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EVALUATION OF EARLY SUGARCANE CLONES FOR YIELD AND QUALITY TRAITS AND THEIR DIVERSITY ANALYSIS

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ABSTRACT

Performance of seven early maturing clones of sugarcane viz., CoSe 16454, CoP 17437, CoP 17436, CoP 17438, CoP 17441, CoP 17440, CoSe 17451 and three check varieties CoLk 94184, CoSe 95422, CoSe 01421 was evaluated at Kalyanpur farm of DR. RPCAU, Pusa during the 2020-2021 in randomized block design with three replication for fifteen characters viz., germination%, number of shoots, stalk length(cm), number of tillers, stalk diameter, number of millable cane, cane yield, single cane weight, brix%, sucrose%, purity%, fibre%, CCS%, pol%, CCS ton/ha. ANOVA, Path coefficient analysis and Correlation was done. Two clones viz., CoP 17437 and CoP 17441 were found to be better for yield and quality over the best check variety and these two can be used for further breeding programme. Diversity analysis was done and all the seven genotypes and check varieties were divided into four cluster.
***Keywords* :** Sugarcane, early maturing, Sucrose%, CCS%, Cane yield, Number of millable cane.

Introduction

The sugarcane (*Saccharum* spp. Hybrid) is the largest tropical plant with a C_4 metabolism of photosynthesis. Brazil is the largest producer of sugarcane followed by India. Tamil Nadu state has the highest output in the tropical zone, whereas Maharashtra is the main sugarcane cultivating state in the region with an extant of roughly 9.4 lakh ha and a production of 61.32 million tonnes. The state with the highest output is UP. Haryana is the state in the sub-tropical zone with the largest productivity, producing 135.64 million tonnes of cane on an area of about 22.77 lakh ha (Cooperative Sugar, 2020). For the years 2020–2021, India's sugarcane production is projected to be at 4.57 million hectares, 355 million tonnes, and 77.89 tons/hectare, respectively. According to the DES, Ministry of Agriculture& Farmer's Welfare, the estimated sugarcane acreage, production, and productivity in Bihar state for the 2019–2020 growing season are 0.219 million hectares, 10.1 million ha, and 48.2 tons/hectare, respectively. Sugarcane is used as a sweetener to extract sugar, and to make "gur" or "khandsari". It is employed in Brazil to make gasoline (1-part ethyl alcohol and 9-part gasoline). Chinese proverb "Among the sugarcane we are safe" demonstrates how sugarcane imprinted in the minds of Chinese people by the symbolism of bravery and protectiveness. India's most significant cash crop is sugarcane. There is less danger involved, and farmers can still expect a profit under challenging circumstances. After textiles, the second-largest agro-based industry uses sugarcane as its primary raw material. The sugar industry has crucial function in creating a significant amount of income generation in the rural area, both by straight action and through its appurtenant businesses. About 50 million farmers and the 5 lakh people who are directly engaged in sugar mills depend on the sugar business for their livelihood in rural areas. Sugarcane is a long duration crop. It takes almost 10-12 months to mature and there are small number of short duration varieties available. Sugar recovery is also low in available varieties. So, the farmers prefer other early maturing crops over sugarcane these days. Thus evolution of improved early varieties with high tonnage, high sugar recovery, is the need of sugarcane farming community and sugar factories and for developing improved varieties crossing between clones having higher genetic distance is the prior requirement because the major drawback in sugarcane breeding is that the parents have limited genetic distance, or that they share a large number of ancestors in common, which increases inbreeding and inbreeding depression. Thus diversity analysis is done to know the clones located on different clusters. Therefore, the research was conducted to find early maturing clones with high sugar yield and cane yield at Kalyanpur farm of Dr. RPCAU, Pusa during 2020-2021. Early in the season of 2020-21, the experiment was run with seven clones viz., CoSe 16454, CoP 17437, CoP 17436, CoP 17438, CoP 17441, CoP 17440, CoSe 17451 and three check varieties CoLk 94184, CoSe 95422, CoSe 01421. With three replications, the experiment was seeded in randomised block design. The plot size was standard. The plot comprised six rows of five-metre-long, 90 cm apart, with a seed rate of twelve buds per metre. Standard agronomic practices, control of pest and disease was done for growing good quality crop. The information needed was gathered over the course of the cropping season.

