A REVIEW

Genetic diversity among sugarcane (*Saccharum* spp. complex) genotypes

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Sugarcane is a very useful industrial crop grown in India for its economic importance and various applications of products and byproduct to industry. It has a wide range of genetic diversity which provides a tremendous scope for genetic improvement of economic traits. An improvement in cane yield and quality characters in sugarcane crop is normally achieved by selecting the genotypes with desirable character combinations existing in nature or by hybridization. Hence, the information in a collection of some genotypes of sugarcane in order to formulate a sound breeding plan for its improvement has been reviewed here.

Key words **:** Sugarcane, Variability, Correlation, Path analysis, Genetic divegence

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INTRODUCTION

Sugarcane is an important crop in the country economically, politically and sociologically. Its botanical name is *Saccharum* spp. complex and belongs to the family Poaceae. Sugar industry is the second largest agro industry next to textile and is a source of food, fuel, fodders and fibre. It is a tropical crop and is the major source of sucrose. Sugar is still the most preferred sweetener and the most widely used calorific food.

Origin:

Tropical sugarcane originated from Oceania (New Guinea) and Indian cane (*Saccharum spontaneum*) (kans) originated from North Eastern India.

Derivation:

The word "sugar" and "sugarcane" are derived from the Sanskrit word "sharkara" and it indicates Indian origin.

Discovery:

"Co.205" was the first interspecific hybrid which became popular for commercial purpose. It was obtained from the cross of cultivated species with wild species (*S. officinarum* x *S. spontaneum*) by Charles Alfred Barber in 1912 in India.

Importance:

Sugarcane is an important cash crop in India and plays a crucial role in the economy by contributing 21.4per cent area and 22.1 per cent production, ranks second (next to Brazil). The sweeteners produced from sugarcane in India are crystal sugar, jaggery and khandsari.

Sugarcane is considered as kulpvruksha because all its plant parts and byproduct of sugar industry are useful for various purposes like food, fodder, fuel, energy, electricity etc

Success of any breeding programme depends much on genetic diversity available to the breeders and the judicious selection of parents. The success of breeding programme is achieved by the efficient utilization of heritability and variability available in a population. Mahalanobis (1936) generalized distance has been used as an efficient tool in quantitative estimation of genetic diversity and a rational choice of potential parents for a breeding programme. Knowledge of interrelationship between cane yield and its components is obvious for efficient selection of desirable plant type. Unlike the correlation coefficient values, which measure the extent of relationship, path coefficient (Wright,1923; Dewey and Lu, 1959) measure the magnitude of direct and indirect effects of characters on complex dependent characters like cane yield

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and thus enable the breeders to judge best about the important component characters during selection.

Growth:

In India 1950-1951 sugarcane area was 1707 (000'ha), with the production of 69220(000'tones), and productivity of 40.5 t/ha.In 2008-2009 area, production and productivity increased *i.e.* 4415(000'ha), 285029(000'tones), and 64.5(t/ha), respectively. In Gujarat state area, production and productivity is 191(000ha), 15280(000 tones) and 80.1(t/ha), respectively. (Source: Indian Sugar, June 2010).

Variability, heritability and genetic advance:

The nature and magnitude of heritable portion of genetic variability present in the population is helpful in deciding the intensity of selection. High heritability coupled with high genetic advance is more useful in sugarcane breeding for evolving high yielding and high sugar content varieties for which additive gene effects and selection may be effective. Plant breeding largely depends on the extent of genetic variability present in the plant population for improvement in cane and sugar yield.

Hapase and Hapase (1990) conducted an experiment with 16 varieties of sugarcane for nine quantitative characters to assess the genetic variability. The highest genotypic and phenotypic coefficient of variation were observed in yield/ ha, germination at 30 and 45 days, number of millable canes/ clump, total and millable height of cane and CCS per cent. Heritability estimates were high for total height, sucrose per cent, weight of cane, millable height of cane and germination percentage. The highest genetic advance was observed in almost all characters except cane girth, number of internodes, sucrose and CCS per cent.

Kang *et al.* (1990) conducted an experiment with 47 sugarcane clones and found that heritability was high for stalk weight, rind hardness, fiber content, flowering and stalk number and lower for sugar per cent, juice extraction, cane yield and sugar yield. GCV was high for flowering and low for juice extraction. The characters with high heritability also exhibited high genetic advance.

