value. The study of path analysis for yield related traits depicted that cane height, cane thickness, leaf area, internodal length and brix value had the direct negative effects on yield.

Tadesse *et al.* (2014) recorded the high GCV for millable cane, cane yield and sugar yield, while; number of inter node, cane diameter and sucrose (%) resulted low GCV. High phenotypic coefficients of variation were recorded for sugar yield, cane yield, millable cane but moderate phenotypic coefficients of variation were recorded for cane height. High GCV and PCV indicated that selection may be effective based on these characters and their phenotypic expression would be good indication of the genotypic potential. Genotypic coefficient of variation alone is not a correct measure to know the heritable variation present and should be considered together with heritability estimates. High heritability were recorded for characters such as sugar yield, cane yield and millable cane, low heritability for No of internodes and cane diameter while moderate heritability were recorded for cane height and sucrose (%).

Arunkumar (2014) reported high genetic advance was observed for the trait, cane yield coupled with high heritability. No. of Internodes, girth of internodes and single cane yield were positively associated with cane yield/ha at both genotypic and phenotypic levels respectively, indicating improvement in these traits will increase the cane yield. Number of internodes, intermodal length and single cane yield had positive direct effect on yield at both genotypic and phenotypic levels respectively.

Bora *et al*., (2014) revealed that moderate to high range of variation for germination (%), shoots number at 120 days, number of millable cane ('000/ha), cane height (cm), single caneweight (kg), cane yield (t/ha) and commercial cane sugar (t/ha). The variation was low for cane diameter and quality characters. The characters showing high genotypic and phenotypic variance, genotypic and phenotypic coefficient of variation, heritability with high genetic advance were number of millable cane, cane height and single cane weight. The characters showing high and significant correlation with cane yield were number of millable cane, germination ($rg = 0.64$), shoot count, cane height and single cane weight. Hence, these characters must be given importance while selecting sugarcane clones for improvement in yield. The sugar recovery had high and significant correlation with field brix and sucrose ($rg = 0.64$). Hence these two characters must be given importance for improvement in sugar recovery.

Jamoza *et al.* (2014) reported high broad sense heritability was detected for stalk diameter, number of millable cane, single stalk weight and number of internodes, indicating that these traits could be easily selected. Highest expected genetic gains were recorded in stalk weight and number of millable cane. Except number of internodes, all traits had low to moderate genetic correlations with cane yield. On average genetic correlations were higher than phenotypic correlations. In view of their high GCV, broad sense heritability and expected genetic advance, a selection strategy based on single stalk weight and number of millable cane could lead to improvement in cane yield.

Devaraju (2014) reported that the GCV and PCV for number of millable canes (NMC), single cane weight (SCW), total shoots (TS) and cane formed shoots (CFS) were higher, wheras moderate variability was observed for plant height (PH), number of internodes (INT), internodal length (IL), cane girth (CG), and commercial cane sugar yield (CCSY).

Devaraj (2015) revealed that genotypic variations observed for cane formed shoots at 120 DAP, NMC, green top yield, cane yield, CCS yield, flowering per cent, and average intermodal length were very high, and indicating selection for these characters are expected to achieve profitable gains in all the diverse locations. Comparatively single cane weight, cane girth and sucrose per cent at 10 month and at harvest, suggesting more directed efforts are needed to achieve improvement in these traits in all the diverse locations. However the heritability and genetic advance as per cent mean for above traits suggested better chances of improving these traits through straight selection.

Laxman (2015) evaluated thirtynine sugarcane clones in pre selected advance clones for rust resistance and economic traits in both organic and integrated environment and observed that higher GCV and PCV for germination percent, single cane weight, Cane yield, brix yield, rust incidence and CCS, whereas moderate variability was observed for juice extraction percent, green top weight, cane height and internode length.

2.1.2 Association and path coefficient analysis

Association of characters can be used as a basis for selection. Correlation coefficient is a measure of association between two or more variables and not a measure of dependence of one variable on the other. Importance of any crop needs better understanding of association between yield and yield attributes. Galton (1889) developed the basic concept of correlation and was later elaborated and discussed by Fisher (1918) and Wright (1921). It helps in determining the nature and degree of relationship between any two measurable characters. Generally, quantitative characters of economic importance are often associated with one another either positively or negatively. Hence, the selection for yield on the basis of *per se* performance alone may not be as effective as that based on the component characters whose association with yield are biometrically determined by correlation and path co-efficient analysis.

The indirect selection schemes concentrate on correlation between characters to improve a highly complex trait like yield. The efficiency of indirect selection depends on the direction and magnitude of association between yield and its component characters. Therefore, study of relationships among the quantitative traits is important for assessing feasibility of joint selection of two or more traits. A positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. Further, understanding the association between the component traits and their relative contribution to the target trait is essential to bring out a rational improvement in the desired trait as they may be differently correlated.

Path analysis furnishes a method of partitioning the correlation coefficient into direct and indirect effects and measures the relative importance of the factors involved. Path coefficient analysis, which is simply a standardized regression analysis was developed by Wright (1921) and later developed by Dewey and Lu (1959). Path coefficient analysis permits the partitioning of correlation coefficients into direct and indirect effects and gives a more realistic relationship of the character and helps in identifying the effective components. The available literature on association and path analysis on cane yield and its component characters is briefly reviewed and presented below.

Singh *et al.* (2001b) observed positive and significant association of number of shoots with number of millable canes and stalk height. Number of shoots and number of millable canes were negatively associated with stalk diameter and stalk weight at genotypic as well as phenotypic level. Stalk height and stalk diameter had high positive association with cane weight. This suggested that stalk height and diameter were the major yield contributing characters.

In another study involving 10 sugarcane genotypes, Nahar *et al.* (2002) reported strong positive correlation of cane yield with number of millable canes and cane height but negative correlation with brix and sucrose percentage at both phenotypic and genotypic levels. On the other hand, cane diameter showed least correlation with cane yield.

In the study consisting of twenty elite lines of sugarcane with four checks, Singh *et al.* (2001a) found that cane yield had non-significant negative correlation with juice brix, juice sucrose, juice purity and extraction per cents, whereas its association with commercial cane was highly significant positive. Path coefficient analysis revealed high direct effect of commercial cane sugar per cent and juice sucrose per cent on commercial cane sugar yields

Chaudhary *et al.* (2003) observed significant positive correlations of cane yield with stalk length, stalk weight, internode number and internode length. Internode length was significantly positively correlated with brix and sucrose in juice. Path coefficient analysis showed that stalk weight and stalk length were the most important components of cane yield. Results suggest that for increasing sucrose per cent, emphasis should be given to brix per cent and purity per cent in juice while selecting clones of sugarcane

Thippeswamy *et al.* (2003) in the study consisting sixty sugarcane genotypes observed the highly significant and positive association of cane yield as well as commercial cane sugar yield with the single cane weight, number of millable canes per plot, leaf area and germination per cent. Path coefficient analysis of cane yield per plot revealed that commercial cane sugar per plot and commercial cane sugar per cent at harvest along with dry matter and number of internodes were the major contributors to cane yield per plot, where as sugar yield was largely dependent on both cane yield and sucrose per cent.

Choudhary and Joshi (2005) observed highly significant positive correlation of cane yield with the stalk cane weight, stalk length and millable cane number, cane diameter and number of internodes.

Kadian *et al.* (2006) reported positive and highly significant correlation among the juice brix, pol per cent, purity per cent and CCS per cent. High direct effect of cane thickness and internode length were observed on cane yield for 32 sugarcane genotypes grown in three environments. Number of millable canes per clump and single cane weight emerged as the most important traits influencing cane yield. Apart from these traits due emphasis should be given to cane height, internode length and juice quality traits while selecting the clones suitable for late planting conditions.

Patel *et al.* (2006) observed significant positive correlation of cane yield with number of shoots per hectare, single cane height, stalk length, stalk diameter, number of internodes and NMC per hectare at both phenotypic and genotypic levels. Path coefficient analysis revealed the highest positive direct effect of CCS (t/ha) on cane yield. Hence, more emphasis should be given to single cane weight, NMC/ ha and CCS (t/ha) while selecting the clone for higher cane yield.

Tyagi and Lal (2007) reported the positive and significant correlation between plant volume and number of millable stalks, plant volume and weight per stalk, plant volume and weight of millable stalks, plant volume and stalk thickness, number of millable stalks and weight of millable stalks. Positive non-significant correlation was observed among number of millable stalks, refractrometer brix, number of millable stalks and stalk height. Path coefficient analysis revealed that the weight of millable stalks was the most important character with the highest direct effect on sugarcane yield followed by stalk height, number of millable stalks and stalk thickness.

Sahu *et al*. (2010) observed that number of tillers per clump, number of millable canes per clump, plant height and single cane weight showed high positive significant correlation with cane yield at both seedling and setting stages while cane diameter and number of leaves per plant were significantly correlated with cane yield at seedling stage only. They reported that number of tillers per clump, number of millable canes per clump, plant height and single cane weight were the most reliable characters for selection of genotypes at seedling and settling stages.

Rahman *et al*. (2009) studied the character association of different characters on cane yield in sugarcane using twenty eight promising clones and two standard cultivars and observed that in general, the genotypic correlation was higher than the corresponding phenotypic correlation. The correlation coefficients between the number of millable canes per hectare, stalk weight and stalk height were highly significant and positive. These characters also showed significant positive correlation with cane yield along with number of millable canes per clump.

Mali *et al.* (2009) observed in a study involving 21 sugarcane genotypes, significant and positive correlation of cane yield with number of internodes at harvest, cane diameter at harvest, single cane weight, CCS (kg/plot) at 360 DAP and NMC/plot. Path coefficient analysis indicated the highest positive direct effect of sucrose per cent juice at 360 DAP on cane yield.

Singh *et al.* (2010) evaluated 17 genotypes of mid-late maturing clones of sugarcane for existing variation for cane yield and its attributing characters. The result revealed that number of shoots at 120 days after planting, number of shoots at 240 days after planting, number of millable canes at 12 months, single cane weight (kg) at 12 months, cane height (cm) at 12 months and cane yield (t/ha) at harvest showed positive and highly significant correlation with sugar yield at both genotypic and phenotypic levels. Out of these characters number of millable canes at 12 months and single cane weight showed high positive direct contribution towards the sugar yield at phenotypic level.

Sayed *et al*. (2012) from their path analysis studies in sugarcane reported that the number of millable stalks per square meter was the most important trait with the highest direct effect on sugar yield followed by sucrose per cent and stalk weight.

Imtiaz *et al.* (2012) observed significant differences among the twelve sugarcane clones for all the plant characters. Highest cane yield (144 t/ha) was recorded in clone NIA82-1026P5 and highest pol per cent (20.82 %) and CCS per cent (16.45 %) were observed in CP84-1198. Correlation coefficient results indicated that cane yield was positively correlated with cane girth, weight per stool, sugar yield, tiller numbers and purity per cent whereas pol per cent and CCS per cent showed negative correlation with cane yield. Sugar yield showed non- significant correlation with cane girth.

Tyagi *et al*. (2012) in a study on thirteen sugarcane cultivars observed a significant positive association was observed between cane yield and number of canes per plot, cane weight, cane height, and Sugar yield per plot. They also observed non significant negative correlation of sucrose per cent, cane yield and sugar yields which implied that both yield and sucrose could be selected simultaneously.

Sanjay and Devendra (2014) subjected three hundred and thirty-nine genotypes of sugarcane germplasm for studying the associations among 15 characters. The cane yield, considered as the most important character of sugarcane was positively and significantly correlated with germination percentage, number of shoots, number of millable canes, stalk diameter, stalk length, number of internodes, length of internodes, stalk weight, number of green leaves, while with the top weight, it showed positive but non-significant correlation. Cane yield was negatively correlated with brix at all the stages.

2.2 To study Inter and intra stage repeatability/association for various productivity traits in the population

2.2.1 Inter stage association (repeatability)

The term “clonal repeatability” refers to the phenotypic correlation between different plants of the same clone. The technique is quite useful to look at the effectiveness of sugarcane selection and to estimate genotype environment interaction. The efficacy of clonal selection in sugarcane relies on spatial and temporal repeatability of attributes across selection stages. The environment interferes with the ability of the breeder to identify superior genotypes and to predict their behaviour in advanced stages. It is expected that environmental effects on final expressions are larger at early selection stages due to the small size of the plots.

Repeatability estimates are utilized to measure the association of the same trait between different initial selection stages and crop cycles (plant cane and ratoons). Knowing these estimates helps to set up selection criteria for visual evaluation, which increases selection efficiency and reduces the risk of losing superior genotypes.

Kang *et al.* (1984) indicated that the effectiveness of selection of sugarcane clones would be enhanced if the character under selection is repeatable across environments. Falconer (1966) regarded two plants of the same clone as two individuals or as one individual replicated twice. He suggested the terms clonal repeatability and individual repeatability, the former when it refers to different plants of the same clone, the latter when it refers to different parts of the same individual. It was also Falconer (1952), who suggested the use of genotypic correlations for a given trait between two different environments as a measure of genotype by environment interaction but, as Kang *et al.* (1984) pointed out, genetic correlations in this fashion have not been commonly used in sugarcane breeding programs.

Most of the work in repeatability has been done to investigate trait repeatability from stage to stage in a sugarcane breeding program (Ladd *et al.,* 1974; Miller and James, 1975). Since sugarcane is vegetatively propagated, a high degree of repeatability should be expected from stage to stage if environment has no effect, however that is the exception rather than the rule. Generally, high repeatabilities have been reported for stalk diameter (Brown *et al.,* 1969; James and Miller, 1971; Mariotti, 1974; Ladd *et al.,* 1974), whereas Kang *et al.* (1984) reported stalk number to have high clonal repeatabilities.

High phenotypic associations between the same traits at two different environments would indicate good repeatability, which may evidence that improvement made in one environment will be translated in improvement in the second environment. High genetic associations between the same trait at two different environments would indicate that the genetic mechanism(s) conditioning that trait in one environment would be the same acting at the second environment (Falconer, 1952).

Studies with estimates of repeatability have been reported by Mariotti (1973) in Argentina, Miller and James (1975) and Milligan *et al.* (1996) in USA, Nageswara and Ethirajan (1985) in India, Rodrigues (1986) in Colombia, Ramdoyal (1999) in Mauritius, and Ram *et al.* (2000) in India, Soomro *et al.* (2006) and Ilyas and khan. (2010) in Pakistan, Glynna *et al.* (2009) in Florida, among others. Great variation in repeatability is observed among these studies, which indicates not only the influence of the environment on selection, but also a strong interaction between genotypes x environments and between genotypes x selection criteria.

Ladd *et al.* (1974) reported study of the repeatability of the major yield characters of sugarcane (stalk no., stalk length, stalk diameter, refractrometric brix, cane volume, & plot weight) all six were found to be repeatable, stalk diameter being the most & cane volume the least repeatable. Environment and type of cross had little effect on the extent of repeatability.

Miller and James (1975) observed repeatability for stalk diameter among plant crops was somewhat higher than that for stalk number and brix, which were about equal. Repeatability for stalk number and diameter was about equal between plant crops and first ratoon crops, but brix was more repeatable among ratoon than among plant crops.

The degree and repeatability of genetic divergence of yield characteristics of the first two cuts among 20 sugarcane clones observed by Viana *et al.* (1991) in two different environments were evaluated by cluster analysis. The clones tested did not show a high degree of divergence. The repeatability of the results obtained under the different conditions was low.

Reillyo *et al.* (1995) reported that clonal repeatability and correlation between family means were highest for stalk diameter, fibre per cent cane, brix per cent dry matter. The traits *viz.*, stalk diameter, stalk weight, length of stalks had higher R values across families.

Singh and Singh (1999) reported repeatability of characters between crops was significantly high for juice brix, sucrose per cent (7 months), yield (10 months), stalk height, number of stalk and stalk diameter (7 months). The genetic association among characters were relatively low in plant cane and the first ratoon (r = -0.15 to 0.78), stalk diameter was the most predictable characters followed by stalk number, stalk height, juice brix and sucrose per cent at grand growth stage for yield potential of genotypes in plant cane as well as ratoon.

Sousa *et al.* (2002) reported R values between all possible environment combinations were high, showing a low effect of the environment on the trait studied (stalk number, length, diameter, weight and plant height).

Ishaq *et al.* (2002) conducted an experiment at 2 locations to determine inter character relationship between various quantitative traits of sugarcane, correlation coefficient obtained between cane yield and all the important yield components were positive and significant except for stalk diameter and leaf width. The correlation coefficient revealed that stalk weight, stalk height, number of stalk per stool, leaf area, juice and CCS per cent were the major traits contributing to the cane and sugar yield. Stem diameter is positively correlated with stalk weight, stalk height and leaf area.

Glaz *et al.* (2002) Genotype correlations between Stage III and Stage IV were significant but low for sugar yield (r = 0.27) and economic index (r = 0.28).

Bressiani *et al.* (2003) reported repeatability for stalk length and brix, rp(x) estimates weren't significantly different between stages I and III and between II and III. For stalk diameter, stalk number and weight of stalks, there was a clear difference of rp(x) values between stages I and III and between II and III.

Ferreira *et al.* (2005) the study conducted on repeatability coefficients (r) and determination of the predictability degree (R_2) for cane yield, percentage of pol in the juice of cane and tons of pol in the juice of cane per hectare in sugarcane genotypes. The result estimates that repeatability coefficient showed values with very similar magnitude. The general average repeatability for those three traits was above 0.60, therefore showing regularity in the genotype performance at several measurements (cuts) and reliability in the genotype discrimination that was higher than 87 (%).

Experiments were conducted by Soomro *et al.* (2006) to evaluate some quantitative and qualitative characteristics of 11 sugarcane varieties. Correlation coefficient values of different yield characters with cane yield were positive and highly significant. The highest value of correlation with cane yield was exhibited from millable canes (r = 0.726) and plant height (r = 0.538).

Shanthi *et al.* (2008) the study was undertaken to assess the relative performance of five sugarcane families for predicting potential parental combinations and also to identify rare and elite recombinants that can be exploited in future. Results from this study highlighted that two families viz., Co 7704 x Co 8209 and Co 85002 x Co 86011 contributed a greater proportion of elite clones combining acceptable levels of cane yield and sugar yield. Overall, the findings suggest that selection of the best families based on their mean performance and further selection of individual clones based on their sugar yield in early stages would improve the efficiency of selection and increase heritability in the genetic populations being tested.

Babu *et al.* (2009) the correlation studies revealed that, it was positively and significantly correlated with major yield and quality traits. Hence rind hardness may be considered as an important parameter during initial stages of selection when the population size is too large to estimate fiber content.

Glynna *et al.* (2009) reported correlation analysis was used to examine repeatability of phenotypic data used to advance genotypes from an unreplicated single location clonal crop test (stage II) to the subsequent stage (stage III; two replicate, four location clonal crop experiment). These results indicate that changes in the advancement strategy from stage II are not required as advancing approximately 135 genotypes identifies almost all genotypes with the genetic potential to yield well in stage III.

Neil *et al.* (2009) reported that Correlation analysis was used to examine repeatability of phenotypic data used to advance genotypes from an unreplicated single location clonal crop test (stage II) to the subsequent stage (stage III; two replicate, four location clonal crop experiment). Correlations between the phenotypic data were significant only for stage III comparisons between TRS and cane yield, which were negatively associated on either soil type. These results indicate that changes in the advancement strategy from stage II are not required as advancing approximately 135 genotypes identifies almost all genotypes with the genetic potential to yield well on muck or sand soils in stage III. Increasing genotypes in stages prior to stage III and changing crossing strategies to improve identification of disease resistant, high-yielding genotypes for sand soils is recommended.

Sahu *et al.* (2010) an experiment was conducted at seedling generation and settling generation, and results showed that only two characters, *viz.*, number of millable canes per clump and single cane weight recorded significant higher value of genetic correlation coefficient at both the generations.

Pedrozo *et al.* (2011) reported moderately high estimates of repeatability for TSH (tons of stalks per hectare) and TBH (tons of brix per hectare) and the high coincidence rates of family selection across the harvests.

Marvellous (2014) the study explored that potential of evaluating cane yield of sugarcane families estimated using stalk number, stalk height, and stalk diameter as compared to individual seedling selection.A sample of 500 seedlings produced a significant association ($r = 89$, $P < 0.0001$) between actual and estimated cane yield. The results showed significant differences for cane yield among families. Family estimates of broad-sense heritability (H) and percent predicted gains (% Gs) were larger than for individual seedling selection. Elite families within populations were identified using BLUP.

2.2.2 Intra stage association

Study of association or correlation among characters within generation is known as intra stage association.

2.2.2.1 Yield and yield components

Sahi (1981) found a strong positive association of single cane weight and stalk diameter with cane weight at 10th month.

According to Punia *et al.* (1983) cane yield was influenced by the nurnber of ttillers per clump, the number of millable canes per clump, cane thickness and cane weight.

Significantly high phenotypic and genotypic association of cane yield with number of millable canes per plot and length of millable cane was reported by Reddy and Reddi (1988).

Sekhar (1986) observed close association of number of internodes, cane length and single cane weight with cane yield. On the other hand Saikh *et al.* (l986) found close association of cane yield with plant weight.

In a similar interrelationship study of cane yield with its components in the hybrid progenies of twelve intervarietal direct and reciprocal crosses at the first clonal generation, Reddy and Reddi (1987) observed highly significant association of cane yield with stalk number in all the 12 crosses, with stalk length in seven crosses and stalk diameter in five crosses. They suggested that the stalk number per plot followed by stalk weight were the major components influencing cane yield per plot.

Poor association of germination and early tillering with cane yield was reported by Nair and Sreenivasan (1990). They also noticed closer correlation between shoot height recorded on 90^{th} day after planting with cane yield. Significant and positive correlation of cane yield with minable cane, millable height of cane, number of internodes and leaf area index was noticed by Gajera *et al.* (1991).

Pillai and Ethirajan (1993) reported significant positive correlation of cane yield with stalk number, stalk length and stalk weight and non significant association with quality traits. Reddy and Somarajan (1994) did not notice any significant positive association of cane yield with any of the yield attributes like single cane weight, cane length, cane thickness and number of internodes except number of millable canes.

Positive correlation of cane yield with number of millable stalks, stalk weight, stalk length, diameter and internode number was reported by Singh and Khan (1995). While Singh *et al*. (1995) observed significant positive association of stalk yield with number of stalks per clump and stalk weight. Das *et al*. (1996b) reported significant association of cane yield with stalk weight, stalk diameter and number of internodes per cane.

Significant positive correlation of cane productivity with number of millable canes, stalk height, stalk weight and internodal length were observed by Kundu and Gupta (1997). While Rishipal *et al.* (1998) noticed close association of cane yield with number of minable canes, single stalk weight and stalk height.

Panhwar *et al.* (2003) undertook an investigation to assess the interrelationship of cane yield and its traits in sugarcane. It was observed that cane girth, no. of internodes per plant, cane height and millable canes were positively and highly significantly correlated with cane yield, the regression coefficients for these traits on cane yield were also positive.

Chaudhary and joshi (2005) reported cane yield showed positively and highly significant correlation with single cane weights stalk length and millable cane number. There was also positively significant correlation of cane diameter and number of internode with cane yield. Length of internode had positive non-significant correlation with cane yield. Single cane weight had the highest positive direct effect on cane yield, followed by millable cane number. Stalk diameter and stalk length was positively and significantly correlated with cane yield, which was due to indirect effect of single cane weight.

Singh *et al.* (2005) an experiment was planted to study the correlation and path analysis among different agronomic as well as quality characters with ratoon yield. The results indicated that the variance for juice quality trait is high. All the quality parameters like juice brix, sucrose per cent in juice and CCS (%) had highly positive and significant genotypic correlation with Pol percent in cane. Among the characters studied, number of millable canes (NMC), single cane weight and cane height showed significant positive correlation with ratoon yield and sugar tonnes per hectare (STH) but there was a weak negative correlation between NMC and single cane weight.

Estimates of correlation coefficients were computed among cane yield and its component traits for 32 sugarcane genotypes grown in three environments by Kadian *et al.* (2006). Cane yield was found significantly con-elated with single cane weight and cane thickness. Positive and highly significant correlations were observed amongst four juice quality traits.

Khan *et al.* (2007) conducted an experiment to estimate the variance and association studies, results revealed that the correlations between of number of tillers per plant with number of leaves, cane height and internodal distance were positive and significant at genotypic level. Correlation of number of tillers per plant were positive and non-significant with cane diameter, leaf area, cane weight and dry matter contents.

Liu *et al*. (2007) Diallel cross experiments were conducted for estimating variance component and the correlations between brix weight (BW) and its components were estimated during a period of two years for brix weight per stool (BW) and its five component traits, including stalk diameter (SD), stalk length (SL), stalk number (SN), stalk weight (SW), and brix scale (BS) of sugarcane and the results showed that additive, dominance, additive x environment, and dominance x environment correlations existed extensively among BW and its component traits in sugarcane.

Tyagi and Lal (2007) reported correlation between agronomic characters revealed positive and significant (P = 0.01) correlation between plant volume and number of millable stalks (0.874), plant volume and weight per stalk (0.812), plant volume and weight of millable stalks (0.962), plant volume and stalk thickness (0.842), number of millable stalks and weight of millable stalks (0.889) and other agronomic characters. There was a non-significant but positive correlation between number of millable stalks, refractrometer brix (0.05), number of millable stalks and stalk height (0.285) and other characters.

Shah *et al.* (2008) studied reported that cane yield showed significantly positive correlations with refractive brix, sucrose content and sugar yield while it gave significantly negative correlation with ratoon stunting disease.

Mancini *et al.* (2012) reported tones of sugarcane per hectare (TCH) was significantly correlated with stalk weight and stalk number in both years. Regarding to all the yield components, stalk number together with stalk weight were the most important components in the determination of TCH. While fiber and Pol (%) cane were negative correlated showing that they are inversely correlated traits.

2.2.2.2 Association among yield components

Kang *et al.* (1983) reported a significant positive association of plant height with stalk diameter and stalk weight. Highly significant negative association of stalk diameter with stalk number and stalk number with stalk weight was observed.

A highly significant positive association of plant height with number of internodes and cane thickness was reported by Saikh *et al.* (1986). While Tehlan *et al.* (1986) reported significant negative association between plant height and stalk diameter and number of canes and number of internodes. Sekhar (1986) observed highly significant positive association between character pairs, cane length and number of internodes; number of internodes and single cane weight; single cane weight and cane length; stalk diameter and single cane weight.

Nageswara Rao *et al*. (1983) reported high negative association of brix with stalk diameter at both genotypic and phenotypic levels, while the clump weight and millable stalks per clump had low positive correlation with brix.

A non-significant positive association of brix with number of stalks, single cane weight, length of millable canes and stalk diameter was reported by Reddy and khan (1984). In another study in 1985, he reported a highly significant negative association of sucrose per cent with cane yield and its components viz., stalk diameter, stalk weight and stalk length.

Tehlan *et al.* (1986) reported the highly significant and positive association of sucrose with plant height and brix. brix had highly significant positive association with plant height and number of internodes. Highly significant positive association of brix with sucrose and CCS per cent was observed by Sekhar (1986).

Rekhi and Gill (1987) reported the significant positive inter relationship between sucrose and purity. Verma *et al*. (1988) reported highly significant negative association of sucrose per cent in juice with number of millable canes and number of internodes per cane. Purity coefficient had highly significant positive association with stalk girth and sucrose per cent in juice.

Reddy (1988) reported significant positive association of stalk weight with stalk diameter and stalk length. Highly significant positive association of number of millable canes per clump with number of internodes per cane and stalk weight was noticed by Verma *et al.* (1988). He also observed highly significant positive association of stalk weight with number of internodes per stalk girth.

Positive association of stalk weight with diameter and stalk length and also between stalk length and number of internodes was reported by Madhavi *et al*. (1991). Patel *et al.* (1993) observed significant negative association of millable canes/ha with weight and stalk diameter and significant positive association of stalk weight with stalk diameter, Das *et al.* (1996b) reported significant negative association of number of millable canes per ha with stalk weight and height of millable cane.

Positive correlation between cane weight and its thickness and negative correlation of NMC with individual cane weight and its length were reported by Das *et al.* (1997).

In a crop like sugarcane, quality plays an important role as such it is imperative to understand the relationship of quality parameters with cane yield and its components and also with commercial sugar yield

High positive association among brix per cent, sucrose per cent, purity per cent and CCS per cent was noticed by Hooda *et al.* (1989). Sreekumar *et al*. (1994) observed significant and positive correlations both at phenotypic as well as genotypic levels for brix with pol, purity, CCS per cent and CCS/ha, but negative association with millable cane count and yield/ha. Singh *et al.* (1995) observed significant correlation of number of green levels and stalk diameter with brix quality. Das *et al*. (1996a) reported significant negative association of number of millable canes per hectare with sucrose per cent in juice and CCS percentage.

2.2.2.3 Association among yield components with CCS yield

Balasundaram and Bhagyalakshmi (1978) reported non-significant negative association between sugar yield and sucrose. Hogarth *et al.* (1981) concluded that progress in breeding for greater yield of sugar per hectare is more likely with selection for greater yields of cane than for higher sugar content.

Reddy and Reddi (1986) revealed that commercial cane sugar (CCS) yield was largely dependent on cane yield rather than on sucrose per cent in juice. Highly significant and positive association of CCS yields with stalk number per plot and stalk weight and stalk diameter was also observed.

The strong positive and significant association of CCS yield with number of millable canes per clump, number of internodes per cane, stalk weight, stalk girth, sucrose per cent in juice and purity coefficient were reported by Verma *et al*. (1988). Nair and Sreenivasan (1990) reported close association between height at 90th day after planting and sugar yield.

Significant association of sugar yield with cane yield, sucrose per cent in juice, CCS per cent and numbers of internodes were observed by Patel *et al.* (1993).

In an investigation to study the mean performance of selected sugarcane genotypes for twenty cane yield and juice quality traits in northern dry zone of Karnataka (Tippeswamy *et al*. 2002) reported genotypes Co 90008, Co 87025 and check variety Co 671 were superior out of sixty genotypes for cane and sugar yield.

Singh *et al.* (2001a) reported the close association of cane yield with number of tillers, number of millable canes per plot, germination percentage, length of inter nodes and single cane weight under moisture deficient conditions, while Kamat and Singh (2001) germinations per cent, number of shoots, LAI, single cane weight sucrose per cent may taken into consideration while selecting rainfed tolerant varieties of sugarcane combining high yield and better juice quality based on correlation studies made under rainfed conditions.

2.3 Identification of suitable genotypes for organic/chemical free jaggery production

Jaggery of sixteen popular commercial promising sugarcane varities was studied by Rakkiyappan *et al.* (1996) and reported considerable variations for physical and chemical characters. The cultivars CoC 671, Co 8021, Co7704 and Co 997 gave high quality jaggery having high values of netrendement, brix, sucrose, purity, recovery indices, low levels of reducing sugars, moisture, ash inversion ratio and non sugars.

High heritability and high genetic advance as per cent mean for jaggery yield was observed by Sankarapandian and Avudainayagam (1996). They also showed strong positive correlation of juice yield with jaggery yield.

Uppal and Sharma (1999), made a study to know the quality of jaggery made from promising varities for Punjab and rated CoJ 82 as excellent in quality with attractive golden yellow colour highly crystalline and sweeter in taste.

Jadhav *et al.* (2000), found that cane harvested at the age of 14th month had highest jaggery recovery with good quality in respect of reducing sugars, non reducing sugars and colour and concluded that good quality jaggery could be produced by cane harvesting at the age of 14th month.

Shivaramu *et al.* (2002) reported that in Mandya district, variety Co 62175 was found best of jaggery recovery and quality parameters but, same variety showed poor keeping quality.

Jain and Pushpa (2000) conducted a study to estimate the moisture content of the jaggery by microwave oven method and hot air oven method. The results obtained by microwave oven method compared well with those obtained by hot air oven method. No statistical difference was observed between pre cent moisture values of jaggery samples by microwave drying and hot air oven drying.

Jambulingam *et al.* (2001) conducted experiment to investigate the effect of different soil moisture regime on CCS per cent, jaggery quality and yield of sugarcane varieties. Results revealed that, reducing sugar, ash, nitrogen, phosphorous, potassium, calcium and magnesium contents in jaggery showed no significant differences due to irrigation treatments, but significant differences among the varieties was noticed.

Uppal (2002) conducted a study for knowing the long and better shelf life of jaggery at different storage period was attempted at low temperature (7-9^0 C). With increase in storage time, there was decrease in quality of jaggery but there was complete check of microbial growth till storage period of 2 years 8 months with some changes in physicochemical characteristics and visual observations along with smell like old jaggery. But storage of jaggery upto 1 year 8 months was very safe with no changes in quality.

Experiments were conducted by Patil *et al.* (2005) to study the clarification efficiency of some synthetic and herbal clarificant suitable for quality jaggery. The synthetic clarificant like Bhendi powder or SNI at 2 ppm with herbal clarificant bhendi plant at 2 kg/1000 lit were found effective in improving non reducing sugars (NRS), Colour, Jaggery recovery and maximum removal of scum, showing better effect on quality of jaggery and also helped in maintaining higher NRS and better colour jaggery during storage than the control treatment. None of the other clarificant was found beneficial in keeping jaggery in good condition during storage.

Mandal *et al.* (2006) revealed that the best packing material for storing gur during monsoon season would be heat-sealed LDPE (Low Density Polyethylene) packet of 150 gauge followed by glass jars. LDPE packets prevented moisture ingress, fall in pH and inversion of sucrose in the stored gur to the maximum extent. However, colour of gur in LDPE packets was darker as compared to gut stored in glass jars. PET (Poly Ethylene Terephthalate) jars were as good as glass jars but the stored gur darkened more in PET jars. Canisters were better in comparison to painted earthen pots provided those were with airtight lid.

Hussain *et al.* (2007) conducted a field study to screen five sugarcane genotypes *viz.,* HSF-242, S97-US-127, S97-US-102, S97-US-161 and HSF-240 as standard for their gur quality, results showed that genotype S97-US-161 produced gur with highest net rendements value and pol per cent before and after storage. Statistically significant differences were observed with respect to mineral content, color, acidity and reducing sugars per cent while non-significant differences for moisture per cent, net rendements value and pol per cent were reported.

Murthy and Shivaramu (2008), evaluated thirteen sugarcane genotypes for their cane yield, jaggery yield, jaggery recovery per cent and the parameters associated with jaggery quality. The results revealed that the genotype Co-95005 registered highest jaggery yield of 16.20 t/ha followed by CoC 90063 (16.17 t/ha) and Co-862249 (16.10 t/ha). For jaggery recovery per cent, the genotype CoC 90063 recorded higher recovery of 11.77 per cent followed by Co.86249 (11.35 %) and Co-93020 (11.27 %). Based on the suitability for jaggery making, the genotypes Co 95005, CoC 90063 and Co 62175 were found promising.

Thangavelu (2009) reported that high quality juice having low reducing sugars/sucrose ratio and high purity is considered to be good for jaggery manufacturing. Juice of high sucrose and lower content of invert sugars, free amino acids, colloids and ash were conducive for superior quality gur. Purity coefficient and sucrose/glucose ratio of the juice were important factors determining the quality of jaggery, higher ratios yielded better jaggery quality.

Sugarcane genotypes tolerant to salinity were tested for jaggery quality that seems to differ under salinity. Among the tolerant genotypes difference in jaggery quality was recorded with respect to net rendement value (%), colour and taste under salinity, grading tolerant genotypes as good, poor and unsuitable for jaggery preparations, when grown in saline soil, as reported by Vasantha *et al.* (2009).

Khan *et al.* (2011) conducted a study on commercial jaggery to observe the effect of storage period on quality characteristics of jaggery. The experimental data revealed that the jaggery moisture content was increased from an initial value of 12.07 to 22.36 per cent (db) in open storage, while it was decreased to 9.23 per cent (db) in bin and was increased up to 15.84 per cent (db) in polythene bags. Similarly the per cent change in sucrose, reducing sugar and color were lesser in bin and polythene bags than in open storage. The color of jaggery became darker during storage. The optical density of jaggery was increased from 0.18 to 0.27.

Madhuri *et al.* (2011) revealed from their study that quality parameters of cane juice and jaggery were positively and significantly influenced by the application of sulphur irrespective of sources of sulphur. Application of sulphur at 100 kg/ha had significantly influenced the quality of juice but it was comparable with the application of sulphur at 80 kg/ha which was reflected in quality of jaggery. An increase of 1.27 units in juice sucrose was observed with the application of sulphur at 80 kg/ha. brix (%) and sucrose (%) of jaggery significantly increased with increasing levels of sulphur up to 80 kg/ha. But sources did not differ markedly on juice quality and jaggery quality parameters. So from this study it can be inferred that the sulphur can also be supplied through organic manures as it has a significant effect on the quality parameters of jaggery.

Thangavelu (2011) reported that, the juice of varieties CoJ 64, CoJ 76, CoJ 81, CoJ 67 which produced excellent and good quality gur had low N/P_2O_5, Fe/P_2O_5, K, Ca, Mg and Cl and high content of P, Zn, Mn and Cu compared to the juice of Co 1148, CoJ 79 and CoJ 77 which gave gur with medium and poor quality. Eliminating the contact of juice with iron, colour of gur was markedly reduced in all the varieties. While organic non-sugars react with iron salts present in juice on contact with crusher and pan forming dark colored complexes, before, during or after clarification, large quantities of ash make the gur saltish and affect its color.

Unde *et al.* (2011) carried out investigations to study the effect of different particle size and packaging materials on storability of jaggery powder on the basis of changes in chemical composition and organoleptic characteristics. Jaggery powder of three different grades *viz.*, coarse (0.500 - 0.708 mm), medium (0.351 - 0.420 mm) and fine (0.211 - 0.296 mm) were prepared and packed in 100 gauge polyethylene bag.The results revealed that change in chemical composition was lower in case of coarse jaggery powder. The coarse jaggery powder having particle size in the range (0.500 - 0.708 mm) was found more acceptable among all other powder sizes after storage period of six months in terms of its chemical properties and organoleptic characteristics.

Zahid *et al.* (2011) carried out investigations to study the effect of contact surface on the properties of jaggery. Results showed that the pol value or sucrose contents depend upon the nature of the surface in contact with the juice during the jaggery formation. It can be seen from the results that the sucrose loses can further be minimized by the use of the pieces of the materials instead of the pans.

A study was conducted by Arun *et al.* (2012) to produce jaggery using naturally available plant based clarifying agents primarily to avoid the present use of chemicals in jaggery production. The quality of the jaggery was compared with the chemically prepared Jaggery. The results revealed that the plant based clarifying agents produce good quality jaggery in terms of sucrose content, hardness, reducing sugar content, moisture content, porosity, microbial load, ash content, net rendement value and dirt & impurities compared to chemically prepared jaggery. The colour was much darker in case of castor milk based jaggery. The ground nut milk based jaggery was found to be the best in the organoleptic evaluation.

Banerji *et al.* (2012) conducted experiment to investigate the contribution of invert sugars towards colour development of jaggery by non-enzymic browning reactions during jaggery making process. Addition of 0.5 and 1.0 g glucose/100 ml cane juice did not alter the colour of juice after boiling for 30 min at 98 ^{0}C, while addition of same quantities of fructose/100 ml in the cane juice enhanced the colour of boiling juice over control.

Investigations were carried out for storage behaviour of jaggery samples, stored in polythene bags, IISR bins and hanging baskets under hilly climatic conditions of Uttarakhand. The study revealed that the quality of jaggery was affected significantly by both containers as well as ambient conditions. The moisture content jaggery samples increased from an initial value of 11.02-24.32 per cent in open storage, while it only increased to 14.89 per cent in bins and 15.84 per cent in case of polythene bags. Similarly the change in percentage of sucrose, reducing sugar and colour was observed less for the samples kept in storage bins and polythene bags than for the samples kept in open storage. Overall, IISR bin preserved the quality better than the open and polythene bag storage as reported by Khan *et al.* (2012).

Madariya and Japraj Rao (2012) conducted a study on utilisation of whey in jaggery production the effect of whey constituents on the sensory quality of jaggery was studied, and results revealed that the overall sensory quality of the whey jaggery prepared by the optimized method was comparable with the quality of sugarcane jaggery (7.7 and 8.1 score out of 9.0 on Hedonic scale, respectively) and contained higher protein and mineral levels than sugarcane jaggery.

Pushpa *et al.* (2012) conducted a study with an objective of enhancing jaggery shelf life at room temperatures by packaging under modified environments. Four jaggery samples were packed under nitrogen (N), vacuum (V), in polythene bags (PB) and airtight glass jars (ATGJ). The samples were analyzed after six months of storage for its physico-chemical, microbial properties and overall acceptability.The results revealed that there was a drastic increase in moisture (15-22 %) of jaggery packed in polythene while no significant change occurred in moisture % of jaggery stored under nitrogen and vaccum environment when compare with fresh jaggery. Jaggery packed under nitrogen environment sustained the sucrose, moisture, reducing sugars, titratable acidity, pore space, total microbial count levels as that of fresh jaggery at room temperature and remained distinctly superior in its overall acceptibilty.

Zahid *et al.* (2012) carried out investigations to study the effect of pre-treatment of juice on the properties and composition of jaggery, Results showed that the pre-treatment of the sugarcane juice with the gases was found to improve the color and sucrose contents of the jaggery. Among the gases nitric oxide was found to be the best which gives jaggery of the best color and better sucrose contents. The use of carbon dioxide and nitric oxide are recommended for the preparation of better quality jaggery.

Guddadamath *et al.* (2014) conducted an experiment to evaluate the performance of twenty productive clones with five commercial varieties *i.e.*, pre-selected highly productive sugarcane hybrid clones for cane yield, jaggery yield and quality parameters under organic and integrated cultivation practices across five locations in northern Karnataka, India. They found that the varieties exhibited wide range of jaggery recovery, yield and juice quality parameters indicating better scope for identifying clones combining good quality and desirable productivity levels under organic cultivation practices. As a result of this experiment, two genotypes *viz.*, SNK 07337 and SNK 07680 were identified as most promising for organic jaggery production as they recorded superior jaggery recovery and productivity over commercial varieties with highly acceptable light golden yellow colour.