Material and Methods

Among all the fifteen characters, the data for number of tillers, germination%, number of shoots were recorded at 120, 30, 240 days following planting and data for other characters were recorded during the harvesting of crop. For quality analysis, juice was extracted with cane crusher. The analysis for brix was done by the approach proposed by "Meade and chen (1977)". A refractometer was used to calculate the sucrose percentage. Purity% was calculated using the following formula:

Purity% = sucrose%/Corrected brix × 100

Fibre% was calculated by the following formula:

Fibre % = Oven dried weight of crushed cane/Weight of fresh cane × 100

Pol% was calculated by the formula:

Pol% = Sucrose% × 100 – (Fibre% + Sucrose%)/100

The following formula was used to determine CCS%:

CCS% = [Sucrose% - (Brix% -Sucrose%) ×0.4)× 0.74]

The CCS ton/ha was calculated on the basis of CCS percent and cane yield. All the statistical analysis is done by standard statistical method described by "Panse and Sukhatme (1978)". The formula of "Burton and Dewane (1953)" was used to obtain the coefficient of variance. Heritability value was obtained by the formula suggested by Hanson *et al* (1956). Correlation analysis was also done by the method suggested by Panse and sukhatme (1978). Diversity analysis was calculated in Rao's estimation (1952).

Result and Discussion

Highly significant difference among all the genotypes had been observed in the Analysis of variance i.e. number of tillers, cane yield, single cane weight, brix %, CCS %, sucrose%, CCS ton/ha e.t.c and other characters have shown significant difference for genotypes. The result shows that there is considerable amount of variability present among the genotypes. Thus it can be said that genotypes included in this study are showing diversity among its genotype and the reason behind it's diversified nature may be the heterozygosity and polyploidy. So, the selection within this genotypes should be effective. The result of the study is similar to the result of Khan *et al.* (2013). It has been shown (Table.1) that for percentage of germination, CoP 17441 has shown highest mean value (43.30), which is better than the best check variety CoSe 95422 performance and for number of tillers also, this variety has shown maximum mean performance. CoP 17441 has shown significant difference for mean values for the character cane yield at harvest (113.10). For number of shoots (152.17), sucrose percentage in juice (17.86), purity percentage (89.46), CCS percent (12.44) and pol percentage (13.913), the genotype CoP 17436 performed superior than the promising check variety. This variety performed well, has shown significant difference from mean for the character's single cane weight (1.05) and CCS ton/hectare at harvest (13.920). the variety CoP 440 was found to show maximum mean value for the character stalk length at harvest (301.33) and the variety CoSe 17451 was found to show maximum mean value for Brix percentage. Current study result is similar with the result found by Sanghera *et al.* (2014). Genetic Coefficient of Variance has shown maximum value for cane yield (ton/hectare) (18.37) and minimum value for purity percentage (0.91). Phenotypic coefficient of variance has shown maximum value for CCS ton/hectare (20.84) and minimum value for purity percentage (1.43). Heritability character has shown highest value for sucrose percentage in juice (73.04) and minimum value for the character fibre percentage (9.66). Cane yield was found to show maximum genetic advance and stalk diameter was found to be minimum for genetic advance. So, selection for sucrose percentage will be better for improving sugar yield and will create better genetic improvement and selection for cane yield will improve the varietal performance in that environment because it is not due to additive gene action. The present study shows that characters like sucrose percentage, CCS percentage and single cane weight had shown high heritability but the genetic advance for these characters are low. So, we can say that this high heritability is due to non-additive gene action, thus selection for these character can be misleading. The character's cane yield and number of tillers at 120 days has shown high heritability along with high genetic advance. So, here it is because of additive gene action. So, it will be wise to choose these two character for selection purpose. The same outcome was reported by Chaudhary (2001) and Singh *et al.