

GENETIC ENCASHMENT OF SUGARCANE
PRODUCTIVITY UNDER WOOLY APHID, WATER AND
SALT STRESSENVIRONMENTS

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I. INTRODUCTION

Sugarcane is an important commercial crop and is a source of food, fuel, fodder and fibre. This crop sustains the second largest organized agro-based industry in the country with an area of 4.36 million hectares, cane production of 281.5 million tonnes, productivity of 64.6 tonnes per hectare and sugar recovery of 10.36 per cent (Anon., 2004). Karnataka state ranks third in sugarcane area and production with an area of 0.385 million hectare, cane production of 32.4 million tonnes and productivity of 84.4 tonnes per hectare. It is cultivated predominantly as an annual irrigated crop in both tropics and sub-tropics of India. Sugarcane is favourably adaptable to a wide range of agricultural situations, but its productivity is generally limited by biotic and abiotic stresses. Northern Karnataka has major stake in the state in respect of area (74%) and production (69%). Though this part of the state is top in the country for sugar recovery, as it is favoured with cold and dry winter coinciding cane ripening (crushing) season, the cane productivity levels are lower compared to southern Karnataka and Tamil Nadu. The lower cane productivity in this highly potential region is primarily because of monoculture of sugarcane varieties either CoC 671 or Co 8011 over large diverse and adverse agro-ecologies viz., drought (35%), salinity water logg complex (10%) and normal irrigated environment (50-55%). In addition, these popular varieties have drawbacks like moderate ratooning ability and susceptibility to abiotic stresses viz., drought and salinity water logg complex.

Besides, recently (since the season 2001-02) sugarcane woolly aphid (SWA), *Ceratovacuna lanigera* Zehntner, has become a serious biotic constraint, threatening cultivation of sugarcane crop itself, as currently recommended varieties including newly developed clones under advanced testing are susceptible (Patil *et al.*, 2005 and Nerkar, 2003). Presently, the pest has attained a serious status in entire peninsular zone and spreading to east coast, north central and north west sugarcane growing zones of the country, causing significant loss in both cane yield and sugar recovery (Anon., 2003 and Joshi and Viraktamath, 2004). Very limited studies were reported on development of sugarcane varieties/ genetic resources for resistance to drought, salinity water logg complex and particularly to sugarcane woolly aphid. Hence, there is an urgent need to generate varieties/ genetic resources to address these major productivity constraints.

Therefore, development of location specific varieties to respond well under favourable conditions and to withstand specific stress could be an ideal approach. Moreover, the advantage of development of different clones with specific adaptive features is that, it favours increased diversity in farmer's fields and hence increases the life span of varieties by genetic buffering against biotic stress (insect pests and diseases).

The novel idea of using wild species, *Saccharum spontaneum* as male parent with *S. officinarum* as female parent in sugarcane breeding with the objective of incorporating gene complexes for resistance to biotic and abiotic stresses and for high biomass production resulted in tremendous level of useful genetic variability (Barber, 1916). Until recently, a very high level of genetic improvement for cane productivity has been achieved. High yielding varieties with wider adaptability are hard to come by, so greater emphasis is being given to develop location specific and specific stress resistant varieties to capitalize on their inherent genetic potential to realize further improvement in productivity. While at the same time, care should be taken not to fritter away the limited chances of obtaining a variety with wider adaptation across diverse agro-ecologies of the zone.

Introgression of wild germplasm is time consuming and requires considerable effort and resources with slower progress (Nair, 2002). In comparison, breeder has recognized inter crossing of already existing diverse commercial hybrids, a faster and more viable option to generate the variability required to cater the diverse and urgent needs. Enough useful variability could be obtained by inter crossing present commercial sugarcane varieties, as they are highly heterozygous and complex aneuploids derived from cultivated and wild species (Bhagyalakshmi, 1985).

In breeding for stress resistance, yield and resistance to the stress factor are to be involved, as the yield of varieties under stress is a function of its response to stress and the yield potential (Moore, 1987). By selecting for genetic improvement of yield potential under non-stress environment, the yield under stress can be improved. Selection for stress resistance under sub-optimum environments may advance germplasm with poor yield potential. Hence, the selection need to be performed in non-stress environment initially for cane and sugar yield and the fairly large number of selections have to be tested for specific targeted stresses, viz., drought, salinity-water logg complex and sugarcane woolly aphid.

The choice of parents for obtaining progenies with specific targeted requirements is of major importance in determining the merit of the crosses in any breeding programmes. Statistical evaluation of parental clones and breeding behaviour studies are difficult in sugarcane because of complex genetic nature and high cost of making measurements in large number of progenies (Brown *et al.*, 1968 and Hogarth, 1977). Therefore, in sugarcane breeding, the extent of useful variability and per cent (frequency) of superior segregants (progenies) in a progeny population are very important. Hence, parents are chosen for further crossing on the basis of high sample mean, number of superior selections and high sample variance in progenies for the traits under consideration.

Sufficient required and specific useful variability occurs in diverse inter varietal crosses and the selection has to be initiated in seedling (sexual) generation itself. The parents with high sugar and high tonnage with some degree of resistance/ tolerance to specific biotic or abiotic stress are expected to exhibit higher amount of heterotic expression and broad spectrum of variability in segregating F_1 generation, for the trait/ environment under consideration, combining other useful parameters.

A variety of methods and models have been developed for assessing variability but such refined models of population genetics find restricted use in genetically complex crop like sugarcane. The genetic analysis of qualitative and quantitative traits is also a problem in sugarcane due to high degree of polyploidy and aneuploidy (Brown *et al.*, 1968 and Hogarth, 1977).

Therefore, practical and successful breeding programmes depend on existence, intensive assessment and early exploitation of useful genetic variability. The starting point of a selection programme is the base population which consists of a number of seedlings possessing genetically determined variability for the diverse attributes for which selection is to be exercised. A sample size of 40-50 seedlings was found to be minimum and essential for the estimation of family means for most of the selection traits (Bhagyalakshmi, 1985, Mariotti *et al.*, 2001 and Tai *et al.*, 2003).

The appropriate stage at which selection is made depends to a large extent upon the genetic nature and magnitude of association of characters and repeatability between stages (seedling and settling) (Bhagyalakshmi, 1985). Selection can be imposed in early generation itself for those having high heritability value. There are contradicting reports regarding the relative effectiveness of selection in the seedling and in the early clonal stages. Therefore, it is essential to assess useful variability existed, heritability and other genetic parameters for selection traits in seedling generation itself. It is also important to identify suitable parents, crosses and progenies for specific environment/ stress tolerance, prevailing in large diverse sugarcane zone like northern Karnataka based on extent of various genetic parameters (variability, family mean, range, h^2 etc., for selection traits). Because, presently development of sugarcane varieties for tolerance/resistance against SWA, drought and salinity water logg complex and also search for high input responsive genotypes which possess inherent capabilities has been on the threshold of sugarcane varietal improvement.

Therefore, in the present investigation an attempt was made to generate genetic resources/ hybrids through early exploitation of useful variability present within and across diverse inter varietal crosses (45) to address major productivity constraints and immediate priorities of the zone, with the following objectives.

1. To estimate genetic parameters and identify productive progenies in seedling and early settling generations under diverse environments (moisture stress, salt stress and normal irrigated environments).
2. To estimate repeatability of important traits between seedling and settling generations across diverse environments.
3. To identify and characterize progenies for sugarcane woolly aphid reaction.
4. Path analysis study of cane yield with its components and physiological traits under moisture stress, salt stress and normal irrigated environments.
5. To identify and characterize superior progenies for cane and sugar yield parameters in moisture stress, salt stress and normal irrigated environments.

II. REVIEW OF LITERATURE

The review of literature pertaining to the present investigation is summarized under the following headings.

- 2.1 Genetic parameters for various traits in early generations
- 2.2 Repeatability of important traits between seedling and settling generations
- 2.3 Studies on sugarcane woolly aphid (*Ceratovacuna lanigera* Zehntner)
- 2.4 Path analysis studies in sugarcane

2.1 GENETIC PARAMETERS FOR VARIOUS TRAITS IN EARLY GENERATIONS

2.1.1 Genetic parameters for various traits in early generations across families

The amount of variability present in breeding material plays an important role in the progress of improvement of crop plants through selection. Further, its expression is likely to be influenced by the environmental conditions. So, the information available at one location may not necessarily be applicable to another. Therefore, the knowledge of variability is desirable for a breeder before making any selection programme. All the breeding methods and strategies for crop improvement are fundamentally based on the availability of genetic variability in the populations. The hybrids involving the parents with more diversity among them are expected to exhibit higher amount of heterotic expression and broad spectrum of variability in segregating generations.

Genetic variability and heritability are useful parameters that can help the breeder during different stages of crop improvement. The success of breeding programme will depend largely on the extent of genetic variability and heritability for important economic traits in early generation populations.

Since the estimate of heritability alone gives no indication of the amount of progress expected from selection, the heritability estimate along with genetic advance is needed in predicting resultant effect from selecting the best individuals (Johnson *et al.*, 1955).

One can find in literature, a good number of such studies on sugarcane crop with respect to yield and quality attributes on these genetic parameters, but such reports are limited for early seedling and settling generations particularly under diverse environments. Hence in general, reports of several authors on estimates of genetic parameters for various traits in seedling generation are presented in Table 1 and that of clonal generation are presented in Table 2.

Table 1. Review of literature on genetic parameters studied for various traits in seedling generation of sugarcane

Table 2. Review of literature on genetic parameters studied for various traits in clonal generations of sugarcane

Table 1. Review of literature on genetic parameters studied for various traits in seedling generation of sugarcane (*Saccharum* spp. Hybrids)

Character	Extent of genetic parameter	References
A. Cane yield and its components		
Cane yield	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Kumar and Bakshi Ram (1996) (GCV)
	Moderate	Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
Single cane weight	High	Singh <i>et al.</i> (1995) (GCV, PCV, H and GA), Ramdoyal and Badaloo (1998) (H, across environments)
	Low	Silva <i>et al.</i> (2002) (GV)
No. of millable canes	High	Xie <i>et al.</i> (1989) (H), Singh <i>et al.</i> (1995) (GCV, PCV, H and GA), Ram and Hemaprabha (1998) (GCV and GA), Singh <i>et al.</i> (2002) (GV), Kumar and Bakshi Ram (1996) (GCV), Rosabal <i>et al.</i> (1999) (H), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM), Reillyo <i>et al.</i> (1995) (H)
Cane girth	High	Singh <i>et al.</i> (1995) (GCV, PCV, H and GA), Ramdoyal and Badaloo (1998) (H across environments) Silva <i>et al.</i> (2002) (H), Nagarajan (1997) (GV), Ram and Hemaprabha (1998) (GCV and GA), Kumar and Ram (1996) (GCV), Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environment), Rosabal <i>et al.</i> (1999) (H), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM), Reillyo <i>et al.</i> (1995) (H)
	Moderate	Gonzalez <i>et al.</i> (1989) (H, SD and RS)
	Low	Xie <i>et al.</i> (1989) (H), Silva <i>et al.</i> (2002) (GV),
Millable cane height	High	Silva <i>et al.</i> (2002) (H 56.6%), Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments), Bakshi Ram <i>et al.</i> (2001) (GV, H and Genetic gain), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM)
	Moderate	Xie <i>et al.</i> (1989) (H)
	Low	Silva <i>et al.</i> (2002) (GV), Kumar and Bakshi Ram (1996) (GCV),
Internodal length	High	Ramdoyal and Badaloo (1998) (H across environments)
No. of internodes	High	Singh <i>et al.</i> (1995) (GCV, PCV, H and GA)

Contd. . .

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B. Sugar yield and its components		
Sugar yield	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Doule and Balasundaram (2002) (GCV, PCV and Sel. Gain)
	Low	Ramdoyal and Badaloo (1998) (H across environments)
Brix (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Gonzalez <i>et al.</i> (1989) (H, SD and RS), Singh <i>et al.</i> (1991) (H 85.5%), Doule and Balasundaram (2002) (GCV, PCV and Sel. Gain), Hemaprabha <i>et al.</i> (2003) (H), Nagarajan (1997) (GV), Hsu <i>et al.</i> (1995) (H), Singh <i>et al.</i> (2002) (GV), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM), Reillyo <i>et al.</i> (1995) (H)
	Moderate	Tai <i>et al.</i> (1992) (H), Ramdoyal and Badaloo (1998) (H across environments) Silva <i>et al.</i> (2002) (H), Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
	Low	Xie <i>et al.</i> (1989) (H)
Sucrose (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Ram and Hemaprabha (1998) (GCV and GA), Singh <i>et al.</i> (2002) (GV), Mamet <i>et al.</i> (1996) (H), Reillyo <i>et al.</i> (1995) (H)
	Moderate	Tai <i>et al.</i> (1992) (H), Das <i>et al.</i> (1996) (H), Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
	Low	Das <i>et al.</i> (1996) (GV)
Purity (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Kumar and Ram (1996) (GCV), Reillyo <i>et al.</i> (1995) (H)
	Moderate	Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
Juice extraction (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM),
	Moderate	Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
CCS (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM)
	Moderate	Das <i>et al.</i> (1996) (H)
	Low	Das <i>et al.</i> (1996) (GV)
Sucrose per cent cane	Moderate	Ramdoyal and Badaloo (1998) (H across environments)
Fibre (%)	High	Reillyo <i>et al.</i> (1995) (H)
	Moderate	Ramdoyal and Badaloo (1998) (H across environments)

Contd. . . Table 1.

C. Other traits		
Na in juice	High	Kumar and Ram (1996) (GCV), Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
K, Cl in juice	Low	Kumar and Ram (1996) (GCV), Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environments)
Flowering	Moderate	Tai <i>et al.</i> (1991) (H)
No.of green leaves	High	Singh <i>et al.</i> (1995) (GCV, PCV, H and GA), Bakshi Ram <i>et al.</i> (2001) (GV, H and Genetic gain), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM)
Leaf area	High	Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM)
Photosynthesis	Low	Gao <i>et al.</i> (1999) (H)
Smut resistance	Moderate	Chao <i>et al.</i> (1990) (H), Lin <i>et al.</i> (1996) (H)
Downey mildew resistance	High	Hsu <i>et al.</i> (1999) (H)
Yellow spot disease infection level	High	Ramdoyal <i>et al.</i> (2001) (H)
Rust resistance	High	Comstock <i>et al.</i> (1992) (H)

H – broad sense heritability; GAM- Genetic Advance as per cent of mean; GA: Genetic Advance ;
GCV and PCV- Genotypic and Phenotypic coefficient of variability; SD-Selection differential; RS- Response to Selection;
E - Environment, CV- Coefficient of variation, GV - Genotypic variability, PV – Phenotypic variability

2.1.2 Family basis studies on genetic parameters for various traits

Differences among families for the degree of genetic determination and expected progresses from selection for several traits were reported (Cuenya *et al.*, 1981; Cuenya and Mariotti, 1987). Similarly Nagarajan (1997) indicated highly significant cross differences compared to within cross differences for stalk number, diameter and brix. Where as, Gill *et al.* (1989) indicated the CP 44-101 x Co 1148 as promising cross for red rot resistance selection based on highest percentage of desirable seedlings (17.7%). On the same line, Garcia *et al.* (1991) indicated the C 389-52 x C 540-47 as overall best cross, based on high degree of genetic variability. They also reported significant differences between sugarcane crosses for cane and sugar yield traits, as reported by Chang and Milligan (1992). On the Contrary, Jackson and Roach (1994) showed no significant differences between the populations of progenies for either mean performance or variance. It is also suggested that little or no immediate gain from favourable gene interactions may be achieved by crossing F₁ clones of diverse genetic backgrounds.

Family x environment interaction for cane and sugar yield traits had a large effect allowing family selection, with zero or negative genetic correlation between some sites (Jackson *et al.*, 1994 and Jackson *et al.*, 1995).

Singh *et al.* (1996), Kumar and Ram (1996), Yin *et al.* (1996), Nagarajan (1997) and Ramdoyal and Badaloo (1998) indicated specific families as promising with higher values for cane yield trait and HR brix. Similarly, Gao *et al.* (1999), Lin *et al.* (1991) and Burner *et al.* (2000) identified few promising crosses for higher photosynthetic traits.

Jackson and McRae (1998) suggested that selecting families on the basis of broad adoption would result in better gains than selecting for specific adoption to individual site in regional sugarcane selection programmes targeting a similar range of environment (based on family means across sites). However, Mariotti *et al.* (2000) indicated the feasibility and convenience for intra family selection for cane yield and quality traits. But for specific biotic stress like rust and yellow spot diseases resistance, Ramdoyal *et al.* (2000 and 2001) indicated that the families comprising resistant x resistant parents are promising as they had higher number of resistant progenies.

Mariotti *et al.* (2001), Khan *et al.* (2001), Barbosa (2001) and Silva *et al.* (2002) reported importance of family selection based on analysis of genetic parameters for various cane and sugar yield traits where as, Bissessur *et al.* (2001) and Sousa *et al.* (2002) indicated large differences between the environment for stalk height and diameter as they are highly variable. However, Tai *et al.* (2003) studied and observed differences in family performance for various cane yield and juice quality traits and indicated stalk diameter as the best predictor of the selection rate within the regular seedling programmes.

2.2 REPEATABILITY OF IMPORTANT TRAITS BETWEEN SEEDLING AND SETTLING GENERATIONS

2.2.1 Repeatability of important traits between seedling and settling generations

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.

Table 2. Review of literature on genetic parameters studied for various traits in clonal generations of sugarcane (*Saccharum* spp. Hybrids)

Character	Extent of genetic parameter	References
A. Cane yield and its components		
Cane yield	High	Singh <i>et al.</i> (1996) (PCV, GCV and GAM), Kadian <i>et al.</i> (1997a) (GAM), Kadian <i>et al.</i> (1997b) (GCV and PCV), Ghosh and Singh (1997) (PCV, GCV, H and GAM), Taghian and Fahmi (1998) (H), Olaoye (2001) (H), in ratoon under moisture stress), Thippeswamy <i>et al.</i> (2001) (H), Puneet Jain <i>et al.</i> (2001) (CV, H and GAM), Gupta <i>et al.</i> (2002) (GCV and PCV), Ravishankar <i>et al.</i> (2003) (GCV, PCV and H), Bhatnagar <i>et al.</i> (2003) (H), Singh <i>et al.</i> (2002) (GCV, PCV and H), Chaudhary and Misra (1996) (GCV, PCV, H and GAM), Bissessur <i>et al.</i> (2001) (GA under dry and wet condition), Sanjeev Kumar <i>et al.</i> (2001) (GCV and PCV under moisture stress), Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress), Milligan <i>et al.</i> (1996) (GCV), Singh and Singh (1999) (GCV, PCV, H and GAM in plant and ratoon crops)
	Moderate	Deren <i>et al.</i> (1991) (H 29-51% water logged condition), Kumar and Singh (1999) (GCV, PCV, H and GAM water logged condition)
	Low	Kang <i>et al.</i> (1990) (H-49%)
Germination%	High	Thippeswamy <i>et al.</i> (2001) (GA, H), Doule and Balasundaram (2003) (GCV, GV and PV), Singh <i>et al.</i> (2002) (GCV, PCV and H), Kumar and Singh (1999) (GCV, PCV, H and GAM water logged condition)
	Moderate	Doule and Balasundaram (2003) (H), Kumar and Singh (1999) (GCV, PCV, H and GAM water logged condition)
No.of Tillers	High	Gupta <i>et al.</i> (2002) (GCV and PCV), Doule and Balasundaram (2003) (GCV, GV and PV), Singh <i>et al.</i> (2002) (GCV, PCV and H), Sanjeev Kumar <i>et al.</i> (2001) (GCV and PCV under moisture stress), Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress), Kumar and Singh (1999) (GCV, PCV, H and GAM water logged condition)
Vigour	Moderate	Gonzalez <i>et al.</i> (1989) (H, SD and RS)
Leaf area	High	Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM), Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress)

Contd. . .

Contd. . . Table 2.

Cane girth	Moderate	Deren <i>et al.</i> (1991) (H 29-51% under water logged condition), Singh <i>et al.</i> (1996) (GA), Sharma <i>et al.</i> (1998) (H), Singh <i>et al.</i> (2002) (GCV and PCV)
	Low	Xie <i>et al.</i> (1989) (H), Singh <i>et al.</i> (1996) (PCV and GCV), Taghian and Fahmy (1998) (H), Tippeswamy <i>et al.</i> (2001) (GA), Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress), Kumar and Singh (1999) (GCV, PCV, H and GAM under water logged condition), Milligan <i>et al.</i> (1996) (GCV)
Millable cane height	High	Kadian <i>et al.</i> (1997a) (GCV, PCV and GAM), Singh <i>et al.</i> (1994) (CV and H), Ghosh and Singh (1997) (PCV, GCV, H and GAM), Taghian and Fahmy (1998) (H), Sharma <i>et al.</i> (1998) (CV), Khan <i>et al.</i> (2001) (H 75.46%), Singh <i>et al.</i> (2002) (GCV and PCV), Sanjeev Kumar <i>et al.</i> (2001) (GCV and PCV under moisture stress), Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress), Kumar and Singh (1999) (GCV, PCV, H and GAM under water logg condition), Singh and Singh (1999) (GCV, PCV, H and GAM in ratoon)
	Moderate	Deren <i>et al.</i> (1991) (H 29-51% under water logg condition), Xie <i>et al.</i> (1989) (H), Singh <i>et al.</i> (1996) (PCV, GCV and GAM), Sharma <i>et al.</i> (1998) (H), Singh <i>et al.</i> (2002) (H)
Internodal length	High	Kadian <i>et al.</i> (1997a) (GCV, PCV, GAM), Kadian <i>et al.</i> (1997b) (GAM), Sharma <i>et al.</i> (1998) (CV), Sanjeev Kumar <i>et al.</i> (2001) (H under moisture stress)
	Moderate	Sharma <i>et al.</i> (1998) (H)
No.of internodes	High	Kadian <i>et al.</i> (1997a) (GCV, PCV and GAM), Singh <i>et al.</i> (1994) (CV and H), Das <i>et al.</i> (1996) (GV and H), Sharma <i>et al.</i> (1998) (CV), Tippeswamy <i>et al.</i> (2001) (H), Ravishankar <i>et al.</i> (2003) (H)
	Moderate	Sharma <i>et al.</i> (1998) (H)
	Low	Tyagi and Singh (1998) (H and GA)
B. Sugar yield and its components		
Sugar yield	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Singh <i>et al.</i> (1994) (CV and H), Cox <i>et al.</i> (1994) (H), Ravishankar <i>et al.</i> (2003) (H), Singh <i>et al.</i> (2002) (GCV, PCV and H), Chaudhary and Misra (1996) (GCV, PCV, H and GAM), Bissessur <i>et al.</i> 2001 (GA under dry and wet condition), Milligan <i>et al.</i> (1996) (GCV), Sharma <i>et al.</i> (1998) (H)
	Low	Kang <i>et al.</i> (1990) (H 49%), Ghosh and Singh, (1997) (Mean, range, GV, PV, H and GA), Sharma <i>et al.</i> (1998) (CV)

Contd. . .

Contd. . . Table 2.

Brix (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Singh <i>et al.</i> (1994) (CV and H), Chang (1996) (H 95.5% across environments), Ravishankar <i>et al.</i> (2003) (GCV, PCV and H), Singh <i>et al.</i> (2002) (H), Deren (1992) (H 88-92%), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM), Gonzalez <i>et al.</i> (1989) (H, SD and RS)
	Moderate	Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environment)
	Low	Singh <i>et al.</i> (1996) (PCV and GCV), Olaoye (2001) (H, GCV and RT under moisture stress), Singh <i>et al.</i> (2002) (GCV and PCV)
Sucrose (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Singh <i>et al.</i> (1994) (CV), Chang (1996) (H across environments), Singh <i>et al.</i> (2002) (H), Reillyo <i>et al.</i> (1995) (H)
	Moderate	Taghian and Fahmi (1998) (H)
	Low	Kang <i>et al.</i> (1990) (H-49%), Singh <i>et al.</i> (1996) (PCV, GCV and GAM), Singh <i>et al.</i> (1996) (PCV and GCV), Singh <i>et al.</i> (2002) (GCV and PCV), Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress), Kumar and Singh (1999) (GCV, PCV, H and GAM under water logg condition)
Purity (%)	High	Hemaprabha <i>et al.</i> (1993) (H and GAM), Chang (1996) (H across environments), Gupta <i>et al.</i> (2002) (H), Reillyo <i>et al.</i> (1995) (H)
	Moderate	Bakshi Ram <i>et al.</i> (1999) (H-moderate to high under water and salt stress and normal environment)
	Low	Kang <i>et al.</i> (1990) (GV and GAM), Gupta <i>et al.</i> (2002) (GA), Chaudhary and Misra (1996) (GCV, PCV, H and GAM)
CCS (%)	High	Singh <i>et al.</i> (1996) (PCV, GCV and GAM), Hemaprabha <i>et al.</i> (1993) (H and GAM), Gupta <i>et al.</i> (2002) (GCV and PCV), Ravishankar <i>et al.</i> (2003) (H)
Sucrose per cent cane	High	Reillyo <i>et al.</i> (1995) (H)
Fibre (%)	High	Kang <i>et al.</i> (1990) (H-86%), Reillyo <i>et al.</i> (1995) (H)
Pith in cane	High	Deren (1992) (H-88-92%)

Contd. . .

Contd. . . Table 2.

C. Other traits		
Proline content	High	Kamat and Singh (2001) (GCV, PCV and H under moisture stress)
Chlorophyll content	Low	Kamat and Singh (2001) (GCV, PCV, H and GA under moisture stress)
Trash	Moderate	Gonzalez <i>et al.</i> (1989) (H, SD and RS)
Dry matter	High	Tippeswamy <i>et al.</i> (2001) (H)
Rind hardness	High	Kang <i>et al.</i> (1990) (H 88%)
	Low	Kang <i>et al.</i> (1990) (GAM 24%)
Flowering	High	Kang <i>et al.</i> (1990) (H 85% and GV 43%), Singh <i>et al.</i> (2002) (H)
Pollen viability	High	Singh <i>et al.</i> (2002) (H)
Inter-veinal distance	High	Singh <i>et al.</i> (1991) (H 85.5%)
No.of green leaves	High	Singh <i>et al.</i> (1995) (GCV, PCV, H and GA), Bakshi Ram <i>et al.</i> (2001) (GV, H and Genetic gain), Singh <i>et al.</i> (1994) (GCV, PCV, H and GAM)
Leaf width	High	Kadian <i>et al.</i> (1997a) (H)
Photosynthesis	Low	Gao <i>et al.</i> (1999) (H)
Red rot index (RI)	High	Yin <i>et al.</i> (1996) (H, Selection gain)
Smut resistance	Moderate	Chao <i>et al.</i> (1990) (H), Lin <i>et al.</i> (1996) (H)
Downey mildew resistance	High	Hsu <i>et al.</i> (1999) (H)
Yellow spot disease infection level	High	Ramdoyal <i>et al.</i> (2001) (H)
Rust resistance	High	Comstock <i>et al.</i> (1992) (H), Cornide <i>et al.</i> (1996) (H)
Sugarcane borer damage response rating and % internodes damaged	High	White <i>et al.</i> (2001) (H)
RSD reaction	Moderate	Comstock <i>et al.</i> (2001) (H)

In the procedure commonly followed even in the first ground nursery, the seedlings are subjected to intense selection resulting in many potential genotypes being inadvertently discarded. The appropriate stage at which selection is made large extent upon the nature and magnitude of association of characters and repeatability between stages. Effective selection can be imposed in the early generation itself for those traits having high heritability value. There are contradicting reports regarding the relative effectiveness of selection in the seedling and in the clonal stages. Some workers reported that there is no relationship between the characters of seedlings and its clonal generations (Venkataraman, 1935; Bhat *et al.*, 1960; Stevenson, 1965). However, McIntosh (1935) reported significant correlation between seedling and clonal stages for quality. Hebert (1965), Breaux *et al.* (1956), Daniels (1959) and Watkins (1956) also recorded significant correlations for brix between seedling and clonal generations. Ethirajan (1965) reported positive association of stalk diameter and brix between the seedling and clonal stages. Miller and James (1975) reported that stalk diameter was more repeatable than stalk number or brix. In India, Tripathi *et al.* (1977) reported positive association for diameter and brix between seedling and clonal stages. Sundaresan *et al.* (1979) reported high and significant correlation between seedling and clonal stages with regard to stalk thickness. Bhagyalakshmi (1985) reported strong correlations between seedlings and clonal stages for various traits except yield and it was of a greater magnitude for diameter and stalk weight. Like wise several researchers estimated the repeatability of selection traits in seedling and early clonal generations which is summarized in Table 3 and 4

Table 3. Review of literature on repeatability studies made across seedling and settling generation for various traits of sugarcane

Table 4. Review of literature on repeatability studies made in settling generations across environments for various traits of sugarcane

2.2.2 Family basis repeatability studies

Several researchers (Breaux *et al.*, 1956; Hebert and Henderson, 1959; Miller and James, 1975) estimated the repeatability of selection traits. Estimations in general were moderate to low at early stages. Important variation of the estimates occurred, however when different progenies were compared to each other (Hebert and Henderson, 1959; Miller and James, 1975). The result suggested that the efficiency of selection also varied among families. The occurrence of moderate to low repeatability at early stages reduces the efficiency of selection. The family component was also analysed in regard to the efficiency of selection in sugarcane. Reddy and Reddi, (1988) reported significant repeatability for any one or two crosses among 12 crosses studied for most of the components and not at all for stalk volume. Whereas Chang and Milligan (1992) observed differences among bi-parental crosses in repeatability for brix, stalk number, weight, diameter, length and stool weight. Similarly Cuenya and Mariotti (1994) reported wide variations of repeatabilities among families for cane and sugar yield traits.

Reillyoo *et al.* (1995) reported that clonal repeatability and correlation between family means were highest for stalk diameter, fibre per cent cane and brix per cent dry matter. The traits viz., stalk diameter, stalk weight and length of stalks had higher R values across families (Bakshi Ram *et al.*, 1996 and Cuenya *et al.*, 1999). Whereas, Burner *et al.*, (2000) indicated that repeatability estimates for the *S. officinarum* hybrids were less than those for the *S. spontaneum* hybrids for most of the selection traits.

The 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) by Sousa *et al.*, 2002.

Table 3. Review of literature on repeatability studies made across seedling and settling generation for various traits in sugarcane (*Saccharum* spp. Hybrids)

Character	Extent of repeatability	References
A. Cane yield and its components		
Cane yield	Moderate	Lin <i>et al.</i> (1991), Sundaresan <i>et al.</i> (1979) (Significant)
	Low	Reddy and Reddi (1988), Bakshi Ram <i>et al.</i> (1996) (Significant)
Single cane weight	High	Cuenya <i>et al.</i> (1999), Sousa <i>et al.</i> (2002)
	Low	Reddy and Reddi (1988)
No.of millable canes	High	Rosabal <i>et al.</i> (1999), Cuenya <i>et al.</i> (1999), Sundaresan <i>et al.</i> (1979), Xie <i>et al.</i> (1989)
	Moderate	Lin <i>et al.</i> (1991)
	Low	Sousa <i>et al.</i> (2002), Bakshi Ram <i>et al.</i> (2000) (Significant)
Cane girth	High	Rosabal <i>et al.</i> (1991), Reillyo <i>et al.</i> (1995) (Between family means), Cuenya <i>et al.</i> (1999), Sousa <i>et al.</i> (2002)
	Moderate	Lin <i>et al.</i> (1991), Bakshi Ram <i>et al.</i> (1996) (Significant), Xie <i>et al.</i> (1989), Sundaresan <i>et al.</i> (1979) (Significant), Bakshi Ram <i>et al.</i> (2000) (Significant)
Internodal length	High	Cuenya and Mariotti (1994)
Cane height	High	Lin <i>et al.</i> (1991), Cuenya <i>et al.</i> (1999), Sousa <i>et al.</i> (2002)
	Moderate	Cuenya and Mariotti (1994), Xie <i>et al.</i> (1989)
	Low	Bakshi Ram <i>et al.</i> (2000) (Significant)
B. Sugar yield and its components		
Brix%	High	Lin <i>et al.</i> (1991), Reillyo <i>et al.</i> (1995) (Between family means), Sundaresan <i>et al.</i> (1979) (Significant)
	Moderate	Bakshi Ram <i>et al.</i> (1996) (Significant), Xie <i>et al.</i> (1989)
Sucrose%	High	Sundaresan <i>et al.</i> (1979)
Fibre %	High	Reillyo <i>et al.</i> (1995) (Between family means)
Smut resistance	High	Chao <i>et al.</i> (1990)
	Moderate	Lin <i>et al.</i> (1991)

Table 4. Review of literature on repeatability studies made in settling generations across environments for various traits in sugarcane (*Saccharum* spp. Hybrids)

Character	Extent of repeatability	References
A. Cane yield and its components		
Cane yield	High	Ramdoyal (1999) (Ratoon across environments), Singh and Singh (1999), Sousa <i>et al.</i> (2003)
	Moderate	Milligan <i>et al.</i> (1996)
	Low	Ramdoyal (1999)
Single cane weight	High	Milligan <i>et al.</i> (1996), Ramdoyal (1999) (Ratoon across environments), Bressiani <i>et al.</i> (2003), Singh and Singh (1999)
	Low	Ramdoyal (1999), Viana <i>et al.</i> (1991)
No.of Millable canes	High	Ramdoyal (1999), Singh and Singh (1999), Bressiani <i>et al.</i> (2003), Singh and Singh (1999)
	Low	Milligan <i>et al.</i> (1996), Viana <i>et al.</i> (1991)
Cane girth	High	Suarej <i>et al.</i> (1989), Milligan <i>et al.</i> (1996), Singh and Singh (1999), Bressiani <i>et al.</i> (2003)
	Low	Viana <i>et al.</i> (1991)
No.of internodes	High	Milligan <i>et al.</i> (1996),
	Low	Viana <i>et al.</i> (1991)
Internodal length	High	Milligan <i>et al.</i> (1996),
	Low	Viana <i>et al.</i> (1991)
Cane height	High	Milligan <i>et al.</i> (1996), Singh and Singh (1999), Bressiani <i>et al.</i> (2003)
	Moderate	Suarej <i>et al.</i> (1989)
	Low	Viana <i>et al.</i> (1991)

Contd. . .

Contd. . . Table 4.

B. Sugar yield and its components		
CCS yield	High	Milligan (1994) (across environments), Ramdoyal (1999) (Ratoon across environments)
	Low	Milligan <i>et al.</i> (1996), Ramdoyal (1999), Glaz <i>et al.</i> (2002), Viana <i>et al.</i> (1991)
Brix (%)	High	Suarej <i>et al.</i> (1989), Milligan <i>et al.</i> (1996), Ramdoyal (1999) (Between cool Environments), Singh and Singh (1999), Bressiani <i>et al.</i> (2003)
	Moderate	Ramdoyal (1999) (Between warm Environments)
	Low	Viana <i>et al.</i> (1991)
Sucrose (%)	High	Suarej <i>et al.</i> (1989), Milligan <i>et al.</i> (1996), Ramdoyal (1999) (Between cool environments), Singh and Singh, (1999), Sousa <i>et al.</i> (2003)
	Moderate	Ramdoyal (1999) (Between warm environments)
	Low	Viana <i>et al.</i> (1991)
Purity (%)	High	Milligan <i>et al.</i> (1996)
	Moderate	Suarej <i>et al.</i> (1989)
	Low	Viana <i>et al.</i> (1991)
Fibre (%)	High	Ramdoyal (1999)
	Low	Viana <i>et al.</i> (1991)
C. Other traits		
Flowering	High	Ramdoyal (1999)
Armyworm resistance	High	Allsopp <i>et al.</i> (2000)

2.3 STUDIES ON SUGARCANE WOOLLY APHID (*Ceratovacuna lanigera* Zehntner)

Cane yield is influenced by several factors like soil fertility, climate, variety, cultural practices and prevalence of pests and diseases. Among these, insect pests cause considerable losses in cane yield as well as sugar recovery. David and Nandgopal (1986) reported over 214 insect species which attack sugarcane crop from the very first day, when the cane setts are planted in the soil and their damage in one or the other form continues until the crop is harvested. Out of these, about a dozen are serious and of regular occurrence. These include the termites, white grubs, moth borers, pyrilla, army worms and grass hoppers which attack the crop at various stages of its growth. Among sucking pests, sugarcane woolly aphid, pyrilla, white flies, agied bugs, scale insects and mealy bugs are common.

Sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner was first reported on sugarcane in 1897 from Java (Zehntner, 1900) and it is a serious pest of sugarcane in Asia (Matsumura, 1910; Copeland, 1917; Uye, 1924; Ishida, 1928; Lim *et al.*, 1977; Arakaki, 1989 and Waterhouse, 1993). In India, it has been reported as a pest on sugarcane from West Bengal, Assam, Nagaland, Sikkim, Tripura and Uttar Pradesh (Saxena, 1967; Ghosh, 1974 ; Phukan, 1978; Phukan *et al.*, 1988; Tripathi, 1992; Gupta and Goswamy, 1995).

Since 2002, it has attained a serious status in Maharashtra and Karnataka (Anon., 2002; Patil, 2003 and Nerkar, 2003) and it has also spread to Andhra Pradesh, Tamil Nadu, Goa, Kerala, Bihar, Uttaranchal and Uttar Pradesh.

2.3.1 Nature of damage

The insect prefers sugarcane as its primary host (Hill, 1993). Bamboo, *Miscanthus sinensis* and *Cynodon dactylon* are reported as secondary hosts (Aoki *et al.*, 1984). Both nymphs and adults desap the leaves ventrally by piercing their stylet through the stomata leading to development of whitish patches, which coalesce and turn yellow. Later affected leaves dry from tip downwards along the margin before complete drying. Due to heavy secretion of honey dew, which falls on lower leaves leading to development of sooty mould which reduce photosynthetic area affecting cane yield and quality. In Vietnam, continuous infestation leads to reduction in the length, girth, height and sugar content of the stalks in susceptible varieties (Anon., 1963). The loss in tonnage as well as sugar recovery was also reported from India (Tripathi, 1995). Gupta and Goswami (1995) assessed the effect of 25 and 100% aphid infected leaves on some yield and quality parameters of sugarcane and found that 100% infestation had detrimental effect on the length (11.6% reduction), girth (3.5% reduction), weight (16.6% reduction), inter-nodal length (18.4% reduction) and leaf width (4.9% reduction). Juice quality parameters also exhibited considerable reduction. The percent reduction in sucrose, brix, glucose, purity and CCS was 53.3, 32.3, 25.3, 31.7 and 64.0 respectively.

The losses due to heavy incidence of SWA were recorded to the extent of 26 per cent in cane yield and 24 per cent in sugar content in Indonesia (Farina, 1994). The favourable climatic conditions enhance the reproduction capacity and in a short period, a huge population is reported. During severe infestation, maximum of 8,000 nymphs was observed on a single leaf with an average of 1,600 nymphs per leaf. In Taiwan, young plants were killed by infestation (Hill, 1993).

A study on loss estimation was carried at ARS, Sankeshwar, involving different commercial varieties viz., Co 92020, CoC 671, Co 86032, Co 8021 and Co 8011. There was significant reduction (30-35%) in both cane yield and sugar yield parameters in severely infested 10 month crop and further infestation at early stages (during germination to tillering phase) leads to complete drying causing 100 per cent loss (Anon., 2002 and 2003). In the affected areas even jaggery industry has suffered heavy loss in terms of jaggery quality and recovery. Seed germination loss to the extent of 40 per cent and considerable fodder (cane tops) quality deterioration has also been reported due to SWA infestation.

2.3.2 Pest control strategies

To manage this pest, several control measures *viz.*, chemical, biological, cultural and host plant resistance have been suggested (Anon., 2002, 2003; Patil, 2003; Nerkar, 2003; Lingappa *et al.*, 2003; Mote and Puri, 2003; Patil, 2003; and Joshi and Viraktamath 2004). Host plant resistance as an important IPM component, is fully compatible with other methods. Moreover, this component is environmentally safe, more stable and viable (Nerkar, 2003; Painter, 1951). Attempts to identify resistant sugarcane germplasm have been made in Taiwan, Philippines and Indonesia. In Taiwan, varietal differences for aphid incidence and its biology were studied and the variety ROC 1 was found to offer resistance to some extent, as it was associated with longer nymphal period and fewer progenies per adult (Pan *et al.*, 1984). In a similar study at Philippines, varietal differences in relation to aphid biology were reported (Rueda and Calilung, 1974). In Indonesia a resistance breeding programme was initiated for SWA (Mirzawan and Irwan, 1995). There is no report available on the level of resistance for SWA in India. However, earlier studies reported relative susceptibility of genotypes (Anon, 2002 and 2003) and varieties with lower nitrogen content, total soluble solids and higher silicon content were reported to be less susceptible (Phukan, 1978). Two hydroxamic acids, DIBOA and DIMBOA were detected in sugarcane that may contribute to resistance to the aphid as they do to aphids on cereals (Nicol *et al.*, 1992).

2.4 PATH ANALYSIS STUDIES IN SUGARCANE

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, 1923 and 1934) 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 path analysis on cane yield and its component characters is briefly reviewed and presented below.

Bhide (1969) reported that cane yield was directly influenced by number of stalks, stalk height and diameter. However, James (1971) indicated stalk number, stalk diameter and stalk length in that order to be the most important components of cane yield. James and Miller (1971) reported the importance of stalk population in determining cane yield. Stalk number, length and diameter were reported by Mariotti (1973a) to be the major components of cane yield based on the phenotypic path. But when the genotypic path was considered, stalk number only appeared to be strongly contributing trait to cane yield. Diameter ranked second, while length and density showed negative contribution.

Mariotti (1973b) observed that in one environment, number of stalks had maximum direct effect on commercial cane sugar yield while sucrose, stalk diameter and length appeared to be poor contributors to the cane yield. However, in an other environment, stalk number, diameter and length were proved to be very important contributors to cane yield.

Miller and James (1974) identified stalk population, diameter and length as the primary components of cane yield. The importance of number of millable canes followed by stalk weight on cane yield and sugar yield was stressed by Batcha (1975). Khairwal and Babu (1975) and Khairwal *et al.*, (1977) observed negative direct effect of cane height as well as sucrose on cane yield.

The importance of stalk number and stalk weight on cane yield was reported by Balasundaram and Bhagyalakshmi (1978). They also noticed stalk thickness as a negative component of sugar yield. Khairwal *et al.* (1978) found strong direct effect of stalk number on cane yield followed by stalk thickness and stalk weight, while Hooda *et al.* (1979) indicated maximum direct effect of stalk weight on cane yield. Kang *et al.* (1983) in their study on genotypic path coefficient analysis indicated stalk height to be less important than stalk diameter and stalk number as a component of cane yield but at the phenotypic level all the three characters were of equal importance. Nagarajan (1983) highlighted the significance, consistency and equal contributions of stalk weight and stalk number to sugar yield.

Reddy and Reddi (1986) reported high phenotypic and genotypic direct effect of stalk number per plot and stalk weight on cane yield. Tehlan *et al.* (1986) observed high direct effect of number of canes followed by stalk height on cane yield. Chauhan *et al.* (1987) reported high positive direct effect of number of millable canes per clump towards cane yield even via sucrose per cent in juice. Based on phenotypic and genotypic path analysis study, Ramana Reddy (1988) indicated that stalk diameter and stalk density were equally important for stalk weight. Maximum positive phenotypic direct effect of number of millable canes followed by cane diameter on cane yield was indicated by Sreekumar *et al.* (1989). Cane length had comparatively low positive direct effect on cane yield.

In a study by Baljit Singh *et al.* (1994) on direct and indirect effects of characters effecting cane yield in five sugarcane crosses, the number of millable canes followed by stalk weight had the greatest direct effects. The direct effects of stalk height, stalk girth, brix per cent and sucrose per cent on cane yield were generally very low. Chaudhary and Singh (1994) indicated that number of millable canes and individual cane weight had the greatest direct contribution to cane yield based on path analysis studies made with early maturing genotypes.

Path analysis studies of Sarvajeet Singh and Khan (1995) revealed greatest direct positive effect of number of millable stalks on cane yield followed by stalk weight. Singh *et al.* (1995) noticed almost equal positive direct path correlation of stalk weight and number of stalks per clump on stalk yield. The plant height had the greatest correlation to clump weight and also the largest direct effect in studies made by Deng *et al.*, 1995. Premachandran (1995) indicated that high single cane weight and moderate sucrose per cent in juice can be selected as water logging resistant in the early selection stages based on character association studies made under water logged conditions.

Das *et al.* (1997) observed maximum direct effect of stalk weight on cane yield followed by number of millable stalks. However, high positive direct effect of number millable canes and single cane weight on both cane yield and sugar yield was reported by Bakshi Ram (1994) and Rishipal *et al.* (1998). Ramdoyal (1999), reported stalk weight as the main determinant of stool weight, followed by cane height and length of internode. While Thippeswamy (1999) reported dry matter and number of internodes were large contributors to cane yield per plot.

Sanjeev Kumar *et al.* (2001) reported close association of cane yield with number of tillers, number of millable canes per plot, germination per cent, length of internodes and single cane weight under moisture deficient conditions. While, according to Kamat and Singh (2002), germination per cent, number of shoots, LAI, single cane weight, total chlorophyll content and sucrose per cent in juice may be 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.

III. MATERIAL AND METHODS

The present investigation was carried out in the Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad during 2000-04. The experiments were conducted at Agricultural Research Station, Sankeshwar, R and D Farm of Nandi Sugars, Hosur (Bijapur dist.), R and D Farm of Ugar Sugars, Ugarkhurd (Belgaum dist.) and Gangavati (Koppal dist.).

3.1 EXPERIMENTAL MATERIAL

The experimental material for the present study consisted of hybrid progenies of 45 crosses involving commercial varieties. The list of these crosses and number of progenies studied is given in Table 5. The characteristic features of parent varieties are summarized in Table 6.

3.2 EXPERIMENTAL LAYOUT

Experiments were laid out in a homogenous blocks following augmented Randomized Block Design II for seedling and early settling generations and RBD with two replications for advanced clonal generation materials at different environments.

Seedling Generation Trial

No.of crosses	:	45
(including GCs & PCs)		
No.of progenies	:	3124
Design	:	Augmented RBD
No.of Blocks	:	22
No.of standards	:	4 (CoC 671, Co 86032, CoM 88121 and Co 740)

Clonal Trials CT-II, RT-I and II (Under moisture stress environment at Sankeshwar)

No.of crosses	:	44*
No.of progenies	:	828
Design	:	Augmented RBD
No.of Blocks	:	9
No.of standards	:	4 (CoC 671, Co 86032, CoM 88121 and Co 740)

*None of the progenies were selected from F41

Clonal Trial CT-II (Under salinity water logg complex environment at Ugar)

No.of crosses	:	44*
No.of progenies	:	828
Design	:	Augmented RBD
No.of Blocks	:	17
No.of standards	:	3 (CoC 671, Co 7508 and CoM 88121)

*None of the progenies were selected from F41

Clonal Trials CT-II and RT-I (Under normal irrigated environment at Hosur)

No.of crosses	:	44*
No.of progenies	:	828
Design	:	Augmented RBD
No.of Blocks	:	13
No.of standards	:	3 (CoC 671, Co 86032 and CoM 88121)

*None of the progenies were selected from F41

Table 5. List of crosses and number of progenies studied

Sl. No.	Cross No.	Cross	No.of progenies studied
1	F01	Co 740 x Co 88028	25
2	F02	Co 740 x CoA 7602	191
3	F03	Co 740 x MS 6847	88
4	F04	Co 6806 x MS 6847	25
5	F05	Co 7424 x Co 775	22
6	F06	Co 7704 x Co 88025	04
7	F07	Co 7704 x CoC 671	165
8	F08	Co 86249 x CoC 671	165
9	F09	Co 88028 x Co 8347	80
10	F10	Co 88028 x Co 88025	144
11	F 11	Co 88028 x MS 6847	126
12	F 12	CoC 671 x Co 88025	112
13	F 13	Co 671 x CoT 8201	63
14	F 14	CoC 671 x 81 V 48	11
15	F 16	CoC 85061 x CoC 671	102
16	F 17	C 81615 x 87 R 40	18
17	F 18	MS 6847 x CoC 671	151
18	F 19	85 R 186 x Co 8213	105
19	F 20	87 R 40 x CoC 671	102
20	F 21	88 R 50 x CoC 671	75
21	F 22	Co 740 PC	36
22	F 23	Co 6806 PC	89
23	F 24	Co 7201 PC	96
24	F 25	Co 7224 PC	10
25	F 26	Co 8013 PC	55
26	F 27	Co 8213 PC	125
27	F 28	Co 8371 PC	70
28	F 30	Co 87023 PC	77
29	F 31	Co 88025 PC	16
30	F 32	Co 88028 PC	96
31	F 33	CoA 7602 PC	46
32	F 34	CoC 671 PC	101
33	F 35	CoC 771 PC	87
34	F 36	CoLk 8901 PC	73
35	F 37	CoT 8201 PC	41
36	F 38	CoV 92101 PC	44
37	F 39	C 81615 PC	38
38	F 41	Co 740 GC	14
39	F 43	Co 8371 GC	12
40	F 44	Co 88025 GC	20
41	F 46	CoA 7602 GC	58
42	F 47	CoC 671 GC	34
43	F 48	CoT 8201 GC	96
44	F 49	KMS 2095 GC	12
45	F 50	MS 6847 GC	08
		Total	3124

Table 6. The parentage and characteristics of parent varieties

Sl.No	Parent	Parentage	Characteristics
1	Co 740	P 3247 x P 4745	Medium thick, high yielding, better ratooner, midlate maturing, tolerant to drought and water logging, resistant to rust and susceptible to smut.
2	Co 88028	Co 7201 x Co 775	Thick, high yielding, hard, tolerant to lodging, midlate maturing, tolerant to drought and moderately susceptible to smut
3	CoA 7602	Co 1287 x Co 775	Erect tall thick, high yielding, midlate maturing, tolerant to drought and salinity with resistance to red rot
4	MS 6847	Co 798 x Co 775	Thick, very high yielding, moderate sucrose content, moderate ratooning, MR to smut and GSD
5	Co 6806	Co 775 x Co 771	Medium thick, high yielding, early maturing with high sucrose variety resistant to smut and red rot
6	Co 7224	Co 740 x Co 658	Medium thick, high yielding, late maturing variety with good ratooning ability. Resistant to red rot
7	Co 775	PoJ 2878 x Co 371	High yielding, early maturing, high sucrose variety with excellent jaggery quality
8	Co 7704	Co 740 x Co 6806	Medium thick purple cane, early ripening with good quality and yield. Resistant to smut, When planted early characteristic leaf drying during summer is noticed and resistant to drought
9	Co 88025	Soma clone of CoC 671	High yielding, high sucrose, early maturing variety.
10	CoC 671	Q 63 x Co 775	High yielding, high sucrose, early maturing variety and moderately tolerant to drought and salinity. Excellent field keeping quality with moderate ratooning ability
11	Co 86249	CoJ 64 x CoA 7601	High yielding, high sucrose, midlate maturing variety with erect, nonlodging feature
12	Co 8347	Co 7507 x CP 34-79	Moderate yield with high sucrose content and resistant to smut
13	CoT 8201	Co 740 x Co 775	Erect, high yielding, high sucrose with very good ratooner and rust resistant variety
14	81 V 48	NCo 310 x CoA 7602	Medium thick, high yielding with good quality
15	CoC 85061	Co 6304 GC	Medium thick green cane, early high sugared variety, high yielding, good ratooner with moderate resistance to drought and smut
16	C 81615		High yielding, moderate ratooner with good quality
17	87 R 40	Co 7704 x CoA 7602	High yielding, early maturing variety with very good sucrose content, Non spiny leaf sheath, solid stalk, non lodging with easy de-trashable feature. Fast growing tall variety with field resistance to red rot and smut.
18	85 R 186	Co 7219 x Co 6806	High yielding, midlate maturing variety, highly tolerant to drought, with loose clasping, solid and erect nature
19	Co 8213	Co 62198 x CoC 671	Tall thick canes with good sugar yield, MR to red rot

Table 6. Contd.

1	2	3	4
20	Co 7201	Co 449 x Co 658	High yielding and midlate maturing variety 'MS' to red rot and 'S' to smut and GSD
21	Co 8013	Co 740 x Co 1287	Medium thick, green cane, early maturing, high quality variety. Resistant to drought, red rot but highly susceptible to water logging. Non flowering, erect cane type with very good ratooning ability.
22	Co 8371	Co 740 x Co 6806	Thick, high tillering, very high yielding variety with better sucrose content. Suitable for flood prone and river bank areas
23	CoC 771	Co 419 x Co 658	Medium thick yellowish/ purple canes, fast growing with good quality, stalks are pithy and prone to cavity formation. Tolerates tannery effluent

The parent varieties with unique features

Moisture stress tolerant	:	Co 740, Co 88028, CoA 7602, CoC 85061, 85R186, Co 8013 and Co 7704
Salinity/ water logg tolerant	:	87R40, 85R186, Co 8371, CoC 771, Co 88028, Co 740, CoC 671 and CoA 7602
Highly productive under normal irrigated conditions	:	MS 6847, Co 6806, Co 7224, Co 775, Co 8347, CoT 8201, Co 7201, CoC 671, Co 88025 and Co 8371
SWA tolerant (Less susceptible):	:	Co 88028, CoA 7602, Co 7704, CoC 671, Co 86249 and Co 88025

Fuzz of these 45 crosses were received from Sugarcane Breeding Institute, Coimbatore (T.N.). Fuzz was sown in plastic trays. The soil mixture used in beds consisted of horse dung, silt and sand in the proportion of 3:3:1 respectively. The soil mixture was sterilized using formalin before sowing. Fuzz was spread uniformly in a thin layer. The trays were kept in mist chamber. Proper attention was paid during early (mist chamber) and subsequent growth of seedlings in poly bags under shade.

3.2.1 Evaluation of hybrid progenies in Seedling Generation Trial

3124 seedlings of 45 crosses were transplanted in an augmented RBD design II with 22 blocks during April 2000. One month old settlings of four check varieties viz., CoC 671, Co 86032, CoM 88121, and Co 740 were randomly repeated in each block. Each block comprised of seedlings and four check varieties. The trial was planted with 0.9 m spacing between rows and 0.6 m between seedlings with in a row. Gaps were filled after 15 days to ensure the cent per cent population. Recommended cultural operations were carried out during the crop season. 828 progenies with higher or on par HR brix and cane yield components compared to commercial check varieties were carried forward to clonal evaluation I (CT-I trial cum multiplication).

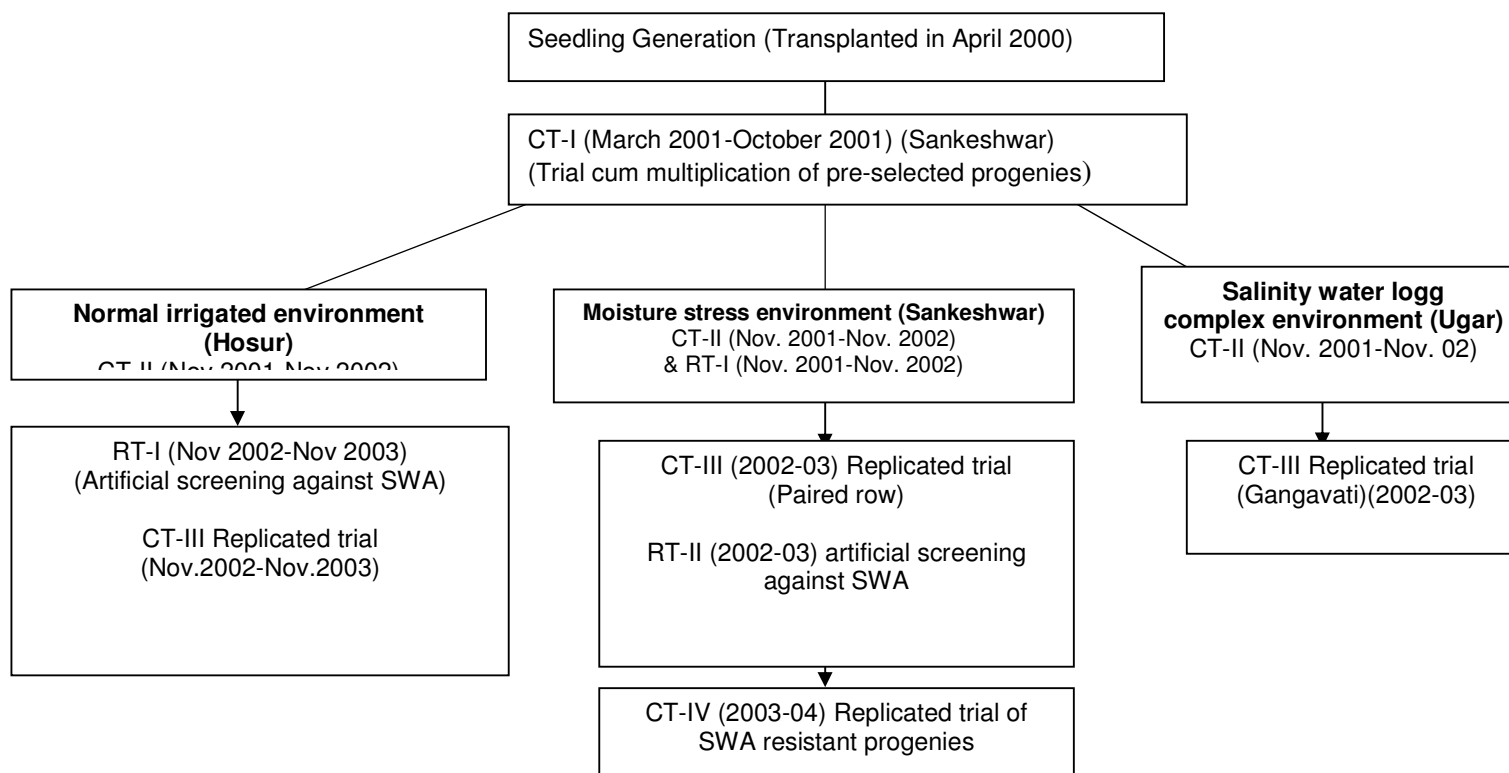


Fig 1. Flow chart of experiments conducted at various environments

3.2.2 Clonal Trial-II (Under moisture stress environment at Sankeshwar)

Pre selected 828 progeny clones were planted under moisture stress environment at ARS, Sankeshwar in an augmented RBD design with 9 blocks during 2001-2002 season. The same four check varieties viz., CoC 671, Co 86032, CoM 88121 and Co 740 were planted in each block randomly. Each block comprised of 92 clones/ genotypes and all four check varieties. Trial was planted in 0.9 m spacing between rows, with 3 m row length. The seed rate of 12 eye budsm⁻¹ was used. The crop was raised as per package of practices of northern Karnataka, excluding moisture stress management practices. In this experiment, irrigations were skipped from 50 to 160 days after planting (critical moisture stress sensitive period i.e. formative phase) and data on ten characters were recorded at respective (suitable) growth stages. The meteorological parameters like temperature, humidity and rainfall during the crop season (2001-02) are presented in Appendix I.

Appendix I. Mean monthly meteorological data for the period from January 2000 to December 2004 at Agricultural Research Station, Sankeshwar

3.2.3 Clonal Trial-II (Under salinity water logg complex environment at Ugar)

All the 828 clones were tested under salinity water logg complex environment at R & D farm, Ugar Sugar Works, Ugar-Khurd (Belgaum dist.), during 2001-02 season, in an augmented design with 17 blocks. All the check varieties except Co 86032, in place Co 7508 was used. All other recommended package of practices was followed for raising crop. The soil pH and EC data of all the blocks of experimental site is given in Appendix IV. The water-logg condition was prevailed during July to October 2002. The water stagnation to the extent of 10-16 cm above soil surface was recorded in the experimental site. The experiment was laid out in middle 17 blocks which have EC values nearer to critical threshold (4 dSm⁻¹) level reported for sugarcane (Rekkiappan, 2002). The meteorological parameters like temperature, humidity and rain fall during the crop season (2001-02) are presented in Appendix III. Though all 828 progenies were evaluated, the clones without cane formation and very poor stand were rejected.

iAppendix III. Weather data of R and D Farm, Ugar sugars, Ugar-khurd for the year 2001 and 2002

Appendix IV. The soil pH and EC (dSm⁻¹) levels of the blocks of the experimental site Clonal trial-II) at Ugar

3.2.4 Clonal Trial-II (Under normal irrigated environment at Hosur)

Similar trial was planted at R and D Farm, Nandi Sugars, Hosur (Bijapur dist.) during 2001-02 with same design, plot size, with 13 blocks and 3 checks viz., CoC 671, Co 86032 and CoM 88121. The crop was raised under normal irrigations through out the season with all other package of practices recommended for northern Karnataka. The meteorological data pertaining to temperature, humidity and rainfall during crop season (2001-02) are presented in Appendix II. Though all 828 progenies were evaluated, the clones without cane formation and very poor stand were rejected.

Appendix II. Mean monthly meteorological data for the period from January 2000 to December 04 at R & D Farm, Nandi Sugars, Hosur (Bijapur Dist.)

3.2.5 Clonal Trial RT-I (CT-I's Ratoon under moisture stress environment)

Clonal Trial-I (Planted with same design, plot size and number of blocks as that of CT-II of moisture stress environment) was ratooned and all observations except germination were recorded as per the schedule followed for clonal trials. The crop was raised as per package of practices recommended for ratoon crop excluding moisture stress management practices his, irrigations were skipped from 30 to 140 days after ratooning. The meteorological data during the crop season (2001-02) is presented in Appendix I.

3.2.6 Clonal Trial RT-II (CT-I's Ratoon-II under moisture stress environment)

Clonal Trial RT-I of moisture stress environment was again ratooned to screen the clones against SWA, during the season 2002-03 under natural and artificial infestation conditions.

3.2.7 Clonal Trial RT-I (Under normal irrigated environment at Hosur)

Clonal Trial-II of normal environment was ratooned to screen the clones against sugarcane woolly aphid, during the season 2002-03 under natural and artificial infestation conditions.

3.2.8 Clonal Trial-III (Under moisture stress environment at Sankeshwar)

The 50 moisture stress tolerant selections including five susceptible progenies were evaluated with four checks viz., CoC 671, Co 86032, CoM 88121 and Co 740 in RBD with two replications. The trial was planted in paired rows of 6 m. length with spacing of 1.8 m. and 0.9 m. between and within pairs respectively. The seed rate ($10 \text{ eye buds m}^{-1}$) and all other package of practices excluding drought management practices were followed for raising the crop. In this experiment irrigations, were skipped from 50 to 160 DAP and observations on various characters were recorded as per schedule planned. The meteorological parameters like temperature, humidity and rain fall during the crop season (2002-03) are presented in Appendix I.

3.2.9 Clonal Trial-III (Under saline water logg complex environment at Gangavati)

The 31 selected progenies for salinity water logg complex environment and 3 checks viz., CoC 671, Co 7508 and CoM 88121 were evaluated in RBD with two replications. Each clone was planted in 4m row length with 0.9m row spacing and $12 \text{ eye buds m}^{-1}$ seed rate. The crop was raised with normal package of practices excluding salinity water logg management practices. The meteorological parameters like temperature, humidity and rain fall during the crop season (2002-03) are presented in Appendix III. The water stagnation to the extent of 8-14 cm above soil surface was recorded in the experimental site during August to October months of 2003. The EC and pH data of all the rows in each blocks of the experimental site is given in Appendix V.

Appendix V. The soil pH and EC (dSm^{-1}) of each of the 34 rows in four blocks of experimental site at Gangavati

3.2.10 Clonal Trial-III (Under normal irrigated environment 2002-03 at Hosur)

The 53 selected progenies for normal irrigated environment and 5 check varieties viz., CoC 671, Co 86032, Co 88121, Co 740 and Co 88028 were evaluated in RBD with two replications. Each clone was planted in 4 rows of 6 m length with 0.9 m row spacing and $10 \text{ eye buds m}^{-1}$ seed rate. The crop was raised with normal package of practices recommended for northern Karnataka. The observations on germination (45 DAP), tillers (90 DAP), juice quality parameters (330 and 360 DAP) and cane yield parameters at harvest (360 DAP) were recorded. The meteorological parameters like temperature, humidity and rain fall during the crop season (2002-03) are presented in Appendix II.

3.3 OBSERVATIONS RECORDED

3.3.1 Seedling generation

3.3.1.1 Tillers per seedling (clump)

The shoots present in each clump were counted and recorded as tillers per clump at 90 days after transplanting.

3.3.1.2 Average cane girth (cm)

The diameter of millable canes in each clump was recorded on the middle internode of the cane by using a vernier callipers at the time of harvest and the average girth expressed in centimetres.

3.3.1.3 Average millable cane height (cm)

The millable cane height was recorded from ground level to the last internode of millable canes in each clump with the help of a measuring scale and the average height is expressed in centimetres.

3.3.1.4 Average number of internodes

The number of internodes present on the millable canes of the clump up to last internode were recorded and expressed as average number of internodes per stalk at the time of harvest.

3.3.1.5 Average internodal length (cm)

The internodal length of top, mid and bottom internodes of millable canes in each clump was recorded with the help of a measuring scale and the average inter-nodal length is expressed in centimetres.

3.3.1.6 Number of millable canes (NMC) per clump

All the canes from each clump were cut, dressed, counted and recorded as number of millable canes per clump.

3.3.1.7 Average single cane weight (SCW) (kg)

The weight of millable canes in each clump was recorded at harvest and the average weight was worked out and expressed as average single cane weight in kilograms.

3.3.1.8 Cane yield per clump (kg)

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

3.3.1.9 Average hand refractometer brix per cent (HRB %)

The per cent brix of a juice sample taken from centre of randomly selected millable canes of each clump was recorded with the help of a hand refractometer at 270 days after transplanting.

3.3.2 Settling/ (clonal) generations

3.3.2.1 Germination per cent

The germination was recorded from the gross plot on 45th day after planting (DAP) and expressed as percentage of the buds planted.

The observations on tillers, average cane girth, average millable cane height, average number of internodes, average internodal length, number of millable canes per plot, average single cane weight, cane yield per plot, average HR brix per cent were recorded as per procedure followed in seedling generation.

3.3.3 Clonal trial-III (under moisture stress environment)

3.3.3.1 Tiller mortality per cent

The number of dead (dried) shoots from the gross plot on 90 and 120 days after planting (DAP) was recorded and expressed as mortality percentage of the total shoots.

3.3.3.2 First leaf area (cm²)

Leaf area of fully developed first emerged leaf was estimated by measuring length and width of leaves and multiplying with a factor 0.75 as proposed by Romero (1987).

3.3.3.3 Internode formed shoots

Internode formed shoots in the gross plot at 120 and 160 days after planting (DAP) were recorded and expressed as number per plot.

3.3.3.4 Number of roots per clump (at 150 DAP)

From each plot two clumps which were planted with the single eye bud set were uprooted by digging the soil, without disturbing the roots and washed gently and the number of roots were counted, averaged and expressed as number of roots per clump.

3.3.3.5 Root dry weight (g) per clump (at 150 DAP)

The roots were cut at the base and were separated and kept for drying at 80°C till a constant weight and expressed as g per clump.

3.3.3.6 Average root length (cm) (at 150 DAP)

The length of all the roots in a clump up to the tip was measured with the help of a measuring scale and expressed as average root length in centimetres.

3.3.3.7 Average long root length (cm) (at 150 DAP)

The length of long (top ten longest) roots in a clump up to the tip was measured with the help of a measuring scale and expressed as average long root length in centimetres.

3.3.3.8 Eighth leaf area (at 150 DAP)

The eighth leaf i.e., upper most fully opened leaf selected and area was estimated by measuring length and width of leaves and multiplying with a factor 0.75 as proposed by Romero (1987).

3.3.3.9 Leaf sheath moisture per cent (at 150 DAP)

The leaf sheath moisture per cent at 150 DAP was determined by following formula and expressed as per cent.

$$\text{Leaf sheath moisture (\%)} = \frac{\text{Leaf sheath dry weight (g)}}{\text{Leaf sheath fresh weight (g)}} \times 100$$

3.3.3.10 Leaf lamina moisture per cent (at 150 DAP)

The leaf lamina moisture per cent at 150 DAP was determined by following formula and expressed as percent.

$$\text{Leaf lamina moisture (\%)} = \frac{\text{Leaf lamina dry weight (g)}}{\text{Leaf lamina fresh weight (g)}} \times 100$$

3.3.3.11 Relative water content (RWC) (at 150 DAP) of leaves

The relative water content was estimated by the method of Barrs and Weatherly (1962). Ten discs from the representative leaves (6th fully opened open leaf from top) were collected randomly in each variety and weighed accurately on an electrically operated single pan analytical balance. This was considered as fresh weight. The weighed leaf discs were allowed to float on distilled water in a petri dish and allowed to absorb water for four hours. After four hours, the leaf discs were taken out and their surface was blotted gently and weighed. This was referred to as turgid weight. After drying in an oven at 70 °C for 48 hours, the dry weight was recorded. RWC was calculated using the following formula.

$$\text{RWC (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

3.3.3.12 LAI and MTA (at 150 DAP)

The leaf area index (LAI) and mean tilt angle (MTA) of leaves at 150 DAP were measured by using portable LICOR Canopy Analyser system. These measurements were made during clear sky hours of the day.

3.3.3.13 Bio-physical traits

The measurement of rate of photosynthesis, transpiration, conductance, leaf temperature, water use efficiency and light use efficiency were made on the top fully opened leaf at moisture stress (mid formative stage) and after alleviation of stress (after the end of formative phase i.e., after irrigation) by using portable photosynthesis system (LI-6400 LICOR, Nebraska, Lincoln USA.). These measurements were made between 10.00 am to 12.00 noon on both the sampling stages.

Parameters	Units
Photosynthesis	: $\mu \text{ mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$
Transpiration	: $\text{m mol of H}_2\text{O m}^{-2} \text{ s}^{-1}$
Conductance	: $\mu \text{ mol m}^{-2} \text{ s}^{-1}$
Leaf temperature	: $^{\circ}\text{C}$
Water use efficiency	: $\mu \text{ mol CO}_2 / \text{m mol H}_2\text{O}$
Light use efficiency	: $\mu \text{ mol CO}_2 / \mu \text{ mol PAR}$

3.3.3.14 Sugar yield parameters

3.3.3.14.1 Brix per cent

Brix reading was recorded using the brix hydrometer at 300, 330 and 360 (at harvest) days after planting. The corrected brix reading was worked out using Bur standards.

3.3.3.14.2 Juice extraction per cent

The juice extraction per cent was calculated by following formula.

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

3.3.3.14.3 Sucrose per cent (Pol %) in juice

It was estimated by Horne's dry lead acetate clarification method using polariscope at 300, 330 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.

3.3.3.14.4 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 300, 330 and 360 days after planting.

3.3.3.14.5 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 300, 330 and 360 days after planting.

$$\text{CCS per cent} = [\text{Sucrose per cent} - (\text{Brix per cent} - \text{Sucrose per cent}) \times 0.40] \times 0.75.$$

3.3.3.14.6 CCS yield per plot (and per ha)

Sugar yield was calculated from commercial cane sugar per cent as

$$\text{CCS per plot (kg)} = \frac{\text{CCS per cent} \times \text{cane yield per plot (kg)}}{100}$$

and also expressed as sugar yield per hectare using appropriate factor.

3.3.3.14.7 Brix yield per ha

Brix yield was calculated from brix per cent as:

$$\text{Brix yield (t/ha)} = \frac{\text{Brix per cent} \times \text{cane yield (t/ha)}}{100}$$

3.3.4 Clonal Trial-III (under salinity water logged complex environment at Gangavati)

3.3.4.1 Healthy shoot count per plot (at 70 and 160 DAP)

The total number of healthy shoots in each plot were counted and recorded as healthy shoots count per plot at 70 and 160 DAP.

The observations on germination (30 and 45 DAP), internode formed shoots (at 160 DAP) and other cane and sugar yield parameters at 360 DAP (at harvest) were recorded as per procedure followed in Clonal Trial-III under moisture stress environment.

3.3.5 Clonal Trial-III (under normal irrigated environment at Hosur)

The observation on germination (45 DAP), tillers (90 DAP), sugar yield parameters (at 330 DAP and 360 DAP) and cane yield parameters (360 DAP) were recorded as per procedure followed in clonal trial-III under moisture stress environment.

3.3.6 Screening of pre-selected progenies and parent varieties against SWA

3.3.6.1 Intensive screening of resistant progenies and commercial varieties using infester row technique

3.3.6.1.1 Under free choice condition

3.3.6.1.1.1 Colonization behaviour of released aphids (Apterous nymphs)

The colonization behaviour of released aphids on test entries and commercial varieties were observed daily and recorded as 'c' for crawlers (non colonization), 'pc' for partial colonization and 'cc' for complete (perfect) colonization. The observations were recorded daily after release (DAR) (24 h) for initial 7 days and later at weekly interval up to harvest (180 DAR / 360 DAP).

3.3.6.1.1.2 Average number of winged adults per plant

The total number of winged adults per plant was counted in randomly selected five plants in each plot which received artificially released aphids and recorded daily for seven days and later at weekly interval till harvest. The observations were expressed as average number of adults per plant.

3.3.6.1.1.3 Mortality per cent of young nymphs

The day on which the winged adults laid young ones on leaves were labelled in each plot and observed daily and number of young nymphs survived were counted and recorded for seven days and expressed as per cent mortality of young nymphs every day (24h). These observations were continued up to harvest of the crop.

3.3.6.1.1.4 Reaction of varieties against SWA

The clones were scored for SWA reaction on a 0-4 scale (Anon., 2002 and 2003), daily for first 7 days after artificial release and later at weekly interval till harvest and scores were recorded as grades.

3.3.6.2 Morpho-biophysical features (traits) of resistant and susceptible varieties

The stomate, spines and bi-celled hairs were studied in resistant progenies and susceptible commercial varieties (parents and commercial checks) at 180 DAP, following leaf surface impressions by using thermocol dissolved xylene solution. This gummy solution was smeared on the lower surface (5th leaf from top). Two to three minutes later, the solidified layer was peeled off, mounted on slide with cover slip and observed under 10 x magnifications. The number of stomate, spines and bi-celled hairs were counted and expressed in terms of number per mm² of leaf area.

The mean tilt angle (MTA) of leaves and leaf area index (LAI) at 180 DAP was measured by using portable LICOR Canopy Analyser system. These observations were made during clear sky hours of the day.

The leaf rolling was scored using following 0-4 scale,

- 0 = No rolling
- 1 = 1-25 % leaf inward rolling
- 2 = 26-50 % leaf inward rolling
- 3 = 51-75 % leaf inward rolling
- 4 = 76-100 % leaf inward rolling

The leaf colour was recorded through visual observation as dark green (dg), green (g) and light green (lg).

3.3.6.3 Traits observed for assessing productivity potential of SWA resistant progenies

The germination per cent (45 DAP), tillers per plot (90 DAP), sugar yield parameters at 300, 330 and 360 DAP and cane yield parameters at 360 DAP were recorded both under caged (artificially infested at 180 DAP) and under open (naturally late infested) rows as per the procedure followed for clonal trials-III under various environments.

3.4 STATISTICAL ANALYSIS

3.4.1 Seedling and early settling generation evaluation

An augmented design-II (Federer, 1956 & 1977), which holds considerable promise for evaluation of large breeding materials was used. Augmented design incorporates the provision of accommodating single replication of all treatments by spreading it over all the blocks (b), while a set of checks (c), numbering three or more are replicated in each block. Randomization is done in such a way that all the checks (c) and a part of test genotypes fall only once in each block. Equal number of test genotypes was planted in each block to facilitate statistical analysis.

The structure of ANOVA for Augmented Design-II

Source of variation	d.f.	SS	MSS	F
Blocks	b-1	bSS	bMS	bMS/EMS
Entries	e-1	eSS	eMS	eMS/EMS
Checks	c-1	cSS	cMS	cMS/EMS
Varieties	v-1	vSS	vMS	vMS/EMS
Checks vs Vars	1	csSS	cvMS	cvMS/EMS
Error	(c-1) (b-1)	ESS	EMS	
Total	N-1	TSS		

Where, b=No. of blocks, c=No. of checks, v=No. of test varieties, e=c+v, N=bc+ v

Different components of ANOVA can be calculated as follows. However, since only the checks (c) but not the test varieties (v) are replicated in this design, adjustment of means of 'v' must be done before ANOVA with the help of the following effects.

$$\text{Block effects } (b_j) = 1/c (T b_j - c - T v \bar{b}_j) \quad (j= 1 \text{ to } b)$$

$$\text{Counter check: } \sum_1^b b_j \cong 0$$

$$\text{Mean effect } (m) = 1/e (GT - (b-1) c - \sum_1^b n_j b_j)$$

Where, n_j is the number of v occurring in j^{th} block

$$\text{Check effects } (c_i) = c_i - m \quad (i = 1 \text{ to } c)$$

$$\text{GCF (General correction factor)} = GT^2/N$$

$$bSS = \sum_1^b T b_j^2 / (c + n_j) - \text{GCF}$$

$$bMS = bSS / (b-1)$$

$$TSS = \sum_{i=1}^c \sum_{j=1}^b c_{ij}^2 + \sum_1^v v_i - \text{GCF}$$

$$cCF (\text{Check correction factor}) = Tc^2/bc$$

$$cSS = \sum_1^c T c_i / b - cCF$$

$$cMS = cSS / (c-1)$$

$$eSS = (m \times GT) + \sum_1^b \left[T b_j + \sum_1^c T c_i \left(c_i + \sum_1^v v_i \right) \right] \left[\sum_1^b T b_j^2 / (c + n_j) \right]$$

$$eMS = eSS / e - 1$$

$$vCF (\text{Variety correction factor}) = T v^2 / v$$

$$vSS = \sum_1^v v_i^2 - vCF$$

$$vMS = vSS / (v-1)$$

$$cvSS = cvMS = eSS - cSS - vSS$$

$$ESS = TSS - eSS - bSS$$

$$EMS = ESS / (c-1) (b-1)$$

If the block effect is significant, following four standard errors are helpful in drawing conclusion.

$$SEd_1 \text{ (between any two check means)} = \sqrt{\frac{2EMS}{b}}$$

$$SEd_2 \text{ (between any two means of test varieties)} = \sqrt{2EMS}$$

$$SEd_3 \text{ (between any two entries of the same block)} = \sqrt{2EMS (1 + \frac{1}{c})}$$

$$SEd_4 \text{ (between means of a check and a test variety)} = \sqrt{EMS (1 + \frac{1}{b} + \frac{1}{c} + \frac{1}{bc})}$$

CD is then calculated using these $SEd_s \times t$ at 5% or 1% levels.

3.4.1.2 Inter-stage Correlations (Repeatability)

Inter-stage correlations were computed to determine the associations among seedlings, clonal/ settlings generations across environments (under normal irrigated, moisture stress and salinity water logg complex) and clonal ratoon for various selection traits. All pre-selected progenies from 44 crosses were considered for this purpose.

3.4.1.3 Estimation of Variance Components

Genotypic and phenotypic components of variance were estimated with the help of following formulae.

$$\text{Genotypic Variance } (\sigma_g^2) = vMSS - EMSS$$

$$\text{Phenotypic variance } (\sigma_p^2) = \sigma_g^2 + EMSS$$

Coefficient of variability

Both genotypic and phenotypic coefficient of variability were computed for each character as per method suggested by Burton and De Vane (1953)

$$\text{Genotypic Coefficient of Variation (GCV)} = \frac{\sigma_g}{\bar{X}} \times 100$$

$$\text{Phenotypic Coefficient of Variation (GCV)} = \frac{\sigma_p}{\bar{X}} \times 100$$

where, σ_g = genotypic standard deviation

σ_p = phenotypic standard deviation

$\bar{X}$ = grand mean of the character

3.4.1.4 Heritability (Board Sense)

Heritability coefficient (h^2) was computed for each character as the ratio of genetic variance to the total variance as suggested by Hanson *et al.*, (1956).

$$h^2 = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

where, σ_g^2 and σ_p^2 are genotypic and phenotypic variances respectively.

3.4.1.5 Genetic advance

Genetic advance (GA) for each character was computed by adopting the formulae given by Johnson *et al.*, (1955).

$$GA = h^2 KP$$

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

Genetic advance as per cent of mean (GAM)

$$GAM = \frac{GA}{\bar{X}} \times 100$$

Where, $\bar{X}$ = General mean of the character

3.4.1.6 Estimation of correlations

The analysis of variance (ANOVA) and analysis of covariance (ANCOVA) was done by following method described by Cochran and Cox (1957) for all characters.

Sources of variation	DF	MSS	Expectations
Replication (r)	r-1	RMSP	
Genotypes (v)	v-1	VMSP	$\sigma e_1 + r \sigma g_2 g_2$
Error	(r-1) (v-1)	EMSP	$\sigma e_1 e_2$
Total	(rv-1)		

$$\begin{aligned} COV_{XY}(g) &= \frac{VMSP - EMSP}{r} \\ COV_{XY}(e) &= EMSP \\ COV_{XY}(p) &= COV_{XY}(g) + COV_{XY}(e) \end{aligned}$$

Phenotypic correlation

$$r_{XY}(p) = \frac{COV_{XY}(p)}{\sqrt{V_X(p) \times V_Y(p)}}$$

Genotypic correlation

$$r_{XY}(g) = \frac{COV_{XY}(g)}{\sqrt{V_X(g) \times V_Y(g)}}$$

where,

$COV_{XY}(g)$	=	Genotypic covariance between characters X and Y
$COV_{XY}(p)$	=	Phenotypic covariance between characters X and Y
$COV_{XY}(e)$	=	Error covariance between characters X and Y
$V_X(p)$	=	Phenotypic variance of character X
$V_Y(p)$	=	Phenotypic variance of character Y
$V_X(g)$	=	Genotypic variance of character X
$V_Y(g)$	=	Genotypic variance of character Y
$r_{XY}(p)$	=	Phenotypic correlation coefficient among characters X and Y
$r_{XY}(g)$	=	Genotypic correlation coefficient among characters X and Y

The significance of correlation coefficients were tested by comparing 'r' values at (n-2) degrees of freedom where, 'n' is number of pair of observation used.

3.4.1.7 Estimation of path coefficients

The correlation coefficients were further partitioned into direct and indirect effects with the help of path coefficient analysis as suggested by Wright (1921) and Dewey and Lu (1959).

Cane yield per plot was assumed to be the dependent variable (effect) which is influenced by other characters, the independent variables (causes) directly as well as indirectly through other characters. The variation in cane yield unexplained by other causes was presumed to have been contributed by residual factor 'R' which is uncorrelated with other factors. Like this, CCS per plot was assumed to be the dependent variable (effect) which is influenced by other characters.

Path coefficients were obtained by solving the simultaneous equations which express the basic relationship between correlations and path coefficients. The equations were as follows.

$$\begin{aligned}
 r_{1,y} &= P_{1,y} + r_{1,2}P_{2,y} + r_{1,3}P_{3,y} + \dots + r_{1,l}P_{l,y} \\
 r_{2,y} &= P_{2,y} + r_{2,1}P_{1,y} + r_{2,3}P_{3,y} + \dots + r_{2,l}P_{l,y} \\
 r_{3,y} &= P_{3,y} + r_{3,1}P_{1,y} + r_{3,2}P_{2,y} + \dots + r_{3,l}P_{l,y} \\
 &\vdots \\
 r_{l,y} &= P_{l,y} + r_{l,1}P_{1,y} + r_{l,2}P_{2,y} + \dots + r_{l,18}P_{l,y}
 \end{aligned}$$

where, $r_{1,y}$ to $r_{l,y}$ denote the correlation coefficients between independent characters 1 to l and dependent character 'y', $r_{1,2}$ to $r_{l,y}$ denote the correlation coefficients between all possible combinations of independent characters and $P_{1,y}$ to $P_{l,y}$ denote the direct effects of characters 1 to l on character y.

The above equations can also be written in matrix form as shown below.

$$\begin{pmatrix} r_{1,y} \\ r_{2,y} \\ r_{3,y} \\ \vdots \\ r_{l,y} \end{pmatrix} \quad \mathbf{A} \quad \begin{pmatrix} 1 & r_{1,2} & r_{1,3} & \dots & r_{1,l} \\ & 1 & r_{2,3} & \dots & r_{2,l} \\ & & 1 & \dots & r_{3,l} \\ & & & \ddots & \vdots \\ & & & & 1 \end{pmatrix} \quad \mathbf{B} \quad \begin{pmatrix} P_{1,y} \\ P_{2,y} \\ P_{3,y} \\ \vdots \\ P_{l,y} \end{pmatrix} \quad \mathbf{C}$$

'B' matrix was inverted and inverted 'B' matrix was multiplied by 'A' matrix to obtain path coefficients. Residual factor which measures the contribution of rest of the characters of the usual scheme was obtained as follows.

$$P_{xy} = \sqrt{1 - R^2}$$

$$\text{where, } R^2 = \sum P_{i,y}^2 + 2i < j P_{i,y} P_{j,y} r_{ij}$$

which, is the square of the multiple correlation coefficient (R) and is known as coefficient of determination.

3.5 SCREENING OF PRE-SELECTED PROGENIES AND SOME PARENT VARIETIES AGAINST SWA

The pre-selected (for cane yield and HR Brix %) 828 hybrid progenies and parents of some crosses were evaluated in clonal generation-II with four commercial varieties viz., CoC 671, Co 86032, CoM 88121 and Co 740 at three hot spot locations for the SWA. The three hot spot locations for SWA were Sankeshwar (ARS) (Belgaum dist.) and R & D farms of Ugar Sugars, Ugarkhurd (Belgaum dist.) and Nandi Sugars, Hosur (Bijapur dist.). The experiments were conducted over 3 crop seasons 2001-02 (Clonal Stage-II and Clonal Stage-I's ratoon-I), 2002-03 (Clonal Stage-I's ratoon-II and Clonal Stage-II's ratoon-I) in an augmented randomized block design and 2004-05 (Clonal Stage-IV) in randomized block design with 3 replications using infester row technique.

3.5.1 Clonal evaluation under natural infestation (free choice) condition

In trials with augmented randomized block design, each clone was grown in a 3m row length spaced 90cm apart with 10 eye buds m^{-1} seed rate. The data on cane yield, flowering and other cane features were recorded at 360 DAP and HR Brix (%) at 300 DAP crop. Simultaneously, the clones were scored for SWA reaction on a 0-4 scale (Anon., 2002 and 2003) under natural infestation (free choice condition) on the following basis:

- 0 = No infestation,
- 1 = 1-25% leaf area covered with woolly aphid,
- 2 = 26-50% leaf area covered with woolly aphid,
- 3 = 51-75% leaf area covered with woolly aphid,
- 4 = 76-100% leaf area covered with woolly aphid.

3.5.2 Clonal evaluation under artificial infestation (no choice) condition

Identified promising clones were evaluated again, during season 2002-03, under artificial infestation (no choice condition) at two locations viz., ARS, Sankeshwar and R & D Farm, Nandi Sugars, Hosur for confirmation of pest reaction observed under natural infestation. Screening under artificial infestation was done in Ratoon-I (clonal stage-II's ratoon-I at Hosur) and Ratoon-II (clonal stage-I's ratoon-II at ARS, Sankeshwar) trials. The reactions against SWA were scored during crop grand growth to early ripening stage (160-300 days after ratooning). For this, five canes in each test clones were selected randomly and three leaves (middle and lower) of each cane were stapled with aphid infested leaves comprising overlapping stages collected from severely infested crop (4th grade), avoiding natural enemies of the pest. The larval or pupal stage of predator, *Dipha aphidivora* Meyrick, was only observed in few aphid colonies and removed at the time of artificial release. The entire row of test clones and susceptible commercial varieties were caged to prevent entry of natural enemies and escape of released aphids. After releases were made, the clones were observed daily and observations recorded at a regular interval of 7 days up to 28 days after release, as the length of nymphal stage usually lasts for about 23-28 days (Phukan *et al.*, 1988; Anon., 2003; Mote and Puri, 2003; Takano, 1941; and Pan and Yang, 1983). Subsequently, critical observations were continued till the crop harvest to confirm the nature of initial clonal reactions.

3.5.3 Infester row technique

3.5.3.1 Free choice condition

Resistant clones were evaluated to assess detailed cane and sugar yield parameters and to reconfirm resistant reaction. Ten resistant clones/ hybrid progenies and three commercial check varieties (susceptible) were evaluated in a randomized block design with three replications during season 2004-05. The single eye budded setts were planted in 4 rows of 6m length with 4 eye budsm⁻¹ seed rate and 0.9m inter row spacing. All the package of practices recommended for sugarcane in northern Karnataka were followed except protection against the test insect *i.e.* SWA. Sankeshwar is considered as one of the “hot spots” for SWA activity, where the susceptible checks were infested to the extent of 3-4 grades (Anon., 2002 and 2003 Patil *et al.*, 2005). In addition, to ensure the build up of the SWA population, an highly susceptible variety Co 92020 was planted around the plot as infester line between replications and in between tester rows, 30 days before the planting of tester clones. For intense screening under no choice condition, two lines each of the testers and infester were caged with aphid proof nylon nets, in all the three replications. Subsequently from first week of June (at 180 DAP), aphids (free from natural enemies) were released sufficiently in both tester and infester rows within the cages to ensure SWA build up in infester rows and to observe colonization if any, in the tester clones. The observations pertaining to various parameters were recorded as explained in previous section (3.3.6) in both caged rows (early artificially infested) and open rows (naturally late infested). Though the natural infestation occurred early in open rows also particularly in commercial checks, they were protected up to 330 DAP, to compare the performance of commercial varieties under late infested conditions with SWA resistant progenies.

3.5.3.2 Extreme no choice condition

Further, for reconfirmation of resistance, the progenies were exposed to extreme no choice condition. For this, 5th leaf from top in each entry was selected and over lapping stages of known number (100) of aphids were released and were made confined by enclosing leaf portion with thin transparent perforated aphid proof poly pipe. To prevent escape of released aphids, care was taken by closing both the ends of the poly pipe of 20cm length. The released aphids were closely observed at an interval of 24 h for survival/ mortality and colonization up to 7 days and number of aphids survived were recorded.

IV. EXPERIMENTAL RESULTS

Sugarcane varieties suitable for normal irrigated conditions and few other with some tolerant to biotic and abiotic stresses were chosen for hybridization. The seedling population of such 45 diverse interval varietal crosses comprising 3124 hybrid progenies was evaluated for cane yield parameters and HR brix. The settling population of 828 hybrids selected based on superior cane yield and / HR brix compared to four commercial checks was evaluated under woolly aphid, water and salinity water logg complex stresses and non stress environments. Further, selected progenies of each environment were tested in respective environments for various growth and yield components to study path analysis of cane yield and mean performance.

The results of various experiments of the present investigation are categorized in following five subheads

- 4.1 Genetic parameters for various traits in seedling (sexual) and early clonal (settling) generations under diverse environments.
- 4.2 Repeatability of important traits between seedling and settling generations across diverse environments.
- 4.3 Identification and characterization of progenies for SWA reaction.
- 4.4 Path analysis of cane yield with its components and physiological traits under moisture, salinity water logg complex stress and normal irrigated environments
- 4.5 Mean performance of selected progenies under moisture, salinity water logg complex stress and normal irrigated environments

4.1 GENETIC PARAMETERS FOR VARIOUS TRAITS IN SEEDLING (SEXUAL) AND EARLY CLONAL (SETTLING) GENERATIONS UNDER DIVERSE ENVIRONMENTS

4.1.1 Genetic parameters for various traits in seedling generation

The analysis of variance for the traits included in the study is presented in the Table 7. As evident from the table, mean sum of squares for all the traits considered in the present investigation were highly significant. The mean, range, genotypic and phenotypic coefficients of variability, heritability estimates and the GAM predicted as per cent of mean in respect of these traits are given in Table 8. The family wise mean, range, variance in respect of these traits, are given in Table 9 to13. The mean values (adjusted) obtained for nine traits included in the study in respect of 827 selected among 3124 progenies are provided in Appendix VI.

Table 9. Family wise mean, range and variance for tillers and average cane girth in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Table 10. Family wise mean, range and variance for average cane height (cm) and average number of internodes in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Table 11. Family wise mean, range and variance for average internodal length (cm) and number of millable canes (NMC) in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Table 12. Family wise mean, range and variance for average single cane weight (kg) and cane yield in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Table 13. Family wise mean, range and variance for average HR Brix (%) in seedling (sexual) generation of 45 inter varietal crosses and per cent superior sugarcane progenies based on cane yield and HR brix

Appendix VI. Adjusted mean values of selected progenies for 9 traits studied in seedling generation of 45 inter-varietal sugarcane crosses

4.1.1.1 Tillers per seedling

The overall mean value for tillers per seedling was 5.15, with a range of -0.55 to 36.82 showing wide variability in the progenies across families. The progeny SNK175 (F08021) had the highest number of tillers per seedling (36.82) followed by SNK733 (F30031) (36.05), while SNK308 (F12035) (-1.98) and SNK321 (F12063) (-1.98) showed lowest number of tillers per seedling.

The phenotypic (251.98) and genotypic (225.03) coefficients of variation were high for number of tillers per seedling. The heritability estimate was relatively high (89.30%) with high GAM as per cent of mean (128.68%).

The family F01 had highest (10.80) number of tillers per seedling with a range of 2.00 to 24.00 and variance of 32.40, while family F32 (3.25) showed lowest number of tillers which varied from 1 to 11.00 with 3.69 variance.

4.1.1.2 Average cane girth

The average cane girth exhibited moderate variability among the progenies of crosses studied with the mean values ranging from 0.98 to 3.78 cm and 2.32 cm overall mean.

The progeny SNK739 (F31012) (3.78 cm) recorded highest average cane girth followed by SNK728 (F30017) (3.42 cm) which were significantly superior from best check CoC671 (2.87 cm). Lowest average cane girth was observed in the progeny SNK194 (F08116) (0.98 cm).

The coefficient of variation was low for this trait at phenotypic (7.41) and genotypic (4.10) levels. This was also evident from the moderate heritability estimate of 55.32 per cent and low GAM of 20.35 per cent.

The family F31 recorded highest mean cane girth (2.66 cm) followed by F43 (2.59 cm) and F47 (2.57 cm), while lowest mean cane girth was observed in F01 (2.07 cm) followed by F19 (2.14 cm) and F17 (2.16 cm) families.

4.1.1.3 Average millable cane height

The mean values for this trait ranged from 50.63 to 430.50 cm with overall mean height of 300.15 cm, revealing high amount of variability among the hybrid progenies obtained from crosses involving diverse commercial varieties.

Among 3124 hybrid progenies, SNK149 (F07097) (430.50 cm) was the tallest followed by SNK299 (F11104) (427.17 cm), whereas progeny SNK727 (F30014) was the shortest (50.63 cm) followed by SNK769 (F34069) (67.73 cm).

The coefficients of variation at phenotypic and genotypic levels were very high *i.e.*, 1198.97 and 999.72 respectively. The heritability estimate (83.38%) and was high while GAM (34.33%) was moderate for this trait.

Highest family mean for millable cane height was recorded in F06 (347.50cm) with a range of 340 to 360 cm and variance of 68.75, whereas lowest mean value was observed in family F50 (200 cm) with wide range from 100 to 300 cm and highest variance of 3450 for this trait.

Table 7. Analysis of variance for important cane yield parameters and HR Brix (%) in seedling (sexual) generation of 45 inter varietal crosses in sugarcane

Source	df	MSS for the characters								
		Tillers / seedling	Average cane girth (cm)	Average millable cane height (cm)	Average number of internodes	Average internodal length (cm)	Number of millable canes / clump	Average single cane weight (kg)	Cane yield (kg) / clump	Average HR Brix (%)
Progenies (v)	3123	12.98**	0.17**	3598.70**	33.58**	14.80**	9.12**	0.09**	4.90**	7.19**
Error	42	1.39	0.08	598.04	5.73	1.78	0.40	0.06	0.07	1.34
SEd 1. Between 2 check means		0.36	0.08	7.37	0.72	0.40	0.19	0.07	0.08	0.35
SEd 2. Between any 2 means of test var.		1.67	0.39	34.58	3.39	1.89	0.90	0.35	0.36	1.63
SEd 3. Between any 2 entries of same block		1.92	0.45	39.93	3.91	2.18	1.04	0.40	0.42	1.89
SEd 4. Between means of check & var.		1.39	0.33	28.87	2.83	1.58	0.75	0.29	0.30	1.36
CD 5%										
Between 2 check means		0.72	0.17	14.89	1.46	0.81	0.39	0.15	0.16	0.70
Between any 2 means of test var.		3.37	0.79	69.86	6.84	3.82	1.82	0.71	0.73	3.30
Between any 2 entries of same block		3.89	0.91	80.67	7.90	4.41	2.10	0.82	0.85	3.81
Between means of check & var.		2.81	0.66	58.32	5.71	3.19	1.52	0.59	0.61	2.76
CD 1%										
Between 2 check means		0.96	0.23	19.91	1.95	1.09	0.52	0.20	0.21	0.94
Between any 2 means of test var.		4.50	1.06	93.38	9.14	5.10	2.43	0.95	0.98	4.41
Between any 2 entries of same block		5.19	1.22	107.82	10.56	5.89	2.80	1.09	1.13	5.10
Between means of check & var.		3.76	0.88	77.96	7.63	4.26	2.03	0.79	0.82	3.68

** Significant at 1 per cent level

Table 8. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in seedling (sexual) generation of 45 inter varietal crosses of sugarcane.

