VARIABILITY STUDY IN SOME INDIGENOUS AND EXOTIC PROMISING CLONES OF SUGARCANE

(*Saccharum officinarum* L.)

BY

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CERTIFICATE

This is to certify that thesis entitled, "VARIABILITY STUDY IN SOME INDIGENOUS AND EXOTIC PROMISING CLONES OF SUGARCANE' (Saccharum officinarum L.)" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN GENETICS AND PLANT BREEDING**, embodies the result of a piece of bona fide research work carried out by MD. MAHBUBUR RAHMAN, Registration No. 05-01840 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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Supervisor

DEDICATED TO

MY

BELOVED PARENTS

LIST OF ABBREVIATIONS AND SYMBOLS

Full word	Abbreviation
Bihar orissa	Bo
Commercial cane sugar	CCS
Coimbatore (Sugarcane breeding station, India)	Co
Cane yield	CY
Error mean square	E
Genotypic co-variance between the traits 1 and 2.	Cov.g1x 2
Genotypic variance	$\sigma^2{}_g$
Genotypic standard deviation	σ_g
Genetic advance	GA
Genotypic co-efficient of variation	GCV
Genotypic correlation co-efficient	r_g
Genotypic mean square	V
Victorias milling company	VMC
Genotypic variance of trait 1	$\sigma^2{}_{g1}$
Genotypic variance of trait 2	$\sigma^2{}_{g2}$
Heritability (in broad sense)	$h^2{}_b$
Ishurdi	I, Isd
Kasetsart (Breeding station, Kasetsart University, Thiland)	K

Full word	Abbreviation
Number of millable cane	NMC
Path co-efficient between the characters and cane yield	Pny
Phenotypic standard deviation	σ_p
Phenotypic variance	σ^2_p
Phenotypic co-efficient of variation	PCV
Path co-efficient analysis	PCA
Proefstation, Oost Java	POJ
Single stalk weight	SSW
Sacchurum	*S*
Population mean.	$\overline{X}$
Sher-e- Bangla Agricultural University	SAU
Ton cane per hectare	t/ha

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By

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ABSTRACT

Variability, heritability, genetic advance, characters association and path coefficient analysis for the characters number of tillers per hectare, number of millable canes per hectare, number of millable canes per clump, stalk height, stalk girth, single stalk weight, number of green leaf, leaf length, leaf breadth, sucrose percentage and cane yield per hectare were studied with 25 (twenty five) indigenous and exotic promising clones and two standard check varieties of sugarcane. The experiment was conducted at the Bangladesh Sugarcane Research Institute, Ishurdi, Pabna during the cropping season of 2005-2006. The genotypes were found to differ significantly for all the characters studied. The genotype I 27-02 produced the maximum number of tillers, millable canes and cane yield. The maximum number of millable cane per clump was found in I 65-02 and I 85-02, respectively. The minimum number of millable cane per clump were I 54-02 and K 88-65, respectively. The tallest genotype was I 191-02 (3.21m) and shortest genotype was K 84-69 (1.57m). The genotypes I 81-02 and I 87-02 produced the highest stalk girth and single stalk weight, respectively. The highest number of green leaf was found in the clones I 20-02 and I 85-02, respectively. The lowest number of green leaf which produced in I 13-02, I 87-02, K 88-65 and K 88-87 respectively. The highest leaf length was found in VMC 84-549 (2.11 m) and the shortest leaf length was found in I 85-02 (0.4m). The widest leaf breadth was found in the genotype K 88-65 (7.16 cm). The study showed that the K 88-87 had the highest potentiality for sucrose percentage (9.45) among the genotypes studied. Number of tillers per hectare, cane yield per hectare and single stalk weight had high genotypic coefficient of variation. Other characters had low to moderate genotypic coefficients of variation. High heritability with high genetic advanced in percentage of mean was observed for number of tiller and stalk height. Other characters showed either high, moderate or low heritability with variable magnitude of genetic advance in percentage of mean. Cane yield per hectare was positively correlated with number of tillers per hectare, number of millable canes per hectare, stalk height and single stalk weight. The direct contribution of the number of millable canes per hectare was highest followed by single stalk weight. These results suggest that there is a scope of improving canes yield in sugarcane through selection of number of millable canes per hectare and single stalk weight.

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Introduction

CHAPTER I
INTRODUCTION

Sugarcane, a perennial tropical crop, is grown for the sugar stored in its stem and propagated through stem cuttings. The present day sugarcane cultivar is highly heterozygous, species-hybrid and complex polyploids (designated as *Saccharum* spp. hybrid). Sugarcane (*Saccharum officinarum* L.) is an important cash crop in Bangladesh agriculture popularly known as ikshu. The term 'ikshu' derived from sanskrit word (Rao *et al.*, 1983), indicates its age-old cultivation in this region of Indian subcontinent.

Sugarcane is cultivated in almost all tropical and temperate countries of the globe between 30° North and South of the latitude. It is a C_4 long duration clonally propagated plant and is one of the most efficient quantum convertors of solar energy. It is not only a most important food-cum-cash crop but also has the ability to develop agro-industry in rural areas (Lactch, 1979). As a raw material for sweetening agent, the importance of sugarcane is established as a key source of renewable energy. It may be described as the most expensive energy food per unit area of land. Moreover, sugarcane has diverse uses (Paturau, 1986). The productivity of sugarcane in Bangladesh is lower compare to other sugarcane growing countries. The lower yield is mainly due to disease, drought, water logging, salinity, high temperature and other environmental stresses prevalent in the country. At present about 150 million tonnes of sugar are produced in the world of which two-third is derived from sugarcane. The annual production of sugar and gur in Bangladesh is about 0.20 and 0.45 million tonnes respectively, which derived from sugarcane only. The present area under sugarcane cultivation is about 1,80,000 hectares with a national average yield of 45-50 t/ha. However, Bangladesh is not self sufficient in sugar and gur production. Sugarcane is one of the most important industrial crops. It is the main crop in some pockets of the eastern zone and in all parts of the northwestern zone of Bangladesh. (Rashid, 1992). However, according to agricultural statistic 50 percent of the total area under sugarcane is in the non –mill zones where the canes are used for chewing and manufacture of gur.

The sugarcane industries of Bangladesh are facing scarcity of stable and high yielding varieties, on the other hand the growers in non mill zones are using genetically degenerated biotic and abiotic stress susceptible varieties resulting in low and unstable yield. Using the existing varieties, sugarcane yield has been increased from 35 tonnes in 1979-80 to 44 t/ha in 1986-87 crushing season in mill zones (Karim and Miah, 1989). The present requirement of sugar and gur in the country is 1.0 million and 0.8 million tonnes, respectively. But the existing 14 sugar mills have the capacity to produce only 0.2 million metric tonnes of sugar every year (Karim and Miah, 1989). Of course, the production of sugar and gur varies from year to year depending on the area of cultivation and diversion of the cane towards gur making.

In sugarcane, under the genus *Saccharum*, there are three cultivated species (*S. officinarum, S. sinense and S. barberi*) and two wild species (*S. robustum* and *S. spontaneum*). The large barreled high sucrose content original canes, *S. officinarum*, is thought to have been originated from the wild species, *S. robustum* which is of medium thickness and low in sucrose content. *S. sinense* and *S. barberi* are indigenous to North India, Bangladesh, Burma and China region. The canes of these two species are characterized by thin stalks, great vigour and wide adaptability. They are poor in cane yield and intermediate to low in sucrose content. *S. spontaneum*, in wild form is found in Indo-China region, the south pacific islands and tropical Africa. In general, the forms of *S. spontaneum* are perennial, have slender stalks, high tillering capacity, high fibre and low sucrose content. These are resistant to most diseases and insect pests. Present sugarcane clones in cultivation are mostly complex hybrids among these species and it would be difficult to classify them into any particular group (Poehlman and Borthakur, 1969). In BSRI hybridization programmes *S. spontaneum* are utilized to transfer its desirable characters such as disease resistance/tolerance etc in to cultivated species.

The aim of any plant breeding programme is to develop commercial varieties having better production potential. This potentiality of the materials is to inherent genetic superiority in yield or quality, resistance to pest and diseases, improved agronomic characters or to a combination of such factors. Under plant improvement programme breeder's problem is to create new variants and to select superior genotypes for further evaluation. Genetic variants normally differ in phenotypic characters due to genetic and environmental factors (Mian and Awal, 1979).

Hybridization cum-selection programme of sugarcane breeding includes collection and critical evaluation of germplasms, direct use of promising germplasms as varieties and utilization of superior genotypes in crossing programme, to achieve specific objectives. Selection at seedling stage is practiced for screening large number of segregating populations. Hence, extensive genetic variability in the material is a prerequisite to isolate desirable genotype according to farmer's need.

The knowledge of genetic variability present in the population, heritability of economically important characters and correlation coefficients of those characters is very important before launching an effective breeding programme. These aspects provide ideas about a particular character on which greater emphasis should be given while selecting suitable plant type (Singh *et al*., 1981).

Therefore, development of high yielding varieties with wide adaptability is urgently needed at this moment to this crop profitable to the growers and for meeting sugar and gur deficiency in the country.

The basic key to bring about the genetic upgrading to a crop requires a sound-breeding programme utilizing the available genetic variability. If the variability in the population is largely due to genetic cause with least environmental effect, the probability of isolating superior genotypes will be high.

The isolation of superior genotype in early generation selection is a prerequisite for obtaining higher yielding variants, which is the ultimate expression of various yield-contributing characters. Yield is a polygenic trait and is influenced by many genetic factors as well as macro-and microenvironmental fluctuations. Therefore, direct selection for yield could be misleading proposition. It is difficult to judge what proportion of the observed variability is heritable. The progress of breeding in such population is primarily conditioned by the magnitude, nature, interactions of genotypic and environmental variations in plant characters. Therefore, studies on genetic parameters, such as, genetic co-efficient of variation, heritability and genetic advance, etc. are necessary to partition the observed variability into heritable and non-heritable components.

