International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1315-1320

Received: 16-01-2019
Accepted: 19-02-2019

Dr. Balwant Kumar
Plant Breeding and Genetics,
S.R.I., Dr. R.P.C.A.U., Pusa,
Bihar, Samastipur, Bihar, India

Correspondence
Dr. Balwant Kumar
Plant Breeding and Genetics,
S.R.I., Dr. R.P.C.A.U., Pusa,
Bihar, Samastipur, Bihar, India

Variability studies and frequency distribution for yield and juice quality traits of sugarcane ratoon under water logged situation

Dr. Balwant Kumar

Abstract
In an experiment, ratoon of sixteen sugarcane clones including two checks were evaluated during 2013-14under low land area where its grand growth phase coincides with water stagnation depth 40-45 cm for three months at Paddy Block, RPCAU Pusa Farm, Samastipur, Bihar to study the variability and frequency distribution for yield and juice quality traits. Wide ranges of the frequency distribution and highly significant variations amongst ratoon of 16 clones were found for the traits *viz*, number of Shoots at 120 days, plant height at 150, 240, and at harvest, cane diameter at harvest, NMC at harvest, single cane weight at harvest, brix % at 9 & 11 month, pol % in juice at 9 & 11 month, purity % at 9 & 11 month, CCS percent at 11 month, cane yield at harvest and CCS t/ha at harvest. The phenotypic variances for all the traits were exhibited higher than the genotypic variances due to major role of non-genetic factors. High values of phenotypic and genotypic coefficient of variation coupled with high heritability and high genetic advance percentage as mean were observed for the traits *viz,* CCS t/ha at harvest, cane yield at harvest, plant height at 240 days and number of shoots at 120 days. Moderate values of PCV and GCV along with high heritability and high genetic advance percentage as mean were recorded for the traits *viz* plant height at harvest, single cane weight NMC and plant height at 150 days. High heritability coupled with high genetic advance percentage as mean showed by the traits *namely*, CCS t/ha, plant height at 240 days, cane yield, number of shoot at 120 days, plant height at harvest, cane diameter, single cane weight, plant height at 150 days and NMC indicating role of dominant genetic effect in determining of these traits therefore, all these nine traits can be used for further sugarcane improvement of ratoon crops under water logging condition.

Keywords: ratoon of sugarcane, variability, genetic parameters, heritability, frequency distribution

1. Introduction
Plant and ratoon crops of sugarcane have contributed towards cane and sugar production of the country, as we know more than 50% of total sugarcane cropped area has been kept under ratoon crop. There are many benefits of rationing such as crop matures earlier and also decrease the cost of field preparation, preparatory irrigation as well as seed cane used for planting. A practice of growing full crop of sugarcane from sprouts of underground stubbles left in the field after harvest of the plant crop is called ratoon of sugarcane. Its contribution to the total cane production is about 25 to 30% (Rehman and Ehsanullah, 2008) [15]. However, more than 35% of its productivity is lost due to improper attention of the farmers towards ratoons (Malik, 1997) [13]. Naturally, the productivity of ratoon is 10 to 30% less than the plant crop of sugarcane. Low yield of ratoon crop is mainly due to low and differential ratooning potential of cultivars under water logging. However, cost of production in ratoon sugarcane ranges between 25 to 30% less than the plant crop because it saves seed material cost so water logging tolerant good ratooner varieties bearing high cane and sugar yield will favour to enhance productivity and sugar recovery. Sugarcane cultivation and its proper production in Bihar has been facing several challenges and most of the sugarcane industries are closed since last three to four decade due to various reason, among them major is 1.00 lakh hectare of sugarcane growing area in Bihar is prone to water-logging situation resulting low productivity and sugar recovery. Problem of water-logging is not only persist in Bihar rather a considerable area under sugarcane crop in several parts of country *viz*, Assam, West Bengal, eastern Uttar Pradesh, coastal region of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka are exposed to stagnant water for two to three months during rainy season. A large difference in varietal

response to water-logging in sugarcane has been reported as we know that varieties differ in degree of tolerance to water-logging based on certain inherent genetic characteristics, age of the crops and other growing conditions. The ratoon crop of BO91, BO 110 and BO147 have been found comparatively well under water-logging situation while some new genotypes of sugarcane in the present investigation performed better for yield and juice quality prevailing such situation in Bihar. Presently 30% area covered by sugarcane varieties *viz* BO91, BO110 and BO 147bearing tolerant to water logging out of these two BO91 and BO 147 used as checks in the experiment along with new genotypes for evaluation. The ratooning and tolerance ability are the inherent potential of some of the clone which must be evaluate under water logging and select the best one to solve the reasons for low cane yield of ratoon crop. Therefore, the present study was conducted to explore the variability of ratoon crop of sugarcane for yield and juice quality traits and its frequency distribution.