Devaraju (2014) conducted an experiment to evaluate the performance of cane, sugar and jaggery yield and quality parameters, top 15 genotypes showing superiority were discussed, among them six genotypes *viz.,* SNK 10131, SNK 10159, SNK 10184, SNK 10260, SNK 10162 and SNK 10229 were found promising as they recorded most acceptable features particularly jaggery productivity and quality parameters under organic cultivation. These promising clones would be advanced to large scale yield trials across diverse locations and could also be utilized as parental material for genetic enhancement of cane and jaggery productivity in the current breeding programmes.

3. MATERIAL AND METHODS

The experiments were conducted at Agricultural Research Station Sankeshwar to study the response of sugarcane (*Saccharum* spp., complex hybrid) genotypes to cane yield, jaggery production and quality with special reference to organic and integrated method of cultivation. The details of the materials used and the techniques adopted in conducting field experiment are presented in this chapter.

3.1 Experimental material

Material for the study comprised of 38 clones developed at Agricultural Research Station, Sankeshwar along with three standard checks. The details of the genotypes, checks and parents used in the present investigation are presented in Table 1. The pedigree and agronomic characteristics feature of parents are furnished in Table 2.

3.1.1 Clonal-III generation

38 progenies with commercially acceptable cane features were studied for assessing exploitable variability in the population.

Design : Randomized Block Design

Number of clones : 38

Number of Blocks/Replication : Two

Number of standards/checks : Three commercial checks

CoC 671, Co 92005 and Co 86032

Location: a) Agriculture Research Station, Sankeshwar (Organic block 399/ III)

b) Agriculture Research Station, Sankeshwar (Integrated block 399 / II)

3.2 Experimental details

3.2.1 Experimental layout

Thirty eight genotypes with three standard checks were planted during January in randomized complete block design with two replications. Each genotype was planted in organic and integrated blocks in two rows of six meter length with spacing of 1.50 m between the rows (2R x 6m x1.20m). Sugarcane set with one eye bud was used for planting at a seed rate of 10 buds per meter.

3.2.2 Cultural practices

The details of the various cultural operations carried out in the experiment are explained below.

3.2.2.1 Land preparation

The land was ploughed once harrowed and smoothened to bring the soil to the fine tilth. The field was then laid out in to V shape ridges and furrows at a spacing of 150 cm, with a furrow depth of 20 cm.

Table 1: Parentage of pre selected progenies used in the present investigation

Sl. No.	Pre-selected clones	Parentage	Sl. No.	Pre-selected clones	Parentage
1	SNK10046	Co 740 GC	20	SNK10193	Madhuri GC
2	SNK10058	CoT 8201 GC	21	SNK10194	
3	SNK10134	Co 92005 GC	22	SNK10199	
4	SNK10141		23	SNK10212	
5	SNK10148		24	SNK10229	
6	SNK10149		25	SNK10232	
7	SNK10151		26	SNK10241	Co 2001- 15 GC
8	SNK10155		27	SNK10243	
9	SNK10157		28	SNK10245	
10	SNK10158		29	SNK10246	
11	SNK10159		30	SNK10248	
12	SNK10162		31	SNK10260	
13	SNK10177		32	SNK10263	
14	SNK10170		33	SNK10274	Co 7704 GC
15	SNK10176		34	SNK10280	
16	SNK10179		35	SNK10283	Co 775 GC
17	SNK10183		36	SNK10286	
18	SNK10184		37	SNK10301	Co 92004 GC
19	SNK10192	Madhuri GC	38	SNK10303	

Commercial checks used in present study		
C1	CoC 671	High yielding, high sucrose, early maturing variety and moderately Tolerant to drought and salinity. Excellent field keeping quality with moderate ratooning ability and excellent Jaggery quality.
C2	Co 92005	Tolerant to internode borer, early shoot borer and mealy bug. Tolerant to node rot and wilt. Susceptible to smut. Suitable for Jaggery production.
C3	Co 86032	Midlate, attractive pink colored cane with high cane yield, higher sucrose, Resistance to smut and Tolerant to salinity. Good ratooner. Retains quality up to 14-16 months. Suitable for wide row planting & high input management.

Table 2: The pedigree and agronomic features of jaggery varieties used in crossing programme

Sl. No.	Parentage	Characteristics
1	Co 740 GC (P3247 x Co 775)	Erect and broad leaves, Medium thick, high yielding, better ratooner, midlate maturing, late and sparse flowering, tolerant to drought and water logging, R to rust S to smut.
2	CoT 8201 GC (Co 740 x Co 775)	Erect, high yielding, high sucrose with very good ratooner and rust resistance variety, very good jaggery quality and recovery.
3	Co 92005 GC (Co 671 x CoT 8201)	High quality jaggery variety with early maturity, suitable for organic jaggery production.
4	Madhuri GC (Co 740x Co 775)	Popular jaggery variety of kerala,high yielding with excellent jaggery quality.
5	Co 2001- 15 GC	High yielding, high sugar variety with excellent jaggery quality.
6	Co 7704 GC (Co 740 x Co 6806)	High yielding, high sugar variety with excellent jaggery quality.
7	Co 775 GC (PoJ 2878 x Co 371)	High yielding, early maturing, high sucrose variety with excellent jaggery quality
8	Co 92004 GC (Co 62175 x Co 86032)	Midlate, erect canes, non sparse flowering, moderately resistant to red rot, high sugar variety with excellent jaggery quality, tolerant to drought and salinity.

3.2.2.2 Fertilizer application for organic block

1. Seed treatment: *Trichoderma viride* @ 5 g lt^{-1} was used through Beejamruth as sett treatment at planting.
2. Green manuring: *Insitu* were incorporated at 50 DAP like cowpea, dhaincha, chicpea, pea, sesame, niger, greengram, blackgram and soyabean.
3. Bio- fertilizers: *Azospirillum* and Phosphorus solubilizing bacteria (PSB) were applied @ 10 kg ha^{-1} each by mixing through FYM.
4. Jeevamruth: It was applied @ 500 lt ha^{-1} used along with irrigation water at alternative month up to 240 DAP.
5. Panchagavya: It was used as foliar spray @ 3 per cent at 60 and 90 DAP.
6. Vermicompost: It was applied @ 2t/ha twice.

3.2.2.3 Fertilizer application for integrated block

1. Seed treatment: The setts were treated with 2ml/gm solution containing Bavistin + 2ml chlorpyriphas per liter of water before planting.
2. Fertilizers: 250: 75: 190 kg N: P2O5: K2O ha^{-1} were applied in furrows in the form of urea, single super phosphate and murate of potash respectively. The crop was top dressed with 50, 75, 100 kg urea ha^{-1} at sixth, tenth and fourteen weeks after planting.
3. Micronutrients: ZnSO4 and FeSO4 @ 25 kg ha^{-1} each were applied at basal..

3.2.2.4 Planting of Sugarcane setts

Single eye budded setts were prepared from healthy crop . The setts were treated with two per cent Bavistin and Chloropyriphos solution for integrated block and *Trichoderm* @ 5 g lt^{-1} through Beejamruth for organic block before planting. The setts were planted to a depth of 5 cm at the rate of 10 eye buds per meter length.

3.2.2.5 Weed control

Two hand weedings were carried out at 40 and 80 days after planting (DAP).

3.2.2.6 Irrigation

The experiment block was irrigated on the day of planting. Thereafter, seven days irrigation interval was followed during the germination phase (8-30 days) and 8-10 days interval during the tillering and grand growth phases of the crop (101-270 days), and once in 12-15 days interval during maturity phase (271-365). The irrigation was skipped during rainy period. No irrigation was scheduled during the last fifteen days before harvesting of crop.

3.2.2.7 Harvesting of sugarcane

The cane was harvested at 360 days after a maturity.

3.3 Observations recorded

3.3.1 Germination (%)

The total number of germinated seedlings were counted in each plots at 30 days after planting and expressed as percentage of the buds planted.

3.3.2 Total number of shoots

The total shoots present in each genotype were counted and recorded as total shoots per plot at 90,120 and 240 days after planting.

3.3.3 Cane formed shoots

Cane formed shoots in the plot at 90 and 120 days after planting (DAP) were recorded.

3.3.4 Average millable cane height (cm)

Height of three randomly selected millable canes was recorded by using measuring tape at 8, 10 and 12 months and expressed as mean cane height in centimeters.

3.3.5 Average plant height (cm)

Height of three randomly selected plants genotype-wise and replication-wise were cut at the ground level. The plant height was measured from base of the plant to tip of the fully top opened leaf from selected plants at 8, 10 and 12 month and expressed as mean plant height in centimeters.

3.3.6 Average cane girth (cm)

Girth of three randomly selected millable canes was recorded by using vernier callipers at 8, 10 and 12 months and expressed as mean cane girth in centimeters.

3.3.7 Average number of internodes

The number of internodes per on millable cane up to the last internode was recorded for three randomly selected canes and expressed as average number of internodes per stalk at 8, 10 and 12 months.

3.3.8 Average millable cane intermodal length (cm)

The internodal length of top, mid and bottom internodes of millable canes were recorded on three randomly selected canes with the help of a measuring scale at 8, 10 and 12 months and and the average inter-nodal length was expressed in centimetres.

3.3.9 Number of millable canes (NMC) ('000/ha)

All the canes from each genotype were cut, dressed, counted and recorded as number of millable canes per plot and expressed as number of millable canes per hectare.

3.3.10 Average single cane weight (SCW) (kg)

The weight of millable canes in each genotype for three randomly selected canes was recorded at 8, 10 and 12 months and expressed as average single cane weight in kilograms.

3.3.11 Green top yield (t ha^{-1})

Three random plants genotype-wise and replication-wise were selected for measuring single cane weight and top green weight were measured in kilo grams.

It was estimated by using the following formula

Green top yield (GTY) (t ha^{-1}) = NMC ('000 ha^{-1}) x Green top weight (GTW)

3.3.12 Cane yield per plot (kg)

All the canes in each plot were cut close to the ground level. The tops and trash were removed and cane weight per plot was recorded in kg and expressed as cane yield per ha in tonnes.

$$CY = NMC \times SCW$$

Where,

CY – Cane yield

NMC – Number of Millable canes

SCW – Single cane weight

3.3.13 Harvest Index (%)

It was estimated by using the following formula.

$$\text{Harvest index (\%)} = \frac{\text{Cane weight}}{\text{Cane weight + Green top weight}} \times 100$$

3.3.2 Sugar yield parameters

3.3.2.1 brix per cent

brix reading was recorded using the brix hydrometer at 8^{th}, 10^{th} and 12^{th} month. The juice was extracted from three randomly selected canes and filtered. The composite sample of juice was taken in a cylindrical jar into which brix hydrometer was suspended and reading was recorded along with temperature of the juice. The corrected juice brix value based on brix value and temperature was worked out using Bur standards.

3.3.2.2 Juice extraction (%)

The juice extraction per cent was calculated by following formula.

$$\text{Juice extraction (\%)} = \frac{\text{Juice weight}}{\text{Cane weight}} \times 100$$

3.3.2.3 sucrose per cent (Pol %) in juice

It was estimated by Horne's dry lead acetate clarification method using polariscope at 240, 300 and 360 days after planting (Ishwaran, 1981). One hundred ml of the filtered juice was transferred to 250 ml conical flask to which one gram of basic lead acetate was added, stirred well and allowed to stand for about an hour until clear supernatant obtained. This supernatant filtered through Whatman No. 40 filter paper and the clarified juice was filled into a 20 mm polariscope tube and pol reading was recorded. The corrected pol readings were obtained by comparing the pol reading measured with the corresponding corrected brix reading referring to Schmitz table.

3.3.2.4 Purity per cent

The ratio of sucrose per cent to the corrected brix was expressed as purity of the juice, which indicates the proportion of the sucrose in the total solids present in the juice. It was calculated at 240, 300 and 360 days after planting.

$$\text{Juice purity per cent} = \frac{\text{Corrected pol}}{\text{Corrected brix}} \times 100$$

3.3.2.5 Commercial cane sugar per cent (CCS %)

The commercial cane sugar percentage is the amount of white sugar obtained commercially from the cane juice after removing total soluble solids. It was calculated by using the following formula at 240, 300 and 360 days after planting.

CCS per cent = [sucrose per cent – (brix per cent - sucrose per cent) x 0.40] x 0.75.

3.3.2.6 Commercial cane sugar yield (t ha^{-1})

Sugar yield was calculated from commercial cane sugar per cent as and expressed in tons per hectare.

$$\text{CCS yield (t ha}^{-1}\text{)} = \frac{\text{CCS per cent x cane yield[t ha}^{-1}\text{]}}{100}$$

3.3.2.7 brix yield (t ha^{-1})

brix yield was calculated from brix per cent as:

$$\text{brix yield (t ha}^{-1}\text{)} = \frac{\text{brix per cent} \times \text{Cane yield (t ha}^{-1}\text{)}}{100}$$

3.3.3 Jaggery quality parameters

3.3.3.1 Colour

The color of the jaggery sample was measured by recording the optical density of 13 per cent jaggery solution at 540 nm. The experiment was repeated three times.

3.3.3.2 Jaggery pH

Ten grams of sample was diluted in 10 ml of distilled water and the pH of the suspension was recorded with the help of pH meter

3.3.3.2 sucrose (%) jaggery

The sucrose in jaggery was determined by Succhroliser by clarifying 0.5N solution of jaggery (13 gms /100ml) with lead acetate and finding out the polarization value.

3.3.3.3 Reducing sugar (%)

The reducing sugar were estimated by titration of dilute jaggery solution (10 g) dissolved in 100ml of water clarified with lead acetate with 10ml o f Felhing's solutizn according to
Lann-Eynon's volumetric methods.

3.3.3.4 Total sugar (%)

The total sugar were estimated by the following formula and expressed as per cent.

Total sugar = sucrose in sugar + Reducing sugar

3.3.3.5 Ash content (%)

Ash content was estimated by igniting and charring 10 g of powedered jaggery in silica crucibles over a burner and then ashing it in a muffle furnace at 500^0 C and recording ash weight (Asokan and Rupa, 2008).

$$\text{Ash content of jaggery (\%)} = \frac{\text{Weight of ash}}{\text{Weight of jaggery sample}} \times 100$$

3.3.3.6 Jaggery Recovery (%)

It was estimated by using following formula and expressed as per cent.

$$\text{Jaggery recovery (\%)} = \frac{\text{Jaggery weight}}{\text{Cane weight taken for jaggery}} \times 100$$

3.3.3.7 Jaggery yield (t ha^{-1})

Jaggery yield was estimated by using the following formula.

$$\text{Jaggery yield (t ha}^{-1}\text{)} = \frac{\text{Cane yield (t ha}^{-1}\text{) x Jaggery recovery per cent}}{100}$$

3.3.3.8 Organoleptic evaluation of jaggery sample

Samples were evaluated for organoleptic characters like colour, texture, taste, flavour and overall acceptability by use of nine point hedonic scales by a panel of 8 trained members at Department of Food Science and Nutrition, College of Rural Home Science, UAS, Dharwad (Fig. 1).

Score card

Rating: 1-9 hedonic scale

9 - Like extremely 8 - Like very much 7 - Like moderately

6 - Like slightly 5 - Neither like nor dislike 4 - Dislike slightly

3 - Dislike moderately 2 - Dislike very much 1- Dislike extremely

Indian standards for jaggery

Grading of jaggery based on Net rendement value

Sl No	NR Values	Grade	Quality
1	>65	A1	Excellent
2	60-65	A2	Good
3	45-60	B	Medium
4	<45	C	Poor

Characteristics	Unit	Grade-I	Grade-II
sucrose %	per cent (db), min	80.0	70.0
Reducing sugars	per cent (db), max	10.0	20.0
Moisture %	per cent (db), max	5.0	7.0
Water insoluble matter	per cent (db), max	1.5	2.0
Sulphated ash	per cent (db), max	3.5	5.0
Sulphur dioxide	ppm (db), max	50.0	50.0
Ash insoluble in dilute HCl	per cent (db), max	0.30	0.30

Ref-IS 12923: 1990

3.4 Statistical analysis

The data collected as explained above was subjected to the following statistical analysis.

3.4.1 Mean

On the basis of individual plant observations, the mean for each character in all the populations/progenies was computed as follows.

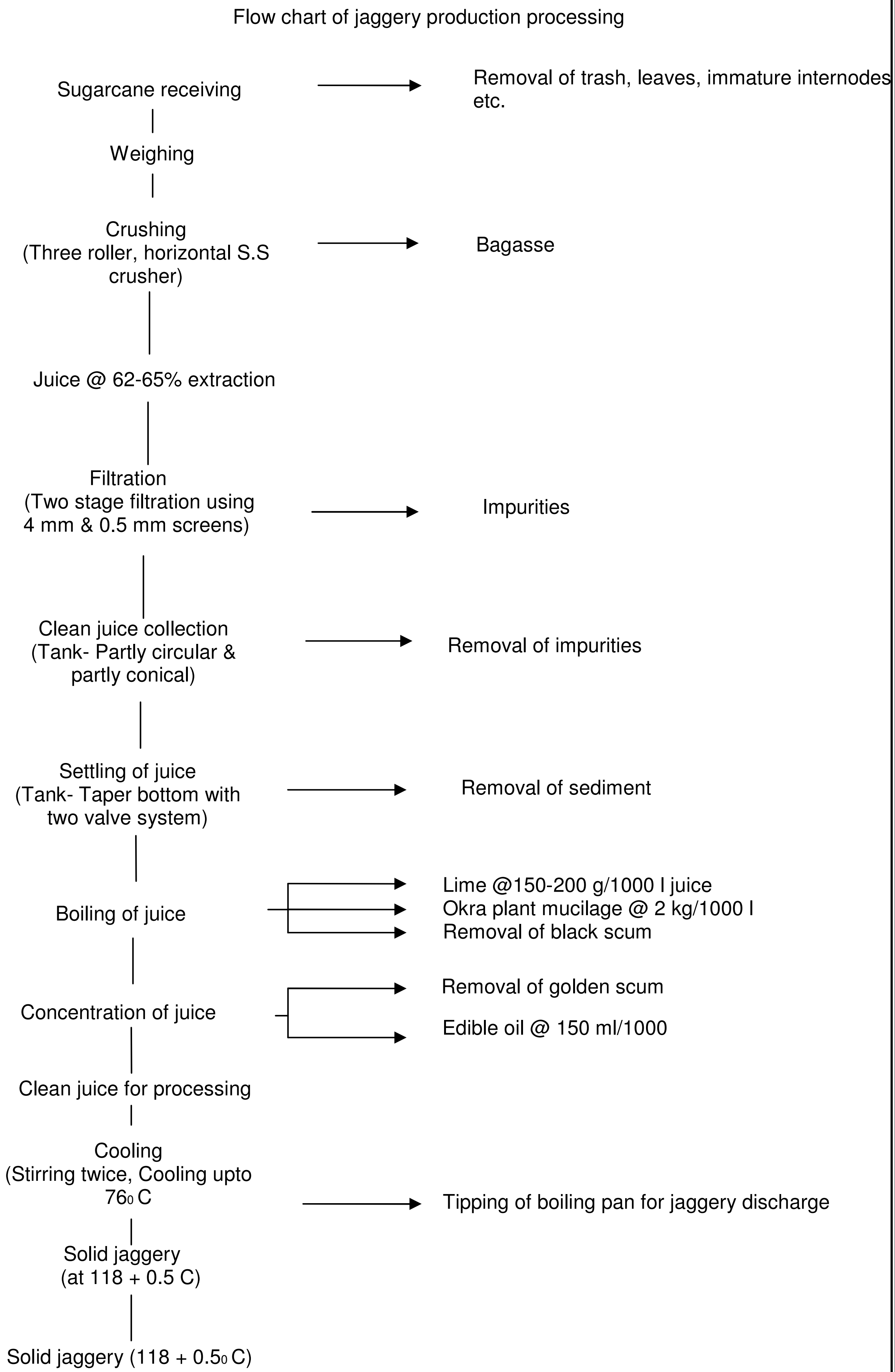

Fig. 1: Schemtic diagram of jaggery processing established at Jaggery Park, ARS, Ssankeshwar

$$\bar{y} = 1/n \left(\sum_{i=1}^{n} y_i\right)$$

Where,

$\bar{y}$ = Population mean

y_i = Individual value

n = Number of observations

3.4.2 Analysis of Variance

The data were subjected to statistical analysis as indicated below.

The analysis of variance was carried out to assess the variability present among the genotypes evaluated. The general format of ANOVA is as follows (Sundaraj *et al.*, 1972).

ANOVA for RCBD

Source of Variation	Degrees of freedom	MSS	Expected mean sum of squares
Replication (r)	r-1	MSSr	$\sigma_e^2 + g\sigma_r^2$
Genotypes (v)	g-1	MSSg	$\sigma_e^2 + r\sigma_g^2$
Error	(r-1) (g-1)	MSSe	σ_e^2
Total	rg-1		

Where,

g = Number of genotypes

r = Number of replications.

MSS = Mean sum of squares

RMSS = Mean sum of squares due to replication

VMSS = Mean sum of squares due to genotype

EMSS = Mean sum of squares due to error

σ_g^2 = genotypic variance

σ_e^2 = error variance

The test of significance was carried out by referring to the 'F' table value at 1 and 5 per cent significance level (Fisher and Yates, 1963).

3.4.3 Critical difference (CD)

In order to compare the means of various entries CD was calculated by using the formula,

CD at 5 per cent = SE (d) x t at 5%

CD at 1 per cent = SE (d) x t at 1%

3.4.4 Standard error of difference SE (d)

$$SE(d) = \sqrt{(2X \text{ Error MSS})/r} \times \text{table } t$$

Where,

t = the table value at 5 per cent or 1 per cent probability level

r = number of replications.

3.4.5 Estimation of genetic parameters

The various genetic parameters *viz.,* genotypic variance (σ_g^2), phenotypic variance (σ_p^2), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance (GA) were estimated as follows.

3.4.5.1 Genotypic and phenotypic variance

$$\text{Genotypic variance } (\sigma_g^2) = \frac{\text{MSS (genotype) - MSS (error)}}{\text{Number of replications}}$$

$$\text{Phenotypic variance } (\sigma_p^2) = \sigma_g^2 + \text{MSS (error).}$$

3.4.5.2 Genotypic and phenotypic coefficient of variation

Both genotypic and phenotypic coefficients of variation were estimated as suggested by Burton (1952).

$$\text{Genotypic coefficient of variability (GCV)} = \frac{\text{Genotypic Standard deviation}}{\text{Grand mean of the character}} \times 100$$

$$\text{Phenotypic coefficient of variability (PCV)} = \frac{\text{Phenotypic Standard deviation}}{\text{Grand mean of the character}} \times 100$$

GCV and PCV were classified (Shivasubramanian and Menon, 1973) as below.

0-10 per cent = Low

10-20 per cent = Moderate

21 per cent and above = High

3.4.5.3 Heritability in broad sense (%)

Heritability (h^2) in broad sense was estimated as suggested by Hanson *et al.* (1963) and expressed in per cent.

$$h^2 \text{ (broad sense)} = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

As suggested by Robinson *et al.* (1949), h^2 broad sense estimates were categorized as follows:

0-30 per cent = Low

31-60 per cent = Moderate

61 per cent and above = High

3.4.5.4 Genetic advance as per cent mean (GAM)

Genetic advance as per cent mean (Johnson *et. al.*, 1955).

$$GA = (h^2 \sigma_p K / \text{mean}) \times 100$$

Where,

h^2 = Heritability

K = Selection differential which is equal to 2.06 at 5 per cent intensity of selection (Lush, 1949).

σ_p = Phenotypic standard deviation.

Genetic estimates	Low	Moderate	High	Author
GAM	0-10 %	10-20 %	20 per cent and above	Johnson *et al.* (1955)

3.4.5.5 Standardized range

It can be calculated by using the formula

$$\text{Standardized range} = \frac{\text{Range}}{\text{Mean}}$$

3.4.6 Inter character correlation

Simple correlation coefficients were calculated to determine the degree of association of different characters with cane yield and also among yield components in each of the populations separately. Correlation coefficients were compared against Table 'r' values (Fisher and Yates, 1963) at (n-2) degrees of freedom at the probability levels 0.05 and 0.01 to test their significance.

Simple correlation was computed by using the formula give by Weber and Moorthy (1952) as given below.

$$r = \frac{\text{Cov xy}}{\sqrt{V \times Vy}}$$

Where,

Cov xy = Covariance between the characters x and y

Vx = Variance of the character x

Vy = Variance of the character y

3.4.7 Inter-stage Correlations (Repeatability)

Inter-stage correlations were computed to determine the associations among clonal I, clonal II, clonal III (INT) and clonal III (ORG) generations for various selection traits.

The repeatability estimates ($r_{p(x)}$) were obtained between crops and between selection stages. According to Falconer and Mackay (1996), rp(x) determines the upper boundary of the broad-sense heritability (h^2), and was estimated using the following expression:

$$r_{p(x)} = \frac{V_G + V_{EP}}{V_P}$$

Where represents the repeatability of trait *x*, V_G represents the genetic variance, V_{EP} is the *P*(*x*) r permanent environmental variance and V_P is the phenotypic variance.

4. EXPERIMENTAL RESULTS

The experimental results of the present investigation during 2015-16 are presented in following three subheads

4.1 Assessment of genetic variability parameters in selected early clonal populations.

4.2 To study Inter and intra stage repeatability/association for various productivity traits in the population.

4.3 Identification of suitable genotypes for organic/chemical free jaggery production

4.1 Assessment of genetic variability parameters in selected early clonal populations.

4.1.1 Genetic variability parameters for various traits in clonal III generation under integrated environment at Sankeshwar

Analysis of variance showed that source of variation due to blocks showed non significant, which indicates blocks are homogenous (Table 3). The clones studied differed significantly for characters *viz.*, germination count at 30 DAP, TS at 90 DAP, TS at 120 DAP, CFS at 120 DAP, average IL (cm), average NI (cm), NMC/ha , average SCW (kg), green top yield (t/ha), CG (cm), harvest index (%), average brix (%) at 8th month, average brix (%) at 10th month, average brix (%) at harvest, sucrose at 8th month, sucrose (%) at 10th month, sucrose (%) at harvest, CCS (%) at harvest, juice extraction (%) at harvest, purity (%) at harvest, cane yield (t/ha), CCS yield (t/ha) and brix yield (t/ha).

The mean, range, genotypic and phenotypic coefficients of variability, heritability estimates and GAM predicted as per cent of mean in respect of all these traits are given in Table 4.

4.1.1.1 Germination percent at 30 DAP

The germination count exhibited higher variability among 38 clones tested under integrated environment. Mean values ranging from 8.50 (SNK10194) to 125.00 (SNK10243) with a overall mean of 58.21.

Estimates of genotypic and phenotypic coefficient of variations were high (37.22 % and 40.35 % respectively) for this character. It showed high heritability estimate of 85.11 (%) as well as high genetic advance as per cent mean of 70.74 per cent.

4.1.1.2 Total Shoots at 90 DAP

It was observed that the trait had a general mean of 115.80 with range of 21.86 (SNK10194) to 181.48 (SNK10243) revealing good amount of variation exist among the genotypes under study.

There was relative difference between genotypic (31.09 %) and phenotypic (34.31 %) coefficient of variation recorded with high heritability (82.12 %) coupled with moderate genetic advance (58.04) as per cent mean.

4.1.1.3 Total Shoots at 120 DAP

According to the data shown by this character, the mean total shoots were 102.01 with a range of 24.64 (SNK10194) to 156.06 (SNK10149) indicating higher variability.

The genotypic (27.54 %) and phenotypic (29.93 %) coefficients of variation, heritability (84.67 %) and GAM (52.20 %) for the character under study were found high.

Table 3: Analysis of variance for different characters of sugarcane genotypes at sankeshwar (Integrated Environment)

Source	df	Germination %	Total number shoots at 90 DAP	Total number shoots at 120 DAP	Cane formed shoots at 120 DAP	Average number of internodes at harvest	Average internodal length at harvest	Number of millable canes ('000 ha^{-1})	Single cane weight (kg)	Green top yield (t ha^{-1})	Cane girth (cm)	Harvest index %
Genotype	40	1021.07**	2874.48*	1721.49*	293.055**	10.005**	3.461**	205.113**	0.184**	14.268**	0.131**	7.614**
Replication	1	155.72	1226.70	797.36	51.356	0.780	1.913	16.081	0.028	9.562	0.059	6.732
Error	40	82.12	282.13	142.87	47.205	2.905	0.682	23.913	0.028	3.968	0.049	1.662
S.Em.		6.41	11.88	8.45	4.86	1.21	0.58	3.46	0.12	1.41	0.16	0.91
CD at 5%		18.31	33.95	24.16	13.89	3.45	1.67	9.88	0.34	4.03	0.45	2.61

Source	df	Brix % at 8 months	Brix % at 10 months	Brix % at harvest	Sucrose % at 8 month	Sucrose % at 10 month	Sucrose % at harvest	CCS % at harvest	Juice extraction % at harvest	Purity % at harvest	Cane yield (t ha^{-1})	CCS yield (t ha^{-1})	Brix yield (t ha^{-1})
Genotype	40	3.744**	2.552**	1.765*	9.457**	3.804**	3.314**	2.50**	25.84**	28.865**	557.892**	8.921**	22.93*
Replication	1	2.170	0.095	2.900	4.219	0.020	4.084	16.69	1.62	179.300	240.18	1.132	2.97
Error	40	0.698	0.656	0.729	1.261	0.676	1.120	0.51	4.56	7.315	59.160	3.011	3.56
S.Em.		0.59	0.57	0.60	0.79	0.58	0.75	0.50	1.51	1.91	5.44	1.23	1.33
CD at 5%		1.69	1.64	1.73	2.27	1.66	2.14	1.44	4.31	5.47	15.55	3.51	3.81

* - Significant of probability at 5%
** - Significant of probability at 1%

Table 4: Estimation of genetic parameters for twenty three characters in sugarcane at sankeshwar (Integrated Environment)

Sl. No.	characters	Mean	Range		PCV (%)	GCV (%)	Heritability (%)	Genetic advance	GAM (%)
			Min	Max					
1	Germination %	58.21	8.50	125.00	40.35	37.22	85.11	41.18	70.74
2	Total shoots at 90 DAP	115.80	21.86	181.48	34.31	31.09	82.12	67.21	58.04
3	Total shoots at 120 DAP	102.01	24.64	156.06	29.93	27.54	84.67	53.26	52.20
4	Cane formed shoots at 120 DAP	39.85	6.94	62.11	32.73	27.82	72.25	19.41	48.72
5	Average number of internodes at harvest	24.10	19.50	29.50	10.54	7.82	54.99	2.88	11.94
6	Average internodal length at harvest	9.61	7.77	13.12	14.98	12.27	67.10	1.99	20.71
7	Number of millable canes ('000 ha^{-1})	53.36	35.10	88.20	20.05	17.84	79.12	17.44	32.68
8	Single cane weight (kg)	1.77	1.25	2.78	18.43	15.82	73.69	0.49	27.98
9	Green top yield (t ha^{-1})	10.70	5.57	17.86	28.22	21.21	56.48	3.51	32.84
10	Cane girth (cm)	3.01	2.54	3.78	9.99	6.73	45.33	0.28	9.33
11	Harvest index %	89.69	84.62	93.91	2.40	1.92	64.17	2.85	3.17
12	Brix % at 8 months	15.40	12.27	17.95	9.67	8.01	68.59	2.11	13.67
13	Brix % at 10 months	19.86	16.63	21.89	6.38	4.90	59.11	1.54	7.76
14	Brix % at harvest	22.22	20.22	24.67	5.03	3.24	41.53	0.96	4.30
15	Sucrose % at 8 month	12.36	7.58	16.30	18.72	16.37	76.47	3.65	29.50
16	Sucrose % at 10 month	17.76	12.63	20.12	8.43	7.04	69.82	2.15	12.12
17	Sucrose % at harvest	19.54	14.67	22.19	7.62	5.36	49.49	1.52	7.77
18	Commercial cane sugar (%) @ Harvest	13.48	8.64	15.47	9.10	7.41	66.24	1.67	12.42
19	Juice extraction (%)	48.86	41.66	58.75	7.98	6.68	70.03	5.62	11.51
20	Brix yield (t ha^{-1})	20.53	12.94	26.65	17.72	15.15	73.11	5.48	26.69
21	Purity (%)	87.92	67.54	92.63	4.84	3.73	59.57	5.22	5.94
22	Cane yield (t ha^{-1})	92.72	56.56	132.00	18.94	17.03	80.83	29.25	31.54
23	CCS yield (t ha^{-1})	12.43	7.47	16.38	19.65	13.83	49.53	2.49	20.04

4.1.1.4 Cane formed Shoots at 120 DAP

As per the data recorded for this attribute, the mean total shoots were 39.85with a range of 6.94 (SNK10148) to 62.11 (SNK10248) indicating higher variability for the character.

The genotypic (27.82 %) and phenotypic (32.73 %) coefficients of variation differed negligibly evidencing high estimates of heritability (72.25 %) and GAM was (48.72 %).

4.1.1.5 Average number of internodes at harvest

Number of internodes varied between 19.50 (SNK10246) to 29.50 (SNK10046) with a mean number of 24.10.

The character showed relatively low GCV (7.82 %) and moderate PCV (10.54 %) coupled with moderate heritability estimate (54.99 %) and genetic advance as per cent mean (11.94 %).

4.1.1.6 Average number of intermodal length at harvest

The internodal length imparted higher variability with mean values ranging from 7.77 (SNK10184) to 13.12 (SNK10246) and with overall mean of 9.61 cm.

A moderate genotypic (12.27 %) and phenotypic (14.98 %) coefficients of variation were observed for number of intermodal length. This attribute exhibited high heritability estimate (67.10 %) with high GAM (20.71 %).

4.1.1.7 Number of millable cane at harvest ('000/ha)

According to the data recorded by this character, the variation for this trait was considerably high as evident from the wide range observed 35.10 (SNK10141) to 88.20 (SNK10245) and other top three genotypes were 79.30 (SNK 10248), 67.37 (SNK 10232) and 65.46 (SNK 10286). The mean were 53.36.

The GCV is moderate to the extent of (17.84 %) and PCV were high (20.05 %) respectively. It showed high heritability estimate (79.12 %) coupled with high genetic advance as per cent mean of 32.68 per cent.

4.1.1.8 Average single cane weight at harvest

According to the data recorded by this character, the mean single cane weight of the population was 1.77 kg and the population showed a range of 1.25 kg (SNK10167) to as high as 2.78 kg (SNK10274). With respect to GCV and PCV, the character showed relatively moderate GCV (15.82 %) and PCV (18.43 %) with high heritability of 73.69 per cent coupled with high per cent of GAM (27.98).

4.1.1.9 Green top yield (t ha^{-1})

As per the data recorded for this trait, the mean green top yield were 10.71 t ha^{-1} with a range of 5.57 t ha^{-1} (SNK10155) to 17.86 t ha^{-1} (SNK10263) indicating high variability for the character under study.

The character showed relatively high genotypic (21.21 %) and phenotypic (28.22 %) coefficients of variation coupled with moderate estimates of heritability (56.48 %) and high GAM was (32.84 %).

4.1.1.10 Average cane girth (cm)

As per the data recorded for this attribute the mean cane girth of the population was 3.01 cm with a range from 2.54 cm (SNK10245) to as high as 3.78 cm (SNK10274) which is evident for the presence of high variability.

The character showed relatively low GCV (6.73 %) and PCV (9.99 %) with moderate heritability of 45.33 per cent coupled with 9.33 per cent of low GAM.

4.1.1.11 Harvest index (%)

As per the data recorded for this trait, it showed a low variability with a range from 84.62 (SNK 10263) to 93.91 (SNK 10155) per cent with a mean of 89.69.

The GCV and PCV were very low to the extent of (1.92 %) and (2.40 %) respectively. It showed high heritability estimate 64.17 %, along with very low genetic advance as per cent mean 3.17 per cent.

4.1.1.12 brix per cent at 8 month

The character showed mean brix per cent of 15.40 and ranging from 12.27 (SNK 10274) to 17.95 (SNK 10167) per cent.

It was also recorded that the genotypic and phenotypic values (8.01 % and 89.67 % respectively) were low and there was a highest heritability estimates of 68.59 % coupled with moderate GAM (13.67 %).

4.1.1.13 brix per cent at 10 month

The data from juice analysis indicated that juice brix of different genotypes varied from 16.63 (SNK 10274) per cent to 21.89 (SNK 10260) per cent with a mean brix of 19.86 per cent which indicated the considerable variability for the juice brix present among the genotypes.

GCV (4.90 %) and PCV (6.38 %) were found to be low. Further the heritability estimate (59.11 %) and genetic advance as per cent mean (7.76 %) were also found to be low for this trait.

4.1.1.14 brix per cent at harvest

The data recorded for this trait shown good variability ranges from 20.22 (SNK 10274) to 24.67 (Co C 671) per cent with the average mean of 22.22 per cent.

The GCV (3.24 %) and PCV (5.03 %) were observed very low. There was a moderate amount of heritability estimate (41.53 %) noticed coupled with low genetic advance as per cent mean (4.30 %).

4.1.1.15 sucrose per cent at 8 month

It was observed that the trait had a general mean of 12.36 per cent with range of 7.58 per cent (SNK 10274) to 16.30 per cent (SNK 10167) revealing good amount of variation exists among the genotypes under study.

There was negligible difference between genotypic (16.37 %) and phenotypic (18.72 %) coefficient of variation recorded with high heritability (76.47 %) coupled with high genetic advance (29.50 %) as per cent mean.

4.1.1.16 sucrose per cent at 10 month

As per the data recorded for this attribute, the mean sucrose per cent at 10 month value ranges between 12.63 per cent (SNK 10274) to 20.12 per cent (SNK 10260) with an average of 17.76 per cent which is a evident for existence of high variability.

The data showed low GCV (7.04 %) and PCV (8.43 %) in the population respectively. The heritability estimate was high as 69.82 % with the moderate genetic advance as per cent mean of 12.12 per cent.

4.1.1.17 sucrose per cent at harvest

The general mean of 19.54 per cent with mean values ranging from 14.67 per cent (SNK 10194) to 22.19 per cent (Co C 671) were observed revealing good amount of variation among the genotypes for pol per cent.

Lower values of GCV (5.36 %) and PCV (7.62 %) with moderate heritability estimate (49.49 %) coupled with low GAM (7.77 %) were recorded for the pol per cent.

4.1.1.18 Commercial Cane Sugar (%) at harvest

CCS per cent ranged from 8.64 per cent (SNK 10194) to 15.47 per cent (Co C 671) with an average of 13.48 per cent.

Lower value of GCV (7.41 %), PCV (9.10 %) and high heritability of 66.24 per cent coupled with moderate GAM (12.42 %) were recorded for this character.

4.1.1.19 Juice extraction per cent at harvest

According to the data of this trait recorded, the mean values ranging from 41.66 (SNK 10179) per cent to 58.75 per cent (SNK 10280) with an average value of 48.86 depicts the presence of good amount of variability among the genotypes.

The GCV and PCV were relatively low as 6.68 per cent and 7.98 per cent. The estimated heritability was high (70.03 %) coupled with moderate of genetic advance as per cent mean (12.42).

4.1.1.20 Purity per cent at harvest

According to the data of this trait recorded, the mean values ranging from 67.54 (SNK 10194) per cent to 93.24 per cent (Co 86032) with an average value of 87.92, which is evident for the presence of good amount of variability among the genotypes.

The GCV and PCV were relatively low as 3.73 per cent and 4.84 per cent noticed. The estimated heritability was nearer to high (59.57 %) coupled with low 5.94 % of genetic advance as per cent mean.

4.1.1.21 Cane yield (t ha^{-1})

Wide variability was noticed for cane yield with a range of 56.56 t ha^{-1} (SNK 10176) to 132t ha^{-1} (SNK 10274) and other three genotypes are 118.00 t ha^{-1} (SNK 10194), 117.50 t ha^{-1} (SNK 10232) and 117.00 t ha^{-1} (SNK 10248) with a mean of 92.72 t ha^{-1}.

The genotypic and phenotypic coefficient of variation was moderate as (17.03 %) and (18.94 %) respectively. A high heritability estimate of 80.83 % with high genetic advance of 31.54 % was observed to this character.

4.1.1.22 CCS yield (t ha^{-1})

The overall CCS yield per hectare observed ranged from 7.47 t ha^{-1}(SNK 10176) to 16.38 t ha^{-1} (SNK 10274) and other three genotypes are 15.81 t ha^{-1} (SNK 10243), 15.75 t ha^{-1} (SNK 10248) and 15.25 t ha^{-1} (SNK 10248) with a mean of 29.22 t ha^{-1}.

Moderate genotypic (13.83 %) and phenotypic (19.65 %) coefficient of variation was recorded. A moderate heritability estimate of 49.53 per cent with high genetic advance of 20.04 per cent was recorded.

4.1.1.23 brix yield (t ha^{-1})

The general mean of 20.53 t ha^{-1} with mean values ranging from 12.94 t ha^{-1} (SNK 10176) to 26.65 t ha^{-1} (SNK 10248) and other three genotypes are 26.43 t ha^{-1} (SNK 10274), 25.82 t ha^{-1} (SNK 10194) and 25.55 t ha^{-1} (SNK 10245) were observed revealing high variation among the genotypes.

Moderate values of GCV (15.15 %) and PCV (17.72 %) with high heritability estimate (73.11 %) coupled with high GAM (26.69 %) was recorded for this trait.

4.1.2 Genetic variability parameters for various traits in jaggery under integrated environment at Sankeshwar

Analysis of variance for ten taits included in study is presented in the (Table 5). The clones studied differed significantly for characters *viz.*, single cane weight (kg), optical density, ash content (%), non-reducing sugar (%), reducing sugar (%), total sugar (%), juice extraction (%), jaggery recovery (%) and jaggery yield (t/ha).