If a plant breeding programme is to advance most rapidly and efficiently, knowledge of the phenotypic and particularly of the genotypic interrelationships among and between yield contributing characters is necessary. Thus determination of correlation between the characters are a matter of considerable importance in selection practices since it helps in the construction of selection indices and also permit the prediction of correlated response.

Following correlation analysis, the path coefficient analysis would provide a true picture of genetic association between different traits (Bhatt, 1973). Path coefficient analysis specifies the cause and effect and measures their relative importance. Therefore, correlation in combination with the path coefficient analysis quantify the direct and indirect contribution of one character upon another (Dewey and Lu, 1959).

From the standpoint of the above views, the present study was undertaken to measure those genetic parameters for some characters of a number of sugarcane genotypes.

However, the present investigation was carried out to determine-

- The nature and magnitude of phenotypic and genotypic variability of important quantitative characters
- The association of yield contributing characters among themselves and with cane yield and
- Direct and indirect effects of the characters on cane yield per hectare through path co-efficient analysis.

Chapter II

Review of literature

CHAPTER II

REVIEW OF LITERATURE

Extensive research on sugarcane breeding have been performed in many countries for its improvement in respect of yield and yield contributing characters. A large number of literature is available on variability, correlation and path analyses of yield and yield contributing characters of sugarcane grown under a particular environment. An attempt has been made here to summaries the findings of these studies relevant to the present investigation. The whole review has been divided into four sections, namely:

A. Variability
B. Heritability and genetic advance
C. Correlation coefficient.
D. Path coefficient

A. Variability

The improvement of a crop is dependent on the magnitude of genetic variability and the extent of heritability of desirable characters. A critical review of genetic variability is therefore, a prerequisite for planning and evaluating a breeding programme.

Yield of sugar per acre, germination percentage, yield of cane per acre and tillering per clump exhibited high degrees of genotypic and phenotypic coefficient of variability (Mian and Awal, 1979). High heritability percentage in broad sense has observed in case of sugar yield per acre, recoverable sucrose content, yield of cane per acre and germination percentage. High values of genetic advance expressed as percentage of mean values were observed in case of sugar and cane yield per acre and germination percentage of the clones. Yield of sugar and cane per acre and germination percentage demonstrated high degrees of genetic advance under selection and were amenable to selection.

Genetic variability present in the population is very essential before launching an efficient breeding programme as these aspects are more helpful for providing an idea about a particular character on which greater emphasis should be given while selecting suitable plant type Singh *et al.*, (1981).

After studies 21 genotype of sugarcane it was found that variability, heritability and expected genetic gain and determined number of millable canes per clump, cane thickness, leaf length and width, internode length, cane height and cane yield per plot (Chaudhary *et al.*, 1983). Highly significant variability was found for all seven characters indicating a noticeable amount of phenotypic variability. Maximum heritability was recorded for cane yield per plot, followed by length of internode and cane height; lowest estimates of heritability were recorded for leaf width. Maximum expected genetic gain was found for leaf width, followed by cane yield per plot; the lowest was found for cane thickness. For selection of high yielding genotypes attention should be paid to number of millable canes per clump and cane height.

Punia and Hooda (1982) reported that variability, heritability and expected genetic gain (genetic advance as percent of mean) were obtained for four quality characters viz, brix (%), sucrose (%), purity (%) and commercial cane sugar (CCS %) in a population of 41 genotypes of sugarcane. A significant variability was recorded for all the four characters in the population. In general, heritability estimates were quite high for most of the characters except for purity percent. Maximum heritability of the order of 84.42% was recorded for brix percent. Commercial cane sugar percent itself provide good amount of variability, high heritability as well as maximum expected genetic gain (13.74%). In the population studied for improving sugar yield (CCS%), more emphasis should be given to brix percent in the early stages of selection programmes and in later stages all these four characters should get due attention.

Six yield components characters in 41 genotypes of sugarcane and reported that millable canes per clump and cane weight were the most important components of cane yield per clump (Punia *et al.*, 1983).

The progeny of crosses involving three high-sugar, three low sugar varieties and examined number of millable stalks, number of leaves, stalk height and diameter, clump weight and brix at the 9th and 12th months of growth. Rao (1985). Marked variation was found for number of millable stalks, clump weight and brix in the seedling (sexual) generation, while number of leaves varied widely in the settling (clonal) generation.

Barua *et al.*, (1988) reported that significant genotypic differences were revealed for all the characters excepting juice purity in the individual as well as combined analysis of variance of the three environments. Genotype-environment interactions were significant for all characters except juice purity. Genetic variability, heritability and genetic advance for cane yield and related characters were higher in magnitude than sucrose content and juice purity.

B. Heritability and Genetic Advance

The heritable variation can be estimated with greater degree of accuracy when heritability in conjunction with genetic advance as percentage of mean (genetic gain) is studied. Johnson *et al.*, (1955) and Swarup and Chaugale (1962) suggested the necessity of estimating genetic advance along with heritability in order to draw a more reliable conclusion in a selection programme. Many researchers investigated heritability along with genetic advance on yields and yield components of sugarcane. Some of the literature in connection with heritability and genetic advance are reviewed here.

Rao *et al.*, (1984) observed 190 progenies from 19 crosses and estimated broad sense heritability and expected genetic advance for stalk length, millable stalk/clump, clump weight, stalk diameter and brix. Broad sense heritability was high for brix and stalk diameter.

Reddy (1986) studied 10 promising and commercial varieties in the Co. (Coimbatore) series and showed that the number of millable canes and individual cane weight had high heritability coupled with high genetic advance, while improvement based on juice sucrose content appeared to be very limited. Correlation coefficients at the genotypic level were higher than for the corresponding phenotypic correlation

Singh and Sharma (1984) carried out a varietal trial with 52 clones and determined heritability, genotypic and phenotypic variability and expected genetic advance for six attributes. Differences between clones were significant for all the characters. Number of millable canes, showed the highest coefficient of variability and genetic advance, closely followed by cane yield, while cane diameter exhibited highest heritability, after which number of millable canes and cane yield.

Data on tiller and millable cane number, cane yield and juice sucrose percentage were recorded for 126 genotypes selected from 10,000 seedling progenies from 15 crosses. Numbers of tillers and millable canes showed high heritability and were positively correlated with cane yield. Increased sucrose percentage was associated with increased cane yield (Singh *et al.*, 1984).

The closeness between GCV and PCV suggested that a major portion of total was due to genetic cause and selection based on phenotypic performance would be important for improvement in these traits. Similarly result based on GCV and PCV had also been reported earlier (Singh *et al.* 1996, Ghose and Singh 1996 and Kamat and Singh 2001). In case of ratoon planted crop high genetic advance showed for number of millable canes, number of shoots, cane yield, germination percentage and single cane weight.

Other characters showed moderate to low genetic advance. Similar results were earlier reported by Singh *et al*,. 1996. Ghose and Singh 1996 and Kamat and Singh 2001.

In respect of sucrose percent juice in cane were recorded in the month of November, December and January as per Spencer and Meade (1955). Cane yield, registered significant positive correlation with number of tiller at 120 and 140 days, number of millable canes, cane height, cane girth and single cane weight, Similar result were reported by Kamat and Singh (2002).

Number of millable cane per clump had positive and significant association with cane yield/clump. Similar results have been reported by Verma and Kamat (1999).

Verma and Kamat (1999) revealed that number of millable canes, commercial cane sugar and cane yield ton per hectare (t/ha) were significant as positively correlated with each other.

Verma and Kamat (1999) revealed that number of millable canes, commercial cane sugar and cane yield (t/ha) were significant as positively correlated with each other.

High variability observed in the component, like number of millable cane yield and single cane weight in conformity with report of Balasundarram and Bhagyalakshmi (1979) and Kamat and Singh (2001).

Moderate to high heritability estimates recorded for majority of characters is in accordance with the report of Kamat and Singh (2001).

Moderate to high heritabilty along with high genetic advances for number of millable canes, single cane weight and cane yield was also reported by Kamat and Singh (2001).

Cane yield, registered significant positive correlation with number of tiller at 120 and 140 days, number millable cane, cane height, cane girth and single cane weight, similar result were reported by Kamat and Singh (2002).

C. Correlation Coefficient

Punia and Paroda (1984) studied 41 genotypes of sugarcane for CCS percent. They reported that length of internode was inversely correlated with CCS percent and CCS percent was positively associated with brix, purity and sucrose percent. The path coefficient analysis indicated that sucrose percent, brix and purity percent were the important components of CCS percent in sugarcane.

Bathla (1980) studied one early sugarcane variety, one mid season variety and two late varieties and concluded that cane weight was highly and positively correlated with cane length, thickness and inernode number. Cane length was positively correlated with internode number.

Mannan and Ghafur (1983) evaluated 20 released and unrelased varieties for cane yield, single stalk weight, number of millable canes and stalk height. Phenotypic and genotypic correlation coefficients are established for all four components. The correlation coefficients showed significant positive association of cane yield with the other three factors. Single stalk weight exhibited strong positive correlation with number of millable canes, while significant negative association was found between numbers of millable canes and stalk thickness.

Lu (1984) studied seven yield components in 20 varieties for correlation and path analysis. He indicated that cane yield per plot and sugar yield per plot were each positively correlated with number of stalks per plot and with single- stalk weight and length. Stalk diameter made the greatest contribution to single stalk weight. Single stalk weight made a major contribution to stalk yield per plot, which was the major factor in sugar yield per plot.

Sangwan and Singh (1984) evaluated 50 cane varieties in the Co (Coimbatore). series for quality characters and found high positive correlation at both genotypic and phenotypic levels, Pol % and CCS% were the major contributors to CCS per plot in February and December, respectively. Cane yield had low or no correlation with the quality attributes and could be improved together with cane quality independently. Brix, which contributed to CCS per plot via CCS % in December and via pol % in February, might be a useful tool for evaluation of large populations of cane early stages of the selection programme.