2. Materials and Methods

The designed study of present investigation was conducted to assess the variability for yield and juice quality traits among the ratoon of 16 sixteen sugarcane genotypes *namely,*BO153, BO141, CoSe96436, CoX07067, CoP081, CoP091, CoP02061, CoP111, CoP04181, BO155, BO154, BO146, CoP092 (CoP 09437), CoLk94184 including two checks BO 147 and BO 91 of the crop season 2013-14 at Paddy Block, RPCAU Pusa Farm, Samastipur, Bihar which were already planted in RBD with three replications during 2012-13 under low land area where its grand growth phase coincides with water-stagnation depth 40-45 cm for more than two months and after harvesting the plant crop first ratoon was left again the same condition of water stagnation was prevailed for ratoon crop during 2013-14. The underground stubbles left in the field after harvest of all the sixteen clones were allow to growing as ratoon follow all agronomical package and practices for ratoon crop and rows saving were done for proper shoot emergence. The plot size of 6 rows of 6 meters length each with a spacing of 0.90 meter between rows as the net plot size was 32.4 m^2. The observations were recorded for the traits *viz*, number of Shoots at 120 days, plant height at 150,240 and 330 days (at harvest), cane diameter at harvest, number of millable cane (NMC) at harvest, single cane weight at harvest, brix%, pol % in juice and purity % at 9 and 11 month (harvest), CCS Per cent at harvest, Cane yield at harvest and CCS t/ha at harvest of sugarcane ratoon crop under water logging condition. Observations were record by selecting five random plants per genotype per replication for cane yield and yield attributing characters. For Juice quality traits Brix % is a measure of total soluble solids present in the juice. It was taken directly by using a Brix hygrometer. In measuring cylinder 250 ml juice was taken and hygrometer dip into the juice then reading was recorded from the juice level after that corrected it to the temperature at 20°C by using temperature correction chart as described by Spencer and Meade (1955) [18]. Pol % refers to the sucrose per cent in juice. It was estimated with the help of Polari scope. At first in the conical flask 100 ml juice was taken and 4 gm Honey dry lead sub acetate was added and mixed well by shaking the flask. After few minutes this solution was filtered twice through a dry Whatsman no. 1 filter paper and the abstract was collected into a clean and dry beaker. The abstract poured into the Polari meter tube. These tubes were placed in the Polari scope. Thereafter Pol values were recorded by polarising the clear juice in Polari scope this value called dial reading. Sucrose per cent in juice was obtained by referring the brix and dial reading to Schmitz's table. Observed data for yield and juice quality traits of sixteen sugarcane ratoon were assessed for statistical analysis as follow Variance components Genotypic and phenotypic level were estimated with the help formulae

Genotypic Variance (σg^2) = (VMSS – EMSS) x CF

Phenotypic variance (σp^2) = σg^2 + EMS

Coefficient of variation for genotypic and phenotypic coefficient were computed for each character as per method suggested by Burton and De Vane (1953) [2].

Genotypic Coefficient of Variation

GCV = genotypic standard deviation (σg) divided by grand mean of the character x 100

Phenotypic Coefficient of Variation

PCV = Phenotypic standard deviation (σp) divided by grand mean of the character x 100

Heritability (h^2) was estimated in broad sense by using formula as suggested by Lush (1949) [12].

h^2 = Genotypic variances (σg^2) divided by Phenotypic variances (σp^2) x 100

Genetic advance (GA) computed by the formulae given by Johnson *et al*., (1955) [7].