Though mean, range, genotypic and phenotypic coefficients of variability, heritability estimates and GAM predicted as per cent of mean in respect of all these traits are given in (Table 6).

4.1.2.1 Single cane weight (kg)

The single cane weight exhibited higher variability among 20 clones tested under integrated environment. Mean values ranging from 1.45 (SNK10245) to 2.52 (SNK10194) with a overall mean of 1.85.

Estimates of genotypic and phenotypic coefficient of variations were moderate (13.51 % and 16.97 % respectively) for this character. It showed high heritability estimate of 63.35 (%) well as high genetic advances as per cent mean of 22.14 per cent

4.1.2.2 Jaggery pH

The data recorded for this trait shown low variability ranges from 4.58 (SNK 10232) to 5.42 (SNK 10245) with the average mean of 4.86.

The GCV (6.16 %) and PCV (17.06 %) were observed very low to moderate respectively. There was a low amount of heritability estimate (17.06 %) noticed coupled with low genetic advance as per cent mean (2.16 %).

4.1.2.3 Optical density

The character showed mean of 0.68 and ranging from 0.34 (Co 92005) to 0.94 (SNK 10199).The genotypic and phenotypic values (22.90 % and 36.91 % respectively) were high and there was a moderate heritability estimates of 38.47 (%) coupled with high GAM (29.25 %).

4.1.2.4 Ash content (%)

As per the data recorded for this trait, it showed a low variability with a range from 3.70 (SNK 10148) to 5.56 (SNK 10286) per cent with a mean of 4.55.

The GCV and PCV were from low to moderate extent of (1.84 %) and (16.26 %) respectively. It showed low heritability estimate 1.28 (%), along with very low genetic advance as per cent mean 0.43 per cent.

4.1.2.5 Non reducing sugar (%)

As per the data recorded for this trait, the mean non reducing sugar were 80.60 per cent with a range of 75.74 (SNK10058) to 86.13 per cent (Co 86032) indicating high variability for the character under study.

Table 5: Analysis of variance for ten jaggery characters in sugarcane at Sankeshwar (Integrated Environment)

Source	df	Single cane weight (kg)	Jaggery pH	Optical Density	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)	Juice extraction %	Jaggery recovery %	Jaggery yield (t ha^{-1})
Genotype	19	0.16**	0.10#	0.09*	0.553#	14.358*	4.471**	14.640*	43.288**	2.795**	2.545*
Replication	1	0.02	0.09	0.05	0.093	20.762	0.372	15.573	25.031	2.798	0.359
Error	19	0.04	0.07	0.04	0.539	6.580	0.540	6.152	11.634	0.642	1.053
S.Em.		0.13	0.19	0.14	0.52	1.81	0.52	1.75	2.41	0.57	0.73
CD at 5%		0.40	0.57	0.41	1.54	5.37	1.54	5.19	7.14	1.68	2.15
CV		10.27	5.61	28.96	16.15	3.18	6.50	2.70	6.67	9.73	12.18

* - Significant of probability at 5%
** - Significant of probability at 1%
# - non Significant

Table 6: Estimation of genetic parameters for ten jaggery characters at Sankeshwar (Integrated Environment)

Sl. No	Characters	Mean	Range		PCV (%)	GCV (%)	Heritabiliy (%)	Genetic advance	GAM (%)
			Min	Max					
1	Single cane weight (kg)	1.85	1.45	2.52	16.97	13.51	63.35	0.41	22.14
2	Jaggery pH	4.86	4.58	5.42	6.16	2.54	17.06	0.11	2.16
3	Optical Density	0.68	0.34	1.13	36.91	22.90	38.47	0.20	29.25
4	Ash content (%)	4.55	3.70	5.56	16.26	1.84	1.28	0.02	0.43
5	Non reducing sugar (%)	80.60	75.74	86.13	4.01	2.45	37.15	2.48	3.07
6	Reducing sugar (%)	11.30	9.45	13.97	14.01	12.41	78.46	2.56	22.64
7	Total Sugars (%)	91.90	86.66	95.58	3.51	2.24	40.82	2.71	2.95
8	Juice extraction %	51.16	43.78	60.35	10.24	7.78	57.64	6.22	12.16
9	Jaggery recovery %	8.24	6.17	10.72	15.91	12.60	62.65	1.69	20.54
10	Jaggery yield (t ha^{-1})	8.42	7.00	10.98	15.92	10.25	41.47	1.15	13.60

The character showed relatively low genotypic (2.45 %) and phenotypic (4.01 %) coefficients of variation coupled with moderate estimates of heritability (37.15 %) and low GAM was (3.07 %).

4.1.2.6 Reducing sugar (%)

As per the data recorded for this attribute, the mean were 11.30 with a range of 9.45 (Co 86032) to 13.97 (SNK10232) indicating higher variability for the character.

The genotypic (12.41 %) and phenotypic (14.01 %) coefficients of variation differed negligibly evidencing high estimates of heritability (78.46 %) and GAM was (22.64 %).

4.1.2.7 Total sugar (%)

As per the data recorded for this trait, it showed a moderate variability with a range from 86.66 (SNK 10194) to 95.58 (Co 86032) per cent with a mean of 91.90.

The GCV and PCV were very low to the extent of (2.24 %) and (3.51 %) respectively. It showed moderate heritability estimate (40.82 %) along with very low genetic advance as per cent mean 2.95 per cent.

4.1.2.8 Juice extraction (%)

The data recorded for this trait shown moderate variability ranges from 43.78 (SNK 10245) to 60.35 (SNK 10286) with the average mean of 51.16.

The GCV (7.78 %) and PCV (10.24 %) were observed very low to moderate respectively. There was a moderate amount of heritability estimate (57.64 %) noticed coupled with genetic advance as per cent mean (12.16 %).

4.1.2.9 Jaggery recovery (%)

It was observed that the trait had a general mean of 8.24 per cent with range of 6.17 per cent (SNK 10199) to 10.72 per cent (CoC 671) revealing good amount of variation exist among the genotypes under study.

There was relative difference between genotypic (12.60 %) and phenotypic (15.91 %) coefficient of variation recorded with high heritability (62.65 %) coupled with high genetic advance (20.54 %) as per cent mean.

4.1.2.10 Jaggery yield (t ha^{-1})

The general mean of 8.42 t $ha^{-1}$with mean values ranging from 7 t ha^{-1} (SNK 10199) to 10.98 t ha^{-1} (SNK 10241) were observed revealing good amount of variation among the genotypes for Jaggery yield.

Moderate values of GCV (10.25 %) and PCV (15.92 %) with moderate heritability estimate (41.47 %) coupled with GAM (13.60 %) were recorded for Jaggery yield.

4.1.3 Genetic variability parameters for various traits in clonal III generation under organic environment at Sankeshwar

4.1.3.1 Germination percent at 30 DAP

The germination count exhibited higher variability (Table 7) among 38 clones tested under organic environment. Mean values ranging from 16.00 (SNK10148) to 90.00 (SNK10303) with a overall mean of 55.30.

Table 7: Analysis of variance for different characters of sugarcane genotypes at sankeshwar (organic Environment)

Source	df	Germination %	Total number shoots at 90 DAP	Total number shoots at 120 DAP	Cane formed shoots at 120 DAP	Average number of internodes at harvest	Average internodal length at harvest	Number of millable canes ('000 ha^{-1})	Single cane weight (kg)	Green top yield (t ha^{-1})	Cane girth (cm)	Harvest index %
Genotype	40	481.05*	904.39**	814.41**	237.520**	8.731**	2.47**	205.178**	0.107**	13.771*	0.092**	9.415**
Replication	1	119.52	339.32	390.97	136.152	0.11	1.77	9.689	0.048	18.833	0.016	5.871
Error	40	258.05	84.47	125.06	50.462	1.98	0.58	38.420	0.014	2.732	0.031	2.521
S.Em.		11.36	6.50	7.91	5.02	1.00	0.54	4.38	0.08	1.17	0.12	1.12
CD at 5%		32.47	18.58	22.60	14.36	2.85	1.55	12.53	0.24	3.34	0.35	3.21

Source	df	Brix % at 8 months	Brix % at 10 months	Brix % at harvest	Sucrose % at 8 month	Sucrose % at 10 month	Sucrose % at harvest	CCS % at harvest	Juice extraction % at harvest	Purity % at harvest	Cane yield (t ha^{-1})	CCS yield (t ha^{-1})	Brix yield (t ha^{-1})
Genotype	40	3.37**	4.14**	2.10**	7.56**	4.78**	3.31**	1.77**	32.34*	11.88**	570.78**	10.00**	28.20**
Replication	1	1.12	0.92	1.40	1.32	1.23	4.08	2.03	86.60	44.92	14.47	4.34	0.03
Error	40	0.40	0.35	0.59	0.80	0.50	1.12	0.51	22.67	11.69	60.05	1.53	3.56
S.Em.		0.45	0.42	0.55	0.63	0.50	0.55	0.50	3.37	2.42	5.48	0.88	1.34
CD at 5%		1.29	1.20	1.56	1.81	1.44	1.56	1.44	9.62	6.91	15.66	2.51	3.82

* - Significant of probability at 5%
** - Significant of probability at 1%

Estimates of genotypic and phenotypic coefficient of variations were high 26.10 and 34.76 (%) respectively for this character. It showed moderate heritability estimate of 30.17 (%) as well as high genetic advance as per cent mean of 21.60 per cent (as shown in Table 8).

4.1.3.2 Total Shoots at 90 DAP

It was observed that the trait had a general mean of 65.76 with range of 18.04 (SNK10246) to 105.14 (SNK10303) revealing good amount of variation exist among the genotypes under study.

There was relative difference between genotypic (30.79 %) and phenotypic (33.81 %) coefficient of variation recorded with high heritability (82.91 %) coupled with high genetic advance (57.76) as per cent mean.

4.1.3.3 Total Shoots at 120 DAP

According to the data shown by this character, the mean total shoots were 72.70 with a range of 26.72 (SNK10194) to 129.08 (SNK10303) indicating higher variability.

The genotypic (25.54 %) and phenotypic (29.81 %) coefficients of variation, heritability (73.38 %) and GAM (45.06 %) for the character under study were found high.

4.1.3.4 Cane formed Shoots at 120 DAP

As per the data recorded for this attribute, the mean total shoots were 29.96with a range of 7.63 (SNK10148) to 53.44 (SNK10303) indicating higher variability for the character.

With respect to GCV and PCV, the character showed relatively high GCV (32.28 %) and PCV (40.05 %) with high heritability of 64.95 per cent coupled with high per cent of GAM (53.59).

4.1.3.5 Green top yield (t ha^{-1})

As per the data recorded for this trait, the mean green top yield were 8.62 t ha^{-1} with a range of 3.99 t ha^{-1} (SNK10046) to 16.79 t ha^{-1} (SNK10134) indicating high variability for the character under study.

The character showed relatively high genotypic (27.25 %) and phenotypic (33.32 %) coefficients of variation coupled with moderate estimates of heritability (66.89 %) and high GAM was (45.92 %).

4.1.3.6 Average cane girth (cm)

As per the data recorded for this attribute the mean cane girth of the population was 2.85cm with a range from 2.50cm (SNK10245) to as high as 3.27cm (SNK10274) which is evident for the presence of high variability.

The character showed relatively low GCV (6.17 %) and PCV (8.71 %) with moderate heritability of 50.12 per cent coupled with 8.99 per cent of low GAM.

4.1.3.7 Harvest index (%)

As per the data recorded for this trait, it showed a low variability with a range from 86.04 (SNK 10134) to 95.25 (SNK 10274) per cent with a mean of 90.20.

The GCV and PCV were very low to the extent of (2.06 %) and (2.71 %) respectively. It showed moderate heritability estimate (57.76 %), along with very low genetic advance as per cent mean 3.22 per cent.

4.1.3.8 brix per cent at 8 month

The character showed mean brix per cent of 16.99 and ranging from 13.86 (SNK 10194) to 19.56 (SNK 10162) per cent.

Table 8: Estimation of genetic parameters for twenty three characters in sugarcane at sankeshwar (organic Environment)

Sl. No.	Characters	Mean	Range		PCV (%)	GCV (%)	Heritability (%)	Genetic advance	GAM (%)
			Min	Max					
1	Germination %	55.30	16.00	90.00	34.76	26.10	56.40	11.95	21.60
2	Total number shoots at 90 DAP	65.76	18.04	105.14	33.81	30.79	82.91	37.98	57.76
3	Total number shoots at 120 DAP	72.70	26.72	129.08	29.81	25.54	73.38	32.76	45.06
4	Cane formed shoots at 120 DAP	29.96	7.63	53.44	40.05	32.28	64.95	16.06	53.59
5	Average number of internodes atharvest	23.35	20.50	27.50	9.91	7.86	62.96	3.00	12.85
6	Average internodal length at harvest	9.30	7.82	11.76	13.31	10.45	61.58	1.57	16.89
7	Number of millable canes ('000 ha^{-1})	54.11	39.88	75.50	20.40	16.87	68.46	15.56	28.76
8	Single cane weight (kg)	1.51	1.02	2.03	16.25	14.22	76.50	0.39	25.61
9	Green top yield (t ha^{-1})	8.62	3.99	16.79	33.32	27.25	66.89	3.96	45.92
10	Cane girth (cm)	2.85	2.50	3.27	8.71	6.17	50.12	0.26	8.99
11	Harvest index %	90.20	86.04	95.25	2.71	2.06	57.76	2.91	3.22
12	Brix % at 8 months	16.99	13.86	19.56	8.10	7.17	78.45	2.22	13.09
13	Brix % at 10 months	20.12	17.26	22.76	7.46	6.85	84.35	2.61	12.96
14	Brix % at harvest	22.84	20.14	24.92	5.09	3.79	55.60	1.33	5.83
15	Sucrose % at 8 month	14.79	9.84	18.11	13.84	12.43	80.74	3.40	23.01
16	Sucrose % at 10 month	17.39	14.87	21.03	9.35	8.41	80.89	2.71	15.58
17	Sucrose % at harvest	20.71	17.67	23.14	6.22	4.98	64.02	1.70	8.21
18	CCS % at harvest	14.51	12.17	16.37	7.36	5.49	55.61	1.22	8.43
19	Juice extraction % at harvest	45.10	37.98	53.91	11.63	4.88	17.59	1.90	4.21
20	Purity % at harvest	90.72	84.56	97.73	3.78	0.34	0.82	0.06	0.06
21	Cane yield (t ha^{-1})	81.26	51.46	110.00	21.86	19.66	80.96	29.62	36.45
22	CCS yield (t ha^{-1})	11.72	7.59	15.82	20.50	17.56	73.37	3.63	30.98
23	Brix yield (t ha^{-1})	18.51	11.89	25.19	21.53	18.96	77.57	6.37	34.40

It was also recorded that the genotypic and phenotypic values (7.17 % and 8.10 % respectively) were low and there was a high heritability estimates of 78.45 (%) coupled with moderate GAM (13.09 %).

4.1.3.9 brix per cent at 10 month

The data from juice analysis indicated that juice brix of different genotypes varied from 17.26 (SNK 10183) per cent to 22.76 (SNK 10162) per cent with a mean brix of 20.12 per cent which indicated the considerable variability for the juice brix present among the genotypes.

GCV (6.85 %) and PCV (7.46 %) were found to be low. It showed highest heritability estimate (84.35 %), along with very low genetic advance as per cent mean 12.96 per cent.

4.1.3.10 brix per cent at harvest

The data recorded for this trait shown good variability ranges from 20.14 (SNK 10194) to 24.92 (Co C 671) per cent with the average mean of 22.84 per cent.

The GCV (3.79 %) and PCV (5.09 %) were observed very low. There was a moderate amount of heritability estimate (55.60 %) noticed coupled with low genetic advance as per cent mean (5.83 %).

4.1.3.11 sucrose per cent at 8 month

It was observed that the trait had a general mean of 14.79 per cent with range of 9.84 per cent (SNK 10194) to 18.11 per cent (SNK 10162) revealing good amount of variation exists among the genotypes under study.

There was relative difference between genotypic (12.43 %) and phenotypic (13.84 %) coefficient of variation recorded with high heritability (80.74 %) coupled with high genetic advance (23.01 %) as per cent mean.

4.1.3.12 sucrose per cent at 10 month

As per the data recorded for this attribute, the mean sucrose per cent at 10 month value ranges between 14.87 per cent (SNK 10232) to 21.03 per cent (SNK 10162) with an average mean of 17.39 per cent which is a evident for existence of high variability.

The data showed low GCV (8.41 %) and PCV (9.35 %) in the population respectively. The heritability estimate was high as 80.89 % with the moderate genetic advance as per cent mean of 15.58 per cent.

4.1.3.13 sucrose per cent at harvest

The general mean of 20.71 per cent with mean values ranging from 17.67 per cent (SNK 10194) to 23.14 per cent (Co C 671) were observed revealing good amount of variation among the genotypes for pol per cent.

Lower values of GCV (4.98 %) and PCV (6.22 %) with high heritability estimate (64.02 %) coupled with moderate GAM (8.21 %) were recorded for the pol per cent.

4.1.3.14 Commercial Cane Sugar (%) at harvest

CCS per cent ranged from 12.17 per cent (SNK 10194) to 16.37 per cent (Co C 671) with an average of 14.51 per cent.

Lower value of GCV (5.49 %), PCV (7.36 %) and moderate heritability of 55.61 per cent coupled with moderate GAM (8.43 %) were recorded for this character.

4.1.3.15 Juice extraction per cent at harvest

According to the data of this trait recorded, the mean values ranging from 37.98 (SNK 10167) per cent to 53.91 per cent (SNK 10303) with an average value of 48.86 depicts the presence of good amount of variability among the genotypes.

The GCV and PCV were relatively low as 4.88 per cent and 11.63 per cent. The estimated heritability was low (17.59 %) coupled with low of genetic advance as per cent mean (4.21).

4.1.3.16 Purity per cent at harvest

According to the data of this trait recorded, the mean values ranging from 84.56 (SNK 10232) per cent to 97.73 per cent (SNK 10179) with an average value of 90.72, which is evident for the presence of good amount of variability among the genotypes.

The GCV and PCV were relatively low as 0.34 per cent and 3.78 per cent noticed. The estimated heritability was low (0.82 %) coupled with low (0.06 %) of genetic advance as per cent mean.

4.1.3.18 Cane yield (t ha^{-1})

Wide variability was noticed for cane yield with a range of 51.46 t ha^{-1} (SNK 10158) to 110 t ha^{-1} (SNK 10245) and other three genotypes are 107.50 t ha^{-1} (SNK10199), 107.50 t ha^{-1} (SNK 10303) and 105.00 t ha^{-1} (SNK 10274) with a mean of 81.26 t ha^{-1}.

The genotypic and phenotypic coefficient of variation was moderate to high as (19.66 %) and (21.86 %) respectively. A high heritability estimate of (80.96 %) with high genetic advance of 36.45 (%) was observed to this character.

4.1.3.19 CCS yield (t ha^{-1})

The overall CCS yield per hectare observed ranged from 7.59 t ha^{-1}(SNK 10158) to 15.82 t ha^{-1} (SNK 10245) and other three genotypes are 15.65 t ha^{-1} (SNK 10303) , 14.86 t ha^{-1} (SNK 10058) and 14.84 t ha^{-1} (SNK 10134) and with a mean of 11.72 t ha^{-1}.

Moderate to high genotypic (17.56 %) and phenotypic (20.50 %) coefficient of variation was recorded respectively. A high heritability estimate of 73.37 per cent with high genetic advance of 30.98 per cent was recorded.

4.1.3.20 brix yield (t ha^{-1})

The general mean of 18.51 t ha^{-1} with mean values ranging from 11.89 t ha^{-1} (SNK 10158) to 25.19 t ha^{-1} (SNK 10245) and other three genotypes are 25.18 t ha^{-1} (SNK 10303), 24.42 t ha^{-1} (SNK 10058) and 23.46 t ha^{-1} (SNK 10134) were observed revealing high variation among the genotypes.

Moderate to high values of GCV (18.96 %) and PCV (21.53 %) was recorded respectively. A high heritability estimate (77.57 %) coupled with high GAM (34.40 %) was recorded for this trait.

4.1.4 Genetic variability parameters for various traits in jaggery under organic environment at Sankeshwar

Analysis of variance for ten taits included in studyis presented in the (Table 9). The clones studied differed significantly for characters *viz*, single cane weight (kg), jaggery pH, optical density, ash content (%), non-reducing sugar (%), reducing sugar (%), total sugar (%), juice extraction (%), jaggery recovery (%) and jaggery yield (t/ha).

Table 9: Analysis of variance for ten jaggery characters in sugarcane at Sankeshwar. (Organic Environment)

Source	df	Single cane weight (kg)	Jaggery pH	Optical Density	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)	Juice extraction %	Jaggery recovery %	Jaggery yield (t ha^{-1})
Genotype	19	0.10*	0.28#	0.12*	0.392*	15.367*	2.890*	9.567*	65.371*	3.046**	4.002*
Replication	1	0.09	0.07	0.12	0.745	7.712	4.351	0.207	57.206	1.865	1.963
Error	19	0.04	0.08	0.05	0.173	6.303	1.221	4.146	23.987	0.999	1.663
S.Em.		0.42	0.20	0.16	0.87	1.78	0.78	1.44	3.46	0.71	0.91
CD at 5%		0.14	0.59	0.48	.29	5.25	2.31	4.26	10.25	2.09	2.70
CV		12.81	5.68	23.31	9.93	3.10	8.79	2.19	9.98	11.75	13.91

* - Significant of probability at 5%
** - Significant of probability at 1%
# - non Significant

Table 10: Estimation of genetic parameters for ten Jaggery characters in sugarcane at Sankeshwar.(Organic Environment)

Sl. No.	Characters	Mean	Range		PCV (%)	GCV (%)	Heritability (%)	Genetic advance	GAM (%)
			Min	Max					
1	Single cane weight (kg)	1.57	1.22	1.92	16.64	10.63	40.79	0.22	13.98
2	Jaggery pH	4.96	4.35	6.12	8.57	6.41	55.99	0.49	9.88
3	Optical Density	0.69	0.44	1.32	42.43	26.28	38.35	0.23	33.52
4	Ash content (%)	4.19	3.39	5.02	12.69	7.90	38.76	0.42	10.14
5	Nonreducingsugar (%)	80.98	76.43	86.06	4.06	2.63	41.83	2.84	3.50
6	Reducing sugar (%)	12.57	10.68	15.11	11.41	7.27	40.61	1.20	9.54
7	Total Sugars (%)	93.54	89.11	96.33	2.82	1.77	39.53	2.13	2.29
8	Juice extraction %	49.09	38.99	60.24	13.62	9.27	46.31	6.38	12.99
9	Jaggery recovery %	8.50	6.70	10.76	16.72	11.90	50.62	1.48	17.44
10	Jaggery yield (t ha^{-1})	9.27	6.79	12.00	18.16	11.67	41.28	1.43	15.44

Though mean, range, genotypic and phenotypic coefficients of variability, heritability estimates and GAM predicted as per cent of mean in respect of all these traits are given in (Table 10).

4.1.4.1 Single cane weight (kg)

The single cane weight exhibited higher variability among 20 clones tested under integrated environment. Mean values ranging from 1.22 (Co 92005) to 1.92 (SNK10274) with a overall mean of 1.57.

Estimates of genotypic and phenotypic coefficient of variations were moderate (10.63 % and 16.64 % respectively) for this character. It showed moderate heritability estimate of 40.79 (%) as well as moderate genetic advance as per cent mean of 13.98 per cent

4.1.4.2 Jaggery pH

The data recorded for this trait shown good variability ranges from 4.35 (SNK 10286) to 6.12 (SNK 10134) with the average mean of 4.96.

The GCV (6.41 %) and PCV (8.57 %) were observed very low respectively. There was a moderate amount of heritability estimate (55.99 %) noticed coupled with low genetic advance as per cent mean (9.88 %).

4.1.4.3 Optical density

The character showed mean of 0.69 and ranging from 0.44 (SNK 10263) to 1.32 (SNK 10170) .The genotypic and phenotypic values (26.28 % and 42.43 % respectively) were high and there was a moderate heritability estimates of 38.35 (%) coupled with high GAM (33.52 %).

4.1.4.4 Ash content (%)

As per the data recorded for this trait, it showed a low variability with a range from 3.39 (SNK 10170) to 5.02 (SNK 10245) per cent with a mean of 4.19.

The GCV and PCV were from low to moderate extent of (7.90 %) and (12.69 %) respectively. It showed moderate heritability estimate 38.76 (%), along with moderate genetic advance as per cent mean 10.14 per cent.

4.1.4.5 Non reducing sugar (%)

As per the data recorded for this trait, the mean non reducing sugar were 80.98 per cent with a range of 86.06 (SNK10232) to 86.13 per cent (SNK10263) indicating good variability for the character under study.

The character showed relatively low genotypic (2.36 %) and phenotypic (4.06 %) coefficients of variation coupled with moderate estimates of heritability (41.83 %) and low GAM was (3.50 %).

4.1.4.6 Reducing sugar (%)

As per the data recorded for this attribute, the mean were 12.57 with a range of 10.68 (Co 671) to 13.97 (SNK10194) indicating moderate variability for the character.

The genotypic (7.27 %) and phenotypic (11.41 %) coefficients of variation differed negligibly evidencing moderate estimates of heritability (40.61 %) and low GAM was (9.54 %).

4.1.4.7 Total sugar (%)

As per the data recorded for this trait, it showed a moderate variability with a range from 89.11 (SNK 10232) to 96.33 (Co 671) per cent with a mean of 93.54.

The GCV and PCV were very low to the extent of (1.77 %) and (2.82 %) respectively. It showed moderate heritability estimate 39.53 %, along with very low genetic advance as per cent mean 2.29 per cent.

4.1.4.8 Juice extraction (%)

The data recorded for this trait shown moderate variability ranges from 38.99 (SNK 10058 to 60.24 (SNK 10286) with the average mean of 49.09

The GCV (9.27 %) and PCV (13.62 %) were observed very low to moderate respectively. There was a moderate amount of heritability estimate (46.31 %) noticed coupled with genetic advance as per cent mean (12.99 %).

4.1.4.9 Jaggery recovery (%)

It was observed that the trait had a general mean of 8.50 per cent with range of 6.70 per cent (SNK 10263) to 10.76 per cent (SNK 10283) revealing good amount of variation exists among the genotypes under study.

There was relative difference between genotypic (11.90 %) and phenotypic (16.72 %) coefficient of variation recorded with moderate heritability (50.62 %) coupled with genetic advance (17.44 %) as per cent mean.

4.1.4.10 Jaggery yield (t ha^{-1})

The general mean of 9.27 t $ha^{-1}$with mean values ranging from 6.79 t ha^{-1} (SNK 10263) to 12.00 t ha^{-1} (SNK 10199) were observed revealing good amount of variation among the genotypes for jaggery yield. Moderate values of GCV (11.90 %) and PCV (18.16 %) with moderate heritability estimate (41.28 %) coupled with GAM (15.44) were recorded for jaggery yield

4.1.5 Correlation studies of cane yield, sugar yield with its traits in clonal III generation under integrated environment at Sankeshwar

4.1.5.1 Association among various characters in clonal generation

The genotypic correlation coefficients was determined to know the nature and magnitude of relationship existing between cane yield, sugar yield and their component characters as well as their association among component characters themselves.

The degree of association of different quantitative characters with cane yield and its components is given in Table 11 and results are explained below.

4.1.5.1.1 Germination Count at 30 DAP

Strong significant positive association of germination count was found with TS at 90 DAP (0.891), CFS at 90 DAP (0.550), TS at 120 DAP (0.798), CFS at 120 DAP (0.692) and NMC (0.368).

Where as it showed significant negative association with harvest index (-0.018), juice extraction (-0.139), cane girth (-0.293) and SCW (-0.236).

4.1.5.1.2 Total shoots at 90 DAP

The character showed significant positive association with CFS at 90 DAP (0.498), TS at 120 DAP (0.968), CFS at 120 DAP (0.733), NMC (0.426), CCS (%) (0.609) and CCS yield (0.454).

Whereas it showed significant negative association with harvest index (-0.014), juice extraction (-0.134), cane girth (-0.398) and SCW (-0.387).

Table 11: Genotypic correlation among twenty diffrent quantitative traits in sugarcane at Sankeshwar (Integrated Environment)

	X 1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
X 1	1.000	0.891**	0.550**	0.798**	0.692**	0.368**	0.232*	0.247*	0.068	-0.293	-0.236	0.127	0.073	0.196	0.495**	0.506**	-0.018	-0.139	0.234*	0.183
X 2		1.000	0.498**	0.968**	0.733**	0.426**	0.206	0.336**	0.002	-0.398	-0.387	0.183	0.125	0.158	0.609**	0.454**	-0.014	-0.134	0.153	0.076
X 3			1.000	0.424**	0.846**	0.374**	0.470**	0.265*	0.318**	-0.476	-0.182	-0.096	0.147	0.117	0.192	0.401**	0.065	-0.204	0.242*	0.239*
X 4				1.000	0.680**	0.333**	0.132	0.239*	0.002	-0.395	-0.413	0.111	0.179	0.132	0.645**	0.332**	-0.108	-0.176	0.061	-0.036
X 5					1.000	0.524**	0.573**	0.381**	0.337**	-0.472	-0.086	-0.201	0.123	0.147	0.318**	0.761**	0.128	0.028	0.430**	0.422**
X 6						1.000	0.224*	-0.342	0.423**	-0.498	-0.401	-0.189	-0.116	-0.062	-0.124	0.657**	-0.114	0.258*	0.637**	0.593**
X 7							1.000	0.567**	0.752**	-0.507	0.190	-0.549	-0.285	0.091	-0.177	0.341**	0.274*	-0.086	0.255*	0.334**
X 8								1.000	-0.124	-0.179	0.258*	-0.392	0.091	0.310**	0.057	-0.063	0.165	-0.302	-0.251	-0.148
X 9									1.000	-0.530	-0.013	-0.286	-0.312	-0.065	-0.177	0.339**	0.076	0.029	0.361**	0.377**
X 10										1.000	0.819**	-0.026	-0.214	-0.304	-0.223	0.182	0.139	0.273*	0.269*	0.267*
X 11											1.000	-0.468	-0.449	-0.224	-0.362	0.391**	0.192	0.185	0.423**	0.485**
X 12												1.000	0.366**	0.388**	0.739**	-0.079	-0.363	-0.270	-0.452	-0.582
X 13													1.000	0.089	0.351**	-0.220	-0.425	-0.409	-0.308	-0.543
X 14														1.000	0.908**	0.404*	-0.097	-0.240	-0.206	-0.253
X 15															1.000	0.268*	-0.222	-0.296	-0.335	-0.431
X 16																1.000	0.068	0.298**	0.055	0.943**
X 17																	1.000	0.203	0.161	0.208
X 18																		1.000	0.430**	0.025
X 19																			1.000	0.989**

X1 - Germination count at 30 DAP
X2 - Total shoots at 90 DAP
X3 - Cane formed shoots at 90 DAP
X4 - Total shoots at 120 DAP
X5- Cane formed shoots at 120 DAP

X6 - Number of millable canes/ha
X7- Average cane height
X8- Average number of internodes
X9 - Average internode length
X10- Average Cane girth

X11- Average single cane weight
X12- Brix % 12 month
X13- Sucrose % 12 month
X14- Purity %
X15 -Commercial cane sugar %

X16 - Commercial cane sugar yield t/ha
X17- Harvest index
X18- Juice extraction %
X19- Brix yield t/ha
X20- Cane yield t/ha

4.1.5.1.3 Cane formed shoots at 90 DAP

Strong significant positive association found with TS at 120 DAP (0.424), CFS at 120 DAP (0.846), NMC (0.374), Avg IL (0.318), CCS yield (t/ha) (0.401), brix yield (t/ha) (0.242) and cane yield (t/ha) (0.239).

Where as it showed significant negative association with juice extraction (-0.204), cane girth (-0.476), SCW (-0.182) and brix (%) at 12^{th} month (-0.096).

4.1.5.1.4 Total shoots at 120 DAP

The character showed significant positive association with CFS at 120 DAP (0.680), NMC (0.333), CCS (%) (0.645) and CCS yield (t/ha) (0.332).

Strong significant negative association with harvest index (-0.108), juice extraction (-0.176), cane girth (-0.395) and SCW (-0.413).

4.1.5.1.5 Cane formed shoots at 120 DAP

The character showed significant positive association with NMC (0.524). Avg no. of INT (0.381), Avg IL (0.337), CCS per cent (0.318), CCS yield (t/ha) (0.761), brix yield (t/ha) (0.430) and cane yield (t/ha) (0.422).

Strong significant negative association with cane girth (-0.472), SCW (-0.086) and brix (%) at 12^{th} month (-0.201).

4.1.5.1.6 Number of Millable Canes at harvest

Strong significant positive association found with Cane height (0.224), Avg IL (0.423), CCS yield (t/ha) (0.657), Juice extraction (0.258), brix yield (t/ha) (0.637) and cane yield (t/ha) (0.593).

Whereas it showed significant negative association with cane girth (-0.498) SCW (-0.401), brix (%) at 12^{th} month (-0.189), sucrose (%) at 12^{th} month (-0.116) and harvest index (-.0114).

4.1.5.1.7 Average cane height

The character showed significant positive association with Average numberof internodes (0.567), average internode length (0.752), CCS yield (t/ha) (0.341), Juice extraction (0.274), brix yield (t/ha) (0.255) and cane yield (t/ha) (0.334).

Whereas it showed significant negative association with cane girth (-0.507), brix (%) at 12^{th} month (-0.549), sucrose (%) at 12^{th} month (-0.285), CCS per cent (-0.177) and juice extraction (-0.086).

4.1.5.1.8 Average number of internodes

The character showed significant positive association with SCW (0.258).

Whereas it showed significant negative association with average internode length (-0.124), cane girth (-0.179) brix (%) at 12^{th} month (-0.392), CCS yield (t/ha) (-0.063), juice extraction (-0.302), brix yield (t/ha) (-0.251) and cane yield (t/ha) (-0.148).

4.1.5.1.9 Average internode length

The character showed significant positive association with CCS yield (t/ha) (0.339), brix yield (t/ha) (0.361) and cane yield (t/ha) (0.377).

Whereas it showed significant negative association with cane girth (-0.530), SCW (-0.0.13), brix (%) at 12^{th} month (-0.286), sucrose (%) at 12^{th} month (-0.312), purity (-0.065) and CCS per cent (-0.177).

4.1.5.1.10 Average cane girth

The character showed highly significant positive association with SCW (0.819), juice extraction (0.273), brix yield (t/ha) (0.269) and cane yield (t/ha) (0.267).

Whereas it showed significant negative association with brix (%) at 12th month (-0.026), sucrose (%) at 12th month (-0.214), purity (-0.304) and CCS per cent (-0.223).

4.1.5.1.11 Average single cane

The character showed significant positive association with CCS yield (t/ha) (0.391), brix yield (t/ha) (0.423) and cane yield (t/ha) (0.485).

Whereas it showed significant negative association with brix (%) at 12th month (-0.468), sucrose (%) at 12th month (-0.449), purity (-0.224) and CCS per cent (-0.362).

4.1.5.1.12 brix (%) at harvest

The character showed significant positive association with sucrose (%) at 12th month (0.366), Purity (0.388), CCS per cent (0.739).

Whereas it showed significant negative association with CCS yield (t/ha) (-0.079), harvest index (-0.363), juice extraction (-0.270), brix yield (t/ha) (-0.452) and cane yield (t/ha) (-0.582).

4.1.5.1.13 sucrose (%) at harvest

The character showed significant positive association with CCS per cent (0.351).

Whereas it showed significant negative association with CCS yield (t/ha) (-0.220), harvest index (-0.425), juice extraction (-0.409), brix yield (t/ha) (-0.308) and cane yield (t/ha) (-0.543).

4.1.5.1.14 Purity (%) at harvest

The character showed significant positive association with CCS per cent (0.908) and CCS yield (t/ha) (0.404).

Whereas it showed significant negative association with harvest index (-0.097), juice extraction (-0.240), brix yield (t/ha) (-0.206) and cane yield (t/ha) (-0.253).

4.1.5.1.15 Commercial cane sugar (%)

The character showed significant positive association with CCS yield (t/ha) (0.268).

Whereas it showed significant negative association with harvest index (-0.222), juice extraction (-0.296), brix yield (t/ha) (-0.335) and cane yield (t/ha) (-0.431).

4.1.5.1.16 Commercial cane sugar yield t/ha

The character showed significant positive association with juice extraction (0.298) and cane yield (t/ha) (0.943).

4.1.5.1.17 Harvest index (%)

The character does not showed significant positive or negative association with the traits.

4.1.5.1.18 Juice extration (%)

The character showed significant positive association with brix yield (t/ha) (0.430).

4.1.5.1.19 brix yield t/ha

The character showed significant and strong positive association with Cane yield (t/ha) (0.989).

4.1.6 Correlation studies of cane yield, sugar yield with its traits in clonal III generation under organic environment at Sankeshwar

4.1.6.1 Germination Count at 30 DAP

Strong significant positive association of germination count was found with TS at 90 DAP (0.937), CFS at 90 DAP (0.882), TS at 120 DAP (0.878), CFS at 120 DAP (0.851), cane height (0.299), CCS per cent (445) and juice extraction (0.262) (as shown in Table 12)

Where as it showed significant negative association with NMC (-0.008), Cane girth (-0.621), SCW (-0.151), CCS yield (t/ha) (-0.007) and brix yield (t/ha) (-0.025).

4.1.6.2 Total shoots at 90 DAP

The character showed significant positive association with CFS at 90 DAP (0.905), TS at 120 DAP (0.955), CFS at 120 DAP (0.846), average number of internodes (0.434), brix at harvest (0.581), sucrose at harvest (0.537), purity (0.902) and CCS per cent (0.532)

Where as it showed significant negative association with average number of internode length (-0.032), cane girth (-0.384), SCW (-0.369), harvest index (-0.073) and cane yield (t/ha) (-0.109).

4.1.6.3 Cane formed shoots at 90 DAP

Strong significant positive association found with TS at 120 DAP (0.872), CFS at 120 DAP (0.980), NMC (0.282), Avg IL (0.504), average number of internode length (0.233), brix at harvest (0.404), sucrose at harvest (0.332), purity (0.653), CCS per cent (0.314), CCS yield (t/ha) (0.362), brix yield (t/ha) (0.326) and cane yield (t/ha) (0.229).

Where as it showed significant negative association with cane girth (-0.396) and SCW (-0.081).

4.1.6.4 Total shoots at 120 DAP

The character showed significant positive association with CFS at 120 DAP (0.789), NMC (0.299), Avg IL (0.292), brix at harvest (0.611), sucrose at harvest (0.517) and CCS per cent (0.494).

Strong significant negative association with average number of internode length (-0.019), cane girth (-0.3457), SCW (-0.486), harvest index (-0.030), juice extraction (-0.080) and cane yield (t/ha) (-0.043).

4.1.6.5 Cane formed shoots at 120 DAP

The character showed significant positive association with NMC (0.259), cane height (0.544), Avg no. of INT (0.502), Avg IL (0.311), brix at harvest (0.483), sucrose at harvest (0.302), CCS per cent (0.249), CCS yield (t/ha) (0.383), brix yield (t/ha) (0.382) and cane yield (t/ha) (0.265).

Strong significant negative association with cane girth (-0.473), SCW (-0.019) and purity (-0.893).

4.1.6.6 Number of Millable Canes at harvest

Strong significant positive association found with cane height (0.252), Avg IL (0.288), CCS yield (t/ha) (0.746), brix yield (t/ha) (0.758) and cane yield (t/ha) (0.717).

Whereas it showed significant negative association with cane girth (-0.239), SCW (-0.128), sucrose (%) at 12^{th} month (-0.095), purity (-0.214), CCS per cent (-0.156), harvest index (-0.290) and juice extraction (-0.279).