Generally genotypic correlation is higher in magnitude than phenotypic correlation Yadava *et al.*, 1984: Reddy *et al.*, 1987, Chauhan *et al.*, (1987) studied the correlation and path analysis at clonal stages in hybrid population of 126 genotypes of sugarcane. Cane yield was significantly associated with number of tillers, number of millable canes and sucrose percent in juice. Path coefficient analysis indicated that the number of millable canes and sucrose percent in juice should be given weightage during selection programme.

Phenotypic and genotypic correlations were studied and path coefficient analysis was done in 52 cane varieties. Results showed that cane yield was associated phenotypically with the number of millable stalks and stalk length and also had considerable genotypic correlation with stalk diameter. The number of millable stalks per plot and stalk diameter are the most important cane yield components provided the negative association between them is overcome by simultaneous selection to achieve an optimum combination. Stalk length is of secondary importance while the number of internodes per stalk is of negligible importance in selection for high yield (Singh and Sharma, 1984).

They reported this after carrying a varietal trial with 12 crosses of sugarcane at first clonal generation. The study revealed the importance of stalk number / plot and stalk weight independently and in combinedly important in determing the cane yield / plot Reddy and Reddy (1986).

Rai *et al*., (1988) studied correlation and path coefficient of 8 characters in 43 genotypes of sugarcane (*Saccharum* hybrid sp). Stool weight showed significant positive correlation with number of millable canes per stool, stalk height and stalk weight at genotypic and phenotypic levels. Where as sucrose content had significant positive correlation with stalk girth and significant negative correlation with number of millable canes/stool at genotypic level only. Path analysis revealed that number of millable canes/stool had higher positive direct effect followed by stalk girth. Stalk weight, stalk density and plant height on stool weight showed significant negative direct effect followed by number of millable canes/stool and stalk weight on sucrose content in juice showed high magnitude of positive direct effect in sucrose content. Hence, to evolve a variety having high yield as well as high sucrose content potentially, number of millable canes, stalk height, stalk girth, stalk weight and stalk density should be taken into account during selection and a balance should be made between number of millable canes and stalk girth, stalk weight and sucrose content and stalk weight and stool weight.

Reddy (1988) studied correlation in four intervarietal crosses of sugarcane showed stalk diameter emerged as the main component character contributing to stalk weight. The path analyses of phenotypic and genotypic characters indicated that both stalk diameter and stalk density were equally important for stalk weight. But strong negative relationship existed between stalk diameter and stalk density. Hence suitable compromise for simultaneous selection of these characters for increased stalk weight was suggested.

Reddy and Reddy (1988) studied degree of genetic determination in seven related traits in 40 genotypes of Co. 7704 x Co. 1287 crosses in the first clonal generation. The analysis of data on cane yield per plot and commercial cane sugar yield per plot revealed that stalk number/plot and stalk weight had a high degree of genetic determination a high genotypic coefficient of variation and high genetic advance in addition to significant position phenotypic and high genotypic associations with both cane and CCS yield. These two characters also had considerable phenotypic and genotypic (direct) effects on cane yield. Hence stalk number/plot and stalk weight are considered to be the major components of cane yield.

Three early growth attributes, namely, germination, tillering and early vigour in 94 genotypes of sugarcane were studied in relation to stalk and sugar yield and their component characters. Germination and tillering influenced final stalk population to a considerable extent (Nair and

Sreenivasan 1990). However, these two characters did not show any significant relationship with any other yield component. Early vigour was strongly correlated with stalk and sugarcane and all their components could be use as an effective early selection criterion.

Thirty four (34) genotypes in three environments were evaluated by Hooda *et al*., (1990). They observed cane yield and its component traits and found insignificant correlation coefficients in the majority of cases. Single cane weight emerged as the most important trait influencing cane yield.

Number of millable cane, millable height of cane, number of internode and leaf area index showed significantly positive correlation with cane yield (Gajera *et al*., 1991).

D. Path coefficient

Partitioning the correlation coefficient into component of direct and indirect effects are necessary because correlation coefficients alone does not give a complete picture of the causal basis of association. It is well established that, as the number of contributing characters increases, the indirect association becomes more complex and important. Under such circumstances, path coefficient analysis is an effective tool in assigning out the direct and indirect effects of different yield contributing characters, Literature on path coefficient analysis in sugarcane are briefly reviewed here.

The number of millable canes had the strongest direct effect on cane yield followed by cane thickness and cane weight Khairwal and Babu (1975). The direct influence of cane height on cane yield was negligible, while direct effect of sucrose content on cane yield was negative. On the other hand, indirect effect of number of millable canes was prominent in the path analysis of cane height versus cane yield.

The path analysis indicated that number of canes per plot and to a lesser extent cane thickness, are main components of both cane and sugar yields Balasundaram and Bhagyalaksmi (1980). Cane length and sucrose percentages were of secondary importance.

Singh *et al.*, (1983) carried out a varietal trial with 16 varieties of sugarcane. The path coefficient analysis revealed that cane height, girth and weight and number and length of internodes showed a positive relationship with sucrose percentage with cane weight showing the highest positive direct effect, followed by length of internodes, whereas the other parameters had only an indirect effect via these two attributes.

The number of millable canes had the strongest direct effect on cane yield and which was found to be followed by stalk thickness and stalk height (Mannan and Ghafur 1983). The effect of single stalk weight on cane yield was observed to be negative.

Four important components, namely milable stalk per plot, stalk diameter, single stalk weight and sucrose percent were studied in relation to sugar yield. From the study of path coefficients millable cane per plot and single stalk weight were found to be major components for sugar yield. Those two characters also possessed high heritability (broad sense), genetic variability and genetic advance, indicating that there is scope for their improvement through selection (Nair and Somarajan 1984).

Sharma and Singh (1984) evaluated 12 early and midlate varieties grown in three replications during 1979-80 cropping year. They reported that almost all traits had direct effects on juice weight per stalk, internode number per stalk, stalk circumference at 9 months, leaf area at 11 months, number of green leaves at 9 months, leaf area at 11 months, number of green leaves at 9 months and number of millable canes per clump had direct effect on sucrose content.

Kang *et al*., (1990) carried out a varietal trial with 48 genotypes of plant cane and first ratoon crops. Path coefficient analysis indicated that the direct effects of rind puncture resistance, juice extraction and moisture percentage on fibre percentage were positive, negative and negative, respectively. The coefficient of genetic variation for rind puncture resistance was higher than those of juice extraction and moisture percentages, selection for softer stalks is suggested to reduce fibre percentage. Fibre percentage was the least important component of cane and sugar yields. The direct effects of stalks number and stalk weight on cane yield were both positive and selection for these characters are recommended to increase cane yield.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

A. Site and soil

The experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna, during the period from December 2005 to December'06 (Figure 1). Geographically, BSRI, Ishurdi is situated at 24.00° North latitude and 89.25° East longitude. The experimental land was medium high. The soil was under Ganges River Flood Plain (AEZ 11) and that was sandy loam in texture with pH 7.5.

B. Climate

The climate of the location is sub-tropical. During the period of research work in the field, the climate of the place was characterized by dry and lower temperature with moderate rainfall (Appendix I).

C. Materials

The experiment comprised of twenty seven (27) sugarcane clones/varieties as experimental materials of which two were considered as standard varieties. The remaining 25 clones were supplied by the Breeding Division, BSRI, Ishurdi, Pabna. Out of 25 clones 19 were indigenous and 6 were exotic. The experiment was laid out in RCBD with three replications and plot size were 6m x 5m where row to row distance maintained 1 meter (Table 1).

Figure 1. Field view of BSRI experimental site, Ishurdi, Pabna

Table 1. List and sources of materials (strains/variety) used in the experiment

SL. No.	Name of the clones/varieties	Parentage	Source of materials	Remarks
1	I 13-02	Isd 19 x I 36-91	BSRI	BSRI Bred
2	I 18-02	Isd 24 x CPI 96-80	BSRI	BSRI Bred
3	I 20-02	Isd 19 x LCP 86-454	BSRI	BSRI Bred
4	I 26-02	COL 33 x Isd 28	BSRI	BSRI Bred
5	I 27-02	CP 44-155x LCP 86-454	BSRI	BSRI Bred
6	I 52-02	I 8-92 x Co 642	BSRI	BSRI Bred
7	I 54-02	CP 85-1439 x Isd 28	BSRI	BSRI Bred
8	I 55-02	Phill 48-15 x B 34-231	BSRI	BSRI Bred
9	I 65-02	Co 1148x I 101-66	BSRI	BSRI Bred
10	I 81-02	POJ 2878 x Co 642	BSRI	BSRI Bred
11	I 84-02	POJ 2878 x Co 642	BSRI	BSRI Bred
12	I 85-02	POJ 2878 x Co 642	BSRI	BSRI Bred
13	I 87-02	Co 630 x I 2880	BSRI	BSRI Bred
14	I 100-02	Co 630 x I 2880	BSRI	BSRI Bred
15	I 140-02	L-5 x BO 43	BSRI	BSRI Bred
16	I 145-02	CO 1158 x CP 55-30	BSRI	BSRI Bred
17	I 163-02	I 174-93 x CO 642	BSRI	BSRI Bred
18	I 191-02	Isd 28 x B 34-231	BSRI	BSRI Bred
19	I 193-02	Isd 28 x B 34-231	BSRI	BSRI Bred
20	K 88-65	Exotic germplasm	Thailand	Exotic
21	K 84-69	Exotic germplasm	Thailand	Exotic
22	K 88-87	Exotic germplasm	Thailand	Exotic
23	K 88-92	Exotic germplasm	Thailand	Exotic
24	VMC 71-234	POJ 3016 x Phil 56-226	Philippine	Exotic
25	VMC 84-549	PR 1059 x CB 45-3	Philippine	Exotic
26	Isd 16	CP 36-13 x BO. 32	BSRI	Commercial varieties used as standard
27	Isd 36	CP 70-1133 x ?	BSRI	Commercial varieties used as standard

D. Land preparation and trenching

The land was thoroughly prepared by mechanical ploughing and harrowing followed by laddering, the land was leveled properly. The trenches were made by trencher with a row distance of 1 meter having depth of 40-45 cm.