GA = h^2 K. σp Where, h^2= Heritability, K = Selection differential (= 2.06) at 5 % intensity of selection (Lush, 1949) [12] and σp = Phenotypic standard deviation of the character

Genetic advance as per cent of mean (GAM)

GAM (%) = Genetic advance (GA) divided by General mean of population (Gm) × 100

The estimated variability parameters are GCV, PCV, ECV, h^2 and GAM. Values of GCV and PCV were categorized as low (0-10%), moderate (10- 20%) and high (20 and above) by Sivasubramanian and Menon (1973) [17]. The heritability was categorized as low (0-30%), moderate (30-60%) and high (60 and above) as given by Robinson *et al*., (1949) [16]. Genetic advance as per cent mean was categorized as low (0-10%), moderate (10-20%) and high (20 and above) as given by Johnson *et al*., (1955) [7]. After statistical analysis all the values are presented in table 1-2 and display of frequency distribution in fig. 1-5 for findings and discussion.

3. Results and Discussion

Ratooning is a capability to growing up full sugarcane crop from sprouts of underground stubbles left in the field after harvest of the plant crop. It is a general practice of sugarcane cultivation covered more than 50% of total sugarcane cropped area. In Bihar 35-40% sugarcane growing area falls under water logged therefore, it needs to evaluation of ratoon and select the better one under water logging situation. The water logging for the early stage of crop growth affects the germination, tillering and cane growth, which may result in crop failure as it coincides with the grand growth phase and may extend up to maturity of the crop and hence, the tolerant one suffers less. Higher water table during active growth phase adversely affects stalk weight and plant population resulting yield loss at the rate of about one tonne per acre for one inch increase in excess water Carter and Floyed (1974) [3], Carter, C. E, (1976) [4]. The phenotypic variances for all the traits under studied were found higher than the genotypic variances, similar result was also reported by Kadian *et al*. (1997) [8]. This may be due to the non-genetic factor which played an important role in the manifestation of these characters. A perusal of table 2, revealed that phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the traits under investigation. The traits *viz*, number of Shoots, plant height, cane diameter, NMC, single cane weight, brix, pol, purity, CCS Per cent, Cane yield and CCS t/ha which showed highly significant variation for all these yield and juice quality traits (Table -1). The frequency distribution of all the traits under studies displayed in Fig-1 to 5 and showed wide range of variability and frequency distributed in lower to higher scored values. Higher score were observed in all traits while their frequency observed from 1 to 3 for most of the traits it means there will be possibility for improvement related to yield and juice quality. Variability is the very important consideration in any crop improvement which is measure by estimation of genotypic and phenotypic variance (σ^2g and σ^2p), genotypic and phenotypic coefficient of variation (GCV and PCV), heritability, genetic advance and genetic advance as per cent of mean are called as parameters of variability. These parameters help in selection for improvement of desired characters. Environment plays an important role in the expression of phenotype. The phenotypic variability which is observable includes both genotypic (heritable) and environmental variation (non-heritable). Hence, variability can be observed through above said parameters. Heritability is a measure of the extent of phenotypic variation caused by the action of genes. It is a good index of the transmission of characters from parents to their offspring. For effective improvement heritability has been adopted by large number of workers as a reliable indicator. The estimates of heritability help plant breeder in selection of elite genotypes from diverse genetic population. The estimates of heritability are more advantageous when expressed in terms of genetic advance. Hanson (1963) [6] stated that heritability and genetic advance are two complementary concepts. However it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*., 1955a) [7]. The heritability in broad sense and genetic advance as per cent of mean was worked out for all the characters, have been presented in table- 2 and their performance categorised on the basis given by Robinson *et al.* (1949) [16] for heritability and Johnson *et al.* (1955a) [7] for genetic advance as per cent of mean. As per this criteria maximum heritability (broad sense) was observed for pol % in juice at 9 & 11 month (98.71& 96.64) followed by CCS t/ha (96.0), single cane weight (94.01) and rest of the all traits under studies have shown more than 60% heritability. A perusal of genetic advance as per cent of mean (table -2) revealed that it ranges from 1.57 (purity at 11 month stage) to 49.62 (CCS t/ha). The trait CCS t/ha had highest GAM followed by plant height at 240 days (39.37), cane yield (38.54), number of shoots at 120 days, plant height at harvest (29.82) single cane weight (28.22), plant height at 150 days and NMC (21.60). All these traits were exhibited high genetic advance as per cent of mean (>20%). Although, other traits *viz,* cane diameter (14.14), CCS % at harvest (13.62), pol % in juice at 11 month (13.19) and Brix % at 11 month were also showed the moderate GAM (>10%). Comparatively the maximum phenotypic and genotypic variance were exhibited by the traits *viz*. plant height at harvest and 240 days, number of shoots at 120 days, plant height at 150 days, cane yield and number of millable canes. High phenotypic and genotypic coefficient of variation were recorded for traits CCS t/ha (25.66 & 24.75) followed by cane yield (20.90 & 19.77), plant height at 240 days (20.60 & 19.87) and number of shoots at 120 days (20.14 & 18.77).The traits having moderate phenotypic and genotypic coefficient of variation were, plant height at harvest (17.16 & 15.76), single cane weight (14.57 & 14.13), NMC (14.06 & 12.14) and plant height at 150 days (13.9 & 12.42). Narrow difference between PCV and GCV were recorded for most of the traits. Wide ranges of variance (phenotypic & genotypic) were observed in the experimental material for all the characters under investigation. The maximum phenotypic and genotypic variance exhibited by the traits, plant height at 240days, plant height at harvest, number of shoots at 120 days, plant height at 150 days, cane yield and number of millable canes under water-logging condition. These findings were in accordance with the result of Thippeswamy *et al.* (2001) [19], Gupta and Chatterjee (2002) [5], Kumar *et al*. (2004) [9], Kumar *et al*. (2017) [10], Agrawal and Kumar (2017) [1], Ranjan and Kumar (2017) [14], Kumar *et al*. (2018) [11] also observed high variance for yield and yield component traits among sugarcane genotypes. Display of frequency distribution in figures 1 to 5 clearly indicate the wide variation and different group from lower to higher value such as for number of shoots 120 days maximum 9 groups/classes form while only 4 groups were form for SCW and purity % at 11 month with different frequencies and classes. Frequency distribution shows us a summarized grouping of data divided into mutually exclusive classes and the number of occurrences in a class and the maximum number of classes. High heritability coupled with high genetic advance percentage as mean showed by the traits *namely*, CCS t/ha at harvest, plant height at 240 days, cane yield at harvest, number of shoot at 120 days, plant height at harvest, cane diameter at harvest, single cane weight at harvest, plant height at 150 days and NMC at harvest.