Table 12: Genotypic correlation among twenty diffrent quantitative traits in sugarcane at Sankeshwar (Organic Environment)

	X 1	X 2	X 3	X 4	X 5	X 6	X 7	X 8	X 9	X 10	X 11	X 12	X 13	X 14	X 15	X 16	X 17	X 18	X 19	X 20
X 1	1.000	0.937**	0.882**	0.878**	0.851**	-0.008	0.299**	0.356**	0.168	-0.621	-0.151	0.205	0.154	0.147	0.445**	-0.007	-0.076	0.262*	-0.025	-0.132
X 2		1.000	0.905**	0.995**	0.846**	0.142	0.181	0.434**	-0.032	-0.384	-0.369	0.581**	0.537**	0.902**	0.532**	0.059	-0.073	0.047	0.013	-0.109
X 3			1.000	0.872**	0.980**	0.282**	0.476**	0.504**	0.233*	-0.396	-0.081	0.404**	0.332**	0.653**	0.314**	0.362**	0.021	0.060	0.326**	0.229*
X 4				1.000	0.789**	0.299**	0.118	0.292**	-0.019	-0.457	-0.486	0.611**	0.517**	0.094	0.494**	0.126	-0.030	-0.080	0.089	-0.043
X 5					1.000	0.259*	0.554**	0.502**	0.311**	-0.473	0.019	0.483**	0.302**	-0.893	0.249*	0.383**	0.246*	0.107	0.382**	0.265**
X 6						1.000	0.252*	0.035	0.288**	-0.239	-0.128	0.081	-0.095	-0.214	-0.156	0.746**	-0.290	-0.279	0.758**	0.717**
X 7							1.000	0.564**	0.852**	-0.709	0.421**	0.060	-0.169	-0.111	-0.242	0.530**	0.551**	0.104	0.569**	0.530**
X 8								1.000	0.039	-0.629	0.028	0.087	0.109	0.187	0.130	0.113	0.292**	-0.542	0.070	0.056
X 9									1.000	-0.484	0.462**	0.011	-0.276	-0.674	-0.375	0.565**	0.461**	0.512**	0.638**	0.600**
X 10										1.000	0.431**	-0.266	-0.092	0.210	-0.044	0.080	0.066	0.260*	0.042	0.093
X 11											1.000	-0.425	-0.462	-0.238	-0.476	0.503**	0.649**	0.464**	0.517**	0.588**
X 12												1.000	0.266**	0.144	0.037	0.049	-0.232	0.157	-0.056	-0.273
X 13													1.000	0.292**	0.002	-0.141	-0.401	0.148	-0.224	-0.435
X 14														1.000	0.366**	-0.559	-0.120	-0.693	-0.793	-0.329
X 15															1.000	-0.205	-0.463	0.136	-0.282	-0.492
X 16																1.000	0.083	0.164	0.998**	0.953**
X 17																	1.000	0.149	0.166	0.200
X 18																		1.000	0.257*	0.098
X 19																			1.000	0.976**

X1 - Germination count at 30 DAP
X2 - Total shoots at 90 DAP
X3 - Cane formed shoots at 90 DAP
X4 - Total shoots at 120 DAP
X5- Cane formed shoots at 120 DAP
X6 - Number of millable canes/ha
X7- Average cane height
X8- Average number of internodes
X9 - Average internode length
X10- Average Cane girth
X11- Average single cane weight
X12- Brix % 12 month
X13- Sucrose % 12 month
X14- Purity %
X15 -Commercial cane sugar %
X16 - Commercial cane sugar yield t/ha
X17- Harvest index
X18- Juice extraction %
X19- Brix yield t/ha
X20- Cane yield t/ha

4.1.6.7 Average cane height

The character showed significant positive association with average number of internodes (0.564), average internode length (0.852), SCW (0.421), CCS yield (t/ha) (0.530), harvest index (0.551), brix yield (t/ha) (0.569) and cane yield (t/ha) (0.530).

Whereas it showed significant negative association with cane girth (-0.709), sucrose (%) at 12th month (-0.169), purity (-0.111) and CCS per cent (-0.242).

4.1.6.8 Average number of internodes

The character showed significant positive association with harvest index (0292)

Whereas it showed significant negative association with cane girth (-0.629) and juice extraction (-0.542).

4.1.6.9 Average internodal length

The character showed significant positive association with SCW (462), CCS yield (t/ha) (0.565), harvest index (0.461), juice extraction (0.512), brix yield (t/ha) (0.638) and cane yield (t/ha) (0.600).

Whereas it showed significant negative association with cane girth (-0.484), sucrose (%) at 12th month (-0.276), purity (-0.674) and CCS per cent (-0.375).

4.1.6.10 Average cane girth

The character showed highly significant positive association with SCW (0.431) and juice extraction (0.260).

Whereas it showed significant negative association with brix (%) at 12th month (-0.266), sucrose (%) at 12th month (-0.092) and CCS per cent (-0.044).

4.1.6.11 Average single cane

The character showed significant positive association with CCS yield (t/ha) (0.503), harvest index (0.649), juice extraction (0.464), brix yield (t/ha) (0.517) and cane yield (t/ha) (0.588).

Whereas it showed significant negative association with brix (%) at 12th month (-0.425), sucrose (%) at 12th month (-0.462), purity (-0.238) and CCS per cent (-0.476).

4.1.6.12 brix (%) at harvest

The character showed significant positive association with sucrose (%) at 12th month (0.266).

Whereas it showed significant negative association with harvest index (-0.232), juice extraction (-0.270), brix yield (t/ha) (-0.056) and cane yield (t/ha) (-0.273).

4.1.6.13 sucrose (%) at harvest

The character showed significant positive association with purity (0.292).

Whereas it showed significant negative association with CCS yield (t/ha) (-0.141), harvest index (-0.401), brix yield (t/ha) (-0.224) and cane yield (t/ha) (-0.435).

4.1.6.14 Purity (%) at harvest

The character showed significant positive association with CCS per cent (0.366).

Whereas it showed significant negative association with CCS yield (t/ha) (-0.559), harvest index (-0.120), juice extraction (-0.693), brix yield (t/ha) (-0.793) and cane yield (t/ha) (-0.329).

4.1.6.15 Commercial cane sugar (%)

The character does not showed significant positive association with any trait.

Whereas it showed significant negative association with CCS yield (t/ha) (-0.205), harvest index (-0.463), brix yield (t/ha) (-0.282) and cane yield (t/ha) (-0.492).

4.1.6.16 Commercial cane sugar yield t/ha

The character showed strong and significant positive association with brix yield (t/ha) (0.998) and cane yield (t/ha) (0.953).

4.1.6.17 Harvest index (%)

The character does not showed significant positive or negative association with any traits.

4.1.6.18 Juice extraction (%)

The character showed significant positive association with brix yield (t/ha) (0.257).

4.1.6.19 brix yield t/ha

The character showed significant and strong positive association with cane yield (t/ha) (0.976).

4.2 Repeatability of important traits between clonal I, clonal II, clonal III (INT) and clonal III (ORG) generations across the environments

Inter-stage correlations have been used to measure the repeatability of different traits in different stages and environments. Productive clones from all the generations across environments were considered to compute inter stage correlations (Table 13.a to13.b) for various traits.

4.2.1 Germination (%)

The analysis of repeatability showed that, the repeatability values were highly significant for germination (%) between all the combinations.

Highest repeatability (0.757) value for germination (%) was recorded between clonal III (INT) and clonal II followed by clonal III (INT) and clonal III (ORG) (0.7342). The lowest repeatability (0.396) was recorded between clonal I and clonal III (ORG), followed by repeatability of (0.468) between clonal I and clonal III.

4.2.2 Total shoots at 90 DAP

This character showed significant and positive repeatability across generation environment.

The analysis of repeatability showed that, highest repeatability (0.842) value for total shoots at 90 DAP recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.357) between clonal III (INT) and clonal II.

The lowest repeatability (0.043) was recorded between clonal I and clonal II, followed by repeatability of (0.179) between clonal I and clonal III (ORG).

4.2.3 Total shoots at 120 DAP

This character showed significant and positive repeatability across generation environment.

The analysis of repeatability showed that, highest repeatability (0.827) value for total shoots at 120 DAP recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.538) between clonal III (INT) and clonal II.

Table 13.a: Inter-stage correlation (repeatability) values for Germination (%) at 30 DAP in productive sugarcane clones over generation

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.47**	1		
CL III(INT)	0.49**	0.76**	1	
CL III(ORG)	0.40**	0.54**	0.73**	1

Table 13.b: Inter-stage correlation (repeatability) values for Total shoot at 90 DAP in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.04	1		
CL III(INT)	0.29*	0.36*	1	
CL III(ORG)	0.18	0.33*	0.84**	1

Table 13.c: Inter-stage correlation (repeatability) values for Total shoot at 120 DAP in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.16	1		
CL III(INT)	0.32*	0.54**	1	
CL III(ORG)	0.38**	0.53**	0.83**	1

Table 13.d: Inter-stage correlation (repeatability) values for Cane formed shoot at 120 DAP in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.06	1		
CL III(INT)	-0.20	0.39**	1	
CL III(ORG)	-0.15	0.42**	0.78**	1

Table 13.e: Inter-stage correlation (repeatability) values for Total shoot at 240 DAP in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.13	1		
CL III(INT)	0.27*	0.65**	1	
CL III(ORG)	0.42**	0.54**	0.81**	1

Table 13.f: Inter-stage correlation (repeatability) values for NMC (000/ha) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.15	1		
CL III(INT)	0.16	0.43**	1	
CL III(ORG)	0.17	0.30*	0.77**	1

Table 13.g: Inter-stage correlation (repeatability) values for SCW (kg) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.40**	1		
CL III(INT)	0.29*	0.50**	1	
CL III(ORG)	0.33*	0.45**	0.87**	1

Table 13.h: Inter-stage correlation (repeatability) values for C.H (cm) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.62**	1		
CL III(INT)	0.56**	0.69**	1	
CL III(ORG)	0.64**	0.72**	0.86**	1

Table 13.i: Inter-stage correlation (repeatability) values for C.G (cm) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.23	1		
CL III(INT)	0.29*	0.58**	1	
CL III(ORG)	0.21	0.66**	0.82**	1

Table 13.j: Inter-stage correlation (repeatability) values for Juice extraction (%) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.18	1		
CL III(INT)	0.46**	0.27*	1	
CL III(ORG)	0.38**	0.28*	0.58**	1

Table 13.k: Inter-stage correlation (repeatability) values for C.B (%) at 10 month in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.54**	1		
CL III(INT)	0.68**	0.64**	1	
CL III(ORG)	0.58**	0.54**	0.68**	1

Table 13.l: Inter-stage correlation (repeatability) values for C.P (%) at 10 month in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.59**	1		
CL III(INT)	0.60**	0.61**	1	
CL III(ORG)	0.54**	0.60**	0.6857**	1

Table 13.m: Inter-stage correlation (repeatability) values for C.B (%) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.13	1		
CL III(INT)	0.41**	0.03	1	
CL III(ORG)	0.33**	0.36**	0.56**	1

Table 13.n: Inter-stage correlation (repeatability) values for C.P (%) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	-0.12	1		
CL III(INT)	0.23	0.10	1	
CL III(ORG)	0.26	0.24	0.75**	1

Table 13.o: Inter-stage correlation (repeatability) values for Cane yield (t/ha) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.18	1		
CL III(INT)	0.29*	0.49**	1	
CL III(ORG)	0.27*	0.47**	0.86**	1

Table 13.p: Inter-stage correlation (repeatability) values for CCS yield (t/ha) at harvest in productive sugarcane clones over generations

Stages / Generations	CL I	CL II	CL III (INT)	CL III (ORG)
CL I	1			
CL II	0.41**	1		
CL III(INT)	0.33*	0.50**	1	
CL III(ORG)	0.28*	0.40**	0.82**	1

The lowest repeatability (0.158) was recorded between clonal I and clonal II.

4.2.4 Cane formed shoots at 120 DAP

This character showed significant and positive repeatability across generation except between clonal III (INT) with clonal I and clonal III (ORG) with clonal I.

The analysis of repeatability showed that, highest repeatability (0.782) value for Cane formed shoots recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.418) between clonal III (ORG) & clonal II.

It had negative repeatability value (-0.154) between clonal III (ORG) & clonal I, followed by (-0.199) between clonal III (INT) and clonal I.where as with other generation it showed significant positive repeatability values.

4.2.5 Total shoots at 240 DAP

The analysis of repeatability showed that, the repeatability values were highly significant for total shoots at 240 between all the combinations.

Highest repeatability (0.814) value for total shoots at 240 was recorded between clonal III (INT) and clonal III (ORG), followed by clonal III (INT) and clonal II (0.645).

The non significant repeatability (0.127) was recorded between clonal I and clonal II.

4.2.6 Number of millable canes

The analysis of repeatability showed that, millable cane number was most repeatable trait across stages and environments, as the repeatability values were comparatively high over the clonal generation.

Highest repeatability estimate (0.770) was recorded between clonal III(INT) and clonal III (ORG) followed by clonal III (INT) and clonal II (0.432) and between clonal III (ORG) and clonal II the repeatability estimates were moderate (0.295).

Whereas lowest estimate (0.146) was observed between clonal I and clonal II.

4.2.7 Average single cane weight (kg) at harvest

The analysis of repeatability showed that, single cane weight was most repeatable trait across stages and environments, as the repeatability values were comparatively high and highly significant.

This is cane yield contributing character was found most repeatable between clonal III (ORG) and clonal III (INT) (0.867) as the repeatability values showed high and significant.

Lowest repeatability value (0.289) was recorded between clonal I with clonal III (INT).

4.2.7 Average single cane weight (kg) at harvest

The analysis of repeatability showed that, single cane weight was most repeatable trait across stages and environments, as the repeatability values were comparatively high and highly significant.

This is cane yield contributing character was found most repeatable between clonal III (ORG) and clonal III (INT) (0.867) as the repeatability values showed high and significant.

Lowest repeatability value (0.289) was recorded between clonal I with clonal III (INT).

4.2.8 Average cane height (cm) at harvest

The analysis of repeatability showed that, the repeatability values were highly significant for cane height at harvest between all the combinations.

Highest repeatability (0.863) value for cane height at harvest was recorded between clonal III (INT) and clonal III (ORG), followed by clonal III (ORG) and clonal II (0.718).

4.2.9 Average cane girth (cm) at harvest

The analysis of repeatability showed that, the repeatability values were highly significant for cane girth at harvest between all the combinations.

Highest repeatability (0.821) value for cane height at harvest was recorded between clonal III (INT) and clonal III (ORG), followed by clonal III (ORG) and clonal II (0.661).

The non significant repeatability (0.225) was recorded between clonal I and clonal II.

4.2.10 Juice extraction at harvest

This character showed significant and positive repeatability across generation environment.

The analysis of repeatability showed that, highest repeatability (0.57) value for total juice extraction recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.465) between clonal III (INT) and clonal II.

The lowest repeatability (0.17) was recorded between clonal I and clonal II, followed by repeatability of (0.12) between clonal II and clonal III (INT).

4.2.11 brix (%) at 10 month

The analysis of repeatability showed that the value for brix (%) were comparatively high and highly significant.

The analysis of repeatability showed that, highest repeatability (0.680) value for brix (%) recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.670) between clonal III (INT) and clonal I.

4.2.12 sucrose (%) at 10 month

The analysis of repeatability showed that the value for sucrose (%) were comparatively high and highly significant.

The analysis of repeatability showed that, highest repeatability (0.685) value for sucrose (%) recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.670) between clonal III (INT) and clonal II.

4.2.13 brix (%) at 12 month

The analysis of repeatability showed that the value for brix (%) were comparatively high and highly significant.

The analysis of repeatability showed that, highest repeatability (0.566) value for brix (%) recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.413) between clonal III (INT) and clonal I.

The non significant repeatability (0.131) was recorded between clonal I and clonal II.

4.2.14 sucrose (%) at 12 month

The analysis of repeatability showed that had very lower and non-significant repeatability values between all the combinations.

The analysis of repeatability showed that, highest repeatability (0.749) value for sucrose (%) recorded between clonal III (INT) and clonal III (ORG), It had negative repeatability value (-0.128) between clonal I and clonal II where as with other generation it showed non significant positive repeatability values.

4.2.15 CCS yield (t/ha)

This character showed significant and positive repeatability across generation environment.

The analysis of repeatability showed that, highest repeatability (0.826) value for CCS yield recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.502) between clonal III (INT) and clonal II.

The lowest repeatability (0.287) was recorded between clonal I and clonal III (ORG).

4.2.16 Cane yield (t/ha)

Cane yield recorded non-significant repeatability value between clonal I and clonal II (0.182).

The analysis of repeatability showed that, highest repeatability (0.867) value for cane yield (t/ha) recorded between clonal III (INT) and clonal III (ORG), followed by repeatability of (0.498) between clonal III (INT) and clonal II.

4.3 Identification of suitable genotypes for organic/chemical free jaggery production

4.3.1.a Performance of superior 10 productive genotypes for cane yield and its components in Sankeshwar (Organic Environment)

4.3.1.1 Average single cane weight (kg)

The result for cane yield components is presented in Table 14. The value for Avg SCW ranged from 1.33 (SNK10058) to 1.99 (SNK10274). The genotype SNK10274 has recorded higher Avg SCW compared to best check CoC 671 (1.61). All other genotypes like SNK10241, SNK10199 and SNK10232 (1.97, 1.83 and 1.69 respectively) recorded higher Avg SCW among all the genotypes compared to all checks.

Only SNK10058 (1.33) recorded lowest Avg SCW among 10 genotypes whereas it showed superior than best popular check Co 92005 (1.22)

All the superior 10 productive genotype recorded superior SCW over the best popular check check Co 92005 (1.22).

4.3.1.2 Number of Millable Cane (‘000/ha)

The number of millable cane ranged from 49.37 (SNK10241) to 75.50 (SNK 10058). The genotype SNK 10058 has recorded higher number of millable cane compared to best Co 92005 (62.70).Other genotypes like SNK10245, SNK10263, SNK10134, SNK10303 and SNK10283 (70.57, 69.78, 69.35, 69.26 and 68.78 respectively) recorded higher number of millable cane among all the genotypes compared to all checks.

None of the genotype showed lower number of millable cane when compared to the check Co 671. Whereas SNK10241, SNK10274, SNK10232 (49.37, 53.26 and 53.36 respectively) recorded lowest when compared to other two checks. But SNK10199 (58.88) on par with checks Co 92005 and Co 86032.

Table 14: Performance of superior 10 productive genotypes for cane yield and its components in Sankeshwar (Organic Environment)

Genotypes	**Single cane weight (kg)**	**Number of millable canes ('000 ha^{-1})**	**Cane yield (t ha^{-1})**
SNK10245	1.42	70.57	110.00*
SNK10199	1.83	58.88	107.50*
SNK10303	1.56	69.26	107.50*
SNK10274	1.99*	53.26	105.00*
SNK10134	1.49	69.35	103.50*
SNK10263	1.46	69.78	101.00
SNK10058	1.33	75.50*	100.00
SNK10232	1.69	53.36	98.50
SNK10283	1.43	68.78	98.00
SNK10241	1.97*	49.37	96.50
Checks			
CoC 671	1.61	43.96	70.50
Co 92005	1.22	62.70	77.50
Co 86032	1.42	60.13	85.00
Mean	**1.57**	**61.91**	**96.96**
S.Em.	0.14	4.98	5.66
CD 5%	0.43	15.36	17.45
CV %	12.46	11.38	8.26

4.3.1.3 Cane yield (t/ha)

The value for Cane yield ranged from 96.50 (SNK10241) to 110.00 (SNK10245).The genotype SNK10245 has recorded higher Cane yield compared to best check Co 86032 (85.00). All other genotypes recorded higher Cane yield among all the genotypes compared to all checks.

All the superior 10 productive genotypes recorded significantly superior cane yield over the best popular check Co 92005 (77.50).

4.3.1.b Performance of superior 10 productive genotypes for cane yield and its components in Sankeshwar (Integrated Environment)

4.3.1.1 Average single cane weight (kg)

The result for cane yield components is presented in Table 15. The value for Avg SCW ranged from 1.32 (SNK10245) to 2.78 (SNK10274). The genotype SNK10274 has recorded higher Avg SCW compared to best check CoC 671 (1.89). All other genotypes like SNK10199, SNK10241 and SNK10243 (2.25, 2.07 and 2.02 respectively) recorded higher Avg SCW among all the genotypes compared to all checks.

Only SNK10245 (1.32) and SNK 10248 (1.48) were lowest Avg SCW recorded among 10 superior productive genotypes compare to than best popular check Co 92005(1.68)

All the superior 10 productive genotype recorded superior SCW over the best popular check check Co 92005 (1.68).

4.3.1.2 Number of Millable Cane (‘000/ha)

The number of millable cane ranged from 47.32 (SNK10274) to 88.20 (SNK 10245). The genotype SNK 10245 has recorded higher number of millable cane compared to best Co 92005 (62.70).

Other genotypes like SNK10248, SNK10232, SNK10286, SNK10303 and SNK10194 (79.30, 67.37, 65.46, 65.00 and 64.21 respectively) recorded higher number of millable cane among all the genotypes compared to all checks.

None of the genotype showed lowest number of millable cane when compared to the all checks. Whereas SNK10274 (47.32) recorded lowest when compared to other two checks Co 92005(50.67) and Co 86032(58.68). But SNK10274, (47.32) superior with checks CoC 671 (44.98).

4.3.1.3 Cane yield (t/ha)

The value for Cane yield ranged from 107.84 (SNK10241) to 132.00 (SNK10274).The genotype SNK10274 has recorded higher Cane yield compared to best check Co 86032 (85.38). All other genotypes recorded higher Cane yield among all the genotypes compared to all checks.

All the superior 10 productive genotypes recorded significantly superior cane yield over the best popular check Co 86032(84.00).

4.3.2.a Performance of superior 10 productive genotypes for sugar yields and its components at Sankeshwar (Organic Environment)

4.3.2.1 brix (%) at harvest

The result for sugar yield components are presented in Table 16.The value of brix (%) ranged from 20.68 (SNK10283) to 24.42 (SNK10058). The genotype SNK10058 has recorded higher brix (%) among the top genotypes but on par with the best check Co 671 (24.92). Other genotypes like SNK10303, SNK10241 and SNK10245 (23.42, 23.39 and 22.93 respectively) were found to be on par with best checks.

Table 15: Performance of superior 10 productive genotypes for cane yield and its components in Sankeshwar (Integrated Environment)

Genotypes	**Single cane weight (kg)**	**Number of millable canes ('000 ha^{-1})**	**Cane yield (t ha^{-1})**
SNK10274	2.78*	47.32	132.00*
SNK10194	1.85*	64.21	118.50*
SNK10232	1.77*	67.37	117.50*
SNK10248	1.48	79.30*	117.00*
SNK10245	1.32	88.20*	116.50*
SNK10199	2.25*	50.67	113.50*
SNK10243	2.02*	55.72	112.71*
SNK10286	1.68	65.46	109.78*
SNK10303	1.68	65.00	109.00*
SNK10241	2.07*	51.99	107.84*
Checks			
CoC 671	1.89	44.98	84.64
Co 92005	1.68	50.67	85.00
Co 86032	1.43	58.68	85.38
Mean	**1.84**	**60.74**	**108.33**
S.Em.	0.1	3.75	5.56
CD 5%	0.3	11.56	17.13
CV %	7.6	11.28	7.26

Table 16: Performance of superior 10 productive genotypes for sugar yields and its components at Sankeshwar (Organic Environment)

Genotypes	Brix % at harvest	Sucrose % Juice at harvest	CCS % at harvest	CCS yield (t ha^{-1})	Juice extraction % at harvest	Purity % at harvest	Brix yield (t ha^{-1})
SNK10245	22.93	20.62	14.37	15.82*	39.23	89.97	25.19*
SNK10199	21.64	19.01	13.1	14.07	45.38	87.85	23.28
SNK10303	23.42	20.93	14.55	15.65	49.15	89.37	25.18*
SNK10274	21.68	18.94	13.03	13.71	46.34	87.35	22.79
SNK10134	22.67	20.26	14.09	14.54	44.75	89.32	23.46
SNK10263	21.68	19.25	13.34	13.49	42.39	88.78	21.91
SNK10058	24.42	21.48	14.82	14.84	43.63	87.97	24.42
SNK10232	22.14	18.73	12.67	12.51	47.78	84.56	21.82
SNK10283	20.68	18.6	12.97	12.69	43.19	89.93	20.26
SNK10241	23.39	21.67	15.31	14.77	48.6	92.78	22.61
Checks							
CoC 671	24.92	23.14	16.37	11.56	46.96	92.86	17.56
Co 92005	24.42	22.43	15.79	12.27	45.52	91.85	18.92
Co 86032	23.42	21.53	15.16	12.89	51.33	91.93	19.93
Mean	**22.88**	**20.5**	**14.28**	**13.75**	**45.71**	**89.58**	**22.10**
S.Em.	0.44	0.49	0.46	0.94	3.08	1.96	1.53
CD 5%	1.36	1.5	1.43	2.9	9.5	6.03	4.72
CV %	2.74	3.35	4.6	9.69	9.54	3.09	9.8

Whereas SNK10283, SNK10199, SNK10263 and SNK10274 (20.68, 21.64, 21.68 and 21.68 respectively) recorded lowest brix (%) among 10 superior productive genotypes compare to checks.

SNK10058 (24.42) recorded same as the best popular jaggery variety Co 92005 (24.42).It showed superiority over Co 86032 (23.42) and on par with best check CoC 671 (24.92).

4.3.2.2 sucrose (%) at harvest

The value of sucrose (%) ranged from 18.60 (SNK10283) to 21.67 (SNK10241). The genotype SNK10241 has recorded higher sucrose (%) among the top genotypes but on par with the best check Co 671 (23.14). Other genotypes like SNK10058, SNK10303, SNK10245 and SNK 10134 (21.48, 20.93, 20.62 and 20.26 respectively) were found to be on par with best checks Whereas SNK 10283, SNK 10232 and SNK 10274 (18.60, 18.73 and 18.94 respectively) recorded lowest sucrose (%) among 10 superior productive genotypes compare to checks.

4.3.2.3 CCS (%) at harvest

The value of CCS (%) ranged from 12.67 (SNK10232) to 15.31 (SNK10241). The genotype SNK10241 has recorded higher CCS (%) among the superior genotypes but on par with the best check CoC 671 (16.37). Other genotypes like SNK 10058, SNK 10241, SNK10303, SNK10245 and SNK10134 (14.84, 14.77, 14.55, 14.37 and 14.09 respectively) were found to be on par with best checks.

Whereas SNK 10232, SNK 10283, SNK 10199 and SNK 10274 (12.67, 12.97, 13.10 and 13.03 respectively) recorded lower CCS (%) among 10 superior productive genotypes compare to checks.

SNK 10241 (15.31) recorded on par with the best popular jaggery variety Co 92005 (15.79).It showed superiority over Co 86032 (15.16).

4.3.2.4 CCS Yield (t/ha)

The value of CCSY ranged from 12.51 (SNK10232) to 15.82 (SNK10245). The genotype SNK10245 has recorded higher CCSY among the superior productive genotypes and the best check Co 86032 (12.89). Other genotypes like SNK 10303, SNK 10058, SNK10241, SNK10134, SNK 10199, SNK 10274, and SNK10263 (15.65, 14.84, 14.77, 14.54, 14.07, 13.71 and 13.49 respectively) recorded higher CCSY among all the genotypes compared to all checks.

Whereas SNK 10232 (12.51) recorded lowest CCSY among 10 superior productive genotypes compare to check Co 86032. But showed superiority over best popular jaggery variety Co 92005 (12.27).

All the progenies recorded significantly higher CCSY over the best popular jaggery check Co 92005 except SNK 10232.

4.3.2.5 Juice extraction (%)

The value of juice extraction (%) ranged from 39.23 (SNK10245) to 49.15 (SNK10303). The genotype SNK10303 has recorded higher juice extraction (%) among the superior productive genotypes but on par with the best check Co 86032 (51.33).

Other genotypes like SNK 10241, SNK 10232, SNK10274 and SNK10199 (48.60, 47.78, 46.34 and 45.38 respectively) were found to be on par with best check and superiority over the popular jaggery variety Co 92005 (45.52).

Whereas SNK 10245, SNK 10263, SNK 10283 and SNK 10263 (39.23, 42.39, 43.19 and 43.63 respectively) recorded lowest juice extraction (%) among 10 superior productive genotypes compare to checks.

4.3.2.6 Purity (%) at harvest

The value of purity (%) ranged from 84.56 (SNK10232) to 92.78 (SNK10241). The genotype SNK10241 has recorded higher purity (%) among the superior productive genotypes but on par with the best check CoC 671 (92.86).

Other genotypes like SNK 10245, SNK 10283, SNK10303, and SNK10134 (89.97, 89.93, 89.37 and 89.32 respectively) were found to be on par with best checks.

Whereas SNK 10232 and SNK 10274 (84.56and 87.35 respectively) recorded lowest purity (%) among 10 superior productive genotypes compare to checks.

4.3.2.7 brix Yield (t/ha)

The value for brix Yield ranged from 20.26 (SNK10283) to 25.19 (SNK10245). The genotype SNK10245 has recorded higher brix yield compared to best check Co 86032 (19.93). All other genotypes like SNK10303, SNK10058, SNK 10134, SNK 10199, SNK 10274, SNK 10241, SNK 10263, and SNK10232 (25.18, 24.42 23.46, 23.28, 22.79, 21.91 and 21.82 respectively) recorded higher brix yield among all the genotypes compared to all checks.

4.3.2.b Performance of superior 10 productive genotypes for sugar yields and its components at Sankeshwar (Integrated Environment)

4.3.2.1 brix (%) at harvest

The result for sugar yield components are presented in Table 17.The value of brix (%) ranged from 20.22 (SNK10274) to 22.71 (SNK10248). The genotype SNK 10248 has recorded higher brix (%) among the superior genotypes but on par with the best check Co 671 (24.67). Other genotypes like SNK10286, SNK10199 and SNK10243 (22.21, 22.14 and 22.14 respectively) were found to be on par with best checks.

Whereas SNK 10274, SNK10232, SNK10303 and SNK10241 (20.22, 20.89, 21.43 and 21.64 respectively) recorded lowest brix (%) among 10 superior productive genotypes compare to checks.

4.3.2.2 sucrose (%) at harvest

The value of sucrose (%) ranged from 17.58 (SNK10274) to 20.05 (SNK10243). The genotype SNK10243 has recorded higher sucrose (%) among the superior genotypes but on par with thebest check Co 671 (23.14).

Whereas SNK 10232, SNK 10194, SNK 10241, SNK 10245, SNK 10303 and SNK 10286 (18.11, 18.67, 18.89, 19.13, 19.15 and 19.70 respectively) recorded lowest sucrose (%) among 10 superior productive genotypes compare to the checks.

4.3.2.3 CCS (%) at harvest

The value of CCS (%) ranged from 9.94 (SNK10194) to 14.03 (SNK10243). The genotype SNK10243 has recorded higher CCS (%) among the superior genotypes but on par with the best check CoC 671 (15.47).

Other genotypes like SNK 10286, SNK 10248 and SNK10303 (13.65, 13.58 and 13.31 respectively) were found to be on par with best checks.

Table 17: Mean performance of superior 10 productive genotypes for sugar yields and its components at Sankeshwar (Integrated Environment)

Genotypes	**Brix % at harvest**	**Sucrose % Juice at harvest**	**CCS % at harvest**	**CCS yield (t ha^{-1})**	**Juice extraction % at harvest**	**Purity % at harvest**	**Brix yield (t ha^{-1})**
SNK10274	20.22	17.58	12.06	12.26	51.00	86.5	26.43*
SNK10194	21.75	18.67	9.94	10.23	52.39*	62.52	25.82*
SNK10232	20.89	18.11	12.40	14.59	52.85*	86.63	24.56*
SNK10248	22.71	19.78	13.58	15.75*	50.00	86.95	26.65*
SNK10245	21.93	19.13	13.14	15.32	51.30*	87.18	25.55*
SNK10199	22.14	19.70	13.67	15.51	50.69	88.97	25.13*
SNK10243	22.14	20.05	14.03	15.81*	48.18	90.60	24.95*
SNK10286	22.21	19.70	13.65	15.02	49.52	88.61	24.40*
SNK10303	21.43	19.15	13.31	14.50	51.00	89.36	23.35
SNK10241	21.64	18.89	12.98	14.01	50.12	87.36	23.32
Checks							
CoC 671	24.67	22.19	15.47	13.10	48.16	89.95	20.87
Co 92005	23.17	21.31	15.01	12.80	45.81	91.99	19.80
Co 86032	22.92	21.09	14.86	12.48	46.53	92.02	19.25
Mean	**22.14**	**19.33**	**13.39**	**13.95**	**49.81**	**86.82**	**23.85**
S.Em.	0.65	1.01	0.77	1.01	1.21	2.25	1.39
CD 5%	2.02	3.12	2.38	3.11	3.73	6.92	4.29
CV %	4.18	7.42	8.14	10.23	3.44	3.66	8.26

Whereas SNK 10194, SNK 10274, SNK 10232 and SNK 10241 (9.94, 12.06, 12.40 and 12.98 respectively) recorded lowest CCS (%) among 10 superior productive genotypes compare to checks.

4.3.2.4 CCS Yield (t/ha)

The value of CCSY ranged from 10.23 (SNK10194) to 15.81 (SNK10243). The genotype SNK10243 has recorded higher CCSY among the superior productive genotypes and the best check CoC 671 (13.10).

Other genotypes like SNK 10248, SNK 10199, SNK10245, SNK10286, SNK 10232, SNK 10303, and SNK10241 (15.75, 15.51, 15.32, 15.02, 14.59, 14.50, and 14.01 respectively) recorded higher CCSY among all the genotypes compared to all checks.

Whereas SNK 10194 (10.23) recorded lowest CCSY among 10 superior productive genotypes compare to check Co 86032(12.48).

All the progenies recorded significantly higher CCSY over the best popular jaggery check Co 92005 except SNK 10194 and SNK 10274.

4.3.2.5 Juice extraction (%)

The value of juice extraction (%) ranged from 48.18 (SNK10243) to 52.85 (SNK10232). The genotype SNK10232 has recorded higher juice extraction (%) among the superior productive genotypes but on par with the best check CoC 671 (48.16).

Other genotypes like SNK 10194, SNK 10245, SNK10303, SNK 10274, SNK 10199, SNK10241, and SNK10248 (52.39, 51.30, 51.00, 51.00, 50.69, 50.12 and 50.00 respectively) were found to be superior over with best check and superiority over the popular jaggery variety Co 92005 (45.81).

All the progenies recorded significantly higher CCSY over the best popular jaggery check Co 92005 (45.81)

4.3.2.6 Purity (%) at harvest

The value of purity (%) ranged from 62.52 (SNK10194) to 90.63 (SNK10243). The genotype SNK10243 has recorded higher purity (%) among the superior productive genotypes but on par with the best check Co 86032 (92.02).

Other genotypes like SNK 10303, SNK 10199, SNK10286, and SNK10241 (89.36, 88.97, 88.61 and 87.36 respectively) were found to be on par with best checks.

Whereas SNK 10194 and SNK 10245 (62.52 and 87.18 respectively) recorded lowest purity (%) among 10 superior productive genotypes compare to checks.

4.3.2.7 brix Yield (t/ha)

The value for brix yield ranged from 23.32 (SNK10241) to 26.65 (SNK10248). The genotype SNK10274 has recorded higher brix yeld compared to best check CoC 671 (20.87).

All other genotypes like SNK10274, SNK10194, SNK 10245, SNK 10199, SNK 10243, SNK 10232, and SNK 10286 (26.43, 25.82, 25.55, 25.13, 24.95, 24.56 and 24.40 respectively) recorded higher brix yield among all the genotypes compared to all checks.

Table 18: Mean performance of superior productive genotypes for jaggery productivity parameters at Sankeshwar (Organic Environment)

Genotypes	**Jaggery recovery %**	**Jaggery yield ($t\ ha^{-1}$)**	**Cane yield ($t\ ha^{-1}$)**
SNK10058	6.94	10.92	100.00
SNK10134	8.24	8.56	103.50
SNK10148	9.23	7.80	84.50
SNK10162	9.70*	9.23	95.50
SNK10170	8.27	11.00	93.00
SNK10194	7.49	7.16	95.50
SNK10199	7.81	12.00	107.50
SNK10232	9.23	9.14	98.50
SNK10241	10.08*	9.72	96.50
SNK10245	7.52	9.67	110.00
SNK10248	7.27	9.50	95.00
SNK10263	6.70	6.79	101.00
SNK10274	6.92	7.26	105.00
SNK10280	8.83	9.00	88.00
SNK10283	10.76*	8.50	98.00
SNK10286	10.45*	10.37	93.50
SNK10303	8.50	10.14	107.50
Checks			
CoC 671	9.43	10.73	70.50
Co 92005	7.41	10.00	77.50
Co 86032	9.28	7.92	85.00
Mean	**8.5**	**9.27**	**95.28**
S.Em.	0.71	0.91	5.70
CD 5%	2.09	2.7	16.86
CV %	11.75	13.91	8.45

4.3.3 Studies on jaggery quality and productivity components

4.3.3.1a Jaggery yield parameters (Organic Environment)

4.3.3.1.1 Jaggery recovery (%)

The result for jaggery productivity parameters are presented in Table 18. The value of jaggery recovery (%) ranged from 6.70 (SNK10263) to 10.76 (SNK10283). The genotype SNK10283 has recorded higher jaggery recovery (%) among the superior productive genotypes and compare to the best check CoC 671 (9.43).

Other genotypes like SNK 10286, SNK 10241, and SNK10162 (10.45, 10.08 and 9.70 respectively) were found to be superior to all the checks.

The genotypes like SNK 10283, SNK 10148, SNK 10283, SNK 10303, SNK 10170, SNK 10134, SNK 10199,SNK 10245 and SNK 10194 (9.23, 9.23,8.83, 8.50, 8.27, 8.24, 7.91, 7.52 and 7.49 89.32 respectively) were found to be superiority over the popular jaggery variety Co 92005 (7.41).

4.3.3.1.2 Jaggery Yield (t/ha)

The value of jaggery yield ranged from 6.79 (SNK10263) to 12.00 (SNK10199). The genotype SNK10199 has recorded higher jaggery yield among the superior productive genotypes and compare to the best check CoC 671 (10.73).

Other genotypes like SNK 10170, SNK 10058, SNK 10286, SNK 10303, SNK 10241,SNK 10245, SNK 10248, SNK 10162, SNK 10232, SNK 10280, SNK 10134 and SNK 10283, (11.00, 10.92, 10.37, 10.14, 9.72, 9.67, 9.50, 9.23, 9.14, 9.00, 8.56 and 8.50 respectively) were found to be superior to all the checks.

The genotypes like SNK 10170, SNK 10058, SNK 10286 and SNK 10303 (11.00, 10.92, 10.37 and 10.14 respectively) were found to be superiority over the popular jaggery variety Co 92005 (10.00).

4.3.3.1.3 Cane Yield (t/ha)

The value for Cane yield ranged from 84.50 (SNK10148) to 110.00 (SNK10245).The genotype SNK10245 has recorded higher Cane yield compared to best check Co 86032 (85.00). All other genotypes recorded higher Cane yield among all the genotypes compared to all checks.

All the genotypes except SNK 10148 (84.50) recorded significantly superior cane yield over the best check Co 86032 (85.00).

4.3.3.1.b Jaggery yield parameters (Integrated Environment)

4.3.3.1.1 Jaggery recovery (%)

The result for jaggery productivity parameters are presented in Table 19. The value of jaggery recovery (%) ranged from 6.17 (SNK10199) to 9.96 (SNK10286). The genotype SNK10286 has recorded higher jaggery recovery (%) among the superior productive genotypes and compare to the best check CoC 671 (1072).

Other genotypes like SNK 10134, SNK 10241, and SNK10162 (9.56, 9.29 and 8.94 respectively) were found to be superiority over the popular jaggery variety Co 92005 (8.93).

Table 19: Mean performance of superior productive genotypes for jaggery productivity parameters at Sankeshwar (Integrated Environment)

Genotypes	**Jaggery recovery %**	**Jaggery yield ($t\ ha^{-1}$)**	**Cane yield ($t\ ha^{-1}$)**
SNK10058	8.24	7.94	96.64
SNK10134	9.56	9.60*	100.47
SNK10148	8.46	8.35	98.50
SNK10162	8.94	8.82	98.50
SNK10170	8.43	7.42	87.87
SNK10194	6.55	7.76	118.50
SNK10199	6.17	7.00	113.50
SNK10232	8.40	9.86*	117.50
SNK10241	9.29	10.02*	107.84
SNK10245	6.69	7.79	116.50
SNK10248	7.25	8.51	117.00
SNK10263	7.54	7.43	98.30
SNK10274	6.94	9.07	132.00
SNK10280	7.68	7.12	92.63
SNK10283	7.75	7.85	101.24
SNK10286	9.96	10.98*	109.78
SNK10303	8.61	9.37	109.00
Checks			
CoC 671	10.72	9.04	84.64
Co 92005	8.93	7.36	85.38
Co 86032	8.65	7.19	84.00
Mean	**8.24**	**8.42**	103.49
S.Em.	0.57	0.73	5.48
CD 5%	1.68	2.15	16.21
CV %	9.73	12.18	7.48

4.3.3.1.2 Jaggery Yield (t/ha)

The value of Jaggery yield ranged from 7.12 (SNK10280) to 10.98 (SNK10286). The genotype SNK10286 has recorded higher Jaggery yield among the superior productive genotypes and compare to the best check CoC 671 (9.04).

Other genotypes like SNK 10241, SNK 10232, SNK 10134, SNK 10303 and SNK 10274 (10.02, 9.86, 9.60 and 9.37 respectively) were found to be superior to all the checks.

All the progenies recorded significantly higher jaggery yield over the best popular jaggery check Co 92005 except SNK 10199 and SNK 10280.

4.3.3.1.3 Cane Yield (t/ha)

The value for Cane yield ranged from 92.63 (SNK10280) to 132.00 (SNK102274).The genotype SNK10274 has recorded higher Cane yield compared to best check Co 92005 (85.38). All other genotypes recorded higher Cane yield among all the genotypes compared to all checks.

The entire genotypes recorded significantly superior cane yield over the best check Co 86032 (84.00).

4.3.3.2.a Jaggery quality parameters (Organic Environment)

4.3.3.2.1 Jaggery pH

The result for jaggery pH parameters are presented in Table 20. The value of jaggery pH ranged from 4.35 (SNK10286) to 6.12 (SNK10134). The genotype SNK10134 has recorded higher jaggery pH among the superior productive genotypes and compare to the best check Co 92005 (5.18).

The genotypes like SNK 10134 (6.12) and SNK 10199 (5.19) showed superiority over the best jaggey check Co 92005 (5.18) for pH of the jaggery solution.

4.3.3.2.2 OD value (at 540nm)

The OD value range from 0.44 (SNK10263, SNK 10303) to 1.22 (SNK 10058). The genotype SNK10058 has recorded higher OD value followed by SNK 10286 among the superior productive genotypes and compare to the best check Co 86032 (0.50).

All the genotypes except SNK 10263(0.44), SNK303 (0.44) and SNK 10280(0.45) showed superiority over the best jaggey check Co 92005(0.50).

4.3.3.2.3 Ash content (%)

The ash content value range from 3.39 (SNK 10170) to 5.02 (SNK 10245). The genotype SNK10245 has recorded higher ash content among the superior productive genotypes and compare to the best check Co 92005(4.47). Whereas genotypes like SNK 10170 and SNK10162 (3.39 and 3.43 respectively) recorded lower ash per cent among superior genotypes compared to checks.