E. Fertilizer application

Recommended rates of fertilizers at 130 kg N, 35 kg P, 60 kg K, 20 kg S and 3 kg Zn ha^{-1} were used in the experiment. The whole amount of phosphorus, sulphur and zinc, one- third of potassium and nitrogen were applied in the trenches at the time of planting. The remaining amount of nitrogen and potassium were applied in two equal installments as top dressing at 90 and 150 days of planting.

F. Design, plot size and planting

The experiment was laid out in Randomized Complete Block design with three replications. Each clone was gown in a plot size of 6m x 5m (30 Sq. m). Each plot consisted of 6 rows 5m long with row-to-row distance of 1m. The planting was done on the 8th December 2005. Planting was done through conventional sett placement in the trenches in three eyed buds.

G. Preparation of setts and treatment

Ninety setts (each sett having 3 eye buds) for each of cultivated types were planted in a 6m ×5m plot size.

H. Intercultural Operations

Necessary intercultural operations such as mulching, weeding and irrigation, etc. were done as and when necessary. Earthing up was done in the month of July 2006. Furadan 5G were applied at the rate of 40 kg/ha during the month of March and May'06 (two times application). There was no significant attack of diseases or insect pests. The tying was done after 250 days of planting.

1. Data collection

A. At growing period

From the growing period to harvest, data on different characters were collected, separately from ten canes selected at random from four middle rows of each plot. The two other rows at the extremes of each plot were considered as non-experimental in order to avoid border effects.

1. Tiller counting

Final tillers were counted after 150 days of planting inspecting individual clumps of different treatments.

2. Millable cane stalk

Millable cane stalks were counted after 300 days of planting.

B. **At harvest**

The sugarcane was harvested in the second week of December 2006. At the time of harvest data on cane stalk weight: number of millable cane per clump; stalk height; stalk girth; Number. of green leaf, leaf length, leaf breadth, sucrose percent and yield estimation were taken for individual varieties/ clones and techniques separately in the following manner.

3. Number of millable cane per clump

Ten cane clumps were selected randomly from each treatment and cane number was counted.

4. Cane stalk weight

After cutting the canes with a sharp knife just above ground level, the cane stalks were detrashed. Treatment wise individual cane stalk was weighted by a balance in kilograms (kg).

5. Stalk height

Ten cane stalks were selected randomly from each treatment and the length of individual cane was measured from the bottom to the top visible dewlap using a meter tape.

6. Stalk girth

The diameter of cane stalk was measured. Average of bottom, middle and top of ten individual stalk girth were taken using a slide caliper for each plot.

7. Number of green leaf

Green leaf to be taken from ten randomly selected plant at 8 month starting after top most dry leaf to onward.

8. Leaf length

Leaf length were taken from ten randomly selected plants at 8 month. Measurement were made from ligule to tip in cm.

9. Leaf breadth

Leaf breadth were taken from ten randomly selected plants at 8 month after planting. Measurement were made at widest points in cm.

10. Percent sucrose

After detracting the leaves, ten cane stalks were selected randomly, extracted juice by power crusher, percent sucrose was determined by polarimeter.

11. Yield estimation

All millable cane was harvested from four middle rows of the plot and was weighted. Total cane yield in hectare was calculated separately for all treatments.

J. Statistical Analysis

1. Analysis of variance and testing the significant differences among means

All the data obtained for each character were subjected to the analysis of variance following the Randomized Completed Block design. The analysis of variance for each of the character under study was performed by F test (Cochran and Cox, 1960). Mean and range were also estimated and comparisons among means were performed using Duncan's New Multiple Range Test (Steel and Torrie, 1960).

2. Estimation of genetic parameters

i) Estimation of genotypic and phenotypic variance

Genotype and phenotypic variances were estimated as per Johson *et al*,. (1955) as follows:

$$\sigma^2 g = \frac{V-E}{N}, \qquad \sigma^2 p = \sigma^2 g + E$$

Where, $\sigma^2 g$ = Genotypic variance, V = Genotypic mean square

$\sigma^2 p$ = Phenotypic variance, E = Error mean square, and

N = Number of replications

ii) Estimation of genotypic and phenotypic coefficient of variance:

Genotypic and phenotypic coefficients of variation were calculated by the formula suggested by Burton (1952), as given by the following formula:

a) GCV $= \dfrac{\sigma^2 g}{\overline{x}} \times 100$

b) PCV $= \dfrac{\sigma^2 p}{\overline{x}} \times 100$

Where, GCV = Genotypic co-efficient of variation.

PCV = Phenotypic co-efficient of variation.

σg = Genotypic standard deviation

σp = Phenotypic standard deviation and

$\overline{x}$ = Population mean.

iii) **Estimation of heritability (in broad sense)**

Board sense heritability of all characters was estimated following the formula used Johnson et. al. , (1955) and Hanson *et. al.*, (1956).

a) h^2b (%) $= \dfrac{\sigma^2 g}{\sigma^2 p} \times 100$

Where, $h^2 b$ = Heritability (in broad sense)

$\sigma^2 g$ = Genotypic variance, and

$\sigma^2 p$ = Phenotypic variance.

iv) **Estimation of genetic advance**

The expected genetic advance for different characters under selection was estimated by the formula as suggested by Lush (1949) and Johnson *et al.*, (1955) as follows:

$$GA = \frac{\sigma^2 g}{\sigma^2 p} \times K \times \sigma p$$

Where, GA = Genetic advance

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

σp = Phenotypic standard deviation

K = Selection differential which is equal to 2.06 at 5% selection intensity.

v) **Estimation of genetic advance in percentage of mean**

Estimation of genetic advance in percentage of mean was calculated from the formula given bt Comstock and Robinson (1952).

$$\text{Genetic advance in \% of mean} = \frac{GA}{\bar{x}} \times 100$$

Where, GA = Genetic advanced and

$\bar{x}$ = Population mean.

3. Estimation of genotypic and phenotypic correlation co-efficient:

The formula suggested by Miller *et al.*, (1958). Johnson *et al.*, (1955) and Hanson *et al.*, (1956) were adopted. The procedure follow in the variance analysis was also followed for the co-variance analysis between pairs of traits. The estimate of the genotypic co-variance component between two traits and of the phenotypic co-variance were designated in the same way as for the corresponding variance components. To compare the genotypic and phenotypic correlation between the pairs of character, these co-variance components were used as follows:

$$rg = \frac{Cov.\ g\ 1 \times 2}{(\sigma^2 g1 \times \sigma^2 g2)^{1/2}}$$

Where,

rg = Genotypic correlation co-efficient.

$Cov.g_{1x2}$ = Genotypic co-variance between the traits 1 and 2.

$\sigma^2 g1$ = Genotypic variance of trait 1 and

$\sigma^2 g2$ = Genotypic variance of trait 2.

Similarly,

$$rp = \frac{Cov.\ p\ 1 \times 2}{\sigma^2 p1 \times \sigma^2 p2}$$

rp = Phenotypic correlation coefficient

COV. Ph 1×2 = Phenotypic covariance of trait 1 and trait 2

$\sigma^2 p1$ = Phenotypic variance of trait 1 and

$\sigma^2 p\ 2$ = Phenotypic variance of trait 2

4. Estimation of path co-efficient

A path co-efficient is simple standardized partial regression co-efficient and as such measures the direct influence of one variable upon another and permits the separation of the correlation co-efficient into components of direct and indirect effects (Wright, 1923).The co-efficient of path analysis originally developed by Wright (1923) and later described by Dewey and Lu (1959) were obtained from genotypic correlation co-efficient by solving the simultaneous equation using matrix method.

$$r_{ny} = Pny + rn_2 + P_2y + rn_3 + P_3y + \ldots\ldots\ldots\ldots rnx\ Pxy.$$

where, r_{ny} = Co-rrelation co-efficient between one causal factor (character) and depended character y i,e, cane yield.

Pny = Path co-efficient between the characters and cane yield.

rn_2 ,rn_3 ...... rnx = Represent the correlation co-efficient, between that character and each of other yield component in turn.

The above equations were in a matrix from as :

$$\begin{vmatrix} r_{1y} \\ r_{2y} \\ \\ r_{3y} \\ \\ r_{1y} \end{vmatrix} = \begin{vmatrix} r_{11} & r_{12} & r_{13} & r_{1j} \\ r_{21} & r_{22} & r_{23} & r_{2j} \\ \\ \\ r_{31} & r_{32} & r_{33} & r_{3j} \\ r_{11} & r_{12} & r_{13} & r_{ij} \end{vmatrix} \times \begin{vmatrix} P_{1y} \\ P_{2y} \\ \\ \\ P_{3y} \\ P_{jy} \end{vmatrix}$$

$$A = B \times C;\ \text{Then}\ C = B^{-1} . A,$$

Where, P_{iy} = Direct effect of the character i on the dependent trait y (cane yield).

The indirect effect of a particular character through other characters were obtained by multiplication of direct path and particular correlation co-efficient between those two characters, respectively.

$$\text{Indirect effect} = r_{ij} \times p_{jy}$$

Where,

$i = 1, \ldots\ldots\ldots\ldots n,$

$j = 1, \ldots\ldots\ldots\ldots\ldots n,$

$p_{1y} = p_{1y} \ldots\ldots\ldots\ldots\ldots p_{ny}$

Where, rij = Correlation co-efficient between two independent characters.