Khan *et al.* (1991) studied 18 genotypes of sugarcane for assessing variability. The maximum variability, heritability and genetic advance was recorded for NMC per plot, number of tillers per plot and germination percentage, while lowest for length of internode per stalk. The characters with high heritability also registered high genetic advance.

Sreekumar *et al.* (1994) conducted an experiment with 20 clones in 1987, 28 clones in 1988 and 10 clones in 1990 to assess variability and heritability. They reported high GCV, heritability and genetic advance for almost all major traits. It is dependable selection criterion for the improvement of sugar yield per unit weight of sugarcane.

Repale *et al.* (1995) evaluated 12 early maturing varieties of sugarcane to study variability, heritability and genetic advance as percentage of mean. Genotypic and phenotypic coefficient of variation were high for number of tillers per plot, germination percentage at 30 and 45 days, number of millable cane/ha, cane yield (t/ha), millable height of cane and CCS MT per hectare.

Singh *et al.* (1996) evaluated 14 sugarcane genotypes to study variability, heritability and genetic advance as percentage of mean. GCV and PCV were high for commercial cane sugar (CCS) and cane yield, moderate for cane height and number of millable canes (NMC) while low for brix per cent, sucrose per cent and cane diameter. Heritability in broad sense was high for all the characters. Genetic advance was high for cane yield and CCS (t/ha) and moderate for cane diameter, cane height and NMC.

Doule and Balasundaram (1997) conducted the trial with 28 clones obtained through interspecitic crosses between S. *officinarum* L., *S. spontaneum* and *S. sinense* L. to assess the extent of variability at genotypic and phenotypic levels. They reported that yield components like NMC and single cane weight had high degree of GCV, heritability and genetic advance.

Kadian *et al.* (1997) evaluated 32 genotypes of sugarcane for assessing the variability, heritability and genetic advance. High heritability was recorded for leaf width followed by single cane weight and lower for NMC per clump. High genetic advance was observed for single cane weight followed by cane yield per clump.

Verma *et al.* (1999) studied variability, heritability and genetic advance in 16 sugarcane clones for eight characters. They reported that stalk girth had highest heritability followed by stalk height. High heritability and high genetic advance was noticed for three characters *viz.* millable canes per plot, CCS kg per plot and cane yield kg per plot. The PCV were higher than GCV for these characters.

Tyagi and Singh (2000) evaluated 18 clones of sugarcane and reported that genotypic coefficient of variation (GCV), heritability and genetic advance were higher for stalk weight and top weight and lower for number of internodes.

Jain *et al.*(2001) studied extent of variability at the phenotypic and genotypic levels , heritability coefficients (BS), genotypic coefficient of variability (GCV) and genetic advance in 81 sugarcane genotypes for characters like NMC per clump, stalk diameter, stalk height, single stalk weight and cane yield per clump. NMC per clump, single stalk weight and cane yield had higher coefficient of variation, heritability and genetic gain.

Kumar *et al.* (2001) conducted an experiment with 33 phenotypically diverse genotypes and found that coefficient of variation both at the genotypic and phenotypic level was high for cane yield per plot, NMCs per plot and tillers per plot.

Estimates of heritability were high for single cane weight, length of internodes, stalk girth and stalk height. High genetic advance in per cent of mean was observed for NMCs per plot, single cane weight, tillers per plot and length of internodes.

Singh *et al.* (2002) examined 28 early maturing high sugar genotypes to determine quality and yield contributing attributes *viz*., NMC/clump, stalk length, stalk diameter, single cane weight, pol per cent in juice, ratoon yield by employing variability, heritability and genetic advance. The result showed significant variation for all traits studied. GCV, PCV, heritability and genetic advance were higher in ratoon for yield, single cane weight, NMC, stalk height and stalk diameter.

Verma and Singh (2002) conducted an experiment for assessing the extent of variability, heritability and genetic advance for ten characters with 35 sugarcane genotypes. They observed that PCV was higher than GCV for most of the characters. Heritability and genetic advance were higher in millable canes per clump, internodes per cane, stalk weight, brix per cent and CCS/cane (kg).

Agrawal (2003) examined 8 high yielding varieties of sugarcane for twelve characters. The genotypic and phenotypic variances were higher for cane length, cane yield and millable canes per plot. Minimum value of this variance was obtained for single cane weight. High heritability coupled with high genetic advance were noticed for six characters *viz*. yield per plot, cane length, extraction per cent, sucrose per cent 300 days, CCS per cent juice 300 days and CCS (kg/plot).