Among superior 17, all the progenies except SNK 10245, SNK 10241, SNK 10248, SNK 10232 and SNK 10148 (5.02, 4.81, 4.81, 4.59 and 4.52 respectively) recorded higher values over the popular jaggery variety Co 92005 (4.47).

4.3.3.2.4 Non-reducing sugars (%)

The value of non-reducing sugars (sucrose % jaggery) ranged from 76.43 (%) (SNK 10232) to 86.06 (%) (SNK 10263). The genotype SNK 10263 has recorded higher sucrose (%) (86.06) in jaggery compared to best jaggery check Co 92005 (85.14). Apart from this, clones like SNK 10162 (83.36 %) and SNK 10148 (82.37 %) were found to be superior with check Co 86032 (82.17 %).

Table 20: Mean performance of superior productive genotypes for jaggery quality parameters at Sankeshwar (Organic Environment)

Genotypes	Jaggery pH	OD value (at 540 nm)	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)
SNK10058	4.67	1.22*	4.22	81.18	10.72	91.9
SNK10134	6.12*	0.83	4.15	78.21	11.95	90.16
SNK10148	5.16	0.79	4.52	82.37	11.12	93.49
SNK10162	4.95	0.76	3.43	83.36	13.09*	96.45
SNK10170	5.25	0.72	3.39	81.18	11.54	92.72
SNK10194	4.87	0.94	4.04	78.21	12.12	90.33
SNK10199	5.19	0.74	4.25	77.22	12.27	89.49
SNK10232	4.48	0.62	4.59	76.43	12.68	89.11
SNK10241	4.97	0.73	4.81	81.18	11.00	92.18
SNK10245	5.10	0.63	5.02	82.17	11.75	93.92
SNK10248	4.93	0.59	4.81	81.18	14.01*	95.19
SNK10263	4.84	0.44	3.97	86.06	11.38	97.44
SNK10274	4.81	0.53	4.20	82.17	12.40	94.57
SNK10280	5.00	0.45	4.09	81.58	13.65*	95.23
SNK10283	4.63	0.66	3.75	78.21	13.26*	91.47
SNK10286	4.35	0.98*	4.47	78.21	11.07	89.28
SNK10303	4.54	0.44	4.04	78.21	11.85	90.06
Checks						
CoC 671	5.05	0.46	3.97	85.14	10.68	95.82
Co 92005	5.18	0.49	4.47	85.14	11.91	97.05
Co 86032	5.21	0.50	3.66	82.17	12.10	94.27
Mean	4.96	0.69	4.19	80.98	12.57	93.54
S.Em.	0.20	0.16	0.29	1.78	0.78	1.44
CD 5%	0.59	0.48	0.87	5.25	2.31	4.26
CV %	5.68	33.31	9.93	3.10	8.79	2.19

Whereas clones like SNK 10232, SNK 10199, SNK 10134, SNK 10194, SNK 10283, SNK10286 and SNK 10303 (76.43, 77.22, 78.21, 78.21, 78.21, 78.21 and 78.21 respectively) recorded lowest sucrose (%) jaggery among superior genotypes compare to all checks.

4.3.3.2.5 Reducing sugars (%)

The reducing sugar ranged from 10.72 (SNK 10058) to 14.01 (SNK 10248). The genotype SNK 10248 recorded higher reducing sugar (%) compare to best check Co 92005(12.91). Apart from this, other genotypes like SNK SNK 10286, SNK 10148, SNK 10263 and SNK 10170 (11.07, 11.12, 11.38, 11.54 respectively) recorded lower reducing sugar (%) compare to best check Co 92005(12.91).

4.3.3.2.6 Total sugars (%)

The value of total sugars (%) ranged from 89.11 (SNK10232) to 97.44 (SNK10263). The genotype SNK10263 has recorded higher total sugars (%) among the superior productive genotypes but on par with the best check Co 92005 (98.05). Other genotypes like SNK 10162, SNK 10280, SNK 10248 and SNK10274 (96.45, 95.23, 95.19 and 94.57 respectively) were found to be on par with all the checks.

Whereas SNK 10199, SNK 10134, SNK 10283, SNK 10058, SNK 10303, SNK 10286, and SNK 10170 (89.49, 90.16, 91.4, 91.90, 92.28, 92.06 and 92.72 respectively) recorded lowest total sugars (%) among superior productive genotypes compare to checks.

4.3.3.2.b Jaggery quality parameters (Integrated Environment)

4.3.3.2.1 Jaggery pH

The result for jaggery pH parameters are presented in Table 21. The value of jaggery pH ranged from 4.60 (SNK10286) to 5.42 (SNK10245). The genotype SNK10245 has recorded higher jaggery pH among the superior productive genotypes and compare to the best check Co 86032 (5.08).

The genotypes like SNK 10245, SNK 10170, SNK 10058, SNK 10199, SNK 10303, SNK 10134, SNK 10263 , SNK 10148 and SNK 10241 (5.42, 5.26, 5.03, 4.92, 4.90, 4.90, 90 4.81, 4.79 and 4.76 respectively) showed superiority over the best jaggey check Co 92005 (4.74) for pH of the jaggery solution.

4.3.3.2.2 OD value (at 540nm)

The OD value range from 0.36 (SNK10303) to 1.13 (SNK 10199). The genotype SNK10199 has recorded higher OD value among the superior productive genotypes and compare to the best check Co C 671(0.49). All the genotypes showed superiority over the best jaggey check Co 92005 (0.34).

4.3.3.2.3 Ash content (%)

The ash content value range from 3.70 (SNK 10170) to 5.56 (SNK 10286). The genotype SNK10286 has recorded higher ash content among the superior productive genotypes and compare to the best check Co 92005(4.53).

Whereas genotypes like SNK 10162, SNK 10148, SNK 10303, SNK 10170, SNK 10280, SNK 10199 and SNK10232 (3.70, 3.84, 3.90, 3.97, 4.19, 4.20 and 4.28 respectively) recorded lower ash per cent among superior productive genotypes compared to the popular jaggery variety Co 92005 (4.53).

Table 21: Mean performance of superior productive genotypes for jaggery quality parameters at Sankeshwar (Integrated Environment)

Genotypes	Jaggery pH	OD value (at 540 nm)	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)
SNK10058	5.03	0.85*	4.92	75.74	12.74*	88.48
SNK10134	4.90	0.81*	4.45	79.40	13.82*	93.22
SNK10148	4.79	0.81*	3.70	82.17	13.32*	95.49*
SNK10162	4.61	0.76*	3.84	78.11	11.43*	89.54
SNK10170	5.26	0.63	3.97	78.31	12.66*	90.97
SNK10194	5.05	0.80*	5.43*	77.02	9.64	86.66
SNK10199	4.92	0.94*	4.20	80.88	11.13	92.01
SNK10232	4.58	0.73	4.28	79.20	13.97*	93.17
SNK10241	4.76	0.70	4.97	80.29	10.16	90.45
SNK10245	5.42*	0.58	4.60	83.57	11.67*	95.24*
SNK10248	5.05	0.51	5.01	76.73	10.43	87.16
SNK10263	4.81	0.81*	5.00	80.19	10.8	90.99
SNK10274	4.65	0.82*	5.05	82.10	12.95*	95.05*
SNK10280	4.67	0.43	4.19	81.58	11.99*	93.57
SNK10283	4.68	0.54	4.76	82.17	10.24	92.41
SNK10286	4.60	0.89*	5.56*	84.08	9.99	94.07
SNK10303	4.90	0.36	3.90	81.18	10.26	91.44
Checks						
CoC 671	4.75	0.49	4.23	83.56	9.75	93.31
Co 92005	4.74	0.34	4.53	79.60	9.62	89.22
Co 86032	5.08	0.48	4.39	86.13	9.45	95.58
Mean	**4.86**	**0.68**	**4.55**	**80.60**	**11.30**	**91.90**
S.Em.	0.19	0.14	0.52	1.81	0.52	1.75
CD 5%	0.57	0.41	1.54	5.37	1.54	5.19
CV %	5.61	28.96	16.15	3.18	6.50	2.70

4.3.3.2.4 Non-reducing sugars (%)

The value of non-reducing sugars ranged from (75.74 %) (SNK 10058) to (84.08 %) (SNK 10286). The genotype SNK 10286 has recorded higher sucrose (%) (84.08) among the superior genotypes and on par with best check Co 86032 (86.13).

Apart from this, clones like SNK 10286, SNK 10245, SNK 10283, SNK 10148, SNK 10274, SNK 10280, SNK 10303, SNK 10199 and SNK 10263 (84.08, 83.57, 82.17, 82.17, 82.10, 81.58, 81.18, 80.88 and 80.19 respectively) were found to be superior with check best popular jaggery variety Co 92005 (79.60 %).

4.3.3.2.5 Reducing sugars (%)

The reducing sugar ranged from 9.64 (SNK 10194) to 13.82 (SNK 10134). The genotype SNK 10134 recorded higher reducing sugar (%) compare to best check CoC 671 (9.75).

All the genotypes recorded significantly superior reducing sugar (%) over the popular jaggery variety Co 92005(9.62).

None of the genotypes recorded lowest reducing sugar (%) except SNK 10194 among superior productive genotypes compared to all checks.

4.3.3.2.6 Total sugars (%)

The value of total sugars (%) ranged from 86.66 (SNK 10194) to 95.49 (SNK 10148). The genotype SNK10148 has recorded higher total sugars (%) among the superior productive genotypes but on par with the best check Co 86032 (95.58).

Other genotypes like SNK 10245, SNK 10274, SNK 10286, SNK 10280 and SNK10232 (95.12, 95.05, 94.07, 93.57 and 93.17 respectively) were found to be on par with Co 86032 (95.58).

All the genotypes recorded significantly superior total sugar (%) over the popular jaggery variety Co 92005(89.22) except SNK 10194 (86.66) and SNK 10058 (88.48).

4.3.3.3.a Performance of superior seventeen productive genotypes for organoleptic characters (Organic Environment)

4.3.3.1 Color and Appearance

The analysis of variance and results for organoleptic characters are presented in Table 22 & 23 respectively. The values for colour and appearance ranged from 6.31 (SNK 10199) to 8.05 (SNK 10232). The genotype SNK 10232 has recorded higher values for color and appearance compared to best check Co 92005 (6.93).

Other genotypes like SNK 10162, SNK 10248, SNK 10134, SNK 10280, SNK 10194,SNK 10286, SNK 10263, SNK 10148, SNK 10283 and SNK 10303 (7.98, 7.66, 7.61, 7.50, 7.45, 7.44, 7.38, 7.38, 7.25 and 7.14 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

4.3.3.2 Texture

The values for texture ranged from 6.83 (SNK 10134) to 8.25 (SNK 10232). The genotype SNK 10232 has recorded higher values for texture compared to best check CoC 671 (7.06).

Other genotypes like SNK 10194, SNK 10162, SNK 10283, SNK 10148, SNK 10280, SNK 1099, SNK 10303, SNK 10148, SNK 10286 and SNK 10241 (7.88, 7.53, 750, 7.50 7.49, 7.44, 7.44, 7.38, 7.25 and 7.16 respectively) recorded higher values for texture among superior genotypes compared to all checks.

Table 22: Analysis of Variance for Organoleptic test parameters of jaggery Lumps (Organic Environment)

Source	df	Colour and appearance	Texture	Taste	Flavor	Overall acceptablility	Acceptability Index
Genotype	19	0.49**	0.40**	0.29**	0.20**	0.28**	31.25**
Replication	1	0.14	0.10	0.11	0.14	0.16	0.40
Error	19	0.05	0.04	0.04	0.05	0.06	0.15
S.Em.		0.15	0.15	0.13	0.16	0.17	0.27
CD at 5%		0.45	0.43	0.40	0.48	0.49	0.80
CV		3.01	2.82	2.53	3.16	3.22	0.48

* - Significant of probability at 5%
** - Significant of probability at 1%

Table 23: Mean performance of superior genotypes for organoleptic characters (Organic Enivrnoment)

Genotypes	Colour and appearance	Texture	Taste	Flavor	Overall acceptablility	Acceptability Index
SNK10058	6.61	6.85	7.19	6.75	7.18	73.69
SNK10134	7.61	6.83	7.75	6.98	7.19	80.05
SNK10148	7.38	7.50	7.36	7.49	7.13	81.11
SNK10162	7.98	7.53	7.89	7.76	7.63	84.72
SNK10170	7.04	7.88	7.31	7.00	7.45	78.72
SNK10194	7.45	8.15	7.31	7.88	7.44	85.28
SNK10199	6.31	7.44	7.26	7.31	6.94	78.06
SNK10232	8.05	8.25	8.13	7.88	8.25	90.00
SNK10241	6.96	7.16	7.38	7.13	6.75	77.78
SNK10245	6.74	7.15	6.61	7.11	6.50	73.61
SNK10248	7.66	7.44	7.99	7.25	7.50	83.61
SNK10263	7.38	7.00	7.63	7.50	7.50	82.11
SNK10274	6.99	7.00	7.88	7.31	7.50	81.94
SNK10280	7.50	7.49	7.88	7.37	7.75	83.00
SNK10283	7.25	7.50	7.88	7.75	7.50	84.08
SNK10286	7.44	7.25	7.00	7.06	7.58	80.00
SNK10303	7.13	7.38	7.23	7.26	7.38	80.83
Checks						
CoC 671	6.23	7.06	7.38	7.13	7.25	77.89
Co 92005	6.93	6.94	7.49	7.25	7.25	79.05
Co 86032	6.71	6.40	7.28	7.00	7.00	76.94
Mean	**7.17**	**7.31**	**7.49**	**7.31**	**7.33**	**80.62**
S Em	0.15	0.15	0.13	0.16	0.17	0.27
CV	3.01	2.82	2.53	3.16	3.22	0.48

4.3.3.3 Taste

The values for taste ranged from 7.00 (SNK 10286) to 8.13 (SNK 10232). The genotype SNK 10232 has recorded higher values for taste and flavor compared to best check Co 92005 (7.49).

Other genotypes like SNK 10248, SNK 10232, SNK 10274, SNK 10280, SNK 10283 and SNK 10134 (7.99, 7.89, 7.88, 7.88, 7.88, and 7.75 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

Whereas SNK 10286, SNK 10058, and SNK 10303 (7.00, 7.19 and 7.23 respectively) recorded lower values for this parameter among superior productive genotypes compare to checks.

4.3.3.4 Flavor

The values for flavor ranged from 6.75 (SNK 10058) to 7.88 (SNK 10194 & SNK 10232). The genotype SNK 10194 & SNK 10232 has recorded higher values for taste and flavor compared to best check Co 92005(7.25). Other genotypes like SNK 10162, SNK 10283, SNK 10263, SNK 10148, SNK 10280, SNK 10274 and SNK 10199 (7.76, 7.75, 7.50, 7.49, 7.37, 7.31, and 7.31 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

Whereas SNK 10058, and SNK 10134 (6.75 and 6.98 respectively) recorded lower values for this parameter among superior productive genotypes compare to checks.

4.3.3.5 Overall acceptablility

The values for overall acceptability ranged from 6.5 (SNK 10245) to 8.25 (SNK 10232). The genotype SNK 10232 has recorded higher values for overall acceptability compared to best check Co 920005 (7.25).

Other genotypes like SNK 10280, SNK 10162, SNK 10286, SNK 10303, SNK 10248, SNK 10263, SNK 10274, SNK 10283 and SNK 10170 (7.75, 7.63, 7.8, 7.38, 7.50, 7.50, 7.50, 7.50, and 7.45 respectively) recorded higher values for overall acceptability among superior genotypes compared to all checks.

Whereas SNK 10245, SNK 10241, and SNK 10199 (6.50, 6.75 and 6.94 respectively) recorded lowest values for overall acceptability among superior productive genotypes compare to all the checks.

4.3.3.5 Acceptability Index

The values for acceptability Index ranged from 73.61 (SNK 10245) to 90.00 (SNK 10232). The genotype SNK 10232 has recorded higher values for taste and flavor compared to best check Co 92005 (79.05).

Other genotypes like SNK 10194, SNK 10162, SNK 10283, SNK 10248, SNK 10280, SNK 10263, SNK 10274, SNK 10148, SNK 10303, SNK 10134 and SNK 10286 (85.28, 84.72, 84.08, 83.61, 83.00, 82.11, 81.94, 81.11, 80.83, 80.05 and 80.00 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

Whereas SNK 10058 (73.69) recorded lower values for this parameter among 17 superior productive genotypes compare to checks.

4.3.3.3.b Performance of superior seventeen productive genotypes for organoleptic characters (Integrated Environment)

4.3.3.1 Color and Appearance

The analysis of variance and results for organoleptic characters are presented in Table 24 & 25 respectively. The values for Colour and appearance ranged from 5.0 (SNK 10194) to 7.8 (SNK 10232). The genotype SNK 10232 has recorded higher values for color and appearance compared to best check CoC (7.30).

Other genotypes like SNK 10134, SNK 10058, SNK 10162 and SNK 10280 (7.5, 7.4, 7.40 and 7.30 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

4.3.3.2 Texture

The values for texture ranged from 6.10 (SNK 10274) to 8.10 (SNK 10232). The genotype SNK 10232 has recorded higher values for texture compared to best check CoC 671 (7.10).

Other genotypes like SNK 10134, SNK 10162, SNK 10241, SNK 10148, SNK 10280 and SNK 10248 (7.5, 7.5, 7.5, 7.5, 7.4 and 7.4, respectively) recorded higher values for texture among superior genotypes compared to all checks.

4.3.3.3 Taste

The values for taste ranged from 5.9 (SNK 10245) to 8.1 (SNK 10232). The genotype SNK 10232 has recorded higher values for taste and flavor compared to best check Co 92005(7.10). Other genotypes like SNK 10248, SNK 10134, SNK 10058, SNK 102148, SNK 10274, SNK 10280 and SNK 10303 (7.6, 7.5, 7.4, 7.4, 7.4, 7.4, and 7.3 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

Whereas SNK 10245, SNK 10286, SNK 10263and SNK 10162 (5.9, 6.6, 6.8 and 6.9 respectively) recorded lower values for this parameter among superior productive genotypes compare to checks.

4.3.3.4 Flavor

The values for flavor ranged from 5.6 (SNK 10245) to 7.9 (SNK 10232). The genotype SNK 10232 has recorded higher values for taste and flavor compared to best check CoC 671 (7.10). Other genotypes like SNK 10248, SNK 10274, SNK 10241, SNK 10148 and SNK 10134 (7.5, 7.4, 7.4. 7.3 and 7.3 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

All the genotypes recorded significantly superior except SNK 10245 (5.6) recorded lower values for this parameter among superior productive genotypes compare to best popular jaggery variety Co 92005 (6.5).

4.3.3.5 Overall acceptablility

The values for overall acceptability ranged from 6.0 (SNK 10248) to 7.9 (SNK 10232). The genotype SNK 10232 has recorded higher values for overall acceptability compared to best check CoC 671 (7.0).

Other genotypes like SNK 10248, SNK 10134, SNK 10162, SNK 10248. SNK 10170, SNK 10194 and SNK 10058 (7.50, 7.50, 7.50, 7.50, 7.50, 7.5 and 7.4 respectively) recorded higher values for overall acceptability among superior genotypes compared to all checks.

Table 24: Analysis of Variance for Organoleptic test parameters of jaggery Lumps (Integrated Environment)

Source	df	Colour and appearance	Texture	Taste	Flavor	Overall acceptablility	Acceptability Index
Genotype	19	1.00**	0.64**	0.32**	0.35**	0.37**	32.82**
Replication	1	0.37	0.51	0.25	0.22	0.17	5.48
Error	19	0.13	0.15	0.06	0.06	0.04	1.47
S.Em.		0.40	0.25	0.27	0.18	0.17	0.15
CD at 5%		1.19	0.75	0.80	0.53	0.51	0.44
CV		10.27	5.35	5.34	3.50	3.43	2.96

* - Significant of probability at 5%
** - Significant of probability at 1%

Table 25: Mean performance of superior genotypes for organoleptic characters (Integrated Environment)

Genotypes	Colour and appearance	Texture	Taste	Flavor	Overall acceptablility	Acceptability Index
SNK10058	7.4	7.3	7.4	7.1	7.4	81.11
SNK10134	7.5	7.5	7.5	7.3	7.5	82.78
SNK10148	6.5	7.5	7.4	7.3	7.5	80.28
SNK10162	7.4	7.5	6.8	7.1	7.5	80.56
SNK10170	6.0	7.1	7.0	6.9	7.5	76.67
SNK10194	5.0	6.9	7.1	7.0	7.5	74.44
SNK10199	5.3	6.8	7.1	6.8	6.8	72.50
SNK10232	7.8	8.1	8.1	7.9	7.9	88.33
SNK10241	6.3	7.5	7.0	7.4	7.0	78.06
SNK10245	6.1	6.4	5.9	5.6	6.0	66.67
SNK10248	7.0	7.4	7.6	7.5	7.5	82.22
SNK10263	6.4	6.8	6.9	7.1	6.8	75.28
SNK10274	6.4	6.1	7.4	7.4	6.9	75.83
SNK10280	7.3	7.4	7.3	6.9	6.5	78.33
SNK10283	6.6	7.1	7.4	6.9	6.6	76.94
SNK10286	6.8	6.9	6.6	6.5	6.8	74.44
SNK10303	6.8	6.9	7.4	6.9	6.6	76.67
Checks						
CoC 671	7.3	7.1	7.1	7.1	7.0	79.17
Co 92005	6.5	6.6	7.1	6.5	6.5	73.89
Co 86032	6.5	6.6	7.6	7.0	7.3	77.78
Mean	**6.72**	**7.18**	**7.26**	**7.10**	**7.11**	**77.97**
S Em	.25	0.27	0.18	0.17	0.15	0.86
CV	5.35	5.34	3.50	3.43	2.96	1.56

All the genotypes recorded significantly superior except SNK 10248 (6.0) recorded lowest values for overall acceptability among superior productive genotypes compare to best popular jaggery variety Co 92005 (6.5).

4.3.3.5 Acceptability Index

The values for acceptability Index ranged from 66.67 (SNK 10245) to 88.33 (SNK 10232). The genotype SNK 10232 has recorded higher values for taste and flavor compared to best check CoC 671 (79.17).

Other genotypes like SNK 10134, SNK 10248, SNK 10058, SNK 10162 and SNK 10148 (82.78, 82.22, 81.11, 80.56 and 80.28 respectively) recorded higher values for this parameter among superior genotypes compared to all checks.

All the genotypes recorded significantly superior except SNK 10245 (66.67) recorded lower values for this parameter among superior productive genotypes compare compare to best popular jaggery variety Co 92005 (73.89).

5. DISCUSSION

Sugarcane is one of the most important commercial crop in the world. It is the main source of energy for man both for his food as well as industrial needs. Sugarcane varietal improvement involves genetic enhancement of the production potential. Sugarcane is grown mainly for sugar and its output is the ultimate character that must show improvement over the current standards. This could be achieved indirectly through several ways like superior cane yield, better juice quality (sugar content), tolerance to insect pests and abiotic stresses. Sugarcane nevertheless, is a difficult plant to breed. Modern day varieties are species hybrids, complex polyploids, defying many conditions necessary for genetic studies.

The cane and sugar yields are determined by the interaction of a number of characters among themselves and with the environment making them highly variable. Therefore, the knowledge about nature and extent of genetic variability, association among various characters and their direct and indirect contributions to cane yield are essential in planning the breeding programmes.

Organic sugarcane farming is basically a holistic management system which promotes and improves the health of agro-ecosystem related to biodiversity, nutrients, soil microbial and bio-chemical activities. It emphasizes management practices involving substantial use of organic manures, green manuring and management of pests and diseases through the use of non synthetic pesticides and practices. Thus, organic sugarcane farming prohibits the use of harmful chemicals and promotes the use of renewable organic resources to maintain the soil productivity and to control the crop diseases and pests (Government of India, 2001). The beneficial effects of organic farming on human health, wildlife, domestic animals, and environment are impressive. Although organic sugarcane farming is gaining importance in recent years, increasing agricultural production is a vital national concern. At one end, high input intensive agriculture is perceived as detrimental to sustainability of agriculture and environment while at the other, concerns are raised about the viability of alternative farming system such as organic farming.

Therefore, it is essential to critically examine the performance of organic vis-a-vis inorganic sugarcane agriculture. In view of this the present investigation, thirty eight newly developed clones of sugarcane along with nine parents and three checks were evaluated for various characters under organic sugarcane farming (OSF) and the integrated sugarcane farming (ISF) in Sankeshwar.

With this perspective, an attempt has been made to assess the performance of OSF and ISF in Sankeshwar with specific focus on chemical free jaggery production. An attempt has also been made to critically examine the OSF with respect to assess the variability and its parameters in sugarcane productive clones, and also aimed at developing high yielding productive clone(s) of sugarcane for cane and jaggery yield with special reference to their suitability for organic cultivation and organic jaggery processing for economic well-being and livelihood security of farmers in North Karnataka. In this view, the results obtained from the present investigation, are discussed under the following heads.

5.1. Assessment of genetic variability parameters in selected early clonal populations.

5.2. To study Inter and intra stage repeatability/association for various productivity traits in the population.

5.3. Identification of suitable genotypes for organic/chemical free jaggery production.

5.1. Assessment of genetic variability parameters in selected early clonal populations

5.1.1 Assessment of genetic variability parameters under organic and integrated environment

Thirty eight genotypes were evaluated in organic block and integrated block at ARS Sankeshwar during 2015-16, to know the amount of variability for cane yield and its component characters. The analysis of variance indicated that highly significant differences among genotypes for all the characters *viz.,* germination count at 30 DAP, total shoots at 90 DAP, total shoots at 120 DAP, cane formed shoots at120 DAP, number of millable canes/ha, average number of internodes at harvest, average internodal length at harvest, average cane girth at harvest, average single cane weight at harvest, harvest index (%),brix per cent at 8 th month, brix per cent at 10th month, brix per cent at harvest, sucrose per cent at 8 th month, sucrose per cent at10th month, sucrose per cent at harvest, commercial cane sugar per cent at harvest, juice extaction (%), purity per cent at harvest, cane yield at harvest (t/ha), commercial cane sugar yield (t/ha), and brix yield at harvest (t/ha).

The results clearly indicated the presence of sufficient amount of variability for all characters among the genotypes studied. Therefore, there is lot of scope for selection for majority of the traits in the progenies. Absolute variability of different characters does not reveal about, which of the particular characters are showing the highest variability. This could be accessed through standardizing the genotypic and phenotypic variance and by obtaining coefficients of variability. Thus, components of variation, such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed.

Further, it is essential to know about the selection by separating out the environmental influence from the total variability. This indicates the accuracy with which a genotype can be identified by its phenotypic performance. The estimates of heritability alone fail to indicate the response to selection. Therefore, the heritability estimates appears to be more meaningful when accompanied by estimates of genetic advance. The genetic advance as per cent means (GAM) was also estimated and discussed.

5.1.1.1 Range

A wide range of variation was noticed for cane yield characters studied in the present investigation which is inferring a wide scope of selection for these traits. These results are in congruence with the studies made by Alam *et al.* (2012) and Shehzad *et al.* (2013). Similarly, larger variation was observed for number of millable canes, average millable cane height and juice purity per cent by Ahmed *et al.* (2012), for germination per cent and total shoots by Kamat *et al.* (2001), for number of internodes, plant height, average single cane weight, cane yield (t/ha) by Thippeswamy *et al.* (2001), for average cane girth and juice quality parameters by Reddy and Somarajan (1994). Remarkable range of variation observed for the characters indicated that these characters were quantitative in nature and under polygenic control (Alam *et al.,* 2012).

The analysis of variance revealed significant differences among the clones for the entire trait studied. Thus the clones were genetically divergent. The significant genotypic effects indicated genetic variability among the genotypes and the possibility of genetic improvement in most of the traits studied through selection Punia (1982) and Khan *et al.* (2004). The relatively large genotypic mean squares indicated that clones differed in their potential for the traits. Genetic variance is important as it describes the amount of genetic variation present for the trait.

5.1.1.2 Genotypic, phenotypic coefficient of variability

The estimates for phenotypic coefficient of variation (PCV) were higher than for genotypic coefficient of variation (GCV) in all the traits, suggesting that the apparent variation is not only due to genetic but also due to environmental influences. However, the differences between PCV and GCV for most of the traits were small indicating high prospects for genetic progress through selection under the conditions of this investigation as reported by Ram (2005).

The highest phenotypic and genotypic coefficient of variation (PCV) were observed in both the environmental condition for character *viz.,* germination per cent, total of shoots at 90 days, total shoots at 120 days, cane formed shoots at 120 days and green top yield (Table 3). Whereas number of millable cane shown high (PCV) and moderate (GCV). Genetic variance is important as it describes the amount of genetic variation present for the traits

Results of current study are not similar to Feyissa and Zinaw (2014), Balasundarum and Bhagyalakshmi, (1978); Nair *et al*., (1980) where in high genotypic coefficient of variation for millable cane were reported, this report is against to Singh and Sangwan (1980) reported before High genotypic and phenotypic coefficients of variation for a cane weight and millable cane number.

Superior GCV and PCV were recorded for Germination (%) and Total shoots which are in agreement with the findings of Singh and Singh (1994), Ghosh *et al.* (1996b), Kumar and Singh (1999), Kamat *et al.* (2001), Alam *et al.* (2012).

The GCV and PCV found moderate for average internodal length, single cane weight, sucrose (%) at 8th month in organic and integrated environment, whereas cane yield and CCS yield shown moderate GCV and PCV in integrated. On the contrary, in organic environment shown high PCV with moderate GCV for cane yield CCS yield.

In accordance, moderate estimates of GCV and PCV were observed for the above trait. These findings are in harmony with the findings of Nair and Somarajan (1984), Kadian *et al.* (1997), Thippeswamy *et al.* (2001), Tyagi *et al.* (2011). Bissessur *et al.* (2001) and Singh *et al.* (2001a) reported high GCV and PCV for cane yield. On the contrary, Ram and Hemaprabha (1998) reported moderate estimates for most of the cane yield parameters. Similar findings were reported by Singh and Singh (1999) for cane yield and its components like cane height and cane girth.

In Clonal-III both integrated and organic population, low GCV and PCV was found for average number of intermodal length , cane girth (cm), harvest index (%), brix (%) at 8th month, brix (%) at 10th month, brix (%) at harvest, sucrose (%) at 10th month, sucrose (%) at harvest, CCS (%), juice extraction (%) and purity (%).

GCV and PCV were recorded for low variability for sucrose (%) were also reported by earlier workers Hapase *et al.* (1999), Lourdusamy and Anbuseram (2009), Anbanandan and saravanan (2010). Reddy and Somarajan (1994) and Ahmed *et al.* (2012) reported low variability for brix (%), sucrose (%), CCS% and purity (%) as it is been exhibited in the present study. Among the cane yield components, cane girth exhibited lowest values of GCV and PCV which is in accordance with findings of Balasundaram and Bhagyalakshmi (1978), Nair *et al.* (1980) and Singh *et al.* (1996).

Quality of cane juice is an important aspect of cane cultivation. Among quality characters like sucrose per cent, brix per cent, juice extraction per cent, purity per cent and CCS per cent had lower GCV and PCV values except CCS yield which had high values indicating little difficulty in improving these traits through simple selection. These findings are in harmony with the findings of Nair *et al.* (1980), Singh *et al.* (1981a), Ghosh and Singh (1996a), Anbanandan and Saravanan (2010).

Quality parameters are least influenced by the environment as suggested by the narrow difference between the GCV and PCV values noticed in the present study as also reported by Ghosh and Singh (1996b) and variability pattern for quality characters indicated that genetic factors were predominantly responsible for these characters (Reddy and somarajan 1994).

5.1.1.3 Heritability and genetic advance

The success of a variety improvement programme depends largely on the amount of genetic variability present in the population. Genetic coefficients of variation along with heritability estimates give a better indication of the amount of genetic variation for a trait than either parameter alone. In present study, high heritability (broad sense) estimates were recorded for Germination count at 30 DAP, TS at 90 DAP, TS at 120 DAP, CFS at120 DAP, Number of millable canes/ha, Avg IL, Avg SCW, Harvest index (%), brix (%) at 8^{th} month, sucrose at 8^{th} month, sucrose at 10^{th} month, CCS (%) at harvest, juice extraction (%), brix yield (t/ha) and Cane yield (t/ha) in integrated environment. On the contrary, in organic shown low heritability for Germination count at 30 DAP and Juice extraction, moderate (h^2) for harvest index (%) and CCS (%) at harvest. This suggests that a large proportion of the total variance is heritable and selection of these traits would be effective. Chaudhary (2001) also reported high heritability Singh *et al.* (1994) recorded high heritability estimates for single stalk weight.

High degree of genetic advance for single cane weight and number of millable canes indicated their reliability in selection. Similar results of maximum genetic gain for NMC were also reported by Sahi *et al.* (1977) and Singh and Singh (1999) and Lourdusamy and Anbu selvam (2009).

Moderate to high heritability coupled with high genetic advance were recorded for juice extraction (%), single cane weight, cane length and sucrose per cent by Sanghera *et al.* (2014).

The characters like cane girth recorded moderate heritability coupled with low genetic advance as per cent of mean which are in agreement with Thippeswamy *et al.* (2001) and Mancini *et al.* (2012). However, some of the sugarcane workers like Reddy (1985), Bissessur *et al.* (2001), Singh *et al.* (2001a) reported contrary results indicating high heritability for cane girth which indicating the scope for further improvement.

Moderate heritability was found for Purity (%) and juice extraction (%) with low genetic advance as per cent of mean indicating the predominance of non additive gene action or more environmental influence. Tyagi and Bhardwaj*.,* (2011) reported low genetic advance as per cent of mean for juice extraction (%) and Thippeswamy *et al.* (2001) reported moderate heritability for purity (%).

Heritability estimates along with expected genetic gain is more useful than the heritability value alone in predicting the resultant effect for selecting the best genotypes (Johnson *et al*., 1955). Maximum genetic gain (as percent of mean) was observed for germination (%) , total shoots, cane formed shoots, NMC, SCW, sucrose (%) at 8th month, brix yield and cane yield, indicating that there exists a scope to improve cane yield to a considerable extent by adopting suitable breeding procedures. High genetic advance (as percent of mean) for single cane weight was also reported by Sahi *et al*. (1977), Tyagi and Singh (1998).

The results inferred that selection should be practiced on the basis of single cane weight and number of millable canes as they exhibited closer values of GCV and PCV indicating the major portion of genetic variance towards superior cane yield. Xie *et al.* (1989) reported that number of millable cane is the most useful trait to consider when selection imposed for high cane yield whereas Walker (1965) reported that millable cane is a reasonable selection criterion for high cane yield. High heritability values for quality characters reveals the performance of the studied genotypes in the process of sugar accumulation is least affected by environment. Therefore, improvement in these traits would lead to a significant improvement in yield in limited selection cycles.

5.1.2 Genetic variability parameters for organoleptic traits of jaggery

All the characters shown significance for all the criteria *viz.,* color and appearance, consistency, taste, flavor and overall acceptability. The results revealed that, there is a huge scope for improvement of these traits with the current genetic material.

5.1.3 Correlation among different quantitative characters

The pair wise simple correlation coefficient (r) among various characters is presented in Table 11 and 12. Cane yield recorded highly correlation with number of millable cane, cane height, average internode length, average single cane weight and CCS yield. While positively and significantly correlated with cane formed shoots and cane girth. Correlation pattern is seen similar in both integrated and organic environment. Except for the cane girth which shown positively and significantly correlated with cane yield in organic environment. A positive value of r shows that the change of two variable are in same direction, i.e. high values of one variable are associated with high values of other and vice versa.

A positive and highly significant correlation between cane yield and its components *viz.,*single cane weight, cane height, and number of millable cane was reported by Brown *et al.* (1969), Balasundarum and Bhagyalakshmi (1978) and Punia *et al.* (1983). Hooda *et al* (1979) also observed cane diameter having significant positive correlation with cane yield. Length of internode had positive significant correlation with cane yield. On the other hand, the negative genetic association between number of millable cane with cane girth, single cane weight sucrose (%) and purity (%) indicates that improvement in the latter could result in decrease in the other traits (number of internodes, cane diameter, cane weight, brix (%), sucrose, purity (%), CCS (%) and CCS yield). which are in accordance with the observations of Legendre (1970), Sekhar (1986), Singh and Khan (1995) and Das *et al.* (1996b) and Thippeswamy (2003) for cane yield, Tehlan (1986) for brix per cent.

Negative correlation indicated their inverse relationship with each other. In our study brix (%), sucrose (%), purity (%), CCS (%) and total shoots have shown negatively correlated with cane yield. But all quality parameters were significantly positive correlation with CCS (%). However, Khan *et al.*, (2012) reported negative correlation for cane yield with Pol (%) and CCS (%).

Therefore, characters like number of millable cane, single cane weight, and cane girth should be given due importance while selecting sugarcane clones for higher cane yield. On the other hand sugar yield could be improved by selection for field brix and sucrose (%) as is evident from their strong positive association with sugar yield. However, intermating among the selected clones followed by progeny selection would give significant increase in sugar recovery as is evident from high heritability with high genetic advance.

5.2 Repeatability studies across generation

The current selection cycle for sugarcane is lengthy and more extensive. There is a necessity to reduce the locations/environments for clonal evaluation, without loss of information and without any reduction in precision in order to improve the efficiency of the programme as economic factors are now exerting pressure on breeding programmes to become more efficient and produce better varieties while reducing costs. If the repeatability values for important selection traits are high and significant, there is scope to exercise selection and also to reduce the locations for large clonal evaluations in early stages.

Inter-stage correlations have been used to measure the repeatability of different traits in different stages and environments. Repeatabiliy means how much extent of the character is reappearing in the next generation. Higher the repeatability higher the efficiency of the selection in early generation selection. On contrary if the repeatability is low, there will be difficulty in selection and efficiency will be very low with less reliability on the character. However, if repeatability is high then selection in early generation will be highly reliable and it saves the time as there in no need of advancing generation. We can practice selection in early generation itself.

The efficacy of clonal selection in sugarcane relies on spatial and temporal repeatability of attributes across selection stages. Studies with estimates of repeatability had been reported by Mariotti (1973); Ram *et al.* (1996); Ramdoyal (1999); Sousa *et al.* (2003); Ilyas *et al.* (2010), Pedrozo *et al.* (2011). Estimations in general were moderate to low at early stages. Kang *et al.* (1988) reported that genotype repeatability was low between two stages.

In the present investigations, inter stage repeatabilities between clonal I, II, clonal III (INT) and clonal III (ORG) generations were estimated for important productivity traits. In the present study, the traits like cane formed shoots at 120 DAP and sucrose (%) at harvest, exhibited poor repeatability values indicating, major role of environmental factors which influence on these traits. Similar results were reported for these traits by Milligan *et al.,* 1996; Reddy and Reddi, 1988; Vianna *et al.* (1991), Cuenya and Mariotti (1974). However, Lin *et al.* (1991), Cuenya *et al.* (1999); Sousa *et al.* (2002); Bressiani *et al.* (2003); Xie *et al.* (1989) reported high values of repeatability.

The analysis of repeatability showed that, the repeatability values were highly significant for germination (%) between all the combinations. Highest repeatability value for germination (%) was recorded between clonal III (INT) and clonal II followed by clonal III (INT) and clonal III (ORG). So that one can select genotypes with good germination potential in any environment at early clonal generations targeting genotypes for specific environment. However, there is no report available in the literature in support of this result.

The character total shoots showed significant and positive repeatability across generations and environments. The analysis of repeatability showed that, highest repeatability recorded between clonal III (INT) and clonal III (ORG) indicating there is no need for specific targeted environment for exercising selection. The lowest repeatability was recorded between clonal I and clonal II. However, there no reports available in the literature in support of this result.

The character cane formed shoots showed insignificant and negative repeatability between clonal I and clonal III generation in both integrated and organic environment indicating its, low repetability in early clonal generation. Whereas highest repeatability recorded between clonal III (INT) and clonal III (ORG) suggesting no need for exercising selection in targeted organic environment.

For number of millable cane and cane yield (Table 13.f and 13.o), the highest repeatability occurred in clonal III between integrated and organic. The result indicate, that the selection can be exercised in early clonal integrated environment for realizing improvement in targeted organic environment, particularly for the enhanced cane productivity components. Repeatabilities between clonal I and II were low, which is inferior to those obtained for cane girth and cane height. In this case our results are different from those of Rodrigues (1986) and Ram and Chaudhary (2000), but similar to those of Miller and James (1975).

The highest repeatability value for cane height at harvest was recorded between clonal III (INT) and clonal III (ORG), followed by clonal III (ORG) and clonal II (Table 13.h). These estimates are similar to those presented by Mariotti (1973) in Argentina, who found for mean stalk length between stages I and II on first ratoon crop. On the other hand, Ram and Chaudhary (2000) found estimates that varied from 0.15 to 0.21 between stage I and II plant cane for three open crosses. However, selecting for cane height on clonal II should be liberal and more intense on stage III where repetability is higher.

The analysis of repeatability showed that, highest repeatability value for cane girth at harvest was recorded between clonal III (INT) and clonal III (ORG), followed by clonal III (ORG) and clonal II. The repeatability values obtained in this study are close to those obtained by Rodrigues (1986) but on par to those reported by Ram and Chaudhary (2000), who found estimates between 0.84 and 0.90. We suggest that selection for stalk diameter should be made on plant cane in stages I and II.. However, selecting for cane girth on clonal II should be liberal and more intense on stage III where repetability is higher. This results in a higher selection gain per unit of time.

As a quantitative trait, resulting from other yield components (cane height, cane girth and number of millable cane), the single cane weight had moderate repeatability values (Table 13.g). These values were small between clonal III(INT) and clonal II. Repeatability values between clonal III (INT) and clonal III (ORG) were higher. However, indicating that single cane weight in clonal I and clonal II should not be used as a direct selection criterion. Its components – stalk length, stalk diameter and number of stalks – should instead be preferred for selection in this stage.