Characters	Mean	Range*		GCV (%)	PCV (%)	Heritability (%)	Genetic advance	GAM (%)
1. Tillers / seedling	5.15	-0.55 (1.00)	- 36.82 (38.00)	225.03	251.98	89.30	6.63	128.68
2. Average cane girth (cm)	2.32	0.98 (0.60)	- 3.78 (4.50)	4.10	7.41	55.32	0.47	20.35
3. Average millable cane height (cm)	300.15	50.63 (30.00)	- 430.50 (430.00)	999.72	1198.97	83.38	103.04	34.33
4. Average number of Internodes	23.89	6.06 (5.00)	- 44.80 (46.00)	116.55	140.54	82.93	9.90	41.43
5. Average internodal length (cm)	13.19	2.27 (1.11)	- 35.94 (32.00)	98.68	112.22	87.94	6.97	52.84
6. Number of millable canes / clump	4.19	0.31 (1.00)	- 32.68 (33.00)	208.14	217.78	95.57	5.95	141.99
7. Average single cane weight (kg)	0.69	-0.10 (0.16)	- 2.77 (2.99)	4.03	12.92	31.19	0.19	27.81
8. Cane yield (kg) / clump	2.69	0.37 (0.27)	- 27.88 (27.49)	179.46	181.90	98.66	4.50	167.04
9. Average HR Brix (%)	15.55	8.26 (1.40)	- 24.71 (23.00)	37.66	46.26	81.42	4.50	28.93

* Range obtained from adjusted mean values of progenies
Figures in parenthesis are actual values

Table 9. Family wise mean, range and variance for tillers and average cane girth in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Family / cross	Progenies studied	Tillers / Seedling			Average cane girth (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	25	10.80	2.00 - 24.00	32.40	2.07	1.20 - 3.00	0.23
F 02	191	5.48	1.00 - 19.00	9.68	2.28	0.90 - 3.20	0.19
F 03	88	7.09	1.00 - 21.00	18.40	2.22	0.60 - 3.10	0.20
F 04	25	5.60	2.00 - 14.00	10.80	2.26	1.30 - 3.20	0.23
F 05	22	6.95	2.00 - 14.00	8.86	2.30	1.20 - 3.00	0.20
F 06	4	5.50	2.00 - 7.00	4.25	2.53	2.40 - 2.60	0.01
F 07	165	5.62	1.00 - 21.00	10.62	2.37	1.20 - 3.20	0.11
F 08	165	5.51	1.00 - 38.00	17.28	2.26	0.90 - 3.40	0.18
F 09	80	6.09	1.00 - 26.00	21.19	2.25	1.20 - 3.00	0.12
F 10	144	5.19	1.00 - 29.00	14.32	2.26	1.10 - 3.40	0.16
F 11	126	5.23	1.00 - 23.00	10.76	2.34	0.90 - 3.10	0.20
F 12	112	4.69	1.00 - 15.00	9.98	2.38	1.30 - 3.20	0.14
F 13	63	4.98	1.00 - 16.00	8.43	2.17	0.80 - 3.00	0.15
F 14	11	5.27	1.00 - 15.00	14.56	2.23	1.90 - 2.60	0.04
F 16	102	5.49	1.00 - 15.00	9.39	2.18	1.00 - 3.20	0.19
F 17	18	3.89	1.00 - 6.00	2.32	2.16	1.20 - 2.90	0.14
F 18	151	4.32	1.00 - 20.00	8.99	2.27	1.40 - 3.20	0.11
F 19	105	4.69	1.00 - 16.00	9.23	2.14	1.20 - 3.20	0.14
F 20	102	4.13	1.00 - 21.00	10.41	2.45	1.40 - 3.70	0.15
F 21	75	5.81	1.00 - 15.00	15.17	2.23	1.40 - 3.40	0.16
F 22	36	5.44	1.00 - 22.00	16.91	2.30	1.40 - 3.20	0.19
F 23	89	5.55	1.00 - 14.00	9.42	2.24	1.40 - 3.60	0.16
F 24	96	5.91	1.00 - 16.00	11.94	2.32	1.50 - 3.40	0.13
F 25	10	5.10	1.00 - 15.00	14.49	2.32	1.40 - 3.00	0.28
F 26	55	4.96	1.00 - 18.00	8.58	2.23	1.30 - 3.40	0.17
F 27	125	4.98	1.00 - 17.00	9.99	2.39	1.20 - 4.50	0.18
F 28	70	4.87	1.00 - 21.00	10.98	2.37	1.30 - 3.30	0.15
F 30	77	5.57	1.00 - 34.00	20.12	2.23	1.20 - 3.40	0.25
F 31	16	6.31	1.00 - 15.00	18.21	2.66	2.00 - 3.90	0.28
F 32	96	3.25	1.00 - 11.00	3.69	2.41	1.40 - 3.20	0.19
F 34	101	4.46	1.00 - 16.00	8.55	2.40	0.60 - 3.20	0.16
F 48	96	4.17	1.00 - 21.00	13.20	2.41	1.40 - 4.00	0.17
F 50	08	5.13	1.00 - 20.00	33.61	2.36	1.80 - 3.00	0.20
F 47	34	4.09	1.00 - 10.00	5.73	2.57	1.90 - 3.20	0.12
F 49	12	6.42	1.00 - 36.00	83.58	2.44	2.00 - 3.00	0.11
F 46	58	4.72	1.00 - 13.00	9.72	2.52	1.60 - 3.20	0.15
F 37	41	4.37	1.00 - 19.00	13.06	2.36	1.70 - 3.00	0.14
F 36	73	4.27	1.00 - 18.00	9.68	2.28	1.40 - 3.30	0.13
F 35	87	5.13	1.00 - 19.00	12.18	2.46	1.60 - 3.80	0.13
F 38	44	5.64	2.00 - 17.00	14.19	2.51	1.60 - 3.40	0.13
F 39	38	5.24	1.00 - 19.00	17.50	2.43	1.80 - 3.30	0.12
F 41	14	3.86	2.00 - 9.00	4.69	2.47	2.00 - 2.80	0.03
F 43	12	5.58	1.00 - 18.00	20.24	2.59	1.80 - 3.20	0.16
F 44	20	5.65	1.00 - 14.00	10.73	2.52	1.20 - 3.10	0.26
F 33	46	4.70	1.00 - 18.00	12.26	2.40	1.40 - 3.20	0.20

4.1.1.4 Average number of internodes

The variation for this trait was considerably high as evident from the wide range observed (6.06 to 44.80). The mean number of internodes was 23.89.

Highest average number of internodes was recorded in progeny SNK552 (F22030) (44.80) followed by SNK203 (F08135) (42.36), whereas lowest average internodal number was observed in SNK516 (F20091) (6.06) followed by SNK434 (F18103) (7.46).

There was also difference between the phenotypic (140.54) and genotypic (116.55) coefficients of variation. This trait exhibited high heritability estimate (82.93%) with moderate GAM (41.43%).

The family F06 (30.75) recorded highest mean number of internodes with relatively narrow range (29.00 to 34.00) and low variance (3.69), may be because of less number of progenies studied, whereas family F50 (14.38) exhibited lowest mean value with a range of 10.00 to 21.00 and variance of 15.73 for this trait.

4.1.1.5 Average internodal length

The average internodal length exhibited higher variability with mean values ranging from 2.27 to 35.94 cm and overall mean of 13.19 cm. The progeny SNK 383 (F16077) (35.94 cm) recorded highest average internodal length followed by SNK516 (F20091) (33.59 cm) which were significantly superior over best check CoC671 (12.86 cm), while SNK085 (F04008) (2.27 cm) recorded lowest internodal length followed by SNK727 (F30014) (2.94).

The phenotypic coefficient of variation was 112.22, whereas genotypic coefficient of variation recorded was 98.68. The hybrid progenies exhibited relatively high heritability estimate (87.94%) coupled with high GAM (52.84%) for this trait.

The highest family mean for average internodal length was recorded in F23 (15.90 cm) with fairly wide range (9.40 to 29.17 cm) and highest variance (18.85), followed by F10 (15.52 cm) with more or less similar range (8.08-29.00 cm) and variance (15.87). The lowest family mean was observed in F46 (9.75 cm) with relatively narrower range (6.13 to 16.15 cm) and lower variance (5.84) for this trait.

4.1.1.6 Number of millable canes per seedling (clump)

The number of millable canes per clump exhibited high variability in the hybrid progeny population studied. The mean values ranged from 0.31 to 32.68 canes with a overall mean of 4.19 canes per clump.

The progeny SNK175 (F08021) (32.68) recorded highest number of millable canes, followed by SNK256 (F10114) (23.55) and SNK733 (F30031) (23.41) which were significantly superior over best check CoM88121 (4.88). The lowest number of millable canes was recorded in SNK229 (F09060) (0.31) followed by SNK117 (F07021) (0.35).

The coefficient of variations were also high for this trait both at phenotypic (217.78) and genotypic (208.14) levels. This was also evident from the high heritability estimate of 95.57 per cent with high GAM of 141.99 per cent.

The family F01 recorded highest (9.92) mean for this attribute with fairly wide range (2.00 to 21.00) and higher variance (30.07) followed by F05 with 5.36, 2.00 to 12.00 and 5.32 values for mean, range and variance respectively whereas, the family F32 recorded lowest mean (3.09) with wider range from 1.00 to 27.00 and moderate variance (8.69).

4.1.1.7 Average single cane weight

The mean of progenies ranged from -0.10 to 2.77 kg with a mean value of 0.69 kg single cane weight.

The highest (2.77 kg) single cane weight was recorded in SNK283 (F11035) followed by SNK051 (F02129) and SNK178 (F08032) with single cane weight of 2.70 kg and 2.63 kg respectively, which were significantly superior over best check CoC671 (1.36 kg). The lowest average single cane weight was observed in SNK765 (F34053) (-0.10 kg).

Table 10. Family wise mean, range and variance for average cane height (cm) and average number of internodes in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Family / cross	Progenies studied	Average cane height (cm)			Average number of internodes		
		Mean	Range	Variance	Mean	Range	Variance
F 01	25	313.48	240.00 - 385.00	965.85	28.36	15.00 - 36.00	29.59
F 02	191	332.96	200.00 - 395.00	1515.46	26.90	11.00 - 38.00	25.75
F 03	88	331.59	220.00 - 400.00	1603.72	25.99	14.00 - 39.00	27.74
F 04	25	332.20	200.00 - 395.00	1850.16	26.68	12.00 - 39.00	37.98
F 05	22	336.82	250.00 - 390.00	1876.24	26.55	18.00 - 39.00	32.16
F 06	4	347.50	340.00 - 360.00	68.75	30.75	29.00 - 34.00	3.69
F 07	165	339.33	220.00 - 430.00	1386.22	24.58	10.00 - 32.00	17.26
F 08	165	337.36	230.00 - 420.00	1385.93	25.87	11.00 - 40.00	26.25
F 09	80	327.41	220.00 - 420.00	1491.05	23.05	9.00 - 39.00	31.19
F 10	144	316.53	200.00 - 395.00	1504.85	21.42	8.00 - 30.00	21.99
F 11	126	314.52	190.00 - 415.00	1975.96	24.21	11.00 - 36.00	25.58
F 12	112	323.17	220.00 - 390.00	1412.50	24.71	11.00 - 38.00	26.99
F 13	63	318.33	210.00 - 390.00	1363.49	23.00	14.00 - 38.00	33.81
F 14	11	332.73	220.00 - 390.00	2165.29	28.91	12.00 - 40.00	56.63
F 16	102	327.25	200.00 - 400.00	1302.81	24.84	10.00 - 38.00	35.19
F 17	18	303.33	200.00 - 340.00	1502.78	26.06	18.00 - 35.00	19.50
F 18	151	313.58	210.00 - 405.00	1417.01	25.34	9.00 - 44.00	43.28
F 19	105	342.95	225.00 - 410.00	1002.71	25.64	12.00 - 36.00	30.19
F 20	102	299.41	210.00 - 405.00	1657.99	21.62	12.00 - 36.00	21.77
F 21	75	308.33	200.00 - 395.00	2110.22	22.05	9.00 - 32.00	27.76
F 22	36	343.75	240.00 - 410.00	1449.13	26.33	16.00 - 46.00	50.44
F 23	89	329.89	210.00 - 415.00	1906.17	22.21	10.00 - 36.00	39.07
F 24	96	328.44	30.00 - 400.00	3048.60	25.75	8.00 - 38.00	34.54
F 25	10	320.50	250.00 - 360.00	1382.25	24.90	16.00 - 37.00	38.89
F 26	55	300.25	200.00 - 375.00	1410.77	24.05	12.00 - 40.00	38.05
F 27	125	315.05	200.00 - 400.00	2626.98	24.32	9.00 - 36.00	33.72
F 28	70	326.41	210.00 - 400.00	2802.24	26.01	14.00 - 35.00	25.62
F 30	77	316.23	60.00 - 395.00	3131.27	25.65	11.00 - 38.00	31.32
F 31	16	299.69	210.00 - 350.00	1307.71	23.81	11.00 - 35.00	57.28
F 32	96	220.47	80.00 - 300.00	1734.94	20.23	7.00 - 32.00	35.49
F 34	101	216.00	80.00 - 320.00	1611.68	20.37	9.00 - 34.00	22.53
F 48	96	229.04	95.00 - 350.00	2179.33	20.54	9.00 - 39.00	30.69
F 50	08	200.00	100.00 - 300.00	3450.00	14.38	10.00 - 21.00	15.73
F 47	34	228.53	95.00 - 300.00	2283.13	21.00	11.00 - 30.00	24.18
F 49	12	266.67	180.00 - 335.00	2405.56	24.58	11.00 - 32.00	31.24
F 46	58	221.47	100.00 - 275.00	1225.01	23.81	9.00 - 35.00	31.84
F 37	41	233.54	100.00 - 290.00	1774.69	23.88	11.00 - 40.00	42.06
F 36	73	233.19	130.00 - 305.00	1219.94	21.70	10.00 - 36.00	28.21
F 35	87	251.90	160.00 - 370.00	1393.24	23.39	10.00 - 38.00	26.15
F 38	44	237.27	160.00 - 290.00	1017.56	22.98	9.00 - 33.00	17.98
F 39	38	217.37	110.00 - 290.00	2227.29	20.95	11.00 - 29.00	23.63
F 41	14	205.71	130.00 - 300.00	2874.49	18.00	8.00 - 25.00	25.00
F 43	12	259.58	210.00 - 300.00	964.41	20.58	15.00 - 26.00	10.91
F 44	20	201.50	100.00 - 260.00	1825.25	18.20	5.00 - 27.00	40.96
F 33	46	219.61	85.00 - 285.00	1529.67	21.15	9.00 - 35.00	26.17

Table 11. Family wise mean, range and variance for average internodal length (cm) and number of millable canes (NMC) in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Family / cross	Progenies studied	Average internodal length (cm)			NMC / clump		
		Mean	Range	Variance	Mean	Range	Variance
F 01	25	11.58	6.70 - 20.70	9.45	9.92	2.00 - 21.00	30.07
F 02	191	12.81	8.00 - 26.54	7.70	3.92	1.00 - 15.00	4.61
F 03	88	13.27	8.65 - 24.29	9.76	5.06	1.00 - 18.00	10.78
F 04	25	12.57	1.40 - 25.00	17.30	4.52	1.00 - 12.00	7.45
F 05	22	13.06	9.74 - 19.74	5.37	5.36	2.00 - 12.00	5.32
F 06	4	11.35	10.00 - 12.41	0.76	4.25	2.00 - 6.00	2.19
F 07	165	14.20	8.85 - 32.00	8.94	4.36	1.00 - 20.00	6.63
F 08	165	13.53	6.92 - 29.09	9.23	4.33	1.00 - 33.00	12.01
F 09	80	15.05	8.72 - 26.00	15.74	5.09	1.00 - 19.00	13.55
F 10	144	15.52	8.08 - 29.00	15.87	4.41	1.00 - 24.00	10.74
F 11	126	13.54	7.78 - 29.09	11.91	4.56	1.00 - 21.00	8.06
F 12	112	13.62	8.16 - 25.83	10.16	4.07	1.00 - 13.00	7.42
F 13	63	14.58	7.78 - 24.67	12.21	4.17	1.00 - 15.00	6.18
F 14	11	12.16	9.47 - 18.33	7.79	4.55	1.00 - 15.00	15.34
F 16	102	13.94	8.42 - 29.00	14.29	4.55	1.00 - 13.00	7.76
F 17	18	11.85	8.33 - 15.00	3.64	3.50	1.00 - 6.00	2.36
F 18	151	13.22	7.75 - 30.00	14.64	3.39	1.00 - 20.00	6.60
F 19	105	14.00	9.44 - 25.83	10.74	3.70	1.00 - 12.00	5.26
F 20	102	14.42	8.33 - 25.38	11.72	3.39	1.00 - 19.00	7.71
F 21	75	14.67	8.06 - 25.83	12.96	4.85	1.00 - 13.00	10.53
F 22	36	13.76	7.93 - 22.22	9.00	4.47	1.00 - 20.00	13.69
F 23	89	15.90	9.40 - 29.17	18.85	4.52	1.00 - 12.00	7.01
F 24	96	13.38	1.11 - 30.00	12.54	4.61	1.00 - 15.00	8.20
F 25	10	13.64	8.33 - 21.56	13.20	4.50	1.00 - 14.00	12.85
F 26	55	13.15	8.13 - 24.17	9.54	4.05	1.00 - 17.00	6.38
F 27	125	13.42	6.88 - 26.11	7.44	4.17	1.00 - 14.00	7.40
F 28	70	12.78	9.56 - 18.81	4.31	4.11	1.00 - 21.00	10.07
F 30	77	12.75	2.73 - 20.83	7.79	4.48	1.00 - 23.00	10.46
F 31	16	13.85	9.12 - 22.86	19.27	3.88	1.00 - 9.00	6.48
F 32	96	11.74	5.77 - 26.67	14.90	3.09	1.00 - 27.00	8.69
F 34	101	11.01	4.62 - 20.91	6.86	3.51	1.00 - 15.00	6.23
F 48	96	11.63	5.94 - 19.17	7.69	3.81	1.00 - 25.00	15.03
F 50	08	14.05	10.00 - 17.86	7.53	4.38	1.00 - 20.00	35.23
F 47	34	11.45	6.35 - 22.08	14.07	3.50	1.00 - 8.00	3.90
F 49	12	11.42	7.59 - 21.36	11.58	3.50	1.00 - 7.00	3.42
F 46	58	9.75	6.13 - 16.15	5.84	4.02	1.00 - 12.00	7.12
F 37	41	10.26	4.00 - 14.71	5.76	3.59	1.00 - 17.00	8.97
F 36	73	11.21	7.24 - 18.18	6.19	3.47	1.00 - 13.00	6.28
F 35	87	11.24	6.84 - 18.75	7.51	4.33	1.00 - 16.00	10.43
F 38	44	10.65	8.18 - 20.83	5.62	4.18	1.00 - 16.00	8.38
F 39	38	10.58	7.12 - 15.00	3.91	4.13	1.00 - 10.00	7.85
F 41	14	11.83	7.95 - 17.50	6.29	3.43	1.00 - 8.00	3.82
F 43	12	12.81	10.00 - 15.33	2.95	5.00	1.00 - 17.00	18.50
F 44	20	12.32	7.78 - 20.00	15.01	4.80	1.00 - 10.00	6.16
F 33	46	10.78	6.07 - 16.82	5.78	4.20	1.00 - 16.00	9.85

Table 12. Family wise mean, range and variance for average single cane weight (kg) and cane yield in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Family / cross	Progenies studied	Av. single cane wt (kg)			Cane yield (kg) / clump		
		Mean	Range	Variance	Mean	Range	Variance
F 01	25	0.67	0.30 - 2.49	0.20	6.54	0.62 - 27.49	33.91
F 02	191	0.65	0.32 - 2.54	0.09	2.51	0.32 - 13.83	2.88
F 03	88	0.55	0.31 - 0.93	0.02	2.81	0.38 - 10.47	4.02
F 04	25	0.79	0.33 - 1.42	0.10	3.67	0.51 - 10.24	6.17
F 05	22	0.86	0.33 - 2.17	0.19	4.54	1.16 - 12.27	8.91
F 06	4	0.79	0.62 - 1.12	0.04	3.38	1.30 - 4.61	1.78
F 07	165	0.66	0.31 - 1.82	0.06	2.90	0.31 - 14.54	4.59
F 08	165	0.64	0.32 - 2.29	0.07	2.88	0.39 - 20.62	7.66
F 09	80	0.60	0.31 - 1.33	0.05	3.00	0.31 - 8.50	4.88
F 10	144	0.54	0.29 - 1.29	0.02	2.47	0.32 - 13.53	4.61
F 11	126	0.69	0.27 - 2.61	0.10	2.84	0.58 - 10.87	2.93
F 12	112	0.64	0.25 - 1.82	0.08	2.52	0.27 - 9.20	3.84
F 13	63	0.57	0.27 - 1.43	0.07	2.25	0.27 - 8.01	2.75
F 14	11	0.89	0.55 - 1.21	0.03	4.46	0.80 - 18.08	22.91
F 16	102	0.70	0.25 - 1.55	0.06	2.93	0.58 - 10.13	4.04
F 17	18	0.85	0.39 - 1.53	0.10	2.79	0.86 - 4.74	1.70
F 18	151	0.73	0.28 - 1.83	0.06	2.21	0.29 - 7.15	1.69
F 19	105	0.81	0.25 - 2.99	0.14	2.86	0.50 - 13.99	5.21
F 20	102	0.82	0.26 - 2.14	0.16	2.56	0.58 - 11.80	4.99
F 21	75	0.74	0.29 - 1.43	0.07	3.46	0.64 - 14.29	9.31
F 22	36	0.82	0.29 - 1.88	0.09	3.72	0.80 - 18.47	13.82
F 23	89	0.81	0.16 - 1.80	0.14	3.52	0.48 - 11.64	8.01
F 24	96	0.73	0.27 - 2.27	0.15	3.10	0.69 - 15.31	6.74
F 25	10	0.82	0.29 - 2.24	0.27	2.85	0.89 - 6.73	3.03
F 26	55	0.81	0.32 - 2.30	0.16	2.93	0.59 - 10.80	3.78
F 27	125	0.76	0.25 - 1.69	0.09	2.94	0.59 - 13.13	5.73
F 28	70	0.89	0.21 - 1.90	0.13	3.21	0.59 - 9.92	4.09
F 30	77	0.69	0.25 - 1.32	0.07	2.82	0.69 - 13.34	4.77
F 31	16	0.75	0.29 - 1.87	0.13	2.46	0.89 - 6.80	2.31
F 32	96	0.78	0.25 - 1.44	0.05	2.09	0.79 - 6.75	1.22
F 34	101	0.69	0.29 - 1.30	0.06	2.06	0.52 - 6.44	1.35
F 48	96	0.61	0.21 - 0.98	0.05	1.75	0.49 - 6.25	1.16
F 50	08	0.68	0.48 - 0.90	0.02	3.43	0.85 - 17.95	30.26
F 47	34	0.67	0.25 - 1.06	0.04	2.23	0.76 - 8.46	2.55
F 49	12	0.64	0.35 - 0.88	0.03	2.11	0.70 - 6.13	1.75
F 46	58	0.63	0.29 - 1.22	0.06	2.19	0.84 - 7.08	2.06
F 37	41	0.60	0.29 - 1.10	0.06	1.75	0.74 - 5.48	1.09
F 36	73	0.63	0.21 - 0.98	0.05	1.99	0.58 - 10.48	2.89
F 35	87	0.68	0.25 - 1.47	0.08	2.53	0.61 - 10.27	3.64
F 38	44	0.61	0.25 - 1.33	0.06	2.37	0.60 - 10.64	3.73
F 39	38	0.67	0.29 - 1.41	0.09	2.43	0.80 - 11.25	4.68
F 41	14	0.64	0.31 - 0.95	0.04	1.86	0.95 - 3.15	0.35
F 43	12	0.61	0.24 - 0.90	0.05	2.48	0.86 - 7.97	3.17
F 44	20	0.53	0.29 - 1.10	0.06	2.10	0.90 - 3.90	0.51
F 33	46	0.61	0.27 - 0.98	0.04	2.06	0.48 - 5.76	0.71

Table 13. Family wise mean, range and variance for average HR Brix (%) in seedling (sexual) generation of 45 inter varietal crosses and per cent superior sugarcane progenies based on cane yield and HR brix

Family / cross	Progenies studied	Average HR Brix (%)			% superior progenies based on cane yield and HR brix
		Mean	Range	Variance	
F 01	25	15.91	8.18 - 19.80	6.74	32.00
F 02	191	16.42	7.80 - 22.20	5.23	26.17
F 03	88	14.81	1.40 - 20.00	9.74	23.86
F 04	25	18.13	13.50 - 21.80	4.75	64.00
F 05	22	17.10	13.40 - 20.60	2.71	54.54
F 06	4	17.45	11.40 - 23.00	18.33	50.00
F 07	165	14.95	7.50 - 21.00	6.84	36.00
F 08	165	14.45	7.80 - 20.00	5.16	24.20
F 09	80	16.12	11.00 - 20.20	5.07	37.00
F 10	144	13.66	6.80 - 20.40	7.78	18.75
F 11	126	15.61	9.50 - 20.00	4.72	29.36
F 12	112	15.35	9.40 - 19.00	4.13	31.25
F 13	63	14.91	7.20 - 19.20	6.78	22.00
F 14	11	17.15	16.00 - 19.20	1.43	64.00
F 16	102	16.44	8.00 - 19.80	5.02	32.35
F 17	18	16.15	14.00 - 19.20	1.39	55.55
F 18	151	15.33	8.40 - 20.60	7.44	27.00
F 19	105	16.83	8.00 - 22.00	5.26	47.61
F 20	102	17.09	9.80 - 21.00	4.68	25.49
F 21	75	17.41	13.60 - 21.00	2.85	33.33
F 22	36	15.51	10.00 - 19.00	6.51	38.88
F 23	89	15.92	8.40 - 21.00	6.25	42.69
F 24	96	16.88	8.60 - 21.00	4.86	35.41
F 25	10	15.33	11.00 - 18.00	6.09	30.00
F 26	55	17.52	12.40 - 21.00	4.76	36.36
F 27	125	15.98	8.00 - 23.00	4.94	31.45
F 28	70	16.47	10.40 - 20.00	3.65	45.07
F 30	77	17.21	11.80 - 21.40	3.39	18.18
F 31	16	15.90	11.00 - 21.00	7.87	18.75
F 32	96	15.48	9.40 - 19.20	4.93	13.54
F 34	101	16.32	9.00 - 20.00	5.20	19.80
F 48	96	12.36	7.00 - 19.00	7.91	3.13
F 50	08	12.89	7.40 - 19.20	16.65	12.50
F 47	34	14.42	5.90 - 19.40	11.32	20.58
F 49	12	15.53	12.50 - 19.00	3.50	16.66
F 46	58	14.73	9.00 - 20.20	7.64	13.79
F 37	41	15.20	10.00 - 19.40	5.82	4.87
F 36	73	12.84	6.00 - 18.20	7.45	9.58
F 35	87	15.00	9.00 - 19.10	5.25	13.79
F 38	44	15.65	10.00 - 19.00	4.67	9.09
F 39	38	14.68	10.00 - 19.00	5.56	10.52
F 41	14	15.29	11.00 - 18.00	4.32	0.00
F 43	12	15.20	10.40 - 19.00	6.53	16.66
F 44	20	16.19	13.00 - 19.10	3.10	10.00
F 33	46	14.07	9.80 - 17.60	4.15	3.13

The genotypic coefficient of variation (4.03) and phenotypic coefficient of variation (12.92) were relatively lower for this trait. A relatively lower heritability estimate of 31.19 per cent coupled with low GAM of 27.81 per cent.

The highest (0.89 kg) family mean for average single cane weight was recorded in F14 and F28 families followed by F05 with mean weight of 0.86 kg for this attribute. Whereas, lowest (0.53) single cane weight was recorded in F44, followed by F10 with 0.54 kg single cane weight.

4.1.1.8 Cane yield (weight) per clump

The data indicates fairly wide variability for cane weight per clump with a range of 0.37 to 27.88 kg and overall mean cane weight of 2.69 kg per clump.

The highest cane weight (27.88 kg) per clump was recorded in SNK004 (F01006) followed by SNK178 (F08032) and SNK175 (F08021) with cane weights 21.01 and 20.08 kg respectively which were significantly superior to best check CoC671 (2.67 kg). The lowest (0.37 kg) cane weight per clump was observed in SNK462 (F19038) followed by SNK434 (F18103) with cane weight of 0.38 kg per clump.

The genotypic (179.46) and phenotypic (181.90) coefficients of variation were also high for this attribute. This was also evident from the high heritability (98.66%) and GAM (167.04).

The family F01 recorded highest (6.54 kg) mean cane weight per clump with widest range (0.62 to 27.49 kg) and highest variance (33.91) followed by F05, F14 and F22 with 4.54, 4.46 and 3.72 family means respectively. The lowest (1.75 kg) mean cane weight per clump was observed in F48 and F37 with relatively narrow range (0.49 to 6.25 kg and 0.74 to 5.48) and low variance (1.16 and 1.09) values.

4.1.1.9 Average hand refractometer brix per cent

There existed a wide variability for this trait, with a range of 8.26 to 24.71 per cent and mean HR Brix of 15.55 per cent.

Among 3124 progenies, SNK662 (F27026) recorded highest (24.71%) HR Brix followed by SNK728 (F30017) and SNK645 (F26041) with mean HR Brix of 23.95 and 22.71 per cent respectively.

The genotypic coefficient of variation was 37.66, while the phenotypic coefficient of variation was 46.26. However, this attribute exhibited relatively higher heritability estimate (81.42%) coupled with moderate GAM (28.93%).

The highest (18.13 %) family mean was recorded in F04 with a range from 13.50 to 21.80 per cent and variance of 4.75, while lowest (12.36 %) family mean observed in F48 with a range from 7.00-19.00 per cent and variance of 7.91 for this trait.

4.1.1.10 Per cent superior progenies obtained based on cane yield and HR brix (Family wise)

Based on cane yield and HR brix (%), percentage of superior progenies ranged from 0 to 64 among 45 families. The families viz., F04, F14, F17, F05, F05, F19, F28, F23, F22 and F09 recorded higher percentage of superior progenies ranging 37.0 to 64.0 ranking top ten.

None of the progenies were superior in case of family F41. The families F33, F48 and F37 gave lower percentage of superior progenies, only to the extent of 3.13, 3.13 and 4.87 respectively.

4.1.2 Genetic parameters for various traits in settling generation under moisture stress environment

Analysis of variance for the ten traits included in the study is presented in the Table 14. As evident from the table, mean sum of squares for all the traits considered in the present investigation were highly significant. The mean, range, genotypic and phenotypic coefficients of variability, heritability estimates and GAM predicted as per cent of mean in respect of these traits are given in Table 15. The family-wise mean range, variance in respect of these traits are given in Table 16-20. The mean values (adjusted) obtained for various traits included in the study in respect of only 50 selected out of 828 progenies evaluated are provided in Appendix VII.

Table 17. Family wise mean, range and variance for average cane girth and average millable cane height in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 18. Family wise mean, range and variance for average number of internodes and average internodal length in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 19. Family wise mean, range and variance for number of millable canes and single cane weight in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Appendix VII. Adjusted mean values of selected progenies for 10 traits studied in settling generation of 44 inter-varietal sugarcane crosses under moisture stress environment at Sankeshwar

4.1.2.1 Germination per cent

The germination per cent showed wide variability among clonal progenies which ranged from of -0.15 to 92.64 per cent with a mean value of 48.11 per cent.

Highest germination of 92.64 per cent was recorded in progenies SNK422 (F18076) and SNK428 (F18090), followed by SNK030 (F02055) (91.95%), SNK371 (F16035), SNK435 (F18110), SNK449 (F19016) and SNK454 (F19023) (each 89.87%), while lowest germination per cent was observed in SNK597 (F24006) (-0.15) followed by SNK285 (F11040), SNK515 (F20090) and SNK530 (F21029) (2.62 %).

Substantial differences between genotypic (316.64) and phenotypic (573.20) coefficients of variation reflected in moderate heritability (55.24%) and GAM (39.28%) estimates.

The highest family mean for this trait was recorded in F50 (77.56 %) followed by F33 (66.48 %), F48 (65.56%) and F16 (61.86%), while lowest value was observed in F43 (29.03 %), followed by F31 (33.24%) and F27 (34.90%).

4.1.2.2 Tillers per plot

The tiller number ranged from -8.42 to 181.08 per plot with overall mean of 59.23 revealing high amount of variability among progenies evaluated under moisture stress environment.

Among 828 progenies, SNK640 (F26032) (181.08) has recorded highest number of tillers followed by SNK601 (F24015) (174.08) and SNK793 (F46037) (160.33) while, lowest tiller number was observed in SNK698 (F28016) (-8.42) followed by SNK732 (F30030) (-5.42) and SNK794 (F46039) (0.33).

Table 14. Analysis of variance for important cane yield parameters and HR Brix (%) in settling (clonal) generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Source	df	MSS for the characters									
		Gernmin- ation %	Tillers / Plot	Average cane girth (cm)	Average millable cane height (cm)	Average number of internodes	Average internodal length (cm)	Number of millable canes / plot	Average single cane weight (kg)	Cane yield (kg) / plot	Average HR Brix (%)
varieties (v)	827	275.79**	635.69**	0.12**	2322.83**	25.13**	8.45**	138.99**	0.77**	8.18*	4.86**
Error	24	123.44	109.78	0.03	629.65	4.19	2.56	45.22	0.03	3.96	0.91
SEd 1. Between 2 check means		5.24	4.94	0.07	11.83	0.97	0.75	3.17	0.08	0.94	0.45
SEd 2. Between any 2 means of test var.		15.71	14.82	0.22	35.49	2.90	2.26	9.51	0.23	2.81	1.35
SEd 3. Between any 2 entries of same block		17.57	16.57	0.25	39.68	3.24	2.53	10.63	0.25	3.15	1.51
SEd 4. Between means of check & var.		13.09	12.35	0.19	29.57	2.41	1.88	7.93	0.19	2.34	1.12
CD 5%											
Between 2 check means		10.79	10.17	0.15	24.37	1.99	1.55	6.53	0.16	1.93	0.93
Between any 2 means of test var.		32.37	30.52	0.46	73.10	5.96	4.66	19.59	0.47	5.80	2.78
Between any 2 entries of same block		36.19	34.13	0.52	81.73	6.67	5.21	21.90	0.52	6.48	3.10
Between means of check & var.		26.97	25.44	0.39	60.92	4.97	3.88	16.33	0.39	4.83	2.31
CD 1%											
Between 2 check means		14.67	13.83	0.21	33.12	2.70	2.11	8.88	0.21	2.63	1.26
Between any 2 means of test var.		44.00	41.49	0.63	99.36	8.11	6.33	26.63	0.63	7.88	3.77
Between any 2 entries of same block		49.19	46.39	0.70	111.09	9.06	7.08	29.77	0.71	8.81	4.22
Between means of check & var.		36.66	34.57	0.52	82.80	6.76	5.28	22.19	0.53	6.57	3.15

*, ** Significant at 5 and 1 per cent levels respectively

Table 15. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in settling (clonal) generation of 44 inter-variatal sugarcane crosses under moisture stress environment at Sankeshwar

Characters	Mean	Range*	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	GAM (%)
1. Germination (%)	48.11	-0.15 (21.80) - 92.64 (58.25)	316.64	573.20	55.24	18.90	39.28
2. Tillers / Plot	59.23	-8.42 (2.31) - 181.08 (170.00)	887.87	1073.22	82.73	42.97	72.54
3. Average cane girth (cm)	2.32	1.13 (1.00) - 3.55 (3.50)	3.98	5.07	78.52	0.55	23.93
4. Average millable cane height (cm)	254.43	90.44 (105.00) - 396.69 (390.00)	665.50	912.97	72.89	72.37	28.44
5. Average number of internodes	18.97	6.31 (7.00) - 37.56 (38.00)	110.41	132.52	83.32	8.60	45.37
6. Average internodal length (cm)	13.90	7.34 (6.84) - 33.00 (32.90)	42.42	60.83	69.74	4.18	30.06
7. Number of millable canes / Plot	29.69	-0.03 (5.00) - 104.22 (102.00)	315.87	468.22	67.46	16.38	55.19
8. Average single cane weight (kg)	0.92	0.23 (0.25) - 4.35 (4.25)	80.95	83.74	96.67	1.75	190.13
9. Cane yield (kg) / Plot	22.69	4.75 (5.00) - 32.75 (33.0)	18.60	36.04	51.60	3.04	13.40
10. Average HR Brix (%)	15.83	8.53 (7.87) - 21.10 (21.03)	24.95	30.69	81.30	3.69	23.32

* Range obtained from adjusted mean values of progenies.
Figures in parenthesis are actual values

High genotypic (887.87) (and phenotypic coefficients of variations (1073.22) were observed for this trait which reflected in higher heritability (82.73%) and high GAM (72.54%) estimates.

Highest mean tiller number was recorded in F50 (115.0) followed by F49 (96.50) and F48 (90.67), while lowest value was observed in F43 (27.50) followed by F31 (36.00) and F08 (41.86).

4.1.2.3 Average cane girth

The range of cane girth was substantial (1.13 to 3.55 cm) with mean of 2.32 cm across the 44 families comprising 828 progenies.

The progeny SNK739 (F31012) (3.55 cm) was thickest followed by SNK330 (F12082) (3.28 cm), SNK540 (F21065), SNK744 (F32036) and SNK750 (F32043) (each 3.25 cm), whereas SNK633 (F26003) (1.13 cm) was thinnest followed by SNK227 (F09056) and SNK389 (F16098) (each 1.40 cm).

The coefficients of variation at genotypic and phenotypic levels were low *i.e.* 3.98 and 5.07 respectively. However, relatively higher heritability (78.52%) estimate and moderate GAM (23.93 %) were recorded by this trait.

Highest family mean for this trait was observed in F31 (2.83 cm) with a range of 2.40 to 3.50 and high variance of 0.23, while the lowest mean value was recorded in F37 (1.85 cm) followed by F43 (1.90 cm) and F49 (2.05 cm).

4.1.2.4 Average millable cane height

As per the data recorded for this attribute, the mean millable cane height was 254.43 cm with a range of 90.44 to 396.69 cm, indicating higher variability.

The progeny SNK029 (F02046) (396.69 cm) was the tallest, followed by SNK027 (F02038) (386.69 cm) and SNK032 (F02057) (386.69 cm), whereas SNK638 (F26017) (90.44 cm) was shortest followed by SNK293 (F11056) (117.94 cm) and SNK635 (F26008) (125.44 cm).

The genotypic and phenotypic coefficients of variation were 665.50 and 912.97 respectively. The heritability (72.89%) estimate was high but GAM (28.44%) was moderate.

Among 44 families, the F01 recorded highest family mean (313.75 cm) with a range of 260.00 to 340.00 cm and variance of 623.44, followed by F50 (310.00), F02 (308.60), whereas the F06 (192.50 cm) recorded lowest mean millable cane height followed by F37 (195.0 cm).

4.1.2.5 Average number of internodes

Average number of internodes exhibited higher variability among the progeny population studied which ranged from 6.31 to 37.56 with overall mean value of 18.97.

Among the 828 progenies, SNK001 (F01001) (37.56) recorded highest average internodes followed by SNK015 (F02018) (36.56), whereas SNK558 (F23002), SNK588 (F23081) and SNK633 (F26003) had lowest (6.31) number of internodes.

The genotypic (110.41) and phenotypic (132.52) coefficients of variation was higher for this attribute with higher heritability (83.32%) and GAM (45.37%).

Family F01 (29.0) recorded highest average internodes with a range of 20.00 to 38.00 and variance of 31.00, whereas lowest internodes were observed in F26 (14.50) with a range of 7.00 to 21.00 and variance of 13.55.

Table 16. Family wise mean, range and variance for germination (%) and tillers in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Germination (%)			Tillers / Plot		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	50.90	41.55 - 69.25	10.98	62.75	44.00 - 87.00	202.19
F 02	50	54.02	27.70 - 88.64	20.73	58.30	26.00 - 100.00	264.89
F 03	21	52.50	5.54 - 80.33	53.66	69.19	15.00 - 140.00	1198.44
F 04	16	39.13	8.31 - 60.94	27.23	50.38	16.00 - 99.00	458.48
F 05	12	48.71	27.70 - 69.25	15.24	66.50	38.00 - 115.00	375.75
F 06	2	48.48	38.78 - 58.17	12.25	51.00	39.00 - 63.00	144.00
F 07	59	51.50	16.62 - 83.10	29.50	61.07	10.00 - 154.00	750.40
F 08	40	38.23	11.08 - 72.02	24.61	41.86	2.30 - 74.00	227.18
F 09	29	47.47	11.08 - 77.56	45.02	52.52	13.00 - 96.00	435.35
F 10	27	52.32	19.39 - 77.56	30.77	61.85	28.00 - 115.00	415.53
F 11	37	44.84	11.08 - 80.33	26.59	54.89	16.00 - 95.00	321.07
F 12	35	47.17	19.39 - 83.10	26.26	44.49	19.00 - 90.00	224.54
F 13	14	54.81	19.39 - 83.10	61.03	63.21	43.00 - 96.00	228.03
F 14	7	55.40	41.55 - 69.25	9.71	55.00	35.00 - 90.00	304.29
F 16	33	61.86	11.08 - 83.10	24.95	61.00	15.00 - 90.00	262.67
F 17	10	52.08	16.62 - 74.79	43.96	53.90	21.00 - 120.00	718.49
F 18	41	55.56	11.08 - 83.10	35.22	59.38	15.00 - 130.00	509.44
F 19	50	57.78	33.24 - 80.33	16.32	67.42	29.00 - 130.00	531.20
F 20	26	39.53	8.31 - 60.94	30.66	44.38	17.00 - 70.00	209.08
F 21	25	39.89	8.31 - 69.25	29.76	58.20	18.00 - 105.00	560.32
F 22	14	45.31	24.93 - 74.79	33.94	50.57	21.00 - 86.00	333.96
F 23	38	44.61	16.62 - 80.33	34.88	52.39	16.00 - 135.00	572.98
F 24	34	39.51	5.54 - 74.79	34.25	63.32	12.00 - 163.00	1302.87
F 25	3	41.55	36.01 - 47.09	2.67	69.00	56.00 - 83.00	122.00
F 26	20	44.60	13.85 - 66.48	25.99	75.65	20.00 - 170.00	907.73
F 27	40	34.90	11.08 - 63.71	23.49	55.33	26.00 - 98.00	272.22
F 28	31	38.15	8.31 - 72.02	36.43	46.94	7.00 - 115.00	687.87
F 30	14	46.50	16.62 - 72.02	25.88	51.36	10.00 - 110.00	589.66
F 31	3	33.24	22.16 - 44.32	10.67	36.00	21.00 - 52.00	160.67
F 32	13	48.58	27.70 - 74.79	19.63	65.69	41.00 - 100.00	384.06
F 34	21	52.37	22.16 - 77.56	29.51	74.95	32.00 - 135.00	508.90
F 33	1	66.48	66.48 - 66.48	0.00	70.00	70.00 - 70.00	0.00
F 48	3	65.56	58.17 - 74.79	6.22	90.67	72.00 - 120.00	440.89
F 50	1	77.56	77.56 - 77.56	0.00	115.00	115.00 - 115.00	0.00
F 47	7	53.42	30.47 - 66.48	17.63	62.00	36.00 - 75.00	148.57
F 49	2	54.02	52.63 - 55.40	0.25	96.50	75.00 - 118.00	462.25
F 46	8	47.78	8.31 - 69.25	38.19	79.38	10.00 - 170.00	2283.98
F 37	2	51.25	47.09 - 55.40	2.25	67.50	25.00 - 110.00	1806.25
F 36	7	50.65	27.70 - 66.48	23.63	80.71	40.00 - 155.00	1153.06
F 35	12	51.71	24.93 - 69.25	20.89	88.92	55.00 - 110.00	271.91
F 38	4	50.55	30.47 - 80.33	46.69	77.25	35.00 - 108.00	861.19
F 39	4	51.25	38.78 - 63.71	16.25	60.00	45.00 - 75.00	125.00
F 43	2	29.09	11.08 - 47.09	42.25	27.50	15.00 - 40.00	156.25
F 44	1	58.17	58.17 - 58.17	0.00	50.00	50.00 - 50.00	0.00

Table 17. Family wise mean, range and variance for average cane girth and average millable cane height in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Average cane girth (cm)			Average millable cane height (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	2.08	1.50 - 2.60	0.09	313.75	260.00 - 340.00	623.44
F 02	50	2.33	1.40 - 3.00	0.14	308.60	190.00 - 390.00	2984.04
F 03	21	2.34	1.60 - 3.00	0.10	284.00	190.00 - 370.00	2609.05
F 04	16	2.41	1.40 - 3.00	0.16	271.88	210.00 - 310.00	815.23
F 05	12	2.38	2.00 - 3.10	0.09	209.58	135.00 - 310.00	2631.08
F 06	2	2.30	2.00 - 2.60	0.09	192.50	175.00 - 210.00	306.25
F 07	59	2.34	1.60 - 3.10	0.09	229.56	140.00 - 305.00	1430.99
F 08	40	2.37	1.60 - 3.00	0.09	255.80	160.00 - 365.00	3310.46
F 09	29	2.22	1.50 - 2.90	0.12	214.14	160.00 - 315.00	1562.19
F 10	27	2.23	1.60 - 2.80	0.11	265.37	150.00 - 345.00	2077.64
F 11	37	2.29	1.50 - 2.90	0.10	266.86	105.00 - 355.00	3518.55
F 12	35	2.26	1.50 - 3.30	0.17	230.69	160.00 - 310.00	1239.99
F 13	14	2.13	1.60 - 2.80	0.09	256.71	190.00 - 310.00	1521.06
F 14	7	2.37	2.20 - 2.60	0.01	233.57	200.00 - 265.00	483.67
F 16	33	2.35	1.40 - 3.00	0.13	253.33	170.00 - 320.00	1841.92
F 17	10	2.31	2.00 - 2.80	0.06	254.50	210.00 - 280.00	342.25
F 18	41	2.27	1.40 - 3.30	0.14	249.18	160.00 - 320.00	1469.17
F 19	50	2.24	1.60 - 2.90	0.10	268.92	165.00 - 335.00	1869.79
F 20	26	2.36	1.80 - 3.00	0.09	249.04	180.00 - 295.00	861.58
F 21	25	2.50	2.10 - 3.30	0.08	289.84	250.00 - 350.00	481.41
F 22	14	2.27	1.80 - 2.90	0.11	232.07	170.00 - 335.00	2945.07
F 23	38	2.30	1.80 - 2.90	0.10	250.26	190.00 - 305.00	747.30
F 24	34	2.37	2.00 - 2.80	0.04	280.03	180.00 - 350.00	2015.91
F 25	3	2.40	1.80 - 2.80	0.19	253.33	200.00 - 300.00	1688.89
F 26	20	2.18	1.00 - 3.00	0.17	203.75	115.00 - 255.00	1237.19
F 27	40	2.32	1.50 - 3.10	0.10	242.63	155.00 - 310.00	2054.98
F 28	31	2.35	1.60 - 3.10	0.10	240.32	160.00 - 305.00	1714.41
F 30	14	2.21	1.60 - 2.60	0.09	248.64	195.00 - 290.00	863.23
F 31	3	2.83	2.40 - 3.50	0.23	256.67	250.00 - 265.00	38.89
F 32	13	2.67	2.20 - 3.20	0.09	272.46	245.00 - 300.00	311.02
F 34	21	2.26	1.80 - 2.60	0.05	234.24	176.00 - 282.00	774.94
F 33	1	2.10	2.10 - 2.10	0.00	230.00	230.00 - 230.00	0.00
F 48	3	2.67	2.60 - 2.80	0.01	238.33	220.00 - 255.00	205.56
F 50	1	2.30	2.30 - 2.30	0.00	310.00	310.00 - 310.00	0.00
F 47	7	2.23	1.80 - 2.60	0.06	247.86	160.00 - 325.00	2734.69
F 49	2	2.05	2.00 - 2.10	0.00	210.00	180.00 - 240.00	900.00
F 46	8	2.39	2.00 - 2.70	0.06	238.13	210.00 - 270.00	337.11
F 37	2	1.85	1.60 - 2.10	0.06	195.00	160.00 - 230.00	1225.00
F 36	7	2.33	1.80 - 3.20	0.18	240.71	155.00 - 285.00	1667.35
F 35	12	2.69	2.40 - 3.40	0.09	265.92	235.00 - 300.00	283.41
F 38	4	2.68	2.60 - 2.80	0.01	263.75	240.00 - 285.00	367.19
F 39	4	2.35	2.20 - 2.60	0.02	222.50	200.00 - 250.00	368.75
F 43	2	1.90	1.80 - 2.00	0.01	222.50	210.00 - 235.00	156.25
F 44	1	2.60	2.60 - 2.60	0.00	210.00	210.00 - 210.00	0.00

Table 18 Family wise mean, range and variance for average number of nter-nodes and average internodal length in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Average number of internodes			Average internodal length (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	29.00	20.00 - 38.00	31.00	11.33	6.84 - 16.00	7.37
F 02	50	25.30	14.00 - 37.00	48.33	12.68	8.62 - 20.00	5.16
F 03	21	20.86	16.00 - 32.00	17.74	13.88	10.00 - 21.76	7.12
F 04	16	20.81	16.00 - 30.00	11.28	13.33	10.00 - 18.75	5.29
F 05	12	17.25	12.00 - 24.00	9.02	12.09	8.75 - 15.30	2.63
F 06	2	16.00	16.00 - 16.00	0.00	12.00	10.90 - 13.10	1.21
F 07	59	16.78	10.00 - 30.00	9.22	13.93	9.47 - 20.80	6.74
F 08	40	22.33	11.00 - 33.00	42.07	11.79	9.38 - 16.40	2.55
F 09	29	16.00	10.00 - 22.00	6.62	13.61	9.77 - 21.00	7.48
F 10	27	17.74	13.00 - 23.00	7.01	14.97	11.30 - 17.78	2.73
F 11	37	19.78	9.00 - 27.00	20.87	13.68	7.50 - 20.00	5.08
F 12	35	16.31	7.00 - 24.00	11.70	14.76	8.75 - 26.43	13.80
F 13	14	17.21	11.00 - 23.00	13.17	15.35	10.00 - 18.80	7.47
F 14	7	20.57	19.00 - 23.00	1.96	11.34	10.20 - 12.50	0.50
F 16	33	18.36	10.00 - 26.00	17.63	14.11	10.30 - 18.60	3.58
F 17	10	17.80	15.00 - 21.00	3.36	14.41	12.60 - 17.50	2.17
F 18	41	17.75	7.00 - 26.00	12.26	14.41	8.75 - 26.43	7.24
F 19	50	19.92	11.00 - 31.00	18.31	13.78	10.00 - 17.30	3.90
F 20	26	17.65	13.00 - 23.00	7.30	14.40	11.10 - 20.70	7.35
F 21	25	21.04	13.00 - 25.00	5.48	13.91	11.90 - 19.20	2.28
F 22	14	18.86	8.00 - 28.00	33.12	13.23	7.14 - 25.00	18.45
F 23	38	16.11	8.00 - 22.00	9.15	16.18	11.20 - 30.00	15.82
F 24	34	21.50	14.00 - 31.00	23.13	13.36	9.47 - 20.70	5.37
F 25	3	22.00	17.00 - 31.00	40.67	11.96	9.68 - 14.40	3.73
F 26	20	14.50	7.00 - 21.00	13.55	15.07	7.67 - 32.90	27.58
F 27	40	16.05	7.00 - 23.00	16.40	15.64	11.40 - 22.90	8.34
F 28	31	15.68	9.00 - 23.00	13.38	15.89	9.41 - 24.40	12.43
F 30	14	17.79	10.00 - 24.00	11.45	14.30	11.50 - 19.50	3.79
F 31	3	21.33	21.00 - 22.00	0.22	12.03	11.90 - 12.14	0.01
F 32	13	21.62	17.00 - 28.00	15.31	12.92	9.46 - 15.59	3.55
F 34	21	17.86	15.00 - 23.00	6.22	13.33	9.35 - 16.94	4.70
F 33	1	19.00	19.00 - 19.00	0.00	12.10	12.10 - 12.10	0.00
F 48	3	17.67	11.00 - 21.00	22.22	14.50	11.40 - 20.00	15.21
F 50	1	19.00	19.00 - 19.00	0.00	16.30	16.30 - 16.30	0.00
F 47	7	19.43	14.00 - 22.00	6.82	12.80	8.89 - 15.70	5.42
F 49	2	19.00	14.00 - 24.00	25.00	11.45	10.00 - 12.90	2.10
F 46	8	18.38	13.00 - 23.00	11.73	13.37	10.20 - 17.33	5.76
F 37	2	16.50	14.00 - 19.00	6.25	11.75	11.40 - 12.10	0.12
F 36	7	16.43	13.00 - 23.00	8.82	14.91	10.00 - 17.86	7.87
F 35	12	25.58	15.00 - 31.00	27.74	10.85	8.87 - 16.40	5.23
F 38	4	19.75	16.00 - 28.00	23.19	13.89	10.18 - 16.47	5.93
F 39	4	21.25	19.00 - 22.00	1.69	10.49	9.55 - 11.40	0.43
F 43	2	20.00	18.00 - 22.00	4.00	11.20	10.70 - 11.70	0.25
F 44	1	17.00	17.00 - 17.00	0.00	12.40	12.40 - 12.40	0.00

4.1.2.6 Average internodal length

This trait exhibited substantial amount of variability with a range of 7.34 to 33.00 cm and overall mean of 13.90 cm.

The progeny SNK648 (F26049) (33.0 cm) had longest internodes followed by SNK558 (F23002) (29.67 cm) and SNK314 (F12048) (27.54 cm), whereas, SNK552 (F22030) and SNK638 (F26017) recorded shortest (7.34 cm) internodes.

There was also difference between the genotypic (42.42) and phenotypic (60.83) coefficient of variations. This attribute exhibited a moderately high heritability estimate (69.74%) with moderate GAM (30.06%).

The family F50 (16.30 cm) had a single progeny with longest internodes followed by F23 (16.18 cm) and F28 (15.89 cm), whereas F39 (10.49 cm) recorded lowest value followed by F35 (10.85 cm).

4.1.2.7 Number of millable canes per plot

There exists high variability in number of millable canes per plot with a wide range (-0.03 to 104.22) and a overall mean of 29.69.

The progeny SNK114 (F07011) (104.22) had highest millable canes followed by SNK136 (F07072) (98.22) and SNK245 (F10034) (73.97) which were significantly superior over best check CoM88121 (34.11). The lowest millable canes were observed in SNK494 (F20005) (-0.03) followed by SNK188 (F08056) (1.97).

The difference in genotypic (315.87) and phenotypic (468.22) coefficients of variation was substantial, which reflected in moderate heritability estimate (67.46 %) and GAM (55.19).

Among 44 families, the family F50 had a single progeny with highest millable canes (60.00) followed by F10 (47.19) and F33 (45.00).

4.1.2.8 Average single cane weight

The hybrid progeny population exhibited very high variation with a wide range from 0.23 to 4.35 kg and overall mean of 0.92 kg.

Among 828 progenies, SNK293 (F11056) had heaviest canes (4.35 kg), followed by SNK288 (F11044) (3.24 kg) and SNK100 (F05006) (2.86 kg) which were significantly superior to best check CoC671 (1.10 kg). The lightest single cane weight was recorded in SNK114 (F07011) (0.23 kg) followed by SNK136 (F07072) (0.24 kg).

The genotypic (80.95%) and phenotypic (83.74%) coefficients of variation differed with relatively narrower magnitude, which reflected in very high heritability estimate (96.67%) and GAM (190.13%).

Highest mean single cane weight was recorded in a single progeny of F44 (1.39 kg) followed by F05 (1.28 kg) and F39 (1.15 kg) where as F50 (0.38 kg) had lightest canes followed by F10 (0.55 kg) and F33 (0.56 kg).

Table 19: Family wise mean, range and variance for number of millable canes and single cane weight in clonal generation of pre selected ugar cane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Number of millable canes / Plot			Average single cane weight (kg)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	26.63	10.00 - 41.00	143.23	0.99	0.40 - 1.92	0.28
F 02	50	24.24	8.00 - 43.00	82.18	1.12	0.50 - 2.17	0.20
F 03	21	28.95	19.00 - 46.00	41.57	0.80	0.48 - 1.26	0.03
F 04	16	25.94	15.00 - 32.00	21.93	0.75	0.55 - 1.07	0.02
F 05	12	23.42	6.00 - 48.00	128.41	1.28	0.48 - 2.88	0.66
F 06	2	20.50	16.00 - 25.00	20.25	1.10	0.88 - 1.31	0.05
F 07	59	29.54	11.00 - 102.00	242.01	0.90	0.25 - 1.92	0.11
F 08	40	25.55	8.00 - 43.00	58.35	0.94	0.50 - 2.33	0.15
F 09	29	29.66	14.00 - 59.00	165.19	0.90	0.37 - 1.79	0.14
F 10	27	47.19	19.00 - 88.00	329.56	0.55	0.28 - 1.32	0.05
F 11	37	30.00	7.00 - 62.00	90.11	0.89	0.35 - 4.25	0.50
F 12	35	28.63	8.00 - 76.00	189.55	0.98	0.33 - 2.30	0.20
F 13	14	31.36	10.00 - 63.00	173.09	0.92	0.35 - 2.50	0.28
F 14	7	26.29	10.00 - 35.00	77.06	1.04	0.57 - 2.60	0.44
F 16	33	30.48	13.00 - 49.00	63.28	0.75	0.41 - 1.62	0.06
F 17	10	26.50	18.00 - 54.00	96.45	0.92	0.48 - 1.19	0.04
F 18	41	29.35	8.00 - 76.00	109.39	0.89	0.33 - 2.63	0.17
F 19	50	31.98	17.00 - 51.00	64.42	0.75	0.43 - 1.24	0.04
F 20	26	29.58	5.00 - 55.00	121.17	0.90	0.44 - 1.86	0.11
F 21	25	30.84	14.00 - 51.00	79.97	0.81	0.47 - 1.64	0.07
F 22	14	30.14	17.00 - 60.00	143.98	0.87	0.37 - 1.35	0.08
F 23	38	31.29	12.00 - 59.00	150.68	0.88	0.39 - 2.17	0.16
F 24	34	30.06	11.00 - 48.00	100.53	0.86	0.42 - 2.55	0.16
F 25	3	28.00	22.00 - 34.00	24.00	0.84	0.68 - 1.05	0.02
F 26	20	31.65	9.00 - 62.00	181.73	0.94	0.40 - 2.78	0.33
F 27	40	28.98	6.00 - 60.00	140.07	0.91	0.37 - 2.83	0.30
F 28	31	27.35	9.00 - 55.00	144.87	1.05	0.41 - 2.56	0.28
F 30	14	27.29	10.00 - 60.00	136.49	0.90	0.38 - 1.47	0.09
F 31	3	29.67	13.00 - 41.00	144.89	0.89	0.54 - 1.54	0.21
F 32	13	27.38	17.00 - 42.00	35.93	0.82	0.50 - 1.00	0.01
F 34	21	32.05	15.00 - 55.00	168.81	0.83	0.42 - 1.67	0.10
F 33	1	45.00	45.00 - 45.00	0.00	0.56	0.56 - 0.56	0.00
F 48	3	32.00	29.00 - 35.00	6.00	0.77	0.76 - 0.78	0.00
F 50	1	60.00	60.00 - 60.00	0.00	0.38	0.38 - 0.38	0.00
F 47	7	28.29	22.00 - 36.00	37.92	0.88	0.61 - 1.14	0.04
F 49	2	41.00	34.00 - 48.00	49.00	0.62	0.52 - 0.71	0.01
F 46	8	28.25	10.00 - 52.00	211.44	0.98	0.42 - 2.17	0.26
F 37	2	34.00	13.00 - 55.00	441.00	1.05	0.40 - 1.69	0.42
F 36	7	28.43	18.00 - 33.00	27.67	0.85	0.67 - 1.22	0.03
F 35	12	33.17	26.00 - 45.00	40.97	0.87	0.58 - 1.23	0.04
F 38	4	26.25	21.00 - 32.00	17.19	1.08	0.89 - 1.43	0.04
F 39	4	26.75	20.00 - 40.00	60.69	1.15	0.80 - 1.65	0.12
F 43	2	31.50	28.00 - 35.00	12.25	0.71	0.71 - 0.71	0.00
F 44	1	23.00	23.00 - 23.00	0.00	1.39	1.39 - 1.39	0.00

Table 20. Family wise mean, range and variance for cane yield and average HR Brix in clonal generation of pre selected sugarcane progenies under moisture stress environment and per cent superior progenies at Sankeshwar

Family / Cross	Progenies studied	Cane yield (kg) / Plot			Average HR Brix (%)			% superior progenies based on cane yield and HR brix
		Mean	Range	Variance	Mean	Range	Variance	
F 01	8	20.38	15.00 - 24.00	11.23	14.29	11.53 - 18.00	4.20	0.00
F 02	50	23.49	16.00 - 29.60	8.29	16.21	12.60 - 20.00	3.15	4.00
F 03	21	22.17	16.00 - 26.00	8.75	16.25	13.33 - 19.40	2.68	0.00
F 04	16	18.88	16.00 - 23.00	5.23	17.31	14.17 - 19.93	2.37	25.00
F 05	12	22.00	17.00 - 26.00	5.00	15.64	12.80 - 17.70	2.58	8.33
F 06	2	21.50	21.00 - 22.00	0.25	15.40	13.67 - 17.13	2.99	50.00
F 07	59	22.65	15.00 - 28.50	10.17	14.71	8.30 - 19.40	5.80	1.69
F 08	40	21.24	16.00 - 25.50	3.87	14.56	9.00 - 20.00	5.53	0.00
F 09	29	22.28	18.00 - 25.00	3.23	16.33	12.87 - 19.00	3.53	0.00
F 10	27	22.86	17.00 - 29.70	7.56	14.80	8.60 - 19.00	5.97	7.41
F 11	37	21.43	17.00 - 25.00	3.70	16.59	11.63 - 19.13	3.22	2.70
F 12	35	22.90	16.00 - 30.60	5.61	15.31	12.70 - 18.40	2.35	0.00
F 13	14	23.14	18.00 - 26.00	6.12	16.21	13.50 - 18.93	2.57	0.00
F 14	7	22.00	20.00 - 27.00	8.29	16.75	14.73 - 18.57	1.55	14.29
F 16	33	21.12	18.00 - 25.00	2.11	16.65	12.30 - 18.93	2.03	3.03
F 17	10	22.60	20.00 - 26.00	4.04	16.64	15.33 - 18.67	1.12	0.00
F 18	41	22.63	16.00 - 30.60	5.34	16.04	10.40 - 19.93	3.36	2.44
F 19	50	22.86	15.00 - 27.00	7.24	16.46	12.80 - 19.60	2.23	6.00
F 20	26	24.85	21.00 - 28.00	3.90	18.06	16.27 - 21.03	1.97	7.69
F 21	25	22.68	21.00 - 25.00	1.34	17.98	15.60 - 20.10	1.71	8.00
F 22	14	23.14	21.00 - 26.00	2.69	15.99	14.13 - 18.13	1.17	14.29
F 23	38	23.13	17.00 - 26.00	4.22	15.85	11.07 - 20.50	4.71	5.26
F 24	34	22.97	5.00 - 28.00	14.09	16.23	12.73 - 20.50	3.58	11.76
F 25	3	22.67	22.00 - 23.00	0.22	15.60	12.73 - 17.40	4.21	0.00
F 26	20	23.25	21.00 - 29.00	2.79	16.13	13.07 - 18.73	2.58	15.00
F 27	40	21.50	16.00 - 26.00	6.40	14.21	7.87 - 19.47	7.27	2.50
F 28	31	22.94	16.00 - 27.00	5.29	14.77	8.20 - 18.60	6.05	6.45
F 30	14	21.50	12.00 - 25.00	8.39	16.10	11.13 - 18.93	5.44	0.00
F 31	3	21.00	20.00 - 22.00	0.67	15.93	12.47 - 18.80	6.86	0.00
F 32	13	21.77	17.00 - 27.00	8.33	13.76	10.47 - 16.53	3.55	23.81
F 34	21	22.90	20.00 - 32.00	6.66	16.43	12.37 - 18.73	2.12	0.00
F 33	1	25.00	25.00 - 25.00	0.00	13.67	13.67 - 13.67	0.00	0.00
F 48	3	24.67	22.00 - 27.00	4.22	13.42	9.53 - 16.60	8.58	0.00
F 50	1	23.00	23.00 - 23.00	0.00	11.53	11.53 - 11.53	0.00	0.00
F 47	7	23.71	22.00 - 25.00	1.06	16.07	14.13 - 17.60	1.20	14.29
F 49	2	24.50	24.00 - 25.00	0.25	16.03	15.93 - 16.13	0.01	0.00
F 46	8	22.50	8.00 - 26.00	31.75	16.97	15.00 - 18.00	0.97	0.00
F 37	2	22.00	22.00 - 22.00	0.00	15.17	14.60 - 15.73	0.32	0.00
F 36	7	23.29	22.00 - 26.00	2.20	13.03	10.20 - 15.40	3.39	0.00
F 35	12	27.75	25.00 - 32.00	5.19	15.16	12.60 - 19.20	2.89	33.33
F 38	4	27.75	25.00 - 31.00	7.69	15.98	14.67 - 16.93	0.69	50.00
F 39	4	28.75	20.00 - 33.00	26.69	15.28	12.53 - 16.60	2.67	25.00
F 43	2	22.50	20.00 - 25.00	6.25	18.20	16.13 - 20.27	4.28	0.00
F 44	1	32.00	32.00 - 32.00	0.00	20.27	20.27 - 20.27	0.00	100.00

4.1.2.9 Cane yield (kg) per plot

Cane yield per plot exhibited wide variation with a range from 4.75 to 32.75 kg and 22.69 kg overall mean.

SNK822 (F39020) (32.75 kg) recorded highest cane yield, followed by SNK754 (F34005), SNK814 (F35075), SNK821 (F39016) and SNK827 (F44003) with cane yield of 31.75 kg per plot, which were significantly superior to best check CoC671 (23.67 kg). The lowest cane yield was observed in SNK597 (F24006) (4.75 kg) followed by SNK732 (F30030) (11.00 kg).

The genotypic (18.60) and phenotypic (36.04) coefficients of variation differed substantially which resulted in moderate heritability estimate (51.60 %) and GAM (13.40%).

The family F44 (32.0 kg) exhibited highest mean cane yield, followed by F39 (28.75 kg), F38 (27.75 kg) and F35 (27.75 kg) whereas lowest cane yield was recorded in F04 (18.88 kg) and F31 (21.00 kg).

4.1.2.10 Average hand refractometer brix per cent

The average HR brix exhibited high variation with a range of 8.53 to 21.10 and overall mean of 15.83 per cent.

Among 828 progenies of 44 diverse crosses involving commercial varieties, the progenies SNK525 (F43004) and SNK827 (F44003) recorded highest (21.10) followed by SNK662 (F27026) (20.77%) and SNK492 (F20003) (20.53%) which are superior over best check Co86032 (18.63%). The lowest HR Brix per cent was observed in SNK138 (F07076) (8.53%) followed by SNK238 (F10001) (9.00%) and SNK684 (F27091) (9.17%).

The genotypic (24.95) and phenotypic (30.69) coefficients of variation differed marginally with fairly high heritability estimate (81.30%) and GAM (23.32%).

Family F44 recorded highest mean HR Brix of 20.27 per cent followed by F43 and F20 with 18.20 and 18.06 per cent respectively. The lowest mean HR Brix per cent was observed in F50 (11.53%) followed by F36 (13.03%).

4.1.2.10.1 Per cent superior progenies obtained based on cane yield and HR brix (family wise)

On the basis of overall selection traits, families F44 (100%), F38 (50.00%), F06 (50.00%), F35 (33.33%) and F39 (25.00%) are promising as they gave higher number of superior progenies.

4.1.3 Genetic parameters for various traits in clonal ratoon under moisture stress environment

Analysis of variance for nine traits included in the study is presented in the table 21. As evident from the table, mean sum of squares for average cane girth, average single cane weight and average HR Brix per cent are only highly significant. The MSS for average number of internodes and average internodal length are significant at 5% level. The attributes tiller number, number millable canes and cane yield per plot had non significant mean sum of squares. The mean, range, genotypic and phenotypic coefficients of variability, heritability estimates and GAM predicted as per cent of mean in respect of these traits are given in Table 22. The family wise mean, range, variance in respect of these traits are given in Table 23 to 27. The mean values (adjusted) obtained for various traits included in the study in respect of 50 selected progenies out of 828 progenies evaluated are provided in Appendix VIII. The results of attributes which had significant mean sum of squares are discussed.

Appendix VIII. Adjusted mean values of selected progenies for 9 traits studied in clonal ratoon generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Table 21. Analysis of variance for important cane yield parameters and HR Brix (%) in clonal ratoon generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Source	df	MSS for the characters								
		Tillers / Plot	Average cane girth (cm)	Average millable cane height (cm)	Average number of internodes	Average internodal length (cm)	Number of millable canes / plot	Average single cane weight (kg)	Cane yield (kg) plot	Average HR Brix (%)
Varieties (v)	827	237.56	0.12**	1583.99	8.77*	6.00*	237.56	0.31**	10.22	4.23**
Error	24	170.86	0.05	1140.64	4.39	3.51	167.69	0.12	10.25	1.23
SEd 1. Between 2 check means		6.16	0.10	15.92	0.99	0.88	6.10	0.16	1.51	0.52
SEd 2. Between any 2 means of test var.		18.49	0.31	47.76	2.96	2.65	18.31	0.49	4.53	1.57
SEd 3. Between any 2 entries of same block		20.67	0.35	53.40	3.31	2.96	20.48	0.54	5.06	1.75
SEd 4. Between means of check & var.		15.40	0.26	39.80	2.47	2.21	15.26	0.40	3.77	1.31
CD 5%										
Between 2 check means		12.69	0.21	32.80	2.03	1.82	12.58	0.33	3.11	1.08
Between any 2 means of test var.		38.08	0.64	98.39	6.10	5.46	37.73	1.00	9.33	3.23
Between any 2 entries of same block		42.58	0.72	110.00	6.82	6.10	42.18	1.12	10.43	3.62
Between means of check & var.		31.73	0.54	81.99	5.09	4.55	31.44	0.83	7.77	2.69
CD 1%										
Between 2 check means		17.25	0.29	44.58	2.77	2.47	17.09	0.45	4.23	1.47
Between any 2 means of test var.		51.76	0.88	133.74	8.30	7.42	51.28	1.36	12.68	4.40
Between any 2 entries of same block		57.87	0.98	149.52	9.28	8.29	57.33	1.52	14.17	4.91
Between means of check & var.		43.13	0.73	111.45	6.91	6.18	42.73	1.13	10.56	3.66

*, ** Significant at 5 and 1 per cent levels respectively

Table 22. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in clonal ratoon generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Characters	Mean	Range*	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	GAM (%)
1. Tillers / Plot	34.28	2.67 - 123.17 (7.00) - (127.00)	194.57	692.99	28.08	8.91	26.01
2. Average cane girth (cm)	2.25	1.24 - 3.39 (1.40) - (3.60)	2.96	5.13	57.69	0.40	17.95
3. Average millable cane height (cm)	218.25	75.49 - 365.59 (107.30) - (360.00)	203.14	725.76	27.99	22.95	10.51
4. Average number of internodes	15.67	7.34 - 31.91 (8.30) - (31.00)	27.98	56.00	49.96	3.05	19.46
5. Average internodal length (cm)	14.14	6.54 - 23.64 (7.00) - (22.82)	17.61	42.43	41.51	2.09	14.81
6. Number of millable canes / Plot	29.28	-1.22 - 118.39 (2.00) - (122.00)	238.61	811.33	29.41	9.34	31.89
7. Average single cane weight (kg)	0.81	0.04 - 4.90 (0.15) - (4.70)	24.91	39.46	63.14	0.74	90.81
8. Cane yield (kg) / Plot	17.56	1.93 - 30.93 (3.00) - (29.00)	-0.16	58.22	-0.28	-0.02	-0.10
9. Average HR Brix (%)	17.44	9.09 - 22.23 (8.80) - (22.46)	17.18	24.25	70.88	3.00	17.21

*Range values obtained from adjusted mean values of progenies
Figures in parenthesis are actual values

4.1.3.1 Average cane girth

The average cane girth ranged from 1.24 to 3.39 cm with overall mean of 2.25 cm revealing high amount of variability among progenies in clonal ratoon generation under moisture stress environment.

The progeny SNK159 (F07137) (3.39 cm) had thickest cane followed by SNK503 (F20045) (3.26 cm) and SNK744 (F32036), whereas SNK227 (F09056) (1.24 cm) was the thinnest followed by SNK091 (F04019) (1.29 cm) and SNK225 (F09054) (1.34 cm).

The genotypic and phenotypic coefficients of variation were 2.96 and 5.13 respectively. The heritability estimate (57.69%) was moderate with low GAM of 17.95 per cent.

The family F25 (2.70 cm) had highest mean thickness, followed by F06 (2.60 cm) and F31 (2.53 cm), whereas lowest mean values were recorded in F48 (1.90 cm) followed by F37 (1.95 cm) and F36 (2.00 cm).

4.1.3.2 Average number of internodes

This attribute exhibited fairly high variability with wide range (7.34 to 31.91) and overall mean of 15.67.

Among 828 progenies, SNK013 (F02016) (31.91) recorded highest number of internodes followed by SNK054 (F02169) and SNK086 (F03034) with 30.91 internodes, whereas lowest number of internodes were observed in SNK283 (F11035) (7.34) and SNK258 (F10122) (7.76).

The difference between genotypic (27.98) and phenotypic (56.00) coefficient was substantial which reflected in moderate heritability estimate (49.96%) and low GAM (19.46%).

The family F06 (31.50) recorded highest mean internodes followed by F05 (28.92) and F04 (26.31). The family F04 had highest variance (43.71) and broad range (12.00 – 39.00).

4.1.3.3 Average internodal length

The internodal length exhibited moderate variability with a range from 6.54 to 23.64 cm and 14.14 cm overall mean.

The progeny SNK613 (F24054) (23.64 cm) had longest internodes followed by SNK581 (F23053) (23.24 cm) and SNK737 (F31010) (22.86 cm) whereas shortest internodal length was observed in SNK269 (F11010) (6.54 cm) followed by SNK195 (F08118) (7.14 cm) and SNK268 (F11009) (7.37 cm).

The genotypic (17.61) and phenotypic (42.43) coefficients of variation differed considerably, which resulted in moderately low estimates of heritability (41.51%) and low GAM (14.81%).

Family F31 (20.76 cm) had the progenies with longest internodal length as depicted by highest mean value followed by F02 (16.64 cm) and F36 (16.45 cm), whereas F06 (11.21 cm) had lowest mean value for internodal length followed by F49 (11.50 cm) and F39 (11.57 cm). The F04 exhibited broad range of variability (1.40 to 25 cm) with highest variance (24.26).

4.1.3.4 Average single cane weight

The single cane weight exhibited high variability with a broad range (0.04 to 4.90 kg) and better overall mean (0.81 kg) under moisture stress environment in ratoon generation.

The progeny SNK132 (F07065) (4.90 kg) had heaviest canes followed by SNK633 (F26003) (4.61 kg) and SNK283 (F11035) (4.54 kg), whereas the progeny SNK678 (F27073) (0.04 kg) recorded lightest canes followed by SNK722 (F28066) (0.10 kg) and SNK659 (F27018) (0.10 kg).

Table 23. Family wise Mean, Range and Variance for tillers and average cane girth in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Tillers / Plot			Average cane girth (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	31.13	10.00 - 57.00	290.36	2.23	1.73 - 3.07	0.19
F 02	50	31.24	8.00 - 54.00	115.98	2.47	1.60 - 3.07	0.10
F 03	21	33.19	16.00 - 54.00	85.87	2.33	1.50 - 3.07	0.17
F 04	16	6.44	2.00 - 14.00	10.12	2.37	1.30 - 3.20	0.27
F 05	12	6.58	4.00 - 9.00	2.91	2.43	1.20 - 3.00	0.23
F 06	2	6.50	6.00 - 7.00	0.25	2.60	2.60 - 2.60	0.00
F 07	59	33.17	10.00 - 127.00	295.35	2.49	1.80 - 3.60	0.11
F 08	40	33.58	7.00 - 87.00	234.14	2.37	1.60 - 3.27	0.13
F 09	29	38.55	16.00 - 74.00	216.52	2.27	1.50 - 3.27	0.17
F 10	27	41.15	10.00 - 105.00	529.53	2.11	1.73 - 2.73	0.06
F 11	37	37.19	9.00 - 75.00	303.99	2.21	1.60 - 2.80	0.07
F 12	35	34.77	10.00 - 75.00	250.35	2.30	1.90 - 3.00	0.07
F 13	14	33.36	14.00 - 80.00	254.09	2.08	1.60 - 2.53	0.06
F 14	7	35.71	21.00 - 81.00	377.06	2.13	1.80 - 2.60	0.08
F 16	33	38.94	17.00 - 66.00	182.48	2.20	1.40 - 2.80	0.10
F 17	10	33.60	12.00 - 75.00	275.84	2.19	1.80 - 2.70	0.06
F 18	41	37.17	10.00 - 83.00	308.19	2.22	1.60 - 2.97	0.12
F 19	50	35.18	12.00 - 65.00	165.79	2.08	1.57 - 2.80	0.09
F 20	26	27.46	10.00 - 55.00	111.48	2.28	1.70 - 3.10	0.09
F 21	25	38.76	9.00 - 68.00	221.94	2.28	1.60 - 2.93	0.09
F 22	14	33.93	8.00 - 65.00	208.78	2.07	1.70 - 2.67	0.09
F 23	38	38.95	12.00 - 75.00	279.00	2.13	1.60 - 2.73	0.09
F 24	34	31.74	12.00 - 67.00	154.08	2.23	1.63 - 2.67	0.05
F 25	3	32.33	13.00 - 44.00	189.56	2.70	2.47 - 2.93	0.04
F 26	20	32.70	8.00 - 55.00	175.71	2.24	1.60 - 3.03	0.09
F 27	40	33.46	7.00 - 94.00	294.81	2.13	1.53 - 2.73	0.06
F 28	31	28.84	8.00 - 63.00	207.57	2.24	1.67 - 2.60	0.09
F 30	14	32.86	15.00 - 70.00	246.84	2.12	1.67 - 2.77	0.08
F 31	3	31.33	9.00 - 45.00	253.56	2.53	2.00 - 3.10	0.20
F 32	13	31.77	11.00 - 45.00	146.18	2.41	1.97 - 3.13	0.14
F 34	21	35.33	15.00 - 70.00	224.98	2.05	1.40 - 2.47	0.05
F 33	1	37.00	37.00 - 37.00	0.00	2.23	2.23 - 2.23	0.00
F 48	3	31.67	20.00 - 38.00	68.22	1.90	1.70 - 2.07	0.02
F 50	1	15.00	15.00 - 15.00	0.00	2.13	2.13 - 2.13	0.00
F 47	7	34.29	19.00 - 56.00	198.20	2.10	1.97 - 2.30	0.01
F 49	2	34.00	18.00 - 50.00	256.00	2.02	1.93 - 2.10	0.01
F 46	8	35.00	17.00 - 65.00	265.25	2.26	1.77 - 2.80	0.11
F 37	2	35.50	35.00 - 36.00	0.25	1.95	1.80 - 2.10	0.02
F 36	7	37.29	26.00 - 55.00	116.20	2.00	1.70 - 2.23	0.04
F 35	12	34.33	18.00 - 55.00	93.89	2.34	1.73 - 2.97	0.11
F 38	4	31.00	16.00 - 55.00	225.50	2.31	1.97 - 2.77	0.12
F 39	4	36.00	24.00 - 50.00	126.00	2.11	1.80 - 2.43	0.09
F 43	2	37.50	34.00 - 41.00	12.25	2.05	2.00 - 2.10	0.00
F 44	1	25.00	25.00 - 25.00	0.00	2.43	2.43 - 2.43	0.00

Table 24. Family wise mean, range and variance for average millable cane height and average number of internodes in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Average Millable ht. (cm)				Average number of internodes			
		Mean	Range		Variance	Mean	Range		Variance
F 01	8	222.34	200.00	- 305.00	1047.49	15.55	13.00	- 17.30	1.62
F 02	50	241.37	169.30	- 350.00	2044.33	14.79	10.30	- 31.00	13.69
F 03	21	240.05	141.70	- 360.00	4074.43	17.60	10.30	- 30.00	30.84
F 04	16	335.63	200.00	- 395.00	1987.11	26.31	12.00	- 39.00	43.71
F 05	12	337.50	250.00	- 390.00	2381.25	28.92	18.00	- 39.00	34.91
F 06	2	350.00	340.00	- 360.00	100.00	31.50	29.00	- 34.00	6.25
F 07	59	217.06	154.70	- 308.30	1041.43	14.93	11.00	- 21.00	5.58
F 08	40	248.25	144.30	- 325.00	1783.40	17.63	11.00	- 25.00	8.27
F 09	29	211.83	120.00	- 279.30	1271.65	17.10	11.00	- 20.70	4.59
F 10	27	188.59	116.30	- 275.00	1082.99	14.40	8.70	- 18.00	4.41
F 11	37	188.24	108.30	- 281.00	1610.13	14.72	9.00	- 30.00	13.41
F 12	35	226.37	158.00	- 308.30	902.51	15.70	10.30	- 18.00	3.42
F 13	14	199.98	120.00	- 250.00	1001.06	14.63	11.00	- 19.70	7.80
F 14	7	224.47	202.70	- 270.00	530.67	16.71	12.70	- 20.00	4.69
F 16	33	226.52	168.30	- 280.00	438.22	15.53	11.00	- 22.00	5.71
F 17	10	199.39	158.30	- 233.30	441.91	15.67	12.70	- 19.00	3.08
F 18	41	213.06	115.00	- 270.00	990.53	16.33	12.00	- 22.00	5.01
F 19	50	238.11	148.30	- 320.00	1486.66	16.09	9.30	- 22.70	7.49
F 20	26	206.27	123.30	- 271.70	1156.94	16.63	11.00	- 25.00	9.37
F 21	25	236.18	161.70	- 285.00	719.76	17.65	12.70	- 21.00	3.83
F 22	14	210.66	156.00	- 250.00	554.63	15.81	13.30	- 18.70	3.03
F 23	38	214.53	155.00	- 245.00	335.41	14.27	9.33	- 19.00	4.28
F 24	34	232.05	161.00	- 285.00	837.13	16.39	10.30	- 20.70	5.08
F 25	3	262.77	245.00	- 278.30	187.31	17.00	14.70	- 19.30	3.53
F 26	20	211.82	113.30	- 285.00	1520.56	16.60	9.30	- 19.70	6.03
F 27	40	193.37	111.00	- 275.00	1773.84	14.45	8.30	- 20.30	9.98
F 28	31	207.04	107.30	- 298.30	2138.60	15.68	9.30	- 20.00	9.16
F 30	14	223.02	130.00	- 281.70	1220.34	15.84	8.70	- 20.00	6.97
F 31	3	252.90	235.00	- 281.70	422.89	12.33	10.30	- 14.00	2.35
F 32	13	229.81	133.30	- 291.70	1360.39	17.27	11.70	- 21.00	6.08
F 34	21	233.47	185.00	- 286.70	710.93	16.37	13.00	- 25.70	6.00
F 33	1	221.70	221.70	- 221.70	0.00	16.00	16.00	- 16.00	0.00
F 48	3	198.33	145.00	- 261.70	2320.15	15.03	13.70	- 17.70	3.56
F 50	1	268.30	268.30	- 268.30	0.00	18.00	18.00	- 18.00	0.00
F 47	7	210.51	176.30	- 273.00	1221.36	16.10	11.70	- 19.30	4.77
F 49	2	192.65	175.30	- 210.00	301.02	16.80	16.30	- 17.30	0.25
F 46	8	202.21	173.30	- 260.00	731.36	15.08	9.30	- 17.00	6.74
F 37	2	236.65	210.00	- 263.30	710.22	16.35	16.00	- 16.70	0.12
F 36	7	201.91	171.70	- 239.30	400.99	12.39	9.70	- 15.30	3.20
F 35	12	219.08	176.70	- 293.30	765.27	15.38	11.00	- 19.00	5.00
F 38	4	199.98	188.30	- 213.30	95.92	16.35	13.70	- 19.30	4.07
F 39	4	198.98	173.00	- 231.30	438.07	17.05	15.30	- 21.30	6.19
F 43	2	217.00	215.00	- 219.00	4.00	14.65	14.00	- 15.30	0.42
F 44	1	146.70	146.70	- 146.70	0.00	10.70	10.70	- 10.70	0.00

Table 25. Family wise mean, range and rariance for average internodal length and number of millable canes in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Average Internodal length (cm)			Number of millable canes / Plot		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	14.31	11.80 - 17.90	2.89	26.13	5.00 - 52.00	290.36
F 02	50	16.64	8.70 - 22.70	6.81	26.24	3.00 - 49.00	115.98
F 03	21	14.00	9.62 - 18.10	6.47	28.19	11.00 - 49.00	85.87
F 04	16	12.75	1.40 - 25.00	24.26	5.25	2.00 - 12.00	6.69
F 05	12	11.90	9.74 - 14.50	2.24	5.33	2.00 - 8.00	2.72
F 06	2	11.21	10.00 - 12.41	1.46	5.00	4.00 - 6.00	1.00
F 07	59	14.70	9.90 - 19.90	3.87	28.17	5.00 - 122.00	295.35
F 08	40	14.28	8.30 - 20.80	6.57	28.58	2.00 - 82.00	234.14
F 09	29	12.43	9.20 - 16.20	3.02	33.55	11.00 - 69.00	216.52
F 10	27	13.15	9.90 - 16.18	3.01	36.15	5.00 - 100.00	529.53
F 11	37	13.09	7.00 - 18.73	6.78	32.19	4.00 - 70.00	303.99
F 12	35	14.56	9.50 - 19.23	4.49	29.77	5.00 - 70.00	250.35
F 13	14	13.96	10.30 - 18.00	6.43	28.36	9.00 - 75.00	254.09
F 14	7	13.75	11.00 - 19.40	8.11	30.71	16.00 - 76.00	377.06
F 16	33	14.84	11.14 - 19.90	4.65	33.94	12.00 - 61.00	182.48
F 17	10	12.78	11.10 - 14.60	1.60	28.60	7.00 - 70.00	275.84
F 18	41	13.17	8.40 - 16.92	4.04	32.17	5.00 - 78.00	308.19
F 19	50	14.98	9.80 - 19.80	4.95	30.18	7.00 - 60.00	165.79
F 20	26	12.60	7.90 - 16.70	4.48	22.46	5.00 - 50.00	111.48
F 21	25	13.44	11.40 - 16.67	1.79	33.76	4.00 - 63.00	221.94
F 22	14	13.50	10.10 - 18.40	5.02	28.93	3.00 - 60.00	208.78
F 23	38	15.30	11.58 - 21.80	5.14	33.95	7.00 - 70.00	279.00
F 24	34	14.41	8.90 - 22.20	6.47	26.74	7.00 - 62.00	154.08
F 25	3	15.57	14.42 - 16.70	0.87	27.33	8.00 - 39.00	189.56
F 26	20	12.80	9.70 - 16.50	2.85	27.70	3.00 - 50.00	175.71
F 27	40	13.55	10.10 - 17.80	4.40	28.46	2.00 - 89.00	294.81
F 28	31	13.27	10.15 - 17.08	4.26	23.84	3.00 - 58.00	207.57
F 30	14	14.27	11.30 - 19.40	4.69	27.86	10.00 - 65.00	246.84
F 31	3	20.76	17.29 - 22.82	6.11	26.33	4.00 - 40.00	253.56
F 32	13	13.38	11.19 - 17.60	3.99	26.77	6.00 - 40.00	146.18
F 34	21	14.46	8.60 - 17.30	4.04	30.33	10.00 - 65.00	224.98
F 33	1	13.90	13.90 - 13.90	0.00	32.00	32.00 - 32.00	0.00
F 48	3	13.03	10.60 - 14.80	3.16	26.67	15.00 - 33.00	68.22
F 50	1	14.90	14.90 - 14.90	0.00	10.00	10.00 - 10.00	0.00
F 47	7	13.33	9.80 - 17.06	7.84	29.29	14.00 - 51.00	198.20
F 49	2	11.50	10.10 - 12.90	1.96	29.00	13.00 - 45.00	256.00
F 46	8	13.72	11.39 - 19.50	6.04	30.00	12.00 - 60.00	265.25
F 37	2	14.46	13.13 - 15.80	1.79	30.50	30.00 - 31.00	0.25
F 36	7	16.45	14.85 - 19.40	2.24	32.29	21.00 - 50.00	116.20
F 35	12	14.50	11.30 - 20.50	6.44	29.33	13.00 - 50.00	93.89
F 38	4	12.35	11.10 - 13.70	0.85	26.00	11.00 - 50.00	225.50
F 39	4	11.75	10.90 - 12.60	0.46	31.00	19.00 - 45.00	126.00
F 43	2	14.85	14.05 - 15.64	0.63	32.50	29.00 - 36.00	12.25
F 44	1	13.70	13.70 - 13.70	0.00	20.00	20.00 - 20.00	0.00

Table 26. Family wise mean, range and variance for average single cane weight and cane yield in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Family / Cross	Progenies studied	Average single cane wt. (kg)			Cane yield (kg) / Plot		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	0.87	0.37 - 2.20	0.34	14.63	11.00 - 20.00	12.23
F 02	50	0.88	0.37 - 3.67	0.43	17.91	11.00 - 28.00	10.76
F 03	21	0.67	0.33 - 1.00	0.04	17.24	11.00 - 23.00	11.13
F 04	16	0.97	0.52 - 1.42	0.06	4.86	1.87 - 10.24	4.60
F 05	12	1.12	0.53 - 2.17	0.19	5.99	2.05 - 12.27	10.04
F 06	2	0.95	0.77 - 1.12	0.03	4.55	4.49 - 4.61	0.00
F 07	59	0.95	0.16 - 4.70	0.70	17.71	10.00 - 29.00	10.90
F 08	40	0.78	0.17 - 2.25	0.21	18.03	11.00 - 25.00	6.07
F 09	29	0.59	0.28 - 1.55	0.07	16.66	10.00 - 19.00	6.02
F 10	27	0.70	0.19 - 2.60	0.28	17.25	10.00 - 28.70	16.68
F 11	37	0.79	0.15 - 4.50	0.57	16.89	11.00 - 21.00	7.18
F 12	35	0.82	0.29 - 2.83	0.32	17.60	3.00 - 26.00	11.38
F 13	14	0.77	0.23 - 1.89	0.22	16.57	11.00 - 19.00	4.53
F 14	7	0.71	0.25 - 1.00	0.05	17.57	13.00 - 21.00	5.39
F 16	33	0.61	0.28 - 1.42	0.09	17.12	12.00 - 21.00	3.26
F 17	10	0.85	0.27 - 2.43	0.34	17.40	16.00 - 19.00	1.04
F 18	41	0.75	0.21 - 2.60	0.30	16.93	11.00 - 22.00	6.07
F 19	50	0.78	0.32 - 2.43	0.22	18.50	8.00 - 23.00	5.41
F 20	26	1.10	0.32 - 3.40	0.57	18.27	15.00 - 23.00	3.12
F 21	25	0.64	0.30 - 1.25	0.07	17.84	5.00 - 23.00	11.17
F 22	14	0.76	0.32 - 1.33	0.11	17.64	4.00 - 24.00	20.52
F 23	38	0.75	0.30 - 2.71	0.27	18.29	14.00 - 22.00	2.94
F 24	34	0.86	0.31 - 2.63	0.22	18.82	5.00 - 25.00	17.03
F 25	3	0.79	0.51 - 1.25	0.11	17.00	10.00 - 21.00	24.67
F 26	20	1.08	0.38 - 4.67	1.08	18.55	14.00 - 25.00	6.05
F 27	40	0.73	0.20 - 2.00	0.14	15.97	3.00 - 24.00	15.00
F 28	31	0.97	0.26 - 2.57	0.29	16.69	3.00 - 24.00	15.46
F 30	14	0.78	0.29 - 1.80	0.24	16.29	4.00 - 19.00	14.06
F 31	3	0.80	0.40 - 1.50	0.24	13.33	6.00 - 18.00	27.56
F 32	13	0.91	0.45 - 2.50	0.30	18.77	8.00 - 24.00	18.49
F 34	21	0.76	0.26 - 1.70	0.13	18.38	10.00 - 29.00	12.81
F 33	1	0.56	0.56 - 0.56	0.00	18.00	18.00 - 18.00	0.00
F 48	3	0.72	0.52 - 1.00	0.04	17.33	15.00 - 20.00	4.22
F 50	1	1.90	1.90 - 1.90	0.00	19.00	19.00 - 19.00	0.00
F 47	7	0.68	0.31 - 1.21	0.10	16.29	10.00 - 19.00	7.35
F 49	2	0.90	0.42 - 1.38	0.23	18.50	18.00 - 19.00	0.25
F 46	8	0.74	0.32 - 1.42	0.10	17.75	15.00 - 19.00	2.19
F 37	2	0.52	0.50 - 0.55	0.00	16.00	15.00 - 17.00	1.00
F 36	7	0.60	0.36 - 0.82	0.03	17.57	17.00 - 18.00	0.24
F 35	12	0.76	0.38 - 1.38	0.10	19.58	17.00 - 23.00	4.08
F 38	4	1.00	0.48 - 1.55	0.15	20.50	17.00 - 24.00	12.25
F 39	4	0.69	0.38 - 1.16	0.10	18.25	15.00 - 22.00	6.69
F 43	2	0.53	0.50 - 0.55	0.00	17.00	16.00 - 18.00	1.00
F 44	1	1.20	1.20 - 1.20	0.00	24.00	24.00 - 24.00	0.00

Table 27. Family wise mean, range and variance for average HR Brix (%) in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment and per cent superior progenies based on cane yield and HR brix at Sankeshwar

Family / Cross	Progenies studied	Average H. R. Brix (%)			% superior progenies based on cane yield and HR brix.
		Mean	Range	Variance	
F 01	8	16.19	13.46 - 18.28	2.51	0.00
F 02	50	18.00	13.64 - 21.00	2.38	4.00
F 03	21	17.62	14.04 - 20.60	2.90	0.00
F 04	16	19.06	16.00 - 21.80	3.86	25.00
F 05	12	17.73	15.00 - 20.60	2.50	8.33
F 06	2	17.70	16.00 - 19.40	2.89	50.00
F 07	59	16.44	10.44 - 21.28	4.79	1.69
F 08	40	16.24	10.00 - 21.28	4.75	0.00
F 09	29	17.09	13.68 - 19.72	2.86	0.00
F 10	27	15.75	11.48 - 20.76	4.80	7.41
F 11	37	17.34	12.64 - 20.60	3.22	2.70
F 12	35	15.80	11.32 - 18.72	2.62	0.00
F 13	14	16.49	11.70 - 18.76	3.72	0.00
F 14	7	18.89	16.00 - 21.04	2.41	14.29
F 16	33	17.49	15.00 - 21.60	2.28	3.03
F 17	10	16.97	14.88 - 19.36	1.60	0.00
F 18	41	16.33	9.68 - 20.64	6.02	2.44
F 19	50	17.32	13.50 - 20.00	2.34	6.00
F 20	26	19.36	16.36 - 22.46	3.36	7.69
F 21	25	19.63	15.56 - 21.72	2.62	8.00
F 22	14	18.30	14.92 - 21.56	3.14	14.29
F 23	38	17.93	14.00 - 21.12	3.62	5.26
F 24	34	18.68	15.80 - 20.48	1.22	11.76
F 25	3	16.35	14.20 - 17.64	2.34	0.00
F 26	20	18.79	15.56 - 20.80	2.04	15.00
F 27	40	17.19	8.80 - 20.56	6.50	2.50
F 28	31	17.78	14.20 - 20.00	2.08	6.45
F 30	14	17.87	13.92 - 20.40	2.79	0.00
F 31	3	18.14	16.00 - 19.30	2.30	0.00
F 32	13	16.77	13.00 - 19.32	4.07	23.81
F 34	21	18.31	16.48 - 20.56	1.13	0.00
F 33	1	19.00	19.00 - 19.00	0.00	0.00
F 48	3	17.15	14.88 - 18.52	2.61	0.00
F 50	1	15.28	15.28 - 15.28	0.00	0.00
F 47	7	18.33	17.72 - 19.52	0.33	14.29
F 49	2	17.80	17.08 - 18.52	0.52	0.00
F 46	8	18.61	16.44 - 20.24	1.41	0.00
F 37	2	17.00	16.50 - 17.50	0.25	0.00
F 36	7	15.97	13.72 - 18.54	1.76	0.00
F 35	12	17.96	15.08 - 19.48	2.09	33.33
F 38	4	18.63	17.88 - 19.60	0.50	50.00
F 39	4	17.62	15.76 - 18.76	1.34	25.00
F 43	2	17.99	16.50 - 19.48	2.22	0.00
F 44	1	19.20	19.20 - 19.20	0.00	100.00

The genotypic and phenotypic coefficients of variation were 24.91 and 39.46 respectively indicating moderately high heritability (63.14%) and GAM (90.81%) estimates.