Hapase and Repale (2004) conducted an experiment with 13 phenotypically diverse genotypes and found that coefficient of variation both at the genotypic and phenotypic level was high for germination percentage, number of tillers at 90 days per ha, number of tillers at 120 days per ha and single cane weight. Estimates of heritability were high for number of tillers at 90 days per ha, number of tillers at 120 days per ha and germination percentage. High genetic advance was observed for total height of cane, germination percentage and millable height of cane.

Kumar *et al.* (2004) evaluated 27 genotypes of mid late sub-tropical sugarcane involving thirteen quality and quantity contributing traits. They reported that number of millable canes at 12 month, number of tillers at 240 days, cane yield, commercial cane sugar (t/ha), cane height, cane girth, single cane weight and number of internodes per stalk recorded high heritability and genetic advance expressed as per cent of mean.

Patel *et al*. (2006) studied genetic variability in 40 phenotypically diverse genotypes for twelve characters. High heritability coupled with high genetic advance observed for single cane weight (kg) and CCS (t/ha) which indicated the presence of additive gene action and direct selection may be highly effective.

Murthy (2007) conducted an experiment with 13 genotypes of sugarcane for thirty seven different yield, quality and ancillary characters in sugarcane to assess the genetic variability. The GCV and PCV per cent for cane yield and CCS t/ha were higher as compared to other traits, showing the high variability among the genotypes for these traits. Among the other traits studied, germination percentage, number of tillers, NMC (‘000/ha), stalk length and single cane weight had high heritability coupled with high genetic advance. Cane diameter exhibited moderate heritability with low genetic advance over mean.

Correlation studies:

Khan *et al.* (1991) studied the correlation on 18 genotypes of sugarcane for yield and major attributes. They noticed that number of germinates per plot, number of tiller per plot, stalk height and NMC/plot had a significant and positive correlation with cane yield/plot. Number of internodes per stalk was negatively correlated with yield.

Madhavi *et al.* (1991) studied 12 early maturing sugarcane genotypes to assess the extent of correlation among six characters and reported that stalk weight had significant and positive association with other characters like stalk length, stalk diameter, number of internodes, stalk volume and had negative correlation with average length of internode.

Gravois and Milligan (1992) evaluated correlation in 22 clones of sugarcane and correlation was assessed for 7 characters including stalk weight, stalk diameter, stalk length, fiber, recoverable sucrose and brix per cent. They observed that cane yield was significantly and positively associated with CCS t/ha, millable height and number of internodes. Whereas, it was negatively correlated with fiber per cent.

Choudhary and Singh (1994) examined 14 sugarcane clones to study the correlation among 8 quantitative characters. Cane yield showed high degree of positive and significant correlation with germination at 45 days, number of shoots at 90 days, height of cane, cane width and NMC. While individual cane weight was not found to be associated with any other traits.

Sreekumar *et al.* (1994) studied correlation for five characters *viz*., juice per cent, sucrose per cent, purity per cent, CCS t/ha and yield t/ha. They found that productivity was negatively correlated with yield but CCS t/ha had positive correlation.

Das *et al.* (1996) examined 20 early maturing clones to determine correlation among cane yield and its component characters. They observed that cane yield was significantly and positively correlated with stalk weight, CCS t/ha, stalk diameter and number of internodes per cane. Whereas, stalk diameter, CCS t/ha, stalk weight were negatively correlated with NMC.

Bakshi and Hemaprabha (1997) studied correlation in F_1 hybrids belonging to four mating groups involving *S. officinarum* crossed with *S. barberi*/*sinense* (OB), *S. robustum*

(OR), *S. sponteneum* (OS) and commercial hybrids (OH). A positive association was found between cane yield and number of millable canes in all mating groups. Cane length also showed significant association with cane yield in OB and OH groups. Whereas, sugar yield was associated with NMC in OB, OH and OR groups, brix and sucrose per cent in OB,OR and OS groups than with juice extraction per cent in OS group alone.

Das *et al. (*1997) evaluated 27 mid-late varieties of sugarcane to assess correlation of sugar productivity with its component characters. Sugar yield was positively and significantly associated with cane productivity, individual cane weight, purity of juice, CCS per cent and cane height at maturity. NMC were negatively correlated with individual cane weight and its length.

Pal *et al.* (1999) examined 26 clones of *Saccharum* complex. They found that the cane and sugar yields were closely associated with NMC. The sugar yield and cane yield both were positively correlated with stalk height and single stalk weight. Cane yield was negatively correlated with CCS per cent and sucrose per cent.