* (2010). Table 2 shows all the values mentioned above. Direct selection for yield will not be successful because it is a quantitative attribute and is influenced by the environment. It will be effective to select for cane and sugar yield by their associated character by indirect selection by association studies (Table 3). Cane yield has shown positively significant correlation with number of tillers at 120 days, germination percentage at 30 days, number of shoots at 240 days, number of millable cane at harvest and single cane weight. The CCS ton/hectare has shown positive significant correlation with germination percentage, single cane weight, number of tillers at 120 days, number of shoots at 240 days, number of millable cane, cane yield, stalk length at harvest, stalk diameter at harvest. So, indirect selection for these characters will be effective to improve the sugar and cane yield. The sucrose percentage at harvest has shown negative significant association with cane yield at harvest. Same result obtained by Tyagi *et al.* (2012). Singh *et al*. (2003) showed that there is a significant negative correlation between brix percentage and cane yield at harvest and we can use this as a tool for negative indirect selection to discut the undesirable genotypes. Sugar yield is a quantitative complex trait; it can't be selected directly. Path coefficient analysis is used to divide the correlation coefficient into indirect and direct effect (Table.4). The number of shoots at 240 days (-0.012), germination percentage at 45 days (-0.014), number of millable canes at harvest (-0.266), single cane weight at harvest (-0.503), sucrose percentage at harvest (0.115) has shown direct negative effect on the sugar yield, which is CCS ton/hectare. Purity percentage at harvest has shown independent relation with sugar yield. The characters i.e. number of tillers at 120 days (0.009), cane yield (1.96), stalk length, stalk diameter (0.010), brix percentage (0.056) had shown positive direct effect on sugar yield. So, these characters contribute their individual values towards sugar yield. This result corresponds to the study of Thippeswamy *et al*. (2003). Brix percentage has a negative direct effect on cane yield. This result was observed by Masri *et al.* (2015). The lower value of residual effect showed that all the characters which is contributed towards yields has included in the present investigation. Genetic divergence is important for making crosses between divergent parent and for a good hybrid production the parent should be genetically diverse origin and it will help in exploiting heterosis. Here the ten genotypes were divided into four clusters. Cluster II has the maximum genotypes, that is five and Cluster I contain three genotypes and cluster III and cluster IV is monogenotypic. Cluster II contain CoSe 16454, CoP 17437, CoP 17440, CoP 17438, CoSe 17451 genotypes. Cluster I contain three genotypes i.e. CoP 17436, CoSe 95422, CoSe 01421 and cluster III contain CoP 17441 and cluster IV contain CoLk 94184. Maximum inter-cluster distance was found to be 177.13, which was found between cluster II and IV and the minimum inter-cluster distance was found to be cluster I and II. Maximum intra-cluster distance was found in Cluster I (table.5). A Dendrogram is made from this result (Figure.1). The character brix percentage at harvest has shown highest contribution towards divergence i.e. 17.78%. Similar result was found by Kang *et. al.* (2013) and minimum contribution percentage has shown by germination percentage at harvest, cane yield at harvest and CCS % at harvest i.e. 2.22% (Table.6). Maximum part of the genetic diversity had shown by four characters i.e. brix percentage at harvest, fibre percentage at harvest, number of tillers at 120 days and purity percentage at harvest which is 60 % of total contribution.

Conclusion

Overall the result of the current research suggested that according to mean values of the variety for different characters, we can select some variety which is showing better performance. Variety CoP 17437 and CoP 17441 performed better over their check varieties and can be selected for further breeding programme. These two varieties are better performing and located in two different cluster.