The residual effect is a composite variable that includes all other unaccounted factors affecting cane yield in this study and is assumed to be independent of remaining variables. It was calculated from the formula proposed by Wright (1921).

Residual effect (X) = $1\text{-}R^2$

Where, $R^2 = p_{iy}+r_{jy}+p_{2y}+ \ldots.p_{ny}.\ r_{ny}.$

R^2 is the required multiple correlation co-efficient and is the amount of variation in yield that can be accounted for by the yield component characters.

Chapter IV

Results and Discussion

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RESULTS AND DISCUSSION

The phenotypic and genotypic variations, heritability and genetic advance in percentage of mean for yield and yield contributing characters in sugarcane studied in the present investigation. The relationships between yield and yield contributing character and the relative contributions of yield attributes were also investigated through correlation and path coefficient analysis.

The results of the present study are discussed character-wise under the following headings:

A. The Variability, Heritability and Genetic Advance in percentage of mean

The analysis of variance (Appendix II) revealed significant variability in all the yield attributes under present study, indicating that all the genotypes differ from each other. Non significant replication variances were observed for Tiller per hectare, number of millable cane per hectare, number of millable cane per clump, stalk height, stalk girth, single stalk weight, number of green leaf, leaf length, leaf breadth, sucrose percentage and cane yield per hectare. The mean performances of the genotypes are presented in Table 2. The results are tested by Duncan's New Multiple Range Test (DMRT) for all the characters studied.

1. **Number of tillers per hectare**

The highest number of tillers per hectare were obtained in the clone I 27-02 followed by I 26-02, I 145-02 and I 163-02. These four clones were statistically identical to each other but significantly superior to the standard varieties Isd 16 and Isd 36. Lowest tillering genotype was K 88-65 and was statistically similar to I 54-02, I 85-02 and K 88-69 (Table 2).

The phenotypic variance was much higher than the genotypic variance (Table 3). This indicates considerable influence of environment was present on the trait. High genotypic and phenotypic coefficient of variation (30.30 % and 3.87 % respectively) were observed for this trait. Almost similar results were reported by Mian and Awal (1979). The magnitude of heritability in broad sense (HB) of this character was high (98.70) with high genetic advance (52.51) and genetic advance in percentage of mean (61.60 %) as compared to other yield contributing characters (Table 4). These indicated the possibility of involvement of additive effects in controlling these characters and suggested that good response might be obtained in selection for early tillering genotypes. Nair and Somarajan (1984) and Punia and Hooda (1982) have also reported high heritabilty, genetic variability and genetic advance for early tillering in sugarcane, which confirmed the results of present study. Early tillering genotype indicates that there is scope of early improvement through selection.

2. Number of millable canes per hectare (thousand)

The highest number of millable canes were obtained from the clone I 27-02 (114.66) which was statistically identical with I 145-02, I 100-02 and I 26-02 (table 2). On other hand, minimum number of millable cane were produced by standard variety Isd 16 and Isd 36. The lowest number of millable cane was found in K 88-65 (36.00) and was statistically similar to K 88-92, K 88-87 and VMC 84-549. The considerable difference between phenotypic and genotypic variances as well as phenotypic and genotypic coefficients of variation indicated considerable environment effect upon the expression of this trait. Such difference between phenotypic and genotypic variations in number of millable cane per hectare also observed by Singh and Sharma (1984). Number of millable cane per hectare showed low heritability (46.67 %) coupled with medium genetic advance in percentage of mean (27.74%). This indicated limited scope of improvement through selection for millable cane. These findings were also in agreement with the results obtained by Reddy and Reddy (1988).

3. Number of millable cane per clump

The highest number of millable cane per clump was found in I 65-02 and I 85-02 respectively followed by I 13-02, I 26-02 and I 55-02. These four clones were statistically identical to each other but significantly superior to the standard variety Isd 36. The lowest number of millable cane per clump was recorded I 54-02 and K 88-65 and found statistically similar to I 52-02, I 87-02, I 191-02 and K 84-69 (Table 2).

The phenotypic variance (4.3817) was higher than the genotypic variance (3.8397) showing considerable environment influence on this trait. High values of genotypic and phenotypic coefficients of variation (27.89 and 26.11 % respectively) along with heritablility (87.62 %) and genotypic advance in percentage of mean (50.36%) were observed which suggested that selection for this trait would be effective (Table 4). The millable cane per clamp is shown in Figure 2.

4. Stalk height

Maximum stalk height was observed in I191-02 (3.21m) which was, however, statistically identical with I 100-02 and I 87-02. Minimum height of stalk was exhibited by K 84-69 (1.57m) which had statistically similar height with K 88-87, K 88-65 and K 88-92 (Table 2). The phenotypic variance (0.112) was same as the genotypic variance (0.110) showing considerable environment influence on this trait. Low values of genotypic and phenotypic coefficients of variation (14.92 and 298.41 % respectively) along with low heritablility (98.75 %) and genotypic advance in percentage of mean (30.35%) were observed which suggested that selection for this trait would not be effective. Similar results were also reported by Singh *et al.*, (1981). Mian and Awal (1979) obtained low genotypic co-efficient of variation, low genetic advance in percentage of mean but height heritability for cane height which were in partial agreement with the present findings.

Figure 2. A clump of millable cane

5. Stalk girth

Maximum stalk girth (2.59 cm) was observed in I 81-02 which was statistically identical with the stalk girth of K 88-65, K 88-92 and K 84-69. The minimum stalk girth (1.00 cm) was found in I 163-02 and I 54-02 (Table 2). Phenotypic variance (0.3035) was higher than the genotypic variance (0.0655). This indicated the influence of environment on expression of the character. The character showed high heritability (21.58%) along with moderate genetic advance in percentage of mean (18.43 %) (Table 4), suggested limited scope for the improvement of this character through selection. Punia *et al.*, (1987) and Mohamed *et al.*, (1991) reported high heritablity for cane girth. Singh *et al.*, (1981) and Mian and Awal (1979) reported low genotypic and phenotypic co-efficients of variation, and low genetic advance in percentage of mean. These results confirmed the present findings.

6. Single stalk weight

The highest single stalk weight (1.55 kg) was obtained in I 87-02 and the lowest (0.63) in I 54-02 (Table 2). The genotypes K 88-65, K 88-92, I 55-02 and I 84-02 was statistically superior to the standard variety for this trait. The results indicated less difference between phenotypic and genotypic variances, suggested comparatively less environmental influence on this trait. High genotypic (19.32%) and high heritability (95.03) along with high genetic advance in percentage of mean (37.81%) indicated that there was considerable inherent variability among the genotypes and a good selection response might be expected. For this trait, high heritability with high genetic advance in percentage of mean were

Table 2. Mean performance of yield and yield contributing characters in sugarcane.

Genotypes	Number of tillers (1000/ha)	Number of mislabel canes (1000/ha)	No. of millable canes/ clump	Stalk height (m)	Stalk girth (cm)	Single stalk weight (kg)	No. of green leaf	Leaf length (m)	Leaf breadth (cm)	Cane yield (t/ha)	Sucrose percentage
I 13-02	115.667b	83.667b-e	10a-c	2.10k	1.10c	0.88hi	7e	0.44b	4.32h-k	73.90bcd	8.87a-d
I 18-02	104.833c	72.000b-f	8d-f	1.901	1.06c	0.72k	8d	0.50b	4.43g-k	51.53de	7.64l-g
I 20-02	57.833k	54.167fg	7gi	2.14jk	1.08c	1.02ef	11a	0.47b	3.92k-m	54.96cde	8.45a-g
I 26-02	118.167d	86.333bcd	10b-d	2.44c	1.15c	1.08de	8d	0.45b	4.50g-k	93.46ab	8.01c-g
I 27-02	146.500a	114.167a	9c-e	2.38c-e	1.25c	1.07de	10b	0.53b	5.32b-f	121.75a	7.93c-g
I 52-02	87.833fg	69.167b-f	5ij	2.26fg	1.24c	1.02de	9c	0.41b	4.92d-h	71.17bcd	8.09b-g
I 54-02	55.000k	54.667efg	4ik	2.11jk	1.02c	0.631	8d	0.51b	4.15i-l	34.27e	7.94c-g
I 55-02	108.333c	72.500b-f	10bc	2.15i-k	1.10c	1.10d	8d	0.49b	4.90d-i	80.13bcd	8.77a-e
I 65-02	69.333i	74.667b-f	11a	2.38c-f	1.18c	1.02def	8d	0.48b	4.33g-k	76.57bcd	7.37g
I 81-02	93.333de	73.000b-f	6h-i	2.30f	2.56a	0.78jk	8d	0.49b	4.86e-j	57.13cde	7.92c-g
I 84-02	94.500d	76.333b-f	8c-g	2.24gh	1.37bc	1.10d	8d	0.50b	5.39d-e	84.07bc	7.97c-g
I 85-02	60.667k	55.667b-f	11a	2.20hi	1.12c	0.90gh	11a	0.40b	4.63f-k	60.62ce	8.86a-d
I 87-02	87.667fg	77.667b-f	5ij	2.65b	1.48bc	1.55a	7e	0.46b	5.96b	121.10a	7.42fg
I 100-02	92.667def	90.667a-c	8c-j	2.70b	1.32bc	1.00ef	8d	0.52b	4.89d-h	93.75b	7.54e-g
I 140-02	71.167i	64.833c-f	7f-j	2.43cd	1.27c	0.98fg	9c	0.48b	4.01k-m	63.97b-e	8.93a-d
I 145-02	117.000b	94.167ab	8ef	2.43c-f	1.06c	0.82ij	10b	0.47b	3.34m	76.52bcd	9.37ab
I 163-02	116.500b	67.500b-f	7g-i	2.44c	1.00c	0.80j	8d	0.47b	5.62bcd	54.92cde	8.70a-f
I 191-02	84.667g	74.500b-f	8c-j	3.21a	1.09c	0.86hij	8d	0.53b	5.82bc	63.49b-e	8.93a-d
I 193-02	85.167g	57.500d-g	5ij	2.37c	1.18c	1.00ef	9c	0.46b	5.04d-h	57.49cd	8.66a-g
K88-65	30.333l	30.000g	4k	1.84m	2.21ab	1.37b	7e	0.53b	7.17a	49.77de	8.54a-g
K84-69	56.833k	56.000e-g	5ij	1.57o	1.77abc	0.98fg	9c	0.51b	5.02d-h	55.28cde	7.99c-g
K 88-87	71.333i	53.000fg	6ghi	1.64n	1.72abc	0.98fg	7e	0.49b	5.09c-g	52.25ced	9.45a
K 88-92	63.333j	52.667fg	6ghj	1.81m	1.79abc	1.18c	9c	0.59b	5.36b-h	62.33cde	7.65d-g
VMC 71-238	67.333k	60.833d-g	8c-g	2.12jk	1.12c	0.90h	10b	0.49b	3.50hn	57.41cde	8.56a-g
VMC 84-549	78.833h	54.500e-g	8c-g	2.25fh	1.29bc	1.05def	8d	2.11a	4.86d-i	57.33cde	8.99abc
Isd 36	92.167gef	61.000d-g	8c-g	2.18ij	1.15c	0.90h	8d	0.49b	4.08j-l	54.92cde	9.13abc
Isd 16	88.333efg	65.500b-f	10a-c	2.38de	1.16c	0.92fgh	11a	0.50b	4.13j-l	59.98cde	9.02abc