Table 13.k and 13.m shows repeatabilities for brix (%) at 10th month and at harvest respectively. Here the values obtained among all stages and crosses were high in cases at 10th month, whereas as in brix (%) at harvest has low repeatability in the initial stages of selection followed by high degree of repetability occurred in clonal III between integrated and organic. These values are higher than those reported in the literature (Mariotti, 1973; Miller and James, 1975; Nageswara and Ethirajan, 1985; Rodrigues, 1986; Ram and Chaudhary, 2000).

Table 13.l and 13.n shows repeatabilities for sucrose (%) at 10th month and at harvest respectively. Here the values obtained among all stages and crosses were high and decreasing from clonal I to clonal III with values greater than 0.60 in most cases at 10th month, whereas as high degree of repetability occurred in clonal III between integrated and organic .The repetability values was negative between clonal I and clonal II which indicate that selection practice should not be done in early generation. However, there no reports available in the literature in support of this result. Hence for practical feasibility in early generation, selection based on brix/ HR brix is enough for better selection efficiency instead of sucrose (%) which is practically laborious and difficult to assess.

For CCS yield the highest repeatability occurred in stage III between organic and integrated, with rp(x) = 0.82. Repeatabilities between stage I and III were low but significant. However, between stages II and III, repeatability values were, highly significant, suggesting its suitability for early generation selection and for non targeted environment.

The important commercial traits *viz*., number of millable canes, single cane weight, cane girth and cane height recorded comparatively higher and highly significant repeatability values across early clonal generations and cultivation practices/ environments indicating these traits as more dependable as selection criteria. Selection for these four important cane productivity traits in early clonal generation in one of the environments is sufficient for targeting the genotypes for diverse environements. These results are in accordance with findings of Milligan and Martin (1996), Ramdoyal (1999), Bressiani *et al*., (2003). Cuenya *et al*., (1999) also reported high repeatability values for number of millable canes and single cane weight in clonal generations across environments, whereas Singh and Singh (1999) and Gravois *et al*. (1991) indicated high degree of repeatability for number of millable canes and juice brix per cent between plant and ratoon crops. Thus, the repeatability of these characters may prove better selection criteria for improving the performance of the crop in advanced clonal generations.

So finally it can be concluded that the cane productivity traits *viz*, millable cane height, cane girth, number of millable canes and single cane weight can be considered for early generation selection to gain improvement in the cane yield in the early generations saving the time and resource. On the other hand it is feasible to practice early generation selection for early high sugar types as both juice brix (%) and sucrose (%) traits exhibited significant and higher ‘r’ value across generation and environments.

Hence, overall early generation in non targeted environment selection could be efficiently be exercised for improvement of both tonnage and juice quality, particularly under organic environment/production practices (organic jaggery).

5.3 Identification of suitable genotypes for organic/chemical free jaggery production

5.3.1 Performance of superior 10 productive genotypes for cane and sugar yield parameters at Sankeshwar (Integrated Environment)

The performance of superior productive genotypes along with commercial checks at ARS Sankeshwar for cane yield and sugar yield components like, average single cane weight (kg), number of millable canes ('000/ha), cane yield (t/ha), sucrose per cent, CCS per cent and CCS yield (t/ha) is presented in Table 26.

It is clear from the Table that, the clones SNK 10274, SNK 10194, SNK 10232, SNK 10199, SNK 10243 and SNK 10241 are significantly superior in terms of their average single cane weight compared to the best productive commercial check Co 86032, where in an improvement of 94.41 per cent (SNK 10274) to 29.37 per cent (SNK 10194) over the best check Co 86032 was recorded.

Similarly for the number of millable canes ('000/ha) (NMC) the genotypes SNK 10245and SNK 10248 are significantly superior compared to the best check Co 86032. Among these superior genotypes SNK 10274 is non significant for NMC but its cane yield is significantly superior than the best check Co 86032, because SNK 10274 had high average single cane weight which ultimately manifests the NMC leading to high cane yield. The per cent increase over best check Co 86032 for NMC was 35.1 per cent (SNK 10248) to 50.3 per cent in (SNK 10248) indicating the contribution to millable cane number. Similarly for cane yield there was an increase of 36.45-37.03 per cent in SNK 10245 and SNK 10248 than the best check Co 86032.

All the superior 10 productive clones, *viz.,* SNK 10274, SNK 10194, SNK 10232, SNK 10248, SNK 10245, SNK 10199, SNK 10243, SNK 10168, SNK 10303 and SNK 10241 were higher in terms of their cane yield compared to the best commercial check Co 86032. The per cent increase over best check Co 86032 for cane yield ranges from 26.31 to 54.60. In all the above genotypes the improved cane yield was attributed by single cane weight. In most of the genotypes the superior single cane weight is on account of higher cane girth, cane height, intermodal length, brix and harvest index. The superior three genotypes for cane yied were SNK 10274, SNK 10194 and SNK 10232. Among these superior genotypes SNK 10243 is also bettert for NMC, sucrose (%), CCS (%) and CCS yield than the best check Co 86032. (Fig. 2)

Though all the top 10 highly productive genotypes recorded superior tonnage, only two *viz.,* SNK 10243 and SNK 10248 recorded superior sugar yield over best check Co 86032, wherein SNK 10243 found superior for juice quality with high sucrose (%) and brix (%) content followed by SNK 10248. Hence these genotypes could be considered as promising for commercial cultivation after large scale testing for integrated cultivation practices (Plate 1).

5.3.2 Performance of superior 10 productive genotypes for cane and sugar yield parameters at Sankeshwar (Organic Environment)

It is clear from the Table 27 that, the clones SNK10274 and SNK 10241 are significantly superior in terms of their average single cane weight compared to the best commercial check Co 86032, wherein increase of 40.08 per cent and 38.97 per cent in SNK 10274 and SNK 10241 respectively for average single cane weight than the best check Co 86032 was recorded.

Table 26: Performance of selected superior 10 productive genotypes for cane and sugar yield parameters at Sankeshwar (Integrated Environment)

Genotypes	Single cane weight (kg)	% Increase or decrease	Number of millable canes ('000 ha^{-1})	% Increase or decrease	Sucrose % Juice at harvest	% Increase or decrease	CCS % at harvest	% Increase or decrease	CCS yield (t ha^{-1})	% Increase or decrease	Cane yield (t ha^{-1})	% Increase or decrease
SNK10274	2.78*	94.41	47.3	-19.4	17.58	-16.64	12.06	-18.84	12.26	-1.76	132*	54.60
SNK10194	1.85*	29.37	64.2	9.4	14.67	-30.44	9.94	-33.11	10.23	-18.03	118.5*	38.79
SNK10232	1.77*	23.78	67.4	14.8	18.11	-14.13	12.4	-16.55	14.59	16.91	117.5*	37.62
SNK10248	1.48	3.50	79.3*	35.1	19.78	-6.21	13.58	-8.61	15.75	26.20	117.0*	37.03
SNK10245	1.32	-7.69	88.2*	50.3	19.13	-9.29	13.14	-11.57	15.32	22.76	116.5*	36.45
SNK10199	2.25*	57.34	50.7	-13.7	19.7	-6.59	13.67	-8.01	15.51	24.28	113.5*	32.94
SNK10243	2.02*	41.26	55.7	-5.1	21.2	0.52	14.96	0.67	15.81	26.68	112.71*	32.01
SNK10286	1.68	17.48	65.5	11.5	19.7	-6.59	13.65	-8.14	15.02	20.35	109.78	28.58
SNK10303	1.68	17.48	65.0	10.7	19.15	-9.20	13.31	-10.43	14.5	16.19	109.0*	27.66
SNK10241	2.07*	44.76	52.0	-11.4	18.89	-10.43	12.98	-12.65	14.01	12.26	107.84*	26.31
Checks												
CoC 671	1.89		45.0		22.19		15.47		13.1		84.64	
Co 92005	1.68		50.7		21.31		15.01		12.8		85.00	
Co 86032	**1.43**		**58.7**		**21.09**		**14.86**		**12.48**		**85.38**	
Mean	**1.84**		**60.74**		**19.33**		**13.39**		**13.95**		**108.33**	
S.Em.	0.1		3.75		1.01		0.77		1.01		5.56	
CD 5%	0.3		11.56		3.12		2.38		3.11		17.13	
CV %	7.6		8.74		7.42		8.14		10.23		7.26	

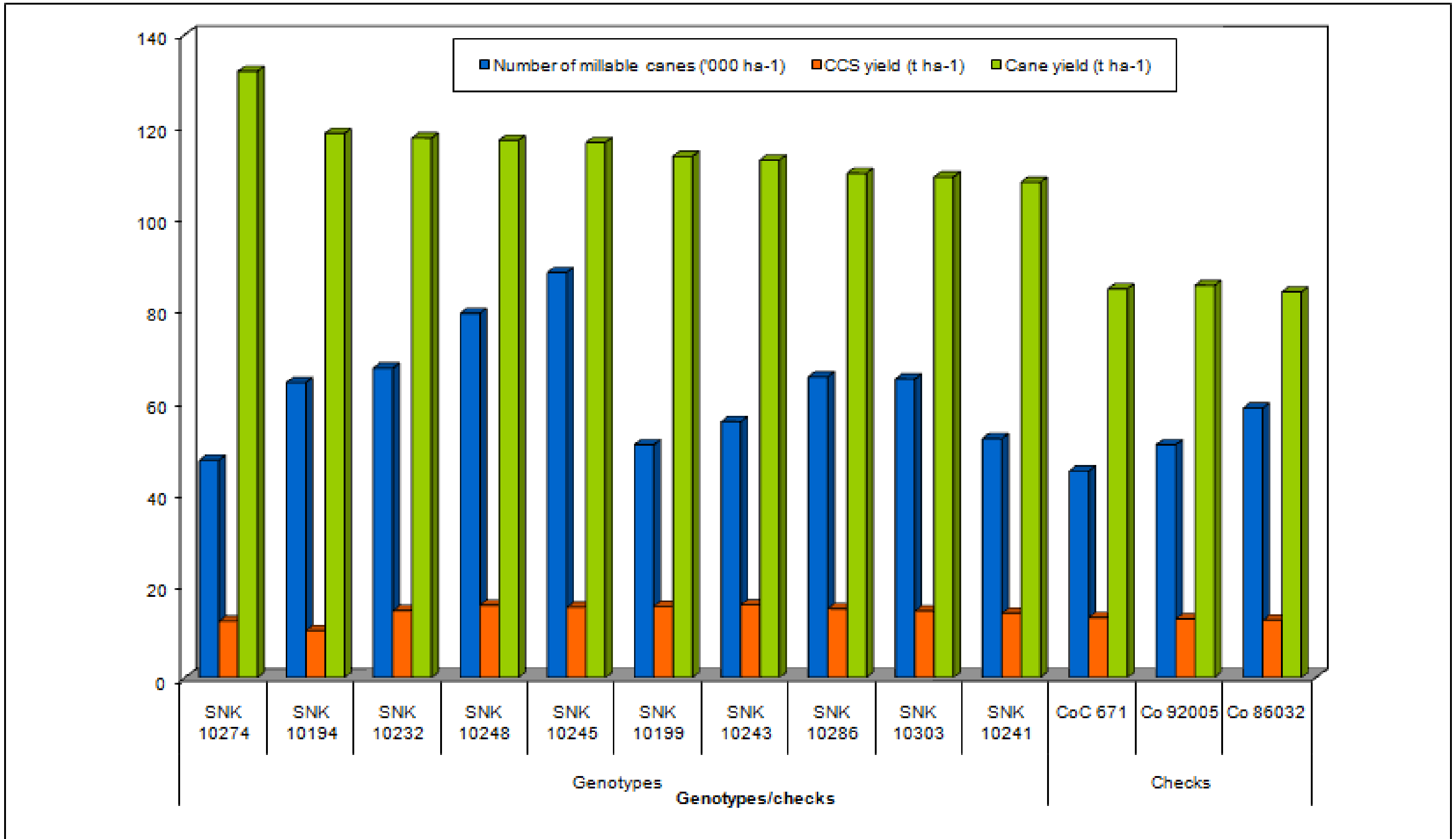

Fig. 2: Mean performance of superior 10 productive genotypes at Sankeshwar (Integrated Environment)

Fig. 2: Mean performance of superior 10 productive genotypes at Sankeshwar (Integrated Environment)

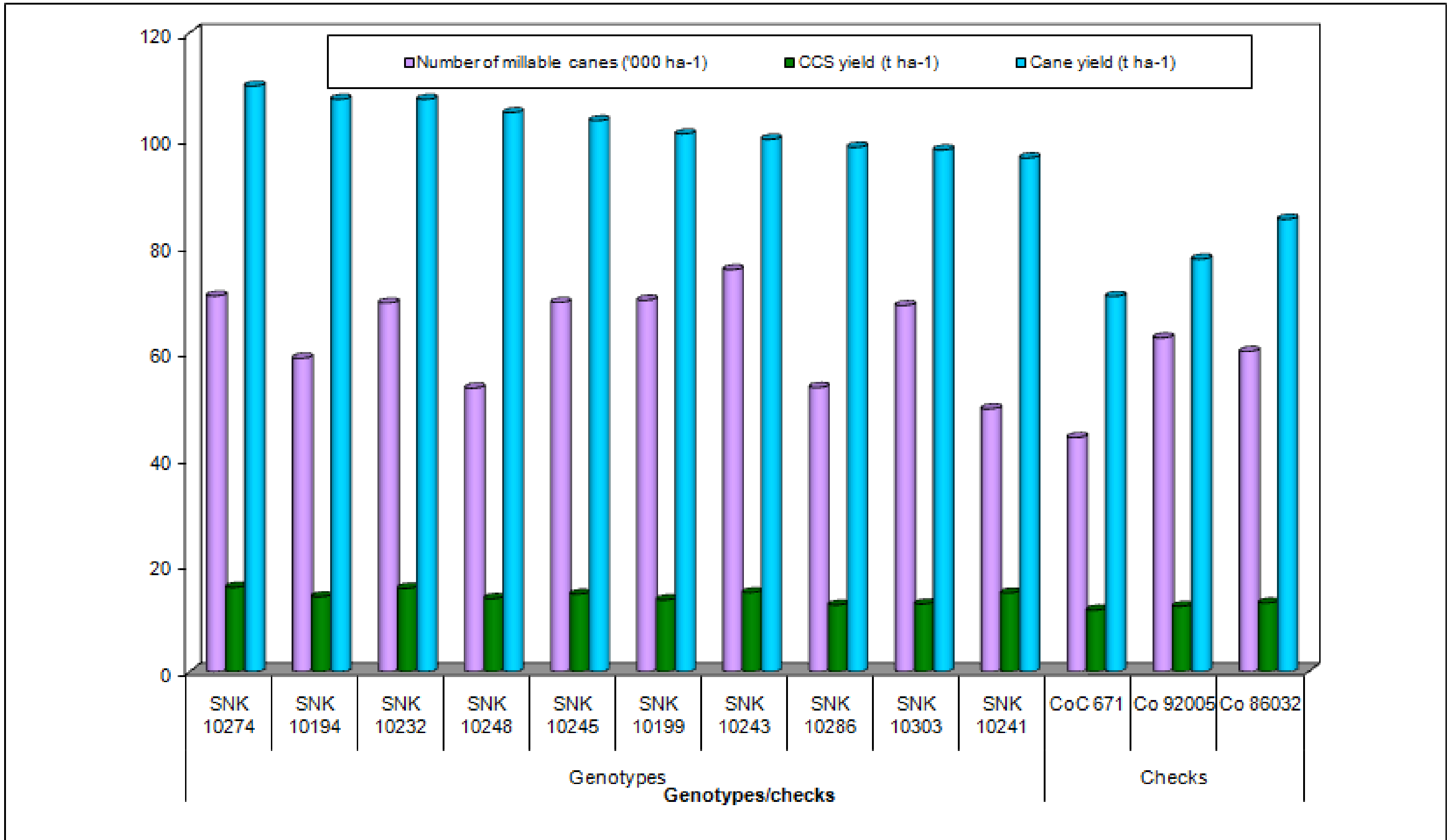

Fig. 3: Mean performance of superior 10 productive genotypes at Sankeshwar (Organic Environment)

Fig. 3: Mean performance of superior 10 productive genotypes at Sankeshwar (Organic Environment)

Plate 1. Superior 10 Superior progenies comparison with Checks under integrated environment

Among the ten genotypes, SNK 10058 recorded significantly higher NMC compared to the best check Co86032, followed by SNK 10245, with an increase of 17-25 (%). The higher NMC obviously because of the more number of shoots per clump, which was clearly noticed in this study. Tippeswamy *et al*. (2003) also reported significant association of NMC to the cane yield (Fig. 3).

For the trait CCS per cent is concern, the genotypes *viz.,* SNK 10241 and SNK 10058 recorded higher CCS per cent with an increase of 1.00 and 0.20 per cent respectively compared to best check Co 86032 indicating their better juice quality. The higher CCS (%) was attributed to better juice quality parameters particularly the brix (%) and sucrose content. The results are in accordance with the results of Das *et al.* (1996a) and Tippeswamy *et al.* (2003).

CCS yield (t ha^{-1}) was found to be significantly superior in the genotype, SNK 10245 compared to the best check Co 86032 with an increase of 22.70 per cent. This was through improved cane yield on account of better single cane weight coupled with cane girth.

The genotypes *viz.,* SNK 10245, SNK 10199, SNK 10303, SNK 10274 and SNK 10134 recorded significantly superior cane yield compared to the best commercial check Co 86032. There was an increase of 20 to 30 per cent across the genotypes (Table 27).

Overall, the five genotypes *viz*., SNK 10245, SNK 10199, SNK 10303, SNK 10274 and SNK 10134 found most promising as they recorded better tonnage, sugar yield and juice quality parameters indicating their suitability for commercial cultivation, under organic environment (Plate 2 and 3)

5.3.3 Studies on jaggery quality and productivity traits under integrated environment

5.3.3.1 Performance of superior genotypes for jaggery productivity traits

The performance of top productive genotypes along with commercial checks for jaggery yield components along with jaggery recovery per cent and jaggery yield (t/ha) is presented in Table 28.

The wide range of jaggery recovery per cent and jaggery yield was observed in the study, as reported by Uppal *et al.* (2005). Jaggery recovery and jaggery yield are the main traits of interest in the present investigation. The genotypes SNK 10286, SNK 10134 and SNK 10241 recorded higher jaggery recovery compared to best jaggery check Co 92005. Similarly, all the other genotypes also recorded numerically superiority over the best check. On the other hand when jaggery yield is considered the same genotypes SNK 10286, SNK 10241, SNK 10232 and SNK 10134 were recorded significantly superior yield of jaggery compared to the check Co 92005. This could obviously be due to the superiority of these genotypes for cane yield and jaggery recovery per cent as well, which would finally lead to superior jaggery yield.

The genotypes SNK 10286, SNK 10134, SNK 10232 and SNK 10241 combined superiority for both jaggery recovery and cane yield could certainly be considered as the best genotypes for jaggery yield over best check Co 92005 under integrated environment (Plate 4)

Overall the investigation reveals that the useful and sufficient variability was obtained by GCs of popular jaggery varieties, compared other commercially popular sugar varieties. Hence, directional trait specific family selection assumes greater importance under specific environments like organic as in the present study.

Table 27: Performance of selected superior 10 productive genotypes for cane and sugar yield parameters at Sankeshwar (Organic Environment)

Genotypes	Single cane weight (kg)	% Increase or decrease	Number of millable canes ('000 ha^{-1})	% Increase or decrease	Sucrose % Juice at harvest	% Increase or decrease	CCS % at harvest	% Increase or decrease	CCS yield (t ha^{-1})	% Increase or decrease	Cane yield (t ha^{-1})	% Increase or decrease
SNK10245	1.42	-0.23	70.57	17.4	20.62	-4.25	14.37	-5.18	15.82*	22.70	110.00*	29.41
SNK10199	1.83	28.52	58.88	-2.1	19.01	-11.73	13.10	-13.56	14.07	9.19	107.50*	26.47
SNK10303	1.56	9.72	69.26	15.2	20.93	-2.79	14.55	-4.01	15.65	21.39	107.50*	26.47
SNK10274	1.99*	40.08	53.26	-11.4	18.94	-12.03	13.03	-14.07	13.71	6.36	105.00*	23.53
SNK10134	1.49	5.22	69.35	15.3	20.26	-5.92	14.09	-7.09	14.54	12.81	103.50*	21.76
SNK10263	1.46	2.76	69.78	16.0	19.25	-10.61	13.34	-12.01	13.49	4.64	101.00	18.82
SNK10058	1.33	-6.16	75.50*	25.6	21.60*	0.33	15.19*	0.20	14.84	15.13	100.00	17.65
SNK10232	1.69	18.78	53.36	-11.3	18.73	-13.03	12.67	-16.41	12.51	-2.94	98.50	15.88
SNK10283	1.43	0.53	68.78	14.4	18.60	-13.61	12.97	-14.43	12.69	-1.56	98.00	15.29
SNK10241	1.97*	38.97	49.37	-17.9	21.67*	0.63	15.31*	1.00	14.77	14.59	96.50	13.53
Checks												
CoC 671	1.61		43.96		23.14		16.37		11.56		70.50	
Co 92005	1.24		62.70		22.43		15.79		12.27		77.50	
Co 86032	**1.42**		**60.13**		**21.53**		**15.16**		12.89		**85.00**	
Mean	1.57		61.91		20.50		14.28		14.28		96.96	
S.Em.	0.14		4.98		0.49		0.46		0.94		5.66	
CD at 5%	0.43		15.36		1.50		1.43		2.90		17.45	
CV	12.46		11.38		3.35		4.60		9.69		8.26	

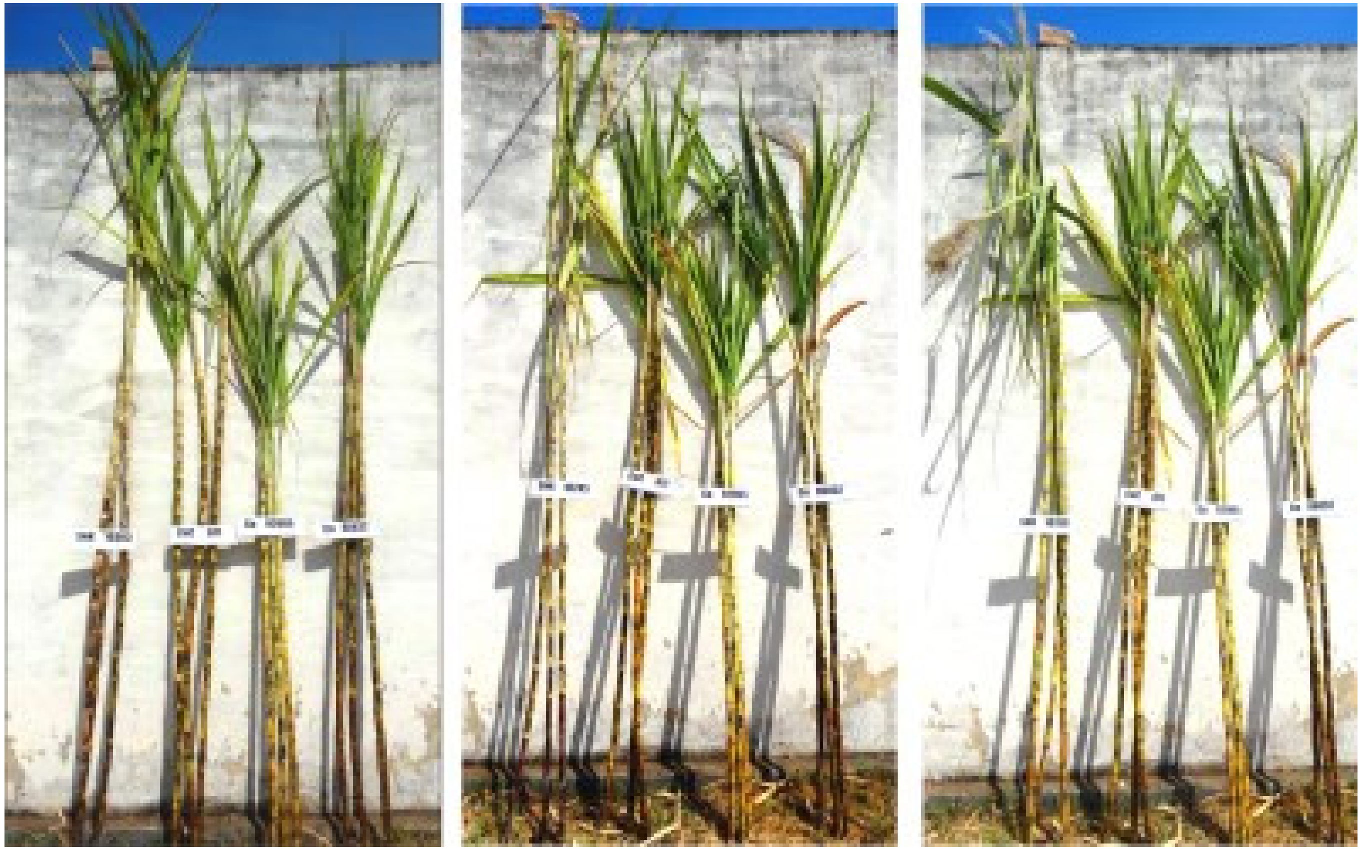

Plate 2: Comparison of superior progenies with Checks in organic environment

Plate 3: Field view of superior 5 progenies under organic environment

5.3.3.2 Performance of superior genotypes for jaggery quality parameters

The jaggery was prepared from all the selected clones and their performance in terms of quality are presented in Table 28. The jaggery is important product of the cottage industry where in the current demand for jaggery is based on its colour, taste, sweetness and its medicinal value. In this regard the parameters like pH, reducing sugars (RS), non reducing sugars (NRS), colour (Optical density at 540 nm), ash content and finally total sugar content values were estimated in these hybrid progenies to identify the genotypes having acceptable jaggery yield and quality parameters suitable for organic processing (Fig. 4).

A direct relation is found between acidity and gur quality because high acidity deteriorates gur quality. The results of this parameter are indicative of the fact that the differences in acidity of gur from different genotypes were significant. The minimum acidity SNK 10286 (4.60) and maximum SNK 10245 (5.42) was observed in the gur of these genotypes compare to check Co 92005 (4.74)

sucrose the non-reducing sugar in jaggery is the most important of all the chemical constituents as it is the chief sweetening component. Being the major sweetening agent, it is the main factor in grading (Hussain *et al.,* 2007). Non-reducing sugars (NRS) sucrose (%) of jaggery genotypes genotypes SNK 10286, SNK 10245 and SNK 10280 were 80-85 per cent which indicated that they fall to Grade-I (Indian standards 12923:1990) and are superior compared to the best checks Co 92005 indicating that these clones have superior sucrose content coupled with high color which is most desirable.

Color is an important physical parameter of jaggery as the dark color is disliked (Hussain *et al.,* 2007). The most desirable is golden yellow colour of the jaggery. The OD value has direct correlation with color of the jaggery, higher the OD value higher will be the color and vice versa. In this study, OD value was recorded upto a maximum of 0.94 by SNK 10199 while the similar trend was also seen for a character in a study conducted by Uppal, (2002).

As per the requirement of the standards for quality of jaggery, the reducing sugars per cent is required to be less which otherwise affects the keeping quality of jaggery (by readily absorbing moisture), the genotypes SNK 10194 and SNK 10286 found to be better by recording the lower reducing sugars (%) (9.64 and 9.99 respectively).

Similarly ash content of the jaggery is also an important indicator of the jaggery quality. Higher the ash content lesser will be the quality of the jaggery. Ash per cent showed a range of 3-5 (%) which are in concordance with the findings of Jambulingam *et al.* (2001) wherein the recorded range was 1-3 (%) for this parameter.

5.3.3.3 Organoleptic test parameters for superior productive clones in integrated environment

Organoleptic study was conducted to know the general acceptance of the prepared jaggery lumps in integrated environment in superior productive progenies.The genotypes *viz.*, SNK 10232, SNK 10248, SNK 10134, SNK 10058 and SNK 10162 were ranked as 'good'. The progeny SNK 10232 recorded light golden yellow colour which is closest to desirable golden yellow colour with crystalline structure and sweet taste besides it was the most acceptable clone/progeny as it is evident with respect to overall acceptability (Table 25).

Table 28: Mean performance of Sugarcane genotypes for jaggery parameters at Sankeshwar (Integrated Environment)

Genotypes	Single cane weight (kg)	Jaggery pH	Optical Density	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)	Juice extraction %	Jaggery recovery %	Jaggery yield (tha-1)
SNK10058	1.96	5.03	0.85*	4.92	75.74	12.74	88.48	48.37	8.24	7.94
SNK10134	1.73	4.9	0.81*	4.45	79.40	13.82	93.22	53.14	9.56	9.60*
SNK10148	1.54	4.79	0.81*	3.70	82.17	13.32	95.49*	53.79	8.46	8.35
SNK10162	1.61	4.61	0.76*	3.84	78.11	11.43	89.54	54.15	8.94	8.82
SNK10170	2.08*	5.26	0.73	3.97	78.31	12.66	90.97	43.89	8.43	7.42
SNK10194	2.52*	5.05	0.88*	5.43	77.02	9.64	86.66	52.88	6.55	7.76
SNK10199	1.96	4.92	0.94*	4.20	80.88	11.13	92.01	44.41	6.17	7.00
SNK10232	1.95	4.58	0.73	4.28	79.20	13.97	93.17	50.66	8.40	9.86*
SNK10241	1.82	4.76	0.70	4.97	80.29	10.16	90.45	55.34*	9.29	10.02*
SNK10245	1.45	5.42	0.58	4.60	83.57	11.67	95.24*	43.78	6.69	7.79
SNK10248	1.55	5.05	0.51	5.01	76.73	10.43	87.16	44.95	7.25	8.51
SNK10263	1.92	4.81	0.81*	5.00	80.19	10.8	90.99	46.28	7.54	7.43
SNK10274	2.44*	4.65	0.82*	5.05	82.10	12.95	95.05	48.88	6.94	9.07
SNK10280	1.86	4.67	0.43	4.19	81.58	11.99	93.57	56.07	7.68	7.12
SNK10283	1.85	4.68	0.54	4.76	82.17	10.24	92.41	49.32	7.75	7.85
SNK10286	1.81	4.6	0.89*	5.56	84.08	9.99	94.07	55.35*	9.96	10.98*
SNK10303	1.65	4.9	0.36	3.90	81.18	10.26	91.44	54.06	8.61	9.37
Checks										
CoC 671	2.10	4.75	0.49	4.23	83.56	9.75	93.31	52.76	10.72	9.04
Co 92005	**1.65**	**4.74**	**0.34**	**4.53**	**79.60**	**9.62**	**89.22**	**48.00**	**8.93**	**7.36**
Co 86032	1.57	5.08	0.48	4.39	86.13	9.45	95.58	50.45	8.65	7.19
Mean	**1.85**	**4.86**	**0.68**	**4.55**	**80.60**	**11.30**	**91.90**	**51.16**	**8.24**	**8.42**
S.Em.	0.13	0.19	0.14	0.52	1.81	0.52	1.75	2.41	0.57	0.73
CD 5%	0.40	0.57	0.41	1.54	5.37	1.54	5.19	7.14	1.68	2.15
CV %	10.27	5.61	28.96	16.15	3.18	6.50	2.70	6.67	9.73	12.18

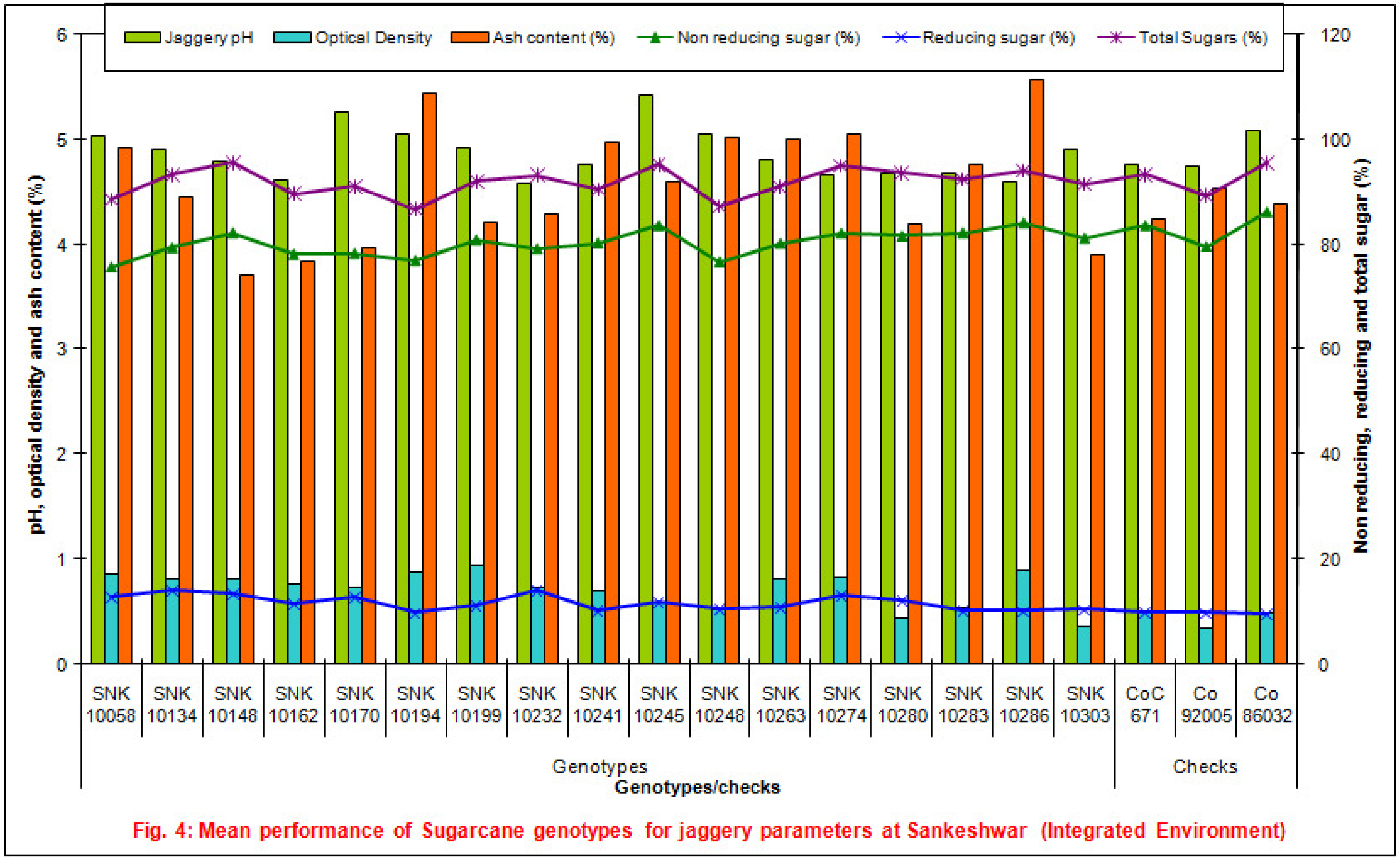

Fig. 4: Mean performance of Sugarcane genotypes for jaggery parameters at Sankeshwar (Integrated Environment)

SNK 10232

SNK 10286

Co 92005

SNK 10134

SNK 10241

Plate 4: Comparison of jiggery lumps with check Co 92005 under Integrated Environment

Although the progenies namely SNK 10134, SNK 10248 and SNK 10058 had higher acceptability index was recorded as 'good'. Similar trend was reported by Lakshmikantham (1973) and Uppal (2005) in their studies, wherein they revealed about varietal difference for this trait. However, the progenies *viz.*, SNK 10286 and SNK 10303 though they shown better sucrose in juice and jaggery recovery were ranked as 'medium' quality jaggeries.

5.3.4 Studies on jaggery quality and productivity traits under organic environment

5.3.4.1 Performance of superior genotypes for jaggery productivity traits

The performance of superior productive genotypes along with commercial checks for jaggery yield components along with jaggery recovery per cent and jaggery yield (t/ha) is presented in Table 29.

The wide range of jaggery recovery per cent and jaggery yield was observed in the study, as reported by Uppal *et al.* (2005). Jaggery recovery and jaggery yield are the main traits in our present investigations. The genotype SNK 10286, SNK 10283, SNK 10162 and SNK 10241 recorded significantly higher jaggery recovery compared to best jaggery check Co 92005 while nine other genotypes are recorded numerical superiority. When these superior productive progenies are looked for jaggery yield , the five genotypes *viz.,* SNK 10199, SNK 10170, SNK 10058, SNK10286 and SNK 10303 recorded numerical superiority over best jaggery check Co 92005, while rest of the genotypes found on par.

The genotypes *viz.,* SNK 10286, SNK 10283, SNK 10162 and SNK 10241 combined superiority for both jaggery recovery and cane yield could be certainly considered as the best genotypes for jaggery yield over best check Co 92005 under organic envirnoment (Plate 5).

5.3.4.2 Performance of superior genotypes for jaggery quality parameters

All the genotypes showed slightly acidic-moderate (neutral) pH and genotypes SNK 10058 recorded as best for color of the jaggery followed by SNK 10286 and SNK 10194 when compared to best jaggery check Co 92005 is presented in Table 29.

sucrose being the major sweetening agent, it is the main factor in grading. It is evident from results that there were significant variations among means for (pol %) gur. The maximum (pol %) gur (86.06 %) was found in genotype SNK 10263, as compare best jaggery check Co 92005 (85.14) followed by SNK 10162 (83.36 %) and SNK 10148 (82.37 %). These explanations are in agreement with those obtained by Mishra (1991) while comparing twelve sugarcane cultivars with respect to pol percentage.

Color is an important physical parameter of gur quality as dark colored gur is disliked. The results of the present study revealed significant ($P < 0.05$) variation among colori metric units of gur. The genotype SNK 10058 (1.22) found significantly superior over best jaggery check Co 92005 (0.49). While other all genotypes shown numerically superior over best check except for two entries SNK 10263 and SNK 10303. Similar results were reported by Uppal (2002) and Patil *et al.* (1994).

Reducing sugar is also an important quality parameter from storage point of view because higher concentration of reducing sugars makes gur hygroscopic. There were significant differences for reducing sugars among five genotypes (Table 29).

Table 29: Mean performance of Sugarcane genotypes for jaggery parameters at Sankeshwar (Organic Environment)

Genotypes	**Single cane weight (kg)**	**Jaggery pH**	**Optical Density**	**Ash content (%)**	**Non reducing sugar (%)**	**Reducing sugar (%)**	**Total Sugars (%)**	**Juice extraction %**	**Jaggery recovery %**	**Jaggery yield (t ha-1)**
SNK10058	1.47	4.67	1.22*	4.22	81.18	10.72	91.9	38.99	6.94	10.92
SNK10134	1.70*	6.12*	0.83	4.15	78.21	11.95	90.16	47.66	8.24	8.56
SNK10148	1.86*	5.16	0.79	4.52	82.37	11.12	93.49	55.65*	9.23	7.80
SNK10162	1.68*	4.95	0.76	3.43	83.36	13.09	96.45	53.10	9.70*	9.23
SNK10170	1.76*	5.25	0.72	3.39	81.18	11.54	92.72	43.25	8.27	11.00
SNK10194	1.66*	4.87	0.94	4.04	78.21	12.12	90.33	49.40	7.49	7.16
SNK10199	1.88*	5.19	0.74	4.25	77.22	12.27	89.49	47.89	7.81	12.00
SNK10232	1.76*	4.48	0.62	4.59	76.43	12.68	89.11	51.11	9.23	9.14
SNK10241	1.81*	4.97	0.73	4.81	81.18	11.80	92.98	52.57	10.08*	9.72
SNK10245	1.36	5.10	0.63	5.02	82.17	11.75	93.92	41.46	7.52	9.67
SNK10248	1.30	4.93	0.59	4.81	81.18	14.01	95.19	45.19	7.27	9.50
SNK10263	1.57*	4.84	0.44	3.97	86.06	11.38	97.44	44.31	6.70	6.79
SNK10274	1.92*	4.81	0.53	4.20	82.17	12.40	94.57	48.97	6.92	7.26
SNK10280	1.50	5.00	0.45	4.09	81.58	13.65	95.23	52.99	8.83	9.00
SNK10283	1.29	4.63	0.66	3.75	78.21	13.26	91.47	44.73	10.76*	8.50
SNK10286	1.36	4.35	0.96	4.47	78.21	11.07	89.28	60.24*	10.45*	10.37
SNK10303	1.50	4.54	0.44	4.04	78.21	11.85	90.06	46.93	8.50	10.14
Checks										
CoC 671	1.39	5.05	0.46	3.97	85.14	10.68	95.82	52.13	9.43	10.73
Co 92005	1.22	5.18	0.49	4.47	85.14	12.91	98.05	45.16	7.41	10.00
Co 86032	1.39	5.21	0.50	3.66	82.17	12.10	94.27	60.13	9.28	7.92
Mean	**1.57**	**4.96**	**0.69**	**4.19**	**80.98**	**12.57**	**93.54**	**49.09**	**8.50**	**9.27**
S.Em.	0.14	0.20	0.16	0.29	1.78	0.78	1.44	3.46	0.71	0.91
CD 5%	0.29	0.59	0.48	0.87	5.25	2.31	4.26	10.25	2.09	2.70
CV %	9.93	5.68	33.31	9.93	3.10	8.79	2.19	9.98	11.75	13.91

SNK 10162

SNK 10286

Co 92005

SNK 10241

SNK 10283

Plate 5: Comparison of jiggery lumps with check Co 92005 under Organic Environment

The highest value of reducing sugars SNK 10162 13.09 %), while the lowest value of reducing sugars SNK 10058 (3.05 %) and other genotypes *viz.,* SNK 10134 SNK 10243, SNK 10170, SNK 10241, SNK 10245, SNK 10263, SNK 10286 and SNK 10 303 were found numerically lower than best jaggery check Co 92005. This finding is in harmony with Singh *et al.* (1975) who reported an increase in trend in reducing sugars due to sucrose hydrolysis (Fig. 5).