Conclusion of this investigation reflect the importance of the traits *viz,* CCS t/ha, plant height at 240 days, cane yield, number of shoot at 120 days, plant height at harvest, cane diameter, single cane weight, plant height at 150 days and NMC for effective evaluation for selection of best performing ratoon of sugarcane genotypes under water logging condition it also indicated the role of dominant genetic effect in determining of these above said traits therefore, all these nine traits may be used for further sugarcane improvement of ratoon crops under water logging condition. Hence, direct selection can be done through these traits for future improvement of sugarcane ratoon under water logging condition.

Table 1: Analysis of variance of yield and juice quality traits for ratoon of 16 sugarcane genotypes under water logging.

Sl. No.	Characters and Symbol		Mean sum of square		
	Characters	Symbol	Replication (d.f. =2)	Treatment (d.f. =15)	Error (d.f. =30)
1	Number of shoots 120 Days (000/ha)	S120D	51.21	1425.12 **	68.39
2	Plant height 150 Days (cm)	PH 150	154.87	966.80 **	74.92
3	Plant height240 Days (cm)	PH 240	3.30	4164.02 **	109.57
4	Brix % at 9th month stage	B% 9	0.02	1.16 **	0.08
5	Pol% in juice at 9th month stage	P%9	0.02	1.34 **	0.01
6	Purity % at 9th month stage	PU%9	0.16	2.46 **	0.13
7	Brix% at 11th month stage	B% 11	0.079	3.567 **	0.075
8	Pol % in juice at 11th month stage	P%11	0.07	3.32 **	0.04
9	Purity% at 11th month stage harvest	PU%11	0.04	1.68 **	0.10
10	Plant height at harvest (cm)	PH 300	45.09	3469.61 **	201.93
11	Cane diameter at harvest (cm)	CD	0.006	0.091 **	0.007
12	Single cane weight at harvest (kg)	SCW	00	0.027 **	0.001
13	Number of millable cane at harvest (000/ha)	NMC	31.77	534.40 **	54.47
14	Commercial cane sugar % at harvest	CCS%	0.13	1.79 **	0.05
15	Commercial cane sugar t/ha at harvest	CCS t/ha	0.17	10.67 **	0.15
16	Cane Yield (t/ha) at harvest	CY	37.27	581.13 **	21.81