In column meant followed by common letter do not differ significantly the 1% level by DMRT

Table 3. Range, Population mean, Phenotypic and genotypic variance for different characters in sugarcane

Characters	Range	Mean ±se(m)	Phenotypic variance (δ^2 ph)	Genotypic variance (δ^2 g)
Number of tillers (1000/ha)	30.00-150.33	85.235±0.3273	666.9640	658.2850
Number of millable cane (1000/ha)	30.00-156.00	69.284±1.6221	399.6580	186.5260
Number of millable canes/ clump	4.00-14.00	7.506±0.0818	4.3817	3.8397
Stalk height (m)	1.57-3.30	2.246±0.0035	0.1123	0.1109
Stalk girth (cm)	1.00-5.54	1.329±0.0542	0.3035	0.0655
Single stalk weight (kg)	0.63-1.63	0.985±0.0050	0.0362	0.0344
No. of green leaf	7.00-11.30	8.543±0.0251	1.4370	1.3860
Leaf length (m)	0.40-5.28	0.549±0.0586	0.2837	0.0057
Leaf breadth (cm)	3.50-8.35	4.799±0.0442	0.7700	0.6120
Cane yield (t/ha)	34.27-169.07	68.149±1.7770	590.5860	334.8030
Sucrose percentage	7.37-11.49	8.40±0.0732	0.6685	0.2342

Table 4. Estimates of genotypic and phenotypic coefficients of variation, heritability, genetic advance and genetic advance in percentage of mean for different character in sugarcane

Characters	Coefficients of variation (%)		Heritability in broad sense (%)	Genetic advance (%)	Genetic advance in percentage of mean
	Genotypic	Phenotypic			
Number of tillers (1000/ha)	30.30	3.87	98.70	52.51	61.60
Number of millable cane 1000/ha)	28.85	5.00	46.67	19.22	27.74
Number of millable cane/clump	27.89	26.11	87.62	3.78	50.36
Stalk height (m)	14.92	298.41	98.75	0.68	30.35
Stalk girth (cm)	41.45	181.52	21.58	0.24	18.43
Single stalk weight (kg)	19.32	525.59	95.03	0.37	37.81
No. of green leaf	14.03	83.42	96.45	2.38	27.88
Leaf length (m)	97.02	187.75	2.00	0.02	3.99
Leaf breadth (cm)	18.28	113.96	79.48	1.44	29.94
Cane yield (t/ha)	35.66	4.11	56.69	28.38	41.64
Sucrose percentage	9.73	122.31	35.03	0.59	7.02

7. Number of green leaf

The highest number of green leaf were found in the clones I 20-02 (11) and I 85-02 (11). The second highest number of green leaf observed in Isd 16 (standard), I 27-02 and

I 145-02. The lowest number of green leaf produced in I 13-02, I 87-02, K 88-65 and

K 88-87. The phenotypic variance (1.4370) was higher than the genotypic variance (1.3860) showing considerable environment influence on this trait. High values of genotypic and phenotypic coefficients of variation (14.03 and 83.42 % respectively) along with high heritablility (96.45 %) and genotypic advance in percentage of mean (27.88%) were observed which suggested that selection for this trait would be effective or beneficial.

8. Leaf length

The maximum leaf length was found in VMC 84-549 (2.11 m) followed by K 88-92,K 88-65, I 191-02 and I 27-02. The minimum leaf length was found in I 85-02 (0.4m). The phenotypic variance (0.2837) was higher than the genotypic variance (0.0057). This indicated the existence of influence of environment on the expression of the character. The character showed high heritability (2.00%) along with genetic advance in percentage of mean (27.88) (Table 4) suggested that there is scope for the improvement of this character through selection.

9. Leaf breadth

The maximum leaf breadth (cm) was found in the genotype K 88-65 (7.16 cm) followed by I 87-02 and I 191-02. The phenotypic variance (0.7700) was higher than the genotypic variance (0.6120). This indicated the existence of influence of environment on the expression of the character. Genotypic and phenotypic coefficients of variation (18.28 and 113.69 % respectively) along with heritablility (79.48 %) and genotypic advance in percentage of mean (29.94%) were observed which suggested that there is scope for the improvement of the character through selection.

10. Cane yield per hectare

The genotype I 27-02 produced the highest cane yield per hectare (121.80 t/ha) which was statistically identical with I 87-02 and I 100-02 (Table 2). The genotype I 54-02 produced the lowest cane yield per hectare (34.27t/ha) among the materials studied. The mean values of the genotypes showed wide range of variation from 159.5 to 24.7 t/ha. The difference between genotypic and phenotypic variance was very high indicating very much influence of environment for this character. Moderate genotypic co-efficient of variation (35.66) was observed for this trait, which indicated the existence of inherent variability among the genotypes. This trait possibly has high potential for selection. More or less similar results were also reported by Punia *et al.*, (1987) and Mohamed *et al.*, (1991).

Moderate heritability (56.69 %) and high genetic advanced in percentage of mean (41.64 %) were obtained for cane yield per hectare. The results suggest that improvement of ultimate yield may be possible through a partial emphasis on yield per hectare during selection. Similar results of high genetic advance in percentage of mean for this trait have also been reported by Chaudhary *et al.*, (1983) and Singh and Sharma (1984).

11. Sucrose percentage

The maximum sucrose percentage was recorded in standard variety Isd 36 and Isd 16 (9.13 %) and (9.02 %) respectively, while the lowest sucrose percentage (7.36 %) was recorded in I 65-02. The findings of Nair and Somarajan confirmed the present result. The test variety K 88-87 produced highest sucrose percentage 9.45 in compare to standard. The second highest sucrose content was about in I 145-02. It indicates that there is no variation exists among the test clones and standard.

B. Inter relationship of characters

Genotypic and phenotypic correlation coefficients between cane yield and its component characters are presented in Table 5. In most case, the genotypic correlation coefficients appeared to be higher than the corresponding phenotypic correlation coefficients. This may be due to the modification of phenotypic expression by environmental influence at genetic level (Salehuzzaman *et al.*, 1979 and Deshmukh *et al.*, 1986): Mannan and Ghafur (1983) and Reddy (1986). The correlation coefficients between number of tillers per hectare, number of millable cane per clump, stalk hight, single stalk weight and cane yield were highly positive significant; significant negative correlation with stalk girth and sucrose percentage. This indicated that the environmental conditions have contributed considerably in enhancing the relationships between these characters. This pattern is distinctly different from the cases obtained in all other combinations where genotypic correlation coefficient values were more than those of phenotypic ones. A higher magnitude of genotypic correlation than corresponding phenotypic values revealed that the environmental factors affected both variables taken at a time at random indicating lack or weak association at environmental level. However, higher magnitude of genotypic correlation also indicates a good extent of strong inherent association between different characters.

1. Number of tillers per hectare

Number of tillers per hectare showed highly significant positive correlation with the number of millable cane and cane yield; significant negative correlation with stalk girth. Significant positive correlation was found with number of millable cane per clump and cane yield. This indicated the positive effectiveness of directional selection for this character for the improvement of cane yield. In support of the present study, many authors reported significant positive relationship between the number of tillers and cane yield (Singh *et al.*, 1984; Chauhan *et al.*, 1987; and Gajera *et al.*, 1991).

2. **Number of millable canes per hectare**

Number of millable cane per hectare had highly significant positive correlation with number of millable cane per clump (genotypic level), stalk height and cane yield per hectare at genotypic and phenotypic level. The character showed significant negative correlation with stalk girth at genotypic level. Significant positive correlation of cane yield with the number of millable canes per hectare indicated the effectiveness for directional selection for the genetic improvement of cane yield in sugarcane. Significant positive correlation between the number of millable canes and cane yield was reported by Mannan and Ghafur (1983); Singh *et al.*, (1984; Chauhan *et al.*, (1987); Reddy and Reddy (1988) and Gajera *et al.*, (1991). All these information's were in agreement with the present findings.

3. **Number of millable canes per clump**

Number of millable canes per clump had highly significant negative correlation with stalk girth at genotypic level and highly significant negative correlation with leaf breadth at genotypic and phenotypic level (Table 5).