Verma *et al.* (1999) examined 16 varieties of sugarcane to estimate the correlation between cane yield and its component character. They observed that millable canes per plot, CCS kg/plot and yield kg/plot were positively correlated with each other.

Tyagi and Singh (2000) studied 18 varieties of sugarcane to assess the extent of correlation among eight characters and reported that stalk weight had a significant and positive association with stalk girth, stalk length and number of internodes. A significant positive association was observed between sucrose per cent with number of green leaves and top weight. The pol per cent in cane increased with an increase in sucrose per cent and top weight.

Kumar *et al.* (2001) studied correlation in *Saccharum* spp. complex by taking 33 phenotypically diverse genotypes. They reported that cane yield was positively correlated with tillers per plot, NMCs per plot, germination per cent, length of internode and single cane weight.

Roodagi *et al.* (2001) analysed correlation in sugarcane + sunnhemp and sugarcane + soyabean intercropping system for cane yield and its attributes. The cane yield was observed to be positively correlated with NMC, single cane weight, and length of internode and sugar yield.

Singh *et al.* (2002) examined 28 early maturing varieties to assess correlation between quality and yield contribution NMC, stalk height, stalk diameter, single cane weight and pol per cent in juice showed positive and significant association with ratoon yield.

Kumar *et al.* (2004) estimated correlation in 27 genotypes of mid late sub tropical sugarcane. They found that cane yield, had high significant positive association with number of tillers at 120 and 240 days, number of millable canes, cane height, cane girth and single cane weight.

Dagar *et al.* (2004) carried out a study comprising 50 sugarcane genotypes. Correlation studies indicated significant and positive association of cane yield with number of millable canes per clump, cane height, cane thickness, number of internodes per cane and single cane weight. No significant relationship was observed between cane yield per clump and the juice quality traits *viz*; brix per cent at 360 DAP, pol per cent at 360 DAP, purity per cent at 360 DAP and commercial cane sugar. The interrelationship among the juice quality attributes was significant and positive, which indicated that improvement in one attributes would certainly lead to the improvement in other traits in desired direction.

Patel *et al.* (2006) studied correlation on 40 phenotypically diverse genotypes. Correlation coefficient revealed that cane yield was found to be significantly and positively correlated with number of shoots per ha, single cane weight, stalk length, stalk diameter, number of internodes per stalk and number of millable canes per ha at both genotypic and phenotypic levels.

Murthy (2007) carried out a study comprising 13 sugarcane genotypes. Correlation studies indicated significant and positive association of cane yield (t/ha) with cane length (cm), single cane weight (kg), internode length (cm), number of millable canes and number of tillers, indicating the importance of these traits in selection of sugarcane genotypes for higher sugar yield (t/ha) and cane yield (t/ha).

Path coefficient analysis:

Bakshi and Hemaprabha (1991) estimated path analysis of 8 clones of sugarcane. This study revealed that number of stalks and sucrose content were important components of sugar yield in HO group (*S. officinarum)*, whereas cane diameter and sucrose content were important character in HS group (*S. sponteneum).* In HB group (*S. barberi/sinence)*, sucrose content was most important character and it had positive association with all the quantitative traits except NMC.

Gravois *et al.* (1991) examined 80 sugarcane genotypes to assess the path analysis. This study revealed that purity and brix were main factors for increasing sucrose content. Indirect effect suggested the selection for low levels of pith will increase levels of brix and purity per cent. Stalk volume had a positive and much larger effect on stalk weight than stalk density, while increased stalk diameter and stalk height had positive and near equal effects on increasing stalk volume.

Khan *et al.* (1991) examined 18 genotypes of sugarcane to estimate the path analysis for yield and its major attributes. Path analysis suggested that selection for NMC/plot, CCS/plot and number of tillers/plot may result into improvement of cane yield.

Gravois and Milligan (1992) estimated path analysis of 22 clones of sugarcane for yield and its component characters. Analysis revealed that fiber content had negative direct effect on sucrose and was significantly correlated with stalk diameter indicating that indirect selection for larger stalk diameter would decrease fiber content. Direct selection for optimum fiber content by evaluating clones in a single crop or location would be effective.

Patel *et al.* (1993) carried out path analysis on 14 early maturing clones including one check for cane yield and its component characters. This study revealed that CCS t/ha had a highest direct positive effect followed by CCS per cent and stalk weight were the most important component of cane productivity. Of the indirect effect, sucrose per cent in juice, CCS per cent and number of internodes through CCS t/ha was higher and in positive direction.