The family F50 (1.90kg) had a single progeny with heaviest canes followed by F44 (1.20kg) and F05 (1.12 kg) where later family had better range (0.53 to 2.17 kg) with variance of 0.19. The family F26 had better mean single cane weight, with high range (0.38 to 4.67 kg) and variance (1.08). Families F43, F33 and F09 had lighter cane with 0.53, 0.56 and 0.59 kg, respectively.

4.1.3.5 Average hand refractometer brix per cent

This attribute exhibited higher variability with a range of 9.09 to 22.23 per cent and overall mean of 17.44 per cent across the 828 progenies comprising 44 crosses (families).

Highest HR Brix per cent was recorded in progeny SNK496 (F20007) (22.23 %) followed by SNK358 (F16001) (22.07%) and SNK503 (F20045) (21.85%) whereas the lowest value was observed in progeny SNK684 (F27091) (9.09%) followed by SNK175 (F08021) (9.67%) and SNK408 (F18031) (10.07%).

The genotypic (17.18) and phenotypic (24.25) coefficients of variation differed marginally with fairly high heritability (70.09%) estimate and low GAM of 17.21 per cent.

The families F21 (19.63%), F20 (19.36%) and F44 (19.20%) had higher mean values. These families recorded higher number of progenies with fairly high values for HR brix per cent. The lowest mean brix value was recorded in F50 (15.28%) followed by F10 (15.75%) and F12 (15.80%).

4.1.3.6 Per cent superior progenies obtained based on cane yield and HR brix (family wise)

The families F44 (100%), F38 (50%), F06 (50%), F35 (33.33%), F39 (25.0%), F04 (25%) and F32 (23.81%) found to be proven as they had higher frequencies of superior progenies, in clonal ratoon generation grown under moisture stress environment.

4.1.4 Genetic parameters for various traits in settling generation under salinity water logg complex environment

Analysis of variance for the eleven traits included in the study is presented in the Table 28. The traits, viz., germination per cent, tillers per plot, average number of millable cane per plot, average single cane weight, cane yield per plot and HR Brix per cent were highly significant, as evident from the mean sum of squares, however average cane girth was found significant only at $p=0.05$. The other traits viz., tiller mortality per cent, average millable cane height, average number of internodes, average number of internodal length had non significant mean sum of squares. 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 29, the traits with significant mean sum of squares are discussed here. The family wise mean range and variance in respect of these traits are given in Table 30 to 35. The mean values (adjusted) obtained for various traits included in the study in respect of 3 checks and only 33 selections out of 828 progenies evaluated are provided in Appendix IX.

Appendix IX. Adjusted mean values of selected progenies for 11 traits studied in settling generation of 44 inter varietal sugarcane crosses under salinity water logg complex environment at Ugar

Table 28. Analysis of variance for important cane yield parameters and HR Brix (%) in settling generations of 44 inter varieta sugaraen crosses under salinity water logg complex environment at Ugar

Source	df	MSS for the characters										
		Germination %	Tillers / plot	Tillers mortality %	Average cane girth (cm)	Average millable cane height (cm)	Average number of internodes	Average internodal length (cm)	Number of millable canes / plot	Average single cane weight (kg)	Cane yield (kg) plot	Average HR Brix (%)
Varieties (v)	441	372.22**	453.22**	13.14	0.13*	1196.61	9.36	2.71	167.00**	0.20**	14.17**	6.77**
Error	32	25.78	208.60	18.49	0.07	836.45	7.72	2.84	45.90	0.06	3.05	3.34
SEd 1. Between 2 check means		1.74	4.95	1.47	0.09	9.92	0.95	0.58	2.32	0.08	0.60	0.63
SEd 2. Between any 2 means of test var.		7.18	20.43	6.08	0.38	40.90	3.93	2.38	9.58	0.34	2.47	2.58
SEd 3. Between any 2 entries of same block		8.29	23.59	7.02	0.44	47.23	4.54	2.75	11.06	0.39	2.85	2.98
SEd 4. Between means of check & var.		6.03	17.16	5.11	0.32	34.36	3.30	2.00	8.05	0.28	2.07	2.17
CD 5%												
Between 2 check means		3.55	10.11	3.01	0.19	20.24	1.94	1.18	4.74	0.17	1.22	1.28
Between any 2 means of test var.		14.65	41.67	12.40	0.78	83.44	8.02	4.86	19.55	0.69	5.03	5.27
Between any 2 entries of same block		16.92	48.11	14.32	0.90	96.35	9.26	5.61	22.57	0.79	5.81	6.09
Between means of check & var.		12.31	35.01	10.42	0.66	70.10	6.74	4.08	16.42	0.58	4.23	4.43
CD 1%												
Between 2 check means		4.79	13.62	4.06	0.26	27.28	2.62	1.59	6.39	0.22	1.65	1.72
Between any 2 means of test var.		19.75	56.17	16.72	1.06	112.48	10.81	6.55	26.35	0.92	6.79	7.11
Between any 2 entries of same block		22.80	64.86	19.31	1.22	129.88	12.48	7.56	30.43	1.07	7.84	8.21
Between means of check & var.		16.59	47.19	14.05	0.89	94.50	9.08	5.50	22.14	0.78	5.70	5.97

*, ** Significant at 5 and 1 per cent respectively

Table 29. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in settling generation of 44 inter varietal sugarcane crosses under salinity water logg complex environment at Ugar

Characters	Mean	Range*	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	GAM (%)
1. Germination (%)	50.34	-7.22 (0.00) - 105.42 (88.64)	688.17	739.38	93.07	36.99	73.48
2. Tillers / Plot	44.14	-11.43 (2.00) - 113.24 (105.00)	554.13	1026.66	53.97	23.67	53.62
3. Tiller mortality (%)	12.22	-4.75 (0.00) - 30.59 (100.00)	301.88	1829.17	16.50	5.08	41.60
4. Average cane girth (cm)	2.23	1.30 (1.17) - 3.46 (3.10)	2.53	5.82	43.37	0.32	14.43
5. Average millable cane height (cm)	163.27	68.14 (101.67) - 297.80 (280.00)	220.60	732.91	30.10	21.45	13.14
6. Average number of Internodes	16.99	2.96 (7.00) - 28.42 (25.70)	9.60	55.08	17.44	1.10	6.47
7. Average internodal length (cm)	9.70	2.39 (6.10) - 19.05 (18.00)	-1.28	27.96	-4.58	-0.16	-1.60
8. Number of millable canes / Plot	26.47	-4.84 (1.00) - 74.16 (84.00)	457.44	630.85	72.51	19.30	72.92
9. Average single cane weight (kg)	0.69	-0.12 (0.14) - 4.08 (4.33)	21.26	29.41	72.30	0.67	97.02
10. Cane yield (kg) / Plot	14.23	1.08 (1.00) - 24.32 (26.00)	78.16	99.56	78.51	6.09	42.77
11. Average HR Brix (%)	18.30	6.77 (6.00) - 24.32 (23.10)	18.74	37.00	50.66	2.72	14.84

*Range values obtained from adjusted mean values of progenies
Figures in parenthesis are actual values

4.1.4.1 Germination per cent

The germination per cent exhibited widest variability among progenies studied under salinity water logged complex environment. The value for this trait varied from -7.22 to 105.42 per cent, with a mean value of 50.34 per cent.

The progeny SNK421 (F18073) (105.42%) showed highest germination, followed by SNK230 (F09062) (100.81%) and SNK422 (F18076) (97.11%) while, SNK011 (F02010) (-7.22) recorded lowest germination followed by SNK003 (F01004) (1.09%) and SNK041 (F02095) (3.86%).

The narrower difference between genotypic (688.17) and phenotypic (739.38) coefficients of variation evidenced with higher heritability (93.07%) and GAM (73.48%) estimates.

The family F48 (72.02%) recorded highest mean germination per cent, followed by F22 (69.25%), F33 (69.25%) and F07 (63.57%) while the family F32 (5.54%) recorded lowest mean germination per cent followed by F30 (19.39%) and F27 (26.91%).

4.1.4.2 Tillers per plot

The number of tillers per plot was ranged from -11.43 to 113.24 with a mean value of 44.14 across the progenies of 44 families studied.

The highest tillers were recorded in SNK422 (F18076) (113.24) followed by SNK421 (F18073) (110.24) and SNK799 (F36033) (104.57), while lowest tillers were observed in SNK192 (F08093) (-11.43) followed by SNK188 (F08056) (-10.43) and SNK187 (F08055) (-6.43).

The genotypic (554.13) and phenotypic (1026.66) coefficients of variations differed considerably which evidenced with moderate estimates of heritability (53.97%) and GAM (53.62%).

Highest family mean for tiller number per plot was recorded in F37 (79.00), followed by F36 (65.67) and F07 (64.05) with wider range of 32.00 to 102.00 and 25.00 to 105.00 respectively. These later two families also recorded higher family variances of 497.00 and 366.83 respectively.

4.1.4.3 Average cane girth

Substantial variation in cane girth was recorded with a range of 1.30 to 3.46 cm and overall mean of 2.23 cm in the hybrid progenies studied.

The progeny SNK715 (F28047) (3.46 cm) was the thickest, followed by SNK712 (F28043) (3.26 cm) and SNK717 (F28054) (3.23 cm), while the thinnest canes were noticed in SNK403 (F18010) (1.30 cm), followed by SNK343 (F13032) (1.40 cm) and SNK093 (F04022) (1.43).

The considerable difference between genotypic (2.53) and phenotypic (5.82) coefficients of variability was evidenced with moderate estimates of heritability (43.37%) and GAM (14.43%).

The families F02 (2.61 cm), F03 (2.59 cm) and F05 (2.44 cm) had higher mean values for cane thickness with better range of 2.10 to 3.00, 2.07 to 3.03 and 2.27 to 2.60 cm respectively. The family F49 (1.59 cm) had thinnest canes followed by F46 (1.70 cm) and F33 (1.73 cm).

Table 30. Family wise mean, range and variance for germination (%) and tillers in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Family / Cross	Progenies studied	Germination (%)			Tillers / Plot		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	32.89	16.62 - 44.32	10.36	29.13	14.00 - 55.00	135.61
F 02	48	58.11	8.31 - 94.18	43.23	47.21	14.00 - 89.00	274.58
F 03	20	61.63	38.78 - 83.10	22.89	50.80	22.00 - 90.00	272.06
F 04	14	50.85	24.93 - 83.10	32.66	38.43	18.00 - 79.00	347.24
F 05	4	49.17	41.55 - 60.94	7.19	40.00	25.00 - 71.00	333.00
F 06	2	45.71	36.01 - 55.40	12.25	44.50	31.00 - 58.00	182.25
F 07	59	63.57	24.93 - 91.41	29.61	64.05	25.00 - 105.00	366.83
F 08	29	31.23	13.85 - 63.71	23.10	26.48	2.00 - 62.00	255.15
F 09	25	59.94	19.39 - 99.72	43.59	54.60	15.00 - 95.00	382.56
F 10	14	55.20	22.16 - 85.87	48.64	47.00	18.00 - 78.00	281.71
F 11	14	39.77	19.39 - 74.79	28.37	36.71	16.00 - 63.00	211.63
F 12	23	57.45	22.16 - 77.56	22.98	47.70	13.00 - 81.00	325.78
F 13	6	50.78	33.24 - 66.48	22.89	42.83	27.00 - 59.00	157.81
F 14	2	31.86	19.39 - 44.32	20.25	28.50	28.00 - 29.00	0.25
F 16	9	37.24	13.85 - 63.71	33.36	34.78	7.00 - 63.00	344.17
F 17	1	52.63	52.63 - 52.63	0.00	43.00	43.00 - 43.00	0.00
F 18	24	42.01	11.08 - 99.72	59.56	27.96	2.00 - 98.00	570.46
F 19	13	50.07	8.31 - 72.02	43.30	39.69	4.00 - 84.00	408.98
F 20	13	57.10	5.54 - 88.64	52.54	42.92	6.00 - 68.00	212.22
F 21	5	45.98	30.47 - 63.71	20.24	36.60	14.00 - 48.00	146.24
F 22	1	69.25	69.25 - 69.25	0.00	45.00	45.00 - 45.00	0.00
F 23	9	31.70	2.77 - 80.33	59.36	27.00	7.00 - 49.00	196.89
F 24	11	47.34	19.39 - 77.56	32.45	33.09	18.00 - 55.00	126.63
F 27	7	26.91	19.39 - 38.78	6.20	30.29	16.00 - 45.00	75.35
F 28	15	42.10	24.93 - 74.79	28.03	29.33	13.00 - 62.00	179.29
F 30	1	19.39	19.39 - 19.39	0.00	10.00	10.00 - 10.00	0.00
F 31	1	33.24	33.24 - 33.24	0.00	21.00	21.00 - 21.00	0.00
F 32	1	5.54	5.54 - 5.54	0.00	3.00	3.00 - 3.00	0.00
F 34	21	39.70	19.39 - 63.71	19.84	40.24	13.00 - 76.00	293.90
F 33	1	69.25	69.25 - 69.25	0.00	63.00	63.00 - 63.00	0.00
F 48	3	72.02	66.48 - 77.56	2.67	56.00	44.00 - 65.00	78.00
F 50	1	38.78	38.78 - 38.78	0.00	39.00	39.00 - 39.00	0.00
F 47	7	51.44	41.55 - 63.71	9.10	52.71	36.00 - 84.00	259.35
F 49	2	52.63	52.63 - 52.63	0.00	43.00	33.00 - 53.00	100.00
F 46	7	53.03	16.62 - 72.02	48.12	56.43	33.00 - 95.00	531.10
F 37	1	55.40	55.40 - 55.40	0.00	79.00	79.00 - 79.00	0.00
F 36	6	58.17	41.55 - 77.56	22.67	65.67	32.00 - 102.00	497.56
F 35	7	39.97	19.39 - 63.71	29.10	41.43	22.00 - 75.00	300.53
F 38	2	36.01	36.01 - 36.01	0.00	33.00	31.00 - 35.00	4.00
F 39	3	54.48	47.09 - 63.71	6.22	37.00	30.00 - 42.00	26.00
F 43	2	52.63	49.86 - 55.40	1.00	54.00	53.00 - 55.00	1.00
F 44	1	52.63	52.63 - 52.63	0.00	41.00	41.00 - 41.00	0.00

Table 31. Family wise mean, range and variance for germination (%) and tillers in settling generation of pre selected sugarcane

Family / Cross	Progenies studied	Tiller Mortality (%)			Average Cane Girth (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	3.75	0.00 - 8.00	6.19	2.45	2.10 - 2.77	0.04
F 02	48	3.58	0.00 - 13.00	7.62	2.61	2.10 - 3.00	0.06
F 03	20	2.40	0.00 - 6.00	2.84	2.59	2.07 - 3.03	0.07
F 04	14	2.71	0.00 - 8.00	3.92	2.32	1.93 - 2.70	0.04
F 05	4	3.50	1.00 - 6.00	3.25	2.44	2.27 - 2.60	0.03
F 06	2	3.00	2.00 - 4.00	1.00	2.22	2.03 - 2.40	0.03
F 07	59	3.66	0.00 - 11.00	6.02	2.42	2.00 - 3.10	0.08
F 08	29	3.21	0.00 - 9.00	4.85	2.33	1.93 - 2.77	0.06
F 09	25	3.76	0.00 - 10.00	9.46	2.28	1.80 - 2.90	0.07
F 10	14	6.50	0.00 - 20.00	30.54	2.11	1.80 - 2.57	0.05
F 11	14	3.50	0.00 - 6.00	2.82	2.13	1.73 - 2.87	0.12
F 12	23	4.96	0.00 - 21.00	21.00	2.18	1.77 - 2.60	0.05
F 13	6	7.17	0.00 - 18.00	36.81	1.98	1.27 - 2.43	0.13
F 14	2	9.00	9.00 - 9.00	0.00	2.07	2.03 - 2.10	0.00
F 16	9	2.22	0.00 - 5.00	2.62	1.90	1.53 - 2.30	0.05
F 17	1	11.00	11.00 - 11.00	0.00	2.00	2.00 - 2.00	0.00
F 18	24	3.58	0.00 - 12.00	9.08	2.11	1.17 - 2.60	0.13
F 19	13	4.31	0.00 - 12.00	9.29	1.96	1.60 - 2.20	0.03
F 20	13	3.15	0.00 - 9.00	9.21	2.03	1.53 - 2.47	0.08
F 21	5	2.20	0.00 - 7.00	6.56	2.18	1.93 - 2.33	0.03
F 22	1	8.00	8.00 - 8.00	0.00	1.97	1.97 - 1.97	0.00
F 23	9	2.33	0.00 - 7.00	4.00	2.01	1.60 - 2.37	0.05
F 24	11	4.09	0.00 - 8.00	4.45	1.96	1.47 - 2.47	0.10
F 27	7	1.00	0.00 - 2.00	0.57	2.06	1.53 - 2.57	0.17
F 28	15	5.47	1.00 - 11.00	11.85	2.10	1.53 - 2.83	0.15
F 30	1	2.00	2.00 - 2.00	0.00	2.37	2.37 - 2.37	0.00
F 31	1	2.00	2.00 - 2.00	0.00	1.97	1.97 - 1.97	0.00
F 32	1	1.00	1.00 - 1.00	0.00	1.93	1.93 - 1.93	0.00
F 34	21	3.71	0.00 - 32.00	44.01	2.01	1.33 - 2.60	0.12
F 33	1	5.00	5.00 - 5.00	0.00	1.73	1.73 - 1.73	0.00
F 48	3	8.33	7.00 - 11.00	3.56	1.77	1.53 - 1.97	0.03
F 50	1	3.00	3.00 - 3.00	0.00	1.80	1.80 - 1.80	0.00
F 47	7	9.14	0.00 - 20.00	32.12	2.06	1.73 - 2.33	0.03
F 49	2	12.00	9.00 - 15.00	9.00	1.59	1.50 - 1.67	0.01
F 46	7	5.00	0.00 - 16.00	24.57	1.70	1.30 - 2.30	0.13
F 37	1	4.00	4.00 - 4.00	0.00	2.17	2.17 - 2.17	0.00
F 36	6	3.50	2.00 - 6.00	1.92	2.02	1.53 - 2.40	0.08
F 35	7	2.71	0.00 - 8.00	6.49	2.06	1.77 - 2.30	0.03
F 38	2	8.50	6.00 - 11.00	6.25	1.74	1.67 - 1.80	0.00
F 39	3	10.33	6.00 - 14.00	10.89	2.32	2.07 - 2.77	0.10
F 43	2	8.00	7.00 - 9.00	1.00	1.88	1.73 - 2.03	0.02
F 44	1	3.00	3.00 - 3.00	0.00	1.93	1.93 - 1.93	0.00

4.1.4.4 Number of millable canes per plot

This attribute exhibited higher variability with a range of -4.84 to 74.16 and mean of 26.47 millable canes per plot.

The progeny SNK114 (F07011) had highest millable canes per plot followed by SNK225 (F09054) (66.49) and SNK324 (F12073) (65.82), whereas the progeny SNK093 (F04022) (-4.84) recorded lowest millable canes followed by SNK087 (F04011) (-3.84) and SNK188 (F08056) (-3.51).

The genotypic (457.44) and phenotypic (630.85) coefficients of variation had narrower difference which evidenced with higher estimates of heritability (72.51%) and GAM (72.92%).

Highest family mean for this character was recorded in family F37 (59.00) followed by F48 (43.67) and F36 (42.17) whereas, lowest mean was observed in F32 (4.00) followed by F30 (6.00) and F31 (10.00).

4.1.4.5 Average single cane weight

Average single cane weight had higher variability among the progeny population studied with the mean values ranged from -0.12 to 4.08 kg and overall mean of 0.69 kg.

Heaviest canes were recorded in SNK006 (F01010) (4.08 kg) followed by SNK190 (F08066) (2.97 kg) and SNK047 (F02118) (2.24 kg) whereas lightest canes were observed in SNK225 (F08054) (-0.12 kg) followed by SNK430 (F18092) (-0.07) and SNK468 (F19053) (-0.07).

Considerably closer genotypic (21.26) and phenotypic (29.41) coefficients of variations indicated higher estimates of heritability (72.30%) and GAM (97.02%).

The family F32 (1.75 kg) had progenies with heaviest canes followed by F01 (1.66 kg) and F23 (1.02 kg), whereas the family F37 (0.27 kg) recorded progenies with lightest canes followed by F48 (0.29 kg) and F33 (0.31 kg).

4.1.4.6 Cane yield per plot

Cane yield exhibited higher variability among the progenies of 44 crosses studied with a range from 1.08 to 24.32 kg and overall mean of 14.23 kg per plot.

The progeny SNK085 (F04008) (24.32 kg) recorded highest cane yield followed by SNK124 (F07042) (24.25 kg) and SNK493 (F20004) (21.82 kg) whereas, as lowest cane yield was observed in SNK188 (F08056) (1.08 kg) followed by SNK472 (F19060) (1.82 kg).

The genotypic and phenotypic coefficients of variation were 78.16 and 99.56 respectively with higher estimates of heritability (78.51%) and moderate GAM (42.77 %).

The family F20 (17.15 kg) had highest family mean cane yield followed by F03 (16.89 kg) and F27 (16.86 kg) whereas the family F30 and F31 recorded lowest (5.00 kg) mean value for this trait followed by F49 (6.50 kg) and F32 (7.00 kg).

4.1.4.7 Average HR Brix per cent

This important cane quality attribute had fairly higher variability among the progenies of 44 families evaluated under salinity water logged complex environment, with mean values ranged from 6.77 to 24.32 per cent and overall mean of 18.30 per cent.

The progeny SNK662 (F27026) (24.32 %) was highest for average HR brix followed by SNK661 (F27024) (24.12%) and SNK512 (F20069) (24.00%) whereas the progenies SNK258 (F10122) (6.77%) and SNK296 (F11073) (6.77%) recorded lowest HR brix followed by SNK722 (F28066) (7.59%) and SNK692 (F28003) (7.72%).

The substantial difference in genotypic (18.74) and phenotypic (37.00) coefficients of variation was evidenced with moderate estimates of heritability (50.66 %) and low GAM (14.84 %).

Table 32. Family wise mean, range and variance for average millable cane height and average number of internodes in settling generation of pre selected sugarcane

Family / Cross	Progenies studied	Average millable cane height (cm)			Average number of Internodes		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	138.96	110.00 - 210.00	987.45	14.61	12.00 - 20.30	6.86
F 02	48	183.19	119.63 - 248.33	701.48	17.47	13.70 - 25.30	5.67
F 03	20	187.97	139.00 - 251.33	787.25	18.95	11.70 - 25.70	12.69
F 04	14	161.91	103.00 - 206.33	836.23	17.72	10.30 - 23.30	10.64
F 05	4	139.08	111.67 - 158.33	300.50	15.83	14.70 - 16.30	0.44
F 06	2	129.33	113.33 - 145.33	256.00	15.65	14.30 - 17.00	1.82
F 07	59	186.89	103.00 - 280.00	1660.17	17.91	7.00 - 25.70	13.01
F 08	29	149.16	102.33 - 206.33	943.29	16.03	11.00 - 21.00	7.45
F 09	25	154.47	106.33 - 205.00	549.99	17.12	11.30 - 21.70	7.12
F 10	14	147.17	101.67 - 238.00	1005.82	14.86	9.00 - 18.00	6.52
F 11	14	139.33	106.33 - 205.33	732.76	15.44	12.00 - 21.00	5.14
F 12	23	156.30	107.33 - 205.00	651.75	17.43	10.30 - 21.70	7.31
F 13	6	139.50	119.33 - 149.67	124.34	16.05	12.30 - 18.00	4.27
F 14	2	128.50	106.00 - 151.00	506.25	15.00	13.00 - 17.00	4.00
F 16	9	139.30	110.00 - 200.00	637.11	16.03	10.30 - 21.70	15.76
F 17	1	147.33	147.33 - 147.33	0.00	17.70	17.70 - 17.70	0.00
F 18	24	153.31	108.33 - 247.00	1311.05	16.34	11.00 - 25.70	14.70
F 19	13	144.15	107.00 - 164.67	194.32	15.45	12.00 - 18.70	4.61
F 20	13	146.97	109.33 - 206.00	438.89	16.21	11.30 - 20.70	6.14
F 21	5	154.87	108.33 - 204.33	1029.74	16.48	13.00 - 21.00	11.17
F 22	1	152.00	152.00 - 152.00	0.00	17.70	17.70 - 17.70	0.00
F 23	9	167.89	107.67 - 204.00	774.42	16.18	12.30 - 21.00	5.30
F 24	11	144.03	105.00 - 183.33	357.59	16.66	13.30 - 21.00	6.11
F 27	7	152.91	119.67 - 173.00	282.73	16.74	12.30 - 20.00	5.24
F 28	15	154.36	101.67 - 250.67	1862.31	16.40	9.00 - 21.70	11.06
F 30	1	144.00	144.00 - 144.00	0.00	15.30	15.30 - 15.30	0.00
F 31	1	150.00	150.00 - 150.00	0.00	12.70	12.70 - 12.70	0.00
F 32	1	153.67	153.67 - 153.67	0.00	16.70	16.70 - 16.70	0.00
F 34	21	177.32	143.00 - 246.00	818.72	17.95	14.00 - 21.70	4.31
F 33	1	155.00	155.00 - 155.00	0.00	17.70	17.70 - 17.70	0.00
F 48	3	180.67	150.67 - 221.67	900.67	18.33	17.70 - 19.30	0.48
F 50	1	172.67	172.67 - 172.67	0.00	19.00	19.00 - 19.00	0.00
F 47	7	147.86	116.67 - 171.00	243.37	17.47	15.00 - 21.70	3.53
F 49	2	120.00	120.00 - 120.00	0.00	11.65	11.00 - 12.30	0.42
F 46	7	198.71	154.33 - 246.67	756.23	19.04	15.00 - 21.30	5.24
F 37	1	206.67	206.67 - 206.67	0.00	21.70	21.70 - 21.70	0.00
F 36	6	178.06	146.67 - 208.67	774.52	17.95	16.70 - 20.00	1.45
F 35	7	171.14	146.00 - 206.00	631.08	18.86	16.00 - 23.70	7.91
F 38	2	168.00	153.00 - 183.00	225.00	15.35	13.70 - 17.00	2.72
F 39	3	139.22	119.67 - 149.00	191.17	17.43	14.30 - 20.30	6.04
F 43	2	149.17	145.33 - 153.00	14.71	17.85	16.70 - 19.00	1.32
F 44	1	151.33	151.33 - 151.33	0.00	15.30	15.30 - 15.30	0.00

progenies under salinity water logg complex environment at Uga+A128r.

Table 33. Family wise mean, range and variance for average internodal length and number of millable canes in settling generation of pre selected sugarcane progenies under salinity water logged complex environment at Ugar.A170+A192

Family / Cross	Progenies studied	Average internodal length (cm)			Number of millable canes / Plot		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	9.49	8.40 - 11.40	0.94	11.50	3.00 - 32.00	71.75
F 02	48	10.62	6.40 - 14.80	3.08	26.92	8.00 - 54.00	122.24
F 03	20	10.28	6.10 - 18.00	5.90	33.70	16.00 - 52.00	106.31
F 04	14	9.27	6.90 - 12.90	2.13	21.93	5.00 - 53.00	194.64
F 05	4	8.85	7.00 - 10.80	1.85	22.50	8.00 - 35.00	107.25
F 06	2	8.20	7.90 - 8.50	0.09	26.00	22.00 - 30.00	16.00
F 07	59	10.54	7.00 - 16.10	2.66	33.37	8.00 - 84.00	144.51
F 08	29	9.38	6.80 - 12.60	2.50	19.07	2.00 - 45.00	121.03
F 09	25	9.10	7.40 - 10.90	1.17	31.60	16.00 - 60.00	153.36
F 10	14	10.00	8.00 - 15.87	3.23	29.71	10.00 - 57.00	185.78
F 11	14	9.03	7.60 - 11.20	1.09	21.93	12.00 - 45.00	116.78
F 12	23	9.06	6.70 - 12.70	1.59	27.13	11.00 - 60.00	129.59
F 13	6	8.85	7.20 - 12.00	2.26	22.00	12.00 - 35.00	64.67
F 14	2	8.55	8.20 - 8.90	0.12	14.50	10.00 - 19.00	20.25
F 16	9	9.03	6.60 - 12.90	3.94	20.11	9.00 - 34.00	66.10
F 17	1	8.30	8.30 - 8.30	0.00	29.00	29.00 - 29.00	0.00
F 18	24	9.52	7.13 - 14.50	2.57	24.42	8.00 - 55.00	184.74
F 19	13	9.46	7.80 - 12.00	1.60	23.46	1.00 - 55.00	300.09
F 20	13	9.15	7.40 - 10.70	0.90	26.23	12.00 - 50.00	109.41
F 21	5	9.42	8.20 - 10.70	1.01	25.40	15.00 - 36.00	84.24
F 22	1	8.60	8.60 - 8.60	0.00	28.00	28.00 - 28.00	0.00
F 23	9	10.49	8.20 - 14.30	3.32	19.56	8.00 - 34.00	96.02
F 24	11	8.74	7.30 - 11.30	1.24	25.09	10.00 - 37.00	53.17
F 27	7	9.21	8.30 - 10.20	0.40	26.71	19.00 - 35.00	24.20
F 28	15	9.44	6.30 - 12.55	3.14	15.13	1.00 - 31.00	62.92
F 30	1	9.40	9.40 - 9.40	0.00	6.00	6.00 - 6.00	0.00
F 31	1	11.80	11.80 - 11.80	0.00	10.00	10.00 - 10.00	0.00
F 32	1	9.20	9.20 - 9.20	0.00	4.00	4.00 - 4.00	0.00
F 34	21	9.91	7.70 - 13.20	1.68	28.14	7.00 - 56.00	138.22
F 33	1	8.80	8.80 - 8.80	0.00	42.00	42.00 - 42.00	0.00
F 48	3	9.87	8.50 - 12.30	2.98	43.67	37.00 - 50.00	28.22
F 50	1	9.10	9.10 - 9.10	0.00	24.00	24.00 - 24.00	0.00
F 47	7	8.50	6.40 - 9.90	1.10	26.43	5.00 - 49.00	193.96
F 49	2	10.35	9.80 - 10.91	0.31	19.50	10.00 - 29.00	90.25
F 46	7	10.49	8.40 - 12.10	1.49	34.71	11.00 - 54.00	201.92
F 37	1	9.50	9.50 - 9.50	0.00	59.00	59.00 - 59.00	0.00
F 36	6	9.88	8.50 - 12.00	1.65	42.17	29.00 - 58.00	87.47
F 35	7	9.10	8.00 - 11.20	0.89	25.29	15.00 - 42.00	71.06
F 38	2	11.00	10.80 - 11.20	0.04	20.50	16.00 - 25.00	20.25
F 39	3	8.03	7.30 - 8.40	0.27	24.00	15.00 - 32.00	48.67
F 43	2	8.40	8.10 - 8.70	0.09	17.00	13.00 - 21.00	16.00
F 44	1	9.90	9.90 - 9.90	0.00	29.00	29.00 - 29.00	0.00

Table 34. Family wise mean, range and variance for average single cane weight and cane yield in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Family / Cross	Progenies studied	Average single cane weight. (kg)			Cane yield (kg) / Plot		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	1.66	0.59 - 4.33	1.23	13.13	10.00 - 19.00	10.36
F 02	48	0.74	0.30 - 2.13	0.17	16.33	12.00 - 22.00	6.73
F 03	20	0.57	0.35 - 1.19	0.06	16.89	15.00 - 20.00	2.13
F 04	14	0.98	0.30 - 2.18	0.23	16.43	5.00 - 26.00	23.24
F 05	4	0.92	0.49 - 2.00	0.39	15.25	10.00 - 18.00	9.69
F 06	2	0.56	0.53 - 0.59	0.00	14.50	13.00 - 16.00	2.25
F 07	59	0.54	0.20 - 2.13	0.09	15.58	10.00 - 24.00	8.58
F 08	29	0.98	0.41 - 2.67	0.40	13.69	1.00 - 19.90	19.55
F 09	25	0.50	0.22 - 1.12	0.05	13.88	9.00 - 19.00	8.59
F 10	14	0.51	0.18 - 1.50	0.13	11.76	4.50 - 20.20	18.05
F 11	14	0.69	0.31 - 1.07	0.06	13.29	4.00 - 18.00	13.35
F 12	23	0.62	0.28 - 1.61	0.08	14.51	10.00 - 19.00	6.68
F 13	6	0.60	0.34 - 1.00	0.06	11.50	10.00 - 13.00	1.25
F 14	2	0.64	0.47 - 0.80	0.03	8.50	8.00 - 9.00	0.25
F 16	9	0.77	0.41 - 1.20	0.08	13.67	8.00 - 18.00	10.89
F 17	1	0.55	0.55 - 0.55	0.00	16.00	16.00 - 16.00	0.00
F 18	24	0.73	0.24 - 2.00	0.20	13.17	8.00 - 18.00	11.72
F 19	13	0.83	0.24 - 2.25	0.30	12.31	1.00 - 18.00	20.98
F 20	13	0.79	0.21 - 1.58	0.15	17.15	8.00 - 21.00	12.90
F 21	5	0.69	0.42 - 1.27	0.10	15.40	11.00 - 19.00	13.44
F 22	1	0.43	0.43 - 0.43	0.00	12.00	12.00 - 12.00	0.00
F 23	9	1.02	0.40 - 2.00	0.27	15.44	12.00 - 19.00	4.02
F 24	11	0.64	0.32 - 1.30	0.09	14.00	10.00 - 18.00	7.27
F 27	7	0.66	0.35 - 0.95	0.03	16.86	11.00 - 19.00	6.69
F 28	15	0.92	0.44 - 1.55	0.14	12.61	1.00 - 18.00	29.80
F 30	1	0.83	0.83 - 0.83	0.00	5.00	5.00 - 5.00	0.00
F 31	1	0.50	0.50 - 0.50	0.00	5.00	5.00 - 5.00	0.00
F 32	1	1.75	1.75 - 1.75	0.00	7.00	7.00 - 7.00	0.00
F 34	21	0.53	0.14 - 1.08	0.05	12.74	3.50 - 19.00	12.61
F 33	1	0.31	0.31 - 0.31	0.00	13.00	13.00 - 13.00	0.00
F 48	3	0.29	0.26 - 0.35	0.00	12.67	12.00 - 13.00	0.22
F 50	1	0.54	0.54 - 0.54	0.00	13.00	13.00 - 13.00	0.00
F 47	7	0.56	0.22 - 1.60	0.19	10.00	8.00 - 13.00	5.43
F 49	2	0.39	0.28 - 0.50	0.01	6.50	5.00 - 8.00	2.25
F 46	7	0.47	0.24 - 1.18	0.10	13.14	12.00 - 17.00	2.69
F 37	1	0.27	0.27 - 0.27	0.00	16.00	16.00 - 16.00	0.00
F 36	6	0.33	0.21 - 0.52	0.01	12.83	12.00 - 15.00	1.14
F 35	7	0.55	0.33 - 0.87	0.03	12.71	11.00 - 14.00	0.78
F 38	2	0.56	0.48 - 0.63	0.01	11.00	10.00 - 12.00	1.00
F 39	3	0.53	0.38 - 0.80	0.04	11.33	10.00 - 12.00	0.89
F 43	2	0.70	0.48 - 0.92	0.05	11.00	10.00 - 12.00	1.00
F 44	1	0.45	0.45 - 0.45	0.00	13.00	13.00 - 13.00	0.00

Table 35. Family wise mean, range and variance for average HR Brix (%) in settling generation of pre selected sugarcane progenies under salinity water logg complex environment and percentage of superior progenies based on superiority cane yield and HR brix at Ugar

Family / Cross	Progenies studied	HR Brix (%)					% superior progenies based on cane yield and HR brix
		Mean	Range			Variance	
F 01	8	16.70	15.24	-	18.20	0.88	-
F 02	48	17.71	14.38	-	22.58	3.63	6.25
F 03	20	17.90	11.18	-	21.98	9.24	15.00
F 04	14	20.24	17.10	-	23.10	2.97	42.86
F 05	4	16.57	14.86	-	18.52	2.73	-
F 06	2	20.17	19.28	-	21.06	0.79	-
F 07	59	17.48	11.20	-	21.40	3.81	8.47
F 08	29	17.88	14.72	-	21.46	2.54	-
F 09	25	19.36	14.36	-	22.26	2.54	8.00
F 10	14	17.26	7.20	-	20.80	12.53	-
F 11	14	18.37	7.20	-	20.94	10.33	7.14
F 12	23	18.85	15.78	-	21.16	1.93	8.70
F 13	6	17.54	15.30	-	20.16	2.57	-
F 14	2	18.84	17.86	-	19.82	0.96	-
F 16	9	20.44	17.80	-	22.76	2.15	11.11
F 17	1	18.40	18.40	-	18.40	0.00	-
F 18	24	17.40	12.00	-	21.32	5.91	4.17
F 19	13	18.13	10.00	-	21.50	8.92	7.69
F 20	13	18.72	16.58	-	22.38	3.06	25.00
F 21	5	18.65	16.20	-	20.40	2.24	-
F 22	1	20.04	20.04	-	20.04	0.00	-
F 23	9	19.55	17.40	-	21.60	1.99	-
F 24	11	19.12	14.20	-	21.72	5.04	-
F 27	7	21.34	19.60	-	22.60	1.31	14.29
F 28	15	16.66	6.00	-	21.40	28.29	6.67
F 30	1	8.20	8.20	-	8.20	0.00	-
F 31	1	7.20	7.20	-	7.20	0.00	-
F 32	1	16.40	16.40	-	16.40	0.00	-
F 34	21	20.02	14.00	-	22.52	4.98	-
F 33	1	19.76	19.76	-	19.76	0.00	-
F 48	3	18.60	18.20	-	18.90	0.09	-
F 50	1	20.34	20.34	-	20.34	0.00	-
F 47	7	18.21	14.20	-	21.50	6.93	-
F 49	2	18.86	17.60	-	20.12	1.59	-
F 46	7	21.04	19.72	-	23.00	1.28	28.57
F 37	1	19.08	19.08	-	19.08	0.00	-
F 36	6	18.76	14.40	-	20.64	4.57	-
F 35	7	18.52	15.98	-	21.58	2.41	14.29
F 38	2	19.89	19.20	-	20.58	0.48	-
F 39	3	16.68	15.88	-	17.58	0.49	-
F 43	2	19.80	19.60	-	20.00	0.04	-
F 44	1	21.88	21.88	-	21.88	0.00	-

The data of family means for this attribute indicated, the family F44 with highest (21.88 %) HR brix followed by F27 (21.34 %) and F46 (21.04 %), whereas the F31 (7.20 %) recorded lowest mean value followed by F30 (8.20 %).

4.1.4.8 Per cent superior progenies obtained on the basis of cane yield and HR brix (family wise)

The families F4 (42.86%), F46 (28.57 %), F20 (25.00 %), F03 (15.00 %), F27 (14.29 %) and F35 (14.29 %) recorded comparatively higher percentage of superior progenies among 44 families evaluated under salinity water logged complex environment.

4.1.5 Genetic parameters for various traits in settling generation under normal irrigated environment

Analysis of variance for ten traits included in the study is presented in the Table 36. The characters viz., germination per cent and tiller per plot had significant mean sum of squares, whereas the traits average internodal length (cm), number of millable canes per plot, average single cane weight (kg), cane yield (kg) per plot and average HR Brix per cent had highly significant mean sum of squares. 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 37, the traits which had significant mean sum of squares only are discussed in this section. The family-wise mean, range and variance in respect of all the traits are given in Table 38 to 42. The mean values (adjusted) for selection traits included in the study in respect of three checks and 54 selections (progenies) among 828 progenies evaluated are provided in Appendix X.

Appendix X. Adjusted mean values of selected progenies for 10 traits studied in clonal ratoon generation of 44 inter varietal sugarcane crosses under normal irrigated environment at Hosur

Table 38. Family wise mean, range and variance for germination (%) and tillers in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Table 39. Family wise mean, range and variance for average cane girth and average millable cane height in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Table 40. Family wise mean, range and variance for average number of internodes and average internodal length in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Table 41. Family wise mean, range and variance for number of millable canes and average single cane weight in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Table 42. Family wise mean, range and variance for average HR Brix (%) in settling generation of pre selected sugarcane progenies under normal irrigated environment and per cent superior progenies obtained based on cane yield and HR brix at Hosur

4.1.5.1 Germination per cent

The germination per cent exhibited higher variability among 828 hybrid progenies tested under normal irrigated environment, with a range of mean values from -19.03 to 111.16 and overall mean of 53.19.

Table 36. Analysis of variance for important cane yield parameters and HR Brix (%) in settling generation of 45

Source	df	MSS for the characters									
		Germination %	Tillers / Plot	Average cane girth (cm)	Average millable cane height (cm)	Average number of internodes	Average internodal length (cm)	Number of millable canes / plot	Average single cane weight (kg)	Cane yield (kg) plot	Average HR Brix (%)
Varieties (v)	766	344.38*	266.76*	0.12	552.55	8.53	2.69**	92.65**	0.35**	16.16**	7.24**
Error	24	161.87	143.04	0.09	478.89	6.64	1.17	28.14	0.08	5.51	1.67
SEd 1. Between 2 check means		4.99	4.69	0.12	8.58	1.01	0.42	2.08	0.11	0.92	0.51
SEd 2. Between any 2 means of test var.		17.99	16.91	0.43	30.95	3.64	1.53	7.50	0.40	3.32	1.83
SEd 3. Between any 2 entries of same block		20.78	19.53	0.49	35.74	4.21	1.77	8.66	0.47	3.83	2.11
SEd 4. Between means of check & var.		15.25	14.33	0.36	26.22	3.09	1.30	6.36	0.34	2.81	1.55
CD 5%											
Between 2 check means		10.28	9.66	0.24	17.68	2.08	0.87	4.29	0.23	1.90	1.04
Between any 2 means of test var.		37.06	34.84	0.88	63.75	7.51	3.15	15.45	0.83	6.84	3.76
Between any 2 entries of same block		42.80	40.23	1.02	73.62	8.67	3.64	17.85	0.96	7.89	4.34
Between means of check & var.		31.41	29.52	0.75	54.02	6.36	2.67	13.09	0.71	5.79	3.19
CD 1%											
Between 2 check means		13.97	13.13	0.33	24.03	2.83	1.19	5.83	0.31	2.58	1.42
Between any 2 means of test var.		50.38	47.36	1.20	86.65	10.21	4.28	21.01	1.13	9.29	5.11
Between any 2 entries of same block		58.17	54.68	1.38	100.06	11.78	4.94	24.26	1.31	10.73	5.90
Between means of check & var.		42.69	40.13	1.02	73.42	8.65	3.63	17.80	0.96	7.87	4.33

*, ** Significant at 5 and 1 per cent respectively

Table 37. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in settling generation of 44 inter varietal sugarcane crosses under normal irrigated environment at Hosur

Characters	Mean	Range*	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	GAM (%)
1. Germination (%)	19.20	53.19 - 111.16 (2.77) - (99.72)	123.87	233.74	53.00	7.31	38.09
2. Tillers / Plot	42.42	-1.64 - 116.03 (2.00) - (100.00)	291.67	628.87	46.38	15.61	36.79
3. Average cane girth (cm)	2.50	1.21 - 3.42 (1.40) - (3.23)	1.32	4.99	26.54	0.19	7.73
4. Average millable cane height (cm)	254.93	111.44 - 376.20 (24.00) - (350.00)	28.89	216.75	13.33	6.45	2.53
5. Average number of internodes	20.94	7.92 - 28.72 (8.00) - (28.00)	9.02	40.74	22.14	1.33	6.36
6. Average internodal length (cm)	12.35	6.38 - 19.72 (1.00) - (18.80)	12.33	21.80	56.55	1.91	15.48
7. Number of millable canes / plot	25.90	0.49 - 66.49 (2.00) - (62.00)	249.08	357.74	69.63	13.81	53.31
8. Average single cane weight (kg)	1.28	0.25 - 4.46 (0.42) - (4.33)	20.63	26.99	76.42	0.93	72.19
9. Cane yield (kg) / plot	28.78	3.08 - 40.41 (1.10) - (40.00)	37.04	56.17	65.93	5.46	18.98
10. Average HR Brix (%)	15.23	4.92 - 21.39 (8.00) - (22.12)	36.57	47.51	76.97	4.27	28.00

*Range values obtained from adjusted mean values of progenies
Figures in parenthesis are actual values

The progenies SNK326 (F12076) and SNK371 (F16035) recorded highest (111.16 %) germination per cent, followed by SNK611 (F24050) (106.54 %) and SNK358 (F16001) (105.62 %) whereas lowest germination was observed in SNK824 (F39024) (-19.03 %) followed by SNK784 (F47023) (-16.26 %) and SNK596 (F24005) (-9.80 %).

The considerable difference in genotypic (343.12) and phenotypic coefficients of variation resulted in moderate estimates of heritability (53.00 %) and GAM (38.09 %).

Family F50 (88.64%) recorded highest mean germination per cent followed by F37 (77.56 %) and F19 (64.12 %) whereas lowest family mean was observed in F39 (26.78%) followed by F25 (39.69%).

4.1.5.2 Tillers per plot

As per the data recorded for this attribute, the mean tillers per plot was 42.42 with a range of -1.64 to 116.03 indicating higher variability.

The progeny SNK102 (F05009) (116.03) found most profuse tillering clone, followed by SNK101 (F05007) (111.03) and SNK339 (F13012) (103.69) whereas, SNK824 (F39024) (-1.64) was most shy tillering type followed by SNK625 (F24088) (-1.31) and SNK666 (F27037) (1.03).

The genotypic (291.67) and phenotypic (628.87) coefficients of variation differed considerably evidencing moderate estimates of heritability (46.38 %) and GAM (36.79 %).

Family F37 (87.00) had highest mean value for this attribute followed by F05 (58.08) and F50 (58.00), whereas F39 (24.67) recorded lowest mean value followed by F22 (29.77) and F14 (33.86).

4.1.5.3 Average internodal length

This attribute exhibited substantial amount of variability with a range of 6.38 to 19.72 cm with 12.35 overall mean.

SNK050 (F02126) (19.72 cm) had longest internodes followed by SNK629 (F25006) (19.47cm) and SNK100 (F05006) (19.03 cm) whereas shortest internodes were noticed in SNK663 (F27030) (6.38 cm) followed by SNK161 (F07143) (7.88 cm) and SNK788 (F46011) (8.00 cm).

The genotypic and phenotypic coefficients of variation were 12.33 and 21.80 respectively with moderate estimates of heritability (56.55 %) and low GAM (15.48 %).

The family F25 (14.40 cm) had progenies with longest internodes followed by F50 (13.90 cm) and F30 (13.38 cm) whereas F37 (9.40 cm) recorded shortest mean internodal length followed by F44 (10.5 cm) and F38 (10.97 cm).

4.1.5.4 Number of millable canes per plot

The progeny population exhibited higher variability for this character with mean values ranged from 0.49 to 66.49 and overall mean of 25.90 under normal irrigated environment.

Highest number of millable canes were recorded in SNK101 (F05007) (66.49) followed by SNK001 (F01001) (61.15) and SNK611 (F24050) (60.49) whereas lowest was observed in SNK178 (F08032) (0.49) followed by SNK807 (F35009) (1.15), SNK823 (F39022) (2.15) and SNK824 (F39024) (2.15).

The genotypic (249.08) and phenotypic (357.74) coefficients of variation differed moderately with relatively higher estimates of heritability (69.63 %) and GAM (53.31 %).

Family F37 (48.00) had progenies with highest millable canes followed by F50 (39.00) and F49 (36.50), whereas lowest mean millable canes were recorded in F39 (15.33) followed by F20 (17.65) and F21 (18.60).

Table 38. Family wise mean, range and variance for germination (%) and tillers in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Family / Cross	Progenies studied	Germination (%)				Tillers / Plot			
		Mean	Range		Variance	Mean	Range		Variance
F 01	8	49.17	7.67	- 237.86	95.94	41.88	2.00	- 72.00	513.86
F 02	50	46.65	23.02	- 222.51	45.13	40.60	11.00	- 67.00	221.72
F 03	15	57.62	30.69	- 222.51	45.63	46.20	17.00	- 78.00	198.43
F 04	13	47.94	69.06	- 207.17	28.67	40.62	15.00	- 67.00	159.16
F 05	12	62.33	84.40	- 237.86	40.58	58.08	38.00	- 100.00	363.08
F 06	2	58.17	138.11	- 184.15	9.00	45.00	22.00	- 68.00	529.00
F 07	58	61.70	30.69	- 276.22	33.75	50.71	11.00	- 90.00	246.86
F 08	38	46.73	23.02	- 214.84	32.80	35.32	9.00	- 70.00	197.37
F 09	27	54.99	46.04	- 222.51	41.09	38.56	17.00	- 61.00	147.36
F 10	26	61.05	84.40	- 245.53	27.34	48.62	25.00	- 79.00	292.85
F 11	34	45.87	23.02	- 214.84	43.48	43.97	11.00	- 92.00	354.50
F 12	33	54.56	61.38	- 245.53	29.36	41.36	24.00	- 82.00	183.75
F 13	14	55.60	84.40	- 207.17	19.92	38.79	19.00	- 84.00	285.74
F 14	6	55.00	99.75	- 207.17	26.98	33.86	22.00	- 48.00	59.55
F 16	31	50.66	76.73	- 245.53	38.27	41.26	17.00	- 72.00	216.26
F 17	9	43.70	15.35	- 222.51	69.28	38.78	7.00	- 68.00	314.84
F 18	37	58.99	92.07	- 260.88	33.18	40.35	20.00	- 68.00	130.93
F 19	47	64.12	61.38	- 260.88	30.47	39.06	14.00	- 73.00	189.63
F 20	26	49.43	23.02	- 222.51	56.59	37.69	7.00	- 74.00	250.60
F 21	20	52.21	7.67	- 253.21	58.33	46.45	3.00	- 78.00	400.25
F 22	13	49.86	30.69	- 268.55	66.31	29.77	6.00	- 56.00	203.87
F 23	34	47.42	30.69	- 214.84	45.34	39.06	14.00	- 74.00	219.35
F 24	31	55.58	15.35	- 337.61	85.74	45.74	7.00	- 109.00	381.35
F 25	3	39.70	38.36	- 153.46	44.22	35.33	13.00	- 51.00	262.89
F 26	20	61.22	53.71	- 260.88	49.69	51.05	26.00	- 80.00	254.85
F 27	37	45.74	38.36	- 199.50	25.01	41.32	13.00	- 98.00	256.00
F 28	28	48.67	53.71	- 191.82	21.17	39.36	18.00	- 86.00	192.02
F 30	13	49.63	46.04	- 176.48	21.58	45.33	21.00	- 68.00	276.22
F 31	3	46.17	107.42	- 145.79	4.22	38.67	26.00	- 48.00	86.22
F 32	12	53.18	84.40	- 283.90	37.22	42.42	28.00	- 69.00	189.19
F 34	20	49.03	23.02	- 214.84	44.01	47.20	10.00	- 82.00	341.06
F 33	1	41.55	115.09	- 115.09	0.00	46.00	46.00	- 46.00	0.00
F 48	3	60.02	153.46	- 191.82	5.56	49.33	42.00	- 60.00	59.56
F 50	1	88.64	245.53	- 245.53	0.00	58.00	58.00	- 58.00	0.00
F 47	4	42.24	30.69	- 237.86	96.69	41.75	23.00	- 64.00	231.19
F 49	2	51.25	130.44	- 153.46	2.25	56.00	44.00	- 68.00	144.00
F 46	6	51.71	99.75	- 214.84	23.89	41.83	22.00	- 62.00	197.47
F 37	1	77.56	214.84	- 214.84	0.00	87.00	87.00	- 87.00	0.00
F 36	7	55.40	99.75	- 207.17	27.71	42.71	24.00	- 64.00	186.49
F 35	12	53.55	107.42	- 214.84	15.56	37.17	19.00	- 62.00	127.47
F 38	4	61.63	138.11	- 191.82	7.19	43.00	18.00	- 56.00	221.00
F 39	3	26.78	23.02	- 99.75	22.22	24.67	13.00	- 39.00	116.22
F 43	2	60.94	138.11	- 199.50	16.00	49.50	34.00	- 65.00	240.25
F 44	1	63.71	176.48	- 176.48	0.00	44.00	44.00	- 44.00	0.00

Table 39. Family wise mean, range and variance for average cane girth and average millable cane height in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Family / Cross	Progenies studied	Average cane girth (cm)			Average millable cane height (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	2.20	1.40 - 3.00	0.20	230.79	203.33 - 253.33	310.14
F 02	50	2.47	1.70 - 3.00	0.06	241.01	150.00 - 288.30	574.99
F 03	15	2.37	1.93 - 2.66	0.05	243.43	210.00 - 276.60	321.32
F 04	13	2.49	1.93 - 3.20	0.09	251.41	200.60 - 275.00	450.03
F 05	12	2.56	2.13 - 2.76	0.03	258.86	185.30 - 295.00	733.98
F 06	2	2.33	2.13 - 2.53	0.04	254.95	248.30 - 261.60	44.22
F 07	58	2.49	1.60 - 3.23	0.13	250.19	24.00 - 288.30	1368.35
F 08	38	2.33	1.73 - 2.90	0.08	258.69	225.00 - 290.00	261.53
F 09	27	2.49	2.13 - 3.00	0.05	249.19	218.33 - 284.00	435.74
F 10	26	2.47	2.00 - 2.96	0.06	259.89	221.60 - 285.00	264.54
F 11	34	2.35	1.73 - 3.03	0.08	253.27	218.33 - 292.00	335.65
F 12	33	2.45	2.10 - 3.13	0.04	263.45	218.30 - 286.60	289.23
F 13	14	2.53	2.10 - 2.90	0.06	256.19	231.60 - 287.00	212.66
F 14	6	2.63	2.16 - 3.16	0.11	257.89	225.00 - 271.30	245.24
F 16	31	2.46	1.79 - 3.16	0.09	264.82	220.00 - 294.64	296.55
F 17	9	2.65	2.23 - 2.97	0.04	267.96	236.67 - 294.33	339.81
F 18	37	2.40	1.80 - 3.03	0.11	251.37	205.00 - 294.97	578.22
F 19	47	2.54	2.00 - 3.20	0.11	263.89	210.00 - 350.00	486.63
F 20	26	2.65	1.93 - 3.20	0.15	271.95	221.67 - 318.33	486.63
F 21	20	2.26	1.53 - 3.20	0.17	254.52	221.67 - 293.67	394.19
F 22	13	2.65	2.00 - 3.17	0.15	243.64	215.00 - 275.00	250.29
F 23	34	2.64	1.93 - 3.17	0.07	271.45	226.67 - 333.33	364.85
F 24	31	2.61	1.93 - 3.27	0.13	271.14	221.67 - 301.67	361.20
F 25	3	2.28	1.57 - 2.93	0.31	267.22	258.33 - 278.33	69.13
F 26	20	2.39	1.40 - 2.97	0.14	251.52	218.33 - 281.67	298.03
F 27	37	2.46	1.63 - 3.17	0.22	245.32	128.00 - 290.00	781.05
F 28	28	2.70	1.60 - 3.20	0.17	247.57	203.30 - 288.33	477.53
F 30	13	2.70	2.37 - 3.17	0.06	252.40	200.00 - 278.33	584.27
F 31	3	2.73	2.53 - 3.10	0.07	254.89	248.33 - 268.00	85.98
F 32	12	2.50	2.57 - 3.20	0.05	254.60	236.67 - 283.67	246.85
F 34	20	2.41	1.53 - 3.20	0.18	244.32	206.67 - 301.67	630.74
F 33	1	2.60	2.60 - 2.60	0.00	265.00	265.00 - 265.00	0.00
F 48	3	2.69	2.60 - 2.80	0.01	275.45	245.00 - 306.67	634.17
F 50	1	2.90	2.90 - 2.90	0.00	265.00	265.00 - 265.00	0.00
F 47	4	2.53	2.17 - 2.80	0.05	236.67	195.00 - 288.33	1252.67
F 49	2	2.25	1.93 - 2.57	0.10	245.83	243.33 - 248.33	6.25
F 46	6	2.32	1.83 - 2.77	0.08	222.50	188.32 - 248.33	390.63
F 37	1	2.27	2.27 - 2.27	0.00	225.00	225.00 - 225.00	0.00
F 36	7	2.30	1.97 - 2.57	0.05	221.14	188.33 - 239.00	268.38
F 35	12	2.68	1.93 - 3.27	0.12	243.00	190.00 - 295.00	908.10
F 38	4	3.00	2.33 - 3.37	0.16	268.17	251.67 - 285.00	140.28
F 39	3	2.53	1.93 - 3.13	0.24	235.00	225.00 - 241.67	51.86
F 43	2	2.59	2.17 - 3.00	0.17	260.00	220.00 - 300.00	1600.00
F 44	1	3.07	3.07 - 3.07	0.00	293.00	293.00 - 293.00	0.00

4.1.5.5 Average single cane weight

The hybrid progenies evaluated under normal irrigated environment exhibited wider range (0.25 to 4.46 kg) of variability with overall mean of 1.28 kg for this trait.

SNK178 (F08032) (4.46 kg) produced heaviest canes followed by SNK630 (F25009) (4.34 kg) and SNK555 (F22035) (3.91 kg) whereas SNK072 (F03052), SNK101 (F05007), SNK110 (F07001), SNK114 (F07011) had lightest (0.25 kg) canes followed by SNK064 (F03027) (0.27 kg).

The difference between genotypic (20.63) and phenotypic (26.99) coefficients of variations were comparatively marginal indicating higher estimates of heritability (76.42 %) and GAM (72.19 %).

The family F39 (2.55 kg) recorded progenies with highest average single cane weight followed by F25 (2.22 kg) and F20 (2.13 kg). Families F25 and F20 had broad range of 1.11 to 4.33 kg and 0.78 to 3.5 kg respectively with higher (0.65) variance of 2.45 or 0.65, respectively for this attribute.

4.1.5.6 Cane yield per plot

Cane yield across the progenies of 44 crosses under normal irrigated environment showed higher variability with a range of 3.08 to 40.41 kg and overall mean of 28.78 kg per plot.

The progenies SNK415 (F18052) (40.41 kg) gave highest cane yield followed by SNK814 (F35075) and SNK825 (F43004) with cane yield of 39.41 kg per plot. Lowest cane yield was recorded in SNK110 (F07001) (3.08 kg) followed by SNK003 (F01004) (3.51 kg) and SNK525 (F21018) (3.94 kg).

The genotypic (37.04%) and phenotypic (56.17%) coefficients of variation differed considerably with moderately high estimates of heritability (65.93 %) and lower GAM (18.98 %).

As per data recorded for family mean for this attribute, the families F43 and F44 were found most productive with mean cane yield of 38.00 kg per plot, followed by F39 (35.33 kg) and F38 (35.00 kg). On the contrary, F01 (23.33 kg), F06 (23.50 kg) and F03 (24.08 kg) were least productive among 44 families evaluated.

4.1.5.7 Average HR Brix per cent

This sugar yield attribute exhibited fairly higher amount of variability among the 828 hybrid progenies of 44 crosses which ranged from 4.92 to 21.39 per cent and overall mean of 15.23 per cent.

Highest average HR brix per cent was recorded in SNK525 (F21018) (21.39 %) followed by SNK507 (F20052) (21.09 %) and SNK386 (F16092) (20.77 %) whereas lowest was observed in SNK065 (F03030) (4.92 %) followed by SNK076 (F03079) (6.48 %) and SNK077 (F03082) (6.60 %).

The difference between genotypic (36.57%) and phenotypic (47.51%) coefficients of variation was narrow which resulted in relatively higher estimates of heritability (76.97 %) and moderate GAM (28.00 %).

The family F04 exhibited better range of HR brix (16.34 to 22.12 %) with highest mean value of 20.33 per cent followed by F06 (19.86 %) and F05 (18.56 %) with a range of 19.16 to 20.55 per cent and 16.20 to 20.62 per cent, respectively.

Table 40. Family wise mean, range and variance for average number of internodes and average internodal length in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Family / Cross	Progenies studied	Average number of internodes			Average internodal length (cm)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	18.59	16.70 - 20.30	2.14	12.53	10.20 - 14.40	2.11
F 02	50	21.20	8.00 - 28.00	13.62	11.63	9.00 - 18.80	2.91
F 03	15	21.76	16.30 - 27.70	11.51	11.45	8.90 - 15.90	3.87
F 04	13	22.28	15.00 - 28.00	9.05	11.45	9.70 - 14.70	2.18
F 05	12	22.38	13.30 - 27.00	12.96	11.83	9.10 - 17.90	4.51
F 06	2	20.35	20.00 - 20.70	0.12	12.55	12.00 - 13.10	0.30
F 07	58	21.80	14.70 - 27.70	8.30	11.67	1.00 - 15.30	4.22
F 08	38	21.49	13.67 - 27.00	6.51	12.19	10.00 - 18.50	2.46
F 09	27	21.27	17.10 - 26.70	8.77	11.90	9.00 - 14.70	2.36
F 10	26	21.17	16.30 - 26.70	9.61	12.50	8.40 - 15.10	2.82
F 11	34	21.56	17.30 - 28.00	7.63	11.89	9.80 - 14.40	1.69
F 12	33	20.93	17.00 - 26.30	5.29	12.72	9.70 - 15.60	1.88
F 13	14	21.23	18.70 - 25.00	3.86	12.15	10.10 - 14.30	1.16
F 14	6	21.30	18.70 - 25.70	4.23	12.20	10.60 - 14.30	1.45
F 16	31	21.93	17.00 - 27.30	6.83	12.21	10.00 - 14.70	1.65
F 17	9	23.44	19.70 - 26.00	3.38	11.44	10.60 - 12.20	0.25
F 18	37	21.17	14.00 - 26.70	8.17	12.07	9.60 - 17.00	3.20
F 19	47	20.82	15.00 - 27.30	5.59	12.76	10.20 - 15.80	1.47
F 20	26	21.73	14.30 - 26.30	7.83	12.64	10.40 - 15.50	1.62
F 21	20	21.23	16.70 - 26.30	6.89	12.12	10.10 - 15.30	1.68
F 22	13	19.58	16.30 - 22.70	3.59	12.57	10.20 - 16.20	2.33
F 23	34	20.99	15.30 - 25.70	7.53	13.08	10.50 - 17.80	2.84
F 24	31	21.04	16.70 - 26.00	4.65	12.98	10.30 - 15.80	1.43
F 25	3	19.53	14.30 - 23.30	14.58	14.40	11.40 - 19.50	13.14

F 26	2 0	20.79	17.0 0 - 25.7 0	4. 33	12.16	9.86 - 13.30	0.6 4
F 27	3 7	19.02	12.3 0 - 25.0 0	6. 93	13.09	7.66 - 17.80	4.0 6
F 28	2 8	19.20	14.7 0 - 24.3 0	6. 01	13.20	11.1 0 - 16.90	2.0 3
F 30	1 3	19.25	14.3 0 - 25.7 0	9. 36	13.38	9.30 - 17.00	4.8 6
F 31	3	19.13	17.7 0 - 20.0 0	1. 04	13.37	12.4 0 - 15.10	1.5 1
F 32	1 2	20.93	15.0 0 - 22.0 0	2. 91	12.34	11.0 0 - 18.40	3.4 8
F 34	2 0	18.95	14.7 0 - 22.0 0	2. 73	12.95	11.0 0 - 15.10	1.5 8
F 33	1	23.70	23.7 0 - 23.7 0	0. 00	11.20	11.2 0 - 11.20	0.0 0
F 48	3	23.33	18.0 0 - 26.3 0	14 .28	12.00	10.7 0 - 13.60	1.4 5
F 50	1	19.00	19.0 0 - 19.0 0	0. 00	13.90	13.9 0 - 13.90	0.0 0
F 47	4	18.50	17.0 0 - 20.0 0	1. 44	12.83	10.8 0 - 14.90	3.7 2
F 49	2	20.35	19.0 0 - 21.7 0	1. 82	12.15	11.2 0 - 13.10	0.9 0
F 46	6	19.45	17.0 0 - 25.0 0	7. 08	11.58	8.70 - 12.90	1.9 8
F 37	1	24.00	24.0 0 - 24.0 0	0. 00	9.40	9.40 - 9.40	0.0 0
F 36	7	18.86	16.3 0 - 20.0 0	1. 83	11.77	10.5 0 - 14.00	1.3 4
F 35	1 2	20.42	17.7 0 - 27.0 0	6. 89	11.71	9.40 - 13.20	1.5 4
F 38	4	24.75	20.0 0 - 27.7 0	8. 28	10.97	9.60 - 12.60	1.1 5
F 39	3	18.77	16.3 0 - 23.7 0	12 .17	12.87	10.2 0 - 14.60	3.6 6
F 43	2	21.80	17.3 0 - 26.3 0	20 .25	12.05	11.4 0 - 12.70	0.4 2
F 44	1	28.00	28.0 0 - 28.0 0	0. 00	10.50	10.5 0 - 10.50	0.0 0

Table 41. Family wise mean, range and variance for number of millable and average single cane weight in settling generation of pre selected sugarcane progenies under normal irrigated environment at Hosur

Family / Cross	Progenies studied	Number of millable canes / Plot			Average single cane weight (kg)		
		Mean	Range	Variance	Mean	Range	Variance
F 01	8	34.50	2.00 - 59.00	395.25	0.89	0.46 - 2.64	0.47
F 02	50	27.16	7.00 - 48.00	77.49	1.05	0.42 - 1.92	0.12
F 03	15	31.47	10.00 - 42.00	91.32	0.82	0.50 - 1.59	0.09
F 04	13	28.46	12.00 - 42.00	79.94	1.15	0.74 - 2.58	0.24
F 05	12	29.67	16.00 - 62.00	126.56	1.08	0.50 - 1.75	0.09
F 06	2	24.00	10.00 - 38.00	196.00	1.39	0.68 - 2.10	0.50
F 07	58	28.79	8.00 - 54.00	81.92	1.06	0.50 - 2.31	0.14
F 08	38	26.71	6.00 - 48.00	67.36	1.21	0.65 - 4.33	0.38
F 09	27	27.70	10.00 - 48.00	86.95	1.21	0.62 - 2.60	0.27
F 10	26	33.08	16.00 - 59.00	146.46	0.95	0.45 - 1.69	0.11
F 11	34	30.41	8.00 - 60.00	114.18	1.05	0.43 - 3.25	0.31
F 12	33	26.94	16.00 - 48.00	61.81	1.12	0.57 - 1.75	0.09
F 13	14	24.57	16.00 - 36.00	31.10	1.22	0.76 - 1.76	0.10
F 14	6	22.86	18.00 - 28.00	13.55	1.39	1.07 - 1.67	0.05
F 16	31	28.32	10.00 - 44.00	67.83	1.12	0.59 - 2.60	0.18
F 17	9	25.56	6.00 - 40.00	103.80	1.18	0.70 - 2.50	0.26
F 18	37	27.59	18.00 - 50.00	47.11	1.10	0.52 - 1.85	0.08
F 19	47	22.62	9.00 - 40.00	57.34	1.36	0.67 - 2.90	0.29
F 20	26	17.65	9.00 - 40.00	74.69	2.13	0.78 - 3.50	0.65
F 21	20	18.60	3.00 - 32.00	47.94	1.57	0.80 - 2.67	0.24
F 22	13	21.46	7.00 - 37.00	46.86	1.50	0.70 - 4.29	0.73
F 23	34	20.74	9.00 - 46.00	65.25	1.67	0.72 - 3.33	0.46
F 24	31	25.23	10.00 - 59.00	181.79	1.60	0.53 - 3.60	0.58
F 25	3	21.00	7.00 - 28.00	98.00	2.22	1.11 - 4.43	2.45
F 26	20	26.20	15.00 - 40.00	54.66	1.29	0.67 - 2.38	0.19
F 27	37	23.97	10.00 - 50.00	68.46	1.37	0.50 - 2.60	0.19
F 28	28	24.04	11.00 - 40.00	62.39	1.55	0.88 - 3.27	0.43
F 30	13	22.83	17.00 - 29.00	14.14	1.28	1.03 - 1.65	0.04
F 31	3	21.67	12.00 - 30.00	54.89	1.59	0.97 - 2.58	0.50
F 32	12	25.88	14.00 - 39.00	64.89	1.28	0.82 - 2.14	0.20
F 34	20	26.55	10.00 - 38.00	46.25	1.18	0.71 - 2.00	0.15
F 33	1	34.00	34.00 - 34.00	0.00	0.88	0.88 - 0.88	0.00
F 48	3	25.33	20.00 - 30.00	16.89	1.20	0.97 - 1.50	0.05
F 50	1	39.00	39.00 - 39.00	0.00	0.77	0.77 - 0.77	0.00
F 47	4	23.00	13.00 - 37.00	76.50	1.45	0.73 - 2.46	0.40
F 49	2	36.50	33.00 - 40.00	12.25	0.87	0.83 - 0.91	0.00
F 46	6	20.50	13.00 - 28.00	21.92	1.45	1.00 - 2.23	0.17
F 37	1	48.00	48.00 - 48.00	0.00	0.63	0.63 - 0.63	0.00
F 36	7	21.71	15.00 - 34.00	37.63	1.31	0.74 - 1.81	0.11
F 35	12	20.17	11.00 - 37.00	45.31	1.75	0.84 - 3.09	0.31
F 38	4	23.00	18.00 - 30.00	19.00	1.56	1.27 - 1.89	0.05
F 39	3	15.33	12.00 - 22.00	22.22	2.55	1.41 - 3.17	0.65
F 43	2	31.50	17.00 - 46.00	210.25	0.52	0.18 - 0.85	0.11
F 44	1	28.00	28.00 - 28.00	0.00	1.36	1.36 - 1.36	0.00

Table 42. Family wise mean, range and variance for average HR Brix (%) in settling generation of pre selected sugarcane progenies under normal irrigated environment and per cent superior progenies obtained based on yield and HR brix at Hosur

Family / Cross	Progenies studied	Cane yield (kg) / Plot			H. R. Brix %			% superior progenies
		Mean	Range	Variance	Mean	Range	Variance	
F 01	8	23.33	1.10 - 29.50	76.88	18.54	15.96 - 21.88	4.57	-
F 02	50	26.25	3.20 - 33.00	20.04	17.41	11.00 - 20.30	4.14	6.00
F 03	15	24.08	5.20 - 29.00	35.96	12.67	8.00 - 17.20	5.69	-
F 04	13	29.08	21.00 - 35.00	12.22	20.33	16.34 - 22.12	2.27	30.77
F 05	12	29.00	27.00 - 32.00	2.50	18.56	16.20 - 20.62	1.90	16.67
F 06	2	23.50	21.00 - 26.00	6.25	19.86	19.16 - 20.55	0.48	-
F 07	58	27.65	4.00 - 35.90	19.17	16.83	11.88 - 21.40	4.90	1.72
F 08	38	28.15	21.00 - 32.00	4.92	17.45	10.20 - 21.32	7.45	2.63
F 09	27	29.07	25.00 - 33.00	5.25	17.87	13.80 - 20.52	2.83	-
F 10	26	27.50	25.00 - 32.90	2.90	14.12	9.96 - 20.64	6.10	-
F 11	34	26.88	25.00 - 32.00	3.28	14.05	9.00 - 18.60	4.48	2.94
F 12	33	28.03	21.00 - 32.00	4.45	14.06	10.00 - 18.88	3.52	3.03
F 13	14	28.43	24.00 - 32.00	4.53	14.72	10.83 - 18.98	5.71	7.14
F 14	6	31.00	30.00 - 34.00	2.00	15.05	11.88 - 18.38	4.25	16.67
F 16	31	28.71	25.00 - 36.00	5.17	14.92	9.60 - 18.56	4.22	3.23
F 17	9	29.00	26.00 - 32.00	2.44	13.21	11.20 - 16.36	3.16	11.11
F 18	37	28.81	23.00 - 40.00	9.83	12.86	8.00 - 17.00	5.91	2.70
F 19	47	27.55	6.00 - 37.00	18.59	14.29	9.08 - 17.96	4.04	0.63
F 20	26	31.38	20.00 - 36.00	11.62	14.77	11.00 - 19.50	3.60	19.23
F 21	20	27.06	3.20 - 32.00	40.27	14.61	11.00 - 19.80	3.16	-
F 22	13	27.54	20.00 - 31.00	6.86	14.56	9.40 - 16.80	3.67	-
F 23	34	29.97	24.00 - 36.00	6.44	13.70	6.20 - 18.50	7.69	2.94
F 24	31	31.52	25.00 - 37.00	9.28	14.69	10.30 - 18.96	3.48	9.68
F 25	3	31.00	31.00 - 31.00	0.00	13.77	12.76 - 14.94	0.81	-
F 26	20	31.00	26.00 - 38.00	8.00	15.65	13.00 - 18.40	2.24	15.00

F 27	37	29.70	25.0 0	- 39.00	9.94	14.86	8.20 - 18.76	4.63	5.41
F 28	28	32.68	26.0 0	- 37.00	10.08	13.59	9.20 - 20.02	4.37	7.14
F 30	13	28.58	25.0 0	- 33.00	6.24	14.29	11.40 - 17.72	3.04	15.3 8
F 31	3	29.33	28.0 0	- 31.00	1.56	14.37	13.30 - 15.20	0.63	-
F 32	12	28.77	29.0 0	- 38.00	8.08	15.23	10.20 - 17.00	3.11	-
F 34	20	28.85	20.0 0	- 38.00	14.49	15.12	12.20 - 17.98	1.76	10.0 0
F 33	1	30.00	30.0 0	- 30.00	0.00	13.80	13.80 - 13.80	0.00	-
F 48	3	29.33	29.0 0	- 30.00	0.22	12.27	10.80 - 13.00	1.08	33.3 3
F 50	1	30.00	30.0 0	- 30.00	0.00	14.40	14.40 - 14.40	0.00	-
F 47	4	28.50	27.0 0	- 32.00	4.25	14.13	10.20 - 16.56	6.04	25.0 0
F 49	2	31.50	30.0 0	- 33.00	2.25	16.60	16.20 - 17.00	0.16	100. 00
F 46	6	28.00	26.0 0	- 30.00	2.33	16.99	14.94 - 19.00	2.27	-
F 37	1	30.00	30.0 0	- 30.00	0.00	14.72	14.72 - 14.72	0.00	-
F 36	7	26.43	24.0 0	- 29.00	2.82	15.64	13.00 - 18.60	3.92	-
F 35	12	31.58	26.0 0	- 39.00	11.91	16.01	10.20 - 18.76	4.70	16.6 7
F 38	4	35.00	32.0 0	- 38.00	5.00	16.20	13.60 - 18.60	3.14	50.0 0
F 39	3	35.33	31.0 0	- 38.00	9.56	12.46	7.40 - 15.00	12.80	-
F 43	2	38.00	37.0 0	- 39.00	1.00	15.50	15.40 - 15.60	0.01	50.0 0
F 44	1	38.00	38.0 0	- 38.00	0.00	16.20	16.20 - 16.20	0.00	100. 00

4.1.5.8 Per cent superior progenies obtained based on cane yield and HR brix traits (Family wise)

The families, F49 and F44 (100%), F43 and F38 (50%), F48 (33.33%), F04 (30.77%), F47 (25.00%), F20 (19.23%), F05, F14, F35 (16.67%) and F30 (15.38%) were found promising under normal irrigated environment as they gave relatively higher percentage of superior segregants.

The families F01, F03, F06, F09, F10, F21, F22, F25, F31, F32, F33, F50, F46, F37, F36 and F39 gave no superior segregants / progenies under normal irrigated environment among 44 families studied.

4.2 REPEATABILITY OF IMPORTANT TRAITS BETWEEN SEEDLING AND SETTLING GENERATIONS ACROSS DIVERSE ENVIRONMENTS

Inter-stage correlations have been used to measure the repeatability of different traits in different stages and environments. Pre-selected population obtained from 44 crosses was considered to compute inter stage correlations (Table 43 a to j) for various traits.

Table 43. Inter - stage correlation (repeatability) values for 10 traits in progenies across 44 inter varietal sugarcane crosses

4.2.1 Germination per cent

This attribute was studied only for clonal settling stages between environments viz., moisture stress, salinity water logg complex and normal irrigated.

Though the repeatability values were highly significant between environments but were moderate. The highest (0.243) value was recorded between moisture stress and salinity water logg complex environment followed by waterlog complex and normal irrigated, whereas lowest was recorded between moisture stress and normal irrigated environment.

4.2.2 Tillers per plot

The repeatability values for tiller number were measured between all 10 combinations of stages and environments viz., seedling stage, clonal stages under three environments and clonal ratoon stage under moisture stress environment.

The repeatability values for this trait were highly significant. The highest (0.359) value was recorded between seedling and clonal ratoon under moisture stress, followed by settling stage and its ratoon under moisture environment (0.287) and between settling stages under moisture stress and salinity waterlog complex environments (0.0256), whereas lowest (0.118) value was observed between seedling and settling stage under normal environment, followed by seedling and settling stage under salinity water logg complex environment (0.176) and between clonal ratoon under moisture stress and settling stage under normal environment.

4.2.3 Average cane girth

The repeatability values were highly significant for cane thickness between all combinations except seedling - settling under salinity water logg complex, settling stages under moisture stress – salinity water logg environments and between settling stages under normal and salinity water logg environments.

Highest repeatability (0.412) value for cane girth was recorded between settling and its ratoon stage under moisture stress environment followed by seedling and settling stage under moisture stress environment (0.377) and between settling ratoon under moisture stress and settling stage under salinity water logg environment (0.332). The lowest value was observed between seedling and settling stage under normal irrigated environment (0.129) followed by settling ratoon under moisture stress and settling under normal irrigated environment (0.210) and between seedling and settling ratoon under moisture stress environment (0.228).

Table 43a Inter - stage correlation (repeatability) values for germination (%) in progenies across 44 inter varietal sugarcane crosses

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	-	-	-	-
SNK CT		-	0.243**	0.117**
SNK RT			-	-
UGAR CT				0.21**

Table 43a Inter - stage correlation (repeatability) values for tillers in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.168**	0.359**	0.176**	0.118**
SNK CT		0.287**	0.256**	0.155**
SNK RT			0.127**	0.176**
UGAR CT				0.233**

Table 43c Inter - stage correlation (repeatability) values for cane girth in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.377**	0.228**	-0.043	0.129**
SNK CT		0.412**	0.066	0.248**
SNK RT			0.332**	0.210**
UGAR CT				0.078

Table 43d Inter - stage correlation (repeatability) values for millable cane height in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.037	0.034	-0.033	0.089*
SNK CT		0.241**	0.13**	0.108**
SNK RT			0.134**	0.08**
UGAR CT				-0.029

Table 43e Inter - stage correlation (repeatability) values for no. of internodes in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.113**	0.016	-0.030	0.031
SNK CT		0.132**	0.008	0.055
SNK RT			0.063	0.033
UGAR CT				0.133**

Table 43f Inter - stage correlation (repeatability) values for internodal length in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.140**	0.023	0.048	0.29**
SNK CT		-0.105	0.004	0.073
SNK RT			0.18**	0.058
UGAR CT				0.001

Table 43g Inter - stage correlation (repeatability) values for no. of millable canes in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.299**	0.359**	0.225**	0.171**
SNK CT		0.48**	0.342**	0.242**
SNK RT			0.327**	0.257**
UGAR CT				0.231**

Table 43h Inter - stage correlation (repeatability) values for single cane weight in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.564**	0.682**	0.577**	0.648**
SNK CT		0.292**	0.147**	0.144**
SNK RT			0.235**	0.182**
UGAR CT				0.151**

Table 43i Inter - stage correlation (repeatability) values for cane yield in progenies across 44 inter varietal sugarcane crosses.

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.109**	0.063	-0.023	0.048
SNK CT		0.445*	0.129**	0.223**
SNK RT			0.182*	0.174**
UGAR CT				0.011

Table 43j Inter - stage correlation (repeatability) values for HR Brix % in progenies across 44 inter varietal sugarcane crosses

Stages / Generations	SNK CT	SNK RT	UGAR CT	GAL CT
GN	0.689**	0.683**	0.199**	0.244**
SNK CT		0.569**	0.223**	0.186**
SNK RT			0.186*	0.118**
UGAR CT				0.173**

*, ** insignificant at 5% & 1% respectively.

GN = Ground nursery / seedling generation
 SNK CT = Clonal stage II under moisture stress environment
 SNK RT = CT 1st ratoon under moisture stress environment
 UGAR CT = Clonal stage II under salinity water logg stress environment
 GAL CT = Clonal stage II under normal irrigated environment

4.2.4 Millable cane height

This attribute had very lower and non significant repeatability values between seedling and settling under moisture stress and salinity water logg complex and settling ratoon under moisture stress, excepting between seedling and settling generation under normal environment, which had lower but significant repeatability value (0.089). On the contrary repeatability values though moderate but highly significant between all combinations of settling stages under various environments excepting between settling stages under salinity waterlog complex and normal environment (-0.029).

The highest repeatability value was noticed between settling and its ratoon under moisture stress (0.241) followed by settling ratoon under moisture stress and settling under salinity waterlog environment (0.134) whereas lowest value was recorded between settling ratoon under moisture stress and settling under normal environment (0.080).

4.2.5 Average number of Internodes

Average number of internodes had very lower and non-significant repeatability values between all the combinations excepting, seedling and settling under moisture stress (0.113), settling and its ratoon under moisture stress (0.132) and settling stages under salinity waterlog and normal environment (0.133), which also had lower but highly significant values.

4.2.6 Average internodal length

This growth parameter across large progeny population of 44 crosses, had lower and non significant correlation coefficient between seedling and settling stages under three environments, excepting seedling and settling under moisture stress (0.140), seedling and settling under normal irrigated environment (0.290) and settling under salinity water logg complex and settling ratoon under moisture stress (0.180), which also had lower but highly significant values.

4.2.7 Number of millable canes

Millable cane number was most repeatable trait across stages and environments, as the repeatability values were comparatively high and highly significant.

Highest repeatability estimate (0.480) was recorded between settling and its ratoon under moisture stress environment followed by seedling and settling ratoon under moisture stress (0.359) and between settling stages under moisture stress and salinity waterlog complex (0.342), whereas lowest estimate (0.171) was observed between seedlings and settling under normal environment followed by that of salinity water logg environment (0.225).

4.2.8 Average single cane weight

This cane yield attribute was found most repeatable between seedling and settling (0.564) and its ratoon (0.682) stages under moisture stress, salinity water logg complex (0.577) and normal irrigated (0.648) as the repeatability values were comparatively very high and highly significant.

Lowest repeatability value was recorded between settling stages under normal and moisture stress (0.144) followed by settling stages under moisture stress and salinity water logg environments (0.147)

4.2.9 Cane yield

Cane yield recorded non-significant correlation coefficients between seedling and settling stages under three environments except under moisture stress (0.109) which had high significant value, whereas high significant repeatability values were observed between settling stages across environments except under normal and salinity water logg complex environments (0.011). Among various combinations of settling stage under three environments, the highest value was recorded between settling and its ratoon under moisture stress (0.445) followed by settling stages under normal and moisture stress environment (0.223) whereas lowest value was observed between settling stages under moisture stress and salinity water logg complex environment (0.129) followed by settling ratoon under moisture stress and settling stage under normal irrigated environment (0.174).

4.2.10 Average HR Brix per cent

This cane quality parameter was highly repeatable as the correlation coefficients were highly significant across seedling and settling stages under three environments. Highest value (0.689) was recorded between seedling and settling under moisture stress followed by between seedlings and settling ratoon under moisture stress (0.683) and between settling and its ratoon under moisture stress (0.569) environment. For the rest of the stage combinations, the values were highly significant but moderate. The lowest repeatability value (0.118) was noticed between settling ratoon under moisture stress and settling stage under normal irrigated environment, followed by between settling stages under normal and salinity water logg complex environment (0.173).

Table 44. Reaction of sugarcane hybrid progenies against SWA under natural infestation (Free choice condition) in clonal generations across three hot spot locations

Progenies	Cross	Reaction to SWA (0-4 Scale) at					
		Sankeshwar			Ugar	Hosur	
		CT-II	RT-I	RT-II	CT-II	CT-II	RT-I
1. SNK 002	Co 740 X Co 88028	0	0	0	0	0	0
2. SNK 044	Co740 X CoA 7602	0	0	0	0	0	0
3. SNK 049	Co740 X CoA 7602	0	0	0	0	0	0
4. SNK 057	Co740 X CoA 7602	0	0	0	0	0	0
5. SNK 061	Co 740 X MS 6847	0	0	0	0	0	0
6. SNK 124	Co 7704 X CoC 671	0	0	0	0	0	0
7. SNK 158	Co 7704 X CoC 671	0	0	0	0	0	0
8. SNK 192	Co 86249 X CoC 671	0	0	0	0	0	0
9. SNK 256	Co 88028 X Co 88025	0	0	0	0	0	0
10. SNK 754	CoC 671 Poly Cross	0	0	0	0	0	0
11. SNK 250	Co 88028 X Co 88025	1	1	2	1	1	2
12. SNK 335	CoC 671 X Co 88025	1	1	2	1	1	2
Checks							
13. CoC 671		2	2	3	2	2	3
14. Co 86032		3	4	4	3	3	4

4.3 IDENTIFICATION AND CHARACTERIZATION OF PROGENIES FOR SWA REACTION

4.3.1 Screening hybrid progeny population under natural infestation (free choice) condition across three hot spot locations

Reactions of 12 promising clones identified out of 828 hybrid progenies and commercial varieties are given in Table 44. Among 828 hybrid progenies evaluated under natural infestation across three hot spot locations, the progenies viz., SNK002, SNK044, SNK049, SNK057, SNK061, SNK124, SNK158, SNK192, SNK256 and SNK754 were free from aphids (0 grade) and two progenies SNK250 and SNK335 with lower aphid load (1-2 grade) compared to commercial check varieties, viz., CoC 671 and Co 86032 which scored 3-4 grade. All other progenies showed susceptible reaction with score ranging between 3-4 grades.

Table 44. Reaction of sugarcane hybrid progenies against SWA under natural infestation (Free choice condition) in clonal generations across three hot spot locations

4.3.2 Screening promising hybrid progenies and commercial check varieties under artificial infestation (no choice condition)

[For confirmation of resistant reaction scored under natural infestation screening]

The clones promising under natural infestation conditions across three hot spot locations were screened under artificial (no choice) condition at ARS, Sankeshwar and R and D Farm Nandi Sugars, Hosur (Dist.: Bijapur) for confirmation of resistant reaction recorded under natural screening.

Out of 12 (10+2) promising progenies evaluated during 2003-04 crop season (Table 45), ten exhibited resistant reaction also under no choice condition. The released aphids could not colonize on resistant progenies viz., SNK002, SNK044, SNK049, SNK057, SNK061, SNK124, SNK158, SNK192, SNK256 and SNK754 even after 48-72 h (2-3 DAR) of release whereas in SNK250, SNK335 and commercial varieties CoC671 and Co 86032, the released aphids immediately colonized within 24 h after release. In case of progeny SNK044, partial colonization was observed in the initial stage soon after release at Hosur but later 100 per cent mortality of aphids was observed within 48-72 h (2-3 DAR).

Table 45. Reaction of sugarcane hybrid progenies against SWA under artificial infestation (no choice) condition

4.3.3 Intensive screening of resistant progenies and commercial check varieties under infester row technique

4.3.3.1 Under free choice condition

4.3.3.1.1. Behaviour of released aphids (apterous nymphs)

The colonization behaviour of released aphids on test progenies, commercial check varieties and infester were given in Table 46.

Table 46. Colonization behaviour of apterous nymphs observed after artificial release, in SWA resistant progenies, their parents and commercial varieties under caged condition with infester row

The released apterous nymphs did not colonize until harvest on resistant progenies, even under continuous flow of aphids from heavily loaded infester rows on either side, whereas on commercial varieties viz., Co92020 (infester), Co86032, MS6847, the released aphids colonized immediately within 24 h (1 DAR). Though on the commercial varieties viz., CoC671, CoM88121, Co740, Co88028, Co88025, Co7704, CoA7602 and Co86249 aphids colonized later, but for initial 24-96 h, aphids colonized partially unlike that observed on infester Co92020 and other susceptible commercial varieties Co86032 and MS6847.

Table 45. Reaction of sugarcane hybrid progenies against SWA under artificial infestation (no choice) condition

Clones	Grade at Release	Grade (Colonization) at							
		Sankeshwar				Hosur, Bijapur			
		7 th DAR	15 th DAR	21 st DAR	28 th DAR	7 th DAR	15 th DAR	21 st DAR	28 th DAR
1. SNK 002	4	0	0	0	0	0	0	0	0
2. SNK 044	4	0	0	0	0	*0	0	0	0
3. SNK 049	4	0	0	0	0	0	0	0	0
4. SNK 057	4	0	0	0	0	0	0	0	0
5. SNK 061	4	0	0	0	0	0	0	0	0
6. SNK 124	4	0	0	0	0	0	0	0	0
7. SNK 158	4	0	0	0	0	0	0	0	0
8. SNK 192	4	0	0	0	0	0	0	0	0
9. SNK 256	4	0	0	0	0	0	0	0	0
10. SNK 754	4	0	0	0	0	0	0	0	0
11. SNK 250	4	3	3	3	4	3	3	3	4
12. SNK 335	4	3	3	3	4	3	3	3	4
Checks									
13. CoC 671	4	3	3	3	4	3	3	3	4
14. Co 86032	4	4	4	4	4	4	4	4	4

DAR = Days after release

* Few aphids colonized initially soon after release and later gradually 100% mortality was observed (2-3 DAR)

Table 46. Colonization behaviour of apterous nymphs observed after artificial release, in SWA resistant progenies, their parents and commercial varieties under caged condition with infester row

Parents# / Commercial Varieties																	
11. CoC 671		c	pc	pc	pc	pc	pc	sc	cc	cc	cc	cc	cc	cc	cc	cc	cc
12. Co 86032		c	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
13. CoM 88121		c	pc	pc	pc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
14. Co 92020 *		c	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
15. Co 740		c	pc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
16. Co 88028		c	pc	pc	pc	pc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
17. Co 88025		c	pc	pc	pc	pc	pc	sc	cc	cc	cc	cc	cc	cc	cc	cc	cc
18. Co 7704		c	pc	pc	pc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
19. MS 6847		c	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
20. CoA 7602		c	pc	pc	pc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc
21. Co 86249		c	pc	pc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc	cc

* Infester variety; c = moving crawlers; pc = partial colonization; cc = complete colonization; DAR = Days After release

In addition to commercial checks other susceptible parental clones were also studied under caged conditions to compare with checks and their progenies

4.3.3.1.2 Average number of winged adults per plant

The average number of winged adults per plant recorded on test progenies and commercial varieties (susceptible) after artificial release under caged condition with two infester rows on either side were given in Table 47.

Table 47. Average number of winged adults observed after artificial release, in SWA resistant progenies, their parents and other commercial varieties under caged condition with infester row

As per the data, though varieties differed significantly overall with respect to this parameter observed on 1, 2, 3, 4, 5, 6, 15, 21, 27, 35, 180, DAR, but there was no significant difference between resistant and susceptible groups studied. On the contrary, significant differences were observed for average number of winged adults between susceptible group of entries and resistant progenies observed on 7, 42, 49 and 56, DAR.

At 7th DAR, average number of winged adults per plant ranged from 1.26 to 2.66 on resistant progenies, whereas on the susceptible group (commercial varieties) adults ranged from 4.20 to 8.70 per plant.

An average number of adults to the extent of 27.23 to 58.50 were observed on susceptible group of entries, whereas on the resistant progenies, they ranged from 15.86 to 22.96 on 42nd DAR.

On 49th day after release, the susceptible group of entries had 36.56 to 57.63 adults per plant whereas on resistant progenies 14.63 to 26.03 adults were found.

The highest number of adults were recorded on CoM88121 (52.00) which ranged from 35.66 to 52.00 in susceptible group whereas, on resistant progenies it ranged from 16.83 to 27.03 with highest number on SNK44 (27.03).

4.3.3.1.3. Mortality per cent of young nymphs

The mortality per cent of young nymphs laid by winged adults on resistant progenies and commercial varieties are given in Table 48.

Table 48. Per cent Mortality of young nymphs laid by winged adults on SWA resistant progenies, parents and other commercial varieties under caged condition with infester row

4.3.3.1.3.1 At 1st DAR (24 h)

The range of mortality per cent in the resistant progenies varied from 24.24 to 31.78 per cent at 1st DAR (24 h), whereas in susceptible entries it ranged from 0.81 to 16.89. In case of resistant progenies, highest mortality was observed on SNK002 (31.78%) followed by SNK124 (30.32%) and SNK192 (27.76 %), whereas lowest mortality per cent was recorded on SNK754 (24.24%) followed by SNK061 (25.04%) and SNK256 (26.28 %). In case of susceptible commercial varieties, highest mortality per cent was noticed on CoA7602 (16.89 %) followed by Co88028 (16.69 %) and Co88121 (16.32%), whereas lowest mortality per cent was recorded on infester variety Co92020 and Co86032 (0.81 %) followed by MS6847 (5.15 %) and Co740 (11.70 %) at 1st DAR.

4.3.3.1.3.2 At 2nd DAR (48 h)

The varieties overall differed significantly at 5 probability level. Per cent mortality ranged from 32.43 to 48.48 in resistant progenies at 2 DAR, whereas in susceptible varieties, it ranged from 0.81 to 17.30 per cent.

Among resistant progenies, SNK124 (48.48 %) had highest nymphal mortality per cent followed by SNK002 (48.08 %), whereas lowest mortality per cent was recorded in SNK049 (32.43 %) followed by SNK061 (35.38 %). In the susceptible group (commercial varieties), CoA7602 (17.30 %) recorded highest mortality followed by Co88028 (16.97%), whereas lowest mortality per cent was scored in infester variety Co92020 and Co86032 (0.81 %) followed by MS6847 (5.64 %).