4. **Stalk height**

Stalk height showed highly significant positive correlation with cane yield and significant negatively correlated with stalk girth at phenotypic level. The results clearly indicated that tall plant produces more yield (Table 5).

Khairwal and Babu (1975) reported significant positive correlation between cane height and cane yield. Mannan and Ghafur (1983) and Gajera *et al.*, (1991), which substantiated the present observations. On the other hand, stalk height showed non-significant positive association with the stalk girth and sucrose percentage. Balasundaram and Bhagyalakshmi (1979) reported similar results in their correlation studies in sugarcane, which confirmed the present findings.

5. Stalk girth

Stalk girth showed highly significant positive correlation with the leaf breadth and significant positive correlation with single stalk weight. Significant negative correlation with number of green leaf and sucrose percentage at genotypic level (Table 5). Singh *et al.*, (1981) and Rai *et al.*, (1988) reported significant positive correlation between stalk girth and single stalk weight. Lu (1984) observed significant correlation's both for single stalk weight and cane yield with cane girth. All these findings supported the present results.

6. Single stalk weight

Single stalk weight had highly significant positive correlation with cane yield and leaf breadth at genotypic and phenotypic level. Significant positive correlation between the single stalk weight and cane yield was reported by Khairwal and Babu (1975) and. Mannan and Ghafur (1983) (Table 5).

7. No. of green leaf

Number of green leaf had highly significant negative correlation with leaf breadth at genotypic; significant negative correlation at phenotypic level and significant negative correlated with leaf length at genotypic level (Table 5).

8. Leaf length

Leaf length had highly significant positive correlation with sucrose percentage and highly significant negative correlation with yield at genotypic level (Table 5).

9. Sucrose percentage

Sucrose percentage had highly significant negative correlation with cane yield at genotypic level, Negative correlation between the sucrose percentage and cane yield also reported by Khairwal and Babu (1975) and Reddy (1986), which is in partial agreement with the results of the present study (Table 5).

Table 5. Genotypic and phenotypic correlation coefficients among yield and yield contributing characters in sugarcane.

Characters		Number of tillers (1000/ha)	No. of millable canes (1000/ha)	No. of millable canes/ clump	Stalk height (m)	Stalk girth (cm)	Single stalk weight (kg)	No. of green leaf	Leaf length (m)	Leaf breadth (cm)	Sucrose percentage	Cane yield (t/ha)
Number of tillers (1000/ha)	G	1										
	P	1										
Number of millable cane (1000/ha)	G	0.97380**	1									
	P	0.63534**	1									
Number of millable canes/clump	G	0.45564*	0.59431**	1								
	P	0.41269*	0.42905*	1								
Stalk height (m)	G	0.37569	0.62336**	0.2348	1							
	P	0.37052	0.39661*	0.2202	1							
Stalk girth(cm)	G	-0.4921**	-0.56912**	-0.7966**	-0.52364**	1						
	P	-0.22078	-0.14431	-0.2681	-0.24287	1						
Single stalk weight (kg)	G	-0.15942	-0.11600	-0.1973	-0.01121	0.4600*	1					
	P	-0.15185	-0.03961	-0.1765	-0.00835	0.2380	1					
No. of green leaf	G	-0.02733	0.15143	0.3010	0.03053	-0.4342*	-0.2230	1				
	P	-0.02878	0.10204	0.2877	0.02838	-0.2006	-0.2161	1				
Leaf length (m)	G	-0.26524	-1.07429	-0.13829	-0.00287	0.3335	0.2957	-0.4864*	1			
	P	-0.03985	-0.07192	0.01892	-0.01634	-0.0156	0.0605	-0.0630	1			
Leaf breadth (cm)	G	-0.12678	-0.24506	-0.4694*	0.03051	0.7402**	0.6095**	-0.5590**	0.13926	1		
	P	-0.11223	-0.13243	-0.384*	0.01733	0.3298	0.5348**	-0.4659**	0.05204	1		
Sucrose percentage	G	-0.00448	-0.35955	0.2174	-0.03005	-0.4525*	-0.3482	0.2493	0.5677**	-0.285257	1	
	P	0.01629	-0.11057	0.0598	-0.00758	-0.0796	-0.1711	0.1246	0.12679	-0.166834	1	
Cane yield (t/ha)	G	0.66207**	0.72843**	0.3277	0.49740**	-0.2085	0.5884**	-0.0369	-0.1413**	0.1907	0.5899**	1
	P	0.4776*	0.83089**	0.2706	0.35318	-0.0222	0.4959**	-0.0245	-0.0303	0.1554	-0.1976	1

G = Genotypic correlation coefficients

P = Phenotypic correlation coefficients

*= Significant at 5% level

**= Significant at 1% level

C. Path Coefficient Analysis

The relationships between cane yield with its component characters were further analyzed by path coefficient analysis. In this system, the association was partitioned into direct and indirect effects. It helps to ascertain the effects of each and every character to yield through direct and alternate pathways. Therefore, path coefficient analysis could be a more effective method for use in selection programme. Path coefficient analysis performed using genotypic correlations, cane yield was considered as a resultant variable and number of tillers per hectare, number of millable canes per hectare, height of stalk, cane girth, single stalk weight and sucrose percentage as casual variables. Estimates of direct and indirect effects of these characters on cane yield per hectare of sugarcane are presented in Table 6.

1. Cane yield vs. number of tillers

Number of tillers per hectare had negative direct effect (-0.173682) on cane yield and high indirect positive effect via number of millable cane per hectare (0.760481). Rest of the characters had negligible indirect positive or negative influence on cane yield. The genotypic correlation of number tillers per hectare with cane yield per hectare was positive and considerably high in magnitude. According to Chauhan *et al.*, (1987) number of tillers had positive direct effect on cane yield but it affected cane yield indirectly in positive direction via number of millable cane. Their finding partially supported the present results.

2. Cane yield vs. number of millable canes

Number of millable canes per hectare showed positive direct effect (0.780940) on cane yield per hectare. It had indirect high negative effect via the number of tillers per hectare (-0.169132). Effects of other characters were negligible and influenced cane yield positively or negatively. The genotypic correlation with cane yield was positive mainly due to positive direct effect of number of millable canes per hectare plus positive indirect effect of other characters. The results indicated that increased in number of millable canes per hectare increased the cane yield mostly through increasing positive indirect effect of other characters. Similar direct positive effect of number of millable canes on cane yield was reported by Khairwal and Babu (1975); Mannan and Ghafur(1983) and Chauhan *et al.*, (1987) which was consistent with the present study.

3. **Cane yield vs. Number of millable cane per clump**

Number of millable cane per clump was positive direct effect (0.076199) on cane yield. The high indirect effect was (0.464132) via number of millable cane per hectare. The genotypic correlation with cane yield was positive. Hence, selection should be practiced for those clones, which have large number of millable canes/clump in order to improve cane yield. Almost all traits on number of millable cane per clump had direct effect on sucrose content (Sharma and Singh, 1984).

4. Cane yield vs. stalk height

Height of stalk had negative direct effect (-0.031768) on cane yield. The positive indirect effect was observed via number of millable cane per hectare (0.486803) and negligible sucrose percentage (0.000865). The indirect effects via some of the characters were positive and some of were negative but negligible. The direct effect was negative and the total effect was positive. The negative direct effect was mainly counter balanced by indirect positive effect through the number of millable cane per hectare. This indicated that selection for more number of millable cane would give better response in the improvement of cane yield in sugarcane. Khairwal and Babu (1975) also reported negligible direct effect; which contradicted the present finding.

5. Cane yield vs. stalk girth

The direct effect of stalk girth (0.190154) on cane yield was positive. The positive direct effect indicated that varieties with high stalk girth could be developed without sacrificing cane yield per hectare. The character showed high negative indirect effect via number of millable cane per hectare (-0.444448) on cane yield. The remaining causal variables showed negligible negative indirect effects for this character on cane yield.

6. Cane yield vs. number of green leaf

Number of green leaf was found negative direct effect (-0.065004) on cane yield. The high positive indirect effect via millable cane per hectare was (0.118256) and low positive effect of (0.00583) via leaf length followed by sucrose percentage was negative (-0.007180). The genotypic correlation with cane yield was negative.

7. Cane yield vs. leaf length

Direct effect of leaf length (-0.001198) on cane yield was negative. The high negative indirect effect via millable cane per hectare was (-0.838956) and (-

0.016349) via sucrose percentage. The genotypic correlation with cane yield was negative. This mainly due to negative direct effect of leaf length and negative indirect effect of millable cane per hectare and sucrose percentage and other character was direct and indirect effect.

8. Cane yield vs. leaf breadth

Direct effect of leaf breadth (-0.074373) on cane yield was negative. The indirect effect was (0.496186) via single stalk weight followed by number of green leaf (0.36336). The genotypic correlation of leaf breadth with cane yield per hectare was positive.

9. Cane yield Vs. Single stalk weight

High positive direct effect (0.814045) was exhibited by single cane weight on cane yield. It also showed indirect positive effect via number of green leaf (0.014493). The indirect effects via number of tillers per hectare (0.027688) by stalk girth (0.087466). Indirect influences of remaining traits were negligible and influenced cane yield both in negative and positive way. The genotypic correlation between single stalk weight and cane yield was significantly positive; which was mainly owing to the highest positive direct effect of single cane weight. From path analysis and correlation studies it is evident that improvement of cane yield would be highly effective by directional selection for more single stalk weight in sugarcane. Positive direct effect of the single stalk weight on cane yield was also reported by Khairwal and Babu (1975); Lu (1984) and Kang *et al.*, (1990), which substantiated the present findings.

10. Cane yield Vs Sucrose percentage

Sucrose percentage had negative direct effect (-0.028800) on cane yield and indirect effect via the number of single stalk weight (-0.283424) followed by negative indirect effect via number of millable cane per hectare (-0.28789). It also showed positive indirect effect through number of green leaf (-0.016207). Other effects were both negative and positive but negligible. The genotypic correlation of sucrose percentage with cane yield was negative and considerably low in magnitude. Negative direct effect of sucrose percentage on cane yield was also reported by Khairwal and Babu (1975). This supported the findings of the present investigation.