* Significant at 5%, ** significant at 1%

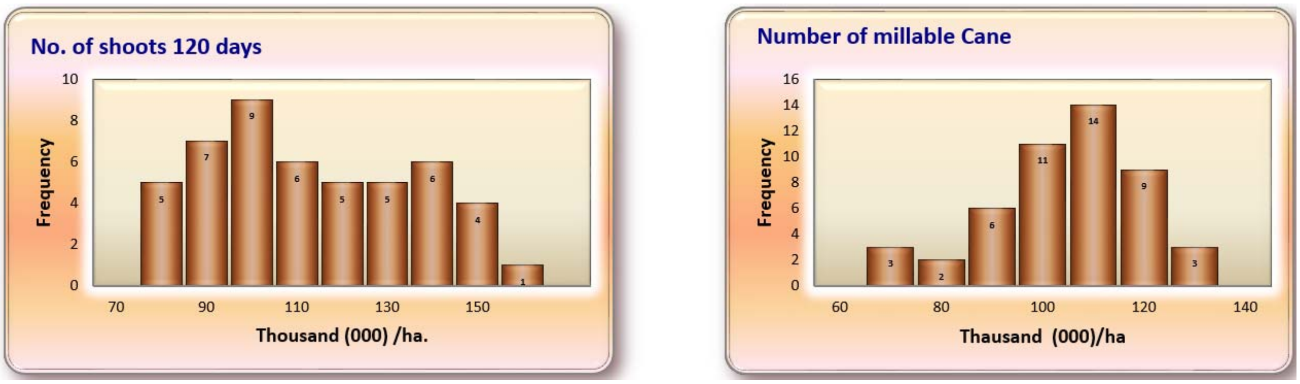

Fig 1: Frequency distribution of 16 clones in 3 replications for no. of shoots and NMC of ratoon crop under water logging condition.

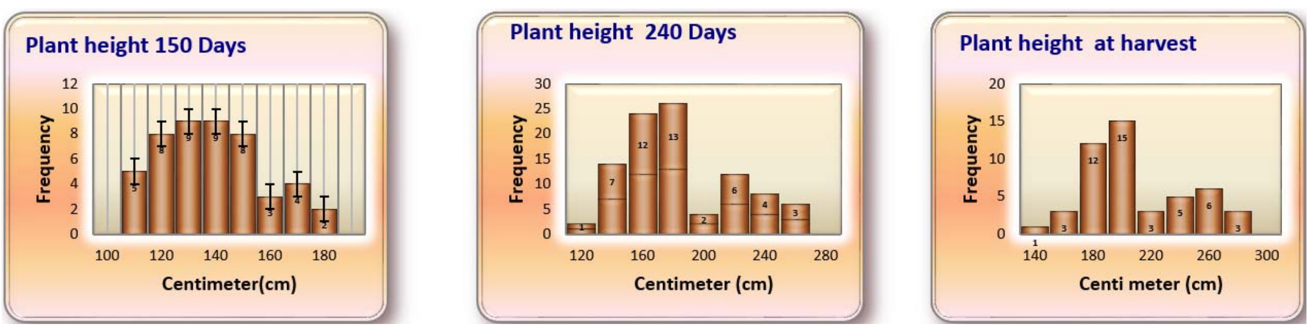

Fig 2: Frequency distribution of 16 clones in 3 replications for Plant Height at different stage of ratoon crop under waterlogging.

