Field Evaluation of Early maturing Sugarcane Clones for Yield, Quality and Resistance to Red Rot Disease

ABSTRACT

Evaluation and identification of sugarcane clones for different maturity groups is of paramount importance in sugarcane cultivation to get higher recoveries in sugar mills.A field experiment was conducted to assess the performance of early maturing sugarcane clones for red rot resistance, cane yield, CCS yield, and their contributing traits. Observation on germination per cent, number of tillers (x1