Table 1 : Mean performance of all early maturing varieties along with checks

Clones/ characters	Germin-ation %	Number of tillers	Number of shoots	Cane yield	Number of millable cane	Stalk length	Stalk diamer	Single cane weight	Brix %	Sucrose %	Purity %	CCS %	CCS t/ha	Fibre %	Pol %
CoSe 16454	35.10	95.27	135.70	78.44	88.69	254.00	2.41	0.89	18.42	16.95	88.60	11.733	9.20	11.933	13.12
CoP 17436	39.80	113.25	148.25	92.98	103.75	283.00	2.50	0.90	17.71	16.04	87.73	10.80	10.033	12.15	12.50
CoP 17437	43.16	120.70	152.17	111.88	106.79	299.33	2.56	1.05	19.34	17.89	89.46	12.44	13.92	12.25	13.91
CoP 17438	40.33	116.90	135.19	100.11	102.82	291.65	2.45	0.95	18.27	16.83	88.10	11.62	11.66	12.70	13.01
CoP 17440	42.30	118.29	139.70	102.22	110.14	301.33	2.52	0.93	18.71	17.22	88.66	11.92	12.18	12.65	13.32
CoP 17441	43.30	125.15	148.79	113.10	115.69	295.00	2.60	0.98	16.67	14.69	85.70	9.853	11.19	12.70	11.36
CoSe 17451	37.13	103.80	123.92	81.75	101.93	273.00	2.35	0.80	18.90	17.43	88.10	12.08	9.85	12.95	12.20
CoLk 94184	38.15	68.10	138.75	74.26	98.75	288.00	2.20	0.75	19.50	17.93	88.66	12.41	9.20	13.33	13.58
CoSe 95422	39.60	88.4167	128.79	67.96	96.79	263.67	2.35	0.70	18.49	17.12	88.26	11.98	8.13	12.90	13.20
CoSe 01421	38.10	102.26	129.90	67.04	94.72	268.00	2.17	0.71	19.54	17.98	88.13	12.41	8.316	12.60	13.91

Table 2 : Genetic parameters of all sugarcane clones

S.No.	Characters	O^2g	O^2p	O^2e	GCV	PCV	ECV	H^2	GA
1	GP at 45 days	6.41	10.70	4.28	6.35	8.20	5.19	59.95	4.04
2	NOT (000/ha) at 120 days	251.75	422.68	170.92	15.08	19.54	12.42	59.56	32.32
3	NOS (000/ha) at 240 days	49.07	164.37	115.29	5.07	9.28	7.77	29.85	7.88
4	CY (ton/ha) after 10 months at harvest	267.41	373.50	106.09	18.37	21.72	11.57	71.59	36.52
5	NMC (thousand/ha) at harvest	36.56	107.70	71.13	5.92	10.16	8.26	33.95	8.389
6	Stalk length (cm) at harvest	100.26	285.96	185.69	3.55	6.00	4.83	35.06	12.21
7	Stalk diameter (cm) at harvest	0.001	0.03	0.02	4.86	7.70	5.96	39.93	0.15
8	SCW (kg) at harvest	0.012	0.019	0.006	12.90	16.00	9.47	64.96	0.23
9	Brix % at harvest	0.63	1.06	0.43	4.28	5.57	3.55	59.24	1.61
10	Sucrose % in juice at harvest	0.90	1.23	0.33	5.58	6.53	3.39	73.04	2.14
11	Purity % at harvest	0.64	1.60	0.95	0.91	1.43	1.11	40.19	1.34
12	CCS % at harvest	0.59	0.82	0.22	6.60	7.75	4.07	72.42	1.73
13	CCS t/ha at harvest	2.75	4.67	1.91	16.00	20.84	13.35	58.97	3.36
14	Fibre % a harvest	0.04	0.43	0.38	1.61	5.19	4.94	9.66	0.16
15	Pol % cane at harvest	0.40	1.10	0.70	4.88	8.07	6.43	36.56	1.01