5.3.4.3 Organoleptic test parameters for superior productive clones in organic environment

More importantly, when the jaggery quality and organoleptic parameters are considered, the progenies *viz*., SNK 10232, SNK 10194, SNK 10162, SNK 10283, SNK 10280 and SNK 10248 were ranked as 'very good' appeared to be best as they stood at the top by recording superiority for almost all the jaggery quality parameters and in addition, the 'sensory evaluation' proved that the progenies *viz*., SNK 10232, SNK 10194 and SNK 10283 are the top most acceptable clones compared to productive clones/progenies (Table 23).

5.3.5 Comparative means performance of superior productive clones in organic and integrated conditions

The comparative mean performance data of superior productive clones under organic and integrated conditions is presented for cane, sugar, and jaggery yield components in Table 30-33.

The mean performance of all the superior productive clones for cane yield shows that, integrated condition cane yield was higher than the organic conditions. The mean cane yield in integrated conditions was 106.26 (t/ha) where as the mean cane yield in organic conditions was 94.72 (t/ha). The Percent reduction organic over integrated is 12.18. The trend was same in all the genotypes, except for SNK 10058 and SNK 10134 where they shown increase in cane yield over integrated, where in extent reduction in cane yield of superior productive clones was relatively lower (less than 20 %) compared to integrated environment, indicating their suitability for organic environment. While Singh *et al.* (2007), Varghese *et al.* (2006) and Thakur *et al.* (2012) reported results where in higher cane yield was recorded in plant and ratoon by organic amendments than conventional method.

Two genotypes *viz.,* SNK 10058 and SNK 10134 performed better in organic than integrated environment indicating their specific suitability to organic cultivation. The improved cane productivity under organic is an account of better millable population because relatively lower millable population under organic environment favoured better groeth and dry matter accumulation leading to better single cane weight.

Similar trend was recorded for number of millable cane where in the promising genotypes *viz.,* SNK 10058, SNK 10134, SNK 10283 and SNK 10199 had shown higher number of millable cane in organic situation than the integrated.

The character like single cane weight shown that, most of the genotypes are higher value of single cane weight in integrated condition when compared with organic condition, except for the entry SNK 10194 and SNK 10245. This discussion is in harmony with Guddadamath *et al.* (2014)

Among the genotypes, SNK 10058, SNK 10134, SNK 10194 and SNK 10303 recorded for high sugar yield in organic condition when compare to integrated. These genotypes shown higher CCS yield in organic situation than the integrated indicating their ability to compensate cane yield reduction through improved sugar recovery. This finding is in harmony with Devaraju (2014) and Laxman (2015).

Table 30: Mean Performance of superior 15 clones compared with commercial standards for cane yield components under organic and integrated environment

Genotypes	Single cane weight (kg)				Number of millable canes ('000 ha-1)				Cane yield (t ha-1)				FLOWERING	
	Int	Org	Mean	Diff.	Int	Org	Mean	Diff.	Int	Org	Mean	**X**	INT	ORG
SNK10058	1.76	1.45	1.61	**0.30**	54.96	75.5	65.23	**-20.54**	96.64	100	98.32	**-3.47**	NF	NSNF
SNK10134	2.09	1.49	1.79	**0.59**	48.25	69.35	58.8	**-21.09**	100.47	103.5	101.99	**-3.01**	NF	NSNF
SNK10162	1.58	1.48	1.53	**0.10**	62.5	64.62	63.56	**-2.12**	98.5	95.5	97	**3.05**	NF	NSNF
SNK10194	1.85	2.03	1.94	**-0.18**	64.21	47.14	55.67	**17.07**	118.5	95.5	107	**19.41**	NF	$+_2$
SNK10199	2.25	1.83	2.04	**0.43**	50.67	58.88	54.77	**-8.20**	113.5	107.5	110.5	**5.29**	$+_2$	$+_1$
SNK10229	1.94	1.65	1.79	**0.29**	54.93	54.94	54.93	**-0.01**	106.54	90.57	98.55	**14.98**	NF	NSNF
SNK10232	1.77	1.69	1.73	**0.08**	67.37	59.43	63.4	**7.94**	117.5	98.5	108	**16.17**	NSNF	$+_2$
SNK10241	2.07	1.97	2.02	**0.10**	51.99	49.37	50.68	**2.62**	107.84	96.5	102.17	**10.52**	NF	$+_1$
SNK10243	2.02	1.77	1.9	**0.25**	55.72	42.93	49.33	**12.79**	112.71	75.33	94.02	**33.16**	NF	NF
SNK10245	1.32	1.42	1.37	**-0.09**	88.2	78.72	83.46	**9.48**	116.5	110	113.25	**5.58**	NSNF	$+_1$
SNK10248	1.48	1.3	1.39	**0.18**	79.3	73.26	76.28	**6.03**	117.0	95	106	**18.8**	NF	NF
SNK10274	2.78	1.99	2.39	**0.79**	47.32	53.26	50.29	**-5.94**	132	105	118.5	**20.45**	$+_2$	$+_1$
SNK10283	1.99	1.43	1.71	**0.57**	51.36	68.78	60.07	**-17.42**	101.24	98	99.62	**3.20**	NSNF	$+_2$
SNK10286	1.68	1.59	1.63	**0.09**	65.46	58.81	62.14	**6.65**	109.78	93.5	101.64	**14.83**	NF	NSNF
SNK10303	1.68	1.56	1.62	**0.12**	65	69.26	67.13	**-4.26**	109.0	107.5	108.25	**1.38**	NSNF	$+_2$
Checks														
CoC 671	1.89	1.61	1.75	**0.27**	44.98	43.96	44.47	**1.02**	84.64	70.5	77.57	**16.7**	NF	NF
Co 92005	1.68	1.42	1.55	**0.26**	50.67	62.7	56.69	**-12.03**	85	77.5	81.25	**8.82**	NF	NF
Co 86032	1.43	1.42	1.43	**0.01**	58.68	60.13	59.41	**-1.45**	85.38	85	85.19	**0.45**	NF	NF
Mean	**1.85**	**1.62**	**1.73**		58.98	**60.61**	**59.79**		**106.26**	**94.72**	**100.49**			
CD 5%	0.31	0.35			10.47	14.44			15.51	15.49				
CV %	7.87	10.24			8.41	11.29			6.92	7.75				

$+_1$ =early profuse flowering, $+_2$ = late sparse flowering, NF = Non flowering and NSNF = Non spiny Non flowering X-Percent reduction over integrate

Table 31: Mean Performance of superior 15 clones compared with commercial standards for sugar yield components under organic and integrated environment

Genotypes	Brix % at harvest				CCS % at harvest				CCS yield (t ha-1)			
	Int	Org	Mean	Diff.	Int	Org	Mean	Diff.	Int	Org	Mean	Diff.
SNK10058	23.21	24.42	23.82	**-1.21**	13.78	14.82	14.30	**-1.04**	13.10	14.84	13.97	**-13.25**
SNK10134	21.67	22.67	22.17	**-1.00**	12.82	14.08	13.45	**-1.26**	12.82	14.54	13.68	**-13.43**
SNK10162	23.21	23.82	23.52	**-0.61**	14.37	15.53	14.95	**-1.16**	14.14	14.86	14.50	**-5.07**
SNK10194	21.75	20.14	20.95	**1.61**	10.64	12.17	11.41	**-1.53**	10.23	11.64	10.93	**-13.78**
SNK10199	22.14	21.64	21.89	**0.50**	13.67	13.10	13.39	**0.56**	15.51	14.07	14.79	**9.25**
SNK10229	21.89	23.64	22.76	**-1.75**	14.33	15.19	14.76	**-0.86**	15.25	13.74	14.49	**9.92**
SNK10232	20.89	22.14	21.52	**-1.25**	12.90	12.67	12.79	**0.23**	14.59	12.51	13.55	**14.26**
SNK10241	21.64	23.39	22.52	**-1.75**	12.98	15.31	14.15	**-2.33**	14.01	14.77	14.39	**-5.46**
SNK10243	22.14	23.39	22.76	**-1.25**	14.03	15.05	14.54	**-1.02**	15.81	11.34	13.58	**28.32**
SNK10245	21.93	22.93	22.43	**-1.00**	13.14	14.37	13.76	**-1.23**	15.32	15.82	15.57	**-3.21**
SNK10248	23.21	22.43	22.82	**0.79**	13.58	13.69	13.63	**-0.11**	15.75	12.99	14.37	**17.52**
SNK10274	20.50	21.68	21.09	**-1.18**	13.58	13.03	13.30	**0.55**	13.00	13.71	13.36	**-5.46**
SNK10283	22.96	20.68	21.82	**2.29**	12.83	12.97	12.90	**-0.14**	13.02	12.69	12.86	**2.55**
SNK10286	22.21	22.18	22.19	**0.04**	12.52	14.03	13.27	**-1.50**	15.02	13.05	14.04	**13.07**
SNK10303	21.43	23.42	22.42	**-2.00**	13.31	14.55	13.93	**-1.24**	14.50	15.65	15.07	**-7.09**
Checks												
CoC 671	24.23	24.92	24.58	**-0.69**	15.47	16.37	15.92	**-0.90**	13.10	11.56	12.33	**11.77**
Co 92005	23.17	24.42	23.80	**-1.25**	15.01	15.79	15.40	**-0.78**	12.80	12.27	12.53	**4.17**
Co 86032	22.92	23.42	23.17	**-0.50**	14.86	15.16	15.01	**-0.30**	12.48	12.89	12.69	**-3.33**
Mean	**22.28**	**22.85**	**22.57**		**13.55**	**14.33**	**13.94**		**13.91**	**13.50**	**13.71**	
CD 5%	1.60	1.29	14.45		1.91	1.43	1.67		2.74	2.63	2.68	
CV %	3.39	2.68			6.67	4.74			9.32	9.25		

Table 32: Performance of superior clones compared with commercial standard for jaggery productivity parameter under organic and integrated environment at Sankeshwar

Genotypes	Jaggery recovery %				Jaggery yield (t ha-1)				FLOWERING	
	Int	Org	Mean	Diff.	Int	Org	Mean	**X**	INT	ORG
SNK10058	8.24	6.94	7.59	**1.3**	7.94	10.92	9.43	**-37.53**	NF	NSNF
SNK10134	9.56	8.24	8.9	**1.32**	9.6	8.56	9.08	**10.83**	NF	NSNF
SNK10148	8.46	9.23	8.85	**-0.77**	8.35	7.8	8.08	**6.59**	NF	$+_2$
SNK10162	8.94	9.7	9.32	**-0.76**	8.82	9.23	9.03	**-4.65**	NF	NSNF
SNK10170	8.43	8.27	8.35	**0.16**	7.42	11	9.21	**-48.25**	$+_2$	NF
SNK10194	6.55	7.49	7.02	**-0.94**	7.76	7.16	7.46	**7.73**	NF	$+_2$
SNK10199	6.17	7.81	6.99	**-1.64**	7	12	9.5	**-71.43**	$+_2$	$+_1$
SNK10232	8.4	9.23	8.82	**-0.83**	9.86	9.14	9.5	**7.3**	NSNF	$+_2$
SNK10241	9.29	10.08	9.69	**-0.79**	10.02	9.72	9.87	**2.99**	NF	$+_1$
SNK10245	6.69	7.52	7.11	**-0.83**	7.79	9.67	8.73	**-24.13**	NSNF	$+_1$
SNK10248	7.25	7.27	7.26	**-0.02**	8.51	9.5	9.01	**-11.63**	NF	NF
SNK10263	7.54	6.7	7.12	**0.84**	7.43	6.79	7.11	**8.61**	$+_2$	$+_2$
SNK10274	6.94	6.92	6.93	**0.02**	9.07	7.26	8.17	**19.96**	$+_2$	$+_1$
SNK10280	7.68	8.83	8.26	**-1.15**	7.12	9	8.06	**-26.4**	$+_2$	$+_1$
SNK10283	7.75	10.76	9.26	**-3.01**	7.85	8.5	8.18	**-8.28**	NSNF	$+_2$
SNK10286	9.96	10.45	10.21	**-0.49**	10.98	10.37	10.68	**5.56**	NF	NSNF
SNK10303	8.61	8.5	8.56	**0.11**	9.37	10.14	9.76	**-8.22**	NSNF	$+_2$
Checks										
CoC 671	10.72	9.43	10.08	**1.29**	9.04	10.73	9.89	**-18.69**	NF	NF
Co 92005	8.93	7.41	8.17	**1.52**	7.36	10	8.68	**-35.87**	NF	NF
Co 86032	8.65	9.28	8.97	**-0.63**	7.19	7.92	7.56	**-10.15**	NF	NF
Mean	**8.24**	**8.5**	**8.37**		**8.42**	**9.27**	**8.85**			
CD 5%	1.68	2.09			2.15	2.7				
CV %	9.73	11.75			12.18	13.91				

$+_1$ =early profuse flowering $+_2$ = late sparse flowering, NF = Non flowering NSNF = Non spiny Non flowering

X =Percent reduction over integrated

Table 33: Performance of superior 15 clones compared with commercial standard under organic and integrated evirnoment (Organoleptic character)

Genotypes	Acceptability Index			
	Int	Org	Mean	**X**
SNK10058	81.11	73.69	77.40	**9.14**
SNK10134	82.78	80.05	81.41	**3.30**
SNK10148	80.28	81.11	80.69	**-1.04**
SNK10162	80.56	84.72	82.64	**-5.17**
SNK10170	76.67	78.72	77.69	**-2.68**
SNK10194	74.44	85.28	79.86	**-14.55**
SNK10199	72.50	78.06	75.28	**-7.66**
SNK10232	88.33	90.00	89.17	**-1.89**
SNK10241	78.06	77.78	77.92	**0.36**
SNK10245	66.67	73.61	70.14	**-10.42**
SNK10248	82.22	83.61	82.92	**-1.69**
SNK10263	75.28	82.11	78.69	**-9.08**
SNK10274	75.83	81.94	78.89	**-8.06**
SNK10280	78.33	83.00	80.67	**-5.96**
SNK10283	76.94	84.08	80.51	**-9.28**
SNK10286	74.44	80.00	77.22	**-7.46**
SNK10303	76.67	80.83	78.75	**-5.43**
Checks				
CoC 671	79.17	77.89	78.53	**1.61**
Co 92005	73.89	79.05	76.47	**-6.98**
Co 86032	77.78	76.94	77.36	**1.07**

X-Percent reduction over integrated

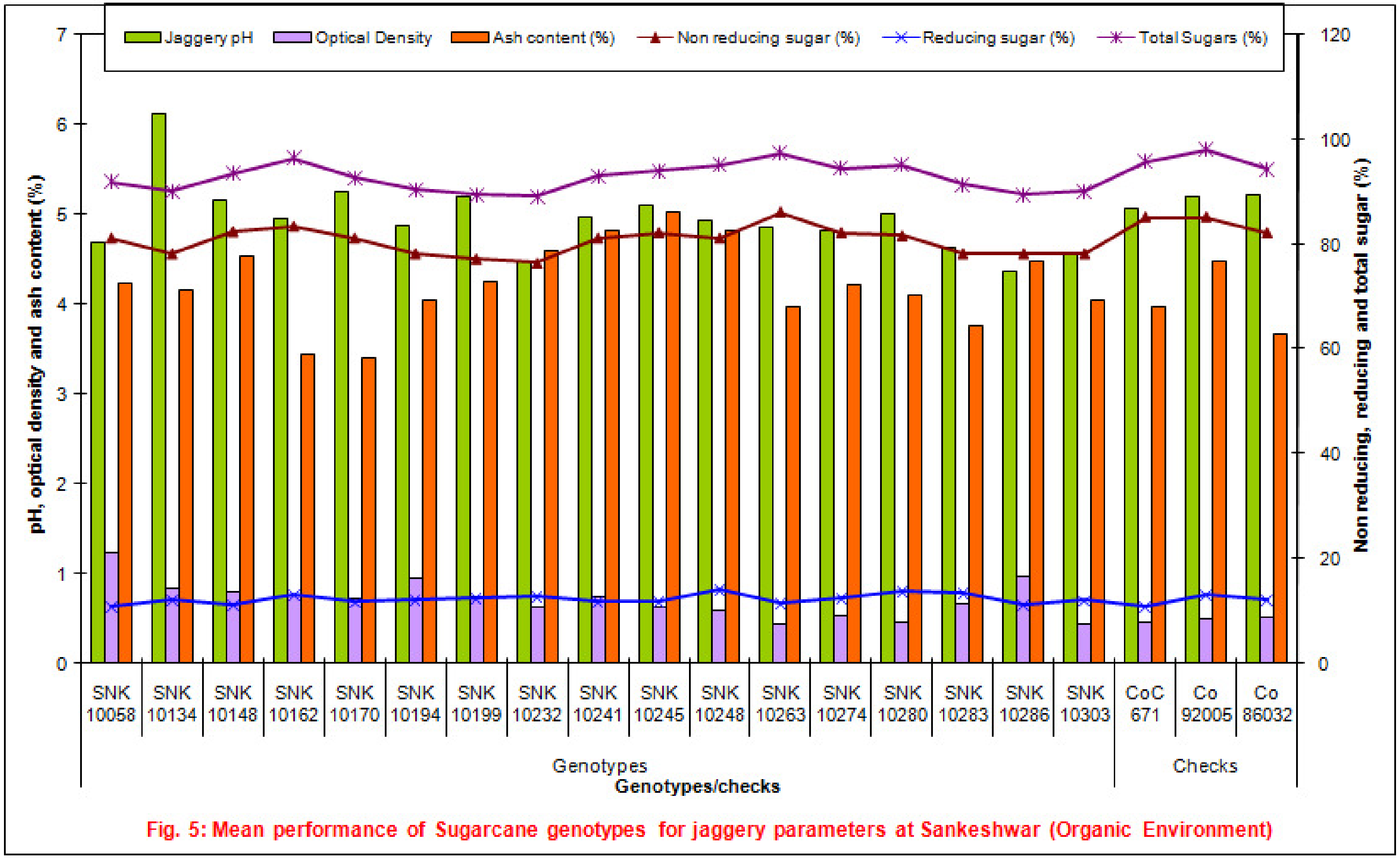

Fig. 5: Mean performance of Sugarcane genotypes for jaggery parameters at Sankeshwar (Organic Environment)

The mean performance of all the superior productive clones for CCS (%) shows that, in organic condition CCS (%) was higher than the integrated conditions. The mean CCS (%) in organic conditions was 14.33 (%) where as the mean CCS (%) in integrated conditions was 13.55 (%). The per cent in increase organic over integrated is 5.44. The genotypes *viz.,* SNK 10241, SNK 10194, SNK 10134, SNK 10303 and SNK10058 were shown superior CCS (%) over integrated indicating their ability for improved sugar recovery.

Similar trend was recorded for brix (%) where in the promising genotypes *viz.,* SNK 10058, SNK 10134, SNK 10241, SNK 10229, SNK 10243 and SNK 10303 had shown higher brix (%) in organic situation than the integrated.

Overall the total sugars (brix %) perse under organic is higher because of relatively lower volume of sink (shorter intermodal length and thinner girth) while source is larger (high number of leaves and number of millable cane).

In the context of importance of organic jaggery for its high nutritional and medicinal value, the performance of promising genotypes were looked for their jaggery recovery (%) and jaggery productivity. Interestingly, almost all the genotypes particularly, the most promising ones *viz.,* SNK 10283, SNK 10199, SNK 10280 and SNK 10194 recorded superior jaggery recovery over the integrated environment and also over the popular jaggery variety Co 92005.This could be on account of their superior juice qualities (CCS % and sucrose %) under organic environments. Though over all across the genotypes, the jaggery productivity is relativiely high under organic with the mean of 8.50 (as against 8.24 in integrated), indicating the extent of improved jaggery recovery under organic which is sufficient to compensate reduction in tonnage (Table 33).

However, when only the promising genotypes were looked for jaggery productivity, three clones *viz.,* SNK 10283, SNK 10286 and SNK 10241 recorded superiority, over integrated environment, indicating their ability to compensate their tonnage reduction due to organic environment. The results clearly suggest the suitability of these genotypes for organic environments, as the extent of improvement in juice quality (CCS % and sucrose %) is fairly high compared to commercial standards.

The jaggery recovery was better in organic conditions than integrated which was evident SNK 10283, SNK 10286 and SNK 10241.Among these the genotypes *viz.,* SNK10283 has shown higher jaggery yield in both integrated and organic environments indicating their suitability for low input as well as high input (all environment) situations (*i.e.,* average stability). This finding is in harmony with Guddadamath (2013a).

In the context of overall consumer acceptability/preference for higher market value, the organoleptic tests are of great importance. Hence organoleptic study was conducted to know the general acceptance of the prepared jaggery lumps from organic and integrated environments. The scoring was done on four characters *viz.,* color and appearance, texture, taste and flavour and finally over all acceptability (OAA) by apanel of experts on nine point's hedonic scale in ten replications and scoring was given to each genotype. The analysis of variance was carried out for these parameters, which showed significant differences among the genotypes, indicating the genotypes differ significantly with respect to all four parameters studied.

The organoleptic test parameters were generally recorded high score in organic compared to integrated conditions for all the characters like colour and appearance, taste, texture, and acceptability index. This is another confirmation for our previous results as the jaggery prepared from the genotypes grown in organic conditions were scored higher than those grown in integrated conditions on account better juice quality under organic. This finding is in harmony with Guddadamath (2013b).

Among genotypes viz., SNK 10194, SNK 10245, SNK 10263 and SNK 10283 recorded superiority in organic condition (over integrated) for acceptability index compared to Co 92005. These superior organoleptic qualities of jaggery produced from genotypes under organic environment exhibit their great promise for better market value.

Over all the principle of advancing early generation clonal material on the basis of productivity under integrated environment, with an idea of identifying productive genotypes for organic environment found more reliable and practicable.

The genotypes *viz.,* SNK 10232 and SNK 10283 combine better productivity and jaggery quality across integrated and organic environment, making them more promising for commercial cultivation.

Flowering in commercial sugarcane production is undesirable particularly for longer/crushing period and better jaggery yield. Hence along with jaggery yield and quality, relatively late sparse flowering or non flowering genotypes are preferred for commercial cultivation. The progenies were evaluated for flowering behavior across organic and integrated environments. Generally flowering was early and profuse under organic compared to integrated which could on account of some kind of stress induced termination of vegetative growth.

The genotypes SNK 10274, SNK 10194, SNK 10232, SNK10248 and SNK 10245 were found more promising under integrated environment as they yield good tonnage and non flowering except SNK 10274(late sparse flowering).Whereas the genotype SNK 10248 found superiority for CCS yield (t/ha) over best check Co 86032. This was through improved cane yield on account of better single cane weight coupled with cane girth. The genotype SNK 10232 shown superiority for jaggery yield (t/ha) and overall acceptability index compare to best jaggery check Co92005. This could obviously be due to superiority of cane yield and jaggery recovery per cent, which finally lead to superior jaggery yield. Similar report was made by Guddadamath and co-workers (2014) (Table 34 and Fig. 6).

Among superior genotypes, *viz.,* SNK 10245, SNK10199, SNK10303, SNK 10274 and SNK 10134 recorded significantly superior cane yield compared to best commercial check Co 86032. These genotypes are early profuse/ late sparse flowering except SNK 10199 and SNK 10134. Whereas SNK 10245 found significant for CCS yield over commercial check Co 86032. Genotypes like, SNK 10199 and SNK 10303 shown numerically superior over the best jaggery check Co 92005. This could be due to cane yield and jaggery recovery (Table 35 and Fig. 7).

When superior clones were looked for jaggery productivity and quality, the clones *viz.*, SNK 10286, SNK 10241, SNK 10134 and SNK 10232 found highly productive over best jaggery standard Co 92005, under integrated environment. The jaggery recovery not shown significant may be due to early/ late sparse flowering. Among top four superior clones, SNK 10232 has shown higher value of jaggery quality especially for the organoleptic features (Table 37 and Fig. 8).

Table 34: Superior 5 Genotypes in integrated environment

Genotypes	Brix % at harvest	Sucrose % Juice at harvest	CCS yield (t ha-1)	Cane yield (t ha^{-1})	Jaggery Recovery %	Jaggey Yield (T/Ha)	Acceptability Index	Flowering
SNK10274	20.22	17.58	12.26	132.0*	6.94	9.07	75.83	$+_2$
SNK10194	21.75	14.67	10.23	118.5*	6.55	7.76	74.44	NF
SNK10232	20.89	18.11	14.59	117.5*	8.4	9.86*	88.33	NSNF
SNK10248	22.71	19.78	15.75*	117.0*	7.25	8.51	82.22	NF
SNK10245	21.93	19.13	15.32	116.5*	6.69	7.79	66.67	NSNF
Checks								
CoC 671	24.67	22.19	13.1	84.64	10.72	9.04	79.17	NF
Co 92005	23.17	21.31	12.8	85.00	8.93	7.36	73.89	NF
Co 86032	22.92	21.09	12.48	85.38	8.65	7.19	77.78	NF
Mean	**22.28**	**19.23**	**13.31**	**106.94**	**8.016**	**8.32**	**77.29**	
CD 5%	2.02	3.12	3.11	17.13	1.68	2.15		
CV %	4.18	7.42	10.23	7.26	9.73	12.18		

$+_1$ =early profuse flowering
$+_2$ = late sparse flowering,
NF = Non flowering
NSNF = Non spiny Non flowering

Table 35: Superior 5 Genotypes in Organic environment

Genotypes	Brix % at harvest	Sucrose % Juice at harvest	CCS yield (t ha-1)	Cane yield (t ha^{-1})	Jaggery Recovery %	Jaggey Yield (T/Ha)	Acceptability Index	Flowering
SNK10245	22.93	20.62	15.82*	110.00*	7.52	9.67	73.61	$+_1$
SNK10199	21.64	19.01	14.07	107.50*	7.81	12.00	78.06	$+_2$
SNK10303	23.42	20.93	15.65	107.50*	8.50	10.14	80.83	$+_2$
SNK10274	21.68	18.94	13.71	105.00*	6.92	7.26	81.94	$+_1$
SNK10134	22.67	20.26	14.54	103.50*	8.24	8.56	80.05	NSNF
Checks								
CoC 671	24.92	23.14	11.56	70.50	9.43	10.73	77.89	NF
Co 92005	24.42	22.43	12.27	77.50	7.41	10.00	79.05	NF
Co 86032	23.42	21.53	12.89	85.00	9.28	7.92	76.94	NF
Mean	**23.14**	**20.86**	**13.81**	**95.81**	**8.13**	**9.53**	**78.55**	
CD 5%	1.36	1.50	2.90	17.45	2.09	2.70		
CV %	2.74	3.35	9.69	8.26	11.75	13.91		

$+_1$ =early profuse flowering
$+_2$ = late sparse flowering,
NF = Non flowering
NSNF = Non spiny Non flowering

Table 36: Superior four productive genotypes for jaggery productivity parameters at Sankeshwar (Organic Environment)

Genotypes	Jaggery Recovery %	Jaggey Yield (T/Ha)	Acceptability Index	Flowering
SNK10162	9.70*	9.23	82.64	NSNF
SNK10241	10.08*	9.72	77.92	$+_1$
SNK10283	10.76*	8.50	80.51	$+_2$
SNK10286	10.45*	10.37	77.22	NSNF
Checks				
CoC 671	9.43	10.73	79.17	NF
Co 92005	7.41	10.00	73.89	NF
Co 86032	9.28	7.92	77.78	NF
Mean	**9.58**	**9.49**	79.20	
CD 5%	2.09	2.7	16.21	
CV %	11.75	13.91	7.48	

$+_1$ =early profuse flowering
$+_2$ = late sparse flowering,
NF = Non flowering
NSNF = Non spiny Non flowering

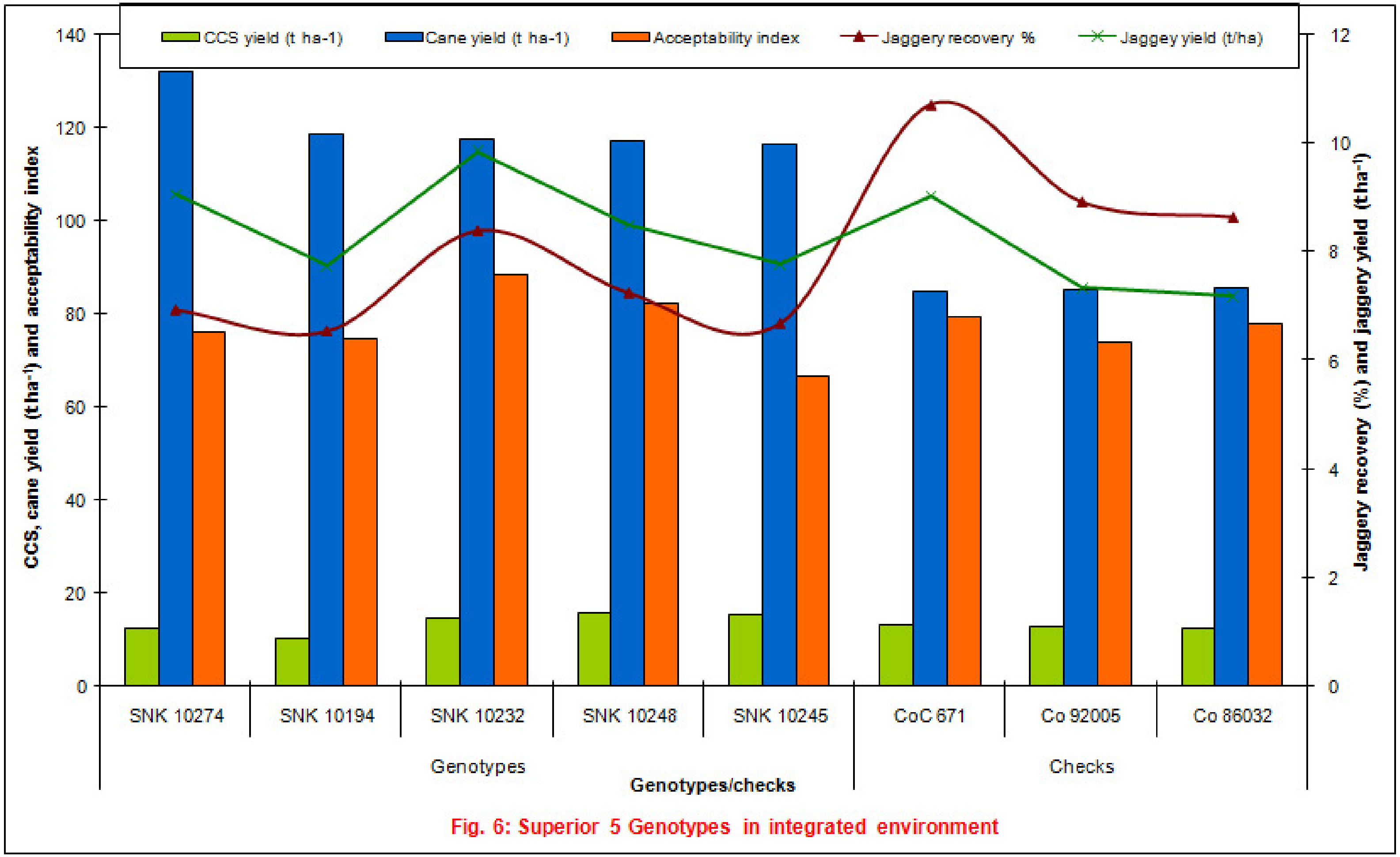

Fig. 6: Superior 5 Genotypes in integrated environment

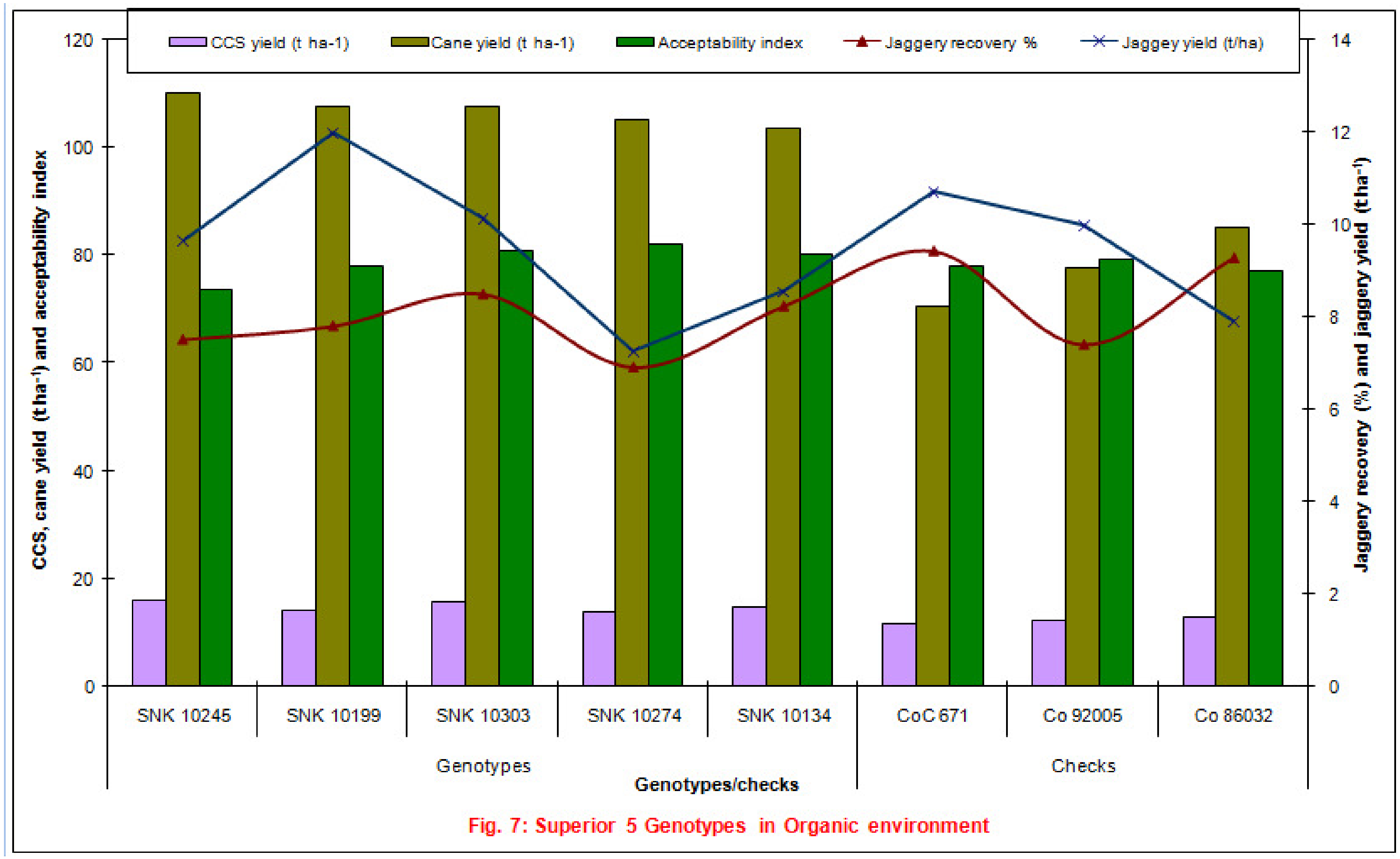

Fig. 7: Superior 5 Genotypes in Organic environment

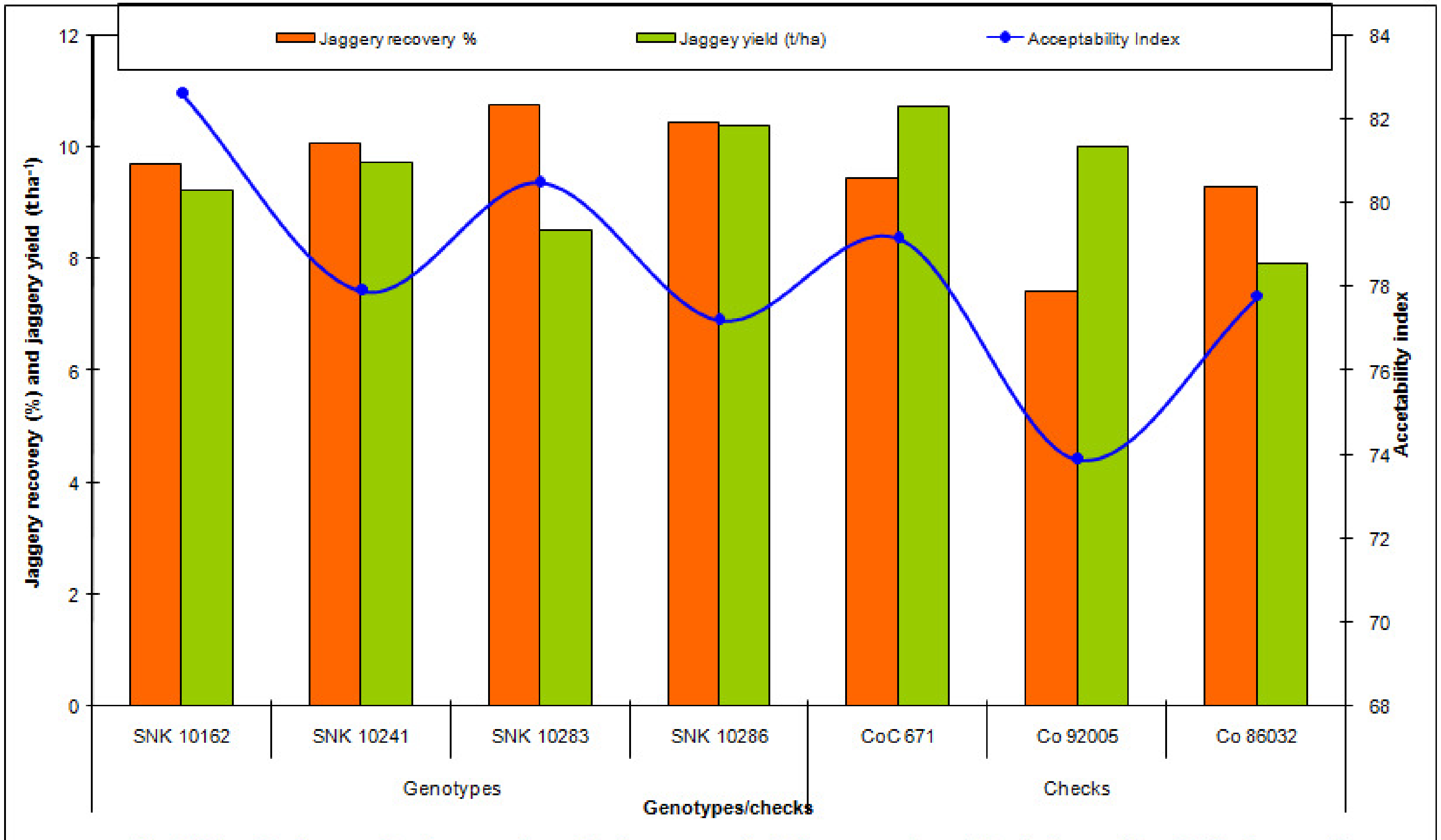

Fig. 8: Superior four productive genotypes for jaggery productivity parameters at Sankeshwar (Organic Environment)

Fig. 8: Superior four productive genotypes for jaggery productivity parameters at Sankeshwar (Organic Environment)

Table 37: Superior four productive genotypes for jaggery productivity parameters at Sankeshwar (Integrated Environment)

Genotypes	Jaggery Recovery %	Jaggey Yield (T/Ha)	Acceptability Index	Flowering
SNK10286	9.96	10.98*	74.44	$+_1$
SNK10241	9.29	10.02*	78.06	NSNF
SNK10134	9.56	9.60*	82.78	$+_2$
SNK10232	8.40	9.86*	88.33	$+_1$
Checks				
CoC 671	10.72	9.04	79.17	NF
Co 92005	8.93	7.36	73.89	NF
Co 86032	8.65	7.19	77.78	NF
Mean	**9.35**	**9.15**	79.20	
CD 5%	1.68	2.15	16.21	
CV %	9.73	12.18	7.48	

$+_1$ =early profuse flowering
$+_2$ = late sparse flowering,
NF = Non flowering
NSNF = Non spiny Non flowering

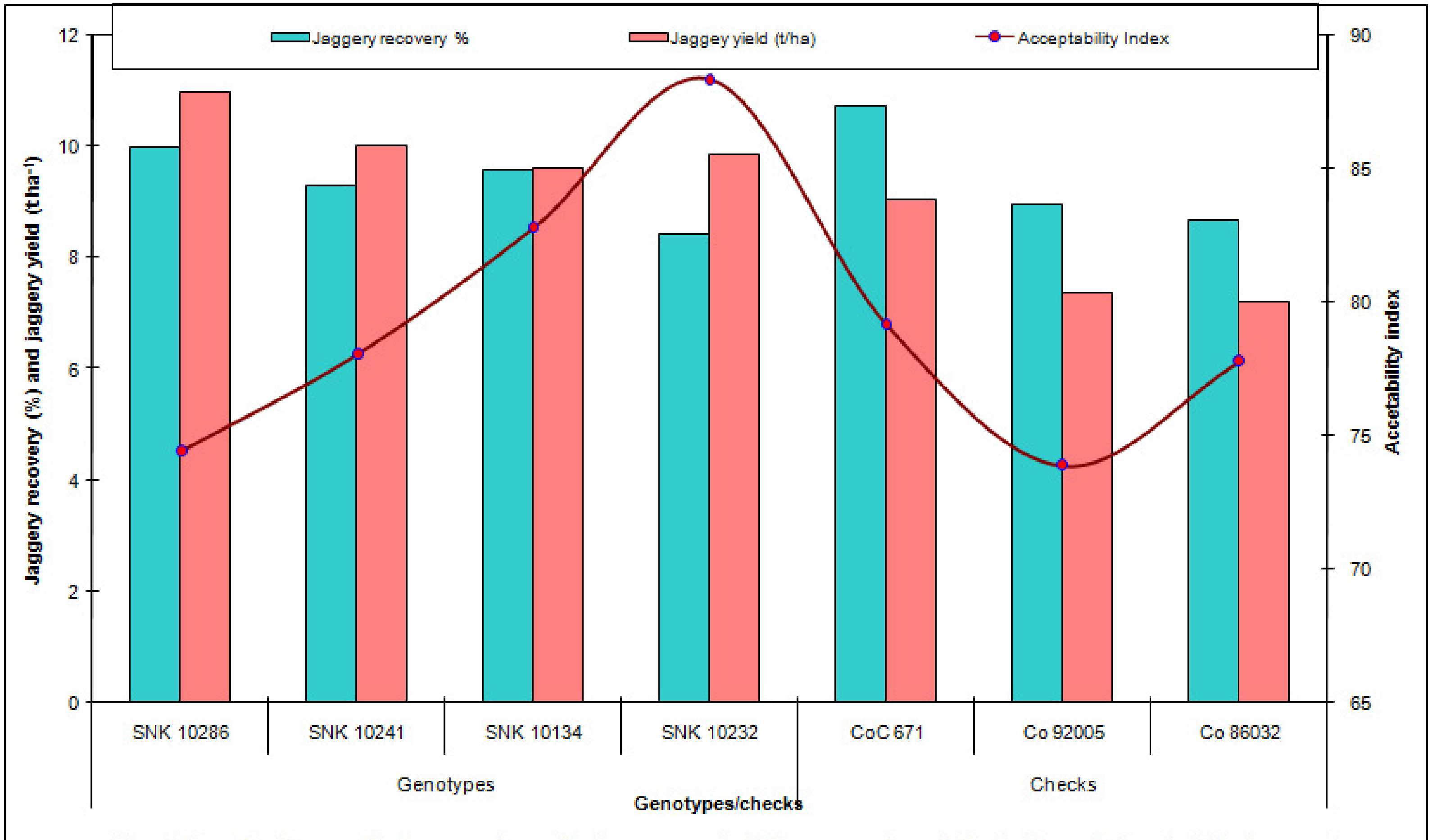

Fig. 9: Superior four productive genotypes for jaggery productivity parameters at Sankeshwar (Integrated Environment)

Fig. 9: Superior four productive genotypes for jaggery productivity parameters at Sankeshwar (Integrated Environment)

The clones SNK10162, SNK 10241, SNK 10283 and SNK 10286 were recorded significantly superior jaggery recovery per cent over best check Co 92005, under organic environment. Whereas SNK 10286 and SNK 10162 found high jaggery yield and overall acceptability index with Non spiny Non flowering respectively (Table 36 and Fig. 9).