Choudhry and Singh (1994) grew 14 sugarcane clones to study the path coefficient analysis of major yield contributing characters. It was revealed that NMC and individual cane weight were the direct contributors of cane yield. All other component characters were indirect contributors via NMC.

Das *et al.* (1996) estimated path analysis for various characters on 24 early maturing varieties. Path coefficient analysis revealed that CCS t/ha had the highest direct positive effect followed by NMC/ha. Stalk weight and stalk diameter were the most important components of cane productivity. The indirect effect of stalk weight, stalk diameter, CCS per cent and sucrose per cent in juice through CCS t/ha was higher and in positive direction.

Bakshi and Hemaprabha (1997) examined four matching group at sugarcane to assess path analysis for various yield contributing characters. Path analysis revealed that NMC and sucrose were important traits of sugar yield in OB (*S. barberi/ sinense)* and OR (*S. robustum)* groups whereas NMC alone was important in OH (commercial hybrid) group while in OS (*S. spontaneam)* group sucrose per cent was significant trait of sugar yield.

Das *et al.* (1997) conducted path analysis on 50 sugarcane genotypes for stalk yield and four other economic traits. Path analysis revealed that stalk weight exercised the maximum effect on stalk yield followed by NMC. The indirect effect of girth and its length were more and in positive direction.

Pal *et al.* (1999) studied path analysis of 26 clones of sugarcane for various quantitative traits. The path analysis revealed that NMC had maximum direct effect followed by single stalk weight on both cane and sugar yields. It was also revealed that stalk height itself was not important trait for direct selection for higher cane and sugar yield.

Singh *et al.* (2002) estimated path analysis of 28 early maturing high sugar genotypes for quality and yield contributing characters. Path analysis revealed that pol per cent in juice, NMC/clump, single cane weight and stalk diameter reflected highly positive direct effect on ratoon yield at genotypic level. Whereas, stalk length showed negative direct but highly positive indirect effect via pol per cent in juice and single cane weight.

Dagar *et al.* (2004) studied path analyses of 50 genotypes. Path coefficient analyses showed the highest direct effect of single cane weight and leaf length on cane yield. Appreciable contribution of cane height, cane thickness, number of internodes, leaf area and leaf length to cane yield was recorded through single cane weight. Path analyses of commercial cane sugar per cent verses other quality characters indicated that brix per cent and purity per cent contributed directly and pol per cent contributed indirectly via brix per cent to the commercial cane sugar per cent.

Kumar and Singh (2005) conducted field experiment involving 40 sugarcane varieties of early and mid late maturing groups to study path coefficient analyses, for two years. Different morphological, biochemical and juice quality characters were studied to identify important characters for selection. Single cane weight, sucrose per cent juice in November, cane diameter and number of shoots were important characters contributing towards cane yield. Therefore, these characters should be given due consideration for selection of high yielding sugarcane varieties.

Patel *et al.* (2006) examined 40 genotypes of sugarcane to assess path analyses. Path analyses indicated the highest positive direct effect of commercial cane sugar (t/ha) on cane yield. Based on findings it can be suggested that for improving cane yield in sugarcane more emphasis should be given to single cane weight, number of millable canes per ha and commercial cane sugar (t/ha).

Genetic divergence:

Hooda *et al.* (1990) worked out D^2 analysis for 34 sugarcane genotypes (28 advanced clones and 6 standard checks) grown in first week of March (normal planting) and first week of May (late planting) at Karnal and found that genotypes CoH 15 and Co J 64 in normal planting and genotype CoH 8 and CoS 767 in late planting were markedly diverse and ay be used as parents for evolving superior varieties.

Rai and Singh (1990) studied D^2 analysis in 30 F_1 hybrids resulted from 10 lines x 3 testers and reported that out of 11 clusters grouped, 6 contained only 1 genotype and genetic divergence was not associated with geographical origin and the clustering pattern of the crosses was not dependent on their parentage.

Viana *et al.* (1991) used D^2 analysis and Tocher algorithms to evaluate eight yield and quality traits of the first two harvest of twenty sugarcane clones grown at two sites in Alagoa state, Brazil. Genetic distances were low especially for the second harvest and repeatability was also poor.