Table 3 : Phenotypic correlation matrix

Traits	Germin ation %	Number of tillers	Number of shoots	NMC	Single Cane Weight	Cane yield	Stalk Length (Cm)	stalk diameter	Brix %	Sucrose %	Purity %	CCS %	Fibre %	Pol %	CCS Ton /ha
Germination %	**1.000**	0.486**	0.358	0.464**	0.474**	0.597**	0.481**	0.376*	-0.140	-0.113	0.033	-0.136	-0.208	-0.024	0.578**
Number of tillers		**1.000**	0.358	0.489**	0.595**	0.669**	0.367*	0.407*	-0.364*	-0.343	-0.158	-0.328	-0.254	-0.144	0.574**
No. of shoots			**1.000**	0.312	0.513**	0.523**	0.114	0.335	-0.260	-0.220	0.090	-0.215	-0.229	0.090	0.467**
NMC				**1.000**	0.325	0.734**	0.660**	0.595**	-0.358	-0.332	-0.198	-0.314	-0.010	-0.242	0.643**
Single Cane Weight					**1.000**	0.879**	0.438*	0.432*	-0.303	-0.296	0.036	-0.305	-0.365*	-0.184	0.825**

Cane yield						**1.000**	0.649**	0.594**	-0.388*	-0.371*	-0.078	-0.370*	-0.262	-0.247	0.918**
Stalk Length (Cm)							**1.000**	0.331	0.022	-0.010	0.125	-0.034	-0.012	-0.108	0.679**
stalk diameter								**1.000**	-0.407*	-0.384*	-0.165	-0.342	-0.311	-0.323	0.508**
Brix %									**1.000**	0.943**	0.630**	0.898**	0.154	0.687**	-0.040
Sucrose %										**1.000**	0.729**	0.985**	0.044	0.730**	0.018
Purity %											**1.000**	0.700**	-0.258	0.613**	0.232
CCS %												**1.000**	0.052	0.719**	0.025
Fibre %													**1.000**	-0.024	-0.283
Pol %														**1.000**	0.038

*Significant at 5% level ** Significant at 1% level

Table 4 : Phenotypic path matrix

Traits	Germin-ation%	Number of tillers	Number of shoots	NMC	Single Cane Weight	Cane yield	Stalk Length (Cm)	stalk diameter	Brix %	Sucrose %	Purity %	CCS %	Fibre %	Pol %	CCS Ton/ha
Germination%	**-0.010**	-0.004	-0.007	-0.011	0.007	0.639	0.002	0.013	0.004	-0.005	0.001	-0.050	0.001	0.000	0.578**
Number of tillers	-0.005	**-0.009**	-0.007	-0.012	0.008	0.716	0.001	0.014	0.010	-0.015	-0.006	-0.121	0.001	-0.001	0.574**
No. of shoots	-0.004	-0.003	**-0.021**	-0.008	0.007	0.559	0.000	0.011	0.007	-0.010	0.003	-0.079	0.001	0.001	0.467**
NMC	-0.005	-0.004	-0.006	**-0.024**	0.004	0.785	0.002	0.020	0.009	-0.015	-0.007	-0.116	0.000	-0.002	0.643**
Single Cane Weight	-0.005	-0.005	-0.011	-0.008	**0.014**	0.940	0.002	0.015	0.008	-0.013	0.001	-0.112	0.001	-0.002	0.825**
Cane yield	-0.006	-0.006	-0.011	-0.018	0.012	**1.070**	0.002	0.020	0.010	-0.016	-0.003	-0.136	0.001	-0.003	0.918**
Stalk Length (Cm)	-0.005	-0.003	-0.002	-0.016	0.006	0.695	**0.004**	0.011	-0.001	0.000	0.005	-0.013	0.000	-0.001	0.679**
stalk diameter	-0.004	-0.004	-0.007	-0.014	0.006	0.636	0.001	**0.034**	0.011	-0.017	-0.006	-0.126	0.001	-0.003	0.508**
Brix %	0.001	0.003	0.005	0.009	-0.004	-0.416	0.000	-0.014	**-0.026**	0.041	0.023	0.331	-0.001	0.007	-0.040
Sucrose %	0.001	0.003	0.005	0.008	-0.004	-0.397	0.000	-0.013	-0.025	**0.044**	0.027	0.362	0.000	0.007	0.018
Purity %	0.000	0.001	-0.002	0.005	0.001	-0.084	0.000	-0.006	-0.017	0.032	**0.037**	0.258	0.001	0.006	0.232
CCS %	0.001	0.003	0.004	0.008	-0.004	-0.396	0.000	-0.012	-0.024	0.043	0.026	**0.368**	0.000	0.007	0.025
Fibre %	0.002	0.002	0.005	0.000	-0.005	-0.280	0.000	-0.011	-0.004	0.002	-0.010	0.019	**-0.004**	0.000	-0.283
Pol %	0.000	0.001	-0.002	0.006	-0.003	-0.265	0.000	-0.011	-0.018	0.032	0.023	0.265	0.000	**0.010**	0.038