Table 47. Average number of winged adults observed after artificial release, in SWA resistant progenies, their parents and other commercial varieties under caged condition with infester row

Progeny	Cross	1 DAR (24 h)	2 DAR (48 h)	3 DAR (72 h)	4 DAR (96 h)	5 DAR	6 DAR	7 DAR	14 DAR	21 DAR	28 DAR	35 DAR	42 DAR	49 DAR	56 DAR	180 DAR (At harvest 360 DAP)
1. SNK 061	Co 740 X MS 6847	4.06	4.10	2.96	3.10	1.90	2.03	1.86	9.26	11.30	10.87	14.06	15.86	17.23	18.73	23.26
2. SNK 754	CoC 671 Poly Cross	4.13	4.43	4.03	3.50	2.50	4.23	2.66	11.46	12.83	15.23	16.30	16.46	14.63	16.83	21.40
3. SNK 158	Co 7704 X CoC 671	4.06	3.93	4.83	3.50	4.90	2.43	2.26	7.06	9.90	11.66	16.06	19.46	20.63	20.73	24.26
4. SNK 049	Co740 X CoA 7602	4.20	4.26	3.63	4.10	4.10	2.03	1.46	7.86	9.50	11.86	17.26	18.46	20.96	22.63	26.46
5. SNK 192	Co 86249 X CoC 671	4.96	5.10	3.83	3.90	2.70	2.03	1.26	8.26	9.70	10.86	18.43	21.40	19.23	20.00	31.26
6. SNK 044	Co740 X CoA 7602	4.26	4.30	3.23	3.50	2.50	1.63	1.86	6.66	6.56	9.86	14.23	19.06	26.03	27.03	28.40
7. SNK 124	Co 7704 X CoC 671	4.70	4.73	4.23	3.30	2.90	1.63	1.86	7.66	8.96	12.00	15.03	22.96	25.56	24.73	27.26
8. SNK 002	Co 740 X Co 88028	3.36	4.03	3.23	2.73	2.16	2.43	2.46	9.26	9.30	11.06	17.06	22.63	24.43	24.03	37.33
9. SNK 256	Co 88028 X Co 88025	3.56	2.80	1.83	2.10	1.36	1.83	1.66	8.46	10.90	15.06	16.46	20.46	25.03	23.93	32.26
10. SNK 057	Co740 X CoA 7602	4.33	2.60	1.70	1.90	1.23	1.63	2.46	5.86	7.90	11.46	14.86	18.06	21.63	20.83	34.13
Parents# / Commercial Varieties																
11. CoC 671		3.26	3.43	2.40	1.83	1.80	1.43	4.70	8.56	11.40	14.86	19.83	27.23	36.56	38.46	41.26
12. Co 86032		4.36	4.36	2.00	2.43	2.00	1.63	5.10	11.96	14.56	19.53	29.03	36.36	46.96	48.26	51.06
13. CoM 88121		3.26	3.20	1.40	1.43	1.80	2.83	8.70	12.76	18.06	23.26	30.96	37.60	51.30	52.00	52.47
14. Co 92020 *		5.03	4.50	4.20	3.93	3.80	3.93	5.00	14.76	23.20	28.36	37.36	46.73	57.63	44.16	39.06
15. Co 740		3.53	4.36	2.80	2.03	1.40	1.26	7.50	8.56	13.26	15.06	20.06	30.63	36.76	39.86	41.86
16. Co 88028		5.16	4.46	4.00	4.33	4.00	4.03	4.60	14.56	23.30	35.17	48.36	58.50	46.70	35.90	36.36
17. Co 88025		3.30	3.63	2.40	1.93	1.90	1.46	4.70	8.66	11.50	15.16	19.86	27.56	37.56	38.86	43.56
18. Co 7704		5.40	5.10	3.90	4.53	4.20	4.13	4.80	14.26	23.00	36.23	49.13	58.46	46.96	35.66	37.16
19. MS 6847		4.30	4.90	2.33	2.03	2.33	1.73	4.86	11.36	14.50	22.30	31.26	35.36	48.86	48.93	45.46
20. CoA 7602		5.50	5.00	3.26	4.23	4.23	5.03	4.20	13.36	28.30	34.36	49.26	55.50	46.93	36.16	35.36
21. Co 86249		4.36	3.93	3.26	3.83	4.33	4.43	4.30	13.76	26.50	31.36	48.36	51.36	43.86	37.36	33.36
SEm		0.19	0.15	0.11	0.11	0.05	0.03	0.10	0.03	0.09	0.73	0.08	0.15	0.06	0.03	0.03
C.D. @ 5%		0.56	0.44	0.33	0.31	0.15	0.08	0.29	0.08	0.26	2.10	0.25	0.44	0.17	0.11	0.09

* A highly susceptible variety used as Infester

#In addition to commercial checks other susceptible parental clones were also studied under caged conditions to compare with checks and their progenies

Table 48. Per cent Mortality of young nymphs laid by winged adults on SWA resistant progenies, parents and other commercial varieties under caged condition with infester row

Progeny	Cross	1 DAR (24 h)	2 DAR (48 h)	3 DAR (72 h)	4 DAR (96 h)	5 DAR (120 h)	21 DAR
1. SNK 061	Co 740 X MS 6847	25.04 (17.9)	35.38 (33.50)	89.19 (100)	89.19 (100)	89.19 (100)	-
2. SNK 754	CoC 671 Poly Cross	24.24 (16.85)	36.72 (35.75)	89.19 (100)	89.19 (100)	89.19 (100)	-
3. SNK 158	Co 7704 X CoC 671	26.64 (20.10)	41.14 (43.30)	89.19 (100)	89.19 (100)	89.19 (100)	-
4. SNK 049	Co740 X CoA 7602	27.29 (21.00)	32.43 (28.80)	63.18 (79.60)	89.19 (100)	89.19 (100)	-
5. SNK 192	Co 86249 X CoC 671	27.76 (21.70)	44.96 (49.95)	89.19 (100)	89.19 (100)	89.19 (100)	-
6. SNK 044	Co740 X CoA 7602	27.75 (21.70)	46.72 (53.00)	89.19 (100)	89.19 (100)	89.19 (100)	-
7. SNK 124	Co 7704 X CoC 671	30.32 (25.50)	48.48 (56.10)	89.19 (100)	89.19 (100)	89.19 (100)	-
8. SNK 002	Co 740 X Co 88028	31.78 (27.75)	48.08 (55.40)	89.19 (100)	89.19 (100)	89.19 (100)	-
9. SNK 256	Co 88028 X Co 88025	26.28 (19.60)	44.80 (49.70)	89.19 (100)	89.19 (100)	89.19 (100)	-
10. SNK 057	Co740 X CoA 7602	27.51 (21.35)	45.57 (51.00)	89.19 (100)	89.19 (100)	89.19 (100)	-
Parents# / Commercial Varieties							
11. CoC 671		14.78 (6.50)	15.54 (7.20)	16.66 (8.25)	15.66 (7.30)	15.66 (7.30)	cc
12. Co 86032		0.81 (0.0)	0.81 (0.0)	0.81 (0.0)	0.81 (0.0)	0.81 (0.0)	cc
13. CoM 88121		16.32 (7.90)	16.74 (8.30)	16.74 (8.30)	16.74 (8.30)	16.74 (8.30)	cc
14. Co 92020 *		0.81 (0.0)	0.81 (0.0)	0.81 (0.0)	0.81 (0.0)	0.81 (0.0)	cc
15. Co 740		11.70 (4.15)	11.98 (4.30)	12.03 (4.35)	12.03 (4.35)	12.03 (4.35)	cc
16. Co 88028		16.69 (8.25)	16.97 (8.50)	16.97 (8.55)	16.97 (8.55)	16.97 (8.55)	cc
17. Co 88025		15.65 (7.30)	15.87 (7.50)	15.91 (7.50)	15.91 (7.50)	15.91 (7.50)	cc
18. Co 7704		15.61 (7.25)	16.13 (7.50)	16.20 (7.80)	16.20 (7.80)	16.20 (7.80)	cc
19. MS 6847		5.15 (0.81)	5.64 (0.95)	5.64 (0.97)	5.64 (0.97)	5.64 (0.97)	cc
20. CoA 7602		16.89 (8.40)	17.30 (8.85)	17.3 (8.85)	17.30 (8.85)	17.30 (8.85)	cc
21. Co 86249		11.93 (4.25)	12.12 (4.40)	12.21 (4.50)	12.21 (4.50)	12.21 (4.50)	cc
SEm±		1.74	1.32	1.08	0.37	0.37	-
C.D. @ 5%		4.98	3.78	3.10	1.05	1.05	-

* A highly susceptible variety used as Infester,

Figures in parentheses are actual per cent values and outside the parenthesis are angular transformed values

cc = complete colonization

#In addition to commercial checks other susceptible parental clones were also studied under caged conditions to compare with checks and their progenies

4.3.3.1.3.3 At 3rd DAR (72 h)

All the resistant progenies except SNK049 (63.18 %) showed 89.19 per cent mortality of young nymphs, whereas among susceptible varieties CoA7602 (17.30 %) had highest mortality per cent followed by Co88028 (16.97 %) and CoM88121 (16.74 %). The lowest mortality per cent was scored by infester Co92020 and Co86032 (0.81 %) followed by MS 6847 (5.64%), Co740 (12.03 %) and Co86249 (12.21 %).

4.3.3.1.3.4 At 4th and 5th DAR (96 h)

All the resistant progenies recorded 89.19 per cent mortality at 4th DAR whereas in susceptible commercial varieties, the mortality per cent ranged from 0.81 (Co86032 and Co92020) to 17.30 per cent (CoA7602). The other commercial varieties had mortality to the extent of 16.97, 16.74, 16.20, 15.91, 12.21, 12.03 and 5.64 per cent in Co88028, CoM88121, Co7704, Co88025, Co86249, Co740 and MS 6847 respectively.

4.3.3.1.3.5 At 21st DAR

On all the parents / commercial varieties, perfect aphid colonies were established whereas, while ten resistant progenies were completely free from aphids.

4.3.3.1.4 Reaction of varieties against SWA

In resistant group, none of the ten progenies recorded any grade as the released aphids could not colonize in spite of sufficient flow of aphids (crawlers) from infester rows on either side of resistant progeny rows under caged condition, whereas in case of susceptible commercial varieties, aphids colonized and perpetuated further and reached 3-4 grades (Table 49).

Table 49. Reaction of SWA resistant progenies, their parents and other commercial varieties under no choice condition with infester row technique

Aphids colonized immediately within 24 h and attained grade 1 within 2nd DAR on the varieties Co92020 (Infester), Co86032, Co740 and MS6847. These varieties except Co740 had maximum aphid build up (grade 4) comparatively within shorter duration i.e. before 35-42 DAR. On the contrary, the varieties CoC671, CoM88121, Co88028, Co88025, Co7704, CoA7602 and Co86249 attained grade 1 gradually after 72 h (3 DAR) as released aphids colonized partially, initially after release. In addition, these commercial varieties started recording advanced grades at 7 DAR and finally at harvest, except MS6847 (4.0 grade) Co86032 (4.0), Co740 (4.0) and Co86249 (4.0 grade), all other commercial varieties attained to 3.0 grade only.

4.3.3.2 Under extreme no choice condition

The survival per cent of released aphids on resistant progenies and infester Co92020 under extreme no choice condition were given in Table 50. As per the data, in all the resistant progenies except SNK049, the survival per cent was reduced gradually attaining 0 per cent at 5th DAR (120 h), whereas in case of highly susceptible infester Co92020 and Co86032, there was absolutely no reduction in survival per cent of released aphids, instead the aphids colonized and number increased 3-4 folds within 5 DAR. In the progeny, SNK 049 complete mortality of released aphids was delayed by one day (6 DAR).

Table 50. Survival of SWA released artificially under extreme no choice condition on resistant progenies and commercial varieties

Table 49. Reaction of SWA resistant progenies, their parents and other commercial varieties under no choice condition with infester row technique

Progeny	Cross	At Release	1 DAR (24 h)	2 DAR (48 h)	3 DAR (72 h)	4 DAR (96 h)	5 DAR	6 DAR	7 DAR	14 DAR	21 DAR	28 DAR	35 DAR	42 DAR	49 DAR	56 DAR	180 DAR (At harvest 360 DAP)
1. SNK 061	Co 740 X MS 6847	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. SNK 754	CoC 671 Poly Cross	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. SNK 158	Co 7704 X CoC 671	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. SNK 049	Co740 X CoA 7602	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. SNK 192	Co 86249 X CoC 671	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. SNK 044	Co740 X CoA 7602	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. SNK 124	Co 7704 X CoC 671	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. SNK 002	Co 740 X Co 88028	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9. SNK 256	Co 88028 X Co 88025	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10. SNK 057	Co740 X CoA 7602	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parents# / Commercial Varieties																	
11. CoC 671		4	-	-	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0
12. Co 86032		4	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0
13. CoM 88121		4	-	-	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0
14. Co 92020 *		4	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0
15. Co 740		4	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	4.0	4.0
16. Co 88028		4	-	-	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
17. Co 88025		4	-	-	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0
18. Co 7704		4	-	-	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
19. MS 6847		4	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0
20. CoA 7602		4	-	-	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
21. Co 86249		4	-	-	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	4.0

* A highly susceptible variety used as Infester,

- = 0 only crawlers with no colonization

#In addition to commercial checks other susceptible parental clones were also studied under caged conditions to compare with checks and their progenies

Table 50. Survival of SWA released artificially under extreme no choice condition on resistant progenies and commercial varieties

Progenies / Varieties	Cross	No. of aphids at release	Average number of aphids at 1 DAR (24 h)	Average number of aphids at 2 DAR (48 h)	Average number of aphids at 3 DAR (72 h)	Average number of aphids at 4 DAR (96 h)	Average number of aphids at 5 DAR (120 h)	Average number of aphids at 6 DAR (144 h)	Average number of aphids at 7 DAR (168 h)
1. SNK 061	Co 740 X MS 6847	100	84.67	65.33	37.00	5.67	0.00	0.00	0.00
2. SNK 754	CoC 671 Poly Cross	100	81.67	60.33	40.00	13.33	0.00	0.00	0.00
3. SNK 158	Co 7704 X CoC 671	100	79.00	67.33	34.00	10.67	0.00	0.00	0.00
4. SNK 049	Co740 X CoA 7602	100	86.00	67.00	42.00	22.33	8.33	0.00	0.00
5. SNK 192	Co 86249 X CoC 671	100	78.33	63.00	38.33	6.00	0.00	0.00	0.00
6. SNK 044	Co740 X CoA 7602	100	76.67	58.00	32.00	7.67	0.00	0.00	0.00
7. SNK 124	Co 7704 X CoC 671	100	82.00	59.33	30.33	5.00	0.00	0.00	0.00
8. SNK 002	Co 740 X Co 88028	100	86.67	52.67	28.00	6.33	0.00	0.00	0.00
9. SNK 256	Co 88028 X Co 88025	100	78.00	49.33	35.67	3.00	0.00	0.00	0.00
10. SNK 057	Co740 X CoA 7602	100	82.67	62.00	35.00	8.67	0.00	0.00	0.00
Commercial Varieties									
11. Co 86032		100	100	> 100	> 200	> 300	> 400	> 500	> 600
12. Co 92020		100	100	> 100	> 200	> 300	> 400	> 500	> 600

4.3.4. Assessing productivity potential of SWA resistant progenies

4.3.4.1. Performance under augmented trials

4.3.4.1.1. Under late (330 DAP) SWA infestation conditions

The analysis of variance for all the important traits studied, at three environments (locations) are provided in tables 7, 14, 21, 28 and 36. For better discussion the mean values for only cane yield, HR brix (%) and brix yield (calculated) of SWA resistant progenies and commercial checks are given in Table 51. The SWA infestation started at later crop growth stages *i.e.* after 11th month onwards at all the three locations during the crop season (2001 – 02). The progenies *viz.*, SNK 002, SNK 044, SNK 049, SNK 057, SNK 061, SNK 124, SNK 158, SNK 192, SNK 256 and SNK 754 remain free from aphid infestation (0 grade), while all other progenies and commercial checks recorded 3-4 grades.

Table 51. Performance of SWA resistant progenies in settling generations across three hot spot locations under late (330 DAP) infestation conditions

4.3.4.1.1.1. Cane yield (t/ha)

The SWA resistant progenies *viz.*, SNK 754 (117.60), SNK 049 (115.20), SNK 044 (111.10) and SNK 158 (107.80) recorded significantly superior cane yield over best check CoC 671 (87.70), while all SWA resistant progenies except SNK 002 (48.80) had significantly higher ratoon cane yield over the check CoC 671 (54.10) at Sankeshwar.

The progenies *viz.*, SNK 124 (89.80), SNK 158 (78.90), SNK 754 (77.70) and SNK 049 (75.80) showed significant superiority for cane yield over the check CoC 671 (58.90) at Ugar. Whereas only three progenies *viz.*, SNK 049 (130.40), SNK 124 (129.50) and SNK 256 (128.30) recorded significant superiority over best check CoC 671 (106.50) at Hosur. Overall, across the environments of three hot spot locations, all the SWA resistant progenies except SNK 002 (69.76) recorded higher cane productivity over the best check CoC 671 (76.80).

4.3.4.1.1.2 HR Brix per cent

The progeny, SNK 754 (19.60%) recorded numerically higher HR brix per cent, over the best check Co 86032 (18.60%) in clonal trial II while, the progenies *viz.*, SNK 044 (20.70%), SNK 754 (20.60%) and SNK 061 (20.50%) recorded higher brix values compared to best checks CoC 671 and Co86032 (19.90%) in clonal ratoon generation at Sankeshwar.

The progenies *viz.*, SNK 754 (22.40%) and SNK 158 (20.20%) recorded higher HR Brix over best check Co 86032 (19.90%), while other eight progenies were on par with the check at Ugar.

All the SWA resistant progenies except SNK 256 (11.90%), SNK 061 (14.10%) and SNK 044 (14.00%) had HR Brix on par with best check CoC 671 (17.50%) at Hosur.

Overall, across locations the progeny SNK 754 (19.63%) recorded higher value over best check Co 86032 (18.95%) followed SNK 002 (18.00%), SNK 061 (17.85%), SNK 057 (16.93%), SNK 049 (16.88%) and SNK 044 (16.83%).

4.3.4.1.1.3. Brix yield (t/ha)

The progenies *viz.*, SNK 754 (23.05), SNK 044 (18.66), SNK 049 (18.43) and SNK 061 (15.96) recorded significantly higher brix yield over best check CoC 671 (15.6) in clonal trial II, while in clonal trial I's ratoon at Sankeshwar, all the SWA resistant progenies except SNK 002 and SNK 256 were significantly superior over best check CoM 888121 (13.37). At Ugar the progenies *viz.*, SNK049, SNK057, SNK061, SNK124, SNK158, SNK192 and SNK754 recorded significantly higher brix yield over best check Co88032, while at Hosur, the progenies *viz.*, SNK 002 (23.49), SNK 124 (22.27), SNK 754 (19.81) and SNK 049 (19.56) recorded significantly higher brix yield over best check CoC 671 (18.64).

Overall, across the locations, the progenies *viz.*, SNK 754 (20.96), SNK 049 (17.82), SNK 124 (17.13), SNK 044 (17.12), SNK 158 (15.84), SNK 057 (15.63) and SNK 061 (15.40) had higher brix yield compared to best check CoC 671 (14.17).

Table 51. Performance of SWA resistant progenies in settling generations across three hot spot locations under late (330 DAP) infestation conditions

Sl. No	PROGENIES	Cane yield (t/ha)				MEAN	HR brix (%)				MEAN	Brix yield (t/ha)				MEAN	SWA grade
		Sankeshwar		UGAR	HOSUR		Sankeshwar		UGAR	HOSUR		Sankeshwar		UGAR	HOSUR		
		CT II	RT I	CT II	CT II		CT II	RT I	CT II	CT II		CT II	RT I	CT II	CT II		
SWA resistant progenies																	
1	SNK 002	87.00	48.80	24.60	118.62	69.76	17.10	18.20	16.90	19.80	18.00	14.88	8.88	4.16	23.49	12.85	0
2	SNK044	111.10	102.50	68.40	127.10	102.28	16.80	20.70	15.80	14.00	16.83	18.66	21.22	10.81	17.79	17.12	0
3	SNK049	115.20	104.40	75.80	130.40	106.45	16.00	19.70	16.80	15.00	16.88	18.43	20.57	12.73	19.56	17.82	0
4	SNK 057	100.40	85.80	65.20	127.40	94.70	14.60	18.90	19.20	15.00	16.93	14.66	16.22	12.52	19.11	15.63	0
5	SNK 061	100.00	85.80	65.20	100.20	87.80	16.90	20.50	19.90	14.10	17.85	16.90	17.59	12.97	14.13	15.40	0
6	SNK 124	100.35	104.40	89.80	129.50	106.01	12.60	17.40	17.20	17.20	16.10	12.64	18.17	15.45	22.27	17.13	0
7	SNK 158	107.40	85.80	78.90	110.60	95.68	15.20	16.40	20.20	15.40	16.80	16.32	14.07	15.94	17.03	15.84	0
8	SNK 192	90.70	91.40	74.00	112.70	92.20	14.70	15.40	17.40	14.80	15.58	13.33	14.08	12.88	16.68	14.24	0
9	SNK 256	91.10	105.10	72.20	128.30	99.18	12.60	10.90	16.40	11.90	12.95	11.48	11.46	11.84	15.27	12.51	0
10	SNK 754	117.60	114.50	77.70	124.60	108.60	19.60	20.60	22.40	15.90	19.63	23.05	23.59	17.40	19.81	20.96	0
CHECKS																	
C1	CoC 671	87.70	54.10	58.90	106.50	76.80	18.20	19.90	19.20	17.50	18.70	15.96	10.77	11.31	18.64	14.17	3
C2	Co 86032	77.80	67.00	57.20	97.10	74.78	18.60	19.90	19.90	17.40	18.95	14.47	13.33	11.38	16.90	14.02	4
C3	Co 88121	83.90	67.50	35.50	86.00	68.23	16.90	19.80	18.70	16.40	17.95	14.18	13.37	6.64	14.10	12.07	3
	C.D.@.(5%)	17.80	28.70	15.60	21.40		2.30	2.69	4.40	3.10		0.41	0.77	0.69	0.66		

Table 52. Ratoon performance of SWA resistant progenies and commercial varieties under early (150 DAR) infestation conditions at Sankeshwar

Varieties	Cane yield (t/ha)	HR Brix (%)	Brix yield (t/ha)	SWA - Grade
SWA resistant progenies				
1. SNK 002	46.4	18.6	8.63	0
2. SNK 044	105.3	21	22.11	0
3. SNK 049	101.5	20.3	20.6	0
4. SNK 057	82.4	19.1	15.73	0
5. SNK 061	91.2	20.9	19.06	0
6. SNK 124	106.3	17.5	18.6	0
7. SNK 158	72.4	16.8	12.16	0
8. SNK 192	85.5	15.6	13.3	0
9. SNK 256	104.4	11.2	11.7	0
10. SNK 754	116.2	22.5	26.14	0
Checks				
1. CoC 671	9.2	3.9	0.35	3
2. Co 86032	8.2	3.2	0.26	4
3. CoM 88121	16.3	4.6	0.74	3
C.D.@ 5% between check means and varieties	31.2	4.5	1.4	

Table 53. Ratoon Performance of SWA resistant and 13 productive (undernormal irrigated) progenies under SWA infestation (170 DAR) at Hosur

Varieties	Cane yield (t/ha)	Brix%	Brix yield (t/ha)	SWA -Grade
SWA resistant progenies				
1. SNK 002	101.5	18.3	18.6	0
2. SNK 044	125.4	17.5	21.9	0
3. SNK 049	131.4	17.6	23.1	0
4. SNK 057	119.5	16.8	20	0
5. SNK 061	103.7	18.6	19.3	0
6. SNK 124	126.4	17.4	22	0
7. SNK 158	98.2	16.2	15.9	0
8. SNK 192	108.6	16.4	17.8	0
9. SNK 256	131.2	12.2	16	0
10. SNK 754	128.9	18.9	24.4	0
Checks				
1. CoC 671	24.1	4.91	1.18	3
2. Co 86032	22.4	4.55	1.01	4
3. CoM 88121	28.5	5.6	1.59	3
C.D.@ 5% below check means and varieties	27.5	4.3	1.18	

DAR : Days after ratooning

4.3.4.1.2. Ratoon performance SWA resistant progenies under early (150 DAR) infestation at Sankeshwar (CT –I's RT-II)

4.3.4.1.2.1 Cane yield

Ratoon performance was studied at Sankeshwar where in SWA infestation started from 150 day after ratooning (DAR). All the commercial checks and progenies except 10 SWA resistant clones scored 3-4 grades, while SWA resistant progenies remain free from aphids (0 grade) (Table 52).

All the SWA resistant progenies except SNK 002 (46.4 t/ha) recorded significantly higher cane yield over the best check CoM 88121 (16.3 t/ha). The progeny SNK 754 (116.2 t/ha) had highest cane yield, followed by SNK 124 (106.30 t/ha), SNK 049 (105.3 t/ha), SNK 049 (101.5 t/ha), SNK 061 (91.2 t/ha), SNK 192 (85.5t/ha), SNK 057 (81.4t/ha) and SNK 158 (72.4t/ha).

Table 54. Analysis of variance for different growth, cane and sugar yield parameters of SWA resistant progenies and commercial varieties evaluated under early (180 DAP) infestation condition

Source	d.f.	MSS for the characters													
		Germination % at 45 DAP	Tillers at 90 DAP	Average single cane weight (kg) at harvest	Average millable cane height (cm) at harvest	Average cane girth (cm) at harvest	Average No. of internodes at harvest	NMC / Plot	Brix % Juice at harvest	Sucrose % Juice at harvest	Juice Extraction % at harvest	Purity % at harvest	CCS % at harvest	CCS yield (t/ha)	Cane yield (t/ha)
Genotype	12	441.354*	13831.41**	0.668**	5420.44**	1.086**	5.778**	15476.97**	114.58**	72.92**	962.75**	27.83	35.74**	93.26**	6126.96**
Error	24	163.6	1431.24	0.022	1396.72	0.01	1.579	1023.16	0.81	0.58	20.45	26.4	0.5	4.9	67.25
SEm		7.42	21.849	0.085	21.57	0.057	0.726	18.46	0.52	0.44	2.61	2.96	0.4	1.27	4.73
CD @ 5%		22.02	64.475	0.249	62.98	0.167	2.118	53.9	1.52	1.28	7.62	NS	1.19	3.73	13.82
CD @ 1%		NS	87.32	0.337	85.33	0.2226	2.869	73.03	2.06	1.74	10.32	NS	1.61	5.05	18.72

*, ** Significant at 5 and 1 per cent respectively

Table 55. Analysis of variance for different sugar yield parameters (300 and 330 DAP) of SWA resistant progenies and commercial varieties evaluated under early (180 DAP) infestation condition

Source	d.f.	MSS for the characters									
		Brix % Juice at 300 DAP	Sucrose % Juice at 300 DAP	Juice Extraction % at 300 DAP	Purity % at 300 DAP	CCS % at 300 DAP	Brix % Juice at 330 DAP	Sucrose % Juice at 330 DAP	Juice Extraction % at 330 DAP	Purity % at 330 DAP	CCS % at 330 DAP
Genotype	12	26.03**	17.84**	131.68**	141.07*	8.87**	48.22**	34.45**	303.56**	50.84**	16.38**
Error	24	0.7	1.39	16.69	53.63	1.15	0.56	0.68	4.82	13.14	0.55
SEm		0.48	0.68	2.35	4.22	0.62	0.43	0.47	1.26	2.09	0.43
CD @ 5%		1.41	1.98	6.88	12.34	1.81	1.26	1.39	3.7	6.11	1.25
CD @ 1%		1.91	2.69	9.33	NS	2.45	1.71	1.88	5.01	8.27	1.7

*, ** Significant at 5 and 1 per cent respectively

Table 56. Germination (30 DAP), tillers (90 DAP), growth and cane yield parameters (at harvest) of SWA resistant progenies and commercial varieties under early (180 DAP) infestation condition

Progenies	Cross	Germination (%)	Tillers / plot	Av. Cane girth (cm)	Av. Cane mill. Ht. (cm)	Av. No. of Internodes	Av. Single c. wt. (kg)	Av. No. of Mill. Canes / Plot	Cane Yield (t /ha)	SWA grade
1. SNK 158	Co 7704 X CoC 671	83.78	195.00	2.45	226.66	17.33	1.30	55.53	77.66	0
2. SNK 256	Co 88028 X Co 88025	87.43	351.00	1.83	283.33	17.33	0.75	188.33	128.33	0
3. SNK 192	Co 86249 X CoC 671	69.48	87.00	2.46	163.33	18.00	0.96	85.83	68.66	0
4. SNK 049	Co740 X CoA 7602	77.56	196.73	2.90	283.33	20.66	1.75	98.50	158.66	0
5. SNK 002	Co 740 X Co 88028	49.60	76.56	1.80	215.00	17.00	0.53	52.50	32.66	0
6. SNK 754	CoC 671 Poly Cross	86.54	193.25	2.53	196.66	19.00	1.09	103.33	117.33	0
7. SNK 044	Co740 X CoA 7602	90.23	155.00	2.83	213.33	18.33	1.55	87.16	119.66	0
8. SNK 061	Co 740 X MS 6847	84.17	239.64	2.46	268.33	20.00	1.51	88.16	126.66	0
9. SNK 057	Co740 X CoA 7602	83.22	163.56	2.86	233.33	18.00	1.58	73.83	108.66	0
10. SNK 124	Co 7704 X CoC 671	77.24	231.50	2.26	270.00	17.00	1.17	84.33	84.33	0
Checks										
11. CoC 671		87.46	191.64	1.28	189.33	18.66	0.53	45.50	25.13	4
12. Co 86032		90.24	151.00	1.23	169.66	15.33	0.42	59.65	26.38	4
13. CoM 88121		88.34	208.67	1.41	186.33	17.33	0.47	66.66	34.20	4
CD @ 5%		20.68	65.50	0.16	62.98	2.11	0.24	26.95	13.82	
SEm		7.58	22.64	0.05	21.57	0.72	0.08	18.46	4.73	

4.3.4.1.2.2. HR Brix per cent

All the SWA resistant progenies recorded significantly higher HR Brix values over best check CoM 88121 (4.6%).

4.3.4.1.2.3. Brix yield

Similar trend was observed as that of cane yield and HR Brix (%), where in all the SWA resistant progenies were significantly superior to best check CoM 88121 (0.74 t/ha).

4.3.4.1.3. Ratoon performance of SWA resistant progenies under early (170DAR) infestation at Hosur (CT –II's RT- I).

Ratoon performance was studied at Hosur where in SWA infestation started from 170 day after ratooning (DAR). The commercial checks and all the progenies except 10 SWA resistant were scored 3-4 grades, while SWA resistant progenies remained free from aphids (0 grade) (Table 53).

4.3.4.1.3.1 Cane yield

Highest cane productivity was recorded by SNK 049 (131.4 t/ha) followed by SNK 256 (131.2 t/ha), SNK 754 (128.9 t/ha), SNK 124 (126.4t/ha), SNK 044 (125.4t/ha), SNK 057 (119.5t/ha), SNK 192 (108.6 t/ha) and SNK 061 (103.7t/ha), while SNK 158 (98.2t/ha) had lowest followed by SNK 002 (101.5t/ha). All the 10 SWA resistant progenies were significantly superior over the best commercial check CoM 88121 (28.5 t/ha).

4.3.4.1.3.2. HR Brix per cent

Similar trend was observed as that of cane yield where in for HR brix per cent all the SWA resistant progenies scored significantly higher values over the best check CoM 88121 (5.6%). The progeny SNK 754 (18.9 %) recorded highest brix per cent followed by SNK 061 (18.6%), SNK 002 (18.3%), SNK 049 (17.6%) and SNK 044 (17.5%).

4.3.4.1.3.3. Brix yield

All the ten SWA resistant progenies were significantly superior over best check CoM 88121 (1.59t/ha) . Highest brix yield was recorded by SNK 754 (24.4t/ha), followed by SNK 049 (23.1 t/ha), SNK 044 (21.9 t/ha) and SNK 061 (19.3 t/ha).

4.3.4.2. Detailed cane and sugar productivity assessment

4.3.4.2.1. At early (180 DAP) infestation condition

Analysis of variance for the traits studied is presented in the Table 54 and 55. As evident from the tables, mean sum of squares for all the traits except purity per cent of juice at harvest were highly significant. The mean values obtained for various characters included in the study in respect of SWA resistant progenies are provided in Table 56 to 58. None of the 10 resistant progenies reached any grade whereas commercial check varieties scored 3-4 grades under artificial infestations in caged conditions.

Table 54. Analysis of variance for different growth, cane and sugar yield parameters of SWA resistant progenies and commercial varieties evaluated under early (180 DAP) infestation condition

Table 55. Analysis of variance for different sugar yield parameters (300 and 330 DAP) of SWA resistant progenies and commercial varieties evaluated under early (180 DAP) infestation condition

4.3.4.2.1.1. Germination per cent (at 45 DAP)

The germination per cent of all the resistant progenies viz., SNK 044 (90.23%), SNK 256 (87.43%), SNK 754 (86.54%), SNK 061 (84.17%), SNK 158 (83.78%) and SNK 057 (83.22%) were on par with the best check Co 86032 (90.24%).

4.3.4.2.1.2. Tillers per plot (at 90 DAP)

The progeny SNK 256 (351.00) recorded highest number of tillers which was significantly superior to best check CoM 88121(208.67) followed by SNK 061 (239. 64) and SNK 124 (231.50) which were on par to the check. Lowest tillers were recorded in SNK 002 (76.56).

4.3.4.2.1.3. Average cane girth (cm) (at harvest)

All the ten resistant progenies recorded significantly superior cane thickness over best check CoM 88121 (1.41 cm). The progeny SNK 049 (2.90cm) had thickest canes followed by SNK 057 (2.86 cm) and SNK 044 (2.83 cm), while SNK 002 (1.80 cm) recorded lowest cane girth followed by SNK 256 (1.83cm).

4.3.4.2.1.4. Average millable cane height (cm) (at harvest)

The progenies viz., SNK 049, SNK 256, SNK 061 and SNK 124 recorded tallest millable canes with significant superiority over best check CoC 671 (189.33 cm), while other six progenies had comparable values for this trait.

4.3.4.2.1.5. Average number of internodes (at harvest)

The number of internodes in resistant progenies were on par with the best check CoC 671 (18.66).

4.3.4.2.1.6. Average single cane weight (kg) (at harvest)

All the resistant progenies except SNK 002 (0.53 kg) had significantly superior single cane weights over best check CoC 671 (0.53 kg). The progeny SNK 049 (1.75 kg) had heaviest canes followed by SNK 057 (1.58 kg), SNK 044 (1.55kg) and SNK 061 (1.51kg).

4.3.4.2.1.7. NMC per plot (at harvest)

Three progenies viz., SNK256 (188.33), SNK 754 (103.33) and SNK 049 (98.50) recorded significantly higher number of canes over best check CoM 88121(66.66) while other progenies except SNK 158 and SNK 002 were numerically superior to check variety for this trait.

4.3.4.2.1.8. Cane yield

All the resistant progenies, except SNK 002 (32.66t/ha) recorded significantly superior cane yield over best check CoM 88121(34.20t/ha). The progeny SNK 049 (158.66 t/ha) had highest cane productivity, followed by SNK 256 (128.33 t/ha), SNK 061 (126.66 t/ha), SNK 044 (119.66 t/ha) and SNK 754 (117.33 t/ha).

4.3.4.2.1.9. Juice extraction per cent (at harvest)

Resistant progenies recorded significantly higher juice extraction per cent over best check CoM 88121(19.70%).

4.3.4.2.1.10. Brix per cent (at harvest)

All ten SWA resistant progenies had significantly superior brix per cent juice compared to best check CoM 88121(6.50%). Highest juice brix was recorded by SNK 754 (21.26%) followed by SNK 044 (20.83%), SNK 061 (19.43%), SNK 002 (19.46%) and SNK 049 (19.33%).

4.3.4.2.1.11. Sucrose per cent (at harvest)

Similar trend was observed as that of brix per cent where in all the ten resistant progenies recorded significantly superior sucrose per cent compared to best check CoM 88121 (6.09%). The progeny SNK 754 (17.70%) had highest sucrose per cent juice followed by SNK 044 (17.66%), SNK 061 (17.63%) and SNK 049 (16.60)

Table 57. Sugar yield and it's parameters (at harvest) of SWA resistant progenies and commercial varieties at harvest under early (180 DAP) infestation condition

Progenies	Cross	Juice Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	CCS Yield (t /ha))
1. SNK 158	Co 7704 X CoC 671	54.66	17.90	15.63	87.35	10.75	8.36
2. SNK 256	Co 88028 X Co 88025	58.00	16.73	14.56	87.23	10.00	12.82
3. SNK 192	Co 86249 X CoC 671	57.66	18.10	15.80	87.23	10.86	7.47
4. SNK 049	Co740 X CoA 7602	62.00	19.33	16.60	85.84	11.31	14.07
5. SNK 002	Co 740 X Co 88028	67.00	19.46	16.50	84.80	11.18	3.52
6. SNK 754	CoC 671 Poly Cross	58.00	21.26	17.70	83.21	11.88	13.95
7. SNK 044	Co740 X CoA 7602	59.66	20.83	17.66	83.93	11.97	14.32
8. SNK 061	Co 740 X MS 6847	61.00	19.43	17.63	90.71	12.34	15.67
9. SNK 057	Co740 X CoA 7602	57.33	19.00	16.66	88.12	11.48	12.51
10. SNK 124	Co 7704 X CoC 671	54.33	18.83	16.50	87.75	11.36	9.57
Checks							
11. CoC 671		18.43	4.78	5.27	91.88	3.24	0.81
12. Co 86032		18.23	4.56	5.05	88.89	3.16	0.83
13.CoM 88121		19.70	6.50	6.09	93.73	4.33	1.47
SEm		2.61	0.52	0.44	2.96	0.40	1.27
CD @ 5%		7.62	1.52	1.28	NS	1.19	3.73

Table 58. Sugar yield parameters of SWA resistant progenies and commercial varieties at 300 and 330 days after planting under early (180 DAP) infestation condition

under early (180

Progenies	Cross	At 300 DAP					At 330 DAP				
		Juice Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	Juice Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)
1. SNK 158	Co 7704 X CoC 671	54.33	14.33	8.04	56.09	4.03	49.00	18.43	13.36	72.60	8.27
2. SNK 256	Co 88028 X Co 88025	47.33	13.70	9.15	66.72	5.35	52.00	17.50	13.00	74.32	8.17
3. SNK 192	Co 86249 X CoC 671	59.33	14.48	10.68	73.78	6.69	61.33	18.66	14.10	75.62	8.96
4. SNK 049	Co740 X CoA 7602	64.33	14.96	10.95	73.12	6.82	60.33	19.40	16.15	83.10	10.84
5. SNK 002	Co 740 X Co 88028	52.00	15.23	10.63	69.75	6.42	59.33	18.93	14.00	74.03	8.78
6. SNK 754	CoC 671 Poly Cross	60.66	17.19	11.96	69.50	7.21	58.66	21.20	16.90	79.76	11.08
7. SNK 044	Co740 X CoA 7602	56.00	16.83	11.23	66.84	6.56	62.00	20.93	17.90	85.56	12.18
8. SNK 061	Co 740 X MS 6847	61.33	16.43	11.60	70.61	7.05	64.00	21.43	17.79	83.15	11.92
9. SNK 057	Co740 X CoA 7602	62.00	13.76	10.06	75.55	6.61	61.00	19.83	16.30	82.92	10.86
10. SNK 124	Co 7704 X CoC 671	57.00	13.26	7.43	55.87	3.72	58.00	19.20	15.23	79.37	9.96
Checks											
11. CoC671		44.80	8.07	4.95	61.63	2.70	38.70	10.47	8.56	81.81	5.69
12. Co86032		46.26	9.18	6.12	66.87	3.57	34.70	10.28	7.98	77.60	5.16
13. CoM88121		48.20	9.50	5.47	56.31	2.82	39.63	11.64	9.37	80.55	6.18
SEm		2.35	0.48	0.68	4.22	0.62	1.26	0.43	0.47	2.09	0.43
CD @ 5%		6.88	1.41	1.98	12.34	1.81	3.70	1.26	1.39	6.11	1.25

4.3.4.2.1.12. CCS per cent (at harvest)

All the ten SWA resistant progenies recorded significantly superior commercial cane sugar per cent in juice compared to best check CoM 88121 (4.33%). The progeny SNK 061 (12.34%) had highest CCS per cent followed by SNK 044 (11.97%) and SNK 754 (11.88%).

4.3.4.2.1.13. CCS yield

All the ten SWA resistant progenies except SNK 002 (3.52 t/ha) recorded significantly higher sugar yield compared to best check CoM 88121 (1.47 t/ha). Highest sugar yield was recorded by SNK 061 (15.67 t/ha) followed by SNK 044 (14.32 t/ha), SNK 049 (14.07 t/ha) and SNK 754 (13.95 t/ha). Lowest sugar yield was recorded by SNK 002 (3.52 t/ha) which was numerically superior to best check CoM 88121 under SWA infestation condition.

4.3.4.2.1.14. Juice extraction per cent (at 300 and 330 DAP)

All the ten SWA resistant progenies along with commercial susceptible checks were also studied for earliness in ripening under SWA infestation condition.

The juice extraction per cent data at 10 and 11 months crop age indicated that all the SWA resistant progenies except SNK 002, SNK 151 and SNK 256 at 10 month age recorded significantly superior values compared best check CoM 88121 which showed 48.20 and 39.63 percent juice in cane at 10 and 11 month crop age respectively.

4.3.4.2.1.15. Brix per cent (at 300 and 330 DAP)

All the ten SWA resistant progenies recorded significantly higher brix per cent in juice compared to best check CoM 88121 which had 9.50 and 11.64 per cent at 10 and 11 month crop age respectively.

4.3.4.2.1.16. Sucrose per cent (at 300 and 330 DAP)

Similar trend as that of brix per cent in juice was observed for sucrose per cent. However, SNK 125 (7.43) and SNK 158 (8.04) were on par with best check Co86032 (6.12) for sucrose per cent at 10 month crop age.

4.3.4.2.1.17. Purity per cent (at 300 and 330 DAP)

All the progenies except SNK 124 (55.87) and SNK 158 (56.09) recorded higher juice purity compared to best check Co 86032 (66.87%) at 10 month crop age under SWA infested conditions. Whereas, at 11 month crop age all the resistant progenies except SNK 158 (72.60), SNK 002 (74.03), SNK 256 (74.32) and SNK 192 (75.62) recorded comparable juice purity as that of best check CoC 671 (81.81%).

4.3.4.2.1.18. CCS per cent (at 300 and 330 DAP)

The CCS per cent data reveals, the progenies SNK 754 (7.21%), SNK 061 (7.05 %), SNK 049 (6.82%), SNK 192 (6.69%), SNK 057 (6.61%), SNK 044 (6.56%) and SNK 002 (6.42%) recorded significantly superior CCS per cent over best check Co 86032 (3.57%) at 10 month crop age. Whereas at 11 month crop age all the resistant progenies recorded significantly higher CCS over best check CoM 88121 (6.18%).

Table 59. Analysis of variance for different growth, cane and sugar yield parameters of SWA resistant progenies and commercial varieties evaluated under late (330 DAP) infestation condition

Source	d.f.	MSS for the characters													
		Germination % at 45 DAP	Tillers at 90 DAP	Average single cane weight (kg) at harvest	Average millable cane height (cm) at harvest	Average cane girth (cm) at harvest	Average No. of internodes at harvest	NMC / Plot	Brix % Juice at harvest	Sucrose % Juice at harvest	Juice Extraction % at harvest	Purity % at harvest	CCS % at harvest	CCS yield (t/ha)	Cane yield (t/ha)
Genotype	12	440.20*	13824.31**	0.479**	4290.11	0.429**	16.139**	21105.10**	4.017**	2.437*	51.124	14.38	1.239	91.29**	3187.41**
Error	24	162.4	1428.25	0.055	4759.79	0.015	2.679	3963.8	1.148	1.007	60.279	17.89	0.647	5.97	108.28
SEm		7.35	21.81	0.135	39.832	0.07	0.945	36.34	0.619	0.579	4.483	2.44	0.464	0.95	6
CD @ 5%		21.47	63.68	0.395	NS	0.205	2.758	106.1	1.805	1.691	NS	NS	NS	2.79	17.53
CD @ 1%		NS	86.29	0.535	NS	0.278	3.737	143.75	2.446	NS	NS	NS	NS	3.79	23.76

*, ** Significant at 5 and 1 per cent respectively

Table 60. Analysis of variance for different sugar yield parameters (at 300 and 330 DAP) of SWA resistant progenies and commercial varieties evaluated under late (330 DAP) infestation condition

Source	d.f.	MSS for the characters									
		Brix % Juice at 300 DAP	Sucrose % Juice at 300 DAP	Juice Extraction % at 300 DAP	Purity % at 300 DAP	CCS % at 300 DAP	Brix % Juice at 330 DAP	Sucrose % Juice at 330 DAP	Juice Extraction % at 330 DAP	Purity % at 330 DAP	CCS % at 330 DAP
Genotype	12	11.35**	10.96**	94.80*	122.04*	6.57**	7.42**	9.63	72.45	36.79	4.39
Error	24	0.97	1.47	42.06	42.15	1.11	0.82	8.32	33.5	21.33	0.45
SEm		0.57	0.7	3.74	3.74	0.61	0.52	1.66	3.34	2.66	0.38
CD @ 5%		1.66	2.04	10.93	10.94	1.78	1.53	NS	NS	NS	1.13
CD @ 1%		2.25	2.77	NS	NS	2.41	2.07	NS	NS	NS	1.53

*, ** Significant at 5 and 1 per cent respectively

Table 61. Growth and cane yield parameters of SWA resistant progenies at harvest (360 DAP) under late (330 DAP) infestation conditions

Progenies	Cross	Av. Cane girth (cm)	Av. Cane mill. Ht. (cm)	Av. No. of Internodes	Av. Single c. wt. (kg)	Av. No. of Mill. Canes / Plot	Cane Yield (t/ha)	SWA grade
1. SNK 158	Co 7704 X CoC 671	2.53	227.50	17.50	1.30	64.00	76.84	0
2. SNK 256	Co 88028 X Co 88025	1.80	284.33	17.66	0.71	218.60	136.75	0
3. SNK 192	Co 86249 X CoC 671	2.37	173.00	17.66	0.95	87.00	69.30	0
4. SNK 049	Co740 X CoA 7602	2.83	189.94	20.66	1.71	103.16	159.54	0
5. SNK 002	Co 740 X Co 88028	1.79	152.03	17.00	0.56	68.63	33.88	0
6. SNK 754	CoC 671 Poly Cross	2.45	197.00	18.50	1.01	120.50	116.42	0
7. SNK 044	Co740 X CoA 7602	2.74	221.00	18.50	1.48	89.00	120.42	0
8. SNK 061	Co 740 X MS 6847	2.47	266.00	21.66	1.55	88.33	126.12	0
9. SNK 057	Co740 X CoA 7602	2.79	236.33	18.66	1.55	78.66	112.88	0
10. SNK 124	Co 7704 X CoC 671	2.35	263.00	16.83	1.08	85.00	82.54	0
Checks								
11. CoM88121		2.73	232.83	21.66	1.35	81.66	95.17	3
12. CoC671		3.04	242.66	24.66	1.88	50.80	88.24	3
13. Co86032		2.79	228.16	20.33	1.63	65.00	95.94	4
S.Em±		0.07	39.83	0.94	0.13	12.11	6.00	-
CD @ 5%		0.20	NS	2.75	0.39	33.05	17.53	-

4.3.4.2.2 At late (330 DAP) infestation condition

The mean values obtained for various characters included in the study in respect of all the SWA resistant progenies are provided in Table 61 to 63 . Analysis of variance for the twenty four characters (Table 59 and 60) revealed that, the mean sum of squares were highly significant for tillers per plot, average cane girth, average number of internodes, average single cane weight, average number of millable canes per plot, brix per cent (300, 330 and 360 DAP), sucrose per cent (300 DAP), CCS per cent (300, 330 DAP) and cane yield. The characters germination per cent (45 DAP), sucrose per cent (360 DAP), purity per cent (300 DAP) and juice extraction per cent (300 DAP) had mean sum of squares significant at only 5 per cent level whereas, average cane height, juice extraction per cent (330 and 360 DAP), purity (330 and 360 DAP), CCS per cent (360 DAP) and sucrose per cent (330 DAP) had non significant mean sum of squares. Therefore, the traits which are significant either at 1 per cent or 5 per cent probability levels only are discussed in this section. The resistant progenies scored 0 grade while the commercial check varieties recorded 3-4 grade under natural late (330 DAP) infestation conditions.

Table 59. Analysis of variance for different growth, cane and sugar yield parameters of SWA resistant progenies and commercial varieties evaluated under late (330 DAP) infestation condition

Table 60. Analysis of variance for different sugar yield parameters (at 300 and 330 DAP) of SWA resistant progenies and commercial varieties evaluated under late (330 DAP) infestation condition

4.3.4.2.2.1 Average cane girth

The progeny SNK049 (2.83 cm) had thickest canes followed by SNK057 (2.79 cm) and SNK044 (2.74 cm), whereas thinnest canes were found in the progeny SNK002 (1.79 cm) followed by SNK256 (1.80 cm) and SNK192 (2.37 cm).

4.3.4.2.2 Average number of internodes

Highest number of internodes were observed in the progeny SNK061 (21.66) followed by SNK049 (20.66) and SNK057 (18.66) which were inferior to best check CoC671 (24.66) whereas, SNK002 recorded lowest (17.00) internodes followed by SNK158 (17.50) and SNK256 (17.66).

4.3.4.2.2.3 Average single cane weight

Heaviest canes were recorded in the SWA resistant progeny SNK049 (1.71 kg) followed by SNK061, SNK057 (1.55 kg) and SNK044 (1.48 kg) where in former three progenies though inferior were statistically on par with best check CoC671 (1.88 kg). On the contrary, lightest canes were observed in the progeny SNK002 (0.56 kg) followed by SNK256 (0.71 kg) and SNK192 (0.95 kg).

4.3.4.2.2.4 Average number of millable canes

The SWA resistant progenies showed higher variability for this important cane yield contributing trait. Highest number of millable canes were recorded in SNK256 (218.60) followed by SNK754 (120.5) and SNK049 (103.16) where, former two progenies were significantly superior to best CoM88121 (81.66), whereas the third progeny was statistically on par with the best check. Lowest number of millable canes were noticed in SNK158 (64.0) followed by SNK002 (68.83) and SNK057 (78.50).

4.3.4.2.2.5 Cane yield

The progeny SNK049 (159.54 t/ha) was most productive with respect to cane yield followed by SNK256 (136.75 t/ha), SNK061 (126.71 t/ha), SNK044 (120.42 t/ha), SNK754 (116.42 t/ha) which were significantly superior to best check Co86032 (95.94 t/ha), whereas SNK057 (112.88 t/ha) was statistically on par with it. Lowest cane yield was recorded in SNK002 (33.88 t/ha) followed by SNK192 (69.30 t/ha) and SNK158 (76.84 t/ha) which were inferior to best check.

Table 62.Sugar yield parameters of SWA resistant progenies at 300 and 330 days after planting under late (330 DAP) infestation conditions

Progenies	Cross	At 300 DAP					At 330 DAP				
		Juice Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	Juice Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)
1. SNK 158	Co 7704 X CoC 671	54.66	14.19	8.37	58.66	4.38	49.00	18.43	13.37	72.33	11.23
2. SNK 256	Co 88028 X Co 88025	46.00	13.69	9.19	67.00	5.38	51.66	17.45	12.99	74.00	10.78
3. SNK 192	Co 86249 X CoC 671	59.33	14.38	10.56	73.00	6.58	62.00	18.50	14.07	76.00	11.56
4. SNK 049	Co740 X CoA 7602	68.33	15.11	10.96	72.66	6.78	60.00	19.42	16.08	82.33	12.71
5. SNK 002	Co 740 X Co 88028	52.33	15.24	10.65	69.00	6.43	63.66	18.96	13.96	73.66	11.65
6. SNK 754	CoC 671 Poly Cross	60.33	17.09	12.02	70.00	7.29	56.66	21.21	16.90	79.33	13.59
7. SNK 044	Co740 X CoA 7602	56.66	16.87	11.15	67.00	6.46	61.66	20.86	11.90	81.66	13.59
8. SNK 061	Co 740 X MS 6847	62.90	16.38	11.71	71.33	7.20	63.16	21.64	17.74	82.33	14.08
9. SNK 057	Co740 X CoA 7602	61.66	13.91	9.90	71.00	7.06	56.33	20.07	15.91	80.33	12.68
10.SNK 124	Co 7704 X CoC 671	55.33	13.19	7.43	76.00	3.74	62.00	19.24	15.46	80.23	12.40
Checks											
11. CoC671		53.00	10.79	6.52	60.33	3.17	66.16	17.58	13.59	76.66	11.08
12. Co86032		58.33	12.31	8.20	66.26	4.78	62.00	17.08	12.94	75.33	10.65
13. CoM88121		54.00	11.67	6.52	54.66	3.27	60.66	16.92	12.81	75.66	10.58
SEm		3.74	0.57	0.70	3.74	0.61	3.34	0.52	1.66	2.66	0.38
CD @ 5%		10.93	1.66	2.04	10.94	1.78	NS	1.53	NS	NS	1.13

Table 63. Sugar yield and it's parameters of SWA resistant progenies at harvest (at 360 DAP) under late 330 DAP) infestation conditions

Progenies	Cross	Juice Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	CCS Yield (t/ha)
1. SNK 158	Co 7704 X CoC 671	55.00	17.79	15.68	88.00	11.11	8.57
2. SNK 256	Co 88028 X Co 88025	57.00	16.62	14.41	86.66	9.83	13.47
3. SNK 192	Co 86249 X CoC 671	57.06	18.06	15.63	86.33	10.70	7.42
4. SNK 049	Co740 X CoA 7602	62.00	19.19	16.49	85.66	11.24	17.89
5. SNK 002	Co 740 X Co 88028	69.33	19.39	16.61	85.33	11.31	3.69
6. SNK 754	CoC 671 Poly Cross	55.66	20.92	17.57	83.66	11.84	13.80
7. SNK 044	Co740 X CoA 7602	58.33	20.62	17.58	85.33	11.94	14.40
8. SNK 061	Co 740 X MS 6847	60.66	19.42	17.57	19.00	12.28	15.51
9. SNK 057	Co740 X CoA 7602	56.66	18.75	16.68	83.66	10.55	11.88
10. SNK 124	Co 7704 X CoC 671	52.66	18.79	16.57	88.33	11.45	9.45
Checks							
11. CoM88121		60.66	18.69	15.94	85.33	10.83	10.29
12. CoC671		57.00	17.89	16.26	90.33	11.39	10.06
13. Co86032		59.66	18.39	16.01	88.66	11.33	10.81
SEm		4.48	0.61	0.57	2.44	0.46	0.96
CD @ 5%		NS	1.80	1.69	NS	NS	2.79

Table 64 : Genotypic path analysis for cane yield per plot showing direct and indirect effects of various important growthcane and sugar yield component traits in productive sugarcane progenies grown under moisture stress environment

Table 64: Genotypic path analysis for cane yield per plot showing, direct and indirect effects of various important growth, cane and sugar yield component traits in productive sugarcane progenies grown under moisture stress environment

Characters	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	Correlation with cane yield
X ₁	0.000	0.001	-0.018	0.065	-0.021	-0.008	0.000	0.035	-0.003	0.024	-0.002	-0.004	0.001	-0.010	0.007	0.071	-0.008	-0.023	0.017	-0.011	0.205
X ₂	0.001	0.000	-0.006	0.058	-0.002	-0.011	0.001	-0.055	0.001	0.117	0.045	-0.012	0.003	-0.004	0.020	0.027	0.018	-0.028	0.055	-0.010	0.302
X ₃	0.019	0.008	-0.008	0.035	-0.006	0.002	0.000	0.044	-0.004	0.098	0.010	-0.010	0.003	-0.012	0.020	0.056	0.021	0.011	0.020	0.005	0.232
X ₄	0.046	0.040	-0.024	0.125	-0.019	-0.005	0.001	-0.004	-0.004	0.136	0.027	-0.014	0.004	-0.013	0.036	0.091	0.010	-0.035	0.092	-0.011	0.477
X ₅	0.019	0.002	-0.006	0.025	-0.006	0.005	0.001	0.043	-0.002	0.021	-0.009	-0.008	0.001	-0.006	0.007	-0.020	-0.008	-0.007	0.032	-0.003	-0.011
X ₆	0.014	0.023	0.003	0.017	0.011	-0.041	0.001	-0.110	0.003	0.054	0.042	0.007	-0.001	-0.001	0.002	0.042	0.019	-0.028	0.082	0.004	0.141
X ₇	-0.009	-0.018	0.009	-0.031	0.015	0.009	-0.004	-0.002	0.002	-0.119	-0.028	0.021	-0.004	0.008	-0.023	-0.098	-0.006	0.048	-0.088	0.004	-0.315
X ₈	-0.014	0.022	0.017	0.002	0.019	-0.021	0.000	-0.217	0.008	-0.046	0.029	0.003	-0.001	0.004	-0.022	-0.011	0.042	0.011	0.060	0.016	-0.131
X ₉	0.015	-0.002	-0.016	0.024	-0.009	0.006	0.000	0.091	-0.019	0.116	-0.006	-0.011	0.001	-0.008	0.029	0.026	-0.004	-0.045	0.046	-0.004	0.229
X ₁₀	0.006	0.030	-0.024	0.050	-0.006	-0.006	0.001	0.029	-0.007	0.343	0.044	-0.023	0.005	-0.012	0.046	0.120	0.009	-0.025	0.116	-0.002	0.694
X ₁₁	-0.002	0.047	-0.011	0.040	0.011	-0.020	0.001	-0.074	0.001	0.180	0.064	-0.016	0.005	-0.011	0.031	0.069	0.029	0.023	0.121	0.005	0.511
X ₁₂	0.006	0.015	-0.012	0.026	-0.013	0.004	0.001	0.009	-0.003	0.114	0.020	-0.009	0.011	-0.025	0.056	0.099	-0.005	-0.036	0.076	0.001	0.277
X ₁₃	0.004	0.019	-0.016	0.033	-0.005	0.004	0.001	0.018	-0.001	0.108	0.027	-0.048	0.016	-0.027	0.079	0.127	0.001	-0.009	0.077	-0.009	0.399
X ₁₄	0.019	0.008	-0.021	0.035	-0.012	-0.001	0.001	0.019	-0.003	0.088	0.019	-0.036	0.009	-0.047	0.100	0.104	0.016	0.019	0.099	-0.001	0.415
X ₁₅	0.005	0.012	-0.012	0.032	-0.005	-0.001	0.001	0.034	-0.004	0.112	0.019	-0.028	0.009	-0.033	0.141	0.114	0.026	-0.038	0.104	-0.013	0.474
X ₁₆	0.023	0.008	-0.017	0.041	0.007	-0.008	0.001	0.009	-0.002	0.148	0.021	-0.024	0.007	-0.018	0.058	0.279	0.008	-0.068	0.085	-0.002	0.557
X ₁₇	-0.008	0.012	-0.017	0.011	0.007	-0.007	0.000	-0.024	0.001	0.028	0.022	0.003	0.000	-0.007	0.033	0.021	0.109	-0.014	0.090	0.021	0.283
X ₁₈	0.007	0.006	0.003	0.015	-0.002	-0.004	0.001	0.008	-0.003	0.028	-0.007	-0.008	0.000	0.003	0.018	0.063	0.005	-0.302	0.043	0.007	-0.118
X ₁₉	0.007	0.020	-0.007	0.048	-0.013	-0.014	0.001	-0.055	-0.004	0.188	0.043	-0.022	0.005	-0.020	0.062	0.100	0.041	-0.055	0.237	0.001	0.543
X ₂₀	-0.013	-0.011	-0.006	-0.019	0.004	-0.002	0.000	-0.046	0.001	-0.008	0.005	-0.001	-0.002	0.001	-0.025	-0.008	0.031	-0.027	0.002	0.075	-0.050

*, ** Significant at 5 and 1 per cent levels respectively

Residual = 0.2336

X₁ - Average cane girth
X₂ - Average number of internodes
X₃ - Juice extraction per cent
X₄ - Tiller mortality per cent at 80 DAP
X₅ - Tiller mortality per cent at 120 DAP
X₆ - Internode formed shoots at 160 DAP
X₇ - Root dry weight per clump
X₈ - Average long root length
X₉ - Leaf sheath moisture per cent
X₁₀ - LAI at 150 DAP

X₁₁ - Average millable cane height
X₁₂ - Average single cane weight
X₁₃ - Average number of tillers at 80 DAP
X₁₄ - Average number of tillers at 120 DAP
X₁₅ - Internode formed shoots at 120 DAP
X₁₆ - Average number of roots per clump
X₁₇ - Average root length
X₁₈ - 8th leaf area
X₁₉ - RWC per cent
X₂₀ - MTA at 150 DAP

4.3.4.2.2.6. Juice extraction per cent

This sugar yield parameter at 330 and 360 DAP had non significant differences among progenies and commercial checks, however at 300 DAP resistant progenies SNK049 (68.33 %), SNK061 (62.9 %), SNK057 (61.66 %), SNK754 (60.33 %), SNK192 (59.33 %), SNK044 (56.66 %) and SNK124 (55.33 %) were on par with best check Co86032 (58.33 %). Lowest juice extraction per cent was noticed in SNK256 (46.00 %) followed by SNK002 (52.33 %) and SNK158 (54.66 %).

4.3.4.2.2.7. Brix per cent (juice)

Juice brix per cent at 300 DAP was highest in SNK754 (17.09 %) followed by SNK044 (16.87 %), SNK061 (16.38 %), SNK002 (15.24 %) and SNK049 (15.11 %) which were significantly superior to best check Co86032 (12.31 %) whereas, all other resistant progenies recorded brix per cent on par with best check Co86032.

This attribute was quantified at 330 DAP also where in highest brix per cent was recorded in SNK061 (21.64 %) followed by SNK754 (21.21 %), SNK044 (20.86 %), SNK057 (20.07 %) and SNK049 (19.42 %) which were significantly superior to best check CoC671 (17.58 %) whereas, lowest brix was observed in SNK256 (17.45 %) followed by SNK158 (18.43 %) and SNK192 (18.50 %) which were on par statistically with best check.

But at harvest (360 DAP), only two progenies SNK754 (20.92 %) and SNK044 (20.62 %) has significantly superior brix value over best check CoM88121 (18.69 %) whereas, all other progenies except SNK256 (16.62 %) had statistically on par values with best check.

4.3.4.2.2.8 Sucrose per cent in juice

Highest sucrose per cent at 300 DAP was recorded in SNK754 (12.02 %) followed by SNK061 (11.71 %) and SNK044 (11.15 %) which were significantly superior to best check Co86032 (8.20%) whereas lowest sucrose per cent was observed in SNK124 (7.43 %) followed by SNK158 (8.37 %) and SNK256 (9.19 %) which were statistically on par with best check.

All the resistant progenies except the three, SNK256 (14.41 %), SNK192 (15.63 %) and SNK158 (15.68 %) were found on par with best check CoC671 (16.26 %) for Sucrose per cent juice at harvest (360 DAP).

4.3.4.2.2.9 Purity per cent

All the SWA resistant progenies except the progeny SNK158 (58.66%) were numerical superior over best check Co86032 (66.26 %) for purity per cent at 300 DAP.

4.3.4.2.2.10. CCS per cent

The progeny SNK754 (7.29%) recorded highest CCS per cent followed by SNK061 (7.20 %), SNK057 (7.06 %), SNK049 (6.78 %), SNK192 (6.58 %) which were significantly superior over best check Co86032 (4.78 %) whereas, lowest CCS per cent was observed in SNK124 (3.74 %) followed by SNK158 (4.38 %), SNK256 (5.38%), SNK 002 (6.43%) which were statistically on par with best check at 300 DAP.

Similar trend was observed at 330 DAP with the progeny SNK061 (14.08%), being the highest followed by SNK754 (13.59%), SNK044 (13.59%), SNK049 (12.71%), SNK057 (12.68%) which were significantly superior over the best check CoC 671 (11.08%), whereas, lowest CCS was recorded in SNK256 (10.78%) followed by SNK158 (11.23%), and SNK192 (11.56%), which were on par with the best check.

4.3.4.2.2.11. CCS yield

Highest CCS yield was recorded in SNK049 (17.89 t/ha) followed by SNK061 (15.51 t/ha), SNK044 (14.40 t/ha) and SNK754 (13.80 t/ha), which were significantly superior over best check Co86032 (10.81 t/ha) whereas, except SNK002 (3.69 t/ha) and SNK192 (7.42 t/ha), the other four progenies, SNK 256 (13.47 t/ha), SNK057 (11.88 t/ha), SNK124 (9.45 t/ha) and SNK158 (8.57 t/ha) were statistically on par with best check.

4.4 PATH ANALYSIS OF CANE YIELD WITH ITS COMPONENTS AND PHYSIOLOGICAL TRAITS UNDER MOISTURE, SALINITY WATER LOGG COMPLEX STRESS AND NORMAL IRRIGATED ENVIRONMENTS

4.4.1 Under moisture stress environment at Sankeshwar

4.4.1.1 Cane and sugar yield components and physiological traits

The path coefficient analysis at genotypic level was worked out for cane yield at clonal stage III comprising of 50 superior clones with 3 checks by considering important cane yield, quality and physiological traits. The results are presented below with respect to genotypic path coefficient analysis (Table 64).

4.4.1.1.1 Direct effects

Internode formed shoots at 120 DAP (0.343) recorded highest direct positive effect on cane yield per plot followed by eighth leaf area (0.279), leaf area index (0.237), average long root length (0.141), average single cane weight (0.125), leaf sheath moisture per cent (0.109), average cane height (0.086) and internode formed shoots at 160 DAP (0.084). However, there was high negative direct effect exhibited by relative water content (-0.302), tiller number at 120 DAP (-0.217), juice extraction per cent (-0.096) and average number of internodes (-0.086). Lowest negative direct effect was recorded in tiller mortality at 80 DAP (-0.004) followed by tiller mortality at 120 DAP (-0.019), on cane yield per plot at genotypic level.

4.4.1.1.2 Indirect effects

4.4.1.1.2.1 Average cane girth

Average cane girth exhibited its major indirect effect through eighth leaf area (0.071) followed by single cane weight (0.065), tiller number (at 120 DAP (0.035), internode formed shoots at 120 DAP (0.024) and LAI at 150 DAP (0.017) however, these values were comparatively lower, whereas lowest indirect positive effect was recorded through tiller mortality at 80 DAP (0.001) followed by root dry matter (0.001). This attribute had its highest negative indirect effect through relative water content (-0.023) followed by juice extraction per cent at harvest (-0.021).

4.4.1.1.2.2 Average millable cane height

Highest positive indirect effect of average millable cane height on cane yield per plot was through internode formed shoots at 120 DAP (0.117). The single cane weight contributed comparatively lower (0.058) effect on average millable cane height followed by LAI at 150 DAP (0.055), whereas lowest positive effect was recorded through average cane girth and tiller mortality (at 80 and 120 DAP) (each 0.001). Comparatively a higher negative effect was obtained through tiller number at 120 DAP (-0.055) followed by relative water content (-0.026) and average root number (-0.012).

4.4.1.1.2.3 Average number of internodes

Internode number at harvest had highest positive indirect effects on cane yield per plot through internode formed shoots at 120 DAP (0.098) followed by eighth leaf area (0.056), tiller number at 120 DAP (0.044) and single cane weight (0.035), whereas highest negative indirect effect was through average root length (-0.012) followed by average number of roots (-0.010) and juice extraction per cent (-0.006).

4.4.1.1.2.4 Average single cane weight

This attribute had negative indirect effect on cane yield per plot mainly through relative water content (-0.035), average number of internodes (-0.024) and juice extraction per cent (-0.019). The highest positive indirect effect on cane yield per plot was through internode formed shoots at 120 DAP (0.136), followed by LAI at 150 DAP (0.092), eighth leaf area (0.091), average cane girth (0.046) and average cane height (0.040).

4.4.1.1.2.5 Juice extraction per cent

The major positive contribution of juice extraction per cent on cane yield per plot was through tiller number at 120 DAP (0.043) followed by LAI at 150 DAP (0.032), single cane weight (0.025) and internode formed shoots at 120 DAP (0.021). The highest negative indirect effects were through internode formed shoots at 160 DAP and average number of roots (-0.009) followed by leaf sheath moisture per cent (-0.008) and relative water content (-0.007).

4.4.1.1.2.6 Tiller number at 80 DAP

The tiller number at 80 DAP had its positive indirect impact on cane yield per plot through LAI at 150 DAP (0.082), internode formed shoots at 120 DAP (0.054), eighth leaf area and internode formed shoots at 160 DAP (each 0.042).

This attribute contributed negatively to the cane yield through tiller number at 120 DAP (-0.110) followed by relative water content (-0.028).

4.4.1.1.2.7 Tiller mortality per cent at 80 DAP

The highest positive contribution of this character towards cane yield per plot was through relative water content (0.048) followed by average root number (0.021), whereas the lowest positive indirect effect was through tiller mortality per cent at 120 DAP (0.002).

The highest negative indirect effect was through internode formed shoots at 120 DAP (-0.119) followed by eighth leaf area (-0.098) and LAI at 150 DAP (-0.086).

4.4.1.1.2.8 Tiller number at 120 DAP

The indirect contribution of tiller number at 120 DAP was the highest and positive on cane yield per plot through LAI at 150 DAP (0.060) followed by internode formed shoots at 160 DAP (0.029) and average cane height (0.022). The negative indirect effect of this trait was exerted through internode formed shoots at 120 DAP (-0.046), average long root length (-0.022) and tiller number of 80 DAP (-0.021).

4.4.1.1.2.9 Tiller mortality per cent at 120 DAP

The path analysis revealed that the tiller mortality per cent at 120 DAP exerted high positive indirect effect through internode formed shoots at 120 DAP (0.116) followed by tiller number at 120 DAP (0.091), LAI at 150 DAP (0.046) and average long root length (0.029). This attribute contributed negatively on cane yield per plot through relative water content (-0.046), followed by number of internodes (-0.016) and average number of roots (-0.011).

4.4.1.1.2.10 Internode formed shoots at 120 DAP

This trait had highest positive indirect effect on cane yield per plot through eighth leaf area (0.120) followed by LAI at 150 DAP (0.116), single cane weight (0.050) and average long root length (0.046).

The highest negative impact was through relative water content (-0.025) followed by average number of internodes (-0.024) and average number of roots (-0.023).

4.4.1.1.2.11 Internode formed shoots at 180 DAP

Internode formed shoots at 160 DAP had highest positive contribution towards cane yield per plot was through internode formed shoots at 120 DAP (0.180) followed by LAI at 150 DAP (0.121), eighth leaf area (0.069) and average cane height (0.047), whereas lowest positive effect was through tiller at 80 and 120 DAP (0.001). The negative impact was recorded through tiller number of 120 DAP (-0.074) followed by tiller number at 80 DAP (-0.020) and average number of roots (-0.016).

4.4.1.1.2.12 Average root number per clump

The root number per clump contributed towards cane yield per plot through internode formed shoots at 120 DAP (0.114) followed by eighth leaf area (0.099), LAI at 150 DAP (0.076) and average long root length (0.058) while, the lowest positive contribution was through tiller mortality at 80 DAP and MTA (0.001). However, negative impact was seen through relative water content (-0.035) followed by average root length (-0.025) and juice extraction per cent (-0.013).

4.4.1.1.2.13 Root dry matter

The direct effect of root dry matter revealed a positive effect on cane yield per plot through eighth leaf area (0.127); internode formed shoots at 120 DAP (0.108) and average root length (0.079) whereas major negative indirect effect was through average root number (-0.048) followed by average long root length (-0.027) and average number of internodes (-0.015).

4.4.1.1.2.14 Average root length

This attribute had highest positive indirect effect on cane yield per plot through eighth leaf area (0.104) followed by average long root length (0.100), LAI at 150 DAP (0.099) and internode formed shoots at 120 DAP (0.088). The highest negative impact was recorded through average number of roots (-0.036) followed by average number of internodes (-0.021) and juice extraction per cent (-0.012).

4.4.1.1.2.1.15 Average long root length

The path analysis revealed that the average long root length exerted high positive indirect effect through eighth leaf area (0.114) followed by internode formed shoots at 120 DAP (0.112), LAI at 150 DAP (0.104) and tiller number at 120 DAP (0.034), while lowest positive effect was through tiller mortality at 80 DAP (0.001). The highest negative indirect effect on cane yield per plot was through relative water content (-0.038) followed by average root length (-0.033) and average number of roots (-0.028).

4.4.1.1.2.16 Eighth leaf area

Eighth leaf area had major positive indirect effect through internode formed shoots at 120 DAP (0.148) followed by LAI at 150 DAP (0.085) and average long root length (0.058) while, lowest positive effect through tiller mortality at 80 DAP (0.001). The highest negative indirect effect was through relative water content (-0.068) followed by average number of roots (-0.024) and average root length (-0.18).

4.4.1.1.2.17 Leaf sheath moisture

The major indirect positive contribution of leaf sheath moisture to cane yield per plot through LAI at 150 DAP (0.090) followed by average long root length (0.033) and internode formed shoots at 160 DAP (0.022) while, highest negative impact of this attribute was through tiller number at 120 DAP (-0.024) followed by average number of internodes (-0.017) and relative water content (-0.014).

4.4.1.1.2.18 Relative water content

The major impact of this attribute on cane yield per plot was observed through eighth leaf area (0.063) followed by LAI at 150 DAP (0.043) and internode formed shoots at 120 DAP (0.028). However, highest negative indirect effect was through average number of roots (-0.008) followed by tiller number at 80 DAP (-0.004).

4.4.1.1.2.19 LAI at 150 DAP

Leaf area index at 150 DAP had major negative indirect impact on cane yield through tiller number at 120 DAP (-0.055) followed by average number of roots (-0.022) however, values were comparatively lower. The highest positive indirect impact on cane yield was through internode formed shoots at 120 DAP (0.168) followed by eighth leaf area (0.100) and average long root length (0.062) while, lowest positive contribution was through tiller mortality at 80 DAP and MTA at 150 DAP (0.001).

4.4.1.1.2.20 Mean tilt angle

Mean tilt angle exerted its major positive effect on cane yield per plot through leaf sheath moisture per cent (0.031) followed by internode formed shoots at 160 DAP (0.005), however the values were comparatively lower. The highest negative impact was through tiller number at 120 DAP (-0.046) followed by relative water content (-0.027).

4.4.1.2 Biophysical traits

The path coefficient analysis at genotypic level was worked out for cane yield at clonal stage III by considering six important biophysical traits under both moisture stress and non stress (after alleviation from stress) conditions. The results pertaining to genotypic path coefficient analysis are presented in Table 65.

4.4.1.2.1 Direct effects

Light use efficiency under stress (at mid formative stage) (5.322) recorded highest direct positive effect on cane yield per plot whereas, photosynthesis rate under non stress (after alleviation stress) (0.716) and stomatal stomatal conductance under stress (0.391) had moderate direct positive effect. Lower positive direct effect was exhibited by water use efficiency under non stress (0.149) whereas lowest positive direct effect was noticed by water use efficiency under stress (0.072). However, there was high negative direct effect on cane yield by photosynthesis rate under stress (-6.001) followed by transpiration rate rate under stress (-0.644) and leaf temperature (-0.344) after alleviation of stress. Lower negative direct effects were exhibited at genotypic level by leaf temperature under stress (-0.161), transpiration rate rate under stress (-0.033) and stomatal stomatal conductance under non stress (-0.007).

4.4.1.2.2 Indirect effects

4.4.1.2.2.1 Rate of photosynthesis

A high positive indirect contribution of photosynthesis rate under stress to cane yield per plot was through light use efficiency under stress (5.323) while it was moderate through stomatal conductance under stress (0.420) and lower through photosynthesis rate under non stress (0.126), leaf temperature under stress (0.118) and leaf temperature under non stress (0.081) and transpiration rate under non stress (0.077). However, the major indirect negative contribution was through water use efficiency under stress (-0.043), transpiration rate under stress (-0.030) and light use efficiency under non stress (-0.019) and low indirect negative effect through water use efficiency under non stress (-0.005).

Photosynthesis under non stress has its higher positive effects through light use efficiency under stress (0.946), while lower positive effects through stomatal conductance under stress (0.056), water use efficiency under non stress (0.050) and light use efficiency (0.043). However, major negative effects on cane yield per plot photosynthesis rate at stress (-0.057) through transpiration rate under non stress (-0.202), while lower negative effects through leaf temperature under non stress (-0.110), leaf temperature under stress (-0.031), water use efficiency under stress (-0.024) transpiration rate under stress (-0.01) and stomatal conductance under non stress (-0.002).

4.4.1.2.2.2 Stomatal conductance

Highest positive effect of stomatal conductance on cane yield per plot was through light use efficiency under stress (5.706) followed by leaf temperature under stress (0.230) transpiration rate under stress (0.104) and photosynthesis rate under non stress (0.102) while lower positive effects were observed through leaf temperature under non stress (0.089) and water use efficiency under non stress (0.031). However, lower negative effects were recorded through light use efficiency under non stress (-0.045), water use efficiency under non stress (-0.045), water use efficiency under stress (-0.029) and transpiration rate under non stress (-0.027), with lowest being through photosynthesis under stress (-6.445).

Table 65. Genotypic path analysis for cane yield per plot showing, direct and indirect effects of biophysical traits under moisture stress and after alleviation of stress in productive sugarcane progenies grown under moisture stress environment

Characters	At stress						After alleviation of stress						Correlation with cane yield
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	
X ₁	-6.001	0.420	-0.030	0.118	-0.043	5.323	0.126	0.000	0.077	0.081	-0.005	-0.019	0.046
X ₂	-6.445	0.391	-0.027	0.230	-0.029	5.706	0.102	-0.002	0.104	0.089	0.031	-0.045	0.105
X ₃	-5.543	0.324	-0.033	0.114	-0.062	4.935	0.229	0.000	0.091	-0.041	0.052	-0.053	0.014
X ₄	4.397	-0.559	0.023	-0.161	0.034	-3.753	0.138	-0.003	0.066	-0.333	0.161	-0.225	-0.215
X ₅	3.636	-0.160	0.028	-0.077	0.072	-3.268	-0.236	-0.001	-0.135	-0.107	-0.114	0.104	-0.044
X ₆	-6.003	0.419	-0.030	0.113	-0.044	5.322	0.127	0.000	0.079	0.082	-0.003	-0.022	0.040
X ₁	-1.057	0.056	-0.010	-0.031	-0.024	0.946	0.716	-0.002	-0.202	-0.110	0.050	0.043	0.375*
X ₂	-0.324	0.125	0.001	-0.076	0.007	0.273	0.208	-0.007	-0.557	0.057	0.035	0.230	-0.026
X ₃	0.717	-0.063	0.005	0.017	0.015	-0.650	0.225	-0.006	-0.644	-0.022	0.039	0.294	-0.075
X ₄	1.413	-0.101	-0.004	-0.156	-0.022	-1.261	0.228	0.001	-0.041	-0.344	0.079	-0.076	-0.284
X ₅	0.206	0.081	-0.011	-0.174	-0.055	-0.095	0.240	-0.002	-0.168	-0.183	0.149	-0.050	-0.061
X ₆	-0.348	0.054	-0.005	-0.110	-0.023	0.362	-0.094	0.005	0.575	-0.080	0.023	-0.329	-0.030

* Significant at 5 per cent level

X₁ - Photosynthesis rate

X₃ - Transpiration rate

X₅ - Water use efficiency

X₂ - Stomatal conductance

X₄ - Leaf temperature

X₆ - Light use efficiency

Residual = 0.5942

Conductance under non stress had positive effects on cane yield per plot through light use efficiency under stress (0.273) and non stress (0.230) conditions and photosynthesis rate under non stress (0.208). Lower positive effects were recorded through leaf temperature under stress (0.057) water use efficiency under non stress (0.035) and transpiration rate under stress (0.001). Negative major effects was seen through transpiration rate under non stress (-0.0557) and lowest by leaf temperature under stress (-0.076).

4.4.1.2.2.3 Transpiration rate

Transpiration rate under stress had highest positive effect through light use efficiency under stress (4.935) on cane yield per plot, followed by stomatal conductance under stress (0.324) and photosynthesis rate under non stress (0.229) while lowest positive effect was through transpiration rate under non stress (0.091) water use efficiency under non stress (0.052). There was high negative effect on cane yield per plot through photosynthesis rate under stress (-5.543), while lowest negative effects were recorded through leaf temperature under non stress (-0.041) followed by light use efficiency under non stress (-0.053) and water use efficiency under stress (-0.062).

There was high positive effect of transpiration rate under non stress through photosynthesis rate under stress (0.717) followed by that of in non stress (0.225) and light use efficiency under non stress (0.294) while lowest positive effect was through transpiration rate under stress (0.005). Highest negative effect was through light use efficiency under stress (-0.650) followed by leaf temperature under non stress (-0.022).

4.4.1.2.2.4 Leaf temperature

The major positive contribution of leaf temperature under stress to cane yield per plot was through photosynthesis rate under stress (4.397) followed by water use efficiency under non stress (0.161) and photosynthesis rate under non stress (0.138) which were comparatively moderate, whereas lowest positive contribution was through transpiration rate (0.023). Highest negative contribution was through light use efficiency under stress (-3.753) followed by stomatal conductance under stress (-0.559) and leaf temperature under non stress (-0.333).

In case of contribution of leaf temperature under non stress towards cane yield per plot, the highest positive contribution was through photosynthesis rate under stress (1.413) followed by that under non stress (0.228) whereas lowest effect was through stomatal conductance under non stress (0.001). However, highest negative effect was through light use efficiency under stress (-1.261) followed by leaf temperature under stress (-0.156).

4.4.1.2.2.5 Water use efficiency

A high positive indirect contribution of water use efficiency under stress was through photosynthesis rate under stress (3.636) and moderate positive effects were through leaf temperature (0.107) and light use efficiency (0.104) under non stress, while lowest positive effect was through transpiration rate (0.028) under stress. Highest negative contribution of water use efficiency under stress was through light use efficiency under stress (-3.268) followed by photosynthesis rate under non stress (-0.236) and stomatal conductance under stress (-0.160).

Water use efficiency under non stress contributed high positive effect through photosynthesis rate under non stress (0.240) and stress (0.206) followed by stomatal conductance under stress (0.081) which had lowest positive contribution. There was a moderate negative contribution through leaf temperature under non stress (-0.183) followed by that of under stress (-0.174) and transpiration rate under non stress (-0.168).

4.4.1.2.2.6 Light use efficiency

Stomatal conductance under stress (0.419) had played major role through which light use efficiency contributed towards cane yield per plot, followed by photosynthesis rate under non stress (0.127) and leaf temperature under stress (0.113), while lowest positive contribution was through transpiration rate under non stress (0.079). Higher negative contribution was recorded through photosynthesis rate under stress (-6.003) and lower negative contribution was through transpiration rate under stress (-0.030), water use efficiency under stress (-0.044) followed by transpiration rate under stress (-0.030).

Light use efficiency under non stress had contributed positively through transpiration rate under non stress (0.575) and light use efficiency under stress (0.362) while lowest positive contribution was through stomatal conductance under non stress (0.005). Highest negative contribution was through photosynthesis rate under stress (-0.348) followed by leaf temperature under stress (-0.110).

4.4.2. Under Salinity water logg complex environment

The path coefficient analysis at genotypic level was worked out for cane yield by considering twelve important component traits of cane and sugar yield. Results are presented below with respect to genotypic path coefficient analysis (Table 66).

Table 66. Genotypic path analysis for cane yield per plot showing direct and indirect effects in productive sugarcane progenies grown under salinity water logg complex environment

4.4.2.1. Direct effects

Number of millable canes per plot (1.710) recorded highest direct positive effect on cane yield per plot, whereas, brix per cent juice (0.403), internode formed shoots at 160 DAP (0.381), healthy shoots at 70 DAP (0.333), sucrose per cent in juice (0.316), single cane weight (0.295) and CCS per cent (0.212) had comparatively lower direct positive effect on cane yield per plot. However, there was high negative direct effect exhibited by germination per cent at 45 DAP (-1.005) followed by purity per cent (-0.788), healthy shoots at 160 DAP (-0.636), juice extraction per cent (-0.156) and germination per cent at 30 DAP (-0.053).

4.4.2.2 Indirect effects

4.4.2.2.1 Germination per cent at 30 DAP

Germination per cent at 30 DAP recorded a highest positive indirect effect through number of millable canes (1.446) followed by internode formed shoots at 160 DAP (0.304), brix per cent (0.272), healthy shoots at 70 DAP (0.199), sucrose per cent (0.194), CCS per cent (0.130) and the lowest positive effect through single cane weight (0.066). However, major negative indirect impact was seen through germination at 45 DAP (-0.967) followed by healthy shoots at 160 DAP (-0.392), purity per cent (-0.282) and juice extraction per cent (-0.065).

4.4.2.2.2 Germination per cent at 45 DAP

Germination per cent at 45 DAP had highest positive contribution to cane yield per plot through number of millable canes (1.508) followed by brix per cent (0.312), internode formed shoots at 160 DAP (0.308), sucrose per cent (0.221), healthy shoots at 70 DAP (0.166), CCS per cent (0.147) and lowest positive impact through single cane weight (0.061). Higher negative indirect effect was seen through healthy shoots at 160 DAP (-0.392) followed by purity per cent (-0.323), juice extraction per cent (-0.062) and germination per cent at 30 DAP (-0.051).

4.4.2.2.3 Healthy shoots at 70 DAP

The major indirect positive contribution of healthy shoots at 70 DAP to cane yield per plot was through number of millable canes (1.120) followed by internode formed shoots at 160 DAP (0.276), brix per cent (0.175), sucrose per cent (0.173) and lowest contribution was through CCS per cent (0.097). This attribute contributed negatively through healthy shoots at 160 DAP (-0.539) followed by germination at 45 DAP (-0.502), purity per cent (-0.402), single cane weight (-0.138) and germination at 30 DAP (-0.032).

4.4.2.2.4 Healthy shoots at 160 DAP

A highest positive contribution of this character to cane yield per plot was through number of millable canes (1.396) followed by internode formed shoots at 160 DAP (0.336), healthy shoots at 70 DAP (0.282), brix per cent (0.157) and sucrose per cent (0.150) and lowest positive was through CCS per cent (0.096). However, a high negative impact was through germination at 45 DAP (-0.620) followed by purity per cent (-0.314) whereas lowest negative contribution was through germination per cent at 30 DAP (-0.033)

Table 66. Genotypic path analysis for cane yield per plot showing direct and indirect effects in productive sugarcane progenies grown under salinity water logg complex environment

Characters	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	Correlation with cane yield
X ₁	-0.053	-0.967	0.199	-0.392	0.304	1.446	0.066	0.272	0.194	-0.065	-0.282	0.130	0.851**
X ₂	-0.051	-1.005	0.166	-0.392	0.308	1.508	0.061	0.312	0.221	-0.062	-0.323	0.147	0.888**
X ₃	-0.032	-0.502	0.333	-0.539	0.276	1.120	-0.138	0.175	0.173	-0.011	-0.402	0.097	0.550**
X ₄	-0.033	-0.620	0.282	-0.636	0.336	1.396	-0.068	0.157	0.150	0.014	-0.314	0.096	0.760**
X ₅	-0.042	-0.811	0.241	-0.559	0.381	1.660	-0.019	0.210	0.187	-0.019	-0.417	0.127	0.939**
X ₆	-0.045	-0.886	0.218	-0.519	0.370	1.710	0.007	0.229	0.192	-0.026	-0.398	0.133	0.985**
X ₇	-0.012	-0.207	-0.156	0.147	-0.025	0.042	0.295	-0.037	-0.043	-0.073	0.271	-0.007	0.195
X ₈	-0.036	-0.778	0.145	-0.248	0.199	0.972	-0.027	0.403	0.302	-0.025	-0.544	0.193	0.556**
X ₉	0.032	-0.701	0.182	-0.303	0.226	1.039	-0.040	0.385	0.316	-0.013	-0.690	0.206	0.574**
X ₁₀	-0.022	-0.399	0.024	0.058	0.048	0.286	0.137	0.065	0.026	-0.156	0.135	0.007	0.208
X ₁₁	-0.019	-0.412	0.170	-0.253	0.202	0.863	-0.101	0.278	0.277	0.027	-0.788	0.188	0.430*
X ₁₂	-0.032	-0.694	0.152	-0.286	0.228	1.067	-0.009	0.366	0.306	-0.005	-0.698	0.212	0.606**

*, ** Significant at 5 and 1 per cent levels respectively

X₁ - Germination per cent at 30 DAP

X₃ - Healthy shoots at 70 DAP

X₅ - Internode formed shoots at 160 DAP

X₇ - Single cane weight

X₉ - Sucrose per cent

X₁₁ - Purity per cent

X₂ - Germination per cent at 45 DAP

X₄ - Healthy shoots at 160 DAP

X₆ - Number of millable canes

X₈ - Brix per cent juice

X₁₀ - Juice extraction per cent

X₁₂ - CCS per cent

Residual = -0.0244

4.4.2.2.5 Internode formed shoots at 160 DAP

The indirect effect of internode formed shoots at 160 DAP revealed high positive effect on cane yield per plot through number of millable canes (1.660) followed by healthy shoots at 70 DAP (0.24), brix per cent (0.210), sucrose per cent (0.187) and CCS per cent (0.127). The major negative effect was through germination per cent at 45 DAP (-0.811) followed by healthy shoots at 160 DAP (-0.559), germination at 30 DAP (-0.042) and lowest negative impact was exerted through two traits viz., single cane weight and juice extraction per cent (-0.019).

4.4.2.2.6 Number of millable canes

The path analysis revealed that number of millable canes exerted high positive indirect effect through internode formed shoots at 160 DAP (0.370) followed by brix per cent (0.229), healthy shoots at 70 DAP (0.218), sucrose per cent (0.192) and CCS per cent (0.133). Number of millable canes contributed negatively through germination at 45 DAP (-0.886) followed by healthy shoots at 160 DAP (-0.519), purity per cent (-0.398), germination at 30 DAP (-0.045) and juice extraction per cent (-0.026).

4.4.2.2.7 Single cane weight

The major indirect positive contribution of single cane weight on cane yield per plot was through purity per cent (0.271) followed by healthy shoots at 160 DAP (0.147) and lowest positive impact was through number of millable canes (0.042). The negative indirect effect was exhibited by germination at 45 DAP (-0.207) followed by healthy shoots at 70 DAP (-0.156) and lower negative effect was through juice extraction per cent (-0.073), sucrose per cent (-0.043), brix per cent (-0.025) and internode formed shoots at 160 DAP (-0.025), with lowest contribution through CCS per cent (-0.007).

4.4.2.2.8 Brix per cent

Brix per cent had its positive indirect impact on cane yield per plot through number of millable canes (0.972) followed by sucrose per cent (0.302), internode formed shoots at 160 DAP (0.199), CCS per cent (0.193), and healthy shoots at 70 DAP (0.145). A negative major impact was through germination at 45 DAP (-0.778), followed by purity per cent (-0.544) and healthy shoots at 160 DAP (-0.248) while lower negative contribution was through germination at 30 DAP (-0.036), single cane weight (-0.027) and juice extraction per cent (-0.025).

4.4.2.2.9 Sucrose per cent

A high positive indirect contribution of sucrose per cent on cane yield per plot was through number of millable canes (1.039), brix per cent (0.385), internode formed shoots at 160 DAP (0.226), CCS per cent (0.206), healthy shoots at 70 DAP (0.182). A negative contribution of this trait on cane yield per plot was mainly through germination per cent 45 DAP (-0.701), purity per cent (-0.690), healthy shoots at 160 DAP (-0.303), single cane weight (-0.040), germination per cent at 30 DAP (-0.032) and juice extraction per cent (-0.013).

4.4.2.2.10 Juice extraction per cent

Juice extraction per cent had its positive indirect impact on cane yield through number of millable canes (0.286), single cane weight (0.137), purity per cent (0.135) and lowest positive contribution was through CCS per cent (0.007). This attribute contributed negatively to cane yield per plot through germination per cent at 45 DAP (-0.399) followed by that of at 30 DAP (-0.022).

4.4.2.2.11 Purity per cent

Path analysis revealed that purity per cent exerted high positive indirect effect through number of millable canes (0.863) followed by brix per cent (0.278), Sucrose per cent (0.277), internode formed shoots at 160 DAP (0.202), CCS per cent (0.188), healthy shoot at 70 DAP (0.170) and lowest positive contribution was through juice extraction per cent (0.027). However, negative indirect contribution was recorded through germination at 45 DAP (-0.412), healthy shoots at 160 DAP (-0.253), single cane weight (-0.101) and lowest negative impact was seen through germination at 30 DAP (-0.019).

4.4.2.2.12 CCS per cent

CCS per cent had its highest positive contribution to cane yield per plot through number of millable canes (1.067) followed by brix per cent (0.366), sucrose per cent (0.306), internode formed shoots at 160 DAP (0.228) and healthy shoots at 70 DAP (0.152). This character contributed negatively through purity per cent (-0.698), germination per cent at 45 DAP (-0.694) healthy shoots at 160 DAP (-0.286), germination per cent at 30 DAP (-0.032), single cane weight (-0.009) and lowest negative impact through juice extraction per cent (-0.005).

4.4.3 Under normal irrigated environment

The path coefficient analysis at genotypic level was worked out for cane yield at clonal stage III by considering all the traits which are significantly associated (including four traits having higher but non significant correlation values) with cane yield. The results with respect to genotypic path coefficient analysis are presented in Table 67.

4.4.3.1 Direct effects

Sucrose per cent (12.83) recorded highest direct positive effect on cane yield per plot, whereas number of millable canes (0.709), single cane weight (0.691) had moderately higher direct contribution to cane yield per plot. Lower direct positive effect was recorded by number of internodes (0.193), internodal length (0.097) and juice extraction per cent (0.090). However, high negative direct impact on cane yield per plot were seen in CCS per cent (-8.345) followed by brix per cent (-3.962) and purity per cent (-0.604).

4.4.3.2 Indirect effects

4.4.3.2.1 Number of internodes

Number of internodes exerted major positive effect on cane yield per plot through sucrose per cent (2.341) followed by single cane weight (0.360), whereas lower positive effect was seen through juice extraction per cent (0.038) and number of millable canes (0.020). However, this character exhibited major negative effect on cane yield through CCS per cent (-1.422) followed by brix per cent (-0.005) and very lower negative impact was through internodal length (-0.071) and purity per cent (-0.032).

4.4.3.2.2 Internodal length

The major positive impact of internodal length on cane yield per plot was seen through CCS per cent (0.763) followed by brix per cent (0.347) and lowest positive effect was recorded through purity per cent (0.035). A major negative impact of this trait was seen through sucrose per cent (-1.156) followed by number of internodes (-0.141) and number of millable canes (-0.124), whereas lowest negative indirect contribution was through two traits viz., single cane weight and juice extraction per cent (-0.039).

4.4.3.2.3 Single cane weight

Single cane weight had highest positive contribution to cane yield per plot through sucrose per cent (1.887) while lower positive impact was seen through number of internodes (0.100) and juice extraction per cent (0.023) and lowest was through purity per cent (0.009). This trait had negative effect through CCS per cent (-1.057) followed by brix (-0.804), number of millable canes (-0.300) and internodal length (-0.006).

4.4.3.2.4 Number of millable canes

Number of millable canes exerted major positive impact on cane yield per plot through sucrose per cent (1.358), while lower positive effect was seen through juice extraction per cent (0.028) and number of internodes (0.005). However, this trait has negative major contribution through CCS per cent (-0.763) followed by brix per cent (-0.555), single cane weight (-0.292) and lower negative impact was through internodal length (-0.017) and purity per cent (-0.011).