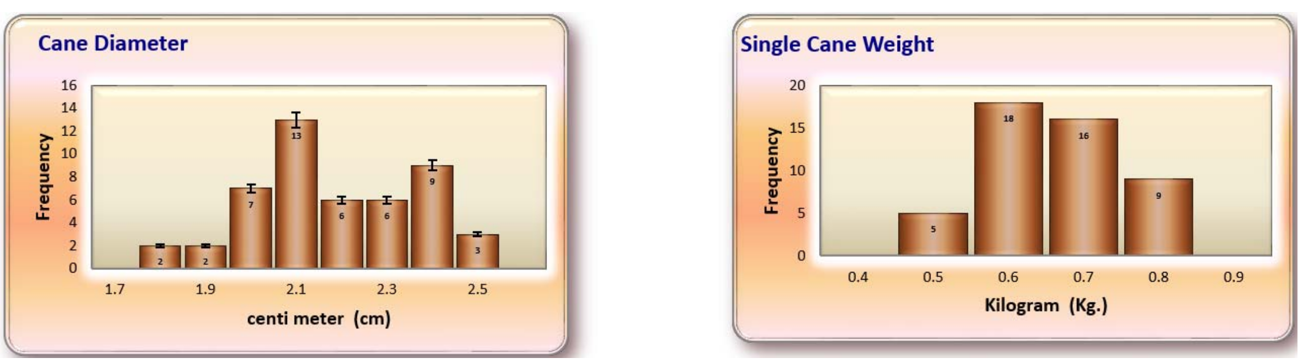

Fig 3: Frequency distribution of 16 clones in 3 replications for cane diameter and SCW of sugarcane ratoon crop under waterlogging.

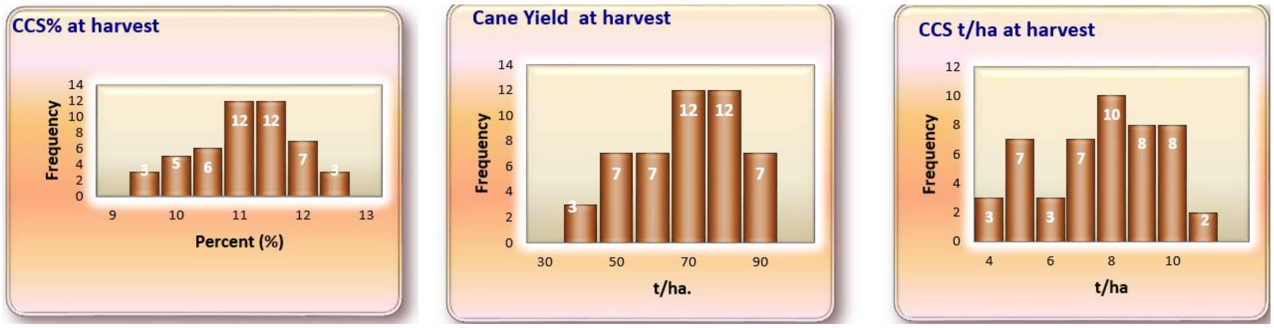

Fig 4: Frequency distribution of 16 clones in 3 replications for traits CCS%, Cane yield and CCS t/ha of ratoon crop under waterlogging.