R SQUARE = 0.9986 RESIDUAL EFFECT = 0.0377

Table 5 : Intra and Inter cluster distance of all sugarcane clones

CLUSTERS	I	II	III	IV
I	12.91	28.82	38.87	99.89
II		11.73	99.53	177.13
III			0.00	91.72
IV				0.00

Table 6 : Percentage contribution of all genotypes towards divergence

Characters	Germination %	Number of tillers	Number of shoots	NMC	Single Cane Weight	Cane yield	Stalk Length (Cm)	stalk diameter	Brix %	Sucrose %	Purity %	CCS %	Fibre %	Pol %	CCS Ton/ha
Time ranked 1st	1	5	2	4	2	1	2	3	8	0	6	1	8	2	0
Contri-bution %	2.22	11.11	4.44	8.89	4.44	2.22	4.44	6.67	17.78	0.00	13.33	2.22	17.78	4.44	0.00

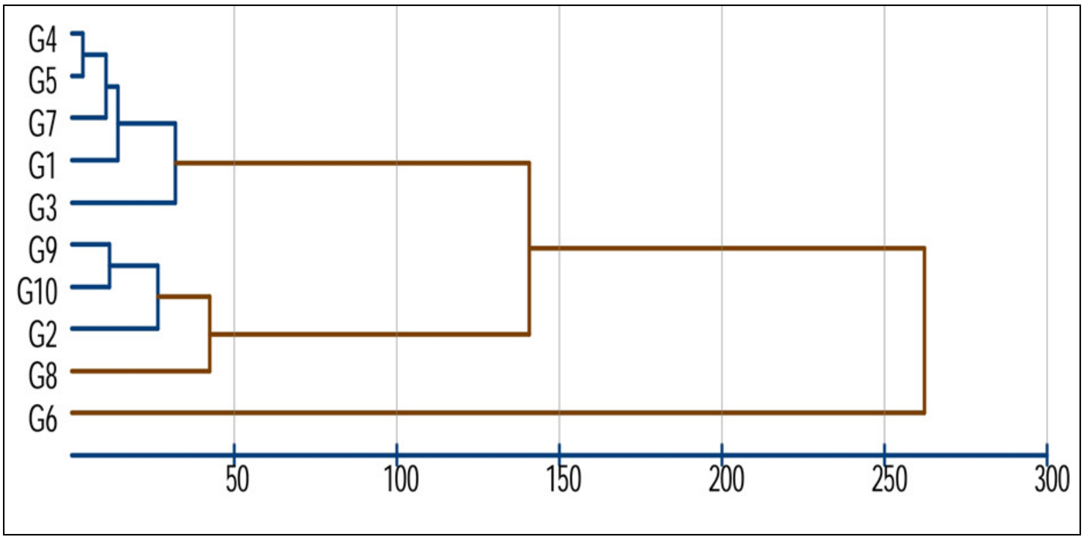

Fig. 1 : Dendrogram of 7 clones and 3 check varieties

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