Table 67. Genotypic path analysis for cane yield per plot showing direct and indirect effects in productive sugarcane progenies grown under normal irrigated environment

Characters	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	Correlation with cane yield
X ₁	0.193	-0.071	0.360	0.020	0.038	-0.085	2.341	-0.032	-1.422	0.576**
X ₂	-0.141	0.097	-0.039	-0.124	-0.039	0.347	-1.156	0.035	0.763	-0.258
X ₃	0.100	-0.006	0.691	-0.300	0.023	-0.804	1.887	0.009	-1.057	0.543**
X ₄	0.005	-0.017	-0.292	0.709	0.028	-0.555	1.358	-0.011	-0.763	0.462**
X ₅	0.082	-0.041	0.175	0.220	0.090	-1.880	4.963	-0.115	-3.008	0.485**
X ₆	0.041	-0.008	0.140	0.099	0.043	-3.962	12.720	-0.506	-8.224	0.344**
X ₇	0.035	-0.009	0.102	0.075	0.035	-3.928	12.830	-0.549	-8.339	0.253
X ₈	0.010	-0.006	-0.010	0.013	0.017	-3.316	11.654	-0.604	-7.745	0.014
X ₉	0.033	-0.009	0.087	0.065	0.033	-3.904	12.821	-0.561	-8.345	0.219

** Significant at 1 per cent level

X₁ - Average number of internodes

X₃ - Average single cane weight

X₅ - Juice extraction per cent

X₇ - Sucrose per cent

X₉ - CCS per cent

X₂ - Average internodal length

X₄ - Number of millable canes

X₆ - Brix per cent

X₈ - Purity per cent

Residual = 0.1201

4.4.3.2.5 Juice extraction per cent

The indirect effect of juice extraction per cent revealed high positive effect on cane yield per plot through sucrose per cent (4.963) followed by number of millable canes (0.220), single cane weight (0.175) and lowest positive impact was through number of internodes (0.082). However, this attribute had major negative impact through CCS per cent (-3.008) followed by brix per cent (-1.880) while lower negative contribution was through purity per cent (-0.115) and internodal length (-0.041).

4.4.3.2.6 Brix per cent

The major indirect positive contribution of brix per cent on cane yield per plot was through sucrose per cent (12.70) followed by single cane weight (0.140) and lower positive impact was through number of millable canes (0.099), juice extraction per cent (0.043) and number of internodes (0.041). The major negative impact of brix per cent on cane yield per plot was through CCS per cent (-8.224) followed by purity per cent (-0.506) and internodal length (-0.008).

4.4.3.2.7 Sucrose per cent

The path analysis revealed that sucrose per cent exerted high positive indirect effect through single cane weight (0.102) and a lower impact through number of millable canes (0.075) followed by number of internodes and juice extraction per cent (0.035). However, a major negative contribution of sucrose per cent was through CCS per cent (-8.339) followed by brix per cent (-3.928), purity per cent (-0.549) and lowest by internodal length (-0.009).

4.4.3.2.8 Purity per cent

Purity per cent had positive indirect effect on cane yield per plot through sucrose per cent (11.654) while very low positive indirect impact was seen through juice extraction per cent (0.017), number of millable canes (0.013) and number of internodes (0.010). The negative impact was seen through CCS per cent (-7.745) followed by brix per cent (-3.316) and a lower negative effect was through single cane weight (-0.010) and internodal length (-0.006).

4.4.3.2.9 CCS per cent

A high positive indirect effect of CCS per cent on cane yield per plot was through sucrose per cent (12.821), while lower positive effect was seen through single cane weight (0.087), number of millable canes (0.065) and juice extraction per cent (0.033). However, this attribute had major negative impact through brix per cent (-3.904) followed by purity per cent (-0.561) and internodal length (-0.009).

4.5 MEAN PERFORMANCE OF SELECTED PROGENIES UNDER MOISTURE, SALINITY WATER LOGG COMPLEX STRESS AND NORMAL IRRIGATED ENVIRONMENTS

4.5.1. Under moisture stress environments

The analysis of variance for the traits included in the study is presented in Table 68a to 68d. As evident from the tables, mean sum of squares for all the traits except leaf temperature and water use efficiency under moisture stress and first leaf area are significant. The mean values for all the traits of ten significantly superior cane yielding progenies over best check Co 86032 with over all mean and range were given in Table 69 to 72. The mean values obtained for various traits included in the study in respect of all the progenies are provided in Appendix XI to XVI. Though the mean values of top 10 cane yielding progenies, along with overall mean and range for all the traits are given in tables, the only traits with highly significant mean sum of squares are discussed.

Table 68a. Analysis of variance for different physiological parameters in selected sugarcane progenies evaluated under moisture stress environment

Source	d.f.	MSS for the characters														
		Tillers Mortality % at 90 DAP	Tillers Mortality % at 120 DAP	First Leaf Area (cm ²)	Internode formed shoots at 120 DAP	Internode formed shoots at 160 DAP	No. of roots / clump at 150 DAP	Root dry weight / clump (g) at 150 DAP	Average root length (cm) at 150 DAP	Average long root length (cm) at 150 DAP	8th Leaf area at 150 DAP	Leaf sheath moisture % at 150 DAP	Leaf lamina moisture % at 150 DAP	RWC % at 150 DAP	LAI at 150 DAP	MTA at 150 DAP
Genotype	53	34.69**	33.96**	1.66	327.56**	452.11**	2328.69**	2.477**	17.31**	39.39**	5156.60**	42.54**	52.74**	165.09**	0.726**	35.30*
Error	53	10.16	13.3	1.13	29.23	48.33	109.56	0.23	5.56	2.73	878.67	0.14	0.17	2.54	0.14	17.38
SEm±		2.25	2.57	0.75	3.82	4.91	7.4	0.34	1.66	1.16	20.96	0.26	0.29	1.12	0.26	2.94
CD @ 5%		6.39	7.31	NS	10.84	13.93	21.55	1	4.85	3.4	60.82	0.77	0.86	3.27	0.76	8.42
CD @ 1%		8.5	9.73	NS	14.42	18.55	29.17	1.35	6.57	4.6	82.14	1.04	1.17	4.41	1.02	NS

*, ** Significant at 5 and 1 per cent respectively

Table 68b. Analysis of variance for different biophysical traits at moisture stress and after alleviation of stress in selected sugarcane progenies

Source	d.f.	MSS for the characters											
		At stress						After alleviation of stress					
		Photo-synthesis	Conductance	Transpiration rate	Leaf temperature	WUE % (physiol)	LUE % (physiol)	Photo-synthesis	Conductance	Transpiration rate	Leaf temperature	WUE % (physiol)	LUE % (physiol)
Genotype	27	65.17**	0.005*	2.99*	1.74	0.012	0.289**	70.44**	.002*	1.36**	1.31**	0.240**	0.357**
Error	54	25.04	0.002	1.31	2.21	0.007	0.112	9.84	0.001	0.202	0.23	0.023	0.041
SEm±		3.53	0.031	0.81	1.05	0.06	0.236	1.81	0.016	0.259	0.28	0.088	0.117
CD @ 5%		10.26	0.091	2.35	NS	NS	0.686	5.13	0.045	0.736	0.79	0.249	0.332
CD @ 1%		13.86	NS	NS	NS	NS	0.926	6.83	NS	0.979	1.06	0.332	0.441

*, ** Significant at 5 and 1 per cent respectively , WUE = Water use efficiency (physiological); LUE = Light use efficiency (physiological)

Table 68c. Analysis of variance for different growth, cane and sugar yield characters in selected sugarcane progenies evaluated under moisture stress environment

Source	d.f.	MSS for the characters															
		Germination % at 45 DAP	Tillers at 90 DAP	Tillers at 120 DAP	Average single cane weight (kg) at harvest	Average millable cane height (cm) at harvest	Average cane girth (cm) at harvest	Average No. of internodes at harvest	Average internodal length (cm) at harvest	NMC (000's / ha)	Brix % Juice at harvest	Sucrose % Juice at harvest	Juice Extraction % at harvest	Purity % at harvest	CCS % at harvest	CCS yield (t/ha)	Cane yield (t/ha)
Genotype	53	401.64**	4607.66**	3889.49**	0.192**	1498.75**	0.102**	13.031**	4.67**	390.21**	2.81**	4.64**	46.51**	45.62**	3.17**	14.17**	905.18**
Error	53	92.34	662	707.35	0.036	458.68	0.036	2.73	0.86	93.54	0.39	0.71	17.02	12.97	0.32	0.27	11.41
SEm±		6.79	18.19	18.8	0.134	15.14	0.135	1.168	0.65	6.83	0.44	0.59	2.91	2.54	0.4	0.37	2.38
CD @ 5%		19.26	51.58	53.32	0.379	42.94	0.383	3.313	1.86	19.39	1.26	1.69	8.27	7.22	1.15	1.05	6.77
CD @ 1%		25.64	68.65	70.96	0.505	57.14	0.509	4.409	2.48	25.8	1.68	2.25	11	9.61	1.53	1.39	9.01

*, ** Significant at 5 and 1 per cent respectively

Table 68d. Analysis of variance for different sugar yield characters at 300 and 330 DAP in selected sugarcane progenies evaluated under moisture stress environment

Source	d.f.	MSS for the characters									
		Brix % Juice at 300 DAP	Sucrose % Juice at 300 DAP	Juice Extraction % at 300 DAP	Purity % at 300 DAP	CCS % at 300 DAP	Brix % Juice at 330 DAP	Sucrose % Juice at 330 DAP	Juice Extraction % at 330 DAP	Purity % at 330 DAP	CCS % at 330 DAP
Genotype	53	5.88**	6.628**	122.56**	146.05*	5.00**	3.77**	5.45**	56.03**	76.95**	3.82**
Error	53	0.601	2.197	40.5	92.24	2.12	0.28	0.86	18.06	27.01	0.93
SEm±		0.548	1.048	4.5	6.79	1.03	0.37	0.65	3	3.67	0.68
CD @ 5%		1.554	2.972	12.76	19.25	2.92	1.06	1.86	8.52	10.42	1.94
CD @ 1%		2.068	3.955	16.98	NS	3.89	1.42	2.47	11.34	13.87	2.85

*, ** Significant at 5 and 1 per cent respectively

Appendix XI. Mean values for germination, growth and cane yield parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Appendix XII. Mean values for sugar yield and its parameters (at harvest) of selected progenies evaluated under moisture stress environment at Sankeshwar

Appendix XIII. Mean values for sugar yield parameters (at 300 and 330 DAP) of selected progenies evaluated under moisture stress environment at Sankeshwar

Appendix XIV. Mean values for physiological parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Appendix XV. Mean values for physiological parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Appendix XVI. Mean values for biophysical parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

4.5.1.1 Germination, growth and cane yield components

4.5.1.1.1 Germination per cent (at 45 DAP)

The germination per cent exhibited wider variability among 50 hybrid progenies selected under moisture stress environments with mean values ranging from 34.16 to 98.75 and overall mean of 72.68. None of the progenies recorded significantly superior germination per cent over best check Co 86032 (89.16%).

4.5.1.1.2 Tillers at 90 DAP

The selected progeny population of moisture stress environment recorded 88.54 to 266.54 tillers with overall mean of 184.42 per plot. The progenies SNK 813, SNK 819, SNK 814, SNK 806 and SNK 562 ranked among top ten with significant superiority over check Co 86032 (201.45) (best cane yielding check) for this attribute. However, none of the top 10 cane yielding progenies was superior to best tillering check CoM 88121 (221.81).

4.5.1.1.3 Tillers at 120 DAP

This attribute ranged from 98.10 to 272.09 with overall mean of 170.11 in a selected population comprising 50 progenies. Out of these, only seven progenies had significantly superior number of tillers over check Co 86032 (165.35), however, none was superior to the best tillering check CoM 8812 (246.49).

4.5.1.1.4 Average single cane weight (kg)

This important cane yield component exhibited higher variability with mean values ranging from 0.87 to 2.05 kg and overall mean of 1.41 kg. Three progenies viz., SNK 632 (2.05), SNK 827 (2.05) and SNK 819 (2.01) recorded significant superiority over best check Co 86032. The other progenies viz., SNK 742, SNK 673, SNK 814, SNK 562, SNK 500, SNK 635 and SNK 024 ranked among top ten with better single cane weights though not superior over best check Co 86032 (1.57 kg)

4.5.1.1.5 Average millable cane height (cm)

The millable cane height showed wide variability in selected clonal progeny population evaluated which ranged from 170 to 300 cm and a overall mean of 236.53 cm. The progenies viz., SNK 459, SNK 562, SNK 819, SNK 814, SNK 041, SNK 822, SNK 673, SNK 024, SNK 452 and SNK 519 ranked among top ten for millable cane height, of these SNK 459 (300.00 cm) and SNK 562 (295.00cm) are significantly superior over best check Co 86032 (234.00cm)

Table 69. Mean values for growth, cane and sugar yield parameters of top 10 superior cane yielding progenies over best check under moisture stress environment

Clone	Cross	Germ. % at 45 DAP	Tillers 90 DAP	Tillers 120 DAP	Average SCW (kg) at harvest	Average millable cane ht (cm) at harvest	Average cane girth (cm) at harvest	Average no. of internodes at harvest	Average internodal length (cm) at harvest	NMC (000's / ha)	Cane yield (t/ha)	JE% at harvest	Brix% at harvest	Sucrose % at harvest	Purity % at harvest	CCS% at harvest	CCS% (t/ha)
1. SNK 632	Co 8013 PC	72.08	138.20	148.08	2.05	255.00	2.35	25.75	9.90	53.46	109.61	65.90	20.05	16.83	83.90	11.37	12.46
2. SNK 819	CoV 92101 PC	83.33	266.23	184.48	2.01	275.00	3.10	25.25	10.89	48.78	98.05	62.73	17.21	13.12	76.19	10.77	10.56
3. SNK 822	C 81615 PC	67.50	186.95	144.37	1.62	265.50	2.60	25.75	10.19	58.10	94.35	60.50	18.17	16.52	90.85	11.59	10.94
4. SNK 827	Co 88025 GC	73.74	247.10	173.99	2.05	249.00	3.10	25.75	9.67	45.47	93.43	62.75	19.27	16.48	85.25	11.20	10.46
5. SNK 024	Co 740 X CoA 7602	82.08	183.55	119.08	1.53	263.00	2.65	26.75	9.80	61.39	90.65	58.97	17.78	13.95	79.76	11.30	10.24
6. SNK 813	CoC 771 PC	88.74	266.54	165.97	1.52	248.00	2.65	21.50	11.54	58.29	88.80	58.50	20.17	17.59	87.10	12.12	10.76
7. SNK 707	Co 8371 PC	70.00	241.86	152.39	1.25	227.00	2.55	20.75	10.94	69.93	86.95	58.00	20.78	18.90	90.90	13.25	11.52
8. SNK 782	CoC 671 GC	82.91	194.66	223.97	1.30	251.50	2.45	22.00	11.45	66.88	86.95	55.22	19.11	15.59	81.62	12.30	10.69
9. SNK 806	CoC 771 PC	76.24	255.12	127.71	1.63	225.50	2.85	25.50	8.84	52.79	86.02	53.90	19.87	17.78	89.40	12.47	10.73
10. SNK 809	CoC 771 PC	66.66	204.84	236.31	1.48	229.5	2.90	21.75	10.57	58.27	83.71	60.43	17.46	14.72	84.28	11.55	9.67
Checks																	
CoC 671		67.08	169.98	161.03	1.62	217.00	3.00	27.50	7.89	39.64	64.29	63.85	20.33	17.78	87.48	13.72	8.82
Co 86032		89.16	201.45	165.35	1.57	234.00	2.80	24.00	9.77	42.69	67.02	49.36	19.96	16.94	83.35	13.11	8.79
CoM 88121		66.66	221.81	246.49	1.37	231.00	2.65	22.25	10.37	43.60	59.66	61.66	19.96	17.22	86.21	13.36	7.97
CD (0.05)		19.26	51.58	53.32	0.37	42.94	0.38	3.31	1.86	19.39	6.77	8.27	1.26	1.70	7.22	1.15	0.08
MEAN		72.68	184.42	170.11	1.41	236.53	2.61	23.98	9.98	45.24	62.57	60.5	18.58	15.45	83.09	11.57	7.24
RANGE		34.16 – 98.75	88.54 – 266.54	98.1 – 272.1	0.872 – 2.05	170.00 – 300.00	2.15 – 3.10	19.25 – 30.5	6.18 – 12.90	17.34 – 74.64	21.28 – 109.61	51.31- 68.50	15.66 – 20.78	11.55 – 18.90	60.29 – 90.90	6.48 – 13.4	6.50 – 12.46

SCW = single cane weight, JE = Juice extraction.

4.5.1.1.6 Average cane girth (cm)

Substantial variation in cane girth was recorded with range of 2.15 to 3.10 cm and a overall mean of 2.61 cm in the selected hybrid progeny population studied, but none of the progenies recorded significant superiority over checks Co 86032 and CoC 671 for cane thickness. However, progenies, SNK 819, SNK 827, SNK 635, SNK 750, SNK 809, SNK 128, SNK 500, SNK 624, SNK 806 and SNK 024 ranked among top 10 for this trait.

4.5.1.1.7 Average number of internodes

Average number of internodes exhibited higher variability among the progenies with the mean values ranging from 19.25 to 30.50 and overall mean of 23.98. The progenies viz., SNK 357, SNK 817, SNK 624 and SNK 632 ranked among top 10, while only top 5 progenies showed significant superiority over best cane yielding check Co 86032 and on par to best check CoC 671 for this attribute.

4.5.1.1.8 Average internodal length

This trait exhibited substantial amount of variability with a range of 6.18 to 12.90 cm and over all mean of 9.98 cm .The progenies viz., SNK 584, SNK 459, SNK 562, SNK 550, SNK 500, SNK 814, SNK 813, SNK 782, SNK 041 and SNK287 ranked among top 10 while top 6 recorded significant superiority over check Co 86032 (9.77 cm) for internodal length. However, only first three progenies were significantly superior over best check CoM 88121 (10.37 cm).

4.5.1.1.9 Number of millable canes

There exists high variability in number of millable canes (000's/ha) with a wide range (17.34 to 74.65) and overall mean of 45.24. The progenies SNK 099 (74.05) recorded highest millable canes followed by SNK 707 (69.93), SNK 459(67.49), SNK 782 (66.88), SNK 082(64.64) and SNK 474 (62.98) being significantly superior over best cane yielding check Co 86032 (42.69) and best check CoM 88121 (43.60) for this trait. The other progenies viz., SNK 024, SNK 452, SNK 813 and SNK 809 (58.27) though ranked among top 10 but statistically on par with the best check Co 86032 (42.69).

4.5.1.1.10 Cane yield

Cane yield exhibited wide variation with a range of 21.28 to 109.61 tonnes per hectare and 62.57 over all mean. The progenies viz., SNK 632 (109.61 t/ha), SNK 819 (98.05 t/ha), SNK 822 (94.35 t/ha), SNK 827 (93.43 t/ha), SNK 024 (90.65 t/ha), SNK 813 (88.80 t/ha), SNK 707(86.95 t/ha) SNK 782 (86.95 t/ha), SNK 806 (86.02 t/ha) and SNK 809 (83.71 t/ha) ranked among top 10 with significant superiority over best check Co 86032 (67.02 t/ha).

4.5.1.2 Sugar yield parameters

4.5.1.2.1 At harvest (360 DAP)

4.5.1.2.1.1 Juice extraction per cent

This cane quality parameter showed wider range (51.31 to 68.50%) of mean values with overall mean of 60.50 per cent. Among 50, the progenies SNK 673, SNK 604, SNK 744, SNK 550, SNK 699, SNK 543, SNK 632, SNK 041, SNK 128, SNK 750 ranked top ten with significant superiority over best check Co 86032 which recorded 49.36 per cent juice extraction. However, none were superior to best check CoC 671 (63.85%) for this trait.

4.5.1.2.1.2 Brix per cent

This important sugar yield parameter exhibited range of 15.66 to 20.78 with 18.58 per cent over all mean, though eight progenies recorded higher juice brix per cent over best check Co 86032 (19.96%), the superiority was not significant. The SNK 707 (20.78%) recorded highest juice brix followed by SNK 109 (20.40%), SNK 645 (20.38%), SNK 388 (20.37%), SNK 500 (20.37%), SNK 813(20.17%), SNK 632(20.05%) and SNK 596 (20.00%).

4.5.1.2.1.3 Sucrose per cent

The selected hybrid progeny population under moisture stress environment exhibited wider range (11.55 to 18.90%) of variability with over all mean of 15.45 per cent sucrose in juice. Among 50, the only progeny SNK 707 (18.90%) recorded highest sucrose per cent with significant and numerical superiority over check Co 86032 (16.94%) and best check CoC 671 (17.78%), respectively. The other top progenies viz., SNK 806, SNK 388, SNK 813, SNK 645, SNK 500, SNK 109, SNK 596 and SNK 604 had sucrose per cent on par with the best cane yielding check Co 86032.

4.5.1.2.1.4 Purity per cent

As per data recorded for this attribute, the over all mean juice purity was 83.09 per cent with a range of 60.29 to 90.90 per cent indicating higher variability. Though top ten superior cane yielding progenies showed high purity per cent over best check Co 86032 (83.35%), only two progenies viz., SNK 707 (90.90%) and SNK 822 (90.85%) recorded significant superiority, while none was significantly superior over best check CoC 671 (87.48%).

4.5.1.2.1.5 CCS per cent

The commercial cane sugar per cent showed wider range (6.48 to 13.40%) of mean values in the population studied under moisture stress environment with over all mean value of 11.57 per cent. Though this parameter exhibited wider variability, none of the progenies recorded significant superiority over Co 86032 (13.11%) and CoC 671 (13.72%). However, SNK 109 (13.40%), SNK 596 (13.33%), SNK 604 (13.28%) and SNK 707 (13.25%) showed numerical superiority over the check Co 86032.

4.5.1.2.1.6 CCS yield

The sugar yield exhibited highest variability with a range of 2.45 to 12.46 tonnes per hectare and over all mean of 7.26. The progenies viz., SNK 632 (12.46 t/ha), SNK 707 (11.52 t/ha), SNK 822 (10.94 t/ha), SNK 813 (10.76 t/ha), SNK 806 (10.72 t/ha), SNK 782 (10.69 t/ha), SNK 819 (10.57 t/ha), SNK 827 (10.46 t/ha), SNK 024 (10.23 t/ha) and SNK 041 (10.15 t/ha) recorded significant superiority over best check Co 86032 (8.81 t/ha).

4.5.1.2.2 At 300 DAP

4.5.1.2.2.1 Juice extraction per cent

The juice extraction per cent exhibited wide variation at 10 month crop age with a range of 38.78 to 85.76 and overall mean of 63.06 per cent. Though all top 10 progenies recorded higher juice extraction per cent over best check Co 86032 (65.93%), the only progeny SNK 635 (85.76%) had significant superiority.

4.5.1.2.2.2 Brix per cent

This important early ripening (sugar accumulation) parameter showed relatively wider variability with a range of 12.16 to 19.52 and over all mean of 15.46 per cent. The only progeny SNK 707 (19.52%) recorded significantly superior mean value over best check Co 86032 (17.92%) followed by SNK 806 (19.01%).

4.5.1.2.2.3 Sucrose per cent

The sucrose per cent exhibited wider range (6.41 to 16.37 %) with overall mean value of 10.25 per cent. Among selected population of 50 progenies, only two viz., SNK 250 (16.37%) and SNK 357 (14.66 %) recorded superior sucrose per cent over best cane yielding check Co 86032 (10.88%) and best check CoM 88121 (11.10%).

4.5.1.2.2.4 Purity per cent

The data indicates fairly wide variability for juice purity with a range of 52.53 to 97.33 and over all mean value of 66.28 per cent. Of the 50 selected progenies only three viz., SNK 250 (97.33%), SNK 357 (85.42%) and SNK 452 (82.52%) showed significant superiority over best cane yielding check Co 86032 (60.73%) and best check CoM 8812 (62.78%) for this attribute.

Table 70. Mean values for sugar yield parameters at 300 and 330 DAP of top 10 superior cane yielding progenies over best check under moisture stress environment

Clone	Cross	At 300 DAP					At 330 DAP				
		Juice Extraction %	Brix %	Sucrose %	Purity %	CCS %	Juice Extraction %	Brix %	Sucrose %	Purity %	CCS %
1. SNK 632	Co 8013 PC	66.83	15.36	8.89	57.96	4.61	68.98	18.92	18.60	98.31	12.49
2. SNK 819	CoV 92101 PC	71.19	13.65	8.26	59.59	4.46	64.74	17.11	14.70	85.98	10.03
3. SNK 822	C 81615 PC	63.76	15.80	8.48	53.65	3.98	64.64	18.53	16.79	90.60	11.78
4. SNK 827	Co 88025 GC	64.64	13.60	7.32	54.50	3.55	56.80	20.18	17.69	87.67	12.18
5. SNK 24	Co 740 X CoA 7602	66.25	13.92	9.28	66.46	5.42	55.88	16.97	12.49	71.37	7.81
6. SNK 813	CoC 771 PC	66.83	16.40	8.85	53.99	4.26	66.28	19.98	15.32	76.65	9.85
7. SNK 707	Co 8371 PC	56.72	19.52	11.70	59.99	6.27	56.77	22.52	18.07	80.20	11.90
8. SNK 782	CoC 671 GC	58.88	16.48	11.00	66.26	6.43	62.14	19.66	14.88	75.71	9.47
9. SNK 806	CoC 771 PC	66.83	19.01	11.69	61.77	6.43	57.57	21.29	17.77	85.53	11.97
10. SNK 809	CoC 771 PC	60.83	14.93	9.86	68.38	5.86	60.29	18.06	13.98	77.39	9.01
CoC 671		65.08	17.54	10.65	60.71	5.79	63.14	20.29	16.37	87.97	10.80
Co 86032		65.93	17.92	10.88	60.73	5.89	58.30	19.37	16.57	85.51	11.28
CoM 88121		61.59	17.72	11.10	62.78	6.17	59.51	20.04	15.70	78.53	10.19
CD (0.05)		12.76	1.55	2.97	19.25	2.92	8.52	1.06	1.86	10.42	1.94
MEAN		63.06	15.46	10.25	66.28	5.96	58.21	18.75	14.89	79.37	9.74
RANGE		38.78 – 85.76	12.16 – 19.52	6.41 – 16.37	52.53 – 97.33	3.00 – 11.92	44.55 – 68.98	15.57 – 22.52	11.02 – 18.60	65.32 – 98.31	6.72 – 12.49

4.5.1.2.2.5 CCS per cent

Similar trend as that of purity per cent was observed for this trait which range from 3.00 to 11.92 and over all mean of 5.96 per cent commercial cane sugar in juice.

4.5.1.2.3 At 330 DAP

4.5.1.2.3.1 Juice extraction per cent

There existed a wide variability for this traits with a range of 44.55 to 68.98 and over all mean of 58.21 per cent juice. Three progenies viz., SNK 632, (68.98%), SNK 635 (68.76%) and SNK 088 (67.92%) recorded significantly superior juice extraction per cent over best cane yielder Co 86032 (58.30%), however, none were superior to best check CoC 671 (63.14%) for this attribute.

4.5.1.2.3.2 Brix per cent

Almost similar trend as that of brix per cent at 300 DAP was observed with mean values ranged from 15.57 to 22.52 and a overall mean of 18.75 per cent. Four progenies viz., SNK 707 (22.52%) SNK 388 (21.42%) SNK 806 (21.29%) and SNK 500(20.97%) recorded significantly superior mean values over check Co 86032 (19.37%). Of the four only former two progenies were significantly superior over best check CoC 671 (20.29%).

4.5.1.2.3.3. Sucrose per cent

The range of sucrose per cent in juice was substantial (11.02 to 18.60%) with mean of 14.89 per cent across 50 selected progenies evaluated under moisture stress environment. The only progeny SNK 632 (18.60%) recorded significantly superior mean value over best check Co 86032 (16.57%) for this attribute, while other progenies viz., SNK 287 (18.26%) SNK 707 (18.07%), SNK 806 (17.77%), SNK 827 (17.69%), SNK 388 (17.56%) SNK 822 (16.79%) and SNK 109 (16.72%) showed numerically higher values.

4.5.1.2.3.4. Purity percent

Similar trend was observed as that of sucrose per cent in juice with mean values ranging from 65.32 to 98.31 and a overall mean of 79.37per cent.

4.5.1.2.3.5. CCS per cent

Similar trend as that of sucrose and purity per cent in juice with a range of values from 6.72 to 12.49 and a overall mean of 9.74 per cent

4.5.1.3. Physiological traits

4.5.1.3.1. Tiller mortality per cent (at 90& 120 DAP)

The tiller mortality per cent varied from 0.52 to 22.15 with 5.66 per cent over all mean value for the population studied. The progenies viz., SNK 624, SNK 287 and SNK 596 showed significantly higher mortality of tillers compared to check CO 86032 (8.28%).

In contrast to above, different trend was observed at 120 DAP *i.e.*, at mid formative phase of the crop under moisture stress with wide range (2.12 to 22.89 %) and over all mean value of 7.08 per cent. The progenies viz., SNK 632 (22.89%) and SNK 024 (18.21%) recorded significantly higher mortality per cent compared to best check Co 86032 (7.57%).

4.5.1.3.2. Internode formed shoots (at 120 and 160 DAP)

The average number of internode formed shoots at 120 DAP varied from 0.00 to 53.37 with over all mean of 13.68 shoots, in the population. The progenies viz., SNK 024 (53.37) , SNK 632 (48.43), SNK 041 (44.42), SNK 474(42.57), SNK 822 (33.93), SNK 819 (33.00) and SNK 827 (28.28) recorded significantly higher number of internode formed shoots over best check Co 86032 (17.27).

Table 71. Mean values of different physiological parameters for top 10 superior cane yielding progenies over best check under moisture stress environment

Clone	Cross	Tiller mortality % at 90 DAP	Tiller mortality % at 120 DAP	1st Leaf Area (cm ²)	Int. formed shoots at		No. of roots / clump at 150 DAP	Root dry. wt (g) / clump at 150 DAP	Av. root. length (cm) at 150 DAP	Av. long root length (cm) at 150 DAP	Area 8 th leaf area at 150 DAP (cm ²)	Leaf sheath moisture % at 150 DAP	Leaf lamina moisture % at 150 DAP	RWC % at 150 DAP	LAI at 150 DAP	MTA at 150 DAP	Leaf rolling (0-4 scale)
					120 DAP	160 DAP											
1. SNK 632	Co 8013 PC	1.56	22.89	1.26	48.43	67.87	177.00	3.18	21.53	35.67	276.11	46.73	41.65	64.20	4.95	50.00	0
2. SNK 819	CoV 92101 PC	1.08	12.42	2.31	33.00	58.30	129.00	2.10	17.77	24.07	379.91	34.00	49.02	48.10	3.27	44.50	0
3. SNK 822	C 81615 PC	1.48	12.18	1.70	33.93	82.06	101.00	2.57	23.10	33.80	301.54	44.92	48.12	47.12	3.85	42.24	0
4. SNK 827	Co 88025 GC	1.87	10.81	1.89	28.38	80.82	108.00	2.44	24.20	29.80	291.89	44.14	43.12	43.12	8.75	44.48	0
5. SNK 24	Co 740 X CoA 7602	2.51	18.21	4.88	53.37	70.95	118.00	2.34	17.85	27.50	290.91	29.91	40.40	61.59	3.09	43.00	0
6. SNK 813	CoC 771 PC	2.19	7.25	1.53	8.63	78.35	65.00	2.40	27.10	34.22	278.92	44.25	41.55	48.12	3.68	40.15	1
7. SNK 707	Co 8371 PC	3.19	8.30	1.03	4.93	65.71	108.00	1.69	22.84	34.24	290.24	46.24	39.92	52.32	3.85	43.12	1
8. SNK 782	CoC 671 GC	8.62	2.12	1.40	15.42	76.50	59.00	1.62	19.51	32.21	292.15	39.42	43.12	50.22	2.84	41.50	2
9. SNK 806	CoC 771 PC	3.51	11.11	1.13	19.12	49.66	63.00	1.90	20.10	33.43	293.21	43.82	42.51	60.12	3.45	44.25	3
10. SNK 809	CoC 771 PC	6.79	6.77	1.66	21.28	62.31	109.00	2.88	26.25	34.00	268.50	36.99	50.69	47.29	2.94	49.50	2
Checks																	
CoC 671		2.38	4.64	3.32	25.60	52.44	98.00	1.20	20.15	27.79	326.80	40.80	48.30	55.38	3.16	47.00	0
Co 86032		8.28	7.57	2.01	17.27	66.01	115.00	1.38	19.50	26.85	242.47	40.84	54.68	43.27	2.21	56.50	3
CoM 88121		2.85	2.87	1.15	3.70	70.95	64.50	0.78	17.28	16.50	207.58	46.57	48.73	57.65	3.94	57.00	1
CD (0.05)		6.39	7.31	NS	10.84	13.93	21.55	1.00	4.85	3.40	60.82	0.77	0.86	3.27	0.76	8.42	-
MEAN		5.66	7.08	2.02	13.68	59.14	92.65	1.89	18.01	26.73	247.52	39.44	44.57	50.51	2.98	44.84	-
RANGE		0.52 – 22.15	2.12 – 22.89	0.58 – 5.07	0.00 – 53.37	26.53 – 90.89	40.50 – 170.00	0.45 – 4.44	10.24 – 27.10	19.02 – 35.67	173.41 – 379.91	25.35 – 48.12	31.51 – 56.43	32.59 – 69.71	2.02 – 8.75	40.15 – 54.50	0 – 4

The trend was little varied at 160 DAP with mean values ranging from 26.53 to 90.89 and a overall mean of 59.14 shoots. Only progenies viz., SNK 519 (90.39) SNK 817 (84.83), SNK 822 (82.06), SNK 041(80.82), and SNK 827 (80.82) showed significant superiority over best check Co 86032(66.01)

4.5.1.3.3 Number of roots per clump (at 150 DAP)

The root number at the end of formative phase was ranged from 40.50 to 177.00 with overall mean of 92.65 roots per clump. Five progenies viz., SNK 632 (177.0), SNK 543 (174.0), SNK 094 (172.0), SNK 459 (158.0) and SNK 511 (142.5) recorded significantly higher number of roots over best check Co 86032 (115.0).

4.5.1.3.4. Root dry weight per clump (at 150 DAP)

The root dry weight varied widely (0.45 to 4.44 g) with over all mean of 1.89 g per clump. The top thirteen progenies viz., SNK 094 ,SNK 432, SNK 533, SNK 511, SNK 632, SNK 128 ,SNK 459, SNK 814, SNK 809 and SNK 817 recorded significantly higher root dry matter over best check Co 86032 (1.38 g).

4.5.1.3.5. Average root length (at 150 DAP)

This attribute ranged from 10.24 to 27.10 cm with overall mean length of 18.01 cm. Only four progenies viz., SNK 813 (27.10cm), SNK 809(26.25cm), SNK 432 (24.80cm) and SNK 533 (24.80cm) had significantly higher mean values over check Co 86032 (19.50cm). Of these only former two progenies were superior over best check CoC 671 (201.5 cm) for this trait.

4.5.1.3.6 Average long root length (at 150 DAP)

This important root parameter ranged from 19.02 to 35.67 cm with a overall population mean of 26.73 cm. All top ten progenies, for this attribute had recorded significant superiority over best check Co 86032 (26.85 cm).

4.5.1.3.7 Eighth leaf area (150 DAP)

The area of eighth leaf was varied widely (173.41 to 379.91 cm²) with over all mean of 247.52 cm². Among 50 progenies only three viz., SNK 819 (379.91 cm²) SNK 094 (330.46 cm²) and SNK 128 (327.28 cm²) had significantly higher leaf area over best check Co 86032 (242.47 cm²), however, none was superior to best check CoC 671 (326.80 cm²).

4.5.1.3.8 Leaf sheath moisture (%) (at 150 DAP)

As per data recorded for this attribute, the overall mean leaf sheath moisture was 39.44 with a range of 25.35 to 48.12 per cent indicating higher variability. All the top 10 progenies which recorded higher values were statistically significant over best check Co 86032 (40.84%)

4.5.1.3.9 Leaf lamina moisture (%) (at 150 DAP)

The range of mean values was from 31.51 to 56.43 per cent and over all mean of 44.57 per cent for this trait. Only two progenies viz., SNK 082 (56.43%) and SNK 533 (55.91%) had significantly higher leaf lamina moisture per cent over best check Co 86032 (54.68 %).

4.5.1.3.10. Relative water content (RWC %) (at 150 DAP)

The range of RWC was substantial (32.59 to 69.71 %) with mean of 50.51 per cent across 50 progenies studied. All top 10 progenies were significantly superior over check C o 86032 (43.27 %). However, only four progenies viz., SNK 094 (69.71%), SNK 250 (69.29%), SNK 500 (62.11) and SNK 632 (64.2%) were superior over best check CoM 8812 (57.65%) for this trait.

4.5.1.3.11. LAI (at 150 DAP)

Leaf area index ranged from 2.02 to 8.75 with overall population mean of 2.98 at the end of formative phase under moisture stress. The top 10 progenies viz., SNK 827, SNK 632, SNK 814, SNK 707, SNK 822, SNK 813, SNK 635, SNK 041, SNK 128 and SNK 024 had significantly higher values over best check Co 86032 (2.21) for this trait.

4.5.1.4 Bio-physical traits

4.5.1.4. Rate of photosynthesis rate ($\mu\text{ mol CO}_2\text{ m}^{-2}\text{ S}^{-1}$)

Photosynthesis rate under stress varied widely (46.92 to 70.76) with over all mean value of 55.02 in 28 selected progenies. The progenies SNK 624 (62.37), SNK 814 (62.14) and SNK 128 (61.61) recorded significantly higher photosynthesis rate over best check Co 86032 (49.92). But the trend was quite different for the photosynthesis rate after alleviation of stress with a range of 41.83 to 62.88 and over all mean of 55.12 in the selected progenies. Among 28 selected, seven progenies viz., SNK 094 (62.88), SNK 819 (62.00) SNK 750 (61.71), SNK 082 (60.75), SNK 543 (60.67), SNK 624 (59.33) and SNK 632 (58.46) had significantly higher photosynthesis rate over best check Co 86032 (52.83).

4.5.1.4.2. Stomatal stomatal conductance ($\mu\text{ mol CO}_2\text{ m}^{-2}\text{ S}^{-1}$)

The range of stomatal conductance was substantial (0.10 to 0.29) with a overall mean of 0.16 under moisture stress. The progenies viz., SNK 707 (0.28), SNK 128 (0.21), SNK 624 (0.21) and SNK 814 (0.21) are superior over best check Co 86032 (0.11). While, after the alleviation of stress the range was from 0.08 to 0.18 with 0.14 over all mean value. The progenies viz., SNK 707 (0.16) and SNK 806 (0.17) and SNK 459 (0.17) recorded significantly higher values over best check Co 86032 (0.13).

4.5.1.4.3 Transpiration rate ($\mu\text{ mol CO}_2\text{ m}^{-2}\text{ S}^{-1}$)

The rate of transpiration rate ranged from 4.67 to 9.19 with overall mean of 7.24 for the selected progenies studied under stress condition. The progenies viz., SNK 624 (9.19), SNK 041 (9.13) and SNK 814 (9.06) recorded higher mean values over best check Co 86032 (6.37). The range of transpiration rate after alleviation of stress was 2.42 to 5.09 with 3.62 overall mean value. The progenies viz., SNK 094 (5.09), SNK 632 (4.42), SNK 511 (4.30), SNK 459 (4.26), SNK 814 (4.15) and SNK 584 (4.15) had significantly higher transpiration rate over best check Co 86032 (3.50).

4.5.1.4.4 Leaf temperature ($^{\circ}\text{C}$)

Leaf temperature showed a variation to the extent of 36.80 to 40.61 with a overall meant of 39.07 $^{\circ}\text{C}$. None of the progenies studied are different from that of best check Co 86032 under stress, while three progenies viz., SNK 624 (34.33), SNK 806 (34.12) and SNK 500 (34.10) had significantly higher leaf temperature compared to Co 86032 (33.29) after alleviation of stress.

4.5.1.4.5 Water use efficiency ($\Delta A/\Delta T, \%$)

The progenies did not differed significantly from the check varieties for this parameter under stress while, after alleviation of stress, three progenies viz., SNK 500 (2.09), SNK 742 (1.99) and SNK 388 (1.90) had significantly superior WUE over best check Co 86032 (1.53%).

4.5.1.4.6 Light use efficiency ($\Delta A/\text{PAR}, \%$)

As per data recorded for this important attribute, the range of variation among the 28 selected progenies was from 3.12 to 4.71 with a over all mean of 3.67 per cent. Three progenies viz., SNK 624 (4.15), SNK 814 (4.12) and SNK 128 (4.08) recorded higher LUE values over best check Co 86032 (3.32). Whereas after alleviation of stress, the range was wider (2.79 to 4.44) with a over all mean of 3.69 per cent. The progenies viz., SNK 750 (4.44), SNK 094 (4.19), SNK 819 (4.13), SNK 543 (4.04), SNK 797 (3.98), SNK 624 (3.95), SNK 806 (3.97), SNK 632 (3.89) and SNK 809 (3.87) were superior over best check Co 86032 (3.52).

Table 72. Mean values of biophysical traits under moisture stress and after relief from stress for top 10 superior cane yielding progenies over best check

Clone	Cross	At stress						After alleviation of stress					
		Photosynth esis	Conducta nce	Transpira- tion	Leaf temper ature	WUE % (Physiol)	LUE % (Physiol)	Photosynt hesis	Conducta nce	Transpirat ion	Leaf temperature	WUE % (Physiol)	LUE % (Physiol)
1. SNK 632	Co 8013 PC	59.51	0.18	8.49	39.13	0.73	3.96	58.46	0.13	4.42	33.58	1.33	3.89
2. SNK 819	CoV 92101 PC	50.71	0.13	7.22	40.31	0.70	3.38	62.00	0.13	3.64	33.66	1.70	4.13
3. SNK 822	C 81615 PC	55.41	0.14	8.11	40.21	0.68	3.69	59.42	0.15	3.51	33.15	1.69	3.96
4. SNK 827	Co 88025 GC	51.51	0.14	7.45	39.55	0.69	3.43	54.32	0.16	4.11	32.17	1.32	3.62
5. SNK 24	Co 740 X CoA 7602	51.32	0.17	6.71	37.93	0.76	3.42	54.08	0.15	3.47	31.70	1.57	3.60
6. SNK 813	CoC 771 PC	52.60	0.12	6.91	41.51	0.76	3.50	58.51	0.16	4.21	33.51	1.38	3.90
7. SNK 707	Co 8371 PC	54.51	0.16	7.31	39.12	0.74	3.63	59.81	0.17	4.31	31.61	1.38	3.98
8. SNK 782	CoC 671 GC	53.12	0.15	7.12	39.41	0.75	3.54	60.28	0.14	4.26	33.11	1.41	4.01
9. SNK 806	CoC 771 PC	54.31	0.17	7.31	38.91	0.74	3.62	58.91	0.17	4.24	34.12	1.38	3.92
10. SNK 809	CoC 771 PC	55.45	0.16	7.95	39.68	0.70	3.69	57.71	0.14	3.82	33.46	1.51	3.87
Checks													
CoC 671		63.51	0.22	8.57	37.61	0.75	4.23	59.64	0.13	3.47	32.20	1.71	3.97
Co 86032		49.92	0.11	6.37	40.91	0.78	3.32	52.83	0.13	3.50	33.29	1.53	3.52
CoM 88121		56.76	0.15	6.98	38.87	0.84	3.78	52.54	0.12	2.75	33.33	1.90	3.50
CD (0.05)		10.26	0.09	2.35	NS	NS	0.68	5.13	0.04	0.40	0.79	0.24	0.33
MEAN		55.02	0.16	7.24	39.07	0.78	3.67	55.12	0.14	3.62	33.24	1.57	3.69
RANGE		46.92 – 70.76	0.10 – 0.29	4.67 – 9.57	36.80 – 40.61	0.62 – 1.00	3.12 – 4.71	41.83 – 62.88	0.08 – 0.18	2.42 – 5.09	31.70 – 34.33	1.16 – 2.15	2.79 – 4.44

4.5.2. Under salinity water logg complex environment

The analysis of variance for the traits included in the study is presented in Table 73. As evident from the table, mean sum of squares for all the traits except brix per cent in juice are significant. The mean values for all the traits of nine significantly superior cane yielding progenies over the best check Co 7508 with overall mean and range are given Table 74. The mean values obtained for various traits included in the study in respect of all the progenies are provided in Appendix XVII. Though the mean values for all the traits of top 9 significantly superior cane yielding progenies along with overall mean and range are given in table, the traits with only significant mean sum of squares are discussed.

Appendix XVII. Mean values for germination, growth, cane and sugar yield parameters of selected progenies evaluated under salinity water logg complex environment at Gangavati

4.5.2.1 Germination, growth and cane yield components

4.5.2.1.1 Germination (at 30 and 45 DAP)

The germination per cent at 30 DAP showed wide variability among 31 selected progenies studied under salinity water logg complex environment with range of 13.52 to 65.52 and a overall mean value of 38.95 per cent. The only progeny SNK 159 recorded significantly higher germination per cent over best check Co 7508 (56.16), followed by progenies, SNK 139 (59.28%), SNK 664 (56.16%), SNK 814 (56.16%), SNK 423 (55.12%), SNK 299 (52.00%), SNK 121 (50.96%), SNK 024 (49.92%), SNK 493 (49.92%) and SNK 790 (48.88%) which had values comparable that of best check Co 7508 (56.16%).

Similar trend was observed at 45 DAP where in three progenies viz., SNK 159 (74.88%), SNK 139 (71.76%) and SNK 664 (70.72%) recorded significantly superior germination per cent over best check Co 7508 (61.36%).

4.5.2.1.2. Healthy shoot count (at 70 and 160 DAP)

The range of healthy shoots per plot was substantial (12.5 to 55.0) with overall mean of 29.60 shoots. None of the progenies recorded significantly higher number of shoots over best check Co 7508 (55.00) at 70 DAP while at 160 DAP, SNK 814 (47.00) recorded significantly higher value over best check Co 7508 (31.00).

4.5.2.1.3. Internode formed shoots (at 160 DAP)

The average number of internode formed shoots exhibited higher variability among the selected progeny population evaluated, with the mean values ranging from 11 to 43 and over all mean of 21.07 per plot. The progenies viz., SNK 814 (48.00), SNK 139 (33.50), SNK 159 (33.00), SNK 664 (32.50), SNK 493 (29.50) and SNK 423 (29.00) had significantly higher number of shoots compared to best check Co 7508 (22.5).

4.5.2.1.4. Number of millable canes

This important cane yield component showed high variability in the selected progeny population studied. The mean values ranged from 11 to 31.5 canes with a overall mean of 19.29 canes per plot. The progenies viz., SNK 139 (31.50), SNK 664 (31.00), SNK 159 (30.50), SNK 814 (30.50), SNK 423 (27.50) and SNK 493 (27.00) recorded significantly higher number of canes compared to best check Co 7508 (21.00).

4.5.2.1.5. Average single cane weight (kg)

The range of mean values for single cane weight was 0.77 kg to 1.07 kg with 0.92 kg a over all mean for the population. The only progeny SNK 068 (1.07kg) recorded significant superiority over best check Co 7508 (0.93kg).

4.5.2.1.6. Cane yield

Cane yield ranged from 27.77 to 79.14 with overall mean of 49.31 tonnes per hectare. Nine progenies viz., SNK 664, SNK 159, SNK 139, SNK 814, SNK 493, SNK 423, SNK 790, SNK 063 and SNK 299 recorded significantly superior cane productivity over best check Co 7508 (54.15 t/ha).

Table 73. Analysis of variance of different growth, cane and sugar yield parameters in selected sugarcane progenies evaluated under salinity water logging complex environment

Source	d.f.	MSS for the characters													
		Germination % at 30 DAP	Germination % at 45 DAP	Healthy shoot count at 70 DAP	Healthy shoot count at 160 DAP	No. of internode formed shoots at 160 DAP	NMC / plot at harvest	Average single cane weight (kg)	Cane yield (kg / plot)	Brix % Juice at harvest	Sucrose % at harvest	Juice Extraction % at harvest	Purity % at harvest	CCS % at harvest	CCS Yield at harvest
Genotype	33	349.06**	400.98**	444.01**	154.67**	106.86**	72.16**	0.009*	62.99**	6.45	2.90**	38.06**	19.98**	2.39**	1.31**
Error	33	7.98	10.51	39.83	17.41	5.58	2.97	0.004	2.91	5.33	0.17	1.15	5.57	0.12	0.05
SEm±		1.99	2.29	4.46	2.95	1.67	1.22	0.046	1.2	1.63	0.29	0.76	1.67	0.25	0.17
CD @ 5%		5.74	6.59	12.82	8.48	4.8	3.5	0.133	3.46	NS	0.85	2.18	4.8	0.72	0.49
CD @ 1%		7.7	8.84	17.21	11.38	6.44	4.7	NS	4.65	NS	1.14	2.93	6.44	0.96	0.65

*, ** Significant at 5 and 1 per cent respectively; NMC = No. of millable canes; CCS = Commercial cane sugar

Table 74. Mean values of germination, maintenance of shoot population, cane and sugar yield parameters (at harvest) for top 9 superior cane yielding progenies over best check under salinity-water logg complex environment.

Progenies	Cross	Germination % at 30 DAP	Germination % at 45 DAP	Healthy shoot count at 70 DAP	Healthy shoot count at 160 DAP	No. of internode formed shoots at 160 DAP	Av. no. of mill. canes / Plot	Av. single cane wt. (kg)	Juice extraction %	Brix %	Sucrose %	Purity %	CCS %	CCS yield (t / ha)	Cane yield (t / ha)
1. SNK 664	Co 8213 PC	56.16	70.72	40.00	34.00	32.50	31.00	0.92	55.85	19.15	16.85	87.99	11.63	9.20	79.14
2. SNK 159	Co 7704 X CoC 671	65.52	74.88	47.00	36.50	33.00	30.50	0.93	56.15	19.20	16.85	87.76	11.61	9.02	77.75
3. SNK 139	Co 7704 X CoC 671	59.28	71.76	41.50	36.00	33.50	31.50	0.88	54.45	19.10	16.70	87.43	11.49	8.77	76.36
4. SNK 814	CoC 771 PC	56.16	61.36	40.50	47.00	43.00	30.50	0.89	55.65	18.40	16.55	89.95	11.54	8.66	74.97
5. SNK 493	87R 40 X CoC 671	49.92	59.28	33.00	33.50	29.50	27.00	0.96	52.70	19.00	16.55	87.11	11.37	8.21	72.30
6. SNK 423	MS 6847 X CoC 671	55.12	66.56	36.50	30.50	29.00	27.50	0.91	60.85	19.60	16.70	85.20	11.34	7.88	69.42
7. SNK 790	CoA 7602 GC	48.88	62.40	42.00	26.00	24.00	23.50	1.00	59.95	18.85	16.35	86.74	11.21	7.30	65.25
8. SNK 068	Co 740 X MS 6847	44.72	54.08	28.00	24.00	23.50	21.50	1.07	49.30	18.95	16.30	86.02	11.13	7.10	63.87
9. SNK 299	Co 88028 X MS 6847	52.00	63.44	26.50	26.50	23.50	23.00	1.01	60.35	18.65	16.15	86.60	11.06	7.05	63.87
Checks															
CoC 671		47.84	52.00	52.50	16.50	24.00	21.00	0.88	53.95	19.50	17.30	88.72	11.99	6.16	51.37
Co 7508		56.16	61.36	55.00	31.00	22.50	21.00	0.93	59.30	19.35	17.20	88.89	11.93	6.47	54.15
CoM 88121		57.20	63.44	63.00	33.50	26.00	23.50	0.75	56.85	18.80	16.75	89.10	11.63	5.66	48.59
CD @ 5%		5.74	6.59	12.83	8.48	4.80	3.51	0.13	2.18	NS	0.85	4.80	0.72	1.36	9.63
MEAN		38.95	47.10	29.60	25.68	21.07	19.29	0.92	53.78	18.24	15.55	85.19	10.57	5.30	49.31
RANGE		13.52 – 65.52	23.92 – 74.88	12.50 – 55.00	11.00 – 47.00	11.00 – 43.00	11.00 – 31.50	0.77 – 1.07	47.35 – 61.70	15.30 – 19.60	11.20 – 17.10	73.20 – 89.97	6.97 – 11.82	2.41 – 9.19	27.77 – 79.14

4.5.2.2. Sugar yield components

4.5.2.2.1 Juice extraction per cent

This cane quality parameter exhibited higher range (47.35 to 61.7%) of variability with a overall mean of 53.78 per cent. The only progeny SNK 509 (61.70%) had significantly higher juice extraction per cent over best check Co 7508 (59.3%).

4.5.2.2.2. Sucrose per cent

The range of sucrose per cent in the population was 11.2 to 17.1 with a overall mean of 15.55 per cent, but none of the selected progenies recorded superior sucrose per cent in juice compared to best check Co 7508 (17.20%).

4.5.2.2.3. Purity per cent

Similar trend was observed as that of sucrose per cent juice with a range from 73.2 to 89.95 and overall mean value of 85.19 per cent.

4.5.2.2.4. CCS per cent

Similar trend was observed as that of sucrose and purity per cent in juice with a relatively narrow range (6.97 to 11.82%) and overall mean of 10.57 per cent.

4.5.2.2.5. CCS Yield

The sugar yield per hectare varied widely (2.41 to 9.19t/ha) with a overall mean of 5.3 tonnes. The progenies, SNK 664, SNK 159, SNK 139, SNK 814, SNK 493 and SNK 423 recorded significantly superior sugar yield over best check Co 7508.

4.5.3. Under normal irrigated environment

The analysis of variance for the traits included in the study is presented in table 75a and 75b. As evident from the table, mean sum of squares for all the traits are highly significant. The mean values for all the traits of 13 significantly superior cane yielding progenies over the best check CoC 671 with overall mean and range are given in table 76. The mean values obtained for various traits included in study in respect of all the progenies are provided in Appendix XVIII and XIX.

Appendix XVIII. Mean values for germination, growth and cane yield parameters of selected progenies evaluated under normal irrigated environment at Hosur

Appendix XIX. Mean values for sugar yield parameters (at 330 and 360 DAP) of selected progenies evaluated under normal irrigated environment at Hosur

4.5.3.1. Germination, growth and cane yield components

4.5.3.1.1. Germination per cent

The germination per cent showed wide variability among selected clonal progeny population which ranged from 19.61 to 82.24 with mean value of 53.96 per cent. The only progeny SNK 635 (82.24%) had significantly higher germination over best check CoC 671 (57.60%). The other progenies viz., SNK 493 (79.46%), SNK 661 (77.03%), SNK 349 (74.95%), SNK 131 (73.39%), SNK 827 (73.22%), SNK 099 (72.70%), SNK 787 (70.96%), SNK 052 (68.71%) and SNK 024 ranked among top 10 for this trait with numerical superiority over best check CoC 671 (56.60%).

4.5.3.1.2. Tillers per plot

The tiller number ranged from 198.50 to 396.00 with a overall mean of 312.96 per plot revealing high amount of variability among 53 progenies evaluated under normal irrigated environment. The progenies viz., SNK 635, SNK 827, SNK 436, SNK 493, SNK 350, SNK 817, SNK 624, SNK 490, SNK 632 and SNK 024 ranked top 10 for this character with significant superiority over best check CoC 671 (247.00).

Table 75a. Analysis of variance for different growth and cane yield parameters in selected sugarcane progenies evaluated under normal irrigated environment

Source	d.f.	MSS for the characters							
		Germination % at 45 DAP	Tillers / plot at 90 DAP	Average single cane weight (kg) at harvest	Average millable cane height (cm) at harvest	Average cane girth (cm) at harvest	Average number of internodes at harvest	NMC / plot at harvest	Cane yield t/ha
Genotype	57	441.18**	4308.45**	0.184**	2069.56**	0.202**	34.92**	4629.64**	1162.65**
Error	57	139.9	1540.87	0.025	506.68	0.022	4.81	793.57	122.3
SEm±		8.36	27.75	0.112	15.91	0.105	1.55	19.91	7.82
CD @ 5%		23.65	78.5	0.316	45.01	0.297	4.38	56.34	22.11
CD @ 1%		31.47	104.44	0.42	59.89	0.395	5.83	74.95	29.24

Table 75b. Analysis of variance for different growth and cane yield parameters in selected sugarcane progenies evaluated under normal irrigated environment

Source	d.f.	MSS for the characters										
		Juice Extraction % at 330 DAP	Brix % Juice at 330 DAP	Sucrose % at 330 DAP	Purity % at 330 DAP	CCS % at 330 DAP	Juice Extraction % at harvest	Brix % Juice at harvest	Sucrose % at harvest	Purity % at harvest	CCS % at harvest	CCS Yield t/ha at harvest
Genotype	57	97.80**	7.33**	6.27**	55.38**	3.65**	66.79**	5.75**	8.11**	59.54**	5.20**	9.95**
Error	57	19.04	1.94	1.99	30.75	1.3	30.86	1.59	2.13	29.92	1.55	1.73
SEm±		3.08	0.98	0.99	3.92	0.8	3.92	0.89	1.03	3.86	0.88	0.93
CD @ 5%		8.72	2.78	2.82	11.09	2.28	11.11	2.52	2.92	10.34	2.49	2.21
CD @ 1%		11.61	3.71	3.76	14.75	3.04	14.78	3.36	3.88	14.55	3.32	3.5

*, ** Significant at 5 and 1 per cent respectively

Table 76. Mean values of germination (at 45 DAP), tillers (at 90 DAP), sugar yield parameters (at 330 and 360 DAP) and cane yield parameters (at 360 DAP) for top 13 superior cane yielding progenies over best check under normal irrigated environment.

Progenies	Cross	Germination %	Tillers / plot	Average single cane wt. (kg)	Average millable cane height (cm)	Average cane girth (cm)	Average No. of internodes	NMC / plot	Cane yield (t / ha)	Juice extraction % at 330 DAP	Brix % at 330 DAP	Sucrose % at 330 DAP	Purity % at 330 DAP	CCS % at 330 DAP	Juice Extraction % at harvest	Brix % at harvest	Sucrose % at harvest	Purity % at harvest	CCS % at harvest	CCS yield (t/ha) at harvest
1. SNK 825	Co 8371 GC	58.47	351.50	1.22	283.50	2.75	29.50	257.00	142.99	57.04	14.64	11.10	75.82	7.07	61.60	20.01	17.08	85.33	11.61	16.60
2. SNK 432	MS 6847 X CoC 671	68.36	335.00	1.89	296.50	2.95	30.50	163.00	142.30	47.16	16.44	13.03	79.15	8.51	50.70	17.82	14.47	81.82	9.58	13.63
3. SNK 627	Co 7201PC	45.11	286.50	1.20	250.00	2.75	21.50	255.50	141.14	46.18	15.64	12.92	82.87	8.64	55.60	15.81	12.65	79.71	8.31	11.73
4. SNK 490	85 R 186 X Co 8213	61.77	360.00	1.48	317.00	3.05	28.50	197.00	133.75	51.38	16.24	11.13	68.28	6.63	51.20	18.81	13.22	78.64	8.60	11.50
5. SNK 814	CoC 771 PC	57.60	310.50	1.40	248.50	2.65	20.50	205.50	131.44	45.00	13.72	9.98	73.51	6.19	53.84	18.45	15.31	82.33	10.26	13.48
6. SNK 349	CoC 671 X CoT 8201	74.95	333.00	1.32	271.75	2.75	26.50	206.50	124.97	45.94	15.62	11.28	71.82	6.97	51.99	18.56	15.54	83.37	10.47	13.08
7. SNK 827	Co 88025 GC	73.22	382.00	1.83	244.50	3.25	22.50	147.00	124.28	46.93	14.91	10.65	70.02	6.53	51.35	16.71	13.60	81.03	9.02	11.20
8. SNK 635	Co 8013 PC	82.24	396.00	1.29	250.50	3.05	25.50	219.00	123.59	52.80	13.59	10.12	74.27	6.38	58.15	18.71	16.49	88.12	11.39	14.08
9. SNK 363	CoC 85061 X CoC 671	56.73	331.50	1.31	252.00	2.90	21.50	216.00	121.97	51.38	16.00	12.96	81.50	8.57	59.38	19.22	15.27	78.78	9.99	12.18
10. SNK 632	Co 8013 PC	58.99	357.00	2.07	275.50	3.90	23.00	127.50	120.35	60.44	15.04	11.54	71.87	7.11	58.45	18.91	15.17	80.38	9.98	12.01
11. SNK 817	CoV 92101 PC	66.97	364.50	1.40	212.00	2.75	23.50	187.00	120.35	50.24	15.94	12.15	76.08	7.76	58.12	20.19	17.08	84.65	11.56	13.91
12. SNK 493	87 R 40 X CoC 671	79.46	378.00	1.69	271.00	3.00	23.50	203.00	118.27	43.97	17.05	13.24	77.87	8.55	52.74	19.26	17.08	88.67	11.83	13.99
13. SNK 024	Co 740 X CoA 7602	64.37	355.50	1.51	256.25	2.85	25.00	164.50	114.58	52.88	15.06	12.43	82.55	8.30	52.95	16.31	12.14	74.46	7.64	8.75
Checks																				
CoC 671		57.60	247.00	1.51	223.00	2.95	20.50	127.50	87.55	44.44	16.44	11.63	67.66	7.08	59.40	18.57	16.17	87.05	11.11	9.72
Co 86032		64.54	417.00	1.38	225.50	2.85	23.50	134.50	84.32	51.17	14.36	10.72	75.82	6.77	62.73	16.61	13.96	83.96	9.42	7.94
CoM 88121		63.33	293.00	1.37	241.50	2.95	23.00	123.00	77.39	61.73	18.46	14.88	80.33	9.81	55.88	20.41	16.47	80.84	10.87	8.41
CD @ 5%		23.66	78.51	0.32	45.02	0.30	4.39	56.34	22.12	8.73	2.79	2.83	11.09	2.29	11.11	2.53	2.92	10.94	2.50	2.21
MEAN		53.96	312.96	1.22	233.72	2.73	21.57	164.79	89.46	50.34	14.93	11.51	76.84	7.40	52.55	17.47	14.26	81.48	9.58	6.57
RANGE		19.61 – 82.24	198.5 – 396.0	0.44 – 2.07	167.00 – 317.00	1.95 – 3.90	12.5 – 31.5	83.0 – 354.5	54.50 – 142.99	31.77 – 64.01	10.77 – 18.91	7.69 – 16.5	66.95 – 87.25	4.66 – 11.34	37.00 – 68.35	13.75 – 21.42	9.22 – 18.16	67.05 – 101.98	5.41 – 13.01	2.41 – 9.19

CCS = Commercial cane sugar

4.5.3.1.3. Average single cane weight (kg)

The range of single cane weight was substantial (0.44 to 2.07 kg) with a mean of 1.22 kg in the population of 53 progenies. The progenies viz., SNK 632 (2.07), SNK 432 (1.89) and SNK 827 (1.83) recorded significant superiority over best check CoC 671 (1.51) while other three progenies viz., SNK 625 (1.77), SNK 493 (1.69) and SNK 393 (1.62) showed numerical superiority.

4.5.3.1.4. Millable cane height (cm)

As per the data recorded for this attribute, the mean millable cane height was 233.72 cm with a range of 167.00 to 317.00 cm, indicating higher variability. Nine progenies viz., SNK 490 (317.00), SNK 625 (314.50), SNK 432 (296.50), SNK 436 (292.50), SNK 825 (283.50), SNK 632 (275.50), SNK 349 (271.75), SNK 493 (271.00) and SNK 350 (268.75) recorded significantly superior cane height compared to best check CoC 671(223.00).

4.5.3.1.5. Cane girth (cm)

Cane girth exhibited higher variability among the progeny population studied with mean values ranging from 1.95 to 3.90 with 2.73 cm overall mean value. Only three progenies viz., SNK 632 (3.90), SNK 131 (3.30) and SNK 827 (3.25) had significantly higher thickness compared to best check CoC 671(2.95).

4.5.3.1.6. Number of internodes

This trait exhibited substantial amount of variability with a range of 12.50 to 30.50 and overall mean of 21.57 internodes. The progenies viz., SNK 432, SNK 579, SNK 825, SNK 350, SNK 490, SNK 085, SNK 349, SNK 625, SNK 635 and SNK 782 recorded significantly higher number of internodes over best check CoC 671(20.50).

4.5.3.1.7. Number of millable canes (NMC)

There exists high variability for NMC per plot with wide range (83 to 354) and a overall mean of 164.79. The progenies viz., SNK 086 (354.50), SNK 825 (257.0), SNK 627 (255.50), SNK 380 (236.00), SNK 083 (232.50), SNK 786 (220.00), SNK 635 (219.00), SNK 421 (318.50), SNK 363 (216.00) and SNK 349 (206.50) and SNK 814 (205.50) recorded significantly higher NMC over best check CoC 671(127.50).

4.5.3.1.8. Cane yield

Cane yield exhibited wide variation with a range from 54.50 to 142.99 and overall mean of 89.46 tonnes per hectare. Among 53, only 13 progenies recorded significant superiority over the best check CoC 671 (87.55 t/ha). The progenies viz., SNK 825 (142.99), SNK 432 (142.30), SNK 627 (141.44), SNK 490 (133.75), SNK 814 (131.44), SNK 349 (124.97), SNK 827 (124.28), SNK 635 (123.59), SNK 363 (121.97) and SNK 632 (120.35) ranked top 10 for cane productivity.

4.5.3.2. Sugar yield and its components

4.5.3.2.1. Juice extraction per cent (at 330 DAP)

The juice extraction per cent was ranged from 31.77 to 64.01 with a overall mean of 50.34 showing wide variability. Nine progenies viz., SNK 086 (64.01), SNK 773(63.65), SNK 632 (60.44), SNK 380 (60.20), SNK 099 (59.99), SNK 052 (59.42), SNK 084 (59.20), SNK 579(58.32) and SNK 085 (58.14) had significant superiority over best check CoC 671(44.44).

4.5.3.2.2. Brix per cent (330 DAP)

Though brix per cent exhibited wide variation among all the progenies with a range of 10.77 to 18.91 and overall mean of 14.93, none of the progenies showed significant superiority over best check CoC 671(16.44).

4.5.3.2.3. Sucrose per cent (at 330 DAP)

The range of sucrose per cent juice was 7.69 to 16.50 with a overall mean of 11.51 showing wide variability among 53 progenies. But only two progenies viz., SNK 661 (16.50), and SNK 192 (15.59) showed significant superiority over best check CoC 671(11.63).

4.5.3.2.4. Purity per cent (at 330 DAP)

The juice purity varied widely (66.95 to 87.25) with a overall mean of 76.84 per cent. The top 10 progenies viz., SNK 661, SNK 085, SNK 084, SNK 030, SNK 081, SNK 100, SNK 627, SNK 192, SNK 024 and SNK 380 were significantly superior over best check CoC 671(67.66%) for this trait.

4.5.3.2.5. CCS per cent (at 330 DAP)

Similar trend as that of sucrose per cent juice was observed with a range of 4.66 to 11.34 and overall mean of 7.40 per cent CCS in juice.

4.5.3.2.6. Juice extraction per cent (at 360 DAP)

Though the range of per cent juice extraction varied widely (37.00 to 68.35 %) with a overall mean of 52.55 per cent, none of the progenies showed significant superiority over best check CoC 671(59.40).

4.5.3.2.7. Brix per cent (at 360 DAP)

The range of brix per cent in juice at 360 DAP was 13.75 to 21.42 with a overall mean of 17.47 per cent for the population studied. Only one progeny viz., SNK 192 (21.42%) showed significant superiority over best check CoC 671 (18.57%) while, other nine progenies viz., SNK 625, SNK 817, SNK 825, SNK 787, SNK 661, SNK 082, SNK 493, SNK 363 and SNK 624 recorded numerically higher values.

4.5.3.2.8. Sucrose per cent (at 360 DAP)

None of the progenies showed significant superiority over best check CoC 671(16.17%) though the range of variability was quite wider (9.22 to 18.16%) with a overall mean of 14.26 for the population studied.

4.5.3.2.9. Purity per cent (at 360 DAP)

Similar trend as that of brix and sucrose per cent was observed with purity per cent which ranged from 67.05 to 101.98 and a overall mean of 81.48 per cent.

4.5.3.2.10. CCS per cent (at 360 DAP)

The commercial cane sugar per cent in juice though varied widely (5.41 to 13.01 %) with a overall mean of 9.50 per cent, none of the progenies recorded significantly superior values over best check CoC 671(11.11%).

4.5.3.2.11. CCS yield

The sugar yield showed wide variation among progenies studied which ranged from 2.41 to 9.19 and overall mean of 6.57 tonnes per hectare. Nine progenies viz., SNK 825 (16.60), SNK 432 (13.63), SNK 814 (13.48), SNK 349 (13.08), SNK 635 (14.08), SNK 363 (12.18), SNK 632 (12.01), SNK 817 (13.91) and SNK 493 (13.99) yielded significantly higher sugar per hectare compared to CoC 671 (9.72).

V. DISCUSSION

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 higher cane yield, better juice quality (sugar content), earliness of sugar accumulation, better ratooning ability, higher 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 noble canes had the advantage of high sugar and low fibre. But they lacked the hardiness and resistance / tolerance to insect pests and diseases. It is *Saccharum spontaneum* which played major role in imparting resistance/ tolerance to major abiotic and biotic stresses in the present day cultivars. The production of new varieties from true seed became an attractive alternative (Roach and Daniels, 1987). The improved clones selected from seedling populations after hybridization contributed much for controlling the sugarcane insect pests, diseases and for high cane and sugar yields even under abiotic stresses.

Introgression of wild germplasm is time consuming and requires considerable efforts and resources with slower progress. In comparison, breeders recognized intercrossing of the already existing commercial varieties known for adaptation under varied biotic and abiotic stresses, a faster and more viable option to generate the variability required to cater the location specific immediate needs.

In many of the cereal crops, the pedigree system of breeding provides right parental combinations to produce desirable segregants with transgressive possibilities. In sugarcane, this system is adopted with some modification in 'proven cross' and 'close breeding' types of crosses, which emphasize "genetic assortative matings". In Hawaii, for identifying the proven parents, clones that are promising are placed in a melting pot, selection record is kept and a selection ratio calculated. Those parents with the best ratio are propagated for further crossing while, those with poor records are discarded. In India and Australia the "proven cross" system of breeding is being followed successfully. Recently greater emphasis is being given to identify parents, crosses and progenies for tolerance specific stresses and adaptable to specific location to achieve further improvement in both cane and sugar productivities.

In view of the enormous initial population, some amount of culling is imposed even at the seedling stages in order to reduce the population to manageable size and to increase the frequency of desirable genotypes in subsequent clonal generations. Seedlings are eliminated based on (a) poor vigour (b) defects in agronomic characters and (c) susceptibility to pests and diseases.

The major gains can be expected, primarily through hybridization and selection for an improvement in plant types which are specifically or widely adaptable with resistance to biotic and abiotic stresses. The sugarcane breeding has been based mainly on visual discrimination of seedlings, ever since the first hybrid crop was raised. For improving efficiency of breeding for cane yield, identification of superior genotype or selection has to be initiated in first generation (sexual) itself. The early generation selection depends upon the nature and magnitude of association of traits and repeatability between stages and environments.

The seedling (sexual) and settling (clonal) population derived from 45 intervarietal crosses were evaluated in major sugarcane agro-ecologies of northern Karnataka to study variability, heritability, genetic advance as per cent of mean for productivity and its related traits. The association of different traits with cane yield and its path analysis under three environments were also worked out. The pre-selected progeny population was also evaluated for reaction against SWA over three hot spot locations both under natural and artificial infestation conditions. The results obtained are discussed under the following subheadings.

- 5.1 Genetic parameters for various traits in seedling (sexual) and early clonal (settling) generations under diverse environments
- 5.2 Repeatability of important traits between seedling and settling generations across diverse environments.
- 5.3 Identification and characterization of progenies for SWA reaction.
- 5.4 Path analysis of cane yield with its components and physiological traits under moisture stress, salinity water logg complex stress and normal irrigated environments
- 5.5 Identification and characterization of superior progenies for cane and sugar yield parameters in moisture stress, salinity water logg complex stress and normal irrigated environments

5.1 GENETIC PARAMETERS FOR VARIOUS TRAITS IN SEEDLING (SEXUAL) AND EARLY CLONAL (SETTLING) GENERATIONS UNDER DIVERSE ENVIRONMENTS

The amount of variability present in breeding material plays an important role in the progress of improvement of crop plants through selection. Further, its expression is likely to be influenced by the environments. So, the information available at one location may not necessarily be applicable to another. Therefore, the knowledge of variability available in a particular type of population under different environments is desirable for a breeder before making any selection programme. In sugarcane, many studies on assessing variability have been made (Hooda *et al.*, 1979 and 1989, Nair *et al.*, 1980, Chaudhary *et al.*, 1982, Punia and Hooda, 1982). However, the information on the nature of variability in hybrid progeny populations involving commercial varieties under diverse environments is meagre. In the present investigation, parameters like phenotypic and genotypic coefficients of variation (PCV and GCV), heritability in broad sense (H) or h^2 and genetic advance as per cent of mean (GAM) were estimated in seedling and clonal generation under three environments and in clonal ratoon under moisture stress environment (Table 8, 15, 22, 29 & 37) to know the nature and magnitude of variation among the progenies derived from 44 inter varietal crosses under study. The progress achieved through selection not only depends on the amount of variability present in the population but also on the extent to which it could be transferred from parent to offspring. Heritability in broad sense is the ratio of genotypic variance to the phenotypic variance and it represents the proportion of heritable variation.

Table. 8 Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in seedling (sexual) generation of 45 inter varietal crosses of sugarcane

Table 15 Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in settling (clonal) generation of 44 inter-varietal sugarcane crosses under moisture stress environment at Sankeshwar

Table 22. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in clonal ratoon generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Table 29. Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in settling generation of 44 inter varietal sugarcane crosses under salinity water logg complex environment at Ugar

Table 37 Mean, range, variability, heritability, genetic advance and genetic advance over per cent mean for important cane yield parameters and HR Brix (%) in settling generation of 44 inter varietal sugarcane crosses under normal irrigated environment at Hosur

5.1.1 Seedling (Sexual) generation

5.1.1.1 Genotypic, phenotypic coefficients of variability

The nature and magnitude of genotypic and phenotypic variability present in the population is pre-requisite to start any crop improvement programme. The scope for improvement through selection is enhanced by the range of variability available in the population. The genotypic coefficient of variability (GCV) estimate the amount of variation exclusively due to gene action. The phenotypic coefficient of variability includes an environmental component of variation. These abiotic and phenotypic parameters could generally be of advantage in choosing the characters of importance in the selection programme.

The analysis of variance showed highly significant differences for all the characters studied in the seedling (sexual) generation comprising of progenies of 45 diverse crosses involving diverse commercial varieties, thereby indicating the sufficient amount of genetic variability in the population (Table 7).

Table 7. Analysis of variance for important cane yield parameters and HR Brix (%) in seedling (sexual) generation of 45 inter varietal crosses in sugarcane

Range of variation is one of the simple approaches for examining the variability. In the present investigation very wide range of variation for all the characters under study in seedling generation was observed than the reported ranges of Singh *et al.* (1995), Singh *et al.* (2002) and Doule and Balasundaram (2003). Considering this, it may be concluded that, there is ample scope for selecting progenies (seedlings) with desirable productivities of both cane yield and HR brix.

The GCV and PCV measures of variability gives an information regarding the relative amount of variation in different traits. In the present study, very high variability estimates were observed for tillers, millable cane height, number of internodes, internodal length, millable canes, cane yield and HR Brix per cent, indicating selection for these characters is expected to achieve profitable gains. Moderate estimates of GCV and PCV were recorded in the present investigation for cane girth and single cane weight. These findings are in accordance with the earlier reports. Many of the earlier workers reported high genetic variability for cane yield, its components and HR Brix (Nagarajan, 1997; Anshuman Singh *et al.*, 2002; Singh *et al.*, 2002; Kumar and Bakshi Ram 1996; Doule and Balasundaram, 2002). Singh and Sundama Singh (1994) also indicated similar trend for leaf area and number of shoots per clump.

Among the cane yield components, cane girth and single cane weight exhibited lowest values of GCV and PCV. The results of the present study are in accordance with the findings of Silva *et al.*, (2002). The moderate variability values observed in the present investigation indicate the limited scope to improve these characters by selection alone.

5.1.1.2 Heritability and Genetic advance

For a breeding programme, knowledge of the overall variability and the magnitude of heritable and non-heritable components is most important. The information on the heritability of important traits indicate the possibility and extent of improvement that can be achieved through selection. The broad sense heritability and its relationship with plant characters associated with yield and quality are widely used as selection criteria in sugarcane (Cuenya and Mariotti, 1994 and Kang *et al.*, 1989).

The expected genetic advance of each trait is an off shoot of heritability and gives an indication of likely improvement that can be achieved by selection for that character. The expected genetic gain from selection is estimated as a product of heritability, phenotypic standard deviation and selection of differential (Burton and DeVane, 1953). Heritability by itself does not indicated the true selection worth of a character unless accompanied by genetic advance. High heritability with high genetic advance is indicative of additive gene effects (Panse, 1957).

In the present study, among cane yield and its seven important components, cane yield, number of millable canes, tillers, average internodal length, average millable cane height and average number of internodes had high heritability. The characters number of millable canes, tillers and cane weight (clump weight) had very high genetic advance as per cent of mean in addition to high heritability suggesting that these attributes were under additive genetic control (Panse, 1957) and these can be improved by straight selection. The findings of present investigation are in line with the results obtained by Hemprabha *et al.* (1993) for cane yield and Singh *et al.* (1995), Ram and Hemaprabha (1998) and Singh *et al.* (1994) for number of millable canes. However there are no reports available in the literature in support of tillers per seedling studied in the sexual generation. The other cane yield components like average number of internodes and average internodal length had moderate genetic advance as per cent of mean where as the average millable cane height showed lower genetic advance. This finding is in accordance with the report of Ramdoyal and Badaloo (1998) for internodal length. However, Singh *et al.*, (1995) reported high heritability coupled with high genetic advance as per cent of mean for number of internodes.

The average cane girth and average single cane weight exhibited moderate and lower heritability respectively and lower genetic advance as per cent of mean indicating predominance of non-additive gene action or more environmental influence, as also supported by larger difference between GCV and PCV values. Gonzalez *et al.* (1989) also reported moderate heritability for cane girth. Johnson *et al.* (1955) opined that high heritability must be associated with high genetic variable to obtain any progress from selection. Hence, selection based on cane girth and single cane weight for improvement of cane yield is not useful as also indicated by Silva *et al.* (2002) and Xie *et al.* (1989). However, some of the sugarcane workers obtained contrary results indicating high heritability for single cane weight (Singh *et al.*, 1995; Ramdoyal and Badaloo, 1998; Silva *et al.*, 2002; Bakshi Ram *et al.*, 1999; Rosabal *et al.*, 1999; Singh *et al.*, 1994 and Reillyo *et al.*, 1995). This may be due to change in the material, population and sample size.

The HR brix measure the total solids in the juice and a high proportion of these solids consist of sucrose. The correlation is usually high enough to make brix a very useful correlated characteristic for selection. The high degree of correlation between brix and recoverable sucrose has been reported by Kang *et al.* (1983) and Lennox *et al.* (1936).

The heritability estimates for HR brix in seedling generation was high with moderate genetic advance as per cent of mean. Similarly, high heritability estimates were reported by Hemaprabha *et al.* (1993); Gonzalez *et al.* (1989); Singh *et al.* (1995); Hemaprabha *et al.* (2003); Hsu *et al.*, (1995); Singh *et al.* (1994) and Reillyo *et al.* (1995). The moderate genetic advance as per cent of mean was reported by many workers (Tai *et al.*, 1992; Ramdoyal and Badaloo, 1998; Sivla *et al.*, 2002 and Bakshi Ram *et al.*, 1999). However lower heritability estimate in seedling generation was reported by Xie *et al.* (1989). The results obtained in the present study indicate, improvement can be achieved by resorting to direct selection based on HR brix.

5.1.1.3 Family wise per cent superior progenies obtained based on cane yield and HR brix

The families F04, F14, F17, F05, F06, F19, F23, F22, F28 and F09 were promising among the 45 families evaluated for per cent superior progenies indicating existence of considerable differences among crosses for isolation of transgressive segregants. These promising crosses (families) may be identified as "proven" for northern Karnataka and further efforts are to be concentrated to exploit these crosses to achieve further improvement in sugarcane productivity. The results also suggest the importance of family selection. These findings are in accordance with many sugarcane workers (Nagarajan, 1997; Reillyo *et al.*, 1995; Singh *et al.*, 1995; Singh and Singh 1994; Garcia *et al.*, 1991; Chang and Milligan 1992; Jackson *et al.*, 1994; Jackson *et al.*, 1995; Jackson and McRae 1998 and Tai *et al.*, 2003).

5.1.2 Genetic parameters for various traits in settling generation under moisture stress environment

The analysis of variance showed highly significant differences for all the cane yield components and HR brix per cent in the settling generation under moisture stress environment. This indicates sufficient amount of genetic variability available in the pre-selected population (Table 14). The mean, range and important genetic parameter estimates in Table 15 and that of familywise parameters in Table 16 to 20.

Table 14. Analysis of variance for important cane yield parameters and HR Brix (%) in settling (clonal) generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Table 16. Family wise mean, range and variance for germination (%) and tillers in clonal generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 20. Family wise mean, range and variance for cane yield and average HR Brix in clonal generation of pre selected sugarcane progenies under moisture stress environment and per cent superior progenies at Sankeshwar

5.1.2.1 Genotypic, phenotypic coefficients of variability

The range of variation for all the traits studied was quite wide in pre-selected population under moisture stress. Similar results were reported by Sanjeev Kumar *et al.* (2001) and Kamat and Singh (2001). Considering this, it may be concluded that there is ample scope for selection of progenies with superior cane and sugar yield over existing adopted commercial varieties CoC671 and Co86032 which are moderately productive under moisture stress environment.

In the present investigation, very high variability was exhibited by the clonal population for the traits, germination per cent, tillers per plot, average millable cane height, average number of internodes, number of millable canes per plot, single cane weight and HR brix per cent. This indicates expected gains can be achieved by selection for these traits.

Sanjeev Kumar *et al.* (2001) and Kamat and Singh (2001) also reported high GCV and PCV estimates for tillers, number of millable canes and millable cane height, whereas moderate estimates were observed by Kamat and Singh (2001) for single cane weight and low for cane girth. Bakshi Ram *et al.*, (1999) estimated moderate variability for number of millable canes. In accordance, with these in the present investigation moderate estimates of GCV and PCV were observed for cane girth, average internodal length and cane yield. However, Bissessur *et al.* (2001) and Sanjeev Kumar *et al.* (2001) reported high GCV and PCV for cane yield, number of millable canes, tillers. On the contrary, Bakshi Ram *et al.* (1999) reported moderate estimates for most of the cane yield and juice quality parameters under moisture stress environment. The moderate variability values obtained for few traits in the present study indicate the relative difficulty in improving them by selection alone.

5.1.2.2. Heritability and Genetic advance

The traits single cane weight, average number of internodes, tillers per plot, number of internodes, HR brix per cent, cane girth, millable cane height had high heritability estimates with moderate to high genetic advance as per cent of mean, whereas, cane yield, germination per cent, length of internodes had moderate heritability with lower genetic advance as per cent of mean. In literature, different sugarcane workers reported widely varied estimates of heritability and genetic advance for various traits under moisture stress environments which could be due to differences in environments, populations and sample size. Kamat and Singh (2001) reported high values of heritability and genetic advance as per cent of mean for cane yield, tillers, leaf area, number of millable canes, cane height and proline content in leaves under moisture stress environment, whereas moderate to lower values for single cane weight and cane girth and chlorophyll contents. In study with clonal population under moisture Sanjeev Kumar *et al.* (2001) also reported high values for cane girth, number of millable

canes and internodal length and Bissessul *et al.* (2001) reported for cane yield, number of millable canes and sugar yield, while Bakshi Ram *et al.* (1999) reported moderate values for sucrose, purity percentages. The high estimates of heritability and genetic advance as per cent of mean indicates that these characters can be improved by straight selection as they are under additive genetic control and less influenced by moisture stress environment. The traits germination per cent, cane yield, number and length of internodes are much influenced as evidenced by moderate heritability estimates and genetic advance as per cent of mean. Hence selections based on these characters for improving productivity under moisture stress are not much useful.

5.1.2.3 Family wise per cent superior progenies obtained based on cane yield and HR brix

Among the 44 families evaluated for recovery of per cent superior progenies on the basis of overall cane sugar yield components under moisture stress environment, families viz., F44, F38, F06, F35, F04 and F39 are promising. These families (crosses) could be identified as proven for improving sugarcane productivity under moisture stress environment.

5.1.3 Genetic parameters for various traits in clonal ratoon generation under moisture stress environment

The analysis of variance showed highly significant differences only for cane girth, single cane weight and HR brix per cent in clonal ratoon population evaluated under moisture stress environment. The number and length of internodes had exhibited differences which were significant at only 5 per cent probability level (Table 21). The mean, range and genetic parameter estimates are given in Table 22 and that of families in Table 23 to 27.

Table 21. Family wise mean, range and variance for average HR Brix (%) in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment and per cent superior progenies based on cane yield and HR brix at Sankeshwar

Table 23. Family wise Mean, Range and Variance for tillers and average cane girth in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 24. Family wise mean, range and variance for average millable cane height and average number of internodes in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 25. Family wise mean, range and variance for average internodal length and number of millable canes in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 26. Family wise mean, range and variance for average single cane weight and cane yield in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment at Sankeshwar

Table 27. Family wise mean, range and variance for average HR Brix (%) in clonal ratoon generation of pre selected sugarcane progenies under moisture stress environment and per cent superior progenies based on cane yield and HR brix at Sankeshwar

5.1.3.1 Genotypic, phenotypic coefficients of variability

The range of variation for nine important traits in ratoon generation of pre-selected clonal population under moisture stress environment was quite high to exercise selection for better ratoon productivity.

In the present investigation, very high GCV and PCV was exhibited by the pre-selected clonal ratoon population for traits, tiller per plot, millable cane height, number and length of internodes, average single cane weight and HR brix per cent suggesting expected gains could be achieved by selecting these ratoon traits in moisture stress conditions. There are no reports in support of these findings in case of clonal ratoon population studied under specific moisture stress environment. However, Olaoye (2001) has reported lower variability in clonal ratoon under moisture stress environment.

5.1.3.2 Heritability and genetic advance

Among five traits which significantly differed in the population under moisture stress, only HR brix per cent exhibited moderately high heritability, followed by single cane weight, cane girth, number and length of internodes. The higher genetic advance as per cent of mean was recorded in single cane weight, followed by number of millable canes, tillers, number of internodes, cane girth and HR brix per cent. All the traits except single cane weight had lower genetic advance as per cent of mean. Only single cane weight and HR brix in ratoon generation under moisture stress could serve as better selection criteria to isolate productive progenies. However, Olaoye (2001) reported lower heritability estimates for HR brix and higher for cane yield contrary to present findings.

The families F44, F38, F06, F35, F39 and F04 are promising for improving ratoon productivities under moisture stress environment on the basis of per cent superior progenies obtained for cane yield and HR brix.

5.1.4 Genetic parameters for various traits in settling generation under salinity water logg complex environment

The analysis variance showed highly significant differences for germination, tillers, number of millable canes, single cane weight, cane yield and HR brix per cent, whereas for cane girth, differences among progenies were significant at only 5 per cent probability level (Table 28). This indicates availability of enough required variability in the pre-selected population under salinity-water logg complex environment. The mean, range and estimates of genetic parameters is given in Table 29 and that of different families in Table 30 to 35.

Table 28. Analysis of variance for important cane yield parameters and HR Brix (%) in settling generations of 44 inter varietal sugarcane crosses under salinity water logg complex environment at Ugar

Table 30. Family wise mean, range and variance for germination (%) and tillers in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Table 31. Family wise mean, range and variance for tiller mortality (%) and average cane girth in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Table 32. Family wise mean, range and variance for average millable cane height and average number of internodes in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Table 33. Family wise mean, range and variance for average internodal length and number of millable canes in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Table 34. Family wise mean, range and variance for average single cane weight and cane yield in settling generation of pre selected sugarcane progenies under salinity water logg complex environment at Ugar

Table 35. Family wise mean, range and variance for average HR Brix (%) in settling generation of pre selected sugarcane progenies under salinity water logg complex environment and percentage of superior progenies based on superiority cane yield and HR brix at Ugar

5.1.4.1 Genotypic, phenotypic coefficients of variability

The range of variability was wide enough for all the traits studied to exercise selection for progenies with higher productivities under salinity-water logg complex environment.

The germination per cent, millable cane height, tillers per plot, tiller mortality per cent, number of millable canes, cane yield and HR brix had exhibited significantly higher variability under salinity-water logg complex environments. Considering this, it may be concluded that the pre-selected productive progeny population is valuable with wide variability for above traits. However, there is a still some scope to augment the population to represent significant and more variation with respect to number and length of internodes and tiller mortality per cent.

The traits which exhibited high variability pre-selected population suggests that selection for these characters is expected to achieve profitable gains in improving productivities of cane and sugar under salinity water logg complex environment. The present findings are in accordance with results reported by Kumar and Singh (1999) for the germination per cent, tillers and millable cane height, Premachandran (1995) for single cane weight studied in clonal population under salt and water logg stress environments respectively. Kumar and Ram (1996) reported high variability in seedling population under salt stress environment for number of millable cane, cane girth, cane yield, purity, and K, Cl, Na content in juice, but moderate variability estimate for millable cane height. The moderate estimates of variability was reported by Kumar and Singh (1999) for cane yield and single cane weight, Premachandran (1995) for sucrose per cent and Bakshi Ram *et al.*, (1999) for number of millable canes and brix per cent in the clonal population under salt and water logg stress environments, whereas lower variability was observed by Kumar and Singh (1999) for cane girth and sucrose per cent.

The lower variability observed for number and length of internodes and cane girth indicate the difficulty in improving these characters by selection alone, as also described by Kumar and Singh (1999) for cane girth and sucrose per cent and Kumar and Ram (1996) for millable cane height.

5.1.4.2 Heritability and genetic advance

The germination per cent, number of millable canes and average single cane weight exhibited higher heritability coupled with higher genetic advance as per cent of mean suggesting, that these traits can be improved by straight selection, aiming to enhance the sugarcane productivity under salinity water logg complex environment. The findings of the present investigation are in line with the results obtained by Kumar and Singh (1999) for germination, tillers and millable cane height and Bakshi Ram *et al.* (1999) for K, Cl and Na in juice, whereas Kumar and Singh (1999) reported lower heritability and genetic advance as per cent of mean for cane girth and sucrose per cent.

Moderate estimates of both the heritability and genetic advance as per cent of mean for cane yield, single cane weight, number of millable canes, cane girth and millable cane height by Deren *et al.* (1991), for only cane yield and single cane weight by Kumar and Singh (1999), for single cane weight and sucrose per cent by Premachandra (1995) and for brix per cent and number of millable canes by Bakshi Ram *et al.* (1999) were reported in the literature pertaining to clonal populations studied under salt and water logg stress environments.

5.1.4.3 Family wise per cent superior progenies obtained based on cane yield and HR brix

The families F04, F46, F20, F03, F27 and F35 are promising as they contributed higher frequencies of superior progenies under salinity water logg complex environment, hence the above crosses could be taken as "proven" for concentrating further improvement efforts. Comparatively the higher frequencies of superior segregants in these specific crosses evidenced the role of parental having some tolerance salinity water logg stress. The greater proportion of the most elite progenies in above crosses in specific environment would result in better gains by selecting specific crosses for individual environments as also indicated by Jackson and McRae (1998), Garcia *et al.* (1991) and Jackson *et al.* (1995). The present findings suggest directed breeding in particular, parental or family selection has the major role to play in achieving targeted improvement in particular environment.

5.1.5 Genetic parameters for various traits in clonal generation under normal irrigated environment

The analysis of variance indicated that the mean sum of squares due to genotypes were highly significant (Table 36) for average internodal length, number of millable canes, single cane weight, cane yield and HR brix per cent, revealing the presence of sufficient variability among the genotypes for the above traits. The germination per cent and tillers per plot exhibited moderate variability as evidenced by significance of mean sum of squares due to genotypes at only 5 per cent probability level.

Table 36. Analysis of variance for important cane yield parameters and HR Brix (%) in settling generation of 45 inter varietal sugarcane crosses under normal irrigated environment at Hosur

5.1.5.1 Genotypic and phenotypic coefficients of variability

The range of variability for the above traits was sufficient to exercise selection for achieving higher sugar and cane productivity compared to existing varieties under normal irrigated environment. Similar results reported by Thippeswamy *et al.* (2001) in fairly large clonal collection under normal irrigated environment.

The present findings evidenced availability of large variability for important cane yield components (germination %, tillers per plot, average internodal length, number of millable canes, average single cane weight and HR brix per cent). Considering this, it may be concluded that the pre-selected clonal population used in the present study are valuable with wide variability for above traits. However, there is a still some scope to augment the population to represent more variation with respect to average cane girth, average millable cane height and average number of internodes, as they have shown comparatively lower amount of variability in the population studied.

These findings are in accordance with the earlier reports. Many of the earlier workers reported high genetic variability for cane yield and its components (Thippeswamy *et al.*, 2001; Daiule and Balasundaram, 2003; Singh *et al.*, 2002; Gupta *et al.*, 2002; Bakshi Ram and Ram, 1994; Bhatnagar *et al.*, 2003; Nair and Somarajan, 1984 and Silva *et al.*, 2002). Singh *et al.*, (1996) and Milligan *et al.* (1996) reported low genetic variability for cane girth and millable cane height. On the contrary high GCV and PCV estimates were reported by Kadian *et al.* (1997a) for cane girth, height and number of internodes, while Singh *et al.* (2002) observed high estimates of genotypic and phenotypic variability for millable cane height in the clonal population studied under normal environment.

5.1.5.2 Heritability and genetic advance

The traits *viz.*, average HR brix per cent, average single cane weight and number of millable canes exhibited higher heritability coupled with moderate to high genetic advance as per cent of mean. Ther higher heritability with higher genetic advance is indicative of additive gene action (Panse 1957). This indicates considerable scope for selecting or identifying clones with high cane yield potential and relatively high HR birx per cent under normal irrigated environment. Similar results were reported by Kadian *et al.* (1997a), Tyagi and Singh (1998) and Puneet Jain *et al.* (2001) for two important cane yield components *viz.*, number of millable canes and single cane weight, while Hemaprabha *et al.* (1993) and Gonzalez *et al.* (1989) for HR brix per cent, an important juice quality parameter.

Moderate heritability estimates were observed for cane yield, average internodal length, germination per cent and tillers per plot with moderately lower genetic advance as per cent of mean. Hence selection based on these attributes under normal irrigated environment is not expected to be of much use, as also reported by Kang *et al.* (1990) for cane yield, Sharma *et al.* (1998) for internodal length and Doule and Balasundaram (2003) for germination per cent. However, many workers reported high heritability and genetic advance for cane yield (Singh *et al.*, 1996; Kadian *et al.*, 1997b; Ghosh and Singh, 1997 and Puneet Jain *et al.*, 2001), while Kadian *et al.*, (1997a) and Thippeswamy *et al.* (2001) estimated high values for internodal length and germination per cent respectively.

In the present study, lower heritability estimates were observed for average cane girth, average millable height and average number of internodes coupled with lower genetic advance as per cent of mean. These lower values for these traits might be attributed to the population for high cane yield features with high HR brix per cent. In these circumstances, there is urgent need to utilize other parental clones which can really contribute towards improving these cane yield components under normal irrigated (non stress) conditions. These findings are in accordance with the results obtained by Thippeswamy *et al.* (2001) and Xie *et al.* (1989) for cane girth and Tyagi and Singh (1998) for number of internodes.

5.1.5.3 Family wise superior progenies obtained based on cane yield and HR brix

Under normal irrigated environment, it is evident that the families viz., F44, F49, F43, F38, F48, F04, F47, F20, F05, F14, F35 and F30 were found to be the proven crosses for improving cane and sugar productivities over existing in the fairly large agro-ecology. Therefore, family selection has major role in achieving further gains through directed breeding. Such identification of crosses as "proven" specific environments were reported by many workers (Garcia *et al.*, 1991; Jackson and Roach, 1994; Jackson *et al.*, 1994; Jackson *et al.*, 1995; Singh *et al.*, 1996; Jackson and McRae 1998; Cornide *et al.*, 1999; and Tai *et al.*, 2003).

5.2 REPEATABILITY OF SELECTION TRAITS BETWEEN SEEDLING AND SETTLING GENERATIONS ACROSS DIVERSE ENVIRONMENTS

The current selection cycle for a 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 high and significant, there is scope to exercise selection and also to reduce the locations for large clonal evaluations in early stages.