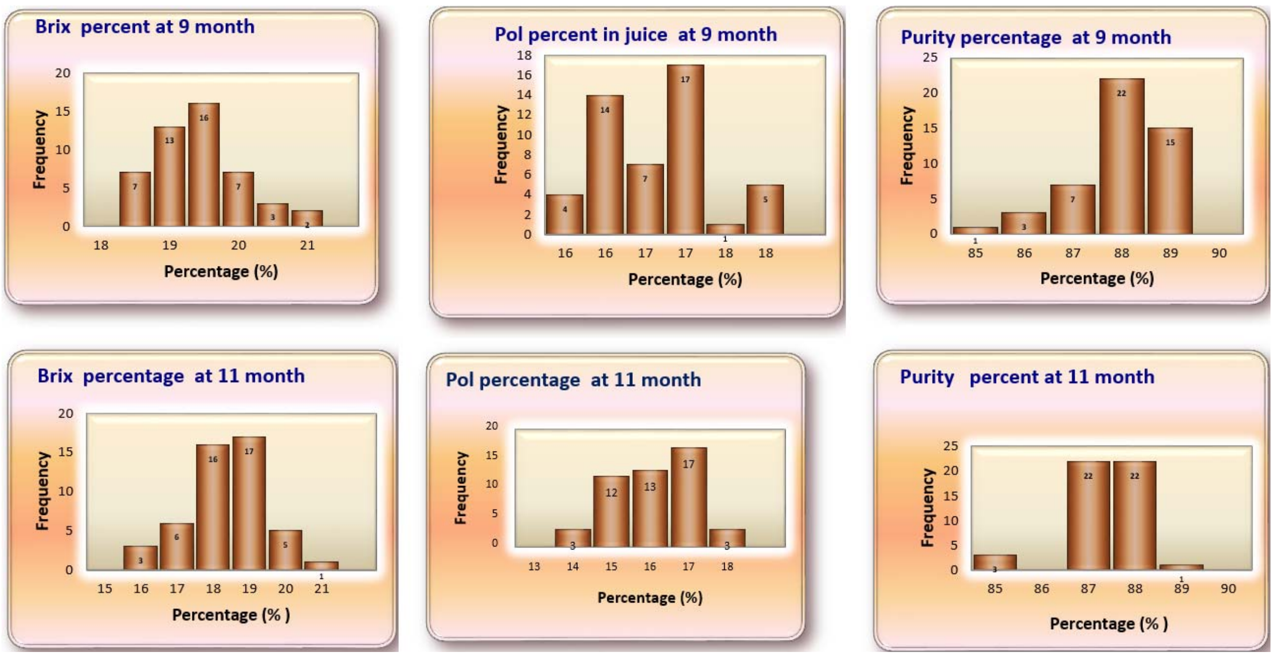

Fig 5: Frequency distribution of 16 clones in 3 replications for juice quality traits (Brix, Pol and Purity) of ratoon at 9 and 11 month stages

Table 2: Mean, range and genetic parameters for yield and juice quality traits of ratoon crop under water logging condition.

Sl. No.	Characters	Mean ± SEM	Range		C.V.	Values of Genetic parameters (%)					
			Max.	Min.		σ^2g	σ^2p	GCV	PCV	h^2 (bs)	GA M
1	No. of shoots at 120 Days	113.32 ± 4.77	150.18	81.32	7.30	452.25	520.63	18.77	20.14	86.86	36.03
2	Plant height at 150 Days	138.78 ± 5.00	172.38	115.22	6.24	297.29	372.21	12.42	13.90	79.87	22.87
3	Plant height at 240 Days	184.98 ± 6.04	255.34	137.37	5.66	1351.48	1461.05	19.87	20.66	92.50	39.37
4	Brix % at 9th month	18.91 ± 0.16	20.2	18.00	1.47	0.36	0.44	3.18	3.51	82.39	5.95
5	Pol% at 9th month	16.60 ± 0.04	17.78	15.74	0.46	0.44	0.45	4.01	4.04	98.71	8.22
6	Purity % at 9th month	87.86 ± 0.21	89	85.50	0.42	0.78	0.91	1.00	1.09	85.35	1.91
7	Brix% at 11th month	18.37 ± 0.16	20.2	15.80	1.49	1.16	1.24	5.87	6.06	93.92	11.72
8	Pol% at 11th month	16.06 ± 0.11	17.72	13.80	1.22	1.10	1.13	6.51	6.63	96.64	13.19
9	Purity% at11th month	87.31 ± 0.18	88.1	85.20	0.37	0.53	0.63	0.83	0.91	83.83	1.57
10	Plant height at harvest	209.43 ± 8.20	262.63	155.58	6.79	1089.23	1291.16	15.76	17.16	84.36	29.82
11	Cane diameter at harvest	2.19 ± 0.05	2.46	2.00	3.81	0.03	0.04	7.67	8.56	80.20	14.14
12	Single cane weight	0.66 ± 0.01	0.8	0.49	3.57	0.009	0.01	14.13	14.57	94.01	28.22
13	NMC	104.17 ± 4.26	125.64	70.85	7.08	159.98	214.45	12.14	14.06	74.60	21.60
14	CCS % at harvest	11.06 ± 0.13	12.26	9.50	2.01	0.58	0.63	6.89	7.17	92.17	13.62
15	CCS t/ha	7.57 ± 0.22	10	4.21	5.12	3.51	3.66	24.75	25.27	96.00	49.62
16	Cane Yield (t/ha)	69.06 ± 2.70	87.54	40.46	6.76	186.44	208.25	19.77	20.90	89.53	38.54