Overall the genotypes *viz.,* SNK 10274 and SNK 10245 found promising across integrated and organic environments with acceptable jaggery quality over jaggery check Co 92005.The genotype SNK 10232 found promising for cane, sugar and jaggery yield hence suitabl exploited for chemical free jaggery production.

On the other hand, the genotype *viz.,* SNK 10286 and SNK 10241 recorded superior jaggery yield over best check Co92005 across integrated and organic environment with highly acceptable jaggery quality.

Future line of work

- In sugarcane, it is not only the cane yield that is important but also sugar yield from the industrial point of view. Hence the clones identified on the mean performance basis as high cane yielding and high sugar yielding can be further evaluated preferably over locations and years to confirm their superiority before considering for possible identification and release as commercial clone or variety
- The most promising progenies *viz.*, SNK 10274 and SNK 10245 can be tested in large scale trials for their superiority with respect to cane, jaggery productivity and quality features and their suitability would also be tested under organic cultivation and processing systems.
- The jaggery varieties *viz.*, SNK 10286 and SNK 10241 can be effectively utilized in future breeding programmes to gain further genetic improvement for jaggery productivity and quality features.

6. SUMMARY AND CONCLUSIONS

The present investigation was carried out to elucidate the information on amount of variability present in respect of cane, sugar and jaggery yield components traits in clonal III generation under integrated and organic environment and the amount to which it is heritable, further to study the repetability and nature of association between cane and sugar yield attributes. Finally identification of suitable clones for organic/chemical free jaggery production.

The experiment conducted with the pre selected clones obtained from parents selected for their quality and cane parameters. Thirty eight genotypes along with three standards checks were planted in a randomized complete block design under integrated and organic environment (Integrated block 399 / II and Organic block 399/ III) at Agricultural Research Station, Sankeshwar. Observations were recorded for cane and sugar/jaggery yield traits at various stages *viz.,* Germination percent at 30 DAP, TS at 90 DAP, CFS at 90 DAP, TS at 120DAP, CFS at 120 DAP, NMC/ha, average NI, average IL (cm), average CG (cm), average SCW (kg), cane yield t/ha, brix (%), sucrose (%), CCS (%), CCS Yield (t/ha) at harvest, jaggery recovery (%), jaggery yield and jaggery quality parameters under integrated and organic environment.

The salient findings of present investigations are summarized below

1. Wide ranges of genotypic variations were observed for all the characters studied both in integrated and organic environment in clonal III generation. The analysis of variance revealed significant differences among the genotypes for all the characters.
2. The genotypic variations recorded for germination per cent, TS at 90 DAP, TS at 120 DAP, CFS at 120 DAP and, green top yield were very high, indicating selection for these characters are expected to achieve profitable gains in across the environment. Comparatively moderate variability was observed for internodal length, single cane weight, NMC, cane girth, sucrose per cent at 8 month, cane yield and CCS yield, suggesting more directed efforts are needed to achieve improvement in these traits.

However, the heritability and genetic advance as per cent mean were high for traits *viz.,* germination per cent, TS at 90 DAP, TS at 120 DAP, CFS at 120 DAP and, green top yield, intermodal length single cane weight, NMC, sucrose per cent at 8 month, cane yield and CCS yield suggested better chances of improving these traits through straight selection. While for other traits *viz.*, cane girth, brix (%) at 10 month and harvest, sucrose (%) at harvest the values were moderate and low respectively indicating predominance of non additive gene action or environmental influence

3. The association studies revealed that, the traits *viz,* number of millable canes, cane height, intermodal length, cane formed shoots at 90 and 120 DAP, single cane weight, CCS Yield were the strongest parameters positively associatied with cane yield indicating these traits can be considered for selection to bring the improvement in the cane yield. The cane girth, shown positively significant association for cane yield under organic environment. Whereas the sucrose, brix, purity and CCS per cent found out to be negatively associated with yield indicating cautious selection has to be made for sucrose per cent without compromising yield loss. These traits can be considered as principal cane yield determining components and it is suggested to use these as selection criteria for cane yield improvement in sugarcane.

4. The repeatability values in clonal generations across the environment for cane and sugar yield component traits, *viz.,* germination (%) , total shoots, number of millable canes, single cane weight, cane height, CCS yield, HR brix and sucrose per cent at 10 months were highly significant with moderate to higher heritability values indicating these traits as more dependable for selection criteria.
5. There exist much similarity at clonal III integrated and organic environments as evident from higher repeatability values between these two stages for all the cane yield and sugar yield parameters. Hence, evaluation in only integrated environment is enough, as it requires additional resources, time and manpower.
6. The genotypes SNK 10274, SNK 10194, SNK 10232, SNK10248 and SNK 10245 were found more promising under integrated environment as they yield good tonnage. Whereas the genotype SNK 10232 found superiority for jaggery yield (t/ha) and acceptability index over best jaggery check Co 92005. So these could be extensively tested for sugar, jaggery and cane productivity performance under integrated cultivation practices for the benefit of sugar industry and farmers.
7. The clones SNK 10245, SNK 10199, SNK 10303, SNK10274 and SNK10134 appeared to be most promising for better tonnage under organic environment. Among these top five superior cane yielders, only one progeny SNK 10245 recorded significantly superior CCS yield per hectare over the best check Co 86032. This could be characterized as high yielding, high sugar clone with moderate jaggery recovery. While SNK 10199 and SNK 10303 recoeded higher jaggery yield with superior cane yield over the best check Co 86032.
8. Across the environments, the genotypes *viz.,* SNK 10274 and SNK 10245 were found most promising, as they recorded higher cane yield and CCS yield respectively.
9. When superior clones were looked for jaggery productivity and quality, the clones *viz.*, SNK10286, SNK 10241, SNK 10134 and SNK 10132 found highly productive over best jaggery standard Co 92005, under integrated environment. Among top four superior clones, SNK 10232 has shown higher value of jaggery quality especially for the organoleptic features.
10. The clones SNK10162, SNK 10241, SNK 10283 and SNK 10286 were recorded significantly superior for jaggery recovery per cent over best check Co 92005.whereas SNK 10286 found high jaggery yield under organic environment.
11. Across the environment, the genotypes *viz.,* SNK 10286 and SNK 10232 were found most promising, as they recorded higher jaggery productivity and acceptability index respectively, over best jaggery standard Co 92005. The mean productivity and jaggery quality especially for organoleptic features is superior across clones and standards under organic compared to integrated cultivation practices, indicating significant role of organics for imparting jaggery quality. The organoleptic fetures and overall acceptability index of jaggery under organic environment were superior over integrated.
12. The mean cane yield in integrated conditions was 106.26 (t/ha) where as the mean cane yield in organic conditions was 94.72 (t/ha). The Percent reduction organic over integrated is 12.18.

13. The genotypes *viz.,* SNK 10058 and SNK 10134 where they shown increase in cane yield over integrated, where in extent reduction in cane yield of superior productive clones was relatively lower (less than 20 (%) compared to integrated environment, indicating their suitability for organic environment.

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Appendix I. Monthly meteorological data during the year 2015 and average of 23 year (1992-2014) at the Agriculture Research Station, Sankeshwar, University of Agricultural Sciences, Dharwad

Months	2015					1992-2014 (Average of last 23 years)				
	Rainfall (mm)	Rainy days	Temperature (℃)		RH (%)	Rainfall (mm)	Rainy days	Temperature (℃)		RH (%)
			Max	Min				Max	Min	
January	6.4	1	29.4	12.4	59	3.3	0.2	30.2	10.5	60
February	0.0	0	32.6	13.3	50	1.6	0.1	32.5	11.7	55
March	22.0	2	34.0	17.8	56	7.6	0.7	35.4	14.1	50
April	23.8	1	36.1	19.9	48	26.5	2.3	36.7	17.5	49
May	160.2	5	35.8	21.3	60	41.3	2.2	35.6	18.1	56
June	183.0	13	30.4	20.3	78	151.7	10.1	30.2	17.8	72
July	60.6	7	29.0	20.2	78	228.7	16.3	27.6	17.1	83
August	91.7	7	29.0	19.5	79	168.2	13.7	27.0	17.1	85
September	42.4	2	31.4	18.9	71	109.6	8.3	29.2	16.7	80
October	196.6	2	32.4	20.4	68	130.4	7.7	30.4	16.1	73
November	2.2	0	32.1	18.0	60	24.9	1.7	29.9	13.6	67
December	0.0	0	31.6	16.7	54	2.9	0.3	29.3	10.8	61
January 2016	0.0	0.0			-	-	-	-	-	-
Total	**788.9**	**40**				**869.7**	**63.7**			

Appendix II: Mean of different characters of sugarcane genotypes under Integrated Environment

Genotypes	Germination %	TS at 90 DAP	TS at 120 DAP	CFS at 120 DAP	Single cane weight (kg)	Cane girth (cm)	Avg INT	Avg INL	NNC ('000 ha-1)	Green top yield (t ha^{-1})	Harvest Index %	Brix % at harvest	Sucrose % Juice at harvest	Purity % at harvest	Brix yield (t ha-1)	Juice extraction % at harvest	CCS % at harvest	CCS yield (t ha-1)	Cane yield (t ha^{-1})
SNK10046	24.50	99.24	88.83	38.17	1.91	2.93	29.50	8.37	41.32	6.00	92.98	20.68	17.95	86.82	16.23	43.62	12.31	9.66	78.57
SNK10058	61.00	147.48	136.37	43.72	1.76	2.92	24.00	10.82	54.96	11.27	89.55	23.21	19.87	86.64	22.40	46.98	13.78	13.10	96.64
SNK10134	36.00	80.85	74.26	55.79	2.09	2.91	26.50	11.12	48.25	13.20	88.40	21.67	18.74	86.49	21.65	49.29	12.82	12.82	100.47
SNK10141	30.00	68.01	74.26	30.19	2.21	3.27	26.00	8.87	35.10	8.87	89.80	21.68	18.65	86.04	16.79	48.69	12.73	9.87	77.45
SNK10148	13.50	29.15	28.45	6.94	2.09	3.38	21.50	8.44	47.16	9.50	91.23	21.22	18.32	86.33	20.91	53.36	12.53	12.36	98.50
SNK10149	72.50	164.48	156.06	51.72	1.72	2.83	24.50	10.33	50.87	11.66	88.12	23.88	21.36	89.45	20.71	44.76	14.86	12.87	86.71
SNK10151	77.50	139.49	113.82	28.80	1.54	2.95	26.50	8.23	48.31	6.76	91.77	22.43	19.90	88.73	16.66	49.63	13.78	10.25	74.41
SNK10155	41.50	86.75	77.38	53.37	1.94	3.11	25.00	9.45	44.90	5.57	93.91	22.18	19.68	88.72	19.18	55.95	13.63	11.78	86.52
SNK10157	57.00	161.70	134.98	33.31	2.03	3.56	23.50	8.65	45.62	10.60	89.76	23.18	20.81	89.78	21.45	51.89	14.50	13.40	92.59
SNK10158	53.00	121.45	107.57	31.80	1.52	3.04	20.50	8.92	53.36	11.38	87.80	22.97	20.09	87.48	18.58	50.83	13.83	11.18	80.91
SNK10159	78.50	134.64	115.17	37.13	1.47	3.22	23.50	9.29	55.09	8.50	90.53	23.47	21.29	90.78	19.06	44.24	14.90	12.08	81.15
SNK10162	47.00	107.92	96.12	40.47	1.58	3.07	21.00	8.05	62.50	12.88	88.46	23.21	20.69	89.13	22.86	53.19	14.37	14.14	98.50
SNK10167	75.00	152.68	126.66	44.76	1.25	2.57	28.00	8.26	59.24	8.81	89.40	22.46	20.40	90.79	16.61	44.03	14.29	10.56	74.02
SNK10170	39.50	81.89	77.73	36.63	2.19	3.29	26.50	9.11	40.42	9.45	90.33	22.96	19.56	85.11	20.15	48.12	13.29	11.61	87.87
SNK10176	45.50	101.32	86.06	34.57	1.43	3.05	24.00	7.85	40.01	6.81	89.26	22.88	19.47	85.07	12.94	44.41	13.21	7.47	56.56
SNK10179	53.00	121.10	110.69	39.56	1.57	2.84	25.00	9.03	48.86	11.06	87.51	22.47	19.82	88.23	17.35	41.66	13.70	10.53	77.17
SNK10183	44.50	97.16	101.32	39.09	1.53	2.89	23.00	7.80	53.01	13.39	85.87	22.68	20.14	88.96	18.40	45.99	13.96	11.30	81.02
SNK10184	69.50	118.67	108.96	34.70	1.57	3.19	23.00	7.77	51.27	12.02	87.03	22.18	19.70	88.87	17.87	51.41	13.66	10.99	80.53
SNK10192	74.50	113.47	118.85	47.57	1.76	2.97	23.50	8.60	44.56	10.87	87.85	22.89	20.59	89.96	17.93	47.68	14.36	11.23	78.30
SNK10193	48.50	111.04	92.30	36.44	1.74	2.83	27.00	8.37	51.82	9.29	90.68	22.18	20.02	90.29	20.04	52.75	13.98	12.62	90.31
SNK10194	8.50	21.86	24.64	8.68	1.85	3.35	20.50	8.71	64.21	14.35	89.25	21.75	14.67	67.54	25.82	52.39	8.64	10.23	118.50
SNK10199	49.50	63.50	66.62	39.78	2.25	3.03	24.00	11.18	50.67	11.97	90.47	22.14	19.70	88.97	25.13	48.53	13.67	15.51	113.50
SNK10212	74.00	154.76	130.47	39.91	1.88	2.94	25.00	11.01	51.18	6.94	93.19	21.39	18.66	87.19	20.51	49.86	12.82	12.33	95.81
SNK10229	70.00	147.48	130.13	47.89	1.94	3.20	23.00	9.43	54.93	12.53	89.51	21.89	20.28	92.63	23.29	52.35	14.33	15.25	106.54
SNK10232	66.00	126.66	108.96	51.65	1.77	2.96	22.00	11.25	67.37	9.38	92.60	20.89	18.11	86.63	24.56	51.53	12.40	14.59	117.50
SNK10241	77.00	132.55	118.64	48.58	2.07	2.97	26.50	10.56	51.99	13.74	88.78	21.64	18.89	87.36	23.32	48.00	12.98	14.01	107.84
SNK10243	125.00	181.48	153.03	56.21	2.02	3.10	24.50	9.21	55.72	12.07	90.32	22.14	20.05	90.60	24.95	48.18	14.03	15.81	112.71
SNK10245	64.00	162.74	129.08	51.36	1.32	2.54	22.50	12.17	88.20	14.78	88.75	21.93	19.13	87.18	25.55	50.27	13.14	15.32	116.50
SNK10246	23.00	50.32	55.17	10.06	1.50	2.67	19.50	13.12	43.37	7.64	90.50	22.22	18.79	84.58	14.28	50.12	12.71	8.20	64.30
SNK10248	79.00	159.27	116.59	62.11	1.48	2.72	24.00	10.02	79.30	13.04	90.01	22.71	19.78	86.95	26.65	49.30	13.58	15.75	117.00
SNK10260	75.50	136.37	106.88	41.29	1.41	2.85	24.50	9.35	49.52	7.85	89.91	22.72	20.02	88.13	15.77	44.19	13.82	9.59	69.40

SNK10263	49.50	79.81	77.38	44.92	1.66	2.73	22.00	11.95	59.96	17.86	84.62	20.47	18.57	90.87	20.07	42.57	13.00	12.83	98.30
SNK10274	52.00	91.96	69.75	40.60	2.78	3.78	24.50	10.08	47.32	10.56	92.52	20.22	17.58	86.50	26.43	49.33	12.06	16.38	132.00
SNK10280	58.50	113.47	100.28	49.27	1.71	2.90	23.50	11.16	54.49	8.33	91.75	20.72	18.41	88.88	19.19	58.75	12.77	11.83	92.63
SNK10283	66.00	102.37	113.30	39.12	1.99	3.19	24.50	9.16	51.36	14.62	87.38	21.46	18.69	87.15	21.78	49.27	12.83	13.02	101.24
SNK10286	75.50	158.23	139.15	52.05	1.68	2.99	21.50	10.49	65.46	13.48	89.07	22.21	19.70	88.61	24.40	49.52	13.65	15.02	109.78
SNK10301	76.50	167.25	127.70	51.36	1.53	2.76	27.00	9.69	56.82	11.36	88.70	21.93	19.25	87.74	19.12	49.05	13.27	11.39	86.91
SNK10303	105.50	147.13	99.94	41.29	1.68	2.79	27.50	9.74	65.00	9.46	92.00	21.43	19.15	89.36	23.35	51.00	13.31	14.50	109.00
Checks																			
CoC 671	49.50	91.96	83.97	33.31	1.89	3.08	25.00	9.19	44.98	10.25	89.19	24.67	22.19	89.95	20.87	48.16	15.47	13.10	84.64
Co 92005	51.00	106.53	95.43	27.41	1.68	3.31	23.50	8.18	50.67	10.74	88.85	23.17	21.31	91.99	19.80	45.81	15.01	12.80	85.38
Co 86032	49.00	113.82	109.65	32.27	1.43	2.75	21.00	10.85	58.68	9.84	89.54	22.92	21.09	92.02	19.25	46.53	14.86	12.48	87.50
MEAN	**58.21**	**115.80**	**102.01**	**39.85**	**1.77**	**3.01**	**24.10**	**9.61**	**53.36**	**10.70**	**89.69**	**22.22**	**19.54**	**87.92**	**20.53**	**48.86**	**13.48**	**12.43**	**92.81**
S.Em.	6.41	11.88	8.45	4.86	0.12	0.16	1.21	0.58	3.46	1.41	0.91	0.60	0.75	1.91	1.33	1.51	0.50	1.23	5.43
CD at 5%	18.31	33.95	24.16	13.89	0.34	0.45	3.45	1.67	9.88	4.03	2.61	1.73	2.14	5.47	3.81	4.31	1.44	3.51	15.52
CV	15.57	14.50	11.72	17.24	9.45	7.39	7.07	8.59	9.16	18.62	1.44	3.84	5.42	3.08	9.19	4.37	5.29	13.96	8.28

Appendix III: Mean of different characters of sugarcane genotypes under Organic Environment

Genotypes	Germination %	TS at 90 DAP	TS at 120 DAP	CFS at 120 DAP	Single cane weight (kg)	Cane girth (cm)	Avg INT	Avg INL	NNC ('000 ha-1)	Green top yield (t ha^{-1})	Harvest Index %	Brix % at harvest	Sucrose % Juice at harvest	Purity % at harvest	Brix yield (t ha-1)	Juice extraction % at harvest	CCS % at harvest	CCS yield (t ha-1)	Cane yield (t ha^{-1})
SNK10046	44.00	69.39	85.36	26.72	1.33	2.74	26.00	8.95	51.43	3.99	94.74	22.43	19.94	88.92	15.13	43.03	13.83	9.33	67.50
SNK10058	66.00	81.55	86.06	42.33	1.33	2.78	21.50	10.20	75.50	13.63	87.96	24.42	21.48	87.96	24.42	43.63	14.82	14.84	100.00
SNK10134	33.00	32.27	45.11	22.90	1.49	2.65	24.00	10.95	69.35	16.79	86.04	22.67	20.26	89.32	23.46	44.75	14.08	14.54	103.50
SNK10141	21.50	31.23	43.03	15.62	1.56	3.14	21.50	9.18	48.82	8.67	89.80	21.93	19.84	90.49	16.77	46.38	13.87	10.63	76.50
SNK10148	16.00	23.94	30.19	7.63	1.64	3.21	21.50	8.54	51.65	7.40	91.93	22.18	20.92	94.40	18.77	52.35	14.90	12.58	84.50
SNK10149	64.50	75.65	91.26	24.64	1.34	2.54	21.50	9.71	54.81	9.05	87.85	24.42	22.08	90.46	17.92	40.46	15.43	11.36	73.50
SNK10151	77.00	73.22	81.89	28.45	1.43	2.95	24.00	8.50	46.39	7.92	89.30	22.93	21.45	93.65	15.21	49.34	15.23	10.16	66.50
SNK10155	48.00	61.42	60.73	32.62	1.66	2.75	25.50	10.55	44.52	5.07	93.57	23.92	21.50	89.87	17.64	48.01	14.99	11.05	73.81
SNK10157	65.00	102.40	87.10	27.07	1.49	3.10	21.00	9.38	45.75	8.12	89.28	21.93	20.94	95.52	14.85	49.95	15.00	10.16	67.77
SNK10158	47.50	53.09	62.46	10.41	1.23	3.05	20.50	7.99	42.18	7.64	87.15	23.18	21.09	91.03	11.89	47.57	14.78	7.59	51.46
SNK10159	63.00	62.46	63.85	19.43	1.02	2.50	21.00	8.38	66.45	7.52	89.28	23.92	21.82	91.27	16.14	38.04	15.32	10.34	67.50
SNK10162	43.50	57.60	69.05	26.72	1.48	3.14	21.00	8.21	64.62	12.45	88.53	23.82	22.00	92.33	22.77	42.46	15.53	14.86	95.50
SNK10167	67.00	99.24	97.16	40.25	1.25	2.60	27.00	9.24	52.46	7.39	89.36	23.42	21.17	90.37	15.32	37.98	14.79	9.67	65.41
SNK10170	25.00	41.29	53.44	15.27	1.64	3.05	25.50	8.43	57.16	8.60	91.53	22.39	19.80	88.44	20.83	43.58	13.70	12.72	93.00
SNK10176	63.00	69.05	69.05	25.68	1.36	2.75	25.50	8.24	39.88	5.98	90.05	22.14	20.44	92.39	11.99	43.35	14.43	7.81	54.14
SNK10179	64.50	78.08	83.97	37.48	1.58	2.82	27.50	8.36	52.12	9.25	89.83	22.39	21.38	97.73	17.91	40.24	15.45	12.66	81.81
SNK10183	51.00	57.26	68.36	19.78	1.15	2.94	20.50	8.08	55.15	8.98	87.54	22.39	20.42	91.25	14.27	44.86	14.33	9.11	63.60
SNK10184	62.00	71.83	80.16	23.60	1.47	2.95	22.00	7.85	44.91	7.82	88.78	22.14	20.68	93.47	14.52	44.50	14.67	9.57	65.49
SNK10192	81.50	82.59	93.69	37.13	1.26	2.90	22.00	8.14	47.01	9.29	86.47	23.64	21.64	91.73	14.02	42.74	15.21	9.02	59.31
SNK10193	28.00	60.73	69.75	31.23	1.33	2.67	22.00	8.53	41.19	5.33	89.87	22.64	20.63	91.28	12.37	43.04	14.47	7.92	54.87
SNK10194	29.50	18.04	26.72	12.49	2.03	3.22	21.00	8.42	46.97	7.98	90.84	20.14	17.67	87.75	19.22	49.92	12.17	11.64	95.50
SNK10199	45.50	44.07	47.19	26.37	1.83	2.89	25.00	9.95	58.88	10.60	90.98	21.64	19.01	87.85	23.28	45.38	13.10	14.07	107.50
SNK10212	55.00	77.03	80.16	32.97	1.56	2.72	26.50	9.81	40.74	4.60	93.42	22.64	20.14	88.93	14.40	50.37	13.97	8.98	63.50
SNK10229	61.50	88.65	92.65	39.21	1.65	3.09	21.50	11.27	54.94	9.62	90.40	23.64	21.62	91.46	21.40	49.10	15.19	13.74	90.57
SNK10232	51.50	58.30	64.20	38.86	1.85	2.82	23.00	10.09	53.36	7.55	92.27	22.14	18.73	84.56	21.82	47.78	12.67	12.51	98.50

SNK10241	77.00	78.08	72.52	43.72	1.97	2.87	27.00	10.52	49.37	9.65	91.00	23.39	21.67	92.78	22.61	48.60	15.31	14.77	96.50
SNK10243	56.00	74.95	84.32	43.38	1.77	3.01	25.00	7.90	42.93	8.33	90.04	23.39	21.41	91.57	17.62	44.13	15.05	11.34	75.33
SNK10245	51.50	65.58	78.77	34.35	1.56	2.50	22.00	11.76	70.57	9.69	90.90	22.93	20.62	89.97	25.19	39.23	14.37	15.82	110.00
SNK10246	50.00	18.04	28.80	9.72	1.73	2.53	21.50	11.02	40.08	6.95	90.88	22.18	19.47	87.76	15.34	48.16	13.42	9.27	69.21
SNK10248	59.00	79.46	87.79	39.91	1.30	2.62	25.00	8.61	73.26	9.80	90.72	22.43	19.80	88.29	21.30	45.02	13.69	12.99	95.00
SNK10260	49.00	79.46	88.49	35.74	1.50	2.80	26.00	7.82	51.51	9.54	88.92	24.17	22.22	91.96	18.56	43.98	15.65	12.04	77.00
SNK10263	50.00	53.09	65.24	29.15	1.46	2.58	23.50	10.55	69.78	13.67	88.01	21.68	19.25	88.78	21.91	47.51	13.34	13.49	101.00
SNK10274	68.00	67.67	71.83	32.62	1.99	3.27	22.00	10.34	53.26	5.23	95.25	21.68	18.94	87.35	22.79	46.34	13.03	13.71	105.00
SNK10280	67.50	69.40	75.99	45.11	1.76	2.78	21.50	11.16	50.15	4.53	94.96	23.42	21.05	89.86	20.61	53.75	14.67	12.86	88.00
SNK10283	46.00	57.60	69.40	23.60	1.43	2.97	23.00	9.20	68.78	12.51	88.66	20.68	18.60	89.93	20.26	43.19	12.97	12.69	98.00
SNK10286	72.50	102.40	90.91	40.95	1.59	2.91	24.00	8.92	58.81	9.81	90.43	22.18	20.06	90.43	20.72	46.07	14.03	13.05	93.50
SNK10301	88.00	78.77	75.99	45.11	1.29	2.56	25.50	9.22	47.80	6.77	90.14	23.17	21.43	92.52	14.28	43.46	15.14	9.28	61.50
SNK10303	90.00	105.14	129.08	53.44	1.56	2.60	25.50	10.61	69.26	8.96	92.31	23.42	20.93	89.37	25.18	53.91	14.55	15.65	107.50
Checks																			
CoC 671	48.50	68.01	61.42	27.07	1.61	2.95	23.50	9.32	43.96	7.62	90.33	24.92	23.14	92.86	17.56	46.96	16.37	11.56	70.50
Co 92005	59.00	58.99	78.77	23.60	1.24	3.00	22.00	7.93	62.70	10.73	87.95	24.42	22.43	91.85	18.92	45.52	15.79	12.27	77.50
Co 86032	61.50	69.05	88.83	36.18	1.42	3.01	22.50	9.34	60.13	8.38	91.06	23.42	21.53	91.93	19.93	51.24	15.50	12.89	85.00
MEAN	**55.30**	**65.76**	**72.70**	**29.96**	**1.51**	**2.85**	**23.35**	**9.30**	**54.11**	**8.62**	**90.20**	**22.84**	**20.71**	**90.72**	**18.51**	**45.75**	**14.51**	**11.72**	**81.26**
S.Em.	8.98	6.50	7.91	5.02	0.08	0.12	1.00	0.54	4.38	1.17	1.12	0.55	0.55	2.42	1.34	2.87	0.50	0.88	5.48
CD at 5%	25.66	18.58	22.60	14.36	0.24	0.35	2.85	1.55	12.53	3.34	3.21	1.56	1.56	6.91	3.82	8.22	1.44	2.51	15.66
CV	22.96	13.98	15.38	23.71	7.88	6.15	6.03	8.25	11.45	19.17	1.76	3.39	3.73	3.77	10.20	8.88	4.90	10.58	9.54

Appendix IV: Mean performance of Sugarcane genotypes for jaggery parameters at Sankeshwar (Integrated Environment)

Genotypes	Single cane weight (kg)	Jaggery pH	Optical Density	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)	Juice extraction %	Jaggery recovery %	Jaggery yield (tha-1)
SNK10058	1.96	5.03	0.85	4.92	75.74	12.74	88.48	48.37	8.24	7.94
SNK10134	1.73	4.9	0.81	4.45	79.40	13.82	93.22	53.14	9.56	9.60
SNK10148	1.54	4.79	0.81	3.70	82.17	13.32	95.49	53.79	8.46	8.35
SNK10162	1.61	4.61	0.76	3.84	78.11	11.43	89.54	54.15	8.94	8.82
SNK10170	2.08	5.26	0.73	3.97	78.31	12.66	90.97	43.89	8.43	7.42
SNK10194	2.52	5.05	0.88	5.43	77.02	9.64	86.66	52.88	6.55	7.76
SNK10199	1.96	4.92	0.94	4.20	80.88	11.13	92.01	44.41	6.17	7.00
SNK10232	1.95	4.58	0.73	4.28	79.20	13.97	93.17	50.66	8.40	9.86
SNK10241	1.82	4.76	0.70	4.97	80.29	10.16	90.45	55.34	9.29	10.02
SNK10245	1.45	5.42	0.58	4.60	83.57	11.67	95.24	43.78	6.69	7.79
SNK10248	1.55	5.05	0.51	5.01	76.73	10.43	87.16	44.95	7.25	8.51
SNK10263	1.92	4.81	0.81	5.00	80.19	10.8	90.99	46.28	7.54	7.43
SNK10274	2.44	4.65	0.82	5.05	82.10	12.95	95.05	48.88	6.94	9.07
SNK10280	1.86	4.67	0.43	4.19	81.58	11.99	93.57	56.07	7.68	7.12
SNK10283	1.85	4.68	0.54	4.76	82.17	10.24	92.41	49.32	7.75	7.85
SNK10286	1.81	4.6	0.89	5.56	84.08	9.99	94.07	55.35	9.96	10.98
SNK10303	1.65	4.9	0.36	3.90	81.18	10.26	91.44	54.06	8.61	9.37
Checks										
CoC 671	2.10	4.75	0.49	4.23	83.56	9.75	93.31	52.76	10.72	9.04
Co 92005	1.65	4.74	0.34	4.53	79.60	9.62	89.22	48.00	8.93	7.36
Co 86032	1.57	5.08	0.48	4.39	86.13	9.45	95.58	50.45	8.65	7.19
Mean	**1.85**	**4.86**	**0.68**	**4.55**	**80.60**	**11.30**	**91.90**	**51.16**	**8.24**	**8.42**
S.Em.	0.13	0.19	0.14	0.52	1.81	0.52	1.75	2.41	0.57	0.73
CD 5%	0.40	0.57	0.41	1.54	5.37	1.54	5.19	7.14	1.68	2.15
CV %	10.27	5.61	28.96	16.15	3.18	6.50	2.70	6.67	9.73	12.18

Appendix V: Mean performance of Sugarcane genotypes for jaggery parameters at Sankeshwar (Organic Environment)

Genotypes	Single cane weight (kg)	Jaggery pH	Optical Density	Ash content (%)	Non reducing sugar (%)	Reducing sugar (%)	Total Sugars (%)	Juice extraction %	Jaggery recovery %	Jaggery yield (t ha-1)
SNK10058	1.47	4.67	1.22	4.22	81.18	10.72	91.9	38.99	6.94	10.92
SNK10134	1.70	6.12	0.83	4.15	78.21	11.95	90.16	47.66	8.24	8.56
SNK10148	1.86	5.16	0.79	4.52	82.37	11.12	93.49	55.65	9.23	7.80
SNK10162	1.68	4.95	0.76	3.43	83.36	13.09	96.45	53.10	9.70	9.23
SNK10170	1.76	5.25	0.72	3.39	81.18	11.54	92.72	43.25	8.27	11.00
SNK10194	1.66	4.87	0.94	4.04	78.21	12.12	90.33	49.40	7.49	7.16
SNK10199	1.88	5.19	0.74	4.25	77.22	12.27	89.49	47.89	7.81	12.00
SNK10232	1.76	4.48	0.62	4.59	76.43	12.68	89.11	51.11	9.23	9.14
SNK10241	1.81	4.97	0.73	4.81	81.18	11.80	92.98	52.57	10.08	9.72
SNK10245	1.36	5.10	0.63	5.02	82.17	11.75	93.92	41.46	7.52	9.67
SNK10248	1.30	4.93	0.59	4.81	81.18	14.01	95.19	45.19	7.27	9.50
SNK10263	1.57	4.84	0.44	3.97	86.06	11.38	97.44	44.31	6.70	6.79
SNK10274	1.92	4.81	0.53	4.20	82.17	12.40	94.57	48.97	6.92	7.26
SNK10280	1.50	5.00	0.45	4.09	81.58	13.65	95.23	52.99	8.83	9.00
SNK10283	1.29	4.63	0.66	3.75	78.21	13.26	91.47	44.73	10.76	8.50
SNK10286	1.36	4.35	0.96	4.47	78.21	11.07	89.28	60.24	10.45	10.37
SNK10303	1.50	4.54	0.44	4.04	78.21	11.85	90.06	46.93	8.50	10.14
Checks										
CoC 671	1.39	5.05	0.46	3.97	85.14	10.68	95.82	52.13	9.43	10.73
Co 92005	1.22	5.18	0.49	4.47	85.14	12.91	98.05	45.16	7.41	10.00
Co 86032	1.39	5.21	0.50	3.66	82.17	12.10	94.27	60.13	9.28	7.92
Mean	**1.57**	**4.96**	**0.69**	**4.19**	**80.98**	**12.57**	**93.54**	**49.09**	**8.50**	**9.27**
S.Em.	0.14	0.20	0.16	0.29	1.78	0.78	1.44	3.46	0.71	0.91
CD 5%	0.29	0.59	0.48	0.87	5.25	2.31	4.26	10.25	2.09	2.70
CV %	9.93	5.68	33.31	9.93	3.10	8.79	2.19	9.98	11.75	13.91

Appendix VI: Mean performance of the genotypes for organoleptic traits for jaggery under (I.E)

Genotypes	Colour and appearance	Texture	Taste	Flavor	Overall acceptablility	Acceptability Index
SNK10058	7.4	7.3	7.4	7.1	7.4	81.11
SNK10134	7.5	7.5	7.5	7.3	7.5	82.78
SNK10148	6.5	7.5	7.4	7.3	7.5	80.28
SNK10162	7.4	7.5	6.8	7.1	7.5	80.56
SNK10170	6.0	7.1	7.0	6.9	7.5	76.67
SNK10194	5.0	6.9	7.1	7.0	7.5	74.44
SNK10199	5.3	6.8	7.1	6.8	6.8	72.50
SNK10232	7.8	8.1	8.1	7.9	7.9	88.33
SNK10241	6.3	7.5	7.0	7.4	7.0	78.06
SNK10245	6.1	6.4	5.9	5.6	6.0	66.67
SNK10248	7.0	7.4	7.6	7.5	7.5	82.22
SNK10263	6.4	6.8	6.9	7.1	6.8	75.28
SNK10274	6.4	6.1	7.4	7.4	6.9	75.83
SNK10280	7.3	7.4	7.3	6.9	6.5	78.33
SNK10283	6.6	7.1	7.4	6.9	6.6	76.94
SNK10286	6.8	6.9	6.6	6.5	6.8	74.44
SNK10303	6.8	6.9	7.4	6.9	6.6	76.67
Checks						
CoC 671	7.3	7.1	7.1	7.1	7.0	79.17
Co 92005	6.5	6.6	7.1	6.5	6.5	73.89
Co 86032	6.5	6.6	7.6	7.0	7.3	77.78
Mean	**6.72**	**7.18**	**7.26**	**7.10**	**7.11**	**77.97**
S Em	.25	0.27	0.18	0.17	0.15	0.86
CV	5.35	5.34	3.50	3.43	2.96	1.56

Appendix VII: Mean performance of the genotypes for organoleptic traits for jaggery under (O.E)

Genotypes	Colour and appearance	Texture	Taste	Flavor	Overall acceptablility	Acceptability Index
SNK10058	6.61	6.85	7.19	6.75	7.18	73.69
SNK10134	7.61	6.83	7.75	6.98	7.19	80.05
SNK10148	7.38	7.50	7.36	7.49	7.13	81.11
SNK10162	7.98	7.53	7.89	7.76	7.63	84.72
SNK10170	7.04	7.88	7.31	7.00	7.45	78.72
SNK10194	7.45	8.15	7.31	7.88	7.44	85.28
SNK10199	6.31	7.44	7.26	7.31	6.94	78.06
SNK10232	8.05	8.25	8.13	7.88	8.25	90.00
SNK10241	6.96	7.16	7.38	7.13	6.75	77.78
SNK10245	6.74	7.15	6.61	7.11	6.50	73.61
SNK10248	7.66	7.44	7.99	7.25	7.50	83.61
SNK10263	7.38	7.00	7.63	7.50	7.50	82.11
SNK10274	6.99	7.00	7.88	7.31	7.50	81.94
SNK10280	7.50	7.49	7.88	7.37	7.75	83.00
SNK10283	7.25	7.50	7.88	7.75	7.50	84.08
SNK10286	7.44	7.25	7.00	7.06	7.58	80.00
SNK10303	7.13	7.38	7.23	7.26	7.38	80.83
Checks						
CoC 671	6.23	7.06	7.38	7.13	7.25	77.89
Co 92005	6.93	6.94	7.49	7.25	7.25	79.05
Co 86032	6.71	6.40	7.28	7.00	7.00	76.94
Mean	**7.17**	**7.31**	**7.49**	**7.31**	**7.33**	**80.62**
S Em	0.15	0.15	0.13	0.16	0.17	0.27
CV	3.01	2.82	2.53	3.16	3.22	0.48

STUDIES ON GENETIC ENHANCEMENT OF SUGARCANE PRODUCTIVITY FOR ORGANIC JAGGERY PRODUCTION

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ABSTRACT

The present investigation was taken up to elucidate the information on the variability in the cane, sugar and jaggery yield components and the amount to which it is heritable. Inter and intra stage correlation was also studied in preselected population across organic and integrated environments.

The GCV and PCV for germination (%), total shoots (TS), cane formed shoots (CFS), and green top yield (GTY) were higher, whereas moderate variability was observed for internodal length (IL), single cane weight (SCW), number of millable cane (NMC), cane girth (CG), cane yield and commercial cane sugar yield (CCSY).

The association studies revealed that *viz.,* NMC, cane height, IL, CFS, SCW and CCSY were positively associated with cane yield. The repeatability studies indicates that traits *viz.,* germination (%), TS, NMC, SCW, cane height, CCS yield, HR brix and sucrose per cent at 10^{th} month were comparatively highly significant with moderate to higher heritability values indicating these traits as more dependable as selection criteria.

For cane, sugar and jaggery yield and quality parameters, top 17 genotypes showing superiority under integrated and organic environment. Among them four genotypes *viz.,* SNK 10286, SNK 10241, SNK 10134 and SNK 10132 found highly productive under integrated environment. The genotypes *viz.,* SNK 10162, SNK 10241, SNK 10283 and SNK 10286 were recorded significantly superior under organic environment.

Across the environments the genotypes *viz.,* SNK 10286 and SNK 10232 were found most promising, as they recorded higher jaggery productivity and acceptability index respectively, over best jaggery standard Co 92005. The organoleptic features and overall acceptability index of jaggery under organic environment were superior over integrated.