The efficacy of clonal selection in sugarcane relies on spatial and temporal repeatability of attributes across selection stages.

Several researchers (Lin *et al.*, 1991; Bakshi Ram *et al.*, 1996; Sousa *et al.*, 2003; Reddy and Reddi, 1988; Bakshi Ram *et al.*, 2000) estimated the repeatability of selection traits. Estimations in general were moderate to low at early stages. Some workers have reported that there is no relationship between the characters of seedlings and its clonal generations (Venkataram, 1935; Bhat *et al.*, 1960; Stevenson, 1965). However McIntosh (1935) reported significant positive correlation between seedling and clonal stages for quality (Hebert, 1965; Breanx *et al.*, 1956). Daniels (1959) and Walkins (1956) also recorded significant correlations for brix between seedling and clonal generations. Ethirajan (1965) reported positive association of cane girth and brix between the seedling and clonal stages. Miller and James (1975) reported that cane girth was more repeatable than number of millable canes or brix. In India, Tripathi *et al.* (1977) reported high significant correlation between seedling and clonal stages with regard to cane girth. Bhagyalakshmi (1985) reported strong correlations between seedling and clonal stages for various traits except cane yield and it was of a greater magnitude for cane girth and weight. In the present investigations, inter stage repeatabilities between seedling and settling generations across diverse environments were estimated for ten important cane and sugar yield traits in the progenies 44 diverse inter varietal crosses.

Among the eight cane yield components and one quality trait HR brix per cent, tiller number, number of millable canes and single cane weight and HR brix per cent had highly significant and moderately higher repeatability values. Of these, single cane weight and HR brix recorded higher repeatabilities between seedling generation and clonal generations across the environments. In the present study, low to moderate repeatability values were highly significant due to high degrees of freedom. On the contrary, number of internodes, millable cane height, of internodal length and cane yield had very lower repeatability values.

These results are in accordance with the earlier reports. Many of earlier workers reported moderately high repeatability values between seedling and settling generations for cane yield components and HR brix (Lin *et al.*, 1991; Bakshi Ram *et al.*, 1996; Ramdayal, 1999; Cuenya *et al.*, 1999; Sousa *et al.*, 2002; Rosabal *et al.*, 1991; Xie, *et al.*, 1989; Bakshi Ram *et al.*, 2000; Cuenya and Mariotti 1994; Reillyo *et al.*, 1995; Bressiani *et al.*, 2003). However, the findings of Reddy and Reddi (1988), Viana *et al.*, (1991) are not in agreement with the results of the present studies.

In the present study, the traits like number of internodes, millable cane height, internodal length and cane yield 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 (1994). However, Lin *et al.* (1991), Cuennya *et al.* (1999); Sousa *et al.* (2002); Bressiani *et al.* (2003); Xie *et al.* (1989) reported high values of repeatability.

The environment interferes with the ability of the breeder to identify superior genotypes and predict their behaviour in advanced clonal stages. It is expected that environmental effects on ultimate expression of characters are larger at early selection stages due to small size of plots. To speed up the breeding process especially in terms of reducing testing environments, early diagnosis is useful in the selection of sugarcane hybrid progenies. Identification of highly repeatable traits across the diverse environments in the early clonal populations reduces the breeding cost and intensifies the selection. In the present study, the correlation coefficients were estimated in early clonal stage across three diverse environments and clonal ratoon under moisture stress environment for nine cane yield and its components with a quality trait HR brix per cent.

The correlation coefficients in clonal generation across normal, salinity water logg complex and moisture stress (both clonal and clonal ratoon) environments were very low and non significant for internodal length except between clonal ratoon under moisture stress and clonal generation under salinity water logg complex which exhibited lower but highly significant repeatability indicating better stability of trait across salinity water logg complex environment and clonal ratoon under moisture stress, compared to other environments. This result is in accordance with the results reported by Milligan *et al.* (1996) and Cuenya and Mariotti (1994). Similar is the trend with respect to number of internodes except in clonal and its ratoon in moisture stress and clonal generation under normal and salinity water logg complex; which recorded lower but highly significant repeatabilities as reported by Milligan *et al.* (1996).

For cane girth exhibited fairly high and highly significant repeatability across environment including clonal ratoon under moisture stress except in clonal generation under moisture stress and salinity water logg complex and clonal generation under normal irrigated and salinity water logg complex environments, which had very lower and insignificant correlations. The results of present investigation are in line with the results obtained by Suarej *et al.* (1989), Milligan *et al.* (1996); Singh and Singh (1999); Bressiani *et al.*, (2003). However, Viana *et al.* (1991) reported poor repeatability in clonal population for two different harvests.

Millable cane height and cane yield though had moderate to lower but highly significant repeatability in clonal generation across the diverse environments except clonal generations between normal irrigated and salinity water logg complex, wherein above two traits had negative and positive insignificant values respectively. Milligan *et al.* (1996) also reported lower to moderate repeatability for these two characters in clonal generations across environments (years and locations). Similar results were obtained for millable cane height by many workers (Suarej *et al.*, 1989; Singh and Singh, 1999; Cuenya *et al.*, 1999, Bressiani *et al.*, 2003) and for cane yield (Ramdoyal, 1999; Sousa *et al.*, 2003 and Singh and Singh, 1999). However, Viana *et al.* (1991) obtained contrary results for millable cane height and Reddy and Reddi (1988) for cane yield.

The trait germination per cent in clonal generation across normal irrigated and salinity water logged complex environment had highly significant but moderately lower values, indicating selection for germinability trait in either of the environment has significant positive influence on germination at other environment. So that one can select genotypes with good germination potential in normal environment targeting genotypes for salinity water logged complex environment in early clonal generations where the population size is comparatively large. However, there are no reports available in the literature in support of this result.

The important commercial traits viz., number of millable canes, single cane weight and HR brix recorded comparatively higher and highly significant repeatability values in clonal generations across three diverse environments and clonal ratoon generation in moisture stress environment indicating these traits as more dependable as selection criteria. Selection for these three important traits in large early generation clonal population in one of the environments is sufficient for targeting the genotypes for diverse environments. These results are in accordance with findings of Milligan *et al.* (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. Similar findings for brix per cent were reported by Suarej *et al.*, (1989), Reillyo *et al.* (1995) and Singh and Singh (1999), indicating the brix per cent is most repeatable and least influenced by environments.

5.3 IDENTIFICATION AND CHARACTERIZATION OF PROGENIES FOR SWA REACTION

Sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner has been recently reported in outbreak proportions from peninsular India. Though the pest was first reported from West Bengal in 1958 and later from other parts of North east India, it had not made its way to other parts of India. It reproduces parthenogenetically and has an anholocyclic (absence of sexually producing generation) life cycle.

Due to continuous sap-sucking the crop becomes stunted (Lopez, 1931) and continuous infestation leads to reduction in the length, thickness, weight and sugar content of the stalk. In Vietnam loss in tonnage as well as sugar recovery were reported in susceptible varieties (Tripathi, 1995). Gupta and Goswami assessed the effects of 25 and 100 per cent aphid infested leaves on yield and quality parameters of sugarcane and found that 100 per cent infestation had detrimental effects on the length (11.6 % reduction), girth (3.5% reduction), weight (16.6% reduction), length of internodes (18.4% reduction) and width of leaf (4.9% reduction). Juice quality parameters also exhibited considerable reduction. Preliminary studies on loss estimation were conducted at Agricultural Research Station, Sankeshwar (UAS, Dharwad) which indicate adverse effects of aphid infestation on cane yield and quality parameters, when infestation occurs at 10 month crop age (Anon., 2002 and 2003). Since from August 2002, the sugarcane areas of Belgaum, Bagalkot and Bijapur districts of northern Karnataka became hot spot for SWA, encountering significant loss in both cane and sugar production ultimately affecting the economy of the sugar factory and farming community (Anon., 2002, 2003; Nerkar, 2003; Lingappa *et al.*, 2003).

To manage this pest, several control measures viz., chemical, biological, cultural and host plant resistance have been suggested (Anon. 2002, 2003; Patil, 2003; Nerkar, 2003; Lingappa *et al.*, 2003, Mote and Puri, 2003; Patil, 2003; Sunil Joshi and Viraktamath, 2004). In spite of these measures, there is ample scope for more directed work on this important emerging pest, especially in the areas of host plant resistance. Early attempts were made in Taiwan, Philippines and Indonesia (Pan *et al.*, 1984; Rueda and Calilung, 1974; Mirzawan and Irwan (1995) but the works were limited to studying varietal differences for aphid incidence and its biology with only some resistance and in Indonesia a resistance breeding programme was initiated for SWA (Mirzawan and Irwan, 1995). There are no reports available on the level of resistance for SWA in India. However, earlier studies reported relative susceptibility of genotypes (Anon. 2002, 2003; Phukan, 1978).

With this view in background, extensive screening and evaluation of pre-selected hybrid progeny populations of 44 inter varietal crosses was carried out at 3 SWA hot spot locations of northern Karnataka, both under natural and artificial infestation conditions. Further the detailed sugar and cane productivity was assessed in identified resistant progenies.

5.3.1 Screening hybrid progenies under natural infestation (free choice) condition across three hot spots

Among all the hybrid progeny clones including commercial checks, ten were totally free from aphids (0-grade) showing resistant reaction (Plate 1) and two SNK 250 and SNK 335 had lower aphid load (1-2 grade) compared to commercial susceptible check varieties CoC671 (2-3 grade) and Co 86032 (3-4 grade). However, there are no reports available in literature indicating resistant progenies for SWA. Actually in screening the genotypes for resistance under natural incidence of pests, it is not selection of resistant types but rejection of susceptible ones in a systematic way. Distinguishing the “escapes” from resistant one is possible by subjecting them to artificial infestation of pests (Shanmugasundaram and Makunthan, 1986). Therefore to confirm the resistant reaction, 10 hybrid progenies, were subjected to artificial infestation of SWA.

Plate. 1. Identified promising SWA resistant progenies (encircled) compared with susceptible progenies / checks

5.3.2 Screening of promising hybrid progenies and commercial checks under artificial infestation (no choice condition)

Ten hybrid progenies viz., SNK 002, SNK 044, SNK 049, SNK 057, SNK 061, SNK 124, SNK 158, SNK 192, SNK 256 and SNK 754 exhibited resistant reaction under artificial infestation (no choice condition). The two hybrid progenies SNK 250 and SNK 335 were equally susceptible as that of commercial checks CoC 671 and Co 86032, which scored maximum grade (4) by 28 days after artificial infestation under no choice condition. Identified resistant hybrid progenies are of great value for direct commercial exploitation in addition to utilizing them as unique germplasm resources in breeding for resistance against woolly aphid in sugarcane. There are no reports available in literature to support these findings. However, earlier studies reported relative susceptibility of genotypes (Anon., 2002, 2003, Phukan, 1978). Varietal differences with respect to aphid biology and varieties with low level of resistance were reported by Pan *et al.* (1984) and Rueda and Calilung (1974).

The progeny SNK 044, though exhibited resistant reaction, partial colonization of aphid population was observed in the initial stage soon after release at Hosur, but 100 per cent mortality of aphids was observed within 48-72 h (2-3 DAR). The aphids failed to colonize, survive and perpetuate on these resistant progenies indicating the possibility of operation of antibiosis and / or non-preference mechanism(s) in suppressing the pest and arresting further colonization and spread.

Various parameters were used to characterize host plant resistance in these clones. Interaction between host plants and insects are spread over a wide spectrum of intensity. The intensity of resistance is a relative term and should be discussed in relation to a susceptible cultivar of the same species (Painter, 1951). In the present findings the resistant progenies experienced very negligible or no damage by the aphids in comparison to susceptible commercial varieties and other susceptible hybrid progenies, where in these susceptible clones encountered much more than the average caused done by SWA.



Plate. 1. Identified promising SWA resistant progenies (encircled) compared with susceptible progenies / checks

5.3.3 Intensive screening of resistant progenies and commercial checks using infester row technique

5.3.3.1 Under free choice condition

The number of winged adults per plant did not differ statistically among resistant group and susceptible group (parents, commercial checks and infester) at all days after release till the harvest (180 DAR) excepting 7, 42 and 56 DAR. This finding indicates that winged adults of SWA do not have much differential preference across susceptible and resistant genotypes. However, non-preference mechanism in pyrilla for oviposition has been reported by Khan and Ramnath (1940); Khanna *et al.* (1950), whereas no such studies are reported in case of SWA even in contrast to our present findings. However prevalence of different levels of non-preference, antixenosis, antibiosis and tolerance to feeding by yellow sugarcane aphid has been reported in sugarcane varieties by White (1989).

The winged adults of SWA though preferred resistant clones and laid young ones, the young nymphs failed to survive and gradual mortality was observed within 3-4 days after laying, whereas, in case of susceptible parents and other commercial varieties including infester, the young nymphs survived perpetuated and formed colonies subsequently after laying. However, in case of parents of these resistant segregants viz., CoC 671, Co 88028, Co 88025, Co 7704, Co 7602 and Co 86249 the mortality of young nymphs was observed for initial 48 h (2 DAR) with comparatively low percentage ranging from 0.81 (0) to 17.30 (8.85). Whereas, on one of the parental clone MS 6847, Infester Co92020 and commercial check variety Co 86032, no mortality of young nymphs was observed. This finding indicates there might be either bio-physical barrier or biochemical suppression mechanism operating in these resistant progenies. The parental clones which exhibited some percentage of nymphal mortality initially, indicated that they too have some partial resistance against young nymphs. In the present finding, these parental combinations had higher frequencies of resistant segregants compared to all other cross combinations (Table 77). Similar findings were reported by Agarwal (1969) where in the varieties Co 449, Co 527 and Co 798 when used in crosses either as male or female parent, such crosses yielded resistant progenies against internode borer. But in present finding the resistant progenies were obtained from relatively susceptible parents also. Two opinions prevail on screening for insect resistance one by virtue of non-confirmity of sugarcane to the Mendelian laws of inheritance (Babu, 1979), there is chance to obtain resistant progenies from susceptible parents. Some of the varieties moderately resistant to top borer viz., Co 5767 and BO 91 and several varieties resistant to redrot have been the progenies of parents that are not resistant to pests and diseases. Secondly, even if insect resistant sources are available, there is possibility for the resistant parents not to donate their blood to their offsprings. Hence, no directed breeding is required. But works of Mathes and Ingram (1942) indicated that parents resistant to *Diatrea saccharalis* (F) transmitted their resistant genes to their offsprings. Similarly parents with high degree of stem hardness increased the average hardness of their progenies (Venkataraman, 1929; Buzacott, 1940). Thus, probability of obtaining resistant varieties in directed breeding is high.

Table 77. Frequency of SWA resistant segregants obtained from crosses involving relatively susceptible commercial varieties

In case of red rot stable resistant progenies were obtained from crosses involving susceptible parents. Such transgressive segregants are the products of additive gene action and they are bound to show stable resistance (Vanderplank, 1968). Infact, there are number of such varieties that are already available viz., Co 7704, Co 8021, Co 86010, Co 93009, Co 95071 and CoC 90063 which have susceptible parents (Natarajan, *et al.*, 2001). In conformity to these, the transgressive segregants obtained in the present study from varying susceptible parents could be the products of additive gene action as they exhibited high level of stable resistance against SWA.

Table 77. Frequency of SWA resistant segregants obtained from crosses involving relatively susceptible commercial varieties

Sl. No.	Cross	Total number of progenies (segregants) screened	No. of Resistant segregants (R)	Percentage of resistant progenies	No. of partial resistant segregants (MR)
1	(F-01) Co 740 X Co 88028	8	1	12.5	-
2	(F-02) Co 740 X CoA 7602	50	3	6.00	-
3	(F-03) Co 740 X MS 6847	21	1	4.76	-
4	(F-07) Co 7704 X CoC 671	58	2	3.44	-
5	(F-08) Co 86249 X CoC 671	40	1	2.50	-
6	(F-10) Co 88028 X Co 88025	27	1	3.70	1
7	(F-34) CoC 671 poly cross	21	1	4.76	-
8	(F-12) CoC 671 X Co 88025	35	0	0.00	1

The behaviour of released apterous nymphs for colonization was studied in resistant and susceptible group comprising parents of resistant progenies and commercial varieties in which the nymphs did not colonized resistant progenies, instead they crawled (restless movement) for 4-5 DAR and disappeared, whereas in case infester Co 92020, Co 86032 and MS 6847 the released nymphs colonized immediately within 24 h (1DAR). However, on few parents viz., CoC 671, CoM 88121, Co 740, Co 88028, Co 88025, Co 7704, CoA 7602 and Co 86249 initially some hindrance for colonization observed resulting partial colonization up to 5 DAR indicating these parental varieties too had some mechanism which hinders colonization by the aphids. This resistance feature might have been transmitted to their progenies leading to transgressive expression.

In case of resistant progenies, aphids crawled from heavily infested inferior row during 28 to 56 DAR but colonization was not observed even under continuous flow of aphids from heavily infested (susceptible) rows on either side of resistant progenies under caged condition.

Consequently resistant progenies remain free from aphids scoring zero grade (Plate 2) whereas the other clones in susceptible group scored 4 grade. However, the parental clones except MS 6847 maximum 3 grade comparatively at slower rate.

Plate 2. SWA resistant progenies free from aphids under infester row technique

5.3.3.2 Under no choice condition

The studies on survival of known number nymphs released under extreme no choice condition also resulted in 100 per cent mortality within 4-5 DAR on all the 10 resistant progenies, whereas on the highly susceptible infester Co 92020, the released aphid colonized and perpetuated further. These findings indicate the presence strong bio-physical, bio-chemical mechanism(s) operating in these resistant progenies against SWA.



SNK 061



SNK 044



SNK 049

Plate 2. SWA resistant progenies free from aphids under infester row technique

5.3.3.3 Morphological features of SWA resistant progenies and susceptible parents and commercial varieties

The plant canopy features like, leaf angle (MTA), leaf area index, leaf rolling, leaf color did not have any correlation with SWA reaction as both susceptible (varieties and parents) and resistant progenies (transgressive segregants) had wide variation irrespective of their specific reaction against SWA. The resistant progenies had exhibited wide range of canopy features (Plate 1) (Table 78). This indicates that these external leaf features had very little or no role in imparting resistance in these clones against SWA. However, varieties with erect rolling leaves were less susceptible compared broad droopy leaves (Anon. 2002, 2003) against SWA. In contrast, in case of pyrilla, narrow and hard leaved varieties of sugarcane were not preferred for oviposition by pyrilla (Khan and Ramnath, 1940 and Khanna *et al.*, 1950). Agarwal (1969) concluded that, wiry clones (leaf width less than 2.5 to 3.3 mm) as well as broad leaved clones (leaf width of 12-14 mm) were almost free from whitefly attack whereas, the clones of narrow and medium leaf width (5-10 mm) were generally attacked.

Table 78. Morphological features of resistant progenies, susceptible parents and other susceptible commercial varieties

The average number of stomate, spines and bi-celled hairs on lower surface of leaves also had little or no differences between susceptible and resistant group of clones (Plate 3), indicating little or no role in imparting resistance to SWA in these resistant progenies. However, in case of white fly, highly spiny clones were comparatively free, because spinous out growth causes obstructions in establishing the nymphs (Agarwal, 1969).

Plate 3. Microscopic view of lower surface of leaf impressions in SWA susceptible and resistant progeny

Hence, there is a need to identify exact biochemical and anatomical features responsible for resistance in these resistant progenies, which can enhance the efficiency of resistance breeding.

Some of these newly identified clones can be considered for commercial cultivation. Hence, studies have been made to assess cane and sugar yield potential of these SWA resistant progenies.

5.3.4 Assessing productivity potential of SWA resistant progenies

SWA infestation on presently grown varieties is causing 0 to 100 per cent loss in cane yields depending on crop stage at which infestation occurs. Significant losses to the extent of 30-35 per cent in cane yield and sugar recovery under infestation at 10 month crop age have been reported (Anon., 2002; Anon., 2003). Little damage (10 – 15%) has been observed under late infestation *i.e.*, after 11 months crop age. On the contrary, under very early infestations, particularly during germination to tillering phase, 100 per cent losses have been observed in commercial (susceptible) varieties. Overall, it has resulted in significant loss in cane yield and sugar recovery, which has led to drastic reduction in sugar production, cane area, and crushing duration, ultimately affecting the economy of sugar mills and cane growers.

The currently cultivated commercial varieties including clones under advanced yield trials are susceptible, necessitating need for identification resistant varieties. Superior or comparable tonnage over existing most popular (susceptible) commercial varieties is a primary requirement for the acceptance of these resistant progenies for commercial cultivation. Hence, studies were made to know the productivity potential of these newly identified resistant progenies in comparison with commercial varieties under early and late SWA infestation conditions.

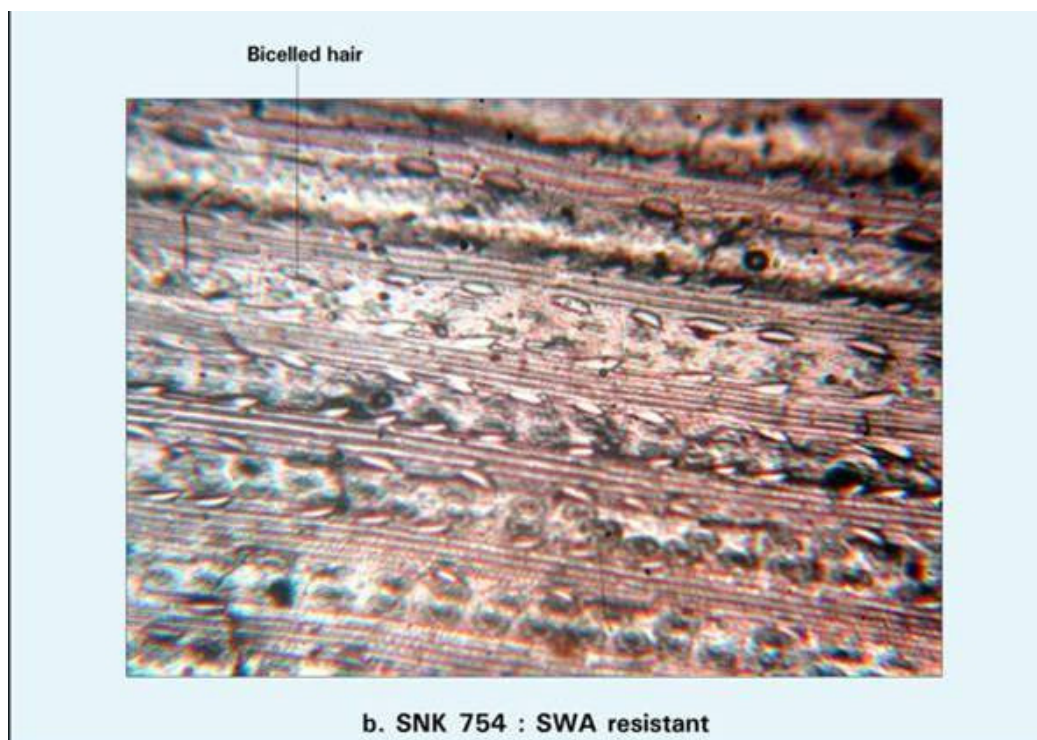
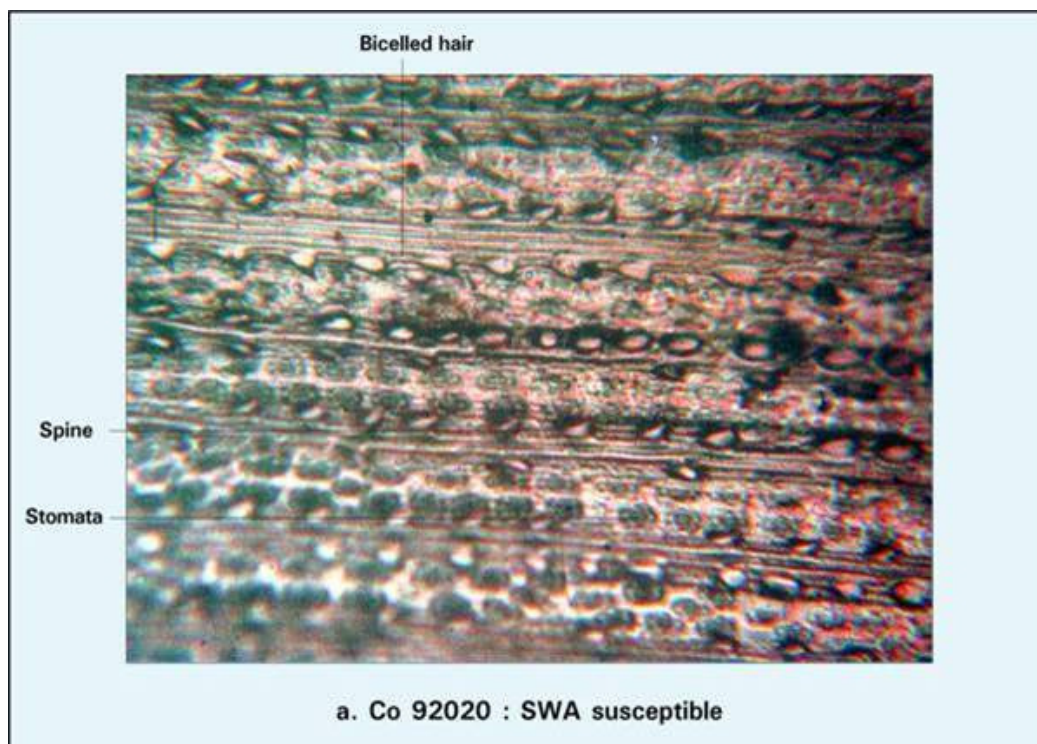


Plate 3 Microscopic view of lower surface of leaf impressions in SWA susceptible and resistant progeny

5.3.4.1 Performance under augmented trials

5.3.4.1.1 Under late (330 DAP) infestation conditions

All the resistant progenies except SNK 002 had superior cane productivity across locations. Among nine superior cane yielding progenies, SNK 754 recorded higher HR brix per cent over best check CoC 671, followed by SNK 061, SNK057, SNK 049 and SNK 044. The brix yield is an important criterion which takes into account both cane yield and HR brix (%). In this context, the progenies, viz., SNK 754, SNK 049, SNK 124, SNK 044, SNK 158, SNK 057 and SNK 061 are promising as they recorded higher brix yield across locations over best check CoC 671. During the cropping season of 2001-02, the infestation occurred during the later crop growth stage *i.e.*, after 11 month crop age which did not affect cane yield significantly as evidenced by normal performance of commercial checks, which recorded 3-4 grades only during harvest.

5.3.4.1.2 Under early (150 DAR) infestation conditions

The clonal trials of both the locations were ratooned to evaluate the performance of progenies under natural infestation of SWA which started at 150 and 170 days after ratooned (DAR) at Sankeshwar and Hosur respectively (Table 52 and 53, plate 1). Under the conditions, the performance of commercial varieties and other susceptible progenies was affected significantly as they scored 3-4 grades of SWA interaction, while the resistant progenies remained free from aphids (O-grade) showing normal performance. All the resistant progenies except SNK 002 at Sankeshwar were promising at both the locations by recording highly significant cane yields over best check CoM 88121. Similarly for HR brix (%) and brix yield, all the resistant progenies were significantly superior over best check.

Table 52. Ratoon performance of SWA resistant progenies and commercial varieties under early (150 DAR) infestation conditions at Sankeshwar

Table 53. Ratoon Performance of SWA - resistant and 13 productive (under normal irrigated) progenies under SWA infestation (170 DAR) at Hosur

The progenies, viz., SNK 754, SNK 044, SNK 049 and SNK 061 were more promising on the basis of higher brix yield at Sankeshwar and Hosur locations.

5.3.4.2 Detailed cane and sugar productivity assessment

The productive SWA resistant progenies were studied further to know the detailed cane and sugar productivity parameters in comparison with of commercial checks under both early (180 DAP) and late (330 DAP) infestation conditions at Sankeshwar.

5.3.4.2.1 Under early (180 DAP) infestation condition

The analysis of variance revealed the presence of highly significant differences among resistant progenies and commercial checks for all the parameters except juice purity per cent at harvest. The mean values for various traits of resistant progenies and checks are presented in Table 56 to 58. The commercial checks and the infester, Co 92020 scored 3-4 grades while, SWA resistant progenies remained free from aphids (0 grades) (Plate 2).

Table 56. Germination (30 DAP), tillers (90 DAP), growth and cane yield parameters (at harvest) of SWA resistant progenies and commercial varieties under early (180 DAP) infestation condition

Table 57. Sugar yield and it's parameters (at harvest) of SWA resistant progenies and commercial varieties at harvest under early (180 DAP) infestation condition

Table 58. Sugar yield parameters of SWA resistant progenies and commercial varieties at 300 and 330 days after planting under early (180 DAP) infestation condition

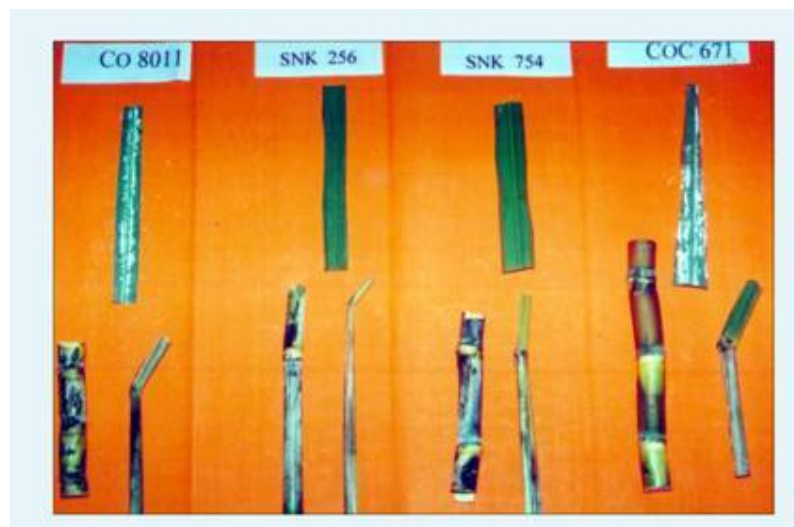
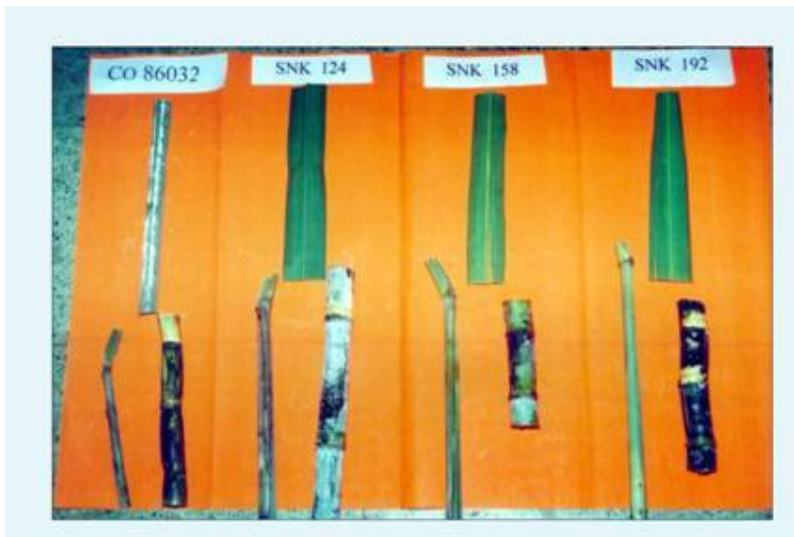


Plate 4. Cane features of SWA resistant progenies and commercial checks

The germinability and tillering potential of SWA resistant progenies was better compared to commercial checks except SNK 002 and SNK 192 progenies. All the resistant progenies had significant superior cane thickness (Plate 4) better millable cane height and number of internodes compared to checks. The progenies viz., SNK 049, SNK 256, SNK 754 and SNK 061 are more promising as they had significantly taller canes compared to best check CoM 88121.

Plate 4. Cane features of SWA resistant progenies and commercial checks

When these progenies were evaluated based on average single cane weight, which is an important cane yield component, all the resistant progenies were superior over checks indicating their high productivity. The progeny SNK 049 recorded heaviest millable canes followed by SNK 057, SNK 044, SNK 061, SNK 158 and SNK 754. The progenies viz., SNK 256, SNK 754, SNK 049 and SNK 061 also recorded significantly higher number of millable canes over best check CoM 88121.

All the resistant progenies except SNK 002 are highly productive as they recorded highly significant cane yields over best check CoM 88121 to the extent of 50.13 to 124.4 tonnes per hectare. Out of these, six progenies viz., SNK 754, SNK 061, SNK 049, SNK 192, SNK 057 and SNK 044 were early maturing, on the basis of their high CCS per cent at 10th and 11th months.

The CCS per cent at harvest revealed that all the 10 progenies had superior values over best check CoM 88121. Among them, the SNK 061 had highest CCS per cent in juice, followed by SNK 044 and SNK 754. These results revealed the possibility of identification of a better clone in place of CoC 671 after verification in large scale testing.

Commercial cane sugar yield depends mainly on tonnage and CCS per cent in juice and practically this is final criterion in the selection of varieties for commercial cultivation. In this context, all the progenies except SNK 002 were superior over the best check. Highest sugar yield was recorded by SNK 061 followed by SNK 044, SNK 049 and SNK 754 making them as most promising progenies for commercial cultivation.

5.3.4.2.2.1 Under late (330 DAP) infestation conditions

Though the superior performance of SWA resistant progenies over susceptible commercial varieties under early infestation conditions has been demonstrated, it is also essential to compare these progenies with commercial varieties under late infestation conditions. Since, under late infestation conditions, the commercial susceptible varieties perform relatively normal without much loss in cane yield and sugar recovery.

The analysis of variance revealed the presence of highly significant differences among the progenies for 13 of the 24 characters studied which are only discussed in this section. The mean values for various traits of resistant progenies and checks are presented in Tables 61 to 63.

Table 61. Growth and cane yield parameters of SWA resistant progenies at harvest (360 DAP) under late (330 DAP) infestation conditions

Table 62. Sugar yield parameters of SWA resistant progenies at 300 and 330 days after planting under late (330 DAP) infestation conditions

Table 63. Sugar yield and its parameters of SWA resistant progenies at harvest (at 360 DAP) under late (330 DAP) infestation conditions

The progeny SNK 256 was the only progeny which had high tillering potential over best check Co 86032, but it had thinner canes making non acceptable for commercial cultivation, however such genotypes could be profitably used for fodder and fibre purposes, as they also have better vigor and growth features. In general, though all the progenies had thinner canes compared to best check CoC 671, many of the canes are in the commercially acceptable range except SNK 256 and SNK 002. Similar was the trend with respect to number of internodes.

Further, average single cane weight of resistant progenies were on par with best check CoC 671 making them acceptable for commercial cultivation. But the progenies SNK 002 and SNK 256 had relatively lighter canes making them non acceptable as a commercial variety. Though the SWA resistant progenies had comparatively lower single cane weight, they had better cane yield through number of millable canes, as all the progenies except SNK 002, SNK 192 and SNK 158 had superior cane yields over best check Co 86032.

The SWA resistant progenies had acceptable juice extraction per cent except SNK 256 and SNK 002. In case of cane quality, not only juice extraction (%), the brix per cent of it is more important, for general acceptance particularly for sugar industrial point of view. Along with high juice brix per cent, it is also important to attain this quality in relatively early age *i.e.* early high brix in juice plays an important role in achieving high sugar productivity in terms of both per unit area and time. If we look the progenies with this view, SNK 754, SNK 061, SNK 044, SNK 049 and SNK 057 are more promising compared to others as they had excelled with high juice brix per cent over early ripening check CoC 671.

Similar trend was observed with another important juice quality parameter *i.e.* sucrose per cent, where in the SWA resistant progenies, SNK 754, SNK 061 and SNK 044 had higher sucrose in juice at 10 months age compared to early ripening check CoC 671. But at the time of harvest (360 DAP), all the SWA resistant progenies except SNK 256, SNK 192 and SNK 158 were on par with the best check CoC 671 indicating their high acceptability as early ripening variety.

The juice purity per cent was also analyzed where in all the progenies except SNK158 (at 10 month) had better and acceptable quality compared to best check Co 86032. For CCS (%) estimates, the progenies SNK 754, SNK 061 and SNK 057 excelled over best check Co 86032 at 10 month age, whereas at 11 month age, another two progenies SNK 044 and SNK 049 excelled over best check CoC 671.

Overall for varietal improvement, sugar yield per unit area and time is most important criterion, therefore CCS yield per plot was calculated which is the product of both cane yield and CCS per cent in juice. This criterion takes into account both cane yield potential and juice quality of progenies for over all acceptance by both the industry and farming community. The SWA resistant progenies SNK 049, SNK 061, SNK 044, SNK 754 and SNK 256 were significantly superior to best check Co 86032, indicating them to be the most promising progenies for commercial cultivation in place of CoC 671, Co 86032 and CoM 88121.

5.4 CHARACTER ASSOCIATION ANALYSIS IN SELECTED SUGRACANE PROGENIES EVALUATED UNDER THREE DIVERSE ENVIRONMENTS

In the process of selection for improvement of any crop, it is important to know selection directed towards one character will cause simultaneous changes in other characters. In sugarcane, the cane yield is the complex character and is influenced by number of inter related component traits. The inter dependence of the component characters among themselves often influence the direct relationship with cane yield as a result, the information based on correlation coefficients becomes undependable. Since path coefficient analysis gives a more realistic relationship of characters, an attempt has been made in the present study to identify the effective components of cane yield having either positive or negative significant association with cane yield

5.4.1 Under moisture stress environment

5.4.1.1 Path coefficient analysis of cane and sugar yield parameter and other physiological traits

Path coefficient analysis was used in working out the direct and indirect effects of 20 characters on cane yield per plot under moisture stress in the present study (Table 64). The genotypic path coefficient analysis accounted for major part of the total variation in cane yield as indicated by relatively lower residual effects.

Table 64. Genotypic path analysis for cane yield per plot showing, direct and indirect effects of various important growth, cane and sugar yield component traits in productive sugarcane progenies grown under moisture stress environment

The results of present investigation indicated some interesting facts. The characters like average number of internodes, tillers at 80 DAP, average root length and root number had high positive correlation with cane yield, but had negative direct effects. Similar observation was made by Patel *et al.* (1995). However, Khan *et al.* (2001) reported positive association of number of internodes, number of millable canes and millable cane height with cane yield and positive direct effect.

From breeder point of view, characters could be useful as selection criteria which are not only having high positive correlation, but also exert high direct effects. In this context, internode formed shoots at 120 DAP, single cane weight average long root length, 8th leaf area, leaf sheath moisture had the significant and positive association with cane yield per plot and exerted high direct effect. Similar view was also expressed by Bodhinayake *et al.* (1998), Kamat and Singh (2002) and Wagih *et al.* (2003). However, Srivastava *et al.* (1997) expressed their views in contrast to the above findings.

The singly cane weight which is an important cane yield component had highly significant correlation with cane yield with better direct effect indicating its importance in enhancing cane yield. However, Bissessur *et al.* (2001) expressed that in any environment, selection of combination of traits is more important than any single trait.

The characters like cane height, internode formed shoots at 160 DAP, and root dry matter though had high positive association with cane yield their direct effects were lower indicating direct selection for these traits may not be effective under moisture stress environment. Bodhinayake *et al.* (1998) expressed similar views with respect to number of roots in the surface horizon.

The juice extraction per cent, relative water content and mean tilt angle of leaves had low non significant negative association with cane yield but had higher direct negative effects suggesting higher cane yield genotypes can be identified with acute leaf angle.

Hence, from the genotypic path analysis study, for improvement of cane yield under moisture stress condition, emphasis must be placed for number of internodes formed shoots at 120 single cane weight (at harvest), average long root length, 8th leaf area, leaf sheath moisture at end of formative stage. The other traits like, internode formed shoots at 160 DAP, cane height and girth at harvest can also be considered as additional selection criteria for improvement of cane yield, under moisture stress conditions.

5.4.1.2 Path coefficient analysis of bio physical traits for cane yield

Path coefficient analysis was used in working out the direct and indirect effects of six biophysical traits under moisture stress and non stress (after alleviation) conditions on cane yield per plot in the present study (Table 65). The genotypic path coefficient analysis accounted for only about 50 per cent of the total variation in cane yield as indicated by considerable residual effects.

Table 65. Genotypic path analysis for cane yield per plot showing, direct and indirect effects of biophysical traits under moisture stress and after alleviation of stress in productive sugarcane progenies grown under moisture stress environment

All the bio-chemical related traits under stress condition in mid formative stage had no significant association with cane yield. Similarly little variation for photosynthetic traits between sugarcane varieties was observed by Singh *et al.* (1994). Even after alleviation from stress, all the photosynthesis related traits except photosynthesis rate had non significant association with cane yield, whereas photosynthesis rate only had significant positive association with cane yield indicating the varieties differed significantly with respect to this parameter after alleviation from moisture stress. The varieties also differed for their ability to recover from stress after irrigation. Ali *et al.* (2003) reported that drought tolerant varieties had a remarkable ability to recover after re-watering if stress period was not prolonged or too severe.

Among six biophysical parameters both under moisture stress and after stress alleviation, the light use efficiency had direct highest positive effects, followed by photosynthesis rate after alleviation from stress, while highest negative direct effect on cane yield was by water use efficiency after relief from moisture stress followed by transpiration rate after alleviation of stress. This suggests that the varietal adjustment/ adoptive ability under moisture stress through better light use efficiency and regaining higher photosynthesis rate after relief from stress are important parameters which had positive direct effects on cane yield and high rate of photosynthesis after stress alleviation is equally important for rejuvenation of varieties which was achieved through high transpiration. This finding is in accordance with the report of Adarsh (2004), where in cotton genotypes responded for rejuvenation ability through higher stomatal conductance. Both the maintenance of photosynthetic ability in stress and better rejuvenation capacity after stress alleviation are important for imparting moisture stress tolerance in sugarcane progenies studied. Srivastava *et al.* (1996) reported role of rejuvenation capacity of drought tolerant varieties Co 1148, Co 5769 and Co 5823 through high stomatal conductance and transpiration.

The higher positive indirect contribution of photosynthesis rate to cane yield per plot was through light use efficiency under stress.

Hence, from the genotypic path analysis study, it is evident that light use efficiency under stress and high photosynthesis rate after stress alleviation through high transpiration largely contribute to cane yield. Hence, for improvement of cane yield under moisture stress environments, emphasis must be placed on light use efficiency under stress and high photosynthesis rate after stress alleviation as evidenced in productive progenies of moisture stress environment.

5.4.2 Path coefficient analysis of cane and sugar yield parameters for cane yield under salinity water logg complex environment

In the present investigation pertaining to association of various traits with cane yield and their path coefficient analysis under salinity water logg complex environment, all the traits except single cane weight had positive and significant association, as evidenced by high genotypic correlations values presented in Table 67. The genotypic path coefficient analysis accounted for all the variation in cane yield as indicated by lower residual effects.

Table 67. Genotypic path analysis for cane yield per plot showing direct and indirect effects in productive sugarcane progenies grown under normal irrigated environment

The important cane yield component, number of millable canes had highest association with cane yield and higher direct effect. Such traits could also be of immense value as selection criteria. Similar view was also expressed by Kumar and Ram (1996), Kumar and Singh (1999) and Mallik and Tomer (2003), whereas Premachandran (1995) emphasized much on single cane weight under water logg environment at early clonal selection stages.

The other traits like, internode formed shoots at 160 DAP, healthy shoots at 70 DAP, brix per cent, sucrose per cent and CCS per cent had not only positive significant association with cane yield but also exert positive direct effect. Such traits could also be useful as selection criteria under salinity water logg complex environment aiming to improve clonal selection for higher sugarcane productivity. The trait single cane weight though had non significant association but exerted higher positive direct effects on cane yield. Therefore, selection based on these traits could be the best criteria for improvement of cane yield. The same view was also expressed by Premachandran (1995) for single cane weight and sucrose per cent, Kumar and Singh (1999) for morphological traits like number of tillers and shoots, germination per cent, millable cane height, single cane weight and Bakshi Ram *et al.* (1999) for stalk diameter as efficient selection criteria under salt and water logg stress environment.

The results of present investigation under salinity water logg complex environment indicated some interesting facts. Those characters with high positive and significant correlation have not always shown high direct effects. Many a times they were associated with negative direct effects. In the present study, the characters, *viz.*, germination per cent at 30 and 45 DAP, healthy shoots at 160 DAP and purity per cent at harvest had significant

positive association with cane yield per plot but the direct effects of these traits were negative. The trait juice extraction per cent also had negative direct impact inspite of positive association with cane yield. Similar results were also reported by Patel *et al.* (1993).

Overall, the genotypic path analysis study revealed that, for improvement of sugarcane productivity under salinity water logged complex environments, much emphasis must be given for number of millable canes, maintenance of healthy shoot populations, germinability and juice quality parameters (brix, sucrose and CCS per cent). The single cane weight also could be considered along with above selection criteria as it had higher positive effects on cane yield.

5.4.3 Path coefficient analysis of cane and sugar yield components for cane yield under normal irrigated environment

In the present investigation among nine important cane and sugar yield components, average number of internodes, single cane weight, number of millable canes, juice extraction per cent and brix per cent at harvest had positive and highly significant genotypic correlation with cane yield under non stress environment (normal irrigated), whereas average internodal length, sucrose per cent, purity per cent and CCS per cent at harvest did not exhibit significant association with cane yield per plot (Table 67). The genotypic path coefficient analysis accounted for major (90%) part of variation in cane yield as indicated by lower residual effects.

For improvement of sugar cane productivity under normal irrigated (non stress) environments, those characters which are having both high positive correlation and also exert high direct effects on cane yield could be used as selection criteria. In this context, it is interesting to note that sucrose per cent at harvest exhibited maximum direct effect on cane yield per plot, without having any significant association with cane yield. Similar results were also reported by Thippeswamy (1999) for CCS per cent at harvest. The characters, average number of millable canes, single cane weight, number of internodes and juice extraction per cent had positive direct effects on cane yield with highly significant association. Such traits should also be emphasized as selection criteria. Similar view was also expressed by Patel *et al.* (1993).

The brix per cent in juice though had highly significant positive correlation with cane yield, it exerted negative direct effects, while maximum positive indirect effect was through sucrose per cent. Negative direct effects of positively correlated characters were also reported by Sharma and Singh (1984) and Patel *et al.* (1993). The other juice quality traits *viz.*, purity per cent and CCS per cent also exerted negative direct effects without significant association with cane yield. Khairwal and Babu (1975), Khairwal *et al.*, (1977) and Reddy and Reddi (1986) also reported negative direct effect of sucrose per cent on cane yield.

The average internodal length exerted direct positive effect and indirect positive effects through CCS per cent, brix per cent and purity per cent at harvest on cane yield with negative non significant correlation. So such traits can also be considered as selection criteria for higher cane yield with higher sugar per cent. The internodal length is also an important selection criteria for improving CCS (%) along with cane yield under normal irrigated environment.

Hence, from this genotypic path analysis study, it is evident that not only cane yield components *viz.*, average number of internodes, internodal length, single cane weight and number of millable canes, but also some quality traits *viz.*, juice extraction, brix per cent and sucrose per cent are equally important for improvement in cane yield under non stress environment.

5.5 IDENTIFICATION AND CHARACTERIZATION OF SUPERIOR PROGENIES FOR DIFFERENT ENVIRONMENTS

5.5.1 For moisture stress environment

The analysis of variance revealed the presence of highly significant differences among the genotypes for all the characters except leaf temperature and WUE per cent under stress and first leaf area (Tables 68 a-d). The mean values for top ten superior cane yielding progenies over best check are given in Table 69 to 72.

Table 68 a. Analysis of variance for different physiological parameters in selected sugarcane progenies evaluated under moisture stress environment

Table 68 b. Analysis of variance for different biophysical traits at moisture stress and after alleviation of stress in selected sugarcane progenies

Table 68 c. Analysis of variance for different growth, cane and sugar yield characters in selected sugarcane progenies evaluated under moisture stress environment

Table 68 d. Analysis of variance for different sugar yield characters at 300 and 330 DAP in selected sugarcane progenies evaluated under moisture stress environment

Table 69. Mean values for growth, cane and sugar yield parameters of top 10 superior cane yielding progenies over best check under moisture stress environment

Table 70. Mean values for sugar yield parameters at 300 and 330 DAP of top 10 superior cane yielding progenies over best check under moisture stress environment

Table 71. Mean values of different physiological parameters for top 10 superior cane yielding progenies over best check under

moisture stress environment

table 72. Mean values of biophysical traits under moisture stress and after alleviation from stress for top 10 superior cane yielding progenies over best check

The important cane yield components viz., single cane weight, NMC and millable cane height played a major role among various other components, contributing towards excellence of none progenies viz., SNK 632, SNK819, SNK 822, SNK 827, SNK 024, SNK 813, SNK 797, SNK 782 and SNK 896 over best check Co86032 (Plate 5). The progenies though differed significantly for germinability, tillering potential, cane thickness, internodal length and number, these traits had moderate contribution towards superior cane productivity of top progenies over best check Co 86032.

Plate 5. Comparative performance of improved progenies for millable cane height and girth under moisture stress environment

All the top ten cane yielding progenies had superior sugar yield to the extent of 9.41 to 41.26 per cent over the best check. However, the progeny SNK 707 recorded highest brix per cent, sucrose per cent, purity per cent, CCS per cent with significant superiority over best check Co 86032 for sucrose, purity and juice extraction per cent at harvest.

The progenies SNK 632 and SNK 813 had better juice brix per cent compared to best check Co 86032. For sucrose per cent, two progenies viz., SNK 806 and SNK 813 recorded numerical superiority over best check whereas all other progenies except SNK 707 had comparable juice sucrose per cent at harvest. For CCS per cent, none of the top cane yielding progenies excelled significantly over best standard variety CO 86032.

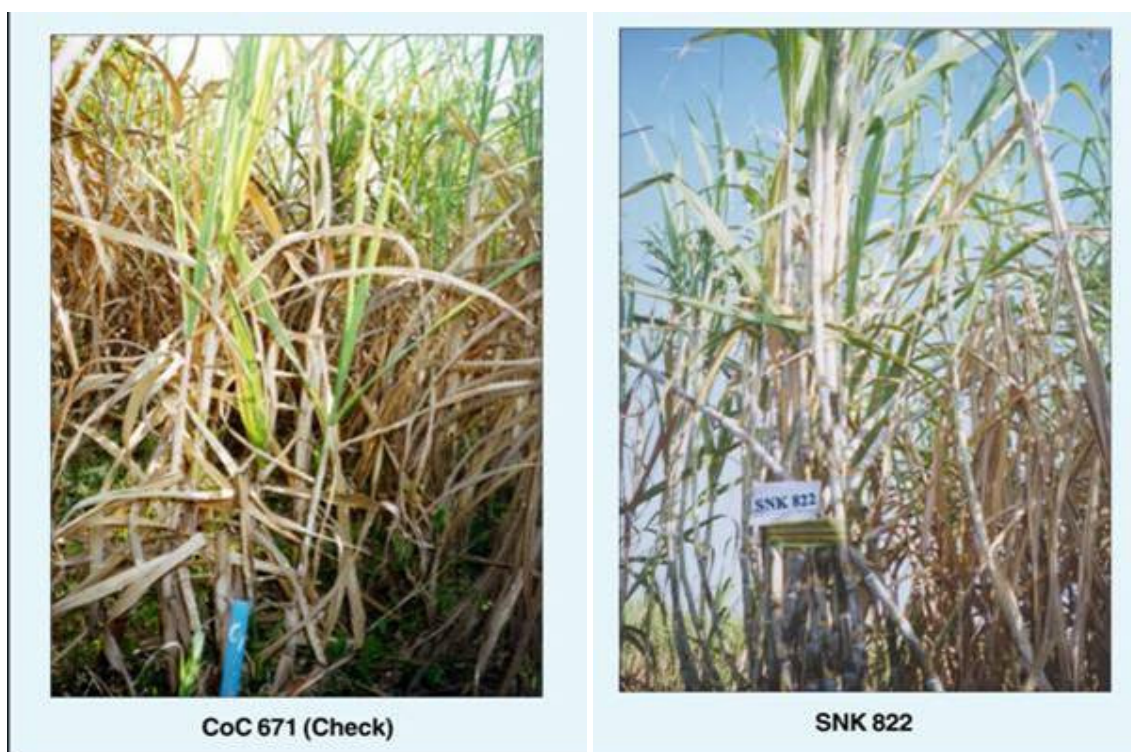


Plate 5. Comparative performance of improved progenies for millable cane height and girth under moisture stress environment

The internodes formed shoots (Plate 6), root dry weight, average long root length, LAI and 8th leaf area had significant role among various physiological parameters studied in cane yield formation. The superior top 10 cane yielding progenies recorded higher number of internode formed shoots even under moisture stress condition indicating their tolerance to moisture stress or the potentiality to maintain growth rate under moisture stress condition. The tolerance capacity could be due to higher root dry matter and deeper (long) root growth features observed in top productive progenies compared to best check Co 86032 (Plate 7). In addition, these progenies also had higher leaf sheath moisture per cent, lower leaf lamina moisture per cent with higher LAI and 8th leaf area.

Plate 6. Promising progenies showing early (120 DAP) internode formation under moisture stress environment

Plate 7. Root morphology of moisture stress tolerant progenies compared with susceptible checks

The leaf rolling feature in response to moisture stress at formative stage appears to be playing an important role in tolerance in the productive progenies viz., SNK 813, SNK 707, SNK 782 and SNK 806, whereas in case of other productive tolerant progenies (SNK 632, SNK 819, SNK 822, SNK 827 and SNK 024), no leaf rolling was observed indicating role of other mechanisms for moisture stress tolerance in them (Plate 8).

Plate 8. Leaf rolling and non rolling progenies under moisture stress environment

The maintenance of productive shoot population under moisture stress is an important character for better productivity. This was studied through mortality per cent of tillers at 90 and 120 DAP i.e. mid formative stage under moisture stress. The top productive progenies exhibited lower mortality per cent at initial (90DAP) stress period, whereas higher mortality was observed at later (severe) stages of moisture stress, there by reducing total shoots per unit area, the progenies produced higher number of productive shoots (internode formed shoots) compared to check variety Co 86032. In case of moisture stress sensitive variety Co 86032, though total shoot population maintained was high with reduced mortality, the productive shoots (internode formed shoots) were lower, there by reducing single cane weight and lower NMC at harvest.

The top productive progenies did not differed much from best check co 86032 for all the photosynthesis related traits under moisture stress condition, indicating minimum role of these traits for imparting moisture stress tolerance, instead the high productive progenies SNK 632, SNK 819 and SNK 024 had inferior water use efficiency because of higher transpiration compared to checks. The higher productivity in spite of lower water use efficiency could be due to their inherent capacity to utilize moisture available at lower soil layers through deep root system (Plate 7) compared to the check varieties which were more sensitive to moisture stress. There by these progenies maintain growth under stress at comparatively high expense of water i.e. low water use efficiency.

The rejuvenation capacity after alleviation from moisture stress is also an important parameter for higher cane productivity under moisture stress environment. In case of top productive progenies viz., SNK 632 and SNK 819, photosynthesis rate was significantly higher compared to check after relief from stress, indicating their higher rejuvenating potential to utilize moisture available, even this could also be due to better root system.

The top productive, moisture tolerant progenies were also studied for their early sugar yield parameters. Three progenies, SNK 707, SNK 782 and SNK 806, recorded superiority over checks at 300 DAP, indicating their earliness. The early maturity associated with early vigor may play an important role in moisture stress tolerance in sugarcane. Almost all the top productive progenies except SNK 819 and SNK 024 had better juice quality features compared to checks at 330 DAP indicating their earliness in ripening. The sugar yield per unit area is an important and final criterion for clonal selection to achieve improvement in sugar productivity. In the context, among top superior ten cane yielding progenies, two progenies viz., SNK 632 and SNK 707 recorded significantly superior CCS yield per hectare over best check Co 86032. The sugar yield superiority was mainly through higher cane yields and higher CCS per cent in SNK 632 and SNK 707 respectively.



a) Co 86032: Check without internode formed shoots
b) SNK 632 : Progeny with internode formed shoots



Plate 6. Promising progenies showing early (120 DAP) internode formation under moisture stress environment

Plate 6. Promising progenies showing early (120 DAP) internode formation under moisture stress environment



Plate 7. Root morphology of moisture stress tolerant progenies compared with susceptible checks

Plate 7. Root morphology of moisture stress tolerant progenies compared with susceptible checks



Leaf non-rolling type: a) Moisture stress susceptible
b) Tolerant
c) Susceptible



Leaf rolling type : Moisture stress tolerant

Plate 8. Leaf rolling and non rolling progenies under moisture stress environment

Plate 8 . . Leaf rolling and non rolling progenies under moisture stress environment

The SNK 707 could be characterized as high yielding, high sugar clone with tolerance to moisture stress, whereas SNK 632 is very high cane yielder with moderate sugar content and tolerance to moisture stress. The other progenies are high cane yielders with moderate sugar content and more tolerant to moisture stress compared to best check Co 86032. However, the performance of these progenies needs to be further tested in large scale multi-location yield trials to confirm their superiority in cane yield and quality attributes.

The pedigree of these top productive progenies indicate that the crosses viz., Co 8013 PC, CoV 92101 PC, C 81515 PC, Co 88025 GC, Co 740 x Co A7602, CoC 771 PC, Co 8371 PC, CoC 671 GC and CoC 771 PC were promising for obtaining superior segregants / progenies targeting to improve productivity under moisture stress environment. This indicates the role of parents viz., Co 740, CoA 7602 and Co 8013 in attributing drought tolerance to their progenies. These findings suggest importance of family selection and also role of parental selection with required features to obtain heterotic progenies combining better moisture stress tolerance and higher productivity.

5.5.2 For salinity water logg complex environment

The differences in progenies were highly significant for all the 14 cane and sugar yield parameters except brix per cent in juice as evidenced by analysis of variance (Table 73). The mean values of various traits of top nine superior cane yielding progenies over best check are given in Table 74.

Table 73. Analysis of variance of different growth, cane and sugar yield parameters in selected sugarcane progenies evaluated under salinity water logg complex environment

Table 74. Mean values of germination, maintenance of shoot population, cane and sugar yield parameters (at harvest) for top 9 superior cane yielding progenies over best check under salinity-water logg complex environment

The germinability of sugarcane setts under salt affected soil appears to be playing major role, as evidenced by superior germination percentage of top productive progenies viz., SNK 664, SNK 159, SNK 139, SNK 423, SNK 790 and SNK 299 at 45 days after planting, which helps to maintain better population.

Further, maintenance of healthy shoot population at the end of formative stage is also important, where in the progenies viz., SNK 814, SNK 159, SNK 139, SNK 664, SNK 493 had better healthy shoot population compared to best salt tolerant commercial variety Co 7508. In addition to healthy shoot population, the number productive (internode formed shoots) shoots per plot play greater role in deciding cane yield potentiality of genotypes. In the present study, all top productive progenies except SNK 790, SNK 088, SNK 299 had significantly higher number of internode formed shoots than popular variety Co 7508. However, the latter three varieties though not significant but had higher number of internode formed shoots, compared to standard check. This trait has significant influence on the NMC per plot, as all the internode formed shoots at the end of formative stage are expected to form millable canes at harvest. Similar trend was observed in case of NMC per plot which is major component of cane productivity and it is more so in salinity water logg complex stress environments (Plate 9).

Plate 9. Comparative performance of productive progenies under salinity water logg complex stress environment

On the contrary, another major cane yield component i.e. single cane weight appears to be least important under this environment as evidenced by present findings where in all the top productive progenies except SNK 068, recorded single cane weight on par with best standard variety Co 7508 for saline environment. All the sugar yield parameters at harvest in case of top nine productive progenies were comparable to best standard variety Co 7508.



Plate 9. Comparative performance of productive progenies under salinity water logg complex stress environment



Plate 10. Comparative performance of productive progenies under normal irrigated environment

Commercial cane sugar yield depends mainly on cane yield and sucrose per cent in juice and usually this is considered as the final criterion in the selection of varieties. In this context, among top nine productive progenies viz., SNK 664, SNK 159, SNK 139, SNK 814 SNK 493 and SNK 423 excelled significantly to the extent of 8.96 to 42.19 per cent over best salt tolerant check. The other three progenies viz., SNK 790, SNK 068 and SNK 299 also had higher sugar yield over best check though not significantly. It is quite evident in the present study that the improvement in sugar productivity under this environment is primarily through higher cane productivity and not through superiority in juice quality parameters. This also implies that improvement in quality parameters is rather difficult with present breeding material compared to cane yield.

The parentage of the top productive progenies suggest the crosses, Co 8213 PC, Co 7704 x CoC 671, CoC771 PC, 87 R40 x CoC 671, MS 6847 x CoC 671, CoA 7602 GC, Co 740 x MS 6847, Co 88028 x Ms 6847 as promising under target environment. Hence, efforts should be concentrated on these crosses for achieving further improvement in the cane and sugar productivities under salinity water logg complex environment.

The present investigation supports the view that the diverse commercial varieties with tolerance to salt stress are expected to produce highly heterotic progenies with improved tolerance and productivity, as some of the parental commercial varieties viz., 87 R40, CoC 771, Co 88028, Co 740 and CoA 7602 have some tolerance to salt and water logg environments. Hence, parental and specific cross selection for targeted environment is essential to achieve further improvement in sugarcane productivity.

5.5.3 Normal irrigated environment

The analysis of variance revealed the presence of highly significant differences among the genotypes for all the 19 characters included in the present study (Table 75a and 75b).

Table 75 a. Analysis of variance for different growth and cane yield parameters in selected sugarcane progenies evaluated under normal irrigated environment

Table 75 b. Analysis of variance for different growth and cane yield parameters in selected sugarcane progenies evaluated under normal irrigated environment

The progenies had germination percentage comparable to the best cane yielding check CoC 671, while one progeny SNK 635 exhibited significant superiority over check. The same progeny also produced significantly highest number of tillers per plot over the check, whereas other progenies produced tillers on par with CoC 671 (Table 76).

Table 76. Mean values of germination (at 45 DAP), tillers (at 90 DAP), sugar yield parameters (at 330 and 360 DAP) and cane yield parameters (at 360 DAP) for top 13 superior cane yielding progenies over best check under normal irrigated environment

The top 13 superior cane yielding progenies had comparable single cane weight, of which two viz., SNK 632 and SNK 432 showed significant superiority over best check CoC 671. These two genotypes also exhibited higher cane girth and millable cane height, indicating the contribution of these characters for higher single cane weight of SNK 632 and SNK 432 compared to checks. The other top productive progenies also had higher millable cane height and comparable cane girth with that of best checks CoC 671. The top 13 progenies in general exhibited numerical superiority over best check for number of internodes, wherein the progenies viz., SNK 024, SNK 825, SNK 432 and SNK 490 had significantly superior value over the checks.

The NMC, an important cane yield component contributed significantly for the superiority of 9 progenies over best check out of 13 top yielders. The other 4 progenies viz., SNK 024, SNK 432, SNK 827 and SNK 632 also had numerically higher NMC compared to best check. In these four progenies the other components like cane girth, millable cane height and single cane weight were major contributors for higher cane yield (Plate 10).

Plate 10. Comparative performance of productive progenies under normal irrigated environment

When the top 13 significantly high cane yielding progenies were looked for the traits pertaining to early high sugar features as that of CoC 671, all the progenies were on par with the check variety CoC 671 except SNK 635, which recorded high sucrose and brix per cent in juice at 330 DAP. The progenies viz., SNK 024, SNK 432, SNK 627 and SNK 363 exhibited superiority over best check variety CoC 671 for juice purity per cent which contributes for higher estimates of CCS per cent in these progenies compared to the check CoC 671. These findings suggests that identified highly productive progenies could be exploited commercially as early high sugar varieties like CoC 671 with higher cane productivity. The results also demonstrated that better gains can be achieved to improve cane productivity without compromising for juice quality. But, it is also very much true that *per se* improvement in sugar content over existing CoC 671 is rather difficult task with existing breeding material (i.e. hybrid progenies of diverse commercial varieties. This could be partly achieved even with similar material where in one should concentrate on proven crosses with fairly large population size, to isolate rare segregats that combine both cane yield and sugar content *per se*.

More or, less similar trend was observed in case of sugar yield parameters at harvest, where in few progenies recorded higher yield to the extent of 1.48 to 6.88 tonnes per hectare over best check CoC 671. The progenies viz., SNK 825, SNK 635, SNK 817 and SNK 493 excelled, for CCS per cent in juice, though not significantly over best check CoC 671 indicating better chances for isolating superior quality progenies as that of cane yield. This needs more directed efforts with proven parents and crosses for high quality and cane yield under specific agro ecology.

In this context, present investigation revealed that the crosses viz., Co 8371 GC, MS 6847 x CoC 671, Co 7201 PC, 85R 186 X Co 8213, CoC 771PC, CoC 671 x CoT 8201, Co 88025 GC, Co 8213 PC, CoC 85061 x CoC 671, Co 8013 PC, CoC 92101 PC and 87 R40 x CoC 671 were promising as proven crosses for normal irrigated agro-ecology of northern Karnatak for isolation of superior progenies.

The final criterion for sugarcane improvement is sugar yield per hectare. The present study revealed that all the above crosses produced significantly superior progenies over existing popular variety CoC 671. Therefore, these specific crosses could be identified as “proven “ for this targeted environment to realize further improvement in sugar productivity. The parents MS 6847, CoT 8201, Co 7201, CoC 671, Co 88025 and Co 8371 proved their potentiality to produce superior heterotic progenies, as they inherited sugar productivity features to their progenies indicating importance of family and parent selection for targeted environments.

5.5.4 Identification of superior common progenies for normal irrigated and moisture stress environments

Out of 13 progenies which recorded significantly superior cane yield in normal irrigated environment over checks, only progenies viz., SNK 024, SNK 632 and SNK 827 were common across both environments (Table 79). Among the progenies viz., SNK 632 and SNK 827 are most promising as they excelled significantly with respect both cane and sugar yield over best check CoC 671. These findings clearly indicate relatively their wider adaptability, as these progenies are tolerant to moisture stress and out perform under normal irrigated environment. These hybrids progenies involved moisture stress tolerant and widely adapted varieties viz., Co 740, Co 8013 and Co 88025. Hence, such crosses could be considered as “proven” and this was also confirmed on the basis of high frequency (%) of superior progenies obtained in these crosses under normal irrigated and moisture stress environments. Such crosses could be considered for further intensive selection for identification of superior clones suitable for major agro-ecologies of northern Karnataka.

Table 79. Mean performance of productive progenies across normal irrigated and moisture stress environment

Table 78. Morphological features of resistant progenies susceptible parents and other susceptible commercial varieties

Table 78. Morphological features of resistant progenies, susceptible parents and other susceptible commercial varieties

Progenies / Varieties	Cross	Av. No. of Stomate / mm ²	Av. No. of Spines / mm ²	Av. No. of Bi Celled hairs / mm ²	MTA at 180 DAP	LAI at 180 DAP	Leaf rolling grade	Leaf colour
Resistant								
1. SNK 158	Co 7704 X CoC 671	179.52	19.60	4.85	40.00	2.37	0.00	g
2. SNK 256	Co 88028 X Co 88025	199.84	29.60	1.62	53.50	2.19	0.00	g
3. SNK 192	Co 86249 X CoC 671	242.72	10.56	1.93	48.00	2.43	0.00	lg
4. SNK 049	Co740 X CoA 7602	199.40	0.39	4.16	44.50	3.12	0.00	g
5. SNK 002	Co 740 X Co 88028	193.80	34.63	2.96	43.50	1.90	0.00	g
6. SNK 754	CoC 671 Poly Cross	211.00	0.42	3.25	43.00	4.01	3.00	dg
7. SNK 044	Co740 X CoA 7602	223.84	6.70	4.96	45.00	3.28	1.00	g
8. SNK 061	Co 740 X MS 6847	152.92	0.45	3.74	42.00	3.65	1.00	g
9. SNK 057	Co740 X CoA 7602	200.20	21.35	2.95	44.50	2.99	1.00	g
10. SNK 124	Co 7704 X CoC 671	203.32	15.93	6.56	43.50	4.37	0.00	g
Susceptible								
11. Co 88028		143.84	11.86	2.21	41.50	3.48	2.00	dg
12. Co 740		203.72	20.46	3.65	42.50	2.53	2.00	g
13. Co 88025		216.84	6.10	4.45	45.50	3.25	1.00	g
14. CoC 671		225.52	0.41	3.39	49.50	3.84	0.00	g
15. Co 92020		174.60	19.92	1.25	41.50	3.66	0.00	g
16. Co 86032		284.32	24.10	4.05	54.00	2.16	3.00	dg
17. Co 86249		282.04	1.50	4.16	44.00	2.25	1.00	g
CD @ 5%		6.00	0.46	0.04	1.68	0.58		
SEm		2.00	0.15	0.01	0.56	0.20		

MTA = Mean tilt angle; LAI = Leaf area index; lg = Light green; g = Green; dg = Dark green

Table 79. Mean performance of productive progenies across normal irrigated and ture stress environment

Progenies	Pedigree	Normal irrigated environment		Moisture stress environment	
		Cane yield (t/ha)	CCS yield (t/ha)	Cane yield (t/ha)	CCS yield (t/ha)
SNK 024	Co 740 x CoA 7602	114.58	8.75	90.65	10.23
SNK 632	Co 8213 PC	120.35	12.01	109.61	12.46
SNK 827	Co 88025 GC	124.28	11.2	93.43	10.46
Checks					
CoC 671		87.55	9.72	64.29	8.82
Co 86032		84.32	7.94	67.02	8.81
CoM 88121		77.39	8.41	59.66	7.98
CD at 5 %		22.12	2.21	6.77	1.05

Table 89. Mean performance of productive progenies across normal irrigated and salinity water logg complex stress environment

Table 80. Mean performance of productive progenies across normal irrigated and salinity water logg complex stress environment

Progenies	Pedigree	Normal irrigated environment		Salinity water logg complex enviomment	
		Cane yield (t/ha)	CCS yield (t/ha)	Cane yield (t/ha)	CCS yield (t/ha)
SNK 493	87R40 x CoC 671	118.27	13.99	72.2	8.21
SNK 814	CoC 771 PC	131.44	13.48	74.97	8.66
Checks					
CoC 671		87.55	9.72	51.37	6.16
Co 86032		84.32	7.94	-	-
CoM 88121		77.39	8.41	48.59	5.66
Co 7508		-	-	54.15	6.47
CD at 5 %		22.12	2.21	9.63	1.36

5.5.5 Identification of superior common progenies for normal irrigated and salinity water logg complex stress environments

Similar efforts was made to identify common superior progenies for normal irrigated and salinity was complex environments. Two progenies viz., SNK 493 and SNK 814 were most promising under normal irrigated environment with better tolerance to salinity water logg complex stress compared to best tolerant check Co 7508 (Table 80). Both the progenies were highly productive across environments, considering both cane and sugar yield per hectare. The percentage of these productive, salinity water logg complex stress tolerant progenies suggest, the crosses 87R40 x CoC 671 and CoC 771 poly cross are promising for major sugarcane agro-ecology of northern Karnataka. On the basis of percentage of superior progenies also these crosses were promising. Hence, criteria adopted for choosing “proven” crosses on the basis of per cent superior progenies is reliable. These findings also evidenced the importance of parental selection based on targeted requirements, as all the three progenies viz., 87R40, CoC 671 and CoC 771 are tolerant to salt stress and are highly productive varieties adapted to wider environments.

Table 80. Mean performance of productive progenies across normal irrigated and salinity water logg complex stress environment

5.5.6 Comparative performance of top productive SWA resistant and other productive progenies identified in three diverse environments under protected condition against SWA

The mean cane yield of top of five SWA resistant progenies viz., SNK 754 SNK 044, SNK 061, SNK 049 and SNK 124 was comparable to the performance of moisture stress tolerant progenies under protected conditions indicating these progenies as promising even under moisture stress condition (Table 81). However, some progenies viz., SNK 632 and SNK 707 were superior for cane yield and CCS per cent compared to SWA resistant progenies.

Table 81. Comparative performance of top 5 each of SWA resistant and moisture stress tolerant progenies under SWA free (protected) moisture stress environment at ARS,Sankeshwar

In a similar comparison made under salinity water logg environment, mean performance of SWA resistant progenies viz., 049, SNK 754, SNK 061 and SNK 044 were on par with performance of progenies identified under water logg complex both for cane yield sugar yield. The better performance of SWA resistant progenies revealed their suitability even under water logg complex in addition to the moisture stress conditions (Table 82).

Table 82. Comparative performance of top 5 each of SWA resistant and salinity water logg complex tolerant progenies under SWA free (protected) salinity water logg complex environment at Ugar

It is also important to compare the performance SWA resistant progenies with productive progenies identified under normal irrigated environment for their general acceptance for commercial cultivation. The SWA resistant progenies viz., SNK 192, SNK 044 and SNK 049 has statistically on par cane and sugar productivity (Table 83). However, these resistant progenies were numerically inferior compared to productive progeny identified in irrigated environment, SNK 825.

Table 83. Comparative performance of top 5 each of SWA resistant and productive progenies of normal irrigated environment under SWA free (protected) normal irrigated environment at Hosur

Table 81.Comparative performance of top 5 each of SWA resistant and moisture stress tolerant progenies under SWA free (protected) moisture stress environment at ARS,Sankeshwar

Varieties	Cane yield (t/ha)	CCS (%)	CCS yield (t/ha)
SWA resistant progenies			
1.SNK 754	103.1	12.05	12.42
2.SNK 044	93.35	11.7	10.92
3.SNK 061	89.5	12.14	10.86
4.SNK 049	94.1	11.15	10.5
5.SNK 124	83.2	11.25	9.36
Moisture stress tolerant progenies			
1.SNK 632	109.61	11.37	12.46
2.SNK 707	86.95	13.25	11.52
3.SNK 822	94.35	11.59	10.94
4.SNK 813	88.8	12.12	10.76
5.SNK 806	86.02	12.47	10.72
Checks			
1.CoC 671	64.29	13.72	8.82
2.Co 86032	67.24	13.11	8.81
3.CoM 88121	59.66	13.36	7.98
C.D.@ 5%	8.5	1.74	1.25

Table 82. Comparative performance of top 5 each of SWA resistant and salinity water logg complex tolerant progenies under SWA free (protected) salinity water logg complex environment at Ugar

Varieties	Cane yield (t/ha)	CCS (%)	CCS yield (t/ha)
SWA resistant progenies			
1.SNK 049	73.5	11.62	8.54
2.SNK 754	71.59	11.74	8.4
3.SNK 061	70.95	11.84	8.4
4.SNK 044	72.24	11.54	8.33
5.SNK 124	68.26	11.15	7.61
salinity water logg complex tolerant progenies			
1.SNK 664	79.14	11.63	9.2
2.SNK 159	77.75	11.61	9.02
3.SNK 139	76.36	11.49	8.77
4.SNK 814	74.97	11.54	8.66
5.SNK 493	72.2	11.37	8.21
Checks			
1.CoC 671	51.37	11.99	6.16
2.Co 86032	54.15	11.93	6.47
3.CoM 88121	48.59	11.63	5.66
C.D.@ 5%	9.90	0.76	1.49

Table 83. Comparative performance of top 5 each of SWA resistant and productive progenies of normal irrigated environment under SWA free (protected) normal irrigated environment at Hosur

Varieties	Cane yield (t/ha)	CCS (%)	CCS yield (t/ha)
SWA resistant progenies			
1.SNK 044	127.50	11.85	15.10
2.SNK 049	124.50	11.70	14.56
3.SNK 754	125.44	12.19	15.29
4.SNK 192	134.85	11.25	15.17
5.SNK 061	124.11	11.86	14.71
Productive progenies of normal irrigated environment			
1.SNK 825	142.99	11.61	16.6
2.SNK 635	123.59	11.39	14.08
3.SNK 493	118.27	11.83	13.99
4.SNK 817	120.35	11.56	13.91
5.SNK 432	142.30	9.58	13.63
Checks			
1.CoC 671	87.55	11.11	9.72
2.Co 86032	84.32	9.42	7.94
3.CoM 88121	77.39	10.87	8.44
C.D.@ 5%	23.90	2.34	2.450

Sugarcane woolly aphid has become a serious constraint for cultivation of crop in peninsular India. There is immediate need to popularize the identified SWA resistant progenies viz., SNK 044, SNK 061, SNK 754 and SNK 049 for commercial cultivation after large scale testing. The identified progenies can also be recommended for adverse environments like moisture stress and salinity water logg complex, as these progenies performed on par with environment specific identified progenies. However, under SWA free or protected environment, progenies like SNK 632 and SNK 077 for moisture stress and SNK 664 for salinity water logg complex needs to be considered as specific genotypes for improvement of cane yield under these specific situations.

The mean performance of the identified progenies under normal irrigated condition in the present study suggest the need to identify progenies separately for such situation as some of the progenies like SNK 825 and SNK 432 out performance over SWA resistant progenies.

FUTURE LINE OF WORK

1. Genetic parameters particularly heritability, GAM and repeatability for important cane and sugar yield components, need to be studied family wise to know the specificity of families and traits for each environment.
2. The exact genetic and biochemical basis of SWA resistance in identified progenies needs to be studied.
3. The SWA resistant progenies need to be compared with environment specific progenies identified in large scale testing for immediate release for general cultivation.

VI. SUMMARY

The present investigation was carried out with a view to get information about the nature and amount of variability in respect of cane and sugar yield component traits in seedling (sexual) generation of population derived from 45 inter varietal crosses and in pre-selected clonal population under three distinct environments viz., moisture stress, salinity water logg complex stress and normal irrigated and to further estimate the inter-stage repeatability of important cane and sugar yield traits across environments. The pre-selected clonal populations along with commercial popular varieties were also evaluated to study path analysis of cane yield and to identify superior progenies for three environments and resistant progenies against SWA.

The experimental material comprising population of 3124 seedlings at ARS, Sankeshwar and pre-selected population at Sankeshwar and R and D Farms of Ugar Sugars, Ugar-Khurd (Belgaum district) and Nandi Sugars, Hosur (Bijapur district) was planted in augmented randomized block design. The selected productive population of each environment was again evaluated in RBD with two replications. The observations on cane and sugar yield component traits and other relevant traits in each environment were recorded at various growth stages. The promising SWA resistant progenies were evaluated using infester row technique to assess resistance and productivity features under early and late infestation.

The salient findings of present investigation are summarized below

1. In the seedling population, very wide range of genotypic variations were observed for tillers, millable cane height, number of internodes, internodal length, NMC, cane yield and HR brix per cent, indicating selection for these characters is expected to achieve profitable gains. Comparatively moderate variability was observed for cane girth and single cane weight, suggesting more directed efforts to achieve improvement in these traits.

Similarly the other parameters like heritability and genetic advance as per cent of mean for above traits suggested better chances of improving these traits through straight selection, while for later traits viz., cane girth and single cane weight, the values were moderate and lower respectively, indicating predominance of non-additive gene action or environmental influence.

2. The families (crosses) viz., F04, F17, F05, F06 and F19 high percentage of superior progenies were more promising as 'proven' for improving cane and sugar productivities.
3. The traits viz., single cane weight, average number of internodes, tillers per plot, HR brix per cent, cane girth, millable cane height recorded high genetic variability, heritability and genetic advance under moisture stress environment, indicating that they are much under genetic control and less influenced by environment.
4. The families viz., F44, F38, F06, F35 and F39 were promising and identified as "proven" for improving sugarcane productivity under moisture stress environment.
5. The important cane and sugar yield components viz., single cane weight and HR brix per cent respectively were better criteria to isolate productive progenies in clonal ratoon generation under moisture stress environment.
6. The families viz., F44, F38, F06, F35, F39, F04 and F32 were promising for improving ratoon productivities under moisture stress environment.
7. The genetic variability, heritability and genetic advance values were high for germination per cent, number of millable canes and single cane weight, suggesting scope for improving cane yield under salinity water logg complex environment through straight selection. While moderate heritability and comparatively lower genetic advance as per cent of mean in spite of very wide range of variability in case of HR brix per cent indicates need for much directed efforts pertaining to specific parental selection for hybridization to improve this important sugar yield parameter.

8. The parents selected for hybridization based on some tolerance to salt and water logg stress have proved to be more promising for isolating high frequency of tolerant and productive progenies, as all the promising crosses viz., F03, F20, F35, F46 except F04 involved salt/ water logg tolerant commercial varieties viz., Co 740, 87 R40, CoC 771 and CoA 7602.
9. Most of the important cane and sugar yield parameters except cane girth, millable cane height and number of internodes were valuable with wide variability. However there is a need to augment the present population to represent more variation with respect to internode number and cane girth and millable height to exercise selection efficiently under normal irrigated environment.
10. There is considerable scope for selecting clones with higher productivities of both cane and sugar under normal irrigated environment, as traits like HR brix per cent, single cane weight and NMC exhibited higher heritability coupled with moderate to high genetic advance which is indicative of additive gene action.
11. The crosses involving parents which are highly productive under normal irrigated conditions produced superior segregants/ progenies with higher frequencies compared to other crosses. Hence, the crosses F44, F43, F38, F48, F04, F47, F20, F05, F14, F35 and F30 were promising which involved the productive commercial varieties viz., MS 6847, Co 6801, Co 7424, Co 775, CoC 676, Co 8371, Co 88025, and CoT 8201.
12. The only two crosses viz., Co6806 x MS 6847 and CoC771 polycross found to be promising for large diverse zone like northern Karnataka as they produced higher percentage of superior progenies under all three diverse environments. In addition, the later cross also produced transgressive segregants with significantly higher productivity over respective best checks in all three environments.
13. Among various cane and sugar yield component traits, the tiller number, NMC, single cane weight and HR brix per cent had highly significant and moderately higher repeatability values. In addition to this, all these traits except single cane weight had higher heritability value, indicating effective selection can be imposed in the seedling generation itself.
14. The repeatability values in early clonal generations across three diverse environments and clonal ratoon generation under moisture stress for important commercial traits, viz., number of millable canes, single cane weight and HR brix per cent were comparatively highly significant with moderate to higher heritability values indicating these traits as more dependable as selection criteria.
15. There exists much similarity between clonal and clonal ratoon in early generations as the same crosses were found promising in both the generations. It is also evident from higher repeatability values between these two stages for most of the cane yield parameters and HR brix per cent. Hence, it is not essential to test for ratoon performance in early clonal generations as it requires additional resources, time and manpower.
16. The 10 hybrid progenies which were found resistant under SWA natural infestation conditions across three hot spot locations confirmed their resistant reaction with artificial infestation (no choice) conditions. Further their strong stable resistance was also confirmed in intense screening using infester row technique under both free and no choice conditions.
17. The similar population of winged adult both in susceptible commercial varieties, parents group and resistant progenies indicate minor role of operation of non-preference mechanism in imparting resistance to these 10 progenies against SWA. Whereas, the non colonization and mortality of released apterous nymphs (both under free and no choice conditions) and young nymphs (laid by winged adults) within 72 to 96 h, indicates the possibility of operation of strong antibiosis/ antixenosis against SWA in these 10 resistant progenies.

18. Important morphological features like, leaf angle (MTA), LAI, leaf rolling and colour and densities of stomata, spines and bicelled hairs studied in susceptible and resistant groups had little or no differences in these groups, indicating little or no role in imparting resistance against SWA.
19. The preliminary assessment for cane yield and HR brix per cent across three environments and clonal ratoon performance under moisture stress environment revealed that all the resistant progenies except SNK 002 had better cane yield potential over commercial susceptible checks viz., CoC 671, Co 86032 and CoM 88121. The progenies viz., SNK 044, SNK 061 and SNK 754 combined superiority for both cane yield and sugar yield (HR brix %) over the commercial check varieties.

The detailed cane and sugar productivity assessment confirmed the superiority of above three resistant progenies for both cane yield and sugar yield parameters. But overall, it is better to consider the parameter, sugar yield per hectare, the ultimate criterion which takes into account both cane yield potential and juice quality of progenies for the acceptance of both industry and farming community. In this context, SWA resistant progenies viz., SNK 049, SNK 061, SNK 044, SNK 754 and SNK 256 were significantly superior to best check Co 86032, indicating them to be most promising progenies for commercial exploitation as an alternative varieties to susceptible commercial varieties viz., CoC 671, Co 86032 and CoM 88121.

20. The families (crosses) viz., Co740 x Co88028, Co740 x CoA7602, Co740 x MS6847, Co7704 x CoC671, Co86249 x CoC671, Co88028 x Co88025 and CoC671 PC were promising for isolating SWA resistant segregants. Among these, three crosses viz., Co740 x CoA7602, Co740 x MS6847 and CoC671 PC were most promising as they produced highly productive resistant progenies acceptable for commercial cultivation.
21. The genotypic path analysis study involving six biophysical traits revealed that, light use efficiency under stress and high photosynthesis rate after alleviation of stress through enhanced transpiration largely contribute to cane yield per plot. Hence, for improvement of cane yield under moisture stress environment, emphasis must be placed on light use efficiency under stress and high photosynthesis rate after alleviation of stress.
22. The genotypic path analysis involving 20 characters pertaining to growth, physiological, root, cane and sugar yield parameters under moisture stress conditions emphasized major role of internode formed shoots at 120 and 160 DAP, average root length, 8th leaf area, leaf sheath moisture at end of formative stage, for higher cane yield. The other traits like tillers at mid formative stage and single cane weight at harvest can also be considered as selection criteria for improvement of cane yield.
23. The important cane yield component the NMC had strongest association with cane yield with highest direct effect. Such trait could be of immense value as selection criterion for improving sugarcane productivity under salinity water logg complex environment. The other traits viz., internode formed shoots and healthy shoots at 160 DAP, healthy shoots at 70 DAP, sucrose per cent, CCS per cent and single cane weight could also be considered as selection criteria.
24. It is evident from genotypic path analysis study under normal irrigated environment that, not only cane yield components like, number of internodes, single cane weight and NMC, but also the juice quality traits viz., juice extraction (%), brix and sucrose per cent can serve as important selection criteria for improvement in cane yield.
25. The final criterion for clonal selection to achieve improvement in sugar productivity would be sugar yield per unit area. Among nine top superior cane yielders, only two progenies viz., SNK 632 and SNK 707 recorded significantly superior CCS yield per hectare over best check Co 86032. The SNK 707 could be characterized as high yielding, high sugar clone with high tolerance to moisture stress, while SNK 632 is very high tonnage type with moderate sugar content and high tolerance to moisture stress. The other moisture stress tolerant, progenies had moderate sugar content.

26. The pedigree of these top productive progenies under moisture stress suggests that the crosses viz., Co 8013 PC, CoV 92101 PC, C 81615 PC, Co 88025 GC, Co 740 x CoA 7602, CoC 771 PC, Co 8371 PC, CoC 671 GC and CoC 771 PC could be exploited for further isolating highly heterotic progenies for the character or combination of characters suitable for moisture stress environment.
27. The progenies viz., SNK 664, SNK 159, SNK 139, SNK 814, SNK 493 and SNK 423 exhibited their significant superiority over best salt tolerant check variety Co 7508. It is quite evident from results that, the improvement in sugar productivity under such environment was mainly through higher cane productivity than superior juice quality parameters, suggesting need for more directed efforts, involving high quality parents with salt or water logg tolerance features.
28. Based on recovery of highly productive segregants, the following crosses viz., Co 8213 PC, Co 7704 x CoC 671, CoC 771 PC, 87 R40 x CoC 671, MS 6847 x CoC 671, CoA 7602 GC, Co 740 x MS 6847 and Co 88028 x MS 6847 could be considered for isolating salinity water logg tolerant progenies with high productivity.
29. It is evident from the present study that, not only the promising crosses (based on higher percentages of superior progenies) but also the inferior crosses could produce rare segregants with very high productivity over the respective best commercial check varieties.
30. The progenies viz., SNK 825, SNK 635, SNK 817 and SNK 493 could be characterized as highly productive based on sugar yield per hectare under normal irrigated environment. These progenies had superior CCS per cent though not significant, indicating better chances of isolating both high yielding and high quality types over CoC 671 through utilizing promising crosses viz., Co 8371 PC, MS 6847 x CoC 671, Co 7201 PC, 85 R186 x Co 8213, CoC 771 PC, CoC 671 x CoJ 8201, Co 88025 GC, Co 8013 PC, CoC 85061 x CoC 671, Co 8013 PC, CoV 92101 PC and 87 R40 x CoC 671.
31. None of the top high yielding progenies exhibited superiority across all three diverse environments of northern Karnataka. However, the three progenies, viz., SNK632, SNK 827 and SNK024 were superior in both normal irrigated and moisture stress environments. While, the progenies SNK493 and SNK 814 were promising both in normal irrigated and salinity water logg complex environments.
32. The mean performance of SWA resistant progenies viz., SNK 049, SNK 754, SNK 061 and SNK 044 was on par with mean performance of progenies identified under moisture and salinity water logg complex stress environments revealing their suitability for these adverse abiotic stresses in addition to resistance against SWA.

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APPENDIX I

Mean monthly meteorological data for the period from January 2000 to December 2004 at Agricultural Research Station, Sankeshwar

[illegible]

Appendix II. Mean monthly meteorological data for the period from January 2000 to December 04 at R & D Farm, Nandi Sugars, Hosur (Bijapur Dist.)

[illegible]

Appendix III. Weather data of R and D Farm, Ugar sugars, Ugar-khurd for the year 2001 and 2002

Progenies	Germ. % at 45 DAP	Tillers at 90 DAP	Tillers at 120 DAP	Average SCW (kg) at harvest	Average millable cane ht (cm) at harvest	Average cane girth (cm) at harvest	Average No. of internodes at harvest	Average internodal length (cm) at harvest	NMC (000's / ha)	Cane yield (t/ha)
SNK 024	82.08	183.55	119.08	1.53	263.00	2.65	26.75	9.80	61.39	90.65
SNK 041	86.66	173.99	154.55	1.65	265.50	2.70	23.25	11.44	49.57	80.47
SNK 082	56.66	108.59	98.10	1.02	197.50	2.70	24.50	8.06	64.64	66.14
SNK 085	57.08	110.13	110.13	1.27	200.50	2.70	25.00	8.10	57.37	73.08
SNK 088	61.25	156.10	110.75	1.32	215.00	2.75	22.75	9.45	48.17	63.83
SNK 094	47.08	99.02	104.89	1.27	185.50	2.75	24.75	7.49	27.61	35.15
SNK 099	82.50	157.64	107.35	0.92	170.00	2.75	27.50	6.18	74.65	68.91
SNK 109	59.16	116.61	120.31	1.30	225.00	2.55	20.50	10.97	47.05	60.59
SNK 128	59.58	153.94	158.26	1.63	227.50	2.85	23.50	9.80	36.10	58.74
SNK 250	66.66	190.96	196.82	0.97	225.00	2.25	22.75	9.89	24.17	23.59
SNK 264	66.66	121.54	133.58	1.21	233.50	2.50	21.25	11.01	49.67	60.13
SNK 287	98.33	191.27	217.18	1.37	237.00	2.65	20.75	11.42	41.01	56.43
SNK 357	67.74	120.93	111.67	1.37	254.50	2.50	30.50	8.40	55.36	75.85
SNK 388	94.58	238.16	272.09	1.25	242.50	2.60	25.50	9.51	18.93	23.59
SNK 432	98.75	207.62	200.21	1.56	241.00	2.65	27.25	8.84	46.97	73.08
SNK 452	90.83	214.40	208.85	1.12	261.00	2.15	23.00	11.41	58.94	65.21
SNK 459	71.25	176.77	211.93	0.91	300.00	2.20	23.75	12.54	67.49	60.59
SNK 474	91.66	224.27	182.94	1.15	247.00	2.20	24.25	10.27	62.98	69.84
SNK 500	77.08	245.25	194.35	1.73	257.00	2.85	21.25	12.09	34.70	60.13
SNK 511	34.16	88.54	103.34	1.68	243.00	2.75	24.25	10.01	34.64	57.81

SNK 519	64.58	210.70	219.65	1.32	261.00	2.40	23.25	11.25	53.57	69.38
SNK 533	44.58	140.98	132.65	1.61	260.00	2.55	23.50	11.07	36.40	58.28
SNK 543	93.74	176.46	199.29	1.48	208.50	2.70	23.25	8.97	38.61	56.89
SNK 550	75.00	245.56	173.37	1.09	242.50	2.65	19.75	12.31	29.02	31.45
SNK 562	77.08	254.51	220.26	1.76	295.00	2.70	23.75	12.42	17.86	31.45
SNK 584	73.75	197.44	217.18	1.30	247.00	2.55	19.25	12.90	19.48	24.51
SNK 596	50.83	124.32	202.68	0.97	214.00	2.25	19.25	11.16	44.55	43.48
SNK 604	84.16	199.29	179.54	1.08	208.00	2.50	27.25	7.67	55.16	59.66
SNK 617	59.58	149.00	157.64	1.62	251.50	2.75	25.50	9.87	38.46	62.44
SNK 624	83.33	168.75	130.80	1.27	184.00	2.85	28.25	6.57	17.34	21.28
SNK 632	72.08	138.20	148.08	2.05	255.00	2.35	25.75	9.90	53.46	109.61
SNK 635	87.08	236.62	212.86	1.72	227.50	2.95	25.25	9.01	44.82	77.24
SNK 645	71.66	209.78	192.50	0.87	190.00	2.25	22.75	8.35	26.93	23.59
SNK 673	61.25	153.63	112.29	1.87	263.50	2.50	28.25	9.39	47.05	64.29
SNK 699	87.91	220.26	161.34	1.31	243.50	2.65	25.00	9.74	45.64	58.74
SNK 707	70.00	241.86	152.39	1.25	227.00	2.55	20.75	10.94	69.93	86.95
SNK 742	59.58	141.91	140.36	1.90	238.00	2.55	26.75	8.93	34.64	65.21
SNK 744	65.83	195.58	176.77	1.52	196.00	2.60	21.50	9.08	30.93	46.71
SNK 745	63.33	120.62	157.33	0.98	221.50	2.25	22.50	9.85	49.39	48.10
SNK 748	83.33	150.85	176.46	1.08	201.00	2.55	22.00	9.10	20.52	22.20
SNK 750	85.00	147.46	172.45	1.67	253.00	2.90	22.75	11.13	36.10	58.74
SNK 782	82.91	194.66	223.97	1.30	251.50	2.45	22.00	11.45	66.88	86.95
SNK 806	76.24	255.12	127.71	1.63	225.50	2.85	25.50	8.84	52.79	86.02
SNK 809	66.66	204.84	236.31	1.48	229.50	2.90	21.75	10.57	58.27	83.71
SNK 813	88.74	266.54	165.97	1.52	248.00	2.65	21.50	11.54	58.29	88.80

SNK 814	74.58	257.90	251.11	1.78	272.00	2.80	23.25	11.74	44.83	80.01
SNK 817	56.66	238.47	245.56	1.31	232.00	2.50	29.00	7.99	57.50	73.54
SNK 819	83.33	266.23	184.48	2.01	275.00	3.10	25.25	10.89	48.78	98.05
SNK 822	67.50	186.95	144.37	1.62	265.50	2.60	25.75	10.19	58.10	94.35
SNK 827	73.74	247.10	173.99	2.05	249.00	3.10	25.75	9.67	45.47	93.43
Checks										
CoC 671	67.08	169.98	161.03	1.62	217.00	3.00	27.50	7.89	39.64	64.29
Co 86032	89.16	201.45	165.35	1.57	234.00	2.80	24.00	9.77	42.69	67.02
CoM 88121	66.66	221.81	246.49	1.37	231.00	2.65	22.25	10.37	43.60	59.66
CD (0.01)	25.64	68.65	70.96	0.50	57.14	0.50	4.40	2.48	25.80	9.01
CD (0.05)	19.26	51.58	53.32	0.37	42.94	0.38	3.31	1.86	19.39	6.77
CV (%)	13.21	13.90	15.46	13.25	9.08	7.27	6.88	9.35	19.60	5.40
S.Em±	6.79	18.19	18.80	0.13	15.14	0.13	1.16	0.65	6.83	2.38

SCW - Single
cane weight
(kg): NMC -
Number of
millable canes.