Symbol- Genotypic variance (σ^2_g), Phenotypic variance (σ^2_p), Genotypic coefficient of variance (GCV), Phenotypic coefficient of variance (PCV), Heritability broad sense (h^2) and Genetic advance as per cent of mean (GAM)

4. Acknowledgement

I express my sincere thanks to Director Sugarcane Research Institute Pusa, Samastipur, scientists of the Institute and all the technical staff of Department of Sugarcane Breeding SRI, Pusa for their kind support to conduct the trial on sugarcane ratoon under waterlogging.

5. References

1. Agrawal RK, Kumar B. Variability, Heritability and Genetic Advance for Cane and its Contributing Traits in Sugarcane Clones under Waterlogged Condition. Int. J Curr. Microbiol. App. Sci. 2017; 6(6):1669-1679.

2. Burton GW, De Vane. Estimating heritability in tall Fescue from replicated clonal material. Agron. J. 1953; 45:475-481.
3. Carter CE, Floyd JM. Inhibition of sugarcane yields by high water table during dormant season. Proc. Am. Soc. Am. Soc. Sug. Cane Technol. 1974; 4:14-18.
4. Carter CE. Excess water decreases cane and sugar yields. Proc. Am. Soc. Sug. Cane Technol. 1976; 6:44-51.
5. Gupta RK, Chatterjee A. Study on some genetic parameters and its implication in selection of sugarcane (*Saccharum officinarum*). Cooperative Sugar. 2002; 33(10):823-826.
6. Hanson WD. Heritability statistical genetics and plant breeding. NAS, NRC, Washington Publication. 1963; 982:125-140.
7. Johnson HW, Robinson HF. and Comstock, R. E. Estimates of genetic and environmental variability in soybeans. Agron. J. 1955a; 47:314-318.
8. Kadian SP, Chander K, Sabharwal PS. Genetic variability and heritability in sugarcane. Indian sugar. 1997; 46(12):973-975.
9. Kumar K, Singh PK, Singh JRP. Genetic variability and character association in sub-tropical clones of sugarcane (*Saccharum* complex hybrid). Indian Sugar. 2004; 54(3):189-198.
10. Kumar P, Kumar B, Chandra K. Estimation of Extent of Variability for Various Productive Traits in Sugarcane under Water-Logged Condition. Int. J Curr. Microbio. App. Sci. 2017; 6(7):1187-1192.
11. Kumar P, Pandey SS, Kumar B, Kamat DN, Kumar M. Assessment of Genetic Parameters for Various Productive Traits in Early Maturing Sugarcane. Int. J. Curr. Microbiol. App. Sci. 2018; 7(05):1387-1392.
12. Lush JL. Heritability of quantitative characters in farm animals. Proceedings of 8th Congress of Genetics and Heriditas. 1949; 35:356-375.
13. Malik KB. Profitable cultivation of sugarcane. Directorate of Agricultural Department of Punjab, Lahore, Pakistan. 1997, 49.
14. Ranjan R, Kumar B. Study of Genetic Variability for Cane Yield and its component Traits in Early Maturing Sugarcane. Int. J Curr. Microbiol. Sci. 2017; 6(10):1739-1748. Doi: https://doi.org/10.20546/ijcmas.2017.610.210.
15. Rehman A, Ehsanullah. Increasing yield of ratoon sugarcane, 2008. Available online at http://www.dawn.com/news/296976/increasing-yield-of-ratoon- sugarcane
16. Robinson HF, Constock RE, Harvey PH. Estimates of heritability and the degree of dominance in corn. Agron. J. 1949; 41:353-59.
17. Sivasubramanian S, Menon M. Heterosis and inbreeding depression in rice. Madras Agric. J. 1973; 60:1139.
18. Spencer GL, Meade GP. Cane Sugar Hand Book. J Wiley and Sons, N.Y, 1955.
19. Thippeswamy S, Kajjidoni ST, Salimath PM, Goud JV, Chetti MB. Variability, heritability and genetic advance for cane yield and its components in sugarcane. Karnataka J Agric. Sci. 2001; 14(1):30-34.