Srivastava *et al.* (1999) studied genetic diversity among 14 interspecific hybrids (ISH lines) along with 2 commercial genotypes at Lucknow for yield and quality attributes. Analysis of data grouped the ISH lines into 3 clusters containing 6, 5 and 5 genotypes each. Intracluster D^2 value ranges from 1.923 to 2.540 and intercluster values from 3.707 to 4.986. Divergence was greatest between cluster II and III and cane yield, juice purity per cent and C.C.S per cent at 12 months contributed the most towards divergence.

Pathak *et al.* (2000) carried out diversity studies using D^2 analysis among 22 genotypes (20 interspecific sugarcane hybrids along with two local checks). The genotypes were grouped into five homogeneous clusters. The clusters II and V had 5 genotypes while other clusters had 4 genotypes each. The intracluster distances ranged from 1.394 in third cluster to 2.760 in fourth cluster. Second cluster was characterized by presence of *S. officinarum* as female parent. The inter-cluster distances varied from 2.695 for third and fifth cluster to 4.724 for second and third cluster. The cluster IV was good for yield, CCS, juice sucrose at 300 and 360 days as cluster means being 62.77 t/ha, 17.06 per cent and 18.23 per cent, respectively. While cluster V was good for stalk diameter and cluster II had maximum number of millable canes. Clustering pattern of interspecific hybrids did not reflect their pedigree relationship. The interspecific hybrids of the same cluster had little divergence from each other in context with aggregate effects of eleven characters.

Ravishankaran *et al.* (2003) conducted an experiment to investigate genetic diversity of 225 sugarcane accessions. The accessions were grouped into XII clusters. Cluster I was the largest, while cluster XI and XII were solitary clusters. Cane yield and sugar yield were major contributors to these values. Based on high diversity, divergent clones Co 8371 and CoC 671 must be examined further for improvement in sugar yield.

Singh *et al.* (2004) studied genetic divergence among 51 *Sachharum* genotypes belonging to *Sachharum officinarum, S. barberi* and *S. sinense*, grown in Lucknow, Uttar Pradesh, India, during 2000-2002, and was determined using Mahalanobis D^2 statistics. The genotypes were grouped into eight clusters and most of the genotypes (32) were in cluster I. Genotypes belonging to the 3 *Saccharum* spp. were randomly distributed into the clusters. The highest inter cluster distance was observed between clusters VI and VII, followed by V and VII. Single cane weight had the highest contribution in the genetic divergence of the material examined.

Singh *et al.* (2004) studied the genetic divergence among 63 commercial hybrids of sugarcane. The genotypes were grouped into 9 clusters. The maximum numbers of genotypes were grouped into cluster I and III (18 each). The genotypes showed random distribution in different clusters. The maximum inter cluster distance was observed between cluster II and IX, followed by IV and IX and I and IX. The characters yield/plot, NMC/plot and cane girth contributed maximum towards genetic divergence.

Mali *et al.* (2009) studied genetic divergence among 21 genotypes and found that generalized distance (D) between two populations varied from 14.043 to 43.592 indicating sufficient diversity in the experimental material for 15 characters under study also clustering pattern indicated no relationship between geographical diversity and genetic divergence. Cluster V may be used for cane yield, stalk length, cane diameter, single cane weight whereas, cluster III for quality parameters *viz.*, juice brix, sucrose per cent juice, juice purity per cent and CCS per cent.

Conclusion:

The literature reviewed in this paper highlighted the variability, heritability, genetic advance, correlation, path analysis and genetic divergence available in sugarcane genotypes. Existence of genetic variability is a per-requisite for any crop improvement programme. High heritability coupled with high genetic advance helps in desirable improvement of any character in quite a good magnitude. In case of sugarcane, cane and sugar yields are the important economic characters and mostly depend on their attributing characters. Yield components governed by additive gene effects should be considered for simultaneous improvement of cane and sugar yields.

The association between yield and its component characters and among themselves can be obtained by correlation analysis. It can be helpful in selection of superior genotypes as per the aims of the breeding programme. Strong positive correlation between yield and its attributes is essential for improvement of cane and sugar yields in sugarcane. For cane yield improvement germination per cent, number of millable canes and single cane weight are the most important characters, hence included in the selection criteria. Similarly for sugar yield sucrose per cent, juice and purity per cent, CCS per cent and fibre per cent are important ones. Also genetic divergence among the genotypes plays an important role in selection of parents having wider variability for different characters which can be exploited through breeding either heterosis or broadening the genetic base of sugarcane crop improvement for the future.

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