Appendix IV: The soil pH and EC (dSm⁻¹) levels of the blocks of the experimental site Clonal trial-II) at Ugar

Progenies	At 330 DAP					At 360 DAP				
	Juice Extraction %	Brix %	Pol %	Purity %	CCS %	Juice Extraction %	Brix %	Pol %	Purity %	CCS %
SNK 024	52.88	15.06	12.43	82.55	8.30	52.95	16.31	12.14	74.46	7.64
SNK 030	54.39	16.15	13.50	83.62	9.09	54.00	16.27	13.26	81.54	8.80
SNK 052	59.42	15.45	12.64	81.81	8.40	60.60	18.31	14.33	78.29	9.30
SNK 081	50.25	16.60	13.80	83.11	9.26	49.30	17.35	14.29	82.28	9.54
SNK 082	54.24	16.31	13.22	81.09	8.75	54.65	19.29	16.80	87.12	11.54
SNK 083	51.89	16.31	12.12	74.30	7.62	52.95	18.59	15.56	83.70	10.47
SNK 084	59.20	12.60	10.55	83.77	7.11	51.70	16.46	12.39	75.27	7.86
SNK 085	58.14	16.40	13.68	84.91	9.19	52.59	14.82	11.73	79.09	7.67
SNK 086	64.01	13.35	10.83	81.09	7.17	53.40	16.00	13.15	82.38	8.77
SNK 094	52.92	10.77	7.69	71.31	4.71	54.47	16.05	11.96	74.64	7.54
SNK 099	59.99	12.07	9.95	82.45	6.65	58.60	14.87	12.50	84.20	8.43
SNK 100	47.92	16.22	13.46	83.01	9.02	52.13	16.12	13.69	84.90	9.28
SNK 131	55.35	15.63	11.98	76.41	7.68	54.10	14.12	10.50	73.37	6.61
SNK 161	52.11	14.83	11.20	75.55	7.12	53.70	16.35	13.50	82.57	9.02
SNK 192	44.50	18.82	15.59	82.86	10.44	51.40	21.42	18.16	84.77	12.31
SNK 253	37.48	15.39	11.65	75.72	7.51	41.00	17.20	12.85	74.75	8.11
SNK 269	38.75	15.84	11.58	73.08	7.21	41.35	18.26	15.70	85.99	10.72
SNK 304	33.94	11.27	7.78	69.00	4.66	37.00	16.90	13.60	80.54	8.97
SNK 349	45.94	15.62	11.28	71.82	6.97	51.99	18.56	15.54	83.37	10.47
SNK 350	46.84	14.05	10.44	74.31	6.57	51.30	13.75	9.22	67.05	5.41
SNK 357	54.46	13.93	10.43	75.01	6.59	68.35	17.77	15.40	86.65	10.55
SNK 363	51.38	16.00	12.96	81.50	8.57	59.38	19.22	15.27	78.78	9.99
SNK 380	60.20	13.05	10.77	82.51	7.19	59.60	15.28	11.06	72.36	6.84
SNK 393	42.99	15.57	11.98	76.69	7.70	45.55	14.91	10.74	72.23	6.62
SNK 421	49.26	13.29	9.13	67.90	5.45	51.90	17.65	13.25	75.08	8.39
SNK 432	47.16	16.44	13.03	79.15	8.51	50.70	17.82	14.47	81.82	9.58
SNK 436	46.10	16.72	13.69	81.88	9.11	49.85	18.40	15.85	86.15	10.83
SNK 442	41.46	12.70	9.65	76.02	6.16	45.85	16.85	13.85	82.20	9.24
SNK 452	31.77	12.83	9.38	73.08	5.84	39.70	16.45	13.65	82.98	9.15
SNK 490	51.38	16.24	11.13	68.28	6.63	51.20	18.81	13.22	78.64	8.60
SNK 493	43.97	17.05	13.24	77.87	8.55	52.74	19.26	17.08	88.67	11.83
SNK 510	45.62	12.70	9.35	72.81	5.85	50.75	16.32	13.82	84.75	9.36
SNK 579	58.32	16.95	12.55	74.05	7.88	58.19	18.31	15.10	82.45	10.09
SNK 580	51.75	15.90	12.85	80.86	8.49	53.80	18.40	15.65	85.07	10.62
SNK 617	47.31	12.05	9.60	79.68	6.29	45.60	15.25	11.60	76.05	7.40
SNK 624	55.03	15.99	11.74	73.41	7.33	55.98	19.11	15.45	80.85	10.21
SNK 625	53.40	16.10	12.25	76.11	7.82	47.45	20.21	18.03	89.32	12.53
SNK 627	46.18	15.64	12.92	82.87	8.64	55.60	15.81	12.65	79.71	8.31
SNK 632	60.44	15.04	11.54	71.87	7.11	58.45	18.91	15.17	80.38	9.98
SNK 635	52.80	13.59	10.12	74.27	6.38	58.15	18.71	16.49	88.12	11.39

SNK 661	50.60	18.91	16.50	87.25	11.34	52.50	19.70	15.90	80.72	10.50
SNK 689	49.15	10.86	8.54	78.16	5.55	45.33	17.46	17.72	101.98	13.01
SNK 724	50.10	12.85	9.87	76.88	6.34	52.85	17.10	13.80	80.73	9.11
SNK 729	53.25	13.00	10.35	79.72	6.79	52.85	16.65	13.40	80.48	8.83
SNK 771	53.42	15.66	10.76	68.67	6.42	54.98	17.29	13.58	78.55	8.83
SNK 773	63.65	15.10	11.14	73.78	6.98	60.35	17.55	14.00	79.77	9.19
SNK 782	45.90	17.12	12.88	74.89	8.17	54.57	17.75	13.83	77.95	8.96
SNK 786	42.02	16.05	10.75	66.95	6.30	46.00	17.05	14.15	83.01	9.48
SNK 787	49.64	16.23	11.98	73.27	7.51	52.95	19.86	17.73	89.31	12.32
SNK 814	45.00	13.72	9.98	73.51	6.19	53.84	18.45	15.31	82.33	10.26
SNK 817	50.24	15.94	12.15	76.08	7.76	58.12	20.19	17.08	84.65	11.56
SNK 825	57.04	14.64	11.10	75.82	7.07	61.60	20.01	17.08	85.33	11.61
SNK 827	46.93	14.91	10.65	70.02	6.53	51.35	16.71	13.60	81.03	9.02
Checks										
C1										
CoC671	44.44	16.44	11.63	67.66	7.08	59.40	18.57	16.17	87.05	11.11
C2										
Co86032	51.17	14.36	10.72	75.82	6.77	62.73	16.61	13.96	83.96	9.42
C3										
CoM88121	61.73	18.46	14.88	80.33	9.81	55.88	20.41	16.47	80.84	10.87
C4 Co740	59.10	16.05	10.14	63.14	5.68	51.27	16.40	14.20	86.88	9.72
C5										
Co88028	57.26	11.65	9.76	74.97	5.55	57.05	14.75	11.10	75.22	7.04
CD @ 5%	8.73	2.79	2.83	11.09	2.29	11.11	2.53	2.92	10.94	2.50
CD @ 1%	11.61	3.71	3.76	14.76	3.04	14.78	3.36	3.89	14.56	3.32
S Em±	3.09	0.99	1.00	3.92	0.81	3.93	0.89	1.03	3.87	0.88
CV %	8.60	3.90	12.28	7.25	15.52	10.49	7.25	10.23	6.70	13.15

Appendix V: The soil pH and EC (dSm⁻¹) of each of the 34 rows in four blocks of experimental site at Gangavati

Progenies	At 330 DAP					At 360 DAP				
	Juice Extraction %	Brix %	Pol %	Purity %	CCS %	Juice Extraction %	Brix %	Pol %	Purity %	CCS %
SNK 024	52.88	15.06	12.43	82.55	8.30	52.95	16.31	12.14	74.46	7.64
SNK 030	54.39	16.15	13.50	83.62	9.09	54.00	16.27	13.26	81.54	8.80
SNK 052	59.42	15.45	12.64	81.81	8.40	60.60	18.31	14.33	78.29	9.30
SNK 081	50.25	16.60	13.80	83.11	9.26	49.30	17.35	14.29	82.28	9.54
SNK 082	54.24	16.31	13.22	81.09	8.75	54.65	19.29	16.80	87.12	11.54
SNK 083	51.89	16.31	12.12	74.30	7.62	52.95	18.59	15.56	83.70	10.47
SNK 084	59.20	12.60	10.55	83.77	7.11	51.70	16.46	12.39	75.27	7.86
SNK 085	58.14	16.40	13.68	84.91	9.19	52.59	14.82	11.73	79.09	7.67
SNK 086	64.01	13.35	10.83	81.09	7.17	53.40	16.00	13.15	82.38	8.77
SNK 094	52.92	10.77	7.69	71.31	4.71	54.47	16.05	11.96	74.64	7.54
SNK 099	59.99	12.07	9.95	82.45	6.65	58.60	14.87	12.50	84.20	8.43
SNK 100	47.92	16.22	13.46	83.01	9.02	52.13	16.12	13.69	84.90	9.28
SNK 131	55.35	15.63	11.98	76.41	7.68	54.10	14.12	10.50	73.37	6.61
SNK 161	52.11	14.83	11.20	75.55	7.12	53.70	16.35	13.50	82.57	9.02
SNK 192	44.50	18.82	15.59	82.86	10.44	51.40	21.42	18.16	84.77	12.31
SNK 253	37.48	15.39	11.65	75.72	7.51	41.00	17.20	12.85	74.75	8.11
SNK 269	38.75	15.84	11.58	73.08	7.21	41.35	18.26	15.70	85.99	10.72
SNK 304	33.94	11.27	7.78	69.00	4.66	37.00	16.90	13.60	80.54	8.97
SNK 349	45.94	15.62	11.28	71.82	6.97	51.99	18.56	15.54	83.37	10.47
SNK 350	46.84	14.05	10.44	74.31	6.57	51.30	13.75	9.22	67.05	5.41
SNK 357	54.46	13.93	10.43	75.01	6.59	68.35	17.77	15.40	86.65	10.55
SNK 363	51.38	16.00	12.96	81.50	8.57	59.38	19.22	15.27	78.78	9.99
SNK 380	60.20	13.05	10.77	82.51	7.19	59.60	15.28	11.06	72.36	6.84
SNK 393	42.99	15.57	11.98	76.69	7.70	45.55	14.91	10.74	72.23	6.62
SNK 421	49.26	13.29	9.13	67.90	5.45	51.90	17.65	13.25	75.08	8.39
SNK 432	47.16	16.44	13.03	79.15	8.51	50.70	17.82	14.47	81.82	9.58
SNK 436	46.10	16.72	13.69	81.88	9.11	49.85	18.40	15.85	86.15	10.83
SNK 442	41.46	12.70	9.65	76.02	6.16	45.85	16.85	13.85	82.20	9.24
SNK 452	31.77	12.83	9.38	73.08	5.84	39.70	16.45	13.65	82.98	9.15
SNK 490	51.38	16.24	11.13	68.28	6.63	51.20	18.81	13.22	78.64	8.60
SNK 493	43.97	17.05	13.24	77.87	8.55	52.74	19.26	17.08	88.67	11.83
SNK 510	45.62	12.70	9.35	72.81	5.85	50.75	16.32	13.82	84.75	9.36
SNK 579	58.32	16.95	12.55	74.05	7.88	58.19	18.31	15.10	82.45	10.09
SNK 580	51.75	15.90	12.85	80.86	8.49	53.80	18.40	15.65	85.07	10.62
SNK 617	47.31	12.05	9.60	79.68	6.29	45.60	15.25	11.60	76.05	7.40
SNK 624	55.03	15.99	11.74	73.41	7.33	55.98	19.11	15.45	80.85	10.21
SNK 625	53.40	16.10	12.25	76.11	7.82	47.45	20.21	18.03	89.32	12.53
SNK 627	46.18	15.64	12.92	82.87	8.64	55.60	15.81	12.65	79.71	8.31
SNK 632	60.44	15.04	11.54	71.87	7.11	58.45	18.91	15.17	80.38	9.98
SNK 635	52.80	13.59	10.12	74.27	6.38	58.15	18.71	16.49	88.12	11.39
SNK 661	50.60	18.91	16.50	87.25	11.34	52.50	19.70	15.90	80.72	10.50
SNK 689	49.15	10.86	8.54	78.16	5.55	45.33	17.46	17.72	101.98	13.01

SNK 724	50.10	12.85	9.87	76.88	6.34	52.85	17.10	13.80	80.73	9.11
SNK 729	53.25	13.00	10.35	79.72	6.79	52.85	16.65	13.40	80.48	8.83
SNK 771	53.42	15.66	10.76	68.67	6.42	54.98	17.29	13.58	78.55	8.83
SNK 773	63.65	15.10	11.14	73.78	6.98	60.35	17.55	14.00	79.77	9.19
SNK 782	45.90	17.12	12.88	74.89	8.17	54.57	17.75	13.83	77.95	8.96
SNK 786	42.02	16.05	10.75	66.95	6.30	46.00	17.05	14.15	83.01	9.48
SNK 787	49.64	16.23	11.98	73.27	7.51	52.95	19.86	17.73	89.31	12.32
SNK 814	45.00	13.72	9.98	73.51	6.19	53.84	18.45	15.31	82.33	10.26
SNK 817	50.24	15.94	12.15	76.08	7.76	58.12	20.19	17.08	84.65	11.56
SNK 825	57.04	14.64	11.10	75.82	7.07	61.60	20.01	17.08	85.33	11.61
SNK 827	46.93	14.91	10.65	70.02	6.53	51.35	16.71	13.60	81.03	9.02
Checks										
C1 CoC671	44.44	16.44	11.63	67.66	7.08	59.40	18.57	16.17	87.05	11.11
C2 Co86032	51.17	14.36	10.72	75.82	6.77	62.73	16.61	13.96	83.96	9.42
C3 CoM88121	61.73	18.46	14.88	80.33	9.81	55.88	20.41	16.47	80.84	10.87
C4 Co740	59.10	16.05	10.14	63.14	5.68	51.27	16.40	14.20	86.88	9.72
C5 Co88028	57.26	11.65	9.76	74.97	5.55	57.05	14.75	11.10	75.22	7.04
CD @ 5%	8.73	2.79	2.83	11.09	2.29	11.11	2.53	2.92	10.94	2.50
CD @ 1%	11.61	3.71	3.76	14.76	3.04	14.78	3.36	3.89	14.56	3.32
S Em±	3.09	0.99	1.00	3.92	0.81	3.93	0.89	1.03	3.87	0.88
CV %	8.60	3.90	12.28	7.25	15.52	10.49	7.25	10.23	6.70	13.15

Appendx VI . Adjusted mean values of selected progenies for 9 traits studied in seedling generation of 45 inter-varietal sugarcane crosses

Selected progenies	Pedigree	Traits								
		1	2	3	4	5	6	7	8	9
SNK 001	001 F01001	7.18	2.42	270.83	38.03	7.07	5.28	1.21	5.74	16.19
SNK 002	002 F01003	10.18	2.62	338.83	17.03	21.07	11.28	0.87	8.43	17.69
SNK 003	003 F01004	13.18	2.22	358.83	27.03	13.57	12.28	0.87	9.15	16.69
SNK 004	004 F01006	18.18	1.62	318.83	30.03	10.77	19.28	1.58	27.88	17.49
SNK 005	005 F01007	16.18	2.12	338.83	22.03	15.87	16.28	0.66	8.83	15.69
SNK 006	006 F01010	3.18	2.02	348.83	36.03	9.77	2.28	2.63	5.38	10.69
SNK 007	007 F01016	23.18	2.12	358.83	30.03	12.17	21.28	1.07	19.95	12.69
SNK 008	008 F01019	8.18	2.22	318.83	30.03	10.77	8.28	1.02	7.47	16.69
SNK 009	009 F02006	6.18	2.62	353.83	23.03	15.87	4.28	0.79	3.00	15.69
SNK 010	010 F02009	3.18	2.02	368.83	28.03	13.47	3.28	1.09	3.26	18.09
SNK 011	011 F02010	2.18	2.02	338.83	26.03	13.27	2.28	1.80	3.72	17.69
SNK 012	012 F02012	3.18	3.12	368.83	30.03	12.47	2.28	0.93	1.98	16.69
SNK 013	013 F02016	3.18	2.22	268.83	29.03	9.27	4.28	1.25	4.84	18.69
SNK 014	014 F02017	4.18	2.42	368.83	35.03	10.67	4.28	1.35	5.25	15.69
SNK 015	015 F02018	3.18	2.82	383.83	37.03	10.47	4.28	0.79	3.02	14.69
SNK 016	016 F02020	10.18	2.22	298.83	33.03	9.07	5.28	0.74	3.44	15.49
SNK 017	017 F02021	8.18	2.42	373.83	34.03	11.17	7.28	0.66	4.04	15.99
SNK 018	018 F02022	1.18	2.22	358.83	27.03	13.57	2.28	0.78	1.69	17.29
SNK 019	019 F02025	3.18	2.72	388.83	37.03	10.67	4.28	0.75	2.86	15.69
SNK 020	020 F02028	4.18	2.22	383.83	30.03	13.07	4.28	0.91	3.50	14.69
SNK 021	021 F02032	7.18	2.62	338.83	28.03	12.27	4.28	1.15	4.44	18.29
SNK 022	022 F02033	5.18	1.82	348.83	27.03	13.17	6.28	0.85	4.67	18.59
SNK 023	023 F02034	7.18	3.32	413.83	34.03	12.37	5.28	1.12	5.31	17.09
SNK 024	024 F02035	1.18	1.52	373.83	28.03	13.67	2.28	1.07	2.26	16.69
SNK 025	025 F02036	3.18	2.62	363.83	27.03	13.77	3.28	1.34	4.02	16.29
SNK 026	026 F02037	4.18	2.72	378.83	36.03	10.67	3.28	0.76	2.27	14.49
SNK 027	027 F02038	2.18	2.62	393.83	35.03	11.47	3.28	1.57	4.68	13.69
SNK 028	028 F02039	4.18	2.82	368.83	28.03	13.47	3.28	0.73	2.18	15.49
SNK 029	029 F02046	4.18	1.82	403.83	26.03	15.97	3.28	0.73	2.17	17.09
SNK 030	030 F02055	2.18	1.62	353.83	32.03	11.17	3.28	1.22	3.65	17.69
SNK 031	031 F02056	7.18	2.22	363.83	28.03	13.27	6.28	0.93	5.14	17.89
SNK 032	032 F02057	6.18	1.82	393.83	36.03	11.07	4.28	0.78	2.95	16.69
SNK 033	033 F02059	7.18	2.62	378.83	30.03	12.87	8.28	0.69	4.86	16.69
SNK 034	034 F02064	6.18	2.82	373.83	31.03	12.27	6.28	1.01	5.64	15.69
SNK 035	035 F02069	6.18	1.72	338.83	30.03	11.47	6.28	0.90	4.99	17.69
SNK 036	036 F02072	8.18	2.62	273.83	17.03	16.67	4.28	0.84	3.20	13.69
SNK 037	037 F02087	0.18	2.62	413.83	31.03	13.67	1.28	2.17	2.43	20.89

SNK 038	038	F02090	13.18	2.62	373.83	33.03	11.47	8.28	0.76	5.35	16.49
SNK 039	039	F02093	6.18	2.32	268.83	22.03	12.37	5.28	1.39	6.67	15.69
SNK 040	040	F02094	7.18	2.32	338.83	30.03	11.47	6.28	1.36	7.76	18.09
SNK 041	041	F02095	4.18	2.52	398.83	31.03	13.17	4.28	1.34	5.22	17.69
SNK 042	042	F02096	2.18	2.52	308.83	22.03	14.37	2.28	0.72	1.57	19.69
SNK 043	043	F02108	8.18	2.82	378.83	30.03	12.87	6.28	1.09	6.09	16.29
SNK 044	044	F02113	14.18	2.62	388.83	31.03	12.77	11.28	1.39	14.22	17.69
SNK 045	045	F02115	4.18	2.22	418.83	32.03	13.37	4.28	1.50	5.83	19.49
SNK 046	046	F02116	3.18	2.62	403.83	27.03	15.37	4.28	0.83	3.16	16.29
SNK 047	047	F02118	3.82	2.58	314.83	25.03	12.26	2.91	2.48	7.14	17.79
SNK 048	048	F02121	3.82	2.38	369.83	35.03	9.26	3.91	1.18	4.27	18.29
SNK 049	049	F02122	4.82	2.38	354.83	32.03	9.96	2.91	1.09	3.00	18.39
SNK 050	050	F02126	10.82	2.88	364.83	31.03	10.76	9.91	0.83	6.94	19.79
SNK 051	051	F02129	3.82	1.98	369.83	32.03	10.46	1.91	2.70	5.27	18.79
SNK 052	052	F02137	0.82	2.28	394.83	31.03	11.86	0.91	1.01	1.04	19.49
SNK 053	053	F02168	4.82	2.78	344.83	33.03	9.18	4.91	1.11	4.95	20.79
SNK 054	054	F02169	2.82	2.48	384.83	39.03	8.31	1.91	1.04	1.95	20.59
SNK 055	055	F02173	9.82	2.78	339.83	31.03	9.86	6.91	0.78	4.53	18.59
SNK 056	056	F02174	5.82	2.58	389.83	35.03	9.88	4.91	1.30	5.89	17.79
SNK 057	057	F02176	6.82	2.58	354.83	35.03	8.75	5.91	1.24	6.67	16.29
SNK 058	058	F02185	3.82	2.58	314.83	32.03	8.53	2.91	1.28	3.57	17.79
SNK 059	059	F03003	14.82	1.88	394.83	30.03	12.46	12.91	0.96	10.66	18.59
SNK 060	060	F03013	4.82	2.08	289.83	26.03	10.41	3.91	0.78	2.69	17.19
SNK 061	061	F03016	2.82	1.88	269.83	22.03	12.18	1.91	0.97	1.81	19.59
SNK 062	062	F03021	6.82	2.38	384.83	22.03	18.57	6.91	0.78	4.52	18.59
SNK 063	063	F03026	8.82	2.08	314.83	35.03	7.46	5.91	1.04	5.51	19.79
SNK 064	064	F03027	13.82	2.48	299.83	26.03	10.86	6.91	0.87	5.14	15.19
SNK 065	065	F03030	9.82	2.18	304.83	30.03	8.99	9.91	0.81	6.69	15.79
SNK 066	066	F03034	2.82	2.28	359.83	35.03	8.91	2.91	1.09	2.98	18.99
SNK 067	067	F03036	11.82	2.28	364.83	30.03	11.30	6.91	0.67	3.76	18.79
SNK 068	068	F03038	3.82	2.38	394.83	26.03	15.18	4.91	1.02	4.51	16.59
SNK 069	069	F03039	19.82	1.98	369.83	27.03	13.33	17.91	0.68	9.62	14.79
SNK 070	070	F03042	12.82	2.98	299.83	22.03	13.84	11.91	0.85	8.45	18.39
SNK 071	071	F03046	4.82	2.48	324.83	25.03	12.69	4.91	1.01	4.46	16.79
SNK 072	072	F03052	14.82	1.98	324.83	37.03	7.15	9.91	0.79	6.55	15.79
SNK 073	073	F03062	10.82	1.38	324.83	33.03	8.49	8.91	0.75	5.55	15.79
SNK 074	074	F03064	3.82	2.58	369.83	37.03	8.52	3.91	1.08	3.88	16.79
SNK 075	075	F03076	5.55	1.98	355.50	27.03	13.57	1.35	1.25	1.96	16.16
SNK 076	076	F03079	5.55	2.38	365.50	21.03	17.88	3.35	1.01	2.88	17.36
SNK 077	077	F03082	15.55	2.48	320.50	21.03	15.63	9.35	0.85	5.45	17.36
SNK 078	078	F03086	8.55	1.78	385.50	30.03	13.29	4.35	1.02	3.60	17.36
SNK 079	079	F03088	5.55	2.18	320.50	31.03	10.71	2.35	0.84	1.67	18.36
SNK 080	080	F04001	10.55	2.08	415.50	31.03	13.88	9.35	1.34	10.33	18.56

SNK 081	081	F04003	9.55	2.18	355.50	33.03	11.19	3.35	1.25	3.81	18.96
SNK 082	082	F04004	4.55	1.98	335.50	28.03	12.36	2.35	1.59	3.91	18.36
SNK 083	083	F04005	6.55	2.88	360.50	21.03	17.63	4.35	1.43	5.67	17.56
SNK 084	084	F04006	8.55	2.38	325.50	13.03	25.88	6.35	1.20	6.30	21.36
SNK 085	085	F04008	6.55	3.18	370.50	25.03	2.27	4.35	1.41	5.55	19.56
SNK 086	086	F04009	6.55	1.78	375.50	32.03	12.17	5.35	1.19	5.30	22.16
SNK 087	087	F04011	6.55	2.28	335.50	26.03	13.28	5.35	1.53	7.37	21.36
SNK 088	088	F04012	3.55	2.98	365.50	21.03	17.88	2.35	1.27	2.94	17.36
SNK 089	089	F04014	14.55	2.78	395.50	21.03	19.38	11.35	0.95	7.71	21.36
SNK 090	090	F04018	4.55	1.88	335.50	27.03	12.80	3.35	1.51	4.85	17.36
SNK 091	091	F04019	3.55	1.28	395.50	29.03	14.09	2.35	0.97	2.04	21.76
SNK 092	092	F04021	11.55	3.08	385.50	40.03	10.11	5.35	0.84	3.24	16.56
SNK 093	093	F04022	2.55	1.88	380.50	37.03	10.74	1.35	1.25	1.96	20.56
SNK 094	094	F04023	4.55	2.58	420.50	31.03	14.04	2.35	1.74	4.36	21.56
SNK 095	095	F04024	7.55	2.38	225.50	22.03	10.40	4.35	1.07	3.86	16.36
SNK 096	096	F05001	4.55	2.98	415.50	35.03	12.35	3.35	1.40	4.42	18.36
SNK 097	097	F05002	6.55	2.58	410.50	34.03	12.54	3.35	1.22	3.71	17.36
SNK 098	098	F05003	8.55	1.88	395.50	29.03	14.09	7.35	1.53	9.82	15.36
SNK 099	099	F05004	6.55	2.28	345.50	30.03	11.91	1.35	1.34	2.15	18.36
SNK 100	100	F05006	6.55	2.28	275.50	19.03	14.77	4.35	2.49	10.96	19.96
SNK 101	101	F05007	9.55	2.38	315.50	21.03	15.38	6.35	0.85	3.80	16.36
SNK 102	102	F05009	5.55	2.38	385.50	37.03	10.88	4.35	1.05	3.74	15.76
SNK 103	103	F05010	5.55	1.18	325.50	26.03	12.88	4.35	1.37	5.34	20.96
SNK 104	104	F05014	9.55	2.98	405.50	40.03	10.62	7.35	1.85	12.36	19.16
SNK 105	105	F05015	5.55	2.88	390.50	31.03	13.04	4.35	1.76	7.33	18.56
SNK 106	106	F05017	7.55	2.48	285.50	27.03	10.88	4.35	1.47	5.84	18.56
SNK 107	107	F05019	9.55	2.58	405.50	30.03	13.98	5.35	0.88	3.50	18.36
SNK 108	108	F06001	6.55	2.58	365.50	35.03	10.88	5.35	1.08	4.70	16.36
SNK 109	109	F06002	7.55	2.58	385.50	30.03	13.29	3.35	1.44	4.58	19.76
SNK 110	110	F07001	2.55	2.38	355.50	25.03	14.63	1.35	1.46	2.38	17.76
SNK 111	111	F07002	4.55	2.58	410.50	26.03	16.28	3.35	1.12	3.32	13.76
SNK 112	112	F07004	7.55	2.88	400.50	27.03	15.30	3.35	1.26	3.87	15.86
SNK 113	113	F07006	10.55	2.08	390.50	28.03	14.40	5.35	1.36	6.33	19.76
SNK 114	114	F07011	21.55	2.18	415.50	18.03	23.82	19.35	0.99	13.49	11.36
SNK 115	115	F07015	8.55	2.88	385.50	30.03	13.29	4.35	0.88	2.90	14.36
SNK 116	116	F07016	6.55	1.78	380.50	18.03	21.76	3.35	0.87	2.31	18.56
SNK 117	117	F07021	1.55	2.08	365.50	29.03	13.02	0.35	1.59	1.36	20.36
SNK 118	118	F07022	6.55	2.58	385.50	26.03	15.28	4.35	1.02	3.63	16.96
SNK 119	119	F07025	6.55	2.48	375.50	28.03	13.84	2.35	1.19	2.72	17.56
SNK 120	120	F07031	4.55	2.98	345.50	19.03	18.65	3.35	0.98	2.75	20.36
SNK 121	121	F07034	4.55	2.38	355.50	29.03	12.66	1.35	1.58	2.63	20.36
SNK 122	122	F07039	4.55	2.58	400.50	29.03	14.27	2.35	1.16	2.63	19.36
SNK 123	123	F07041	6.55	2.38	345.50	28.03	12.73	3.35	1.49	4.77	13.36

SNK 124	124	F07042	5.55	2.08	295.50	19.03	15.88	2.35	1.19	2.72	18.16
SNK 125	125	F07045	6.55	2.58	365.50	30.03	12.60	5.35	1.01	4.26	17.56
SNK 126	126	F07050	5.55	2.48	335.50	27.03	12.80	2.35	1.50	3.64	18.16
SNK 127	127	F07051	6.55	2.38	345.50	31.03	11.54	5.35	0.98	4.07	13.36
SNK 128	128	F07053	7.55	2.78	360.50	23.03	16.10	4.35	1.02	3.59	17.36
SNK 129	129	F07056	8.55	2.78	370.50	23.03	16.56	5.35	1.50	7.19	19.36
SNK 130	130	F07058	6.55	1.78	385.50	27.03	14.72	3.35	1.79	5.98	16.36
SNK 131	131	F07061	7.55	2.28	390.50	28.03	14.40	5.35	1.05	4.49	20.86
SNK 132	132	F07065	9.55	2.98	395.50	16.03	25.54	7.35	2.13	14.63	15.16
SNK 133	133	F07067	4.55	2.38	330.50	21.03	16.13	3.35	1.07	3.10	13.36
SNK 134	134	F07068	5.55	2.28	390.50	25.03	16.09	3.35	1.04	3.00	17.96
SNK 135	135	F07069	5.55	2.18	395.50	32.03	12.81	4.35	0.93	3.14	19.96
SNK 136	136	F07072	5.82	2.08	425.50	27.36	16.01	5.68	1.29	6.06	13.76
SNK 137	137	F07075	10.82	2.88	415.50	33.36	12.59	8.68	0.80	4.51	13.16
SNK 138	138	F07076	3.82	2.58	405.50	31.36	13.11	2.68	1.16	2.85	10.16
SNK 139	139	F07078	4.82	2.68	345.50	31.36	11.04	4.68	1.29	5.13	14.76
SNK 140	140	F07079	3.82	2.88	355.50	30.36	11.79	4.68	1.08	4.10	18.16
SNK 141	141	F07080	1.82	2.08	265.50	23.36	11.44	2.68	1.41	3.61	19.76
SNK 142	142	F07081	4.82	2.48	375.50	26.36	14.59	2.68	1.39	3.54	17.76
SNK 143		B2 143 F07083	15.82	3.28	385.50	30.36	12.87	6.68	0.99	4.96	18.16
SNK 144	144	F07084	13.82	2.08	385.50	23.36	17.15	5.68	1.05	4.65	18.76
SNK 145	145	F07085	13.82	2.48	380.50	30.36	12.69	9.68	1.01	7.07	11.76
SNK 146	146	F07088	5.82	2.68	375.50	30.36	12.51	5.68	1.05	4.63	12.76
SNK 147	147	F07089	8.82	2.18	420.50	26.36	16.47	7.68	0.97	5.41	13.26
SNK 148	148	F07096	3.82	2.28	385.50	31.36	12.42	4.68	1.02	3.79	11.76
SNK 149	149	F07097	2.82	2.48	430.50	28.36	15.59	8.68	1.28	8.87	11.76
SNK 150	150	F07100	3.82	2.38	420.50	32.36	13.18	2.68	1.34	3.38	12.76
SNK 151	151	F07101	4.82	2.68	365.50	26.36	14.18	5.68	1.02	4.44	16.76
SNK 152	152	F07104	8.82	2.08	365.50	27.36	13.61	8.68	0.97	6.04	12.76
SNK 153	153	F07107	3.82	2.38	375.50	25.36	15.23	3.68	1.36	4.47	9.76
SNK 154	154	F07109	4.82	2.38	270.50	24.36	11.15	1.68	1.41	2.53	14.36
SNK 155	155	F07113	8.82	2.28	395.50	26.36	15.43	8.68	1.81	13.62	13.96
SNK 156	156	F07117	4.82	2.98	335.50	22.36	15.51	5.68	0.93	3.90	12.76
SNK 157	157	F07132	3.82	1.98	345.50	27.36	12.81	2.68	0.94	2.18	17.76
SNK 158	158	F07134	1.82	2.68	345.50	15.36	24.62	2.68	1.83	4.85	16.76
SNK 159	159	F07137	5.82	2.48	380.50	30.36	12.69	4.68	1.18	4.59	15.76
SNK 160	160	F07139	2.82	1.48	355.50	25.36	14.36	3.68	0.82	2.31	17.16
SNK 161	161	F07143	4.82	2.28	360.50	26.36	13.97	3.68	0.99	3.00	17.76
SNK 162	162	F07144	1.82	2.08	335.50	29.36	11.49	2.68	1.31	3.29	16.16
SNK 163	163	F07145	5.82	2.18	335.50	22.36	15.51	6.68	0.87	4.12	13.96
SNK 164	164	F07151	6.82	2.68	345.50	24.36	14.55	3.68	0.89	2.59	15.36
SNK 165	165	F07152	2.82	2.38	370.50	33.36	11.14	3.68	0.86	2.45	16.76

SNK 166	166	F07155	3.82	2.58	420.50	28.36	15.20	2.68	1.18	2.91	13.76
SNK 167	167	F07158	0.82	2.68	410.50	29.36	14.27	1.68	1.50	2.70	13.76
SNK 168	168	F07159	1.82	2.48	325.50	23.36	14.29	1.68	0.93	1.56	13.96
SNK 169	169	F08002	1.82	2.38	405.50	38.36	10.56	2.68	2.12	5.74	14.76
SNK 170	170	F08004	10.82	2.08	420.50	28.36	15.20	8.68	1.00	6.31	14.76
SNK 171	171	F08005	6.82	2.48	335.50	24.36	14.10	7.68	1.45	9.24	10.56
SNK 172	172	F08010	4.82	1.38	365.50	30.36	12.15	5.68	1.08	4.81	16.36
SNK 173	173	F08013	4.82	1.88	295.50	22.36	13.51	4.68	0.98	3.58	18.26
SNK 174	174	F08014	0.82	2.08	295.50	27.36	10.81	1.68	0.94	1.58	15.26
SNK 175	175	F08021	6.82	2.28	355.50	16.36	23.58	12.68	0.94	20.08	8.76
SNK 176	176	F08027	5.82	2.58	375.50	33.36	11.30	5.68	1.44	6.95	13.76
SNK 177	177	F08029	5.82	2.08	350.50	35.36	9.86	6.68	1.61	9.23	16.76
SNK 178	178	F08032	7.82	2.98	425.50	35.36	12.13	8.68	2.63	21.01	14.16
SNK 179	179	F08035	12.82	2.68	355.50	30.36	11.79	12.68	0.93	8.03	9.36
SNK 180	180	F08037	2.82	2.48	425.50	30.36	14.29	3.68	1.40	4.63	16.16
SNK 181	181	F08039	3.82	2.48	375.50	28.36	13.47	3.68	1.15	3.61	17.96
SNK 182	182	F08040	2.82	2.18	365.50	27.36	13.61	3.68	1.15	3.63	18.76
SNK 183	183	F08047	0.82	2.18	380.50	27.36	14.21	1.68	1.02	1.74	18.16
SNK 184	184	F08049	7.68	2.18	342.17	24.36	14.04	6.15	0.98	5.72	15.13
SNK 185	185	F08051	4.68	1.58	297.17	26.36	10.84	5.15	1.27	6.23	17.93
SNK 186	186	F08054	7.68	2.88	362.17	32.36	10.46	7.15	0.65	4.37	17.53
SNK 187	187	F08055	2.68	2.78	352.17	33.36	9.74	2.15	1.24	2.49	16.83
SNK 188	188	F08056	4.68	2.18	337.17	27.36	11.93	4.15	1.06	4.15	14.33
SNK 189	189	F08058	6.68	2.28	302.17	28.36	10.05	6.15	0.59	3.39	15.13
SNK 190	190	F08066	9.68	1.48	292.17	21.36	13.92	8.15	1.32	10.29	16.93
SNK 191	191	F08077	3.68	2.08	347.17	26.36	12.92	4.15	0.77	3.02	17.33
SNK 192	192	F08093	8.68	2.48	362.17	25.36	14.22	5.15	1.22	5.97	14.83
SNK 193	193	F08105	4.68	1.98	362.17	26.36	13.55	4.15	1.60	6.33	17.33
SNK 194	194	F08116	10.68	0.98	332.17	29.36	10.72	6.15	0.91	5.32	13.83
SNK 195	195	F08118	7.68	2.38	312.17	28.36	10.44	7.15	1.20	8.21	14.33
SNK 196	196	F08119	5.68	2.38	362.17	18.36	21.26	6.15	0.63	3.59	14.33
SNK 197	197	F08121	1.68	2.58	302.17	27.36	10.53	2.15	1.00	2.00	14.33
SNK 198	198	F08124	3.68	2.28	322.17	33.36	8.78	4.15	0.89	3.47	14.33
SNK 199	199	F08128	7.68	2.28	332.17	40.36	7.08	7.15	0.84	5.67	14.33
SNK 200	200	F08129	4.68	2.08	352.17	30.36	10.99	4.15	0.91	3.56	13.33
SNK 201	201	F08131	1.68	1.88	322.17	34.36	8.44	2.15	1.09	2.18	18.33
SNK 202	202	F08132	4.68	1.88	292.17	30.36	8.85	5.15	1.31	6.42	15.83
SNK 203	203	F08135	5.68	1.88	352.17	42.36	7.13	6.15	0.72	4.16	15.33
SNK 204	204	F08138	5.68	2.08	332.17	32.36	9.46	4.15	1.23	4.83	17.33
SNK 205	205	F08147	6.68	2.38	382.17	34.36	10.32	3.15	0.97	2.89	12.33
SNK 206	206	F08149	7.68	2.38	242.17	21.36	11.29	4.15	0.76	2.98	13.33
SNK 207	207	F08150	4.68	2.28	332.17	24.36	13.59	5.15	1.20	5.87	15.33
SNK 208	208	F08160	6.68	1.38	332.17	31.36	9.86	7.15	0.79	5.34	15.83

SNK 209	209	F09005	6.68	1.28	302.17	28.36	10.05	6.15	0.84	4.88	15.53
SNK 210	210	F09008	1.68	1.88	302.17	15.36	21.98	2.15	1.37	2.76	16.93
SNK 211	211	F09011	4.68	1.88	312.17	21.36	14.97	5.15	1.03	5.02	15.33
SNK 212	212	F09022	9.68	2.48	322.17	29.36	10.35	8.15	0.77	5.95	17.73
SNK 213	213	F09025	13.68	2.18	262.17	19.36	14.01	12.15	0.65	7.44	17.33
SNK 214	214	F09026	4.62	2.25	360.50	32.36	10.77	4.31	1.37	5.38	16.03
SNK 215	215	F09031	3.62	1.65	330.50	28.36	11.38	2.31	0.94	2.05	11.83
SNK 216	216	F09033	1.62	1.85	340.50	29.36	11.30	1.31	1.35	2.29	15.83
SNK 217	217	F09034	6.62	2.05	330.50	14.36	24.55	5.31	0.93	3.79	16.83
SNK 218	218	F09040	2.62	2.15	385.50	29.36	12.91	2.31	1.52	3.81	16.03
SNK 219	219	F09041	11.62	2.85	380.50	23.36	16.43	9.31	1.09	7.69	18.43
SNK 220	220	F09042	5.62	2.65	380.50	30.36	12.26	4.31	0.91	3.07	16.83
SNK 221	221	F09046	7.62	2.35	350.50	26.36	13.16	6.31	1.50	8.37	16.83
SNK 222	222	F09050	4.62	2.45	360.50	28.36	12.49	4.31	1.02	3.65	18.63
SNK 223	223	F09051	9.62	2.35	270.50	21.36	12.66	8.31	1.09	6.91	14.83
SNK 224	224	F09052	14.62	2.55	300.50	26.36	11.16	8.31	1.01	6.23	14.83
SNK 225	225	F09054	25.62	2.35	310.50	20.36	15.48	16.31	0.73	6.75	16.83
SNK 226	226	F09055	4.62	2.45	320.50	26.36	11.96	4.31	1.49	5.99	14.23
SNK 227	227	F09056	10.62	1.95	350.50	29.36	11.66	8.31	1.11	7.16	18.83
SNK 228	228	F09057	6.62	1.85	340.50	22.36	15.35	6.31	0.87	3.95	17.03
SNK 229	229	F09060	0.62	2.45	320.50	23.36	13.71	0.31	1.33	1.27	15.83
SNK 230	230	F09062	11.62	2.55	370.50	28.36	12.86	9.31	1.03	7.07	16.43
SNK 231	231	F09065	3.62	2.15	320.50	25.36	12.49	3.31	1.26	3.91	19.03
SNK 232	232	F09069	1.62	2.25	360.50	23.36	15.52	1.31	1.29	2.17	12.83
SNK 233	233	F09070	6.62	2.05	380.50	30.36	12.26	6.31	1.19	6.14	18.23
SNK 234	234	F09072	9.62	2.35	350.50	30.36	11.23	5.31	0.86	3.34	11.43
SNK 235	235	F09074	7.62	2.65	370.50	23.36	15.98	7.31	1.41	8.79	17.83
SNK 236	236	F09076	4.62	1.95	340.50	27.36	12.24	4.31	0.92	3.13	13.83
SNK 237	237	F09077	3.62	2.25	360.50	29.36	12.02	3.31	1.10	3.27	13.83
SNK 238	238	F10001	11.62	2.35	310.50	18.36	17.40	9.31	1.56	12.34	12.83
SNK 239	239	F10006	10.62	2.45	310.50	25.36	12.08	7.31	0.97	5.28	11.83
SNK 240	240	F10009	10.62	2.05	320.50	18.36	17.98	8.31	0.87	4.97	15.03
SNK 241	241	F10012	5.62	1.65	350.50	23.36	15.07	3.31	0.98	2.82	17.83
SNK 242	242	F10016	5.62	2.45	370.50	30.36	11.92	4.31	0.84	2.76	9.83
SNK 243	243	F10019	6.62	2.45	330.50	14.36	24.55	6.31	0.74	3.02	13.83
SNK 244	244	F10025	1.62	2.85	290.50	11.36	28.16	1.31	0.97	1.52	16.83
SNK 245	245	F10034	9.62	2.85	350.50	30.36	11.23	9.31	0.67	3.52	13.33
SNK 246	246	F10035	12.62	2.25	340.50	22.36	15.35	10.31	0.86	5.89	12.83
SNK 247	247	F10047	8.62	2.35	340.50	29.36	11.30	8.31	0.76	3.99	11.83
SNK 248	248	F10061	7.62	3.05	360.50	25.36	14.16	7.31	1.17	6.83	11.83
SNK 249	249	F10068	4.62	2.45	340.50	24.36	13.94	4.31	0.76	2.34	11.83
SNK 250	250	F10070	5.62	2.65	360.50	16.36	23.16	5.31	1.25	5.71	13.33
SNK 251	251	F10071	9.62	2.45	375.50	21.36	17.91	8.31	1.13	7.28	16.33

SNK 252	252	F10072	2.62	2.55	370.50	27.36	13.39	2.31	0.98	2.19	14.83
SNK 253	253	F10085	5.62	2.15	330.50	24.36	13.51	5.31	1.13	4.95	16.83
SNK 254	254	F10089	4.72	2.35	352.17	27.36	12.59	3.55	0.91	3.20	15.79
SNK 255	255	F10107	6.72	3.05	382.17	20.36	19.13	4.55	0.97	4.27	13.79
SNK 256	256	F10114	29.72	3.25	312.17	23.36	13.22	23.55	0.73	13.76	10.79
SNK 257	257	F10116	8.72	1.45	272.17	22.36	11.98	6.55	1.45	9.25	13.79
SNK 258	258	F10122	5.72	2.45	327.17	29.36	10.73	4.55	1.28	5.82	19.19
SNK 259	259	F10123	16.72	2.85	282.17	25.36	10.79	14.55	0.76	9.23	11.79
SNK 260	260	F10124	4.72	2.25	352.17	28.36	12.09	3.55	0.75	2.56	13.79
SNK 261	261	F10127	8.72	2.25	247.17	18.36	13.54	6.55	0.75	4.35	13.79
SNK 262	262	F10138	6.72	2.45	322.17	24.36	13.04	4.55	0.72	3.01	14.79
SNK 263	263	F10142	6.72	2.35	330.17	26.36	12.25	5.55	0.89	4.56	15.79
SNK 264	264	F10144	3.72	2.85	300.17	24.36	12.08	2.55	1.26	3.51	15.79
SNK 265	265	F11002	3.72	2.55	322.17	27.36	11.43	2.55	1.11	3.05	14.79
SNK 266	266	F11007	5.72	2.65	332.17	29.36	10.91	3.55	0.88	3.10	17.99
SNK 267	267	F11008	6.72	2.85	392.17	35.36	10.60	4.55	0.82	3.49	17.79
SNK 268	268	F11009	4.72	2.25	302.17	23.36	12.76	2.55	1.06	2.91	16.79
SNK 269	269	F11010	6.72	2.25	322.17	31.36	9.79	5.55	0.90	4.65	16.79
SNK 270	270	F11011	8.72	2.05	302.17	24.36	12.17	7.55	0.83	5.52	16.79
SNK 271	271	F11012	3.72	2.85	382.17	26.36	14.33	2.55	1.70	4.83	18.39
SNK 272	272	F11014	4.72	2.35	397.17	27.36	14.32	3.55	0.91	3.21	14.79
SNK 273	273	F11015	3.72	2.65	382.17	28.36	13.20	2.55	0.81	2.16	15.79
SNK 274	274	F11017	9.72	2.55	392.17	23.36	16.85	6.55	0.68	3.82	15.79
SNK 275	275	F11019	11.72	2.35	352.17	35.36	9.42	4.55	0.91	3.97	15.79
SNK 276	276	F11021	5.72	3.25	312.17	19.36	16.35	3.55	1.44	5.33	12.79
SNK 277	277	F11023	6.72	2.05	322.17	26.36	11.93	5.55	0.70	3.44	11.79
SNK 278	278	F11024	4.72	2.85	372.17	27.36	13.36	3.55	0.96	3.43	12.79
SNK 279	279	F11027	3.72	3.05	342.17	29.36	11.27	1.55	1.44	2.78	18.79
SNK 280	280	F11029	2.72	2.65	362.17	29.36	11.98	1.55	0.71	1.31	15.79
SNK 281	281	F11031	4.72	2.65	322.17	12.36	28.22	1.55	0.76	1.42	16.79
SNK 282	282	F11034	5.72	2.85	342.17	27.36	12.20	4.55	0.76	3.19	14.79
SNK 283	283	F11035	3.72	2.55	332.17	25.36	12.88	2.55	2.77	8.05	14.79
SNK 284	284	F11038	2.72	2.45	332.17	32.36	9.77	1.55	0.73	1.36	13.79
SNK 285		B3 285 F11040	3.72	2.65	322.17	34.36	8.82	2.55	1.02	2.78	16.19
SNK 286	286	F11041	7.72	2.25	292.17	19.36	15.24	5.55	0.89	4.61	17.79
SNK 287	287	F11043	9.72	2.05	252.17	25.36	9.54	7.55	1.00	6.94	14.79
SNK 288	288	F11044	7.72	2.25	322.17	24.36	13.04	6.55	1.72	11.10	17.59
SNK 289	289	F11048	8.72	2.25	292.17	26.36	10.73	5.55	0.92	4.75	17.79
SNK 290	290	F11049	3.72	1.25	292.17	25.36	11.21	2.55	1.10	3.03	17.79
SNK 291	291	F11050	14.72	3.25	312.17	24.36	12.60	11.55	0.66	6.23	18.19
SNK 292	292	F11055	5.72	2.55	282.17	19.36	14.68	4.55	0.74	3.10	17.79
SNK 293	293	F11056	6.72	1.25	277.17	19.36	14.40	4.55	2.06	9.72	16.79

SNK 294	294	F11063	4.72	2.75	392.17	24.36	16.08	3.55	0.74	2.55	13.79
SNK 295	295	F11072	13.72	2.25	292.17	23.36	12.31	12.55	0.54	5.08	12.79
SNK 296	296	F11073	4.72	2.75	392.17	19.36	20.79	3.55	1.26	4.61	15.39
SNK 297	297	F11078	6.72	3.05	312.17	30.36	9.82	4.55	1.39	6.38	15.79
SNK 298	298	F11103	1.02	3.08	397.17	17.36	26.73	2.55	1.46	3.89	17.86
SNK 299	299	F11104	4.02	3.08	427.17	40.36	9.87	4.55	1.01	4.21	20.36
SNK 300	300	F11109	12.02	2.48	382.17	30.36	12.31	11.55	0.91	8.79	18.86
SNK 301	301	F11118	8.02	2.88	347.17	34.36	9.37	9.55	0.88	7.03	17.86
SNK 302	302	F12001	9.02	2.88	417.17	36.36	10.91	11.55	0.90	8.74	16.86
SNK 303	303	F12007	0.02	2.68	367.17	30.36	11.73	2.55	1.65	4.46	15.86
SNK 304	304	F12018	5.02	2.28	377.17	33.36	10.76	7.55	1.33	9.26	16.86
SNK 305	305	F12025	2.02	2.28	347.17	20.36	18.41	2.55	1.32	3.49	18.26
SNK 306	306	F12026	10.02	2.38	287.17	26.36	10.40	10.55	0.57	4.38	15.86
SNK 307	307	F12028	9.02	2.38	257.17	21.36	11.98	9.55	0.71	5.36	14.86
SNK 308	308	F12035	-1.98	2.48	367.17	34.36	10.04	0.55	1.18	1.06	12.86
SNK 309	309	F12037	4.02	2.68	387.17	28.36	13.62	6.55	1.04	6.08	17.06
SNK 310	310	F12038	0.02	2.48	347.17	27.36	12.52	2.55	1.50	4.03	16.86
SNK 311	311	F12039	3.02	3.28	277.17	22.36	12.37	4.55	0.86	3.47	16.86
SNK 312	312	F12043	2.02	2.68	357.17	20.36	19.04	4.55	1.36	5.96	17.86
SNK 313	313	F12047	2.02	3.28	357.17	29.36	11.84	4.55	1.44	6.34	13.86
SNK 314	314	F12048	2.02	2.08	367.17	30.36	11.73	4.55	2.00	9.14	15.86
SNK 315	315	F12051	10.02	2.28	397.17	29.36	13.44	12.55	0.62	5.78	16.86
SNK 316	316	F12054	2.02	2.18	357.17	28.36	12.37	4.55	0.71	2.72	16.86
SNK 317	317	F12055	2.02	2.68	362.17	27.36	13.17	4.55	0.71	2.73	18.06
SNK 318	318	F12059	1.02	2.48	347.17	31.36	10.52	3.55	0.87	2.84	18.66
SNK 319	319	F12061	1.02	2.48	372.17	40.36	8.34	3.55	1.04	3.49	16.86
SNK 320	320	F12062	3.02	1.88	347.17	42.36	7.20	5.55	1.18	6.04	14.86
SNK 321	321	F12063	-1.98	2.38	367.17	32.36	10.82	0.55	1.32	1.20	18.86
SNK 322	322	F12071	-0.98	2.28	372.17	30.36	11.92	1.55	1.07	1.83	16.86
SNK 323	323	F12072	2.02	2.98	427.17	34.36	12.04	3.55	0.79	2.49	13.86
SNK 324	324	F12073	10.02	2.08	377.17	33.36	10.76	9.55	0.80	6.26	16.86
SNK 325	325	F12075	3.02	2.48	357.17	18.36	21.89	4.55	1.05	4.43	18.86
SNK 326	326	F12076	0.02	2.28	427.17	41.36	9.58	1.55	0.92	1.54	19.46
SNK 327	327	F12077	2.02	2.78	367.17	26.36	14.04	4.55	0.95	3.91	15.86
SNK 328	328	F12080	6.02	2.48	347.17	29.36	11.44	8.55	0.98	7.26	15.86
SNK 329	329	F12081	6.02	1.48	347.17	33.36	9.73	7.55	0.99	6.58	16.86
SNK 330	330	F12082	12.02	2.88	397.17	31.36	12.37	8.55	1.03	7.69	14.36
SNK 331	331	F12083	9.02	1.88	377.17	22.36	17.93	6.55	0.89	5.06	15.86
SNK 332	332	F12087	-1.98	2.68	367.17	34.36	10.04	0.55	1.26	1.14	18.86
SNK 333	333	F12089	0.02	2.28	427.17	28.36	15.29	2.55	1.32	3.48	16.86
SNK 334	334	F12096	3.02	2.68	377.17	29.36	12.64	4.55	0.98	4.08	18.86
SNK 335	335	F12101	0.02	3.18	397.17	32.36	11.89	1.55	1.35	2.40	16.86
SNK 336	336	F12106	-0.55	2.48	352.50	23.36	15.66	1.08	1.70	1.76	19.16

SNK 337	337	F13004	0.45	1.98	332.50	30.36	10.21	2.08	0.91	1.74	18.16
SNK 338	338	F13006	2.45	1.98	322.50	24.36	13.29	4.08	0.77	2.72	19.16
SNK 339	339	F13012	0.45	2.18	262.50	29.36	7.89	1.08	0.74	0.80	18.56
SNK 340	340	F13015	4.45	2.78	342.50	25.36	13.52	6.08	0.67	3.37	18.16
SNK 341	341	F13021	2.45	2.78	342.50	29.36	11.09	2.08	1.01	1.94	15.16
SNK 342	342	F13022	7.45	2.18	347.50	20.36	18.60	5.08	1.17	5.35	18.16
SNK 343	343	F13032	5.45	2.58	372.50	25.36	14.95	7.08	0.85	5.21	13.16
SNK 344	344	F13034	2.45	2.48	342.50	22.36	16.06	4.08	1.31	4.88	14.16
SNK 345	345	F13035	1.45	1.58	312.50	22.36	14.40	2.08	1.57	3.06	13.16
SNK 346	346	F13047	6.45	2.48	332.50	29.36	10.69	7.08	1.22	7.78	19.36
SNK 347	347	F13050	10.45	1.48	282.50	22.36	12.73	10.08	0.91	7.96	16.96
SNK 348	348	F13051	1.45	2.38	352.50	23.36	15.66	3.08	1.12	3.13	18.16
SNK 349	349	F13059	2.45	2.58	372.50	37.36	8.89	4.08	1.08	3.97	17.16
SNK 350	350	F13062	7.45	2.38	232.50	31.36	6.06	6.08	1.47	8.20	18.16
SNK 351	351	F14002	6.45	2.48	302.50	30.36	9.06	7.08	1.22	7.75	16.16
SNK 352	352	F14003	2.45	2.38	352.50	29.36	11.49	4.08	0.87	3.12	16.16
SNK 353	353	F14004	13.45	2.08	382.50	25.36	15.43	15.08	1.34	18.27	19.36
SNK 354	354	F14006	2.45	2.18	382.50	36.36	9.54	3.08	1.23	3.48	17.56
SNK 355	355	F14008	3.45	2.38	242.50	16.36	16.62	4.08	1.01	3.69	16.16
SNK 356	356	F14009	5.45	2.18	382.50	37.36	9.20	7.08	0.95	5.91	18.16
SNK 357	357	F14011	5.45	2.38	332.50	32.36	9.36	5.08	1.02	4.59	19.16
SNK 358	358	F16001	13.45	2.28	397.50	42.36	8.16	13.08	0.85	9.54	15.16
SNK 359	359	F16002	-0.55	2.78	362.50	27.36	13.07	1.08	1.06	1.12	18.36
SNK 360	360	F16003	8.45	2.98	382.50	24.36	16.29	8.08	0.74	5.03	17.16
SNK 361	361	F16004	8.45	1.98	377.50	37.36	9.04	9.08	0.81	6.23	16.16
SNK 362	362	F16005	5.45	1.88	372.50	31.36	11.25	7.08	0.69	4.09	17.96
SNK 363	363	F16008	8.45	2.58	352.50	36.36	8.60	7.08	1.36	8.78	15.96
SNK 364	364	F16010	4.45	2.58	417.50	31.36	12.92	6.08	0.90	4.80	13.76
SNK 365	365	F16012	6.45	2.38	382.50	30.36	12.13	7.08	1.11	7.02	16.16
SNK 366	366	F16016	3.45	2.38	352.50	29.36	11.49	5.08	1.22	5.61	19.56
SNK 367	367	F16019	6.45	2.78	422.50	40.36	9.40	8.08	0.88	6.14	18.16
SNK 368	368	F16025	6.45	2.58	332.50	30.36	10.21	8.08	0.90	6.28	18.36
SNK 369	369	F16028	7.45	2.58	367.50	20.36	19.85	8.08	0.85	5.91	18.16
SNK 370	370	F16029	7.45	3.38	392.50	18.36	24.72	9.08	0.93	7.34	17.16
SNK 371	371	F16035	1.45	2.98	372.50	31.36	11.25	3.08	0.67	1.80	18.56
SNK 372	372	F16037	2.45	2.28	352.50	28.36	12.04	2.08	0.97	1.86	18.56
SNK 373	373	F16039	1.45	2.78	342.50	36.36	8.29	3.08	1.00	2.77	18.16
SNK 374	374	F16041	5.45	2.58	342.50	28.36	11.62	6.08	0.77	4.01	19.76
SNK 375	375	F16044	3.45	2.58	392.50	40.36	8.56	3.08	1.16	3.28	18.16
SNK 376	376	F16046	6.45	2.28	372.50	33.36	10.36	8.08	1.08	7.77	17.16
SNK 377	377	F16051	8.45	2.58	412.50	30.36	13.29	6.08	0.84	4.41	17.16
SNK 378	378	F16055	4.45	2.48	352.50	28.36	12.04	5.08	1.69	7.96	16.16
SNK 379	379	F16060	7.18	2.42	368.83	24.13	15.35	6.38	0.96	7.21	15.27

SNK 380	380	F16071	7.18	2.92	348.83	18.13	18.50	5.38	0.47	3.58	15.27
SNK 381	381	F16073	4.18	2.12	358.83	28.13	13.17	3.38	0.32	1.71	15.27
SNK 382	382	F16074	9.18	2.12	398.83	26.13	15.43	5.38	0.25	2.49	14.77
SNK 383	383	F16077	10.18	2.12	318.83	17.13	35.94	9.38	0.45	6.18	13.27
SNK 384	384	F16081	11.18	1.52	343.83	31.13	11.65	10.38	0.79	10.23	15.27
SNK 385	385	F16087	3.18	2.32	378.83	28.13	13.83	2.38	0.83	2.20	15.27
SNK 386	386	F16092	11.18	1.92	348.83	23.13	15.10	7.38	0.37	4.25	16.27
SNK 387	387	F16094	11.18	2.92	328.83	36.13	9.92	7.38	0.36	4.20	16.27
SNK 388	388	F16095	8.18	2.22	253.83	15.13	15.91	7.38	0.58	5.74	14.77
SNK 389	389	F16098	8.18	1.92	248.83	20.13	12.41	7.38	0.36	4.20	16.27
SNK 390	390	F16100	4.18	2.52	378.83	31.13	12.71	2.38	1.09	2.72	14.27
SNK 391	391	F17002	7.18	1.32	333.83	28.13	12.33	6.38	0.26	2.99	14.67
SNK 392	392	F17003	6.18	2.52	338.83	26.13	13.29	4.38	0.78	4.11	14.27
SNK 393	393	F17004	4.18	2.32	288.83	22.13	13.17	3.38	1.26	4.54	15.27
SNK 394	394	F17009	4.18	2.22	328.83	21.13	15.41	2.38	1.31	3.16	15.27
SNK 395	395	F17011	7.18	2.22	328.83	26.13	12.93	5.38	0.57	4.06	13.87
SNK 396	396	F17012	6.18	1.52	348.83	23.13	15.10	5.38	0.55	3.96	13.67
SNK 397	397	F17013	6.18	2.52	318.83	21.13	14.98	5.38	0.72	4.84	14.27
SNK 398	398	F17015	6.18	2.42	323.83	30.13	11.34	5.38	0.69	4.66	14.27
SNK 399	399	F17017	3.18	2.32	328.83	20.13	16.05	2.38	0.86	2.27	15.27
SNK 400	400	F17018	7.18	2.52	318.83	25.13	12.98	5.38	0.61	4.26	15.27
SNK 401	401	F18002	3.18	2.12	348.83	23.13	15.10	2.38	0.93	2.41	16.67
SNK 402	402	F18006	4.18	2.32	278.83	10.13	24.00	3.38	1.05	3.92	15.37
SNK 403	403	F18010	9.18	2.32	368.83	21.13	17.15	7.38	0.46	4.87	12.67
SNK 404	404	F18013	9.18	2.32	413.83	30.13	14.16	6.38	0.38	3.71	13.27
SNK 405	405	F18016	3.18	2.42	328.83	23.13	14.30	2.38	1.61	3.75	15.27
SNK 406	406	F18018	11.18	2.72	398.83	42.13	10.36	5.38	0.89	5.65	9.77
SNK 407	407	F18022	9.18	2.32	338.83	23.13	14.70	5.38	0.46	3.49	9.27
SNK 408	408	F18031	9.18	2.52	338.83	31.13	11.50	7.38	0.62	5.97	8.27
SNK 409	409	F18032	5.18	3.12	268.83	18.13	14.50	4.38	0.85	4.40	16.27
SNK 410	410	F18033	5.18	1.72	298.83	17.13	16.76	4.38	0.56	3.23	16.77
SNK 411	411	F18037	5.18	2.32	328.83	28.13	12.17	4.38	0.45	2.77	16.27
SNK 412	412	F18038	4.18	2.22	288.83	29.13	10.53	2.38	0.48	1.49	15.27
SNK 413	413	F18039	4.18	2.52	348.83	28.13	12.83	3.38	0.67	2.76	13.27
SNK 414	414	F18041	6.18	2.52	308.83	18.13	16.50	5.38	0.77	5.05	13.27
SNK 415	415	F18052	6.18	2.62	328.83	28.13	12.17	5.38	0.92	5.82	14.27
SNK 416	416	F18053	4.18	2.92	348.83	33.13	11.21	2.38	0.71	1.95	12.27
SNK 417	417	F18055	4.18	2.52	298.83	10.13	25.67	3.38	0.64	2.68	14.87
SNK 418	418	F18057	8.18	2.12	318.83	24.13	13.42	5.38	0.35	2.95	15.27
SNK 419	419	F18060	8.18	1.92	268.83	28.13	10.17	4.38	0.64	3.55	11.27
SNK 420	420	F18070	3.18	2.12	258.83	12.13	19.36	2.38	0.80	2.15	16.67
SNK 421	421	F18073	9.18	1.92	343.83	38.13	9.87	6.38	0.38	3.69	17.47
SNK 422	422	F18076	15.18	2.32	218.83	21.13	10.63	13.38	0.24	6.07	15.27

SNK 423	423	F18080	4.18	2.12	348.83	28.13	12.83	2.38	1.14	2.82	16.27
SNK 424	424	F18081	4.15	2.32	354.40	30.46	12.30	2.61	0.13	0.80	14.86
SNK 425	425	F18083	12.15	2.22	294.40	25.46	12.05	10.61	0.32	6.91	8.26
SNK 426	426	F18085	9.15	2.02	314.40	21.46	14.51	5.61	0.54	4.43	11.06
SNK 427		B4 427 F18087	11.15	2.22	329.40	21.46	15.11	6.61	0.17	3.13	14.86
SNK 428	428	F18090	6.15	2.92	329.40	29.46	11.86	2.61	0.10	0.75	16.26
SNK 429	429	F18091	9.15	2.52	339.40	27.46	12.84	6.61	0.28	3.82	17.86
SNK 430	430	F18092	6.15	1.82	364.40	19.46	17.80	2.61	0.06	0.66	14.66
SNK 431	431	F18093	7.15	2.22	294.40	18.46	15.35	4.61	1.11	5.79	12.26
SNK 432	432	F18100	5.15	2.12	274.40	27.46	10.74	1.61	0.86	1.02	13.26
SNK 433	433	F18102	7.15	2.02	304.40	36.46	9.46	4.61	0.39	2.89	16.86
SNK 434	434	F18103	3.15	2.02	264.40	7.46	26.25	1.61	0.22	0.38	16.26
SNK 435	435	F18110	10.15	2.62	319.40	26.46	12.54	6.61	0.26	3.68	16.26
SNK 436	436	F18112	9.15	2.32	304.40	17.46	16.47	3.61	0.69	3.02	16.26
SNK 437	437	F18113	9.15	2.52	319.40	18.46	16.48	2.61	0.40	1.35	15.86
SNK 438	438	F18117	4.15	2.32	369.40	28.46	13.43	2.61	0.62	1.79	16.26
SNK 439	439	F18127	5.15	1.82	264.40	17.46	14.57	3.61	0.38	2.07	13.26
SNK 440	440	F18128	4.15	2.72	279.40	23.46	12.26	1.61	0.94	1.09	13.26
SNK 441	441	F18150	6.15	2.82	344.40	18.46	17.62	3.61	0.52	2.51	17.26
SNK 442	442	F19003	7.15	2.42	354.40	21.46	16.11	4.61	0.87	4.80	14.26
SNK 443	443	F19004	5.15	2.22	384.40	28.46	13.90	4.61	1.04	5.47	15.66
SNK 444	444	F19006	8.15	1.62	384.40	20.46	17.96	3.61	0.25	1.68	17.46
SNK 445	445	F19007	5.15	1.62	359.40	27.46	13.48	3.61	0.16	1.42	17.66
SNK 446	446	F19008	8.15	1.52	304.40	16.46	17.21	6.61	0.68	6.21	17.26
SNK 447	447	F19012	5.15	2.22	344.40	25.46	13.78	3.61	0.65	2.88	14.26
SNK 448	448	F19013	12.15	2.02	344.40	23.46	14.67	4.61	0.48	3.24	15.26
SNK 449	449	F19016	11.15	3.02	354.40	12.46	24.21	8.61	1.36	13.75	12.26
SNK 450	450	F19017	4.15	1.92	339.40	21.46	15.51	2.61	0.40	1.34	14.26
SNK 451	451	F19018	6.15	2.42	329.40	25.46	13.26	2.61	0.92	2.39	15.26
SNK 452	452	F19020	6.15	2.02	334.40	27.46	12.68	3.61	0.44	2.25	16.26
SNK 453	453	F19021	6.15	2.22	324.40	27.46	12.35	4.61	0.87	4.83	13.46
SNK 454	454	F19023	7.15	2.22	314.40	27.46	12.03	4.61	0.50	3.33	11.26
SNK 455	455	F19024	6.15	2.32	339.40	28.46	12.49	3.61	2.60	8.73	16.46
SNK 456	456	F19025	6.15	2.82	384.40	25.46	15.16	4.61	1.20	6.15	16.26
SNK 457	457	F19026	6.15	1.42	339.40	26.46	13.21	4.61	0.18	2.04	15.26
SNK 458	458	F19032	5.15	2.82	334.40	31.46	11.42	3.61	0.72	3.09	17.26
SNK 459	459	F19034	4.15	2.02	344.40	25.46	13.78	1.61	0.37	0.53	15.26
SNK 460	460	F19035	10.15	2.62	359.40	25.46	14.30	7.61	0.56	6.45	16.46
SNK 461	461	F19037	12.15	2.22	389.40	20.46	18.17	8.61	0.40	6.10	15.26
SNK 462	462	F19038	3.15	2.02	354.40	24.46	14.57	1.61	0.22	0.37	15.26
SNK 463	463	F19041	14.15	2.42	384.40	27.46	14.29	5.61	0.22	2.81	14.26
SNK 464	464	F19043	4.15	1.22	294.40	18.46	15.35	1.61	0.95	1.10	16.26

SNK 465	465	F19044	4.15	1.62	359.40	27.46	13.48	2.61	0.47	1.48	18.26
SNK 466	466	F19046	5.15	2.02	314.40	21.46	14.51	3.61	0.59	2.72	14.26
SNK 467	467	F19048	4.15	1.82	359.40	20.46	16.92	2.61	0.45	1.44	11.36
SNK 468	468	F19053	13.15	2.32	389.40	20.46	18.17	9.61	0.13	4.44	16.76
SNK 469	469	F19056	6.15	2.42	364.40	24.46	14.92	4.61	0.30	2.53	14.26
SNK 470	470	F19058	7.15	2.22	404.40	32.46	13.10	3.61	0.47	2.34	14.66
SNK 471	471	F19059	7.15	2.22	374.40	28.46	13.58	3.61	0.70	3.04	17.46
SNK 472	472	F19060	12.15	2.32	364.40	12.46	24.83	9.61	0.41	6.98	16.26
SNK 473	473	F19061	5.15	1.82	339.40	20.46	16.08	3.61	0.74	3.15	14.26
SNK 474	474	F19062	5.15	2.32	349.40	32.46	11.57	3.61	0.54	2.55	15.46
SNK 475	475	F19067	3.15	2.02	384.40	24.46	15.64	1.61	0.56	0.71	16.06
SNK 476	476	F19068	6.15	2.32	384.40	28.46	13.90	3.61	0.47	2.35	14.26
SNK 477	477	F19070	5.15	2.22	334.40	14.46	20.60	2.61	0.53	1.61	13.26
SNK 478	478	F19071	5.15	2.22	294.40	18.46	15.35	3.61	0.26	1.72	15.26
SNK 479	479	F19074	3.22	1.72	312.27	20.06	15.26	2.61	0.96	2.56	13.14
SNK 480	480	F19076	4.22	2.12	312.27	19.06	15.94	3.61	0.54	1.87	14.14
SNK 481	481	F19077	4.22	2.52	347.27	30.06	11.77	3.61	0.65	2.29	15.14
SNK 482	482	F19079	4.22	1.92	277.27	9.06	26.09	3.61	0.86	3.13	13.14
SNK 483	483	F19080	11.22	2.12	287.27	17.06	16.26	6.61	0.76	5.05	12.14
SNK 484	484	F19083	4.22	2.52	307.27	33.06	9.70	2.61	0.71	1.82	15.34
SNK 485	485	F19085	4.22	1.92	267.27	23.06	11.79	3.61	1.83	7.01	14.14
SNK 486	486	F19089	6.22	2.02	312.27	25.06	12.58	4.61	0.72	3.29	13.14
SNK 487	487	F19090	5.22	2.52	287.27	20.06	14.17	3.61	0.80	2.91	15.14
SNK 488	488	F19091	10.22	1.92	287.27	19.06	14.80	8.61	1.34	11.81	14.14
SNK 489	489	F19095	8.22	2.52	312.27	15.06	19.42	6.61	1.17	7.94	14.14
SNK 490	490	F19099	6.22	1.72	277.27	15.06	17.48	5.61	1.31	7.58	15.54
SNK 491	491	F19103	3.22	2.32	267.27	20.06	13.30	1.61	0.98	1.64	16.14
SNK 492	492	F20003	5.22	1.92	297.27	15.06	18.59	2.61	1.52	4.24	18.14
SNK 493	493	F20004	3.22	2.32	267.27	19.06	13.89	2.61	1.40	3.90	16.14
SNK 494	494	F20005	2.22	2.22	187.27	16.06	11.84	0.61	1.23	0.90	16.14
SNK 495	495	F20006	8.22	2.32	322.27	24.06	13.40	3.61	1.19	4.45	16.74
SNK 496	496	F20007	2.22	2.62	327.27	25.06	13.11	1.61	0.91	1.51	16.94
SNK 497	497	F20008	4.22	2.92	287.27	23.06	12.56	3.61	1.19	4.47	16.54
SNK 498	498	F20028	3.22	2.32	312.27	25.06	12.58	1.61	1.57	2.83	16.14
SNK 499	499	F20029	7.22	3.22	327.27	26.06	12.67	5.61	1.33	7.72	16.34
SNK 500	500	F20036	4.22	2.22	257.27	24.06	11.00	2.61	1.21	3.32	18.14
SNK 501	501	F20038	5.22	2.12	327.27	21.06	15.26	4.61	0.76	3.53	15.74
SNK 502	502	F20043	5.22	2.12	317.27	22.06	14.26	3.61	1.16	4.34	16.74
SNK 503	503	F20045	3.22	3.22	287.27	19.06	14.80	2.61	0.99	2.65	16.64
SNK 504	504	F20046	6.22	2.52	297.27	24.06	12.48	3.61	1.12	4.18	15.74
SNK 505	505	F20048	2.22	1.72	277.27	23.06	12.18	1.61	2.08	3.85	15.14
SNK 506	506	F20050	21.22	2.22	312.27	24.06	13.03	18.61	0.56	10.43	15.94
SNK 507	507	F20052	3.22	2.32	287.27	23.06	12.56	2.61	1.06	2.88	17.14

SNK 508	508	F20053	11.22	2.52	312.27	24.06	13.03	10.61	0.58	6.18	15.14
SNK 509	509	F20054	3.22	2.52	297.27	22.06	13.46	2.61	1.85	5.25	15.14
SNK 510	510	F20055	4.22	2.12	257.27	18.06	14.07	2.61	1.99	5.66	16.74
SNK 511	511	F20066	8.22	3.12	327.27	24.06	13.59	7.61	1.46	11.46	14.64
SNK 512	512	F20069	6.22	2.32	297.27	23.06	12.95	3.61	2.12	8.20	16.34
SNK 513	513	F20074	2.22	2.12	277.27	29.06	9.94	1.61	1.32	2.31	16.34
SNK 514	514	F20088	2.22	2.52	242.27	19.06	12.76	1.61	1.62	2.93	15.14
SNK 515	515	F20090	9.22	1.82	317.27	23.06	13.72	8.61	0.61	5.24	15.14
SNK 516	516	F20091	6.22	2.32	267.27	6.06	33.59	4.61	1.46	7.02	15.14
SNK 517	517	F20092	8.22	2.62	277.27	18.06	15.02	5.61	0.75	4.25	15.24
SNK 518	518	F21001	10.22	1.72	327.27	24.06	13.59	7.61	1.17	9.08	14.34
SNK 519	519	F21003	4.22	2.22	297.27	19.06	15.26	3.61	0.89	3.25	15.14
SNK 520	520	F21007	13.05	2.25	290.27	11.80	23.13	9.05	0.71	7.18	17.19
SNK 521	521	F21010	10.05	2.15	295.27	30.80	10.05	7.05	0.52	4.18	16.39
SNK 522	522	F21011	9.05	2.35	245.27	20.80	11.96	7.05	1.17	8.70	16.69
SNK 523	523	F21015	5.05	1.95	340.27	26.80	12.97	5.05	0.99	5.24	17.39
SNK 524	524	F21016	9.05	2.65	340.27	26.80	12.97	9.05	0.82	8.17	17.59
SNK 525	525	F21018	10.05	1.65	330.27	20.80	15.83	9.05	0.62	6.32	18.69
SNK 526	526	F21020	7.05	1.35	220.27	19.80	11.30	6.05	0.46	3.14	15.19
SNK 527	527	F21021	10.05	2.75	360.27	26.80	13.68	10.05	1.18	12.68	16.39
SNK 528	528	F21026	9.05	2.35	345.27	26.80	13.15	9.05	1.17	11.29	15.19
SNK 529	529	F21028	5.05	1.75	340.27	24.80	13.90	4.05	0.39	1.75	15.19
SNK 530	530	F21029	2.05	1.95	290.27	25.80	11.57	2.05	1.06	2.07	17.79
SNK 531	531	F21031	9.05	1.75	290.27	14.80	18.95	6.05	0.64	4.25	17.19
SNK 532	532	F21032	6.05	1.75	370.27	27.80	13.59	6.05	0.87	5.63	17.19
SNK 533	533	F21034	10.05	2.15	360.27	26.80	13.68	9.05	0.76	7.60	17.19
SNK 534	534	F21036	13.05	2.75	245.27	19.80	12.49	10.05	0.74	8.25	17.19
SNK 535	535	F21040	7.05	2.15	360.27	23.80	15.23	7.05	0.69	5.33	16.99
SNK 536	536	F21042	2.05	2.35	335.27	20.80	16.05	2.05	0.55	1.05	17.19
SNK 537	537	F21051	12.05	1.65	340.27	30.80	11.45	9.05	0.77	7.72	15.19
SNK 538	538	F21063	13.05	2.15	300.27	23.80	12.83	10.05	0.93	10.16	18.19
SNK 539	539	F21064	2.05	2.25	270.27	20.80	13.10	2.05	1.02	1.99	16.79
SNK 540	540	F21065	10.05	3.35	330.27	16.80	19.16	10.05	1.32	14.01	16.19
SNK 541	541	F21071	7.05	2.25	240.27	22.80	10.83	7.05	0.81	6.19	17.19
SNK 542	542	F21075	3.05	2.45	285.27	21.80	13.22	2.05	0.54	1.03	18.19
SNK 543	543	F22006	8.05	2.75	370.27	39.80	9.85	7.05	0.59	4.68	14.79
SNK 544	544	F22007	7.05	1.75	350.27	25.80	13.79	6.05	0.82	5.33	14.19
SNK 545	545	F22012	8.05	2.85	380.27	30.80	12.70	8.05	0.78	6.85	17.19
SNK 546	546	F22015	2.05	2.15	360.27	27.80	13.24	2.05	0.86	1.67	15.19
SNK 547	547	F22017	5.05	2.35	365.27	28.80	12.99	4.05	0.96	4.01	13.59
SNK 548	548	F22022	3.05	1.35	345.27	28.80	12.33	3.05	0.55	1.71	16.19
SNK 549	549	F22024	8.05	2.45	325.27	29.80	11.31	7.05	0.85	6.49	16.19
SNK 550	550	F22026	9.05	1.75	400.27	16.80	23.05	9.05	1.09	10.53	15.19

SNK 551	551	F22027	14.05	1.95	295.27	16.80	17.22	10.05	0.57	6.56	15.79
SNK 552	552	F22030	13.05	2.55	365.27	44.80	8.76	11.05	1.00	11.97	13.99
SNK 553	553	F22031	22.05	3.15	390.27	33.80	11.97	20.05	0.81	18.19	14.79
SNK 554	554	F22033	6.05	2.35	340.27	17.80	18.72	5.05	0.97	5.16	14.99
SNK 555	555	F22035	4.05	2.55	325.27	18.80	17.08	3.05	1.76	5.36	16.19
SNK 556	556	F22036	7.05	2.15	365.27	23.80	15.43	5.05	1.07	5.64	16.19
SNK 557	557	F23001	9.05	1.95	385.27	22.80	16.87	9.05	0.91	8.91	17.19
SNK 558	558	F23002	3.05	1.95	355.27	21.80	16.26	2.05	0.88	1.71	15.19
SNK 559	559	F23004	5.05	2.35	385.27	27.80	14.10	4.05	0.81	3.41	11.99
SNK 560	560	F23005	2.05	1.75	320.27	17.80	17.67	2.05	0.39	0.74	14.19
SNK 561	561	F23006	5.05	2.15	365.27	19.80	18.21	5.05	0.79	4.26	14.19
SNK 562	562	F23007	3.05	2.65	360.27	26.80	13.68	3.05	1.69	5.13	13.29
SNK 563	563	F23008	6.05	1.95	415.27	24.80	16.79	6.05	0.76	4.99	13.79
SNK 564	564	F23010	9.05	2.75	395.27	28.80	13.99	7.05	1.46	10.72	15.19
SNK 565	565	F23011	4.05	2.05	400.27	21.80	18.22	3.05	1.27	3.89	13.19
SNK 566	566	F23012	5.05	2.95	365.27	24.80	14.87	5.05	0.65	3.56	16.19
SNK 567	567	F23013	8.05	1.75	325.27	17.80	17.93	8.05	0.63	5.67	14.19
SNK 568	568	F23016	7.05	2.05	325.27	19.80	16.30	7.05	1.24	9.19	10.59
SNK 569		B5 569 F23020	10.05	2.25	370.27	29.80	12.76	9.05	0.46	4.90	14.19
SNK 570	570	F23025	8.05	1.95	320.27	15.80	19.65	5.05	0.75	4.04	11.19
SNK 571	571	F23029	5.05	1.95	360.27	26.80	13.68	3.05	1.48	4.51	17.19
SNK 572	572	F23031	10.05	1.55	310.27	20.80	14.92	9.05	0.75	7.53	16.19
SNK 573	573	F23034	4.05	2.35	275.27	14.80	18.01	2.05	0.82	1.60	16.19
SNK 574	574	F23036	5.05	2.15	270.27	8.80	27.83	5.05	1.50	7.79	17.59
SNK 575	575	F23039	2.98	2.15	315.07	25.26	12.60	2.78	1.65	4.58	17.88
SNK 576	576	F23040	8.98	1.85	210.07	20.26	10.56	7.78	0.94	6.48	18.88
SNK 577	577	F23044	2.98	2.85	335.07	15.26	20.16	0.78	1.22	1.11	19.28
SNK 578	578	F23045	12.98	3.05	310.07	17.26	17.00	8.78	1.04	8.19	17.88
SNK 579	579	F23046	4.98	2.05	200.07	13.26	14.12	4.78	1.27	5.71	20.88
SNK 580	580	F23048	8.98	2.45	320.07	11.26	24.57	4.78	0.91	3.91	17.88
SNK 581	581	F23053	5.98	2.45	325.07	19.26	16.22	5.78	1.51	8.27	13.28
SNK 582	582	F23058	3.98	1.85	225.07	12.26	16.66	3.78	1.30	4.68	20.28
SNK 583	583	F23062	9.98	1.85	280.07	12.26	20.33	8.78	1.10	8.73	19.88
SNK 584	584	F23066	5.98	2.35	340.07	22.26	15.00	5.78	0.75	3.73	19.88
SNK 585	585	F23073	2.98	1.85	335.07	19.26	16.68	0.78	1.16	1.05	16.68
SNK 586	586	F23074	11.98	2.25	350.07	23.26	14.84	6.78	1.79	11.65	14.88
SNK 587	587	F23078	0.98	2.05	335.07	15.26	20.16	0.78	0.62	0.51	21.88
SNK 588	588	F23081	13.98	2.25	400.07	32.26	12.71	11.78	1.10	11.67	16.38
SNK 589	589	F23082	2.98	2.35	380.07	22.26	16.60	2.78	0.86	2.21	15.88
SNK 590	590	F23083	9.98	2.15	380.07	32.26	12.14	9.78	0.85	7.14	15.88
SNK 591	591	F23084	4.98	2.95	375.07	25.26	14.75	3.78	1.19	4.23	19.88
SNK 592	592	F23085	7.98	2.85	310.07	24.26	12.85	5.78	0.90	4.65	16.68

SNK 593	593	F23086	6.98	2.15	370.07	33.26	11.55	5.78	1.80	10.03	19.88
SNK 594	594	F23089	8.98	2.85	330.07	29.26	11.62	6.78	1.74	11.30	15.88
SNK 595	595	F24002	6.98	2.35	355.07	18.26	18.38	5.78	1.46	8.00	19.88
SNK 596	596	F24005	8.98	2.25	320.07	25.26	12.78	1.78	1.28	2.31	21.88
SNK 597	597	F24006	3.98	2.05	255.07	21.26	12.04	1.78	0.54	0.84	21.88
SNK 598	598	F24008	6.98	2.35	270.07	26.26	10.65	3.78	2.10	7.88	20.08
SNK 599	599	F24012	5.98	2.45	260.07	9.26	23.50	4.78	0.84	3.58	17.88
SNK 600	600	F24014	4.98	2.25	340.07	17.26	18.50	4.78	1.20	5.34	21.88
SNK 601	601	F24015	3.98	2.85	350.07	20.26	16.65	3.78	1.20	4.30	19.88
SNK 602	602	F24017	4.98	2.45	370.07	23.26	15.61	3.78	0.64	2.04	16.48
SNK 603	603	F24022	7.98	2.45	335.07	25.26	13.32	7.78	2.05	15.33	16.68
SNK 604	604	F24025	5.98	1.85	330.07	25.26	13.14	4.78	1.36	6.15	18.88
SNK 605	605	F24029	5.98	2.25	265.07	16.26	15.47	4.78	1.60	7.34	18.88
SNK 606	606	F24031	8.98	2.25	350.07	21.26	16.00	7.78	1.51	11.01	19.88
SNK 607	607	F24034	4.98	2.05	365.07	27.26	13.50	4.78	1.04	4.58	17.28
SNK 608	608	F24035	13.98	2.15	370.07	22.26	16.20	13.78	0.89	10.62	20.88
SNK 609	609	F24043	14.98	2.25	345.07	21.26	15.79	14.78	0.58	6.69	15.88
SNK 610	610	F24048	2.98	2.05	330.07	24.26	13.59	2.78	0.73	1.80	19.88
SNK 611	611	F24050	2.98	2.15	280.07	16.26	16.26	2.78	0.73	1.82	18.88
SNK 612	612	F24052	0.98	2.35	300.07	19.26	15.09	0.78	0.83	0.72	17.88
SNK 613	613	F24054	7.98	1.65	220.07	8.26	21.91	7.78	0.99	6.85	19.68
SNK 614	614	F24061	8.98	2.45	320.07	20.26	15.35	7.78	1.06	7.42	21.28
SNK 615	615	F24063	5.98	2.35	310.07	29.26	11.00	5.78	1.37	7.46	18.88
SNK 616	616	F24070	7.98	2.55	345.07	29.26	12.09	5.78	1.12	5.92	17.88
SNK 617	617	F24071	1.98	2.35	310.07	29.26	11.00	1.78	1.46	2.67	20.48
SNK 618	618	F24072	11.98	2.15	335.07	27.26	12.50	9.78	1.22	10.90	17.88
SNK 619	619	F24074	3.98	2.35	350.07	23.26	14.84	3.78	1.42	5.18	16.88
SNK 620	620	F24077	6.98	2.55	310.07	25.26	12.43	4.78	1.02	4.47	16.48
SNK 621	621	F24082	4.98	2.05	370.07	24.26	15.07	3.78	1.01	3.55	18.88
SNK 622	622	F24083	5.98	2.25	350.07	23.26	14.84	2.78	1.32	3.59	19.88
SNK 623	623	F24085	2.98	2.45	360.07	28.26	12.93	2.78	1.30	3.52	20.48
SNK 624	624	F24087	1.98	1.85	380.07	30.26	12.82	0.78	1.27	1.16	19.28
SNK 625	625	F24088	2.98	2.05	355.07	30.26	12.06	1.78	2.41	4.57	19.68
SNK 626	626	F24090	4.98	2.15	300.07	24.26	12.48	4.78	0.86	3.63	18.88
SNK 627	627	F24091	11.52	2.35	296.73	20.50	14.45	7.31	0.74	6.14	15.71
SNK 628	628	F24095	12.52	2.35	356.73	23.50	15.21	6.31	0.61	4.48	19.11
SNK 629	629	F25006	7.52	1.95	316.73	20.50	15.36	5.31	0.61	3.69	17.71
SNK 630	630	F25009	6.52	2.75	356.73	35.50	10.54	3.31	2.09	6.58	19.71
SNK 631	631	F25010	8.52	2.45	346.73	29.50	12.10	5.31	0.68	4.02	15.71
SNK 632	632	F26002	4.52	3.35	336.73	34.50	10.26	2.31	1.54	3.25	19.11
SNK 633	633	F26003	6.52	2.35	371.73	24.50	15.23	4.31	1.97	8.35	19.71
SNK 634	634	F26007	8.52	2.25	346.73	31.50	11.42	6.31	0.97	6.62	17.71
SNK 635	635	F26008	9.52	2.55	326.73	27.50	12.19	5.31	1.44	7.83	18.71

SNK 636	636	F26014	20.52	2.55	371.73	29.50	12.91	17.31	0.48	10.66	21.11
SNK 637	637	F26015	8.52	2.25	356.73	26.50	13.67	4.31	0.49	2.44	20.71
SNK 638	638	F26017	6.52	1.95	306.73	29.50	10.81	2.31	2.14	4.45	20.11
SNK 639	639	F26030	12.52	1.95	326.73	22.50	14.56	5.31	0.59	3.60	18.71
SNK 640	640	F26032	7.52	2.15	296.73	32.50	9.63	4.31	0.51	2.54	20.71
SNK 641	641	F26034	9.52	1.75	321.73	19.50	16.29	6.31	0.41	3.24	21.71
SNK 642	642	F26035	5.52	2.35	316.73	23.50	13.61	3.31	1.09	3.59	21.71
SNK 643	643	F26037	5.52	2.95	276.73	24.50	11.58	2.31	0.78	1.73	21.51
SNK 644	644	F26038	7.52	2.25	321.73	30.50	10.97	4.31	0.66	3.11	20.71
SNK 645	645	F26041	5.52	2.15	286.73	27.50	10.81	3.31	0.91	3.05	22.71
SNK 646	646	F26042	8.52	3.15	266.73	15.50	16.69	5.31	0.62	3.72	21.71
SNK 647	647	F26045	7.52	2.05	306.73	24.50	12.73	5.31	0.77	4.47	21.71
SNK 648	648	F26049	4.52	2.15	316.73	23.50	13.61	1.31	1.26	1.27	21.71
SNK 649	649	F26050	8.52	2.35	291.73	20.50	14.22	5.31	0.82	4.74	21.51
SNK 650	650	F26051	6.52	1.85	266.73	18.50	14.31	4.31	0.69	3.25	21.71
SNK 651	651	F26055	12.52	2.05	296.73	18.50	15.81	6.31	0.84	5.81	15.51
SNK 652	652	F27005	13.52	2.25	316.73	26.50	12.24	10.31	0.97	11.08	20.71
SNK 653	653	F27007	6.52	2.35	366.73	24.50	15.04	4.31	0.57	2.77	15.71
SNK 654	654	F27008	7.52	1.95	376.73	26.50	14.38	5.31	1.53	8.31	18.71
SNK 655	655	F27009	5.52	2.35	346.73	23.50	14.81	2.31	0.83	1.83	21.71
SNK 656	656	F27013	14.52	2.55	356.73	20.50	17.17	9.31	0.34	4.33	18.71
SNK 657	657	F27014	6.52	1.95	376.73	30.50	12.69	4.31	0.69	3.25	21.71
SNK 658	658	F27015	8.52	2.35	381.73	21.50	17.55	3.31	0.90	3.03	18.71
SNK 659	659	F27018	11.52	1.75	366.73	17.50	20.28	9.31	0.21	3.19	19.31
SNK 660	660	F27021	3.52	2.35	356.73	30.50	12.06	1.31	0.72	0.74	20.11
SNK 661	661	F27024	11.52	2.05	376.73	34.50	11.37	7.31	0.56	4.87	20.71
SNK 662	662	F27026	11.52	1.95	306.73	19.50	15.57	8.31	0.94	8.64	24.71
SNK 663	663	F27030	5.52	3.15	306.73	32.50	9.93	3.31	1.37	4.42	19.71
SNK 664	664	F27031	16.52	2.95	391.73	26.50	14.92	14.31	0.78	12.98	17.71
SNK 665	665	F27035	11.52	2.15	341.73	18.50	18.06	9.31	0.57	6.41	18.21
SNK 666	666	F27037	7.52	2.15	311.73	26.50	12.06	4.31	1.29	5.64	13.71
SNK 667	667	F27041	9.52	2.05	366.73	19.50	18.43	4.31	1.38	6.00	17.71
SNK 668	668	F27044	12.52	2.55	366.73	19.50	18.43	9.31	0.90	9.36	18.71
SNK 669	669	F27046	6.52	2.35	356.73	33.50	11.10	3.31	0.98	3.28	16.71
SNK 670	670	F27048	8.52	3.25	346.73	30.50	11.75	5.31	1.07	5.97	19.71
SNK 671	671	F27051	9.52	2.55	386.73	32.50	12.28	7.31	0.53	4.65	16.71
SNK 672	672	F27052	8.52	2.05	291.73	18.50	15.56	5.31	0.75	4.38	18.61
SNK 673	673	F27054	11.52	1.75	226.73	17.50	12.92	5.31	0.55	3.38	17.71
SNK 674	674	F27056	6.52	1.15	336.73	28.50	12.14	3.31	0.84	2.86	18.71
SNK 675	675	F27058	8.52	2.75	276.73	19.50	14.14	5.31	0.48	3.03	20.21
SNK 676	676	F27071	7.52	2.05	206.73	11.50	16.96	5.31	0.78	4.56	15.91
SNK 677	677	F27072	3.12	2.02	200.63	16.16	12.56	3.05	1.26	3.82	17.65
SNK 678	678	F27073	10.12	2.02	250.63	16.16	15.50	8.05	1.44	11.82	17.75

SNK 679	679	F27081	6.12	1.82	260.63	30.16	8.92	6.05	0.59	3.69	19.35
SNK 680	680	F27082	13.12	2.12	310.63	27.16	11.64	10.05	0.73	7.67	19.05
SNK 681	681	F27085	4.12	2.22	320.63	25.16	12.90	3.05	1.08	3.26	18.65
SNK 682	682	F27088	3.12	2.62	310.63	20.16	15.45	3.05	0.78	2.38	19.65
SNK 683	683	F27089	5.12	2.52	310.63	24.16	13.01	5.05	0.65	3.37	17.75
SNK 684	684	F27091	5.12	1.82	260.63	19.16	13.71	5.05	0.62	3.24	10.55
SNK 685	685	F27092	9.12	2.12	320.63	22.16	14.56	7.05	0.92	6.69	14.65
SNK 686	686	F27110	17.12	2.22	230.63	18.16	12.84	13.05	0.83	11.28	18.55
SNK 687	687	F27111	8.12	2.72	370.63	27.16	13.78	7.05	0.81	5.86	18.95
SNK 688	688	F27115	6.12	2.32	360.63	32.16	11.42	5.05	1.19	6.09	20.75
SNK 689	689	F27116	4.12	2.62	335.63	32.16	10.66	4.05	1.29	5.22	12.35
SNK 690	690	F27119	4.12	2.42	241.63	18.16	13.42	4.05	1.18	4.79	14.75
SNK 691	691	F28002	10.12	2.42	260.63	23.16	11.46	8.05	0.61	5.18	19.55
SNK 692	692	F28003	4.12	3.22	375.63	32.16	11.88	3.05	1.55	4.67	19.05
SNK 693	693	F28004	6.12	2.32	370.63	24.16	15.41	6.05	0.96	5.94	17.55
SNK 694	694	F28005	5.12	2.42	335.63	20.16	16.64	3.05	0.93	2.82	18.75
SNK 695	695	F28007	4.12	2.62	335.63	33.16	10.36	4.05	1.29	5.23	18.85
SNK 696	696	F28009	7.12	2.42	390.63	27.16	14.49	7.05	0.64	4.72	17.75
SNK 697	697	F28012	7.12	2.72	390.63	33.16	11.97	7.05	0.97	6.99	16.05
SNK 698	698	F28016	7.12	3.02	385.63	28.16	13.83	5.05	1.51	7.66	19.75
SNK 699	699	F28018	11.12	2.62	350.63	28.16	12.62	10.05	0.84	8.76	18.95
SNK 700	700	F28019	5.12	2.12	360.63	27.16	13.42	3.05	0.99	2.99	19.75
SNK 701	701	F28020	11.12	2.32	360.63	21.16	17.03	8.05	0.69	5.80	17.55
SNK 702	702	F28025	6.12	3.32	330.63	27.16	12.35	6.05	1.61	9.81	17.75
SNK 703	703	F28032	7.12	2.02	300.63	23.16	13.13	4.05	0.81	3.34	20.65
SNK 704	704	F28033	9.12	2.12	340.63	28.16	12.28	6.05	0.59	3.69	19.75
SNK 705	705	F27122	4.12	2.72	380.63	23.16	16.46	4.05	1.02	4.15	18.75
SNK 706	706	F28036	5.12	2.02	320.63	28.16	11.59	4.05	0.60	2.49	18.75
SNK 707	707	F28037	4.12	2.72	350.63	28.16	12.62	3.05	1.27	3.85	22.55
SNK 708	708	F28038	5.12	2.52	340.63	25.16	13.67	3.05	0.64	1.95	19.55
SNK 709	709	F28039	2.12	2.62	370.63	31.16	12.08	2.05	1.22	2.42	18.55
SNK 710	710	F28040	4.12	2.42	370.63	28.16	13.31	4.05	1.47	5.94	18.15
SNK 711		B6 711 F28042	2.12	2.42	370.63	30.16	12.47	2.05	0.77	1.53	20.95
SNK 712	712	F28043	4.12	3.02	365.63	33.16	11.24	4.05	1.28	5.20	20.55
SNK 713	713	F28044	3.12	2.42	355.63	27.16	13.24	3.05	1.86	5.61	19.95
SNK 714	714	F28046	4.12	2.12	340.63	23.16	14.79	4.05	1.53	6.21	18.55
SNK 715	715	F28047	4.12	2.32	380.63	30.16	12.79	3.05	1.04	3.17	20.55
SNK 716	716	F28048	2.12	2.02	350.63	31.16	11.46	2.05	1.42	2.82	22.35
SNK 717	717	F28054	3.12	2.32	310.63	20.16	15.45	3.05	1.15	3.49	21.95
SNK 718	718	F28055	8.12	2.42	310.63	28.16	11.24	8.05	0.66	5.55	18.55
SNK 719	719	F28056	4.12	2.62	300.63	27.16	11.28	3.05	1.55	4.67	18.55
SNK 720	720	F28059	5.12	2.62	300.63	25.16	12.13	4.05	0.88	3.58	18.55