Table 6. Path coefficient analysis of yield and yield contributing characters based on genotypic correlation coefficients of cane yield per hectare.

Characters	Number of tillers 1000/ha	No.of millable canes (1000/ha)	No. of millable canes/ clump	Stalk height (m)	Stalk girth (cm)	Single stalk weight (kg)	No. of green leaf	Leaf length (m)	Leaf breadth (cm)	Sucrose percentage	Genotypic correlation coefficient of cane yield /ha
Number of tillers (1000/ha)	**-0.173682**	0.760481	0.034719	-0.011935	-0.093586	-0.129772	0.001777	0.000318	0.009429	0.000128	0.662
Number of millable cane(1000/ha)	-0.169132	**0.780940**	0.045286	-0.019802	-0.108220	-0.094428	-0.009843	0.001287	0.018226	0.010355	0.728
Number of millable canes/clump	-0.079136	0.464122	**0.076199**	-0.007460	-0.151481	-0.160646	-0.019566	0.000166	0.034912	-0.006260	0.328
Stalk height (m)	-0.065251	0.486803	0.017895	**-0.031768**	-0.099572	-0.009122	-0.001985	0.000003	-0.002269	0.000865	0.497
Stalk girth (cm)	0.085479	-0.444448	-0.060702	0.016635	**0.190154**	0.374439	0.028224	-0.000399	-0.055048	0.013032	-0.209
Single stalk weight (kg)	0.027688	-0.090588	-0.015037	0.000356	0.087466	**0.814045**	0.014493	-0.000354	-0.045333	0.010027	0.588
No. of green leaf	0.004747	0.118256	0.022936	-0.000970	-0.082563	-0.181496	**-0.065004**	0.000583	0.021215	-0.007180	-0.037
Leaf length (m)	0.046067	-0.838956	-0.010538	-0.031768	0.063408	0.240694	0.031619	**-0.001198**	0.041573	-0.016349	-0.641
Leaf breadth (cm)	0.022019	-0.191380	-0.035770	0.016635	0.140747	0.496186	0.36336	-0.000167	**-0.074373**	0.008215	0.191
Sucrose percentage	0.000774	-0.280789	0.016563	0.000954	-0.086045	-0.283424	-0.016207	-0.000680	0.021215	**-0.028800**	-0.590

Under line figure indicate direct effect

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna, during the cropping season of 2005-2006. Twenty seven (27) sugarcane clones were included as experimental materials of which two was considered as standard varieties. The remaining 25 were promising clones supplied by the Breeding Division, BSRI, Ishurdi, Pabna. Out of 25 clones of which 19 were indigenous and 6 were exotic. The selected clones were planted in 6m x 5m plot in RCBD design with 3 replications. Intercultural operations were done as and when required. The study was undertaken to evaluate the existing variations, the inter relationships of some important yield contributing characters with cane yield and their direct and indirect contributions towards cane yield.

The analysis of variances revealed significant mean squares for different characters indicated the presence of sufficient variation among the genotypes for cane yield and its component characters. The genotype I 27-02 produced the highest number of tillers and number of millable canes per hectare. The highest number of millable canes per clump was found in I 65-02 and I 85-02. The minimum number of millable cane per clump was recorded I 54-02 and K 88-65. The tallest genotype was I 191-02 and the shortest genotype was K 84-69. Maximum stalk girth was found the I 81-02 and single stalk weight were obtained from the genotype I 87-02, while the highest cane

yield per hectare was found in the genotype I 27-02 followed by I 87-02 and I 100-02 (Table 2). The miximum number of green leaf were found in the clones I 20-02 and I 85-02 (11). The minimum number of green leaf was produced the genotype I 13-02, I 87-02, K 88-65 and K 88-87, respectively. The maximum leaf length was found in VMC 84-549 (2.11 m) followed by K 88-92, K 88-65, I 191-02 and I 27-02. The minimum leaf length was found in the genotype I 85-02 (0.4m). The widest leaf breadth was found in the genotype K 88-65 (7.16 cm) followed by I 87-02 and I 191-02 respectively. The test variety K 88-87 produced maximum sucrose percentage (9.45%) in compare to standard varieties Isd 36 (9.13%) and Isd 16 (9.02%), respectively. The minimum sucrose content was obtained in I 65-02 (7.36%). It indicates that there is no variation among the test clones and standard. The study also showed that the K 88-87 had the highest potentiality for sucrose percentage among the genotypes studied. But the genotype I 27-02 could be considered as best genotype because of having maximum number of tillers, number of millable canes and cane yield per hectare. This genotype was statistically similar with the maximum yielding genotype I 87-02 in respect of stalk girth and single stalk weight.

Wide range of variations were observed for number of tillers per hectare, number of millable canes per hectare and cane yield per hectare. The genotypic coefficient of variation was high for leaf length, cane yield and number of tillers per hectare; moderate for number of millable canes per hectare and number of millable canes per clump; and low for the rest of the characters. Highest and lowest genotypic coefficients of variation were observed for leaf length and sucrose percentage respectively. Heritability estimates were high for stalk height, number of tiller per hectare, number of green leaf and single stalk weight. The value was moderate for number of millable canes per clump and leaf breadth, while the rest of the traits showed low heritability. Highest and lowest heritability was found in stalk height and leaf length, respectively. High genetic advance was observed in number of tillers per hectare and cane yield; the values of moderate number of millable canes per clump and number of green leaf and low for rest of the characters studied.

Genetic advance in percentage of mean was high for number of tillers, number of millable canes and cane yield per hectare; moderate for single stalk weight and stalk height; and low for the rest of the characters studied. Genotypic and phenotypic correlation coefficients among the characters were studied to determine the association between yield and yield components. In general, the genotypic correlations were higher than the corresponding phenotypic correlation in most cases, suggesting that there was fairly a strong inherent relationship between the characters. The correlation coefficients between the number of tillers per hectare, number of millable canes per hectare, number of millable canes per clump, stalk height, single stalk weight, leaf length and cane yield were highly positive significant, but sucrose percentage and number of green leaf had highly significant negative correlation with cane yield.

Path coefficient analysis revealed that the number of millable canes per hectare had maximum positive direct effect on cane yield followed by single stalk weight. Number of tillers per hectare had negative direct effect on cane yield and high indirect positive effect via number of millable canes per hectare. The genotypic correlation of number tillers per hectare with cane yield per hectare was positive and considerably high in magnitude. Number of millable canes per hectare and number of millable cane per clump were showed positive direct effect on cane yield. The high indirect effect was via number of millable cane per hectare. Height of stalk had negative direct effect on cane yield. The positive indirect effect was observed via number of millable cane per hectare and negligible sucrose percentage. This indicated that selection for more number of millable cane would give better response in the improvement of cane yield in sugarcane. The direct effect of stalk girth on cane yield was positive. Number of green leaf was found negative direct effect on cane yield. The high positive indirect effect via millable cane per hectare and low positive effect of via leaf length followed by sucrose percentage was negative. The genotypic correlation with cane yield was negative. Direct effect of leaf length on cane yield was negative.

The results of path coefficient studies indicated that number of millable canes per hectare and single stalk weight were the most important contributors to cane yield per hectare. These characters could be chosen as selection criteria for the improvement of cane yield in sugarcane.

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Appendices

Appendix I. Meteorological data during the growing season of sugarcane (December 2005 to December 2006)

Month/Year	Average Temperature (0^0c)		Dew point (^{0}c)	Humidity (%)	Total rainfall (mm)	Bright Sun shine (hours)	Evaporation (mm)
	Max	Min					
December' 05	25.03	13.32	14.26	82.46	0.00	6.90	2.24
January' 06	24.29	11.00	12.85	84.18	0.00	5.51	2.20
February' 06	31.61	16.93	18.72	85.57	0.00	7.72	2.66
March' 06	33.98	19.40	20.71	79.03	0.00	8.46	4.63
April' 06	35.70	23.67	24.83	82.88	91.94	7.51	5.28
May' 06	35.27	24.66	25.45	83.73	127.20	7.08	5.95
June' 06	33.87	26.23	26.63	86.57	146.28	4.66	4.49
July' 06	32.55	26.50	26.57	88.26	188.98	5.16	5.09
August' 06	33.24	26.48	26.67	88.72	178.08	5.99	4.94
September' 06	32.38	25.77	26.48	90.26	289.15	5.08	4.09
October' 06	32.26	24.10	24.93	85.86	4.77	7.83	3.12
November' 06	28.88	18.67	19.67	84.30	0.00	6.22	2.48
December' 06	25.68	13.74	15.02	83.04	0.00	5.88	2.38

Weather record at Bangladesh Sugarcane Research Institute. Weather Yard, Ishurdi, Pabna.

Appendix II. Analysis of variance of yield contributing characters in sugarcane

Sources of variation	Degree of freedom	Mean sum of squares value										
		Number of tillers (1000/ha)	Number of millable canes (1000/ha)	Number of millable canes/ clump	Stalk height (m)	Stalk girth (cm)	Single stalk weight (kg)	Cane yield (t/ha)	No. of green leaf	Leaf length (m)	Leaf breadth (cm)	Sucrose percentage
Replication	2	4.688	3265.559	0.235	0.00782	0.24091	0.01013	3757.874	0.01235	0.2772	0.29272	2.875
Genotypes	26	1983.53**	772.71**	12.061**	0.33407**	0.43456*	0.10508**	1260.192**	4.20893**	0.29509ns	1.9929**	1.137**
Error	52	8.679	213.132	0.542	0.00147	0.23801	0.00176	255.783	0.05081	0.27834	0.15784	0.434

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