SNK 721	720	F28063	4.12	2.02	310.63	26.16	12.06	2.05	1.25	2.48	19.95
SNK 722	722	F28066	9.12	2.22	230.63	17.16	13.54	8.05	0.62	5.27	19.55
SNK 723	723	F30005	12.12	2.22	230.63	13.16	17.35	10.05	0.79	8.29	21.75
SNK 724	724	F30007	10.12	2.62	310.63	21.16	14.75	8.05	0.80	6.68	20.55
SNK 725	725	F30009	4.12	2.42	330.63	25.16	13.29	4.05	1.00	4.08	20.55
SNK 726	726	F30010	8.12	1.52	320.63	24.16	13.41	6.05	0.68	4.27	21.75
SNK 727	727	F30014	6.12	2.12	50.63	21.16	2.94	5.05	1.07	5.49	20.55
SNK 728	728	F30017	3.12	3.42	385.63	27.16	14.32	3.05	1.14	3.45	23.95
SNK 729	729	F30020	6.05	2.08	410.50	31.46	13.51	4.41	0.61	3.12	19.13
SNK 730	730	F30021	15.05	1.08	365.50	37.46	10.38	13.41	0.66	11.22	19.73
SNK 731	731	F30023	8.05	1.68	295.50	33.46	9.40	6.41	0.92	6.63	20.73
SNK 732	732	F30030	15.05	1.88	395.50	24.46	16.37	9.41	0.58	7.03	21.33
SNK 733	733	F30031	36.05	2.28	405.50	28.46	14.62	23.41	0.36	13.17	14.83
SNK 734	734	F30032	10.05	2.28	335.50	23.46	14.50	4.41	1.10	5.09	18.83
SNK 735	735	F30036	7.05	2.38	340.50	20.46	16.64	4.41	0.80	3.89	19.83
SNK 736	736	F30039	8.05	2.08	365.50	30.46	12.46	5.41	1.06	6.20	19.83
SNK 737	737	F31010	12.05	2.08	335.50	33.46	10.58	8.41	0.40	4.77	18.73
SNK 738	738	F31011	13.05	2.28	360.50	32.46	11.62	9.41	0.54	6.63	20.93
SNK 739	739	F31012	5.05	3.78	325.50	25.46	13.09	2.41	1.66	3.57	20.73
SNK 740	740	F32015	8.05	2.48	255.50	16.46	15.29	5.41	0.94	5.58	15.93
SNK 741	741	F32016	5.05	2.28	270.50	29.46	9.67	3.41	0.92	3.23	17.33
SNK 742	742	F32023	6.05	2.48	275.50	31.46	9.29	3.41	0.85	3.01	17.83
SNK 743	743	F32033	6.05	2.68	265.50	14.46	17.83	3.41	1.15	3.92	13.73
SNK 744	744	F32036	7.05	2.88	235.50	17.46	13.39	4.41	0.78	3.80	17.93
SNK 745	745	F32037	6.05	1.98	235.50	15.46	14.92	4.41	0.70	3.49	18.83
SNK 746	746	F32038	6.05	2.48	310.50	23.46	13.46	4.41	0.53	2.80	19.63
SNK 747	747	F32040	6.05	2.88	265.50	21.46	12.53	4.41	1.11	5.14	18.13
SNK 748	748	F32041	5.05	2.08	245.50	18.46	13.27	3.41	0.58	2.22	18.23
SNK 749	749	F32042	6.05	1.88	175.50	10.46	15.71	3.41	1.22	4.15	16.73
SNK 750	750	F32043	5.05	2.88	285.50	21.46	13.44	3.41	0.59	2.25	16.83
SNK 751	751	F32044	10.05	2.48	265.50	16.46	15.87	8.41	0.43	5.03	18.23
SNK 752	752	F32080	4.02	2.02	217.73	22.23	9.88	3.88	0.53	3.05	19.03
SNK 753	753	F34002	6.02	1.92	197.73	13.23	15.58	4.88	0.35	3.39	21.13
SNK 754	754	F34005	4.02	1.72	137.73	15.23	9.42	3.88	0.37	2.60	21.73
SNK 755	755	F34014	8.02	1.72	187.73	29.23	6.32	3.88	0.43	2.76	19.93
SNK 756	756	F34016	6.02	1.92	187.73	14.23	13.71	4.88	- 0.03	1.89	20.13
SNK 757	757	F34017	7.02	1.72	237.73	26.23	9.04	6.88	0.23	4.39	16.93
SNK 758	758	F34019	9.02	2.02	227.73	24.23	9.42	4.88	0.45	3.77	19.93
SNK 759	759	F34030	6.02	2.02	232.73	19.23	12.32	4.88	0.26	3.05	18.93
SNK 760	760	F34031	4.02	2.12	197.73	22.23	8.97	3.88	0.34	2.49	17.33
SNK 761	761	F34034	7.02	1.62	237.73	22.23	10.79	6.88	0.56	6.36	20.93
SNK 762	762	F34041	4.02	1.92	207.73	18.23	11.64	3.88	0.36	2.56	20.33

SNK 763	763	F34049	3.02	2.12	177.73	17.23	10.60	2.88	0.04	1.04	15.93
SNK 764	764	F34051	8.02	2.22	197.73	22.23	8.97	6.88	0.54	6.24	20.93
SNK 765	765	F34053	14.02	2.52	247.73	26.23	9.42	8.88	- 0.10	3.27	20.93
SNK 766	766	F34056	14.02	1.62	257.73	24.23	10.67	12.88	- 0.02	5.84	20.03
SNK 767	767	F34059	5.02	2.22	217.73	27.23	7.94	3.88	0.48	2.91	20.13
SNK 768	768	F34066	6.02	1.72	207.73	17.23	12.36	5.88	0.06	2.79	20.03
SNK 769	769	F34069	8.02	1.02	67.73	9.23	8.31	6.88	0.01	3.07	18.13
SNK 770	770	F34070	7.02	1.82	247.73	24.23	10.26	4.88	0.52	4.09	19.03
SNK 771	771	F34071	10.02	1.82	227.73	21.23	10.85	7.88	0.19	4.88	19.13
SNK 772	772	F34083	4.02	2.62	227.73	23.23	9.86	2.88	0.79	2.53	18.43
SNK 773	773	F34094	5.02	2.22	197.73	16.23	12.55	3.88	0.60	3.28	19.13
SNK 774	774	F33034	4.72	2.15	213.70	32.03	7.41	4.31	0.34	1.97	17.35
SNK 775	775	F48017	8.72	2.95	253.70	22.03	11.75	8.31	0.48	5.42	16.95
SNK 776	776	F48026	5.72	1.75	233.70	31.03	8.20	6.31	0.39	3.44	20.95
SNK 777	777	F48068	6.72	3.75	213.70	15.03	13.88	6.31	0.65	4.95	13.95
SNK 778	778	F50006	19.72	2.35	193.70	12.03	15.22	20.31	0.66	17.61	9.35
SNK 779	779	F47004	3.72	1.75	163.70	23.03	7.86	3.31	0.21	0.99	19.95
SNK 780	780	F47005	5.35	2.32	222.73	29.03	7.63	6.65	0.45	4.77	19.43
SNK 781	781	F47010	5.35	2.72	232.73	20.03	11.68	6.65	0.26	3.64	17.23
SNK 782	782	F47015	7.35	2.62	257.73	17.03	15.13	8.65	0.68	8.29	20.43
SNK 783	783	F47016	4.35	2.82	212.73	27.03	7.87	5.65	0.51	4.23	17.43
SNK 784	784	F47023	4.35	2.52	167.73	17.03	10.13	5.65	0.51	4.24	19.63
SNK 785	785	F47028	9.35	1.82	137.73	25.03	5.65	5.65	0.60	4.70	17.43
SNK 786	786	F49001	6.35	2.02	307.73	31.03	9.77	7.65	0.50	5.95	18.83
SNK 787	787	F49011	4.35	1.92	272.73	22.03	12.34	5.65	0.14	2.39	20.43
SNK 788	788	F46011	4.35	2.92	232.73	18.03	12.99	5.65	0.71	5.23	20.43
SNK 789	789	F46012	5.35	2.12	212.73	23.03	9.30	5.65	0.85	5.94	20.43
SNK 790	790	F46013	8.35	2.72	162.73	30.03	5.43	5.65	0.43	3.84	20.83
SNK 791	791	F46014	6.35	2.52	142.73	12.03	12.38	6.65	0.52	5.22	19.43
SNK 792	792	F46027	12.35	1.92	232.73	27.03	8.59	12.65	0.12	5.77	15.43
SNK 793	793	F46037	11.35	2.12	212.73	17.03	12.63	12.65	0.22	6.91	18.43
SNK 794	794	F46039	4.35	2.52	182.73	12.03	15.46	4.65	0.42	2.99	20.03
SNK 795	795	F46046	3.35	2.32	212.73	31.03	6.80	4.65	0.83	4.63	21.63
SNK 796	796	F37022	2.35	1.92	222.73	23.03	9.72	2.65	0.09	0.75	16.43
SNK 797	797	F37035	4.35	1.62	157.73	26.03	6.15	5.65	0.72	5.30	18.83
SNK 798	798	F36006	3.68	2.05	249.93	18.70	13.18	2.91	0.74	2.08	14.41
SNK 799	799	F36033	9.68	2.35	189.93	17.70	10.91	9.91	0.87	8.40	17.91
SNK 800	800	F36043	2.68	2.25	219.93	14.70	14.24	2.91	0.78	2.22	15.61
SNK 801	801	F36046	8.68	1.75	189.93	20.70	9.66	6.91	0.80	5.38	16.61
SNK 802	802	F36060	12.68	3.25	219.93	17.70	12.34	12.91	0.82	10.40	15.51
SNK 803	803	F36065	3.68	2.15	204.93	20.70	10.29	2.91	0.75	2.13	13.61
SNK 804	804	F36068	9.68	1.95	179.93	19.70	9.61	8.91	0.92	8.06	15.41

SNK 805	805	F35004	3.68	2.45	219.93	27.70	8.65	2.91	0.94	2.68	18.41
SNK 806	806	F35005	1.68	2.35	229.93	20.70	11.33	0.91	1.25	1.16	18.41
SNK 807	807	F35009	4.68	2.15	209.93	21.70	10.11	4.91	1.45	7.10	19.41
SNK 808	808	F35034	6.68	2.35	229.93	20.70	11.33	5.91	1.49	8.75	15.81
SNK 809	809	F35048	7.68	2.55	169.93	21.70	8.51	6.91	1.13	7.69	16.01
SNK 810	810	F35051	8.68	2.95	259.93	30.70	9.15	6.91	1.08	7.34	16.81
SNK 811	811	F35052	2.68	2.25	189.93	23.70	8.69	1.91	1.17	2.23	19.41
SNK 812	812	F35055	3.68	1.95	199.93	10.70	16.63	3.91	0.83	3.17	18.41
SNK 813	813	F35072	4.08	2.78	203.07	23.93	8.69	4.18	1.39	5.31	17.94
SNK 814	814	F35075	8.08	1.78	273.07	21.93	12.49	7.18	1.32	7.97	15.94
SNK 815	815	F35076	11.08	1.68	208.07	29.93	7.14	10.18	1.04	7.93	16.94
SNK 816	816	F35083	18.08	2.28	163.07	8.93	17.89	15.18	0.95	10.16	15.94
SNK 817	817	F38002	13.08	2.28	243.07	20.93	11.70	9.18	1.15	8.34	15.44
SNK 818	818	F38017	4.08	2.08	223.07	19.93	11.31	3.18	1.49	4.61	19.94
SNK 819	819	F38039	5.08	2.78	203.07	20.93	9.89	4.18	1.50	5.87	18.94
SNK 820	820	F38040	7.08	2.98	253.07	23.93	10.69	7.18	1.64	10.53	17.94
SNK 821	821	F39016	3.08	3.18	243.07	22.93	10.72	2.18	0.98	1.91	16.94
SNK 822	822	F39020	8.08	2.38	223.07	26.93	8.46	7.18	1.71	11.15	19.94
SNK 823	823	F39022	6.08	1.98	243.07	22.93	10.72	6.18	1.71	9.68	16.94
SNK 824	824	F39024	5.08	2.38	183.07	20.93	8.98	4.18	1.50	5.85	19.14
SNK 825	825	F43004	5.08	1.78	203.07	13.93	14.55	4.18	1.07	3.69	19.94
SNK 826	826	F43005	17.08	2.18	253.07	17.93	14.10	16.18	0.78	7.86	16.84
SNK 827	827	F44003	2.08	2.58	193.07	25.93	7.66	2.18	1.41	3.19	19.44
SNK 828	827	F44004	6.10	2.41	185.60	22.50	8.00	2.20	1.21	2.66	17.94

Mean values of checks

CoC 671	4.23	2.87	256.15	20.16	12.86	2.05	1.36	2.67	17.85
Co 86032	5.60	2.45	251.68	21.03	12.11	2.44	1.04	2.41	17.93
CoM 88121	5.03	2.62	248.66	20.89	12.07	2.85	0.90	2.30	16.60

CD at 5 % level

Between means of check & var.	2.81	0.66	58.32	5.71	3.19	1.52	0.59	0.61	2.76
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1. Tillers / Seedling (90 DAP); 2. Average cane girth (cm); 3. Average millabe height (cm);
4. Average number of internodes; 5. Average internodal length (cm); 6. Number of millable canes / clump; 7. Average single cane weight (kg); 8. Cane yield (kg) / clump; 9.Average HR Brix (%) at 300 DAP

Appendix VII. Adjusted mean values of selected progenies for 10 traits studied in settling generation of 44 inter-varietal sugarcane crosses under moisture stress environment at Sankeshwar

Selected progenies	Pedigree	Traits									
		1	2	3	4	5	6	7	8	9	10
SNK 024	F02035	58.71	61.33	1.50	356.69	26.56	13.70	30.97	0.95	27.50	16.88
SNK 041	F02095	67.02	50.33	2.70	251.69	15.56	16.03	29.97	1.03	28.50	16.55
SNK 082	F04004	36.55	61.33	2.60	266.69	19.56	13.73	28.97	0.65	18.50	19.01
SNK 085	F04008	58.71	54.33	2.80	216.69	19.56	11.23	33.97	0.63	21.50	16.95
SNK 088	F04012	47.63	78.33	3.10	306.69	25.56	12.27	28.97	0.78	21.50	17.61
SNK 094	F04023	43.47	40.33	2.50	302.44	21.81	13.68	24.22	0.98	22.50	17.16
SNK 099	F05004	37.93	33.33	2.50	192.44	16.81	11.42	27.22	0.86	22.50	17.23
SNK 109	F06002	57.32	34.33	2.50	202.44	16.81	12.02	18.22	1.29	21.50	17.36
SNK 128	F07053	57.32	51.33	2.30	212.44	14.81	14.62	26.22	1.02	25.50	15.03
SNK 250	F10070	68.40	95.08	1.70	275.44	16.06	16.91	58.97	0.58	28.70	15.07
SNK 264	F10144	35.16	52.08	2.70	305.44	21.06	14.65	32.97	0.73	23.00	17.87
SNK 287	F11043	49.71	71.83	2.28	272.94	19.56	14.11	37.22	0.73	24.75	14.72
SNK 357	F14011	52.48	37.83	2.28	262.94	19.56	13.61	34.22	0.70	21.75	16.25
SNK 388	F16095	56.63	73.58	2.30	189.19	20.56	9.10	25.97	0.82	20.00	18.30
SNK 432	F18100	78.79	83.58	2.60	294.19	23.56	12.30	31.97	0.87	27.00	15.03
SNK 452	F19020	64.94	57.58	2.30	294.19	21.56	13.56	45.97	0.39	21.00	18.16
SNK 453	F19021	70.48	69.58	2.40	309.19	20.56	15.05	24.97	1.01	23.00	13.63
SNK 474	F19062	44.17	102.8 3	1.85	221.69	17.06	13.00	17.97	1.31	27.75	16.97
SNK 500	F20036	55.25	40.83	1.95	246.69	16.06	15.20	23.97	1.00	25.75	19.50
SNK 511	F20066	38.63	44.83	2.95	231.69	20.06	11.60	20.97	1.14	26.75	15.77
SNK 519	F21003	13.70	52.83	2.55	261.69	17.06	15.20	13.97	1.30	22.75	17.23
SNK 533	F21034	46.94	54.83	2.35	301.69	24.06	12.60	45.97	0.63	25.75	16.90
SNK 543	F22006	55.25	44.83	2.85	301.69	26.06	11.68	18.97	1.22	26.75	15.50
SNK 550	F22026	24.78	52.83	1.95	166.69	17.06	9.92	19.97	1.06	23.75	15.30
SNK 561	F23006	35.86	65.08	2.13	190.44	12.31	15.07	21.47	0.94	22.75	15.18
SNK 583	F23062	24.78	61.08	1.93	205.44	14.31	14.07	56.47	0.37	22.75	18.38
SNK 596	F24005	24.78	59.08	2.43	245.44	14.31	16.57	30.47	0.74	24.75	17.78
SNK 604	F24025	46.94	135.0 8	2.53	285.44	20.31	13.76	39.47	0.57	24.75	17.55
SNK 617	F24071	27.55	58.08	2.63	285.44	27.31	10.36	36.47	0.64	25.75	15.38
SNK 624	F24087	35.86	116.0 8	2.93	155.44	17.31	9.14	38.47	0.61	25.75	14.58
SNK 632	F26002	52.48	76.08	2.73	205.44	16.31	12.47	19.47	1.30	28.75	15.25
SNK 635	F26008	58.02	84.08	1.93	125.44	8.31	14.67	16.47	1.19	22.75	14.78
SNK 645	F26041	31.01	35.58	1.80	191.69	14.56	13.20	37.22	0.55	21.00	19.30
SNK 672	F27052	39.32	62.58	2.20	321.69	20.56	15.89	36.22	0.45	17.00	13.17
SNK 699	F28018	53.17	54.58	2.30	316.69	22.56	14.15	32.22	0.78	25.00	18.10

SNK 707	F28037	39.32	26.58	2.60	261.69	17.56	15.10	30.22	0.81	24.00	19.30
SNK 742	F32023	46.94	38.33	2.75	279.44	22.56	12.32	32.97	0.81	26.75	14.83
SNK 744	F32036	80.18	76.33	3.25	254.44	19.56	13.07	29.97	0.76	22.75	15.96
SNK 745	F32037	52.48	78.33	2.25	259.44	18.56	14.17	30.97	0.77	23.75	14.63
SNK 748	F32041	66.33	52.33	2.45	280.44	26.56	10.30	32.97	0.75	24.75	12.76
SNK 750	F32043	71.87	80.33	3.25	304.44	25.56	11.75	22.97	0.88	19.75	13.10
SNK 782	F47015	69.10	53.33	2.15	254.44	23.56	10.56	34.97	0.71	24.75	17.53
SNK 806	F35005	38.63	45.33	2.65	255.44	16.56	15.86	28.97	1.00	28.75	13.43
SNK 809	F35048	52.48	65.33	2.75	279.44	31.56	8.46	38.97	0.78	30.75	15.83
SNK 813	F35072	63.56	80.33	2.75	274.44	29.56	8.93	26.97	1.08	28.75	14.03
SNK 814	F35075	74.64	95.33	3.05	279.44	30.56	8.77	26.97	1.20	31.75	15.56
SNK 817	F38002	58.02	91.33	2.65	294.44	29.56	9.64	32.97	0.94	30.75	16.83
SNK 820	F38040	35.86	25.33	2.75	289.44	18.56	15.93	24.97	1.01	24.75	15.50
SNK 822	F39020	44.17	45.33	2.35	259.44	23.56	10.86	20.97	1.62	32.75	17.23
SNK 827	F44003	63.56	40.33	2.65	219.44	18.56	11.86	23.97	1.36	31.75	21.10
Mean values of checks											
CoC 671		60.94	46.00	2.63	250.56	17.89	14.08	22.44	1.10	23.67	18.27
Co 86032		56.94	69.78	2.40	233.00	18.44	12.73	24.00	0.90	21.00	18.63
CoM 88121		61.25	56.56	2.61	226.56	18.00	12.75	34.11	0.70	22.67	16.96
CD at 5 % level											
Between means of check & var.		26.97	25.44	0.39	60.92	4.97	3.88	16.33	0.39	4.83	2.31

TRAITS : 1. Germination per cent (45 DAP) 2. Tillers / Plot (90 DAP) 3. Average cane girth (cm),
4. Average millabe height (cm),
5. Average number of internodes, 6. Average internodal length (cm), 7. Number of millable canes / Plot,
8. Average single cane weight (kg), 9. Cane yield (kg) / Plot, 10. Average HR Brix at 300 DAP (%)

Appendix VIII . Adjusted mean values of selected progenies for 9 traits studied in clonal ratoon generation of 44 inter varietal sugarcane crosses under moisture stress environment at Sankeshwar

Selected progenies	Pedigree	Traits								
		1	2	3	4	5	6	7	8	9
SNK 024	F02035	38.92	2.89	295.59	14.21	21.04	32.14	0.60	20.18	15.49
SNK 041	F02095	38.92	2.29	288.89	14.91	19.48	32.14	0.60	20.18	19.89
SNK 082	F04004	19.92	2.46	122.29	11.61	10.14	13.14	2.24	19.18	17.45
SNK 085	F04008	31.92	2.32	170.59	15.91	10.24	25.14	0.76	18.18	19.17
SNK 088	F04012	27.92	2.59	232.29	15.61	14.64	21.14	0.99	18.18	19.77
SNK 094	F04023	27.17	2.82	196.14	12.04	16.93	22.39	0.89	17.18	20.67
SNK 099	F05004	16.17	2.32	214.74	14.44	15.16	11.39	1.40	17.18	17.07
SNK 109	F06002	34.17	2.16	205.44	11.74	18.26	29.39	0.75	17.18	18.27
SNK 128	F07053	44.17	2.62	210.14	14.74	14.46	39.39	0.71	21.18	16.71
SNK 250	F10070	34.67	1.94	173.89	14.36	12.34	29.89	0.81	26.68	13.71
SNK 264	F10144	30.67	2.47	172.19	14.06	12.54	25.89	0.75	21.68	16.43
SNK 287	F11043	21.67	2.23	171.59	12.04	13.64	16.89	0.99	19.93	18.99
SNK 357	F14011	28.67	1.86	200.99	16.34	12.34	23.89	0.66	16.93	18.87
SNK 388	F16095	33.17	2.09	179.24	15.56	11.40	28.39	0.57	16.43	17.25
SNK 432	F18100	23.17	2.42	216.24	18.56	11.50	18.39	1.02	22.43	17.55
SNK 452	F19020	44.17	2.12	238.24	15.26	15.40	39.39	0.57	21.43	18.39
SNK 459	F19034	34.17	2.19	279.94	18.86	14.60	29.39	0.76	23.43	18.09
SNK 474	F19062	36.67	2.36	264.67	14.66	18.24	31.89	0.79	22.93	15.97
SNK 500	F20036	25.67	2.49	166.37	14.96	10.94	20.89	1.02	18.93	21.53
SNK 511	F20066	38.67	2.89	246.37	18.96	13.04	33.89	0.71	21.93	19.09
SNK 519	F21003	61.67	2.63	226.37	15.66	14.44	56.89	0.44	22.93	18.27
SNK 533	F21034	56.67	2.36	254.67	17.66	14.44	51.89	0.48	22.93	18.27
SNK 543	F22006	44.67	2.83	236.37	19.36	12.24	39.89	0.63	22.93	16.77
SNK 550	F22026	23.67	1.86	209.67	15.36	13.64	18.89	1.31	21.93	19.15
SNK 562	F23007	21.42	2.51	249.12	14.19	17.64	16.64	1.63	21.68	14.40
SNK 583	F23062	45.42	1.81	239.12	13.19	18.14	40.64	0.45	18.68	18.76
SNK 596	F24005	39.42	2.07	215.72	16.79	12.99	34.64	0.68	22.68	19.92
SNK 604	F24025	38.42	2.37	282.42	21.19	13.74	33.64	0.71	22.68	18.88
SNK 617	F24071	36.42	2.67	312.42	19.79	16.24	31.64	0.80	23.68	19.44
SNK 624	F24087	42.42	2.44	242.42	17.79	13.84	37.64	0.65	23.68	18.00
SNK 632	F26002	26.42	3.07	312.42	20.19	15.94	21.64	1.33	24.68	18.70
SNK 635	F26008	20.42	2.47	264.12	19.49	13.94	15.64	1.94	23.68	16.24
SNK 645	F26041	28.42	2.61	234.12	18.49	12.94	23.64	1.04	21.68	19.92
SNK 673	F27054	56.17	2.94	281.37	21.46	13.44	51.39	0.37	23.06	16.71
SNK 699	F28018	52.17	2.81	289.67	18.16	16.54	47.39	0.46	24.06	18.25
SNK 707	F28037	29.17	2.31	169.67	13.46	13.04	24.39	1.09	20.06	20.05
SNK 742	F32023	46.17	2.68	223.07	19.06	11.88	41.39	0.51	24.93	17.82
SNK 744	F32036	43.17	3.24	221.77	14.76	14.88	38.39	0.53	23.93	18.06
SNK 745	F32037	33.17	2.11	230.07	18.76	12.38	28.39	0.80	24.93	18.86
SNK 748	F32041	40.17	2.31	218.47	16.76	13.08	35.39	0.62	24.93	18.02
SNK 750	F32043	47.17	2.91	288.47	16.76	17.08	42.39	0.52	25.93	13.54
SNK 782	F47015	34.17	2.08	212.77	15.06	14.08	29.39	0.62	20.93	19.94
SNK 806	F35005	28.17	2.61	221.77	14.76	14.91	23.39	0.97	23.93	19.54

SNK 809	F35048	35.17	2.71	212.07	18.06	11.88	30.39	0.71	23.93	17.42
SNK 813	F35072	24.17	2.54	245.07	15.06	16.08	19.39	1.21	23.93	18.28
SNK 814	F35075	44.17	3.08	290.07	13.36	21.08	39.39	0.54	24.93	18.78
SNK 817	F38002	57.17	2.64	210.07	18.36	11.68	52.39	0.40	25.93	18.30
SNK 819	F38039	34.17	2.88	201.77	15.76	12.88	29.39	0.81	25.93	18.46
SNK 822	F39020	26.17	2.54	228.07	20.36	11.48	21.39	1.08	23.93	19.18
SNK 827	F44003	27.17	2.54	143.47	9.76	14.28	22.39	1.12	25.93	19.62
Mean values of checks										
CoC 671		19.33	2.48	200.41	15.13	13.32	15.22	1.09	14.61	19.92
Co 86032		31.22	2.53	190.48	15.71	12.08	26.22	0.85	18.11	19.91
CoM 88121		35.33	2.44	218.71	16.27	13.51	30.33	0.75	18.22	19.84
CD at 5 % level										
Between means of check & var.		31.73	0.54	81.99	5.09	4.55	31.44	0.83	7.77	2.69

TRAITS : 1. Tillers / Plot (90 DAR) 2. Average cane girth (cm), 3. Average millabe height (cm), 4. Average number of internodes, 5. Average internodal length (cm), 6. Number of millable canes / Plot, 7. Average single cane weight (kg), 8. Cane yield (kg) / Plot, 9. Average HR Brix at 300 DAR (%).

Appendix IX: Adjusted mean values of selected progenies for 11 traits studied in settling generation of 44 intervarietal sugarcane crosses under salinity water logg complex environment at Ugar

Selected progenies	Pedigree	Traits										
		1	2	3	4	5	6	7	8	9	10	11
SNK 024	F02035	26.02	33.57	2.59	2.43	196.70	19.25	10.47	31.16	0.41	15.65	16.49
SNK 047	F02118	31.56	28.57	11.25	2.17	122.37	11.52	10.79	0.16	2.42	17.48	15.23
SNK 052	F02137	70.34	71.57	6.25	2.07	140.70	20.12	7.61	33.16	0.74	16.48	17.65
SNK 066	F03034	45.41	22.90	1.59	2.13	173.71	17.69	10.75	8.49	1.34	16.82	18.81
SNK 068	F03038	26.02	19.90	5.59	2.50	149.04	21.09	8.15	7.49	1.41	16.82	19.55
SNK 074	F03064	53.72	40.90	4.59	2.50	164.71	14.09	11.85	12.49	1.03	14.82	21.09
SNK 081	F04003	20.48	3.90	8.59	2.16	180.37	14.69	12.35	3.49	1.89	17.82	19.63
SNK 082	F04004	42.64	5.57	0.92	2.10	175.94	16.22	11.02	7.16	1.31	17.32	21.80
SNK 083	F04005	26.02	4.57	-2.08	2.20	179.27	19.22	9.92	7.16	1.31	17.32	19.46
SNK 084	F04006	45.41	20.57	-1.08	2.00	143.61	16.22	9.42	15.16	0.99	18.32	20.84
SNK 085	F04008	42.64	10.57	-0.08	1.83	126.61	13.92	9.52	12.16	1.37	24.32	19.22
SNK 086	F04009	50.95	46.57	-1.08	1.63	123.94	12.92	9.92	19.16	0.85	17.32	21.02
SNK 121	F07034	80.49	74.90	2.92	2.66	218.90	21.69	10.76	20.49	0.92	17.25	15.84
SNK 139	F07078	61.10	54.90	5.92	2.53	216.57	17.39	12.66	13.49	1.16	20.25	19.24
SNK 154	F07109	74.03	55.90	3.25	3.03	272.80	13.75	18.57	34.16	0.43	20.32	17.62
SNK 155	F07113	65.72	55.90	4.25	2.33	222.80	17.05	13.17	39.16	0.31	19.32	16.44
SNK 159	F07137	93.42	44.90	2.25	2.06	267.80	22.35	12.67	45.16	0.26	20.32	20.40
SNK 210	F09008	48.18	49.90	2.92	2.96	231.37	16.75	13.56	23.49	0.78	18.32	17.75
SNK 235	F09074	20.48	17.90	-3.08	2.59	191.03	15.75	11.86	24.49	0.66	17.32	20.81
SNK 299	F11104	38.94	38.90	5.59	1.87	192.27	20.09	9.97	35.82	0.33	17.32	23.91
SNK 319	F12061	58.33	49.90	3.59	2.57	188.60	24.09	8.07	26.82	0.59	17.32	22.87

SNK 320	F12062	63.87	45.90	2.59	2.40	191.93	20.09	9.97	33.82	0.41	18.32	22.21
SNK 372	F16037	68.49	43.24	-2.75	2.06	120.80	20.79	4.19	23.82	0.87	18.65	21.08
SNK 423	F18080	80.49	46.24	2.59	2.30	169.47	28.42	3.36	29.82	0.47	18.32	23.28
SNK 447	F19012	72.18	58.24	14.59	2.07	107.47	21.42	3.06	22.82	0.75	17.32	20.56
SNK 493	F20004	62.95	56.24	4.59	1.80	106.70	20.85	3.47	25.16	0.84	21.82	20.50
SNK 509	F20054	10.32	17.24	-2.41	2.47	124.03	20.45	4.67	18.16	1.31	19.82	20.02
SNK 511	F20066	60.18	54.24	0.59	2.27	127.03	20.15	4.97	23.16	0.85	19.82	18.30
SNK 664	F27031	26.94	39.90	4.92	2.70	158.04	22.49	6.24	29.16	0.82	21.32	21.48
SNK 714	F28046	58.33	40.57	0.59	3.06	250.70	27.49	8.00	19.49	1.25	19.98	17.07
SNK 790	F46013	78.65	51.57	3.59	2.46	201.23	15.62	12.99	36.49	0.44	18.32	18.01
SNK 791	F46014	42.64	40.57	5.59	1.69	165.57	18.92	9.29	12.49	1.31	14.32	21.09
SNK 814	F35075	73.11	77.57	0.59	1.93	201.90	20.92	10.09	43.49	0.46	15.32	16.85
Mean values of checks												
CoC 671		38.13	27.53	4.47	2.43	167.95	16.07	10.86	17.00	1.07	15.91	19.27
Co 7508		42.36	35.94	5.71	2.42	173.86	17.08	10.64	19.65	0.90	15.45	19.99
CoM 88121		33.57	32.24	5.59	2.24	158.29	16.32	9.89	19.82	0.58	9.60	18.71
CD at 5 % level												
Between means of check & var.		12.31	35.01	10.42	0.66	70.10	6.74	4.08	16.42	0.58	4.23	4.43

TRAITS : 1. Germination (%) (45 DAP) 2. Tillers / Plot (90 DAP) 3. Tiller mortality (%) (90 DAP) 4. Average cane girth (cm),
5. Average millable cane height (cm), 6. Average number of internodes, 7. Average internodal length (cm), 8. Number of millable canes / Plot,
9. Average single cane weight (kg), 10. Cane yield (kg) / Plot, 11. Average HR Brix at 300 DAP (%)

Appendix X .Adjusted mean values of selected progenies for 10 traits studied in clonal ratoon generation of 44 inter varietal sugarcane crosses under normal irrigated environment at Hosur

Selected progenies	Pedigree	Traits									
		1	2	3	4	5	6	7	8	9	10
SNK 024	F02035	53.91	53.36	2.81	236.14	19.22	12.12	26.15	1.25	34.41	17.73
SNK 030	F02055	59.45	62.36	2.78	288.54	27.92	10.52	30.15	1.03	33.41	16.75
SNK 052	F02137	84.38	65.36	2.58	284.54	27.22	10.62	31.15	1.06	35.41	16.09
SNK 081	F04003	54.83	64.03	2.68	275.60	26.25	10.83	46.49	0.49	30.08	17.12
SNK 082	F04004	46.52	57.03	2.68	266.70	23.25	11.63	44.49	0.63	34.08	18.32
SNK 083	F04005	71.45	69.03	2.68	255.10	20.95	12.13	45.49	0.51	30.08	17.52
SNK 084	F04006	46.52	52.03	2.41	268.10	20.25	13.13	25.49	0.75	20.08	15.52
SNK 085	F04008	38.21	31.03	2.81	265.10	17.55	14.63	24.49	1.35	31.08	17.52
SNK 086	F04009	46.52	56.03	2.01	280.10	21.95	12.73	31.49	0.75	26.08	19.04
SNK 094	F04023	85.30	58.03	3.28	235.10	21.25	11.13	16.49	2.33	30.08	18.10
SNK 099	F05004	49.29	55.03	2.54	190.40	18.55	10.23	33.49	0.75	28.08	16.32
SNK 100	F05006	90.84	78.03	2.54	243.40	11.55	19.03	20.49	1.50	27.08	17.06
SNK 161	F07143	74.22	48.69	2.54	206.27	26.55	7.88	28.49	0.95	26.08	16.70
SNK 192	F08093	75.15	27.03	2.12	274.30	23.58	11.65	26.82	1.16	30.44	14.83
SNK 269	F11010	53.91	50.36	2.48	273.77	21.05	12.82	33.15	1.13	33.74	19.14
SNK 304	F12018	20.67	31.36	2.55	252.37	17.05	14.42	29.15	1.12	29.74	15.54
SNK 349	F13059	75.15	40.69	2.62	294.44	25.28	11.73	23.49	1.39	31.08	18.29
SNK 357	F14011	83.46	47.69	3.18	278.74	25.98	10.83	25.49	1.40	34.08	19.75
SNK 363	F16008	52.99	50.69	2.99	272.44	22.28	12.23	26.49	1.42	36.08	16.81
SNK 393	F17004	58.53	31.69	2.68	252.01	23.95	10.53	30.82	1.00	29.41	14.81
SNK 432	F18100	86.23	18.69	2.65	239.67	14.95	16.63	18.82	1.94	37.41	15.21
SNK 442	F19003	58.53	42.03	2.95	376.20	28.55	13.39	15.49	2.31	30.74	15.59
SNK 452	F19020	52.99	42.03	2.68	261.20	19.95	13.19	22.49	1.43	29.74	17.99
SNK 490	F19099	64.07	51.03	3.15	290.87	24.95	11.79	20.49	1.99	36.74	15.11
SNK 493	F20004	77.92	57.03	2.82	341.20	25.25	13.69	15.49	2.70	35.74	17.11
SNK 500	F20036	33.60	51.03	2.75	311.20	22.55	13.99	18.49	2.18	35.74	17.13
SNK 510	F20055	74.22	32.69	2.88	278.77	26.72	10.14	18.15	2.44	31.74	18.87
SNK 511	F20066	21.59	23.69	2.85	269.11	22.72	11.94	18.15	2.71	34.74	14.05
SNK 512	F20069	54.83	28.69	2.88	248.44	22.02	11.34	16.15	2.84	29.74	17.75
SNK 579	F23046	23.44	14.69	2.89	264.40	24.52	10.87	21.49	1.11	22.08	17.47
SNK 617	F24071	23.44	29.69	2.42	252.73	19.12	13.17	12.49	3.09	33.08	16.57
SNK 624	F24087	34.52	19.69	3.09	281.40	23.12	12.17	18.49	1.97	33.08	14.75
SNK 627	F24091	59.45	47.69	2.42	286.07	23.12	12.37	51.49	0.63	34.08	16.61
SNK 632	F26002	40.06	47.69	2.79	202.73	16.52	12.27	17.49	2.29	36.08	15.21
SNK 635	F26008	67.76	33.03	2.43	260.11	22.12	11.72	25.82	1.34	32.74	17.68
SNK 638	F26017	76.07	42.03	2.45	251.77	21.82	11.52	29.82	1.05	31.74	15.85

SNK 661	F27024	67.76	86.03	2.58	201.77	13.12	16.52	40.82	0.54	27.74	18.37
SNK 688	F27115	34.52	27.03	3.15	273.44	20.82	13.22	32.82	1.09	36.74	13.89
SNK 707	F28037	52.99	26.36	3.19	255.64	18.48	13.63	10.49	2.85	35.74	20.09
SNK 719	F28056	44.68	21.36	3.22	278.97	18.48	14.73	12.49	2.63	37.74	9.27
SNK 724	F30007	39.14	55.36	2.59	208.97	19.18	10.83	26.49	1.19	30.74	17.79
SNK 729	F30020	50.22	59.36	3.15	263.97	19.18	13.53	21.49	1.45	31.74	11.87
SNK 771	F34071	30.83	52.36	2.48	228.77	20.72	11.10	15.15	1.73	32.41	14.80
SNK 773	F34094	28.06	30.36	2.82	253.44	20.72	12.30	12.15	2.18	38.41	16.60
SNK 775	F48017	28.06	27.36	2.85	300.44	27.02	11.00	16.15	1.57	29.41	11.40
SNK 782	F47015	11.44	8.36	2.58	188.77	18.42	10.30	3.15	2.91	32.41	17.16
SNK 786	F49001	19.75	53.36	2.62	242.10	19.72	12.40	23.15	1.36	30.41	17.60
SNK 787	F49011	28.06	29.36	1.98	237.10	22.42	10.50	30.15	1.28	33.41	16.80
SNK 807	F35009	22.52	47.36	2.82	242.10	23.02	10.40	1.15	3.54	34.41	19.36
SNK 814	F35075	22.52	12.36	3.32	183.77	20.42	8.90	11.15	2.31	39.41	17.20
SNK 817	F38002	41.91	37.36	3.42	263.44	26.02	10.00	12.15	1.90	32.41	17.00
SNK 819	F38039	33.60	41.36	3.25	260.10	28.42	8.90	20.15	1.72	38.41	14.20
SNK 825	F43004	44.68	50.36	3.05	293.77	27.02	10.70	36.15	1.30	39.41	16.00
SNK 827	F44003	36.37	29.36	3.12	286.77	28.72	9.80	18.15	1.81	38.41	16.80

Mean values of checks

CoC 671	53.27	39.69	3.04	260.03	21.74	12.01	19.23	1.54	28.77	17.56
Co 86032	58.60	46.38	2.49	264.62	22.82	11.69	24.62	1.14	26.23	17.44
CoM 88121	47.09	46.00	2.62	263.96	22.89	11.60	24.62	1.04	23.23	16.36
CD at 5 % level										
Between means of check & var.	31.41	29.52	0.75	54.02	6.36	2.67	13.09	0.71	5.79	3.19

TRAITS : 1. Germination at 45 DAP (%) 2. Tillers / Plot (90 DAP) 3. Average cane girth (cm), 5. Average millable height (cm),
5. Average number of internodes, 6. Average internodal length (cm), 7. Number of millable canes / Plot,
8. Average single cane weight (kg), 9. Cane yield (kg) / Plot, 10. Average HR Brix at 300 DAP (%)

Appendix XI . Mean values for germination, growth and cane yield parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Progenies	Germ. % at 45 DAP	Tillers at 90 DAP	Tillers at 120 DAP	Average SCW (kg) at harvest	Average millable cane ht (cm) at harvest	Average cane girth (cm) at harvest	Average No. of internodes at harvest	Average internodal length (cm) at harvest	NMC (000's / ha)	Cane yield (t/ha)
SNK 024	82.08	183.55	119.08	1.53	263.00	2.65	26.75	9.80	61.39	90.65
SNK 041	86.66	173.99	154.55	1.65	265.50	2.70	23.25	11.44	49.57	80.47
SNK 082	56.66	108.59	98.10	1.02	197.50	2.70	24.50	8.06	64.64	66.14
SNK 085	57.08	110.13	110.13	1.27	200.50	2.70	25.00	8.10	57.37	73.08
SNK 088	61.25	156.10	110.75	1.32	215.00	2.75	22.75	9.45	48.17	63.83
SNK 094	47.08	99.02	104.89	1.27	185.50	2.75	24.75	7.49	27.61	35.15
SNK 099	82.50	157.64	107.35	0.92	170.00	2.75	27.50	6.18	74.65	68.91
SNK 109	59.16	116.61	120.31	1.30	225.00	2.55	20.50	10.97	47.05	60.59
SNK 128	59.58	153.94	158.26	1.63	227.50	2.85	23.50	9.80	36.10	58.74
SNK 250	66.66	190.96	196.82	0.97	225.00	2.25	22.75	9.89	24.17	23.59
SNK 264	66.66	121.54	133.58	1.21	233.50	2.50	21.25	11.01	49.67	60.13
SNK 287	98.33	191.27	217.18	1.37	237.00	2.65	20.75	11.42	41.01	56.43
SNK 357	67.74	120.93	111.67	1.37	254.50	2.50	30.50	8.40	55.36	75.85
SNK 388	94.58	238.16	272.09	1.25	242.50	2.60	25.50	9.51	18.93	23.59
SNK 432	98.75	207.62	200.21	1.56	241.00	2.65	27.25	8.84	46.97	73.08
SNK 452	90.83	214.40	208.85	1.12	261.00	2.15	23.00	11.41	58.94	65.21
SNK 459	71.25	176.77	211.93	0.91	300.00	2.20	23.75	12.54	67.49	60.59
SNK 474	91.66	224.27	182.94	1.15	247.00	2.20	24.25	10.27	62.98	69.84
SNK 500	77.08	245.25	194.35	1.73	257.00	2.85	21.25	12.09	34.70	60.13

SNK 511	34.16	88.54	103.34	1.68	243.00	2.75	24.25	10.01	34.64	57.81
SNK 519	64.58	210.70	219.65	1.32	261.00	2.40	23.25	11.25	53.57	69.38
SNK 533	44.58	140.98	132.65	1.61	260.00	2.55	23.50	11.07	36.40	58.28
SNK 543	93.74	176.46	199.29	1.48	208.50	2.70	23.25	8.97	38.61	56.89
SNK 550	75.00	245.56	173.37	1.09	242.50	2.65	19.75	12.31	29.02	31.45
SNK 562	77.08	254.51	220.26	1.76	295.00	2.70	23.75	12.42	17.86	31.45
SNK 584	73.75	197.44	217.18	1.30	247.00	2.55	19.25	12.90	19.48	24.51
SNK 596	50.83	124.32	202.68	0.97	214.00	2.25	19.25	11.16	44.55	43.48
SNK 604	84.16	199.29	179.54	1.08	208.00	2.50	27.25	7.67	55.16	59.66
SNK 617	59.58	149.00	157.64	1.62	251.50	2.75	25.50	9.87	38.46	62.44
SNK 624	83.33	168.75	130.80	1.27	184.00	2.85	28.25	6.57	17.34	21.28
SNK 632	72.08	138.20	148.08	2.05	255.00	2.35	25.75	9.90	53.46	109.61
SNK 635	87.08	236.62	212.86	1.72	227.50	2.95	25.25	9.01	44.82	77.24
SNK 645	71.66	209.78	192.50	0.87	190.00	2.25	22.75	8.35	26.93	23.59
SNK 673	61.25	153.63	112.29	1.87	263.50	2.50	28.25	9.39	47.05	64.29
SNK 699	87.91	220.26	161.34	1.31	243.50	2.65	25.00	9.74	45.64	58.74
SNK 707	70.00	241.86	152.39	1.25	227.00	2.55	20.75	10.94	69.93	86.95
SNK 742	59.58	141.91	140.36	1.90	238.00	2.55	26.75	8.93	34.64	65.21
SNK 744	65.83	195.58	176.77	1.52	196.00	2.60	21.50	9.08	30.93	46.71
SNK 745	63.33	120.62	157.33	0.98	221.50	2.25	22.50	9.85	49.39	48.10
SNK 748	83.33	150.85	176.46	1.08	201.00	2.55	22.00	9.10	20.52	22.20
SNK 750	85.00	147.46	172.45	1.67	253.00	2.90	22.75	11.13	36.10	58.74
SNK 782	82.91	194.66	223.97	1.30	251.50	2.45	22.00	11.45	66.88	86.95
SNK 806	76.24	255.12	127.71	1.63	225.50	2.85	25.50	8.84	52.79	86.02
SNK 809	66.66	204.84	236.31	1.48	229.50	2.90	21.75	10.57	58.27	83.71

SNK 813	88.74	266.54	165.97	1.52	248.00	2.65	21.50	11.54	58.29	88.80
SNK 814	74.58	257.90	251.11	1.78	272.00	2.80	23.25	11.74	44.83	80.01
SNK 817	56.66	238.47	245.56	1.31	232.00	2.50	29.00	7.99	57.50	73.54
SNK 819	83.33	266.23	184.48	2.01	275.00	3.10	25.25	10.89	48.78	98.05
SNK 822	67.50	186.95	144.37	1.62	265.50	2.60	25.75	10.19	58.10	94.35
SNK 827	73.74	247.10	173.99	2.05	249.00	3.10	25.75	9.67	45.47	93.43
Checks										
CoC 671	67.08	169.98	161.03	1.62	217.00	3.00	27.50	7.89	39.64	64.29
Co 86032	89.16	201.45	165.35	1.57	234.00	2.80	24.00	9.77	42.69	67.02
CoM 88121	66.66	221.81	246.49	1.37	231.00	2.65	22.25	10.37	43.60	59.66
CD (0.01)	25.64	68.65	70.96	0.50	57.14	0.50	4.40	2.48	25.80	9.01
CD (0.05)	19.26	51.58	53.32	0.37	42.94	0.38	3.31	1.86	19.39	6.77
CV (%)	13.21	13.90	15.46	13.25	9.08	7.27	6.88	9.35	19.60	5.40
S.Em±	6.79	18.19	18.80	0.13	15.14	0.13	1.16	0.65	6.83	2.38

SCW - Single
cane weight
(kg): NMC -
Number of
millable canes.

Appendix XII .Mean values for sugar yield and its parameters (at harvest) of selected progenies evaluated under moisture stress environment at Sankeshwar

Progenies	JE%	Brix%	Sucrose %	Purity %	CCS%	CCS Yield (t/ha)
SNK 024	58.97	17.78	13.95	79.76	11.30	10.23
SNK 041	65.56	18.03	14.42	79.99	12.57	10.15
SNK 082	61.50	19.88	12.00	60.29	6.48	4.28
SNK 085	62.57	18.85	16.29	86.42	12.64	9.22
SNK 088	57.50	17.87	14.99	83.80	10.13	6.46
SNK 094	58.50	19.18	15.39	80.06	10.14	3.56
SNK 099	55.50	17.37	14.39	82.75	9.66	6.66
SNK 109	56.06	20.40	17.18	84.43	13.40	8.12
SNK 128	65.02	17.93	14.94	83.28	11.78	6.92
SNK 250	60.75	19.27	16.27	85.60	11.04	2.60
SNK 264	61.91	17.75	15.89	89.42	12.14	7.28
SNK 287	53.50	17.57	14.69	83.55	9.84	5.55
SNK 357	59.08	19.75	15.70	79.27	12.64	9.55
SNK 388	54.50	20.37	17.60	86.35	12.01	2.83
SNK 432	61.65	16.50	13.76	83.36	10.84	7.92
SNK 452	53.23	17.85	15.09	83.76	11.82	7.74
SNK 459	59.08	18.18	15.17	83.42	11.95	7.23
SNK 474	51.31	18.83	15.43	81.94	12.26	8.56
SNK 500	60.50	20.37	17.30	86.35	12.06	7.25
SNK 511	59.16	18.95	16.32	86.10	12.68	7.33
SNK 519	56.33	18.81	15.65	82.99	12.36	8.57
SNK 533	64.43	18.86	16.96	89.92	12.93	7.54
SNK 543	66.34	18.25	15.97	87.29	12.32	7.01
SNK 550	68.00	19.17	15.53	80.75	10.27	3.23
SNK 562	56.50	18.18	14.81	81.17	9.83	3.09
SNK 584	61.73	18.65	16.21	87.08	12.55	3.08
SNK 596	60.13	20.00	17.11	85.58	13.33	5.79
SNK 604	68.48	19.85	17.08	85.93	13.28	7.90
SNK 617	62.92	17.05	14.18	83.15	11.20	6.99
SNK 624	63.50	18.23	14.75	80.88	11.78	2.51
SNK 632	65.90	20.05	16.83	83.90	11.37	12.46
SNK 635	58.50	19.37	16.48	85.00	11.18	8.63
SNK 645	57.50	20.38	17.35	85.05	11.80	2.78
SNK 673	68.50	17.20	14.29	83.12	11.28	7.25

SNK 699	66.66	17.55	14.49	82.55	12.40	7.29
SNK 707	58.00	20.78	18.90	90.90	13.25	11.52
SNK 742	57.79	17.35	14.05	80.94	11.22	7.31
SNK 744	68.24	18.26	15.09	82.62	11.94	5.58
SNK 745	63.53	17.01	13.53	79.82	10.89	5.24
SNK 748	61.67	17.52	13.79	78.48	11.07	2.45
SNK 750	64.92	15.66	11.55	73.78	9.63	5.65
SNK 782	55.22	19.11	15.59	81.62	12.30	10.69
SNK 806	53.90	19.87	17.78	89.40	12.47	10.72
SNK 809	60.43	17.46	14.72	84.28	11.55	9.65
SNK 813	58.50	20.17	17.59	87.10	12.12	10.76
SNK 814	59.48	18.21	14.71	80.70	11.75	9.41
SNK 817	55.85	18.43	14.41	78.36	11.71	8.61
SNK 819	62.73	17.21	13.12	76.19	10.77	10.57
SNK 822	60.50	18.17	16.52	90.85	11.59	10.94
SNK 827	62.75	19.27	16.48	85.25	11.20	10.46
Checks						
CoC 671	63.85	20.33	17.78	87.48	13.72	8.82
Co 86032	49.36	19.96	16.94	83.35	13.11	10.12
CoM 88121	61.66	19.96	17.22	86.21	13.36	7.98
CD (0.01)	11.00	1.68	2.26	9.61	1.53	1.39
CD (0.05)	8.27	1.26	1.70	7.22	1.15	1.05
CV (%)	6.86	3.38	5.44	4.33	4.91	7.11
S.Em±	2.91	0.44	0.60	2.54	0.40	0.37

JE - Juice extraction

Appendix XIII. Mean values for sugar yield parameters (at 300 and 330 DAP) of selected progenies evaluated under moisture stress environment at Sankeshwar

Progeny	At 300 DAP					At 330 DAP				
	Juice Extraction %	Brix %	Pol %	Purity %	CCS %	Juice Extraction %	Brix %	Pol %	Purity %	CCS %
SNK 024	66.25	13.92	9.28	66.46	5.42	55.88	16.97	12.49	71.37	7.81
SNK 041	70.57	14.46	10.18	70.58	6.18	62.14	19.01	14.96	78.74	9.73
SNK 082	66.83	17.40	10.76	61.65	5.88	56.87	19.87	15.32	77.08	9.85
SNK 085	65.14	16.06	11.78	77.48	7.61	62.29	18.66	14.73	79.04	9.61
SNK 088	64.73	16.49	10.82	64.97	6.23	67.92	19.57	14.30	73.05	8.89
SNK 094	63.81	16.23	9.81	60.69	5.28	64.29	19.17	13.95	72.79	8.63
SNK 099	52.88	14.05	7.34	52.53	3.38	50.50	18.37	16.56	90.15	11.57
SNK 109	62.80	17.41	12.98	74.87	8.18	58.86	20.36	16.72	82.15	11.14
SNK 128	71.97	14.80	11.69	78.80	7.63	59.69	18.56	13.93	75.07	8.82
SNK 250	50.50	16.78	16.37	97.33	11.92	44.55	17.90	14.79	82.90	9.90
SNK 264	65.49	14.86	10.81	72.76	6.71	54.41	16.62	12.20	73.67	7.66
SNK 287	58.74	16.35	9.60	58.79	5.10	57.75	19.92	18.26	91.64	12.45
SNK 357	61.09	17.16	14.66	85.42	9.97	52.53	18.76	15.36	81.95	11.75
SNK 388	53.66	17.85	11.09	61.87	6.11	65.89	21.42	17.56	81.93	11.37
SNK 432	57.57	12.66	9.01	71.47	5.51	59.99	15.57	11.02	70.82	6.72
SNK 452	70.25	16.62	13.71	82.52	9.15	50.36	18.96	14.84	78.30	9.63
SNK 459	38.78	15.93	11.93	75.41	7.58	49.99	19.06	14.94	78.41	9.71
SNK 474	43.82	17.33	11.67	68.65	6.87	48.33	18.61	13.86	74.32	8.73
SNK 500	66.60	17.09	10.57	61.97	5.89	60.67	20.97	14.65	70.06	8.91
SNK 511	62.81	14.18	10.06	71.02	6.14	57.62	17.56	13.83	78.77	9.01
SNK 519	67.78	16.01	11.36	70.91	6.94	51.42	18.81	14.97	79.62	9.80
SNK 533	47.36	15.10	10.51	69.91	6.33	50.88	19.16	16.14	84.20	10.90
SNK 543	61.57	13.54	8.73	64.19	4.97	54.65	18.01	14.63	81.23	9.69
SNK 550	53.53	17.09	10.82	63.71	6.12	63.75	20.07	14.37	71.58	8.79
SNK 562	62.64	15.52	8.60	55.56	4.24	53.32	17.90	16.05	89.70	11.17
SNK 584	55.00	15.48	10.07	65.39	5.77	58.33	19.16	15.42	80.51	10.16
SNK 596	71.98	15.78	11.41	72.35	7.05	57.43	19.46	16.07	82.59	10.74
SNK 604	67.18	15.61	11.45	73.90	7.15	57.41	19.16	14.84	77.49	9.57
SNK 617	65.94	12.41	8.57	69.35	5.13	54.95	17.69	13.09	73.99	8.21
SNK 624	71.28	12.18	7.10	58.58	3.70	60.66	17.68	13.65	77.32	8.78
SNK 632	66.83	15.36	8.89	57.96	4.61	68.98	18.92	18.60	98.31	12.49
SNK 635	85.76	16.32	10.20	62.78	5.72	68.76	19.87	15.97	80.35	10.53

SNK 645	66.50	17.72	11.28	63.86	6.41	54.96	19.87	16.02	80.38	10.61
SNK 673	68.74	13.69	9.62	68.88	5.83	60.81	17.43	13.22	75.92	8.42
SNK 699	63.53	13.10	7.95	60.59	4.29	61.38	16.98	12.69	74.69	8.01
SNK 707	56.72	19.52	11.70	59.99	6.27	56.77	22.52	18.07	80.20	11.90
SNK 742	64.25	14.38	10.62	67.21	5.63	54.59	17.24	13.40	77.78	8.66
SNK 744	57.77	14.60	8.70	59.44	4.63	57.94	18.37	14.11	76.71	9.05
SNK 745	56.51	14.49	9.28	64.72	5.26	53.54	16.85	14.28	84.82	9.67
SNK 748	68.21	14.59	9.67	66.57	5.63	59.02	19.02	12.36	65.32	7.08
SNK 750	72.80	12.16	6.41	52.97	3.00	62.03	16.18	13.03	80.33	8.59
SNK 782	58.88	16.48	11.00	66.26	6.43	62.14	19.66	14.88	75.71	9.47
SNK 806	66.83	19.01	11.69	61.77	6.43	57.57	21.29	17.77	85.53	11.97
SNK 809	60.83	14.93	9.86	68.38	5.86	61.29	18.06	13.98	77.39	9.01
SNK 813	66.83	16.40	8.85	53.99	4.26	66.28	19.98	15.32	76.65	9.85
SNK 814	64.02	15.46	9.89	64.52	5.59	57.79	18.12	14.32	79.08	9.35
SNK 817	69.69	15.14	10.24	67.11	6.05	56.92	18.36	13.68	74.55	8.62
SNK 819	71.19	13.65	8.26	59.59	4.46	64.74	17.11	14.70	85.98	10.03
SNK 822	63.76	15.80	8.48	53.65	3.98	64.64	18.53	16.79	90.60	11.78
SNK 827	64.64	13.60	7.32	54.50	3.55	56.80	20.18	17.69	87.67	12.18
Checks										
CoC 671	65.08	17.54	10.65	60.71	5.79	63.14	20.29	6.37	87.97	10.80
Co 86032	65.93	17.92	10.88	60.73	5.89	58.30	19.37	16.57	85.51	11.28
CoM 88121	61.59	17.72	11.10	62.78	6.17	59.51	20.04	15.70	78.53	10.19
CD (0.01)	16.98	2.06	3.95	NS	3.89	11.34	1.42	2.47	13.87	2.58
CD (0.05)	12.76	1.55	2.97	19.25	2.92	8.52	1.06	1.86	10.42	1.94
CV (%)	10.08	4.97	14.40	14.55	19.20	7.29	2.83	6.21	6.53	9.88
S.Em±	4.50	0.54	1.04	6.79	1.03	3.00	0.37	0.65	3.68	0.68

Appendix XIV. Mean values for physiological parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Progeny	Tiller Mortality at 90 DAP	Tiller Mortality at 120 DAP	I Leaf Area	Int. formed shoots at		No.of roots / clump 150 DAP	Root Dry. Wt (g) / clump at 150 DAP	Av. Root. Length at 150 DAP
				120 DAP	160 DAP			
SNK 024	2.51	18.21	4.88	53.37	70.95	118.00	2.34	17.85
SNK 041	0.52	5.47	3.56	44.42	80.82	127.50	2.19	18.35
SNK 082	3.12	14.15	2.17	3.70	42.57	99.00	1.26	18.55
SNK 085	2.35	3.43	2.67	16.96	45.96	87.00	1.50	17.38
SNK 088	4.15	9.19	1.04	12.34	48.43	69.00	1.39	16.12
SNK 094	4.05	10.88	1.35	1.54	35.78	172.00	4.44	23.65
SNK 099	11.15	12.35	1.28	11.10	49.97	64.00	1.49	13.80
SNK 109	12.52	3.85	2.96	4.93	37.63	61.00	1.44	13.50
SNK 128	2.75	4.29	2.90	6.78	56.45	118.00	2.94	22.43
SNK 250	1.78	12.69	1.09	0.00	51.21	106.00	1.26	19.62
SNK 264	4.52	6.39	2.86	11.10	51.21	70.00	1.39	11.50
SNK 287	15.00	5.82	2.47	4.31	58.30	72.00	1.34	11.80
SNK 357	1.77	5.15	2.86	17.27	58.61	90.00	1.66	15.80
SNK 388	6.22	3.28	1.44	0.30	65.40	103.50	1.08	18.76
SNK 432	2.05	2.82	5.07	24.37	70.95	135.00	4.08	24.80
SNK 452	11.43	2.43	1.49	13.57	71.26	83.00	1.70	16.31
SNK 459	5.71	4.08	2.70	9.25	64.16	158.00	2.94	18.75
SNK 474	7.63	5.38	1.57	42.57	76.81	78.00	1.82	17.21
SNK 500	5.66	9.05	0.58	7.71	69.72	67.00	1.66	12.91
SNK 511	5.14	7.66	1.85	5.55	48.12	142.50	3.18	19.85
SNK 519	5.61	2.54	1.71	23.44	90.39	70.00	2.17	16.22
SNK 533	4.72	5.10	1.53	10.18	72.18	133.00	3.90	24.80
SNK 543	6.90	3.47	2.58	15.11	66.32	174.00	2.04	20.20
SNK 550	1.63	5.87	1.79	3.70	40.72	70.00	0.74	11.31
SNK 562	3.03	3.50	2.40	3.39	75.27	64.00	0.77	12.01
SNK 584	9.84	7.44	3.20	0.00	44.73	58.00	0.78	10.83
SNK 596	14.73	8.14	1.84	6.17	46.89	69.00	1.00	13.62
SNK 604	5.21	6.05	1.37	7.09	49.66	73.00	1.12	16.21
SNK 617	4.58	3.13	1.68	13.26	55.83	70.00	1.18	17.31
SNK 624	22.15	11.27	1.48	0.00	26.53	40.50	0.45	22.81
SNK 632	1.56	22.89	1.26	48.43	67.87	177.00	3.18	21.53
SNK 635	8.21	5.94	1.05	9.56	52.75	92.00	1.34	19.21
SNK 645	3.09	5.38	1.23	0.00	54.60	60.00	0.97	10.24
SNK 673	8.29	8.93	2.07	17.27	56.76	67.00	1.02	18.60
SNK 699	7.32	6.48	1.34	11.41	70.64	126.50	2.04	20.15
SNK 707	3.19	8.30	1.03	4.93	65.71	108.00	1.69	22.84
SNK 742	4.15	4.53	1.42	10.79	61.70	68.00	1.56	16.32
SNK 744	5.53	4.73	2.34	4.62	43.19	52.00	1.32	11.81
SNK 745	7.93	4.60	2.49	3.39	34.55	91.00	1.80	22.90

SNK 748	8.29	3.63	1.59	0.00	30.23	49.00	0.98	11.91
SNK 750	4.79	5.15	2.80	4.93	43.49	63.00	1.45	14.92
SNK 782	8.62	2.12	1.40	15.42	76.50	59.00	1.62	19.51
SNK 806	3.51	11.11	1.13	19.12	49.66	63.00	1.90	20.10
SNK 809	6.79	6.77	1.66	21.28	62.31	109.00	2.88	26.25
SNK 813	2.19	7.25	1.53	8.63	78.35	65.00	2.40	27.10
SNK 814	0.95	4.67	1.77	22.21	79.90	112.00	2.94	22.80
SNK 817	5.85	3.18	2.40	13.26	84.83	91.00	2.88	15.09
SNK 819	1.08	12.42	2.31	33.00	58.30	129.00	2.10	17.77
SNK 822	1.48	12.18	1.70	33.93	82.06	101.00	2.57	23.10
SNK 827	1.87	10.81	1.89	28.38	80.82	108.00	2.44	24.20
Checks								
CoC 671	2.38	4.64	3.32	25.60	52.44	98.00	1.20	20.15
Co 86032	8.28	7.57	2.01	17.27	66.01	115.00	1.38	19.50
CoM 88121	2.85	2.87	1.15	3.70	70.95	64.50	0.78	17.28
CD (0.01)	8.50	9.73	NS	14.42	18.55	29.17	1.35	6.57
CD (0.05)	6.39	7.31	NS	10.84	13.93	21.55	1.00	4.85
CV (%)	20.00	20.00	19.87	18.93	11.72	9.16	19.54	11.69
S.Em±	2.25	2.57	0.75	3.82	4.91	7.40	0.34	1.66

Appendix XV. Mean values for physiological parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Progeny	Av. Long Root Length.	Area 8th Leaf area 150 DAP	L. sheath Moisture% at 150 DAP	L. lamina Moisture% at 150 DAP	RWC % at 150 DAP	LAI at 150 DAP	MTA at 150 DAP
SNK 024	27.50	290.91	29.91	40.40	61.59	3.09	43.00
SNK 041	27.70	273.48	34.33	41.87	58.11	3.60	41.50
SNK 082	22.37	202.78	25.35	56.43	32.59	2.09	42.00
SNK 085	23.66	259.89	43.94	51.05	46.23	2.35	48.00
SNK 088	21.00	240.21	37.21	41.40	42.3	2.25	42.00
SNK 094	33.74	330.46	34.58	39.92	69.71	2.36	44.00
SNK 099	23.61	230.24	45.21	42.31	46.2	2.55	43.00
SNK 109	22.52	240.21	41.25	39.28	51.2	2.09	46.50
SNK 128	32.87	317.28	38.04	46.45	54.87	3.60	41.00
SNK 250	26.54	247.31	39.66	36.73	69.29	2.86	54.50
SNK 264	23.93	256.29	40.12	41.20	52.12	2.50	44.50
SNK 287	21.52	252.23	38.19	48.10	54.12	2.38	46.50
SNK 357	25.21	292.91	48.12	38.20	54.15	2.35	50.50
SNK 388	23.37	206.64	41.51	48.45	51.77	2.86	52.00
SNK 432	30.01	288.16	41.79	46.65	48.13	3.52	44.50
SNK 452	24.92	262.12	38.12	37.12	46.12	2.88	43.50
SNK 459	26.80	234.12	44.61	49.60	46.12	2.56	46.00
SNK 474	27.23	245.21	42.31	38.12	52.51	2.52	47.00
SNK 500	24.24	240.40	33.00	42.09	62.11	2.76	43.50
SNK 511	28.08	191.37	33.04	43.95	52.57	2.40	43.00
SNK 519	22.12	204.86	37.61	53.80	43.82	3.46	46.50
SNK 533	32.54	228.73	42.60	55.91	41.00	2.67	44.00
SNK 543	28.21	239.77	37.32	46.85	44.37	3.07	45.50
SNK 550	20.11	198.24	39.12	31.51	60.12	2.02	47.00
SNK 562	19.02	196.92	38.42	41.32	60.5	2.13	42.00
SNK 584	21.24	180.74	41.29	49.92	48.46	3.08	41.50
SNK 596	24.22	173.41	40.12	46.21	41.5	2.68	45.50
SNK 604	25.11	199.20	43.12	48.25	39.95	2.43	53.50
SNK 617	26.23	210.21	44.25	46.12	43.12	3.05	43.00
SNK 624	26.12	183.35	35.98	47.98	48.01	2.23	46.50
SNK 632	35.67	276.11	46.73	41.65	64.20	4.95	50.00
SNK 635	28.10	252.12	46.42	43.12	61.2	3.65	43.12
SNK 645	20.80	208.26	35.12	41.25	45.1	2.08	44.21
SNK 673	27.75	209.29	42.00	46.21	53.41	2.86	45.00
SNK 699	33.14	211.21	38.12	38.28	50.12	2.86	41.50
SNK 707	34.24	290.24	46.24	39.92	52.32	3.85	43.12
SNK 742	25.21	255.38	40.03	49.42	47.27	2.33	42.50
SNK 744	20.24	230.25	32.35	42.52	46.12	2.32	42.50
SNK 745	28.43	232.31	33.12	46.12	43.12	2.39	43.00
SNK 748	20.21	181.25	34.15	43.12	60.12	2.77	43.50

SNK 750	26.31	217.19	38.52	49.26	48.73	2.14	42.00
SNK 782	32.21	292.15	39.42	43.12	50.22	2.84	41.50
SNK 806	33.43	293.21	43.82	42.51	60.12	3.45	44.25
SNK 809	34.00	268.50	36.99	50.69	47.29	2.94	49.50
SNK 813	34.22	278.92	44.25	41.55	48.12	3.68	40.15
SNK 814	28.45	303.01	38.20	51.08	43.93	4.06	43.50
SNK 817	24.66	285.62	43.12	41.25	43.12	3.40	50.00
SNK 819	24.07	379.91	34.00	49.02	48.10	3.27	44.50
SNK 822	33.80	301.54	44.92	48.12	47.12	3.85	42.24
SNK 827	29.80	291.89	44.14	43.12	43.12	8.75	44.48
Checks							
CoC 671	27.79	326.80	40.80	48.30	55.38	3.16	47.00
Co 86032	26.85	242.47	40.84	54.68	43.27	2.21	56.50
CoM 88121	16.50	207.58	46.57	48.73	57.65	3.94	57.00
CD (0.01)	4.60	82.14	1.04	1.17	4.41	1.02	NS
CD (0.05)	3.40	60.82	0.77	0.86	3.27	0.76	8.42
CV (%)	5.99	11.87	0.99	0.88	3.14	13.16	9.09
S.Em±	1.16	20.96	0.26	0.29	1.12	0.26	2.94

Progeny	Under moisture stress						After alleviation from stress					
	Rate of photosynthesis	Stomatal conductance	Transpiration rate	Leaf temperature (°C)	WUE %	LUE %	Rate of photosynthesis	Stomatal conductance	Transpiration rate	Leaf temperature (°C)	WUE %	LUE %
SNK 024	51.32	0.17	6.71	37.93	0.76	3.42	54.08	0.15	3.47	31.70	1.57	3.60
SNK 094	49.93	0.10	5.61	40.24	0.89	3.33	62.88	0.17	5.09	33.43	1.23	4.19
SNK 128	61.16	0.21	7.75	37.60	0.80	4.08	50.74	0.15	3.89	32.20	1.30	3.38
SNK 388	48.33	0.11	6.41	40.61	0.76	3.22	50.49	0.09	2.65	33.50	1.90	3.36
SNK 432	56.72	0.15	6.62	38.14	0.88	3.78	41.83	0.14	3.60	32.73	1.16	2.79
SNK 459	46.92	0.10	4.67	39.17	1.00	3.12	49.39	0.17	4.26	32.63	1.16	3.29
SNK 500	49.06	0.11	6.08	39.04	0.88	3.27	53.41	0.08	2.55	34.10	2.09	3.56
SNK 511	53.04	0.14	6.34	39.73	0.83	3.53	55.65	0.18	4.30	32.75	1.30	3.71
SNK 543	54.86	0.28	7.10	38.89	0.78	3.66	60.67	0.16	3.72	33.86	1.63	4.04
SNK 584	58.66	0.18	7.75	39.20	0.75	3.91	56.25	0.16	4.15	32.80	1.37	3.75
SNK 624	62.37	0.21	9.19	39.11	0.69	4.15	59.33	0.14	3.83	34.33	1.55	3.95
SNK 632	59.51	0.18	8.49	39.13	0.73	3.96	58.46	0.13	4.42	33.58	1.33	3.89
SNK 673	56.81	0.17	7.80	39.10	0.73	3.79	56.71	0.13	3.73	33.45	1.52	3.78
SNK 707	54.51	0.16	7.31	39.12	0.74	3.63	59.81	0.17	4.31	31.01	1.38	3.98
SNK 742	55.41	0.16	7.68	39.62	0.72	3.69	56.10	0.13	2.82	33.88	1.99	3.73
SNK 750	55.83	0.17	7.86	39.50	0.72	3.72	61.71	0.16	3.50	33.10	1.76	4.44
SNK 782	53.12	0.15	7.12	39.41	0.75	3.54	60.28	0.14	4.26	33.11	1.41	4.01
SNK 806	54.31	0.17	7.31	36.81	0.74	3.62	58.91	0.17	4.24	34.12	1.38	3.92
SNK 809	55.45	0.16	7.95	39.68	0.70	3.69	57.71	0.14	3.82	33.46	1.51	3.87
SNK 813	52.6	0.12	6.91	41.51	0.76	3.50	58.51	0.16	4.21	33.51	1.38	3.90

SNK 814	62.14	0.21	9.06	38.82	0.69	4.14	57.54	0.15	4.15	33.75	1.39	3.83
SNK 819	50.71	0.13	7.22	40.31	0.70	3.38	62.00	0.13	3.64	33.66	1.70	4.13
SNK 822	55.41	0.14	8.11	40.21	0.62	3.69	59.42	0.15	3.51	33.15	1.69	3.96
SNK 827	51.51	0.14	7.45	39.55	0.69	3.43	54.32	0.16	4.11	32.17	1.32	3.62
Checks												
CoC 671	63.51	0.22	8.57	37.61	0.75	4.23	59.64	0.13	3.47	32.20	1.71	3.97
Co 86032	49.92	0.11	6.37	40.91	0.78	3.32	52.83	0.13	3.50	33.29	1.53	3.52
CoM 88121	56.76	0.15	6.98	38.87	0.84	3.78	52.54	0.12	2.75	33.33	1.90	3.50
Co 740	54.80	0.17	6.82	38.28	0.80	3.65	55.82	0.14	3.28	32.23	1.73	3.72
CD (0.01)	13.86	NS	NS	NS	NS	0.92	6.83	NS	0.54	1.06	0.33	0.44
CD (0.05)	10.26	0.09	2.35	NS	NS	0.68	5.13	0.04	0.40	0.79	0.24	0.33
CV (%)	9.07	19.40	15.86	3.82	10.79	9.08	5.69	19.56	6.90	1.47	9.55	5.49
S.Em±	3.53	0.03	0.81	1.05	0.06	0.23	1.81	0.01	0.14	0.28	0.08	0.11

WUE - Water use
efficiency
(Physiological),
LUE - Light use
efficiency

Appendix XVI. Mean values for biophysical parameters of selected progenies evaluated under moisture stress environment at Sankeshwar

Appendix XVII. Mean values for germination, growth, cane and sugar yield parameters of selected progenies evaluated under salinity water logg complex environment at Gangavati

Prognies	Germ. % at 30 DAP	Germ. % at 45 DAP	Healthy Shoot Count at 70 DAP	Healthy Shoot Count at 160 DAP	No. of internode formed shoots at 160 DAP	NMC / Plot	Av. Single Cane wt. (kg)	Juice Extraction %	Brix %	Pol %	Purity %	CCS %	CCS Yield (t / ha)	Cane Yield (t / ha)
SNK 024	49.92	61.36	18.00	25.50	24.50	23.50	0.96	51.85	19.20	15.50	80.73	10.23	6.38	62.33
SNK 068	44.72	54.08	28.00	24.00	23.50	21.50	1.07	49.30	18.95	16.30	86.02	11.13	7.09	63.71
SNK 139	59.28	71.76	41.50	36.00	33.50	31.50	0.88	54.45	19.10	16.70	87.43	11.49	8.75	76.18
SNK 159	65.52	74.88	47.00	36.50	33.00	30.50	0.93	56.15	19.20	16.85	87.76	11.61	9.01	77.56
SNK 299	52.00	63.44	26.50	26.50	23.50	23.00	1.01	60.35	18.65	16.15	86.60	11.06	7.05	63.71
SNK 493	49.92	59.28	33.00	33.50	29.50	27.00	0.96	52.70	19.00	16.55	87.11	11.37	8.19	72.02
SNK 423	55.12	66.56	36.50	30.50	29.00	27.50	0.91	60.85	19.60	16.70	85.20	11.34	7.86	69.25
SNK 664	56.16	70.72	40.00	34.00	32.50	31.00	0.92	55.85	19.15	16.85	87.99	11.63	9.18	78.95
SNK 790	48.88	62.40	42.00	26.00	24.00	23.50	1.00	59.95	18.85	16.35	86.74	11.21	7.29	65.10
SNK 814	56.16	61.36	40.50	47.00	43.00	30.50	0.89	55.65	18.40	16.55	89.95	11.54	8.63	74.79
SNK 074	41.60	48.88	12.50	13.50	12.00	12.00	0.96	59.70	18.30	15.70	85.79	10.70	3.41	31.86
SNK 210	36.40	41.60	24.50	26.50	17.50	15.50	0.97	51.60	19.35	17.10	88.37	11.83	4.91	41.55
SNK 155	13.52	23.92	12.50	17.00	13.50	13.50	0.85	47.35	16.55	14.50	87.61	9.99	3.04	30.47
SNK 085	26.00	37.44	19.50	17.00	16.00	15.50	0.84	48.65	18.20	15.85	87.09	10.88	3.92	36.01
SNK 086	34.32	47.84	17.00	21.50	18.50	17.00	0.91	52.00	18.50	16.10	87.03	11.05	4.75	42.94
SNK 121	50.96	46.80	39.00	17.50	15.50	15.00	0.94	56.45	17.70	15.35	86.72	10.52	4.08	38.78
SNK 082	39.52	46.80	14.00	23.50	19.00	17.50	0.94	48.65	18.70	15.05	80.48	9.92	4.53	45.71
SNK 081	26.00	35.36	36.50	25.00	17.50	15.54	0.77	48.65	18.20	16.05	88.19	11.09	3.69	33.24
SNK 319	32.24	41.60	32.50	27.50	23.50	20.00	0.88	54.50	17.40	15.15	87.07	10.40	5.04	48.48
SNK 320	31.20	32.24	30.50	24.00	16.50	15.50	0.97	52.65	17.00	15.10	88.82	10.47	4.35	41.55
SNK 511	38.48	40.56	28.00	24.00	17.50	15.50	0.90	51.50	18.20	15.65	85.99	10.68	4.14	38.78
SNK 066	23.92	29.12	27.50	19.50	16.00	15.00	0.94	51.75	17.60	14.80	84.09	9.99	3.87	38.78

SNK 052	45.76	53.04	47.00	39.00	23.20	21.00	0.86	49.00	17.35	14.45	83.29	9.70	4.84	49.86
SNK 084	34.32	42.64	55.00	35.50	19.50	17.00	0.91	47.45	18.80	15.55	82.71	10.40	4.47	42.94
SNK 154	21.84	29.12	44.50	31.50	18.50	16.50	0.92	52.15	18.35	15.80	86.10	10.79	4.48	41.55
SNK 714	35.36	39.52	38.00	35.00	24.50	20.50	0.88	55.95	17.85	15.55	87.11	10.68	5.32	49.86
SNK 447	28.08	27.04	17.00	13.50	13.00	12.50	1.00	59.75	15.30	11.20	73.20	6.98	2.42	34.63
SNK 509	32.24	41.60	14.00	14.00	12.50	12.00	0.92	61.70	18.50	14.10	76.22	9.01	2.74	30.47
SNK 235	23.92	41.60	12.50	11.50	11.50	11.50	0.92	60.40	18.35	15.95	86.92	10.94	3.18	29.09
SNK 791	21.84	28.08	13.00	11.00	11.00	11.00	0.91	49.70	17.85	13.65	76.47	8.74	2.42	27.70
SNK 372	32.24	39.52	29.50	29.00	20.50	19.00	0.90	50.65	17.40	15.00	86.21	10.25	4.83	47.09
Checks														
CoC 671	47.84	52	52.5	16.5	24	21	0.88	53.95	19.5	17.30	88.72	11.99	6.14	51.25
Co 7508	56.16	61.36	55	31	22.5	21	0.93	59.3	19.4	17.20	88.89	11.93	6.44	54.02
CoM 88121	57.2	63.44	63	33.5	26	23.5	0.745	56.85	18.8	16.75	89.10	11.63	5.64	48.48
CD @ 5%	5.74	6.59	12.83	8.48	4.80	3.51	0.13	2.18	NS	0.85	4.80	0.72	1.36	9.61
CD @ 1%	7.71	8.85	17.22	11.38	6.45	4.71	NS	2.93	NS	1.15	6.44	0.97	1.80	12.88
SEm±	2.00	2.29	4.46	2.95	1.67	1.22	0.05	0.76	1.63	0.30	1.67	0.25	0.47	3.35
CV %	7.02	6.74	19.37	16.18	11.07	8.84	7.14	1.99	12.79	2.52	2.59	3.01	11.25	9.57

Appendix XVIII: Mean values for germination, growth and cane yield parameters of selected progenies evaluated under normal irrigated environment at Hosur

Progenies	Germination % at 45 DAP	Tillers / plot at 90 DAP	Average single cane wt. (kg)	Average millable Cane height (cm)	Average Cane girth (cm)	Average No. of internodes	NMC / plot	Cane yield (t / ha)
SNK 024	64.37	355.50	1.51	256.25	2.85	25.00	164.50	114.58
SNK 030	67.84	306.50	0.91	227.75	2.75	22.00	137.00	57.29
SNK 052	68.71	310.00	0.95	230.00	2.60	21.50	171.00	74.38
SNK 081	55.52	298.00	1.41	259.50	2.60	24.00	125.50	81.54
SNK 082	55.87	327.00	1.28	190.00	2.90	18.50	124.50	73.23
SNK 083	56.73	312.00	0.79	208.25	2.30	20.00	232.50	84.32
SNK 084	47.02	276.00	1.50	247.65	3.00	20.50	83.00	57.29
SNK 085	43.38	278.50	1.15	214.75	2.70	26.50	156.00	82.70
SNK 086	44.42	283.50	0.44	167.00	1.95	15.00	354.50	70.92
SNK 094	27.24	250.00	1.11	219.75	2.85	18.50	160.00	81.08
SNK 099	72.70	350.50	0.95	188.50	2.75	17.50	193.50	84.78
SNK 100	56.39	330.00	1.06	181.50	2.50	21.50	162.50	79.23
SNK 131	73.39	326.50	1.40	213.75	3.30	20.00	124.50	78.54
SNK 161	37.65	312.00	1.19	203.50	3.15	17.00	114.00	62.60
SNK 192	44.42	284.00	1.29	233.25	2.75	21.50	181.00	107.65
SNK 253	34.70	293.50	0.78	190.00	2.65	15.50	151.00	54.05
SNK 269	47.54	341.50	0.96	206.00	2.05	17.50	161.00	71.38
SNK 304	32.62	269.00	1.18	197.50	2.75	14.50	109.50	59.60
SNK 349	74.95	333.00	1.32	271.75	2.75	26.50	206.50	124.97
SNK 350	52.22	376.50	1.29	268.75	2.40	29.00	122.50	72.77
SNK 357	41.99	313.50	1.17	231.00	2.85	24.50	164.50	88.94
SNK 363	56.73	331.50	1.31	252.00	2.90	21.50	216.00	121.97
SNK 380	56.39	322.50	0.86	230.50	2.40	19.50	236.00	93.32
SNK 393	50.84	306.00	1.62	221.50	3.00	20.00	131.50	94.71
SNK 421	62.98	314.50	0.88	203.00	2.65	15.00	218.50	88.94
SNK 432	68.36	335.00	1.89	296.50	2.95	30.50	163.00	142.30
SNK 436	56.91	378.00	1.29	292.50	2.65	24.50	136.00	80.85
SNK 442	24.81	217.00	1.00	197.50	2.55	12.50	166.50	76.69
SNK 452	43.20	229.50	1.27	232.50	2.45	14.50	135.00	79.23
SNK 490	61.77	360.00	1.48	317.00	3.05	28.50	197.00	133.75
SNK 493	79.46	378.00	1.69	271.00	3.00	23.50	203.00	118.27
SNK 510	25.85	326.00	1.48	238.50	2.95	21.50	96.50	63.53
SNK 579	64.20	354.50	1.44	261.00	2.70	30.50	147.00	97.94
SNK 580	44.24	237.50	0.99	225.00	2.35	16.50	144.00	88.70
SNK 617	59.16	300.50	0.76	214.50	2.65	23.00	185.00	64.22
SNK 624	53.61	363.50	1.25	212.00	2.95	24.50	130.50	74.84
SNK 625	37.30	281.50	1.77	314.50	2.85	26.50	90.00	73.46
SNK 627	45.11	286.50	1.20	250.00	2.75	21.50	255.50	141.14
SNK 632	58.99	357.00	2.07	275.50	3.90	23.00	127.50	120.35
SNK 635	82.24	396.00	1.29	250.50	3.05	25.50	219.00	123.59

SNK 661	77.03	295.50	0.87	247.50	2.85	22.50	165.50	88.94
SNK 689	25.33	308.00	1.14	225.00	2.75	22.50	110.50	58.21
SNK 724	51.36	257.50	0.96	217.50	2.35	17.50	144.00	63.99
SNK 729	60.55	300.50	1.17	221.50	2.25	17.00	122.50	65.84
SNK 771	47.54	283.50	1.29	220.50	3.05	21.00	147.00	87.55
SNK 773	52.22	325.50	1.17	207.50	2.60	15.50	114.00	60.98
SNK 782	67.15	284.50	1.38	250.00	2.85	25.50	138.50	88.24
SNK 786	19.61	198.50	0.76	187.50	2.35	22.50	220.00	76.46
SNK 787	70.96	323.00	1.11	260.00	2.35	24.00	179.00	92.63
SNK 814	57.60	310.50	1.40	248.50	2.65	20.50	205.50	131.44
SNK 817	66.97	364.50	1.40	212.00	2.75	23.50	187.00	120.35
SNK 825	58.47	351.50	1.22	283.50	2.75	29.50	257.00	142.99
SNK 827	73.22	382.00	1.83	244.50	3.25	22.50	147.00	124.28
Checks								
C1 CoC671	57.60	247.00	1.51	223.00	2.95	20.50	127.50	87.55
C2 Co86032	64.54	417.00	1.38	225.50	2.85	23.50	134.50	84.32
C3 CoM88121	63.33	293.00	1.37	241.50	2.95	23.00	123.00	77.39
C4 Co740	75.13	413.00	1.11	224.50	2.55	21.50	147.50	73.92
C5 Co88028	61.59	278.00	1.26	239.00	3.10	23.00	142.00	81.77
CD @ 5%	23.66	78.51	0.32	45.02	0.30	4.39	56.34	22.12
CD @ 1%	31.47	104.45	0.42	59.89	0.40	5.84	74.96	29.43
S Em±	8.36	27.76	0.11	15.92	0.11	1.55	19.92	7.82
CV %	21.56	12.49	12.84	9.64	5.40	10.14	17.37	12.46

Appendix XIX: Mean values for sugar yield parameters (at 330 and 360 DAP) of selected progenies evaluated under normal irrigated environment at Hosur

Progenies	At 330 DAP					At 360 DAP				
	Juice Extraction %	Brix %	Pol %	Purity %	CCS %	Juice Extraction %	Brix %	Pol %	Purity %	CCS %
SNK 024	52.88	15.06	12.43	82.55	8.30	52.95	16.31	12.14	74.46	7.64
SNK 030	54.39	16.15	13.50	83.62	9.09	54.00	16.27	13.26	81.54	8.80
SNK 052	59.42	15.45	12.64	81.81	8.40	60.60	18.31	14.33	78.29	9.30
SNK 081	50.25	16.60	13.80	83.11	9.26	49.30	17.35	14.29	82.28	9.54
SNK 082	54.24	16.31	13.22	81.09	8.75	54.65	19.29	16.80	87.12	11.54
SNK 083	51.89	16.31	12.12	74.30	7.62	52.95	18.59	15.56	83.70	10.47
SNK 084	59.20	12.60	10.55	83.77	7.11	51.70	16.46	12.39	75.27	7.86
SNK 085	58.14	16.40	13.68	84.91	9.19	52.59	14.82	11.73	79.09	7.67
SNK 086	64.01	13.35	10.83	81.09	7.17	53.40	16.00	13.15	82.38	8.77
SNK 094	52.92	10.77	7.69	71.31	4.71	54.47	16.05	11.96	74.64	7.54
SNK 099	59.99	12.07	9.95	82.45	6.65	58.60	14.87	12.50	84.20	8.43
SNK 100	47.92	16.22	13.46	83.01	9.02	52.13	16.12	13.69	84.90	9.28
SNK 131	55.35	15.63	11.98	76.41	7.68	54.10	14.12	10.50	73.37	6.61
SNK 161	52.11	14.83	11.20	75.55	7.12	53.70	16.35	13.50	82.57	9.02
SNK 192	44.50	18.82	15.59	82.86	10.44	51.40	21.42	18.16	84.77	12.31
SNK 253	37.48	15.39	11.65	75.72	7.51	41.00	17.20	12.85	74.75	8.11
SNK 269	38.75	15.84	11.58	73.08	7.21	41.35	18.26	15.70	85.99	10.72
SNK 304	33.94	11.27	7.78	69.00	4.66	37.00	16.90	13.60	80.54	8.97
SNK 349	45.94	15.62	11.28	71.82	6.97	51.99	18.56	15.54	83.37	10.47
SNK 350	46.84	14.05	10.44	74.31	6.57	51.30	13.75	9.22	67.05	5.41
SNK 357	54.46	13.93	10.43	75.01	6.59	68.35	17.77	15.40	86.65	10.55
SNK 363	51.38	16.00	12.96	81.50	8.57	59.38	19.22	15.27	78.78	9.99
SNK 380	60.20	13.05	10.77	82.51	7.19	59.60	15.28	11.06	72.36	6.84
SNK 393	42.99	15.57	11.98	76.69	7.70	45.55	14.91	10.74	72.23	6.62
SNK 421	49.26	13.29	9.13	67.90	5.45	51.90	17.65	13.25	75.08	8.39
SNK 432	47.16	16.44	13.03	79.15	8.51	50.70	17.82	14.47	81.82	9.58
SNK 436	46.10	16.72	13.69	81.88	9.11	49.85	18.40	15.85	86.15	10.83
SNK 442	41.46	12.70	9.65	76.02	6.16	45.85	16.85	13.85	82.20	9.24
SNK 452	31.77	12.83	9.38	73.08	5.84	39.70	16.45	13.65	82.98	9.15
SNK 490	51.38	16.24	11.13	68.28	6.63	51.20	18.81	13.22	78.64	8.60
SNK 493	43.97	17.05	13.24	77.87	8.55	52.74	19.26	17.08	88.67	11.83
SNK 510	45.62	12.70	9.35	72.81	5.85	50.75	16.32	13.82	84.75	9.36
SNK 579	58.32	16.95	12.55	74.05	7.88	58.19	18.31	15.10	82.45	10.09
SNK 580	51.75	15.90	12.85	80.86	8.49	53.80	18.40	15.65	85.07	10.62
SNK 617	47.31	12.05	9.60	79.68	6.29	45.60	15.25	11.60	76.05	7.40
SNK 624	55.03	15.99	11.74	73.41	7.33	55.98	19.11	15.45	80.85	10.21
SNK 625	53.40	16.10	12.25	76.11	7.82	47.45	20.21	18.03	89.32	12.53
SNK 627	46.18	15.64	12.92	82.87	8.64	55.60	15.81	12.65	79.71	8.31
SNK 632	60.44	15.04	11.54	71.87	7.11	58.45	18.91	15.17	80.38	9.98
SNK 635	52.80	13.59	10.12	74.27	6.38	58.15	18.71	16.49	88.12	11.39
SNK 661	50.60	18.91	16.50	87.25	11.34	52.50	19.70	15.90	80.72	10.50

SNK 689	49.15	10.86	8.54	78.16	5.55	45.33	17.46	17.72	101.98	13.01
SNK 724	50.10	12.85	9.87	76.88	6.34	52.85	17.10	13.80	80.73	9.11
SNK 729	53.25	13.00	10.35	79.72	6.79	52.85	16.65	13.40	80.48	8.83
SNK 771	53.42	15.66	10.76	68.67	6.42	54.98	17.29	13.58	78.55	8.83
SNK 773	63.65	15.10	11.14	73.78	6.98	60.35	17.55	14.00	79.77	9.19
SNK 782	45.90	17.12	12.88	74.89	8.17	54.57	17.75	13.83	77.95	8.96
SNK 786	42.02	16.05	10.75	66.95	6.30	46.00	17.05	14.15	83.01	9.48
SNK 787	49.64	16.23	11.98	73.27	7.51	52.95	19.86	17.73	89.31	12.32
SNK 814	45.00	13.72	9.98	73.51	6.19	53.84	18.45	15.31	82.33	10.26
SNK 817	50.24	15.94	12.15	76.08	7.76	58.12	20.19	17.08	84.65	11.56
SNK 825	57.04	14.64	11.10	75.82	7.07	61.60	20.01	17.08	85.33	11.61
SNK 827	46.93	14.91	10.65	70.02	6.53	51.35	16.71	13.60	81.03	9.02
Checks										
C1 CoC671	44.44	16.44	11.63	67.66	7.08	59.40	18.57	16.17	87.05	11.11
C2 Co86032	51.17	14.36	10.72	75.82	6.77	62.73	16.61	13.96	83.96	9.42
C3 CoM88121	61.73	18.46	14.88	80.33	9.81	55.88	20.41	16.47	80.84	10.87
C4 Co740	59.10	16.05	10.14	63.14	5.68	51.27	16.40	14.20	86.88	9.72
C5 Co88028	57.26	11.65	9.76	74.97	5.55	57.05	14.75	11.10	75.22	7.04
CD @ 5%	8.73	2.79	2.83	11.09	2.29	11.11	2.53	2.92	10.94	2.50
CD @ 1%	11.61	3.71	3.76	14.76	3.04	14.78	3.36	3.89	14.56	3.32
S Em±	3.09	0.99	1.00	3.92	0.81	3.93	0.89	1.03	3.87	0.88
CV %	8.60	3.90	12.28	7.25	15.52	10.49	7.25	10.23	6.70	13.15

GENETIC ENHANCEMENT OF SUGARCANE PRODUCTIVITY UNDER WOOLLY APHID, WATER AND SALT STRESS ENVIRONMENTS

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2005

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ABSTRACT

The present investigation was carried out to study magnitude and nature of variability of cane and sugar yield components in seedling (sexual) generation population of 45 inter varietal crosses and in pre-selected clonal population under three distinct environments viz., moisture stress, salinity water logg complex stress and normal irrigated and further to estimate the inter stage repeatability of important economic traits. The pre-selected clonal populations along with commercial varieties were also evaluated to study path analysis of cane yield and to identify superior progenies for three environments and resistant against sugarcane woolly aphid (SWA).

The traits viz., tillering, millable cane height and number, length and number of internodes and HR brix exhibited wide genotypic variation with high h^2 and GAM suggesting greater scope for selection in seedling generation itself. The families (crosses) viz., F14, F17, F05, F06 and F19 were promising on the basis of high frequency of superior segregants obtained. The most promising traits and families were also identified in each of the diverse environments and for SWA resistance. Under moisture stress, the traits viz., SCW, internode number, millable cane height and thickness and HR brix were important whereas in salinity water logg complex stress, germination, NMC and SCW were most reliable / dependable traits. On the contrary all the above traits except millable cane height and thickness and internode number were identified under normal irrigated environment. Though for each of the diverse environments specific crosses were identified, the two crosses viz., Co6806 x MS6847 and CoC 771PC were promising across environments.

The contributions of identified traits in each of the environments were also confirmed through path analysis studies. In addition to these, the physiological traits like photosynthesis rate, LUE, WUE, tiller mortality, early internode formation, extensive root system and leaf sheath moisture were also important contributing parameters for improved tolerance to moisture stress.

Among the various traits, HR Brix, SCW, NMC and tillering were most reliable to exercise early generation selection as they exhibited highly significant 'r' values between seedling and clonal generations across the diverse environments.

Ten SWA resistant progenies were identified of these four viz., SNK044, SNK049, SNK061 and SNK754 are most promising for commercial cultivation. These resistant progenies can also be recommended for diverse environments, in addition, under SWA free (protected) environment, SNK632 and SNK707 for moisture stress, SNK664 for salinity water logg complex stress and SNK825 and SNK432 for normal irrigated environment needs to be considered after large scale testing as specific genotypes for improvement of productivity under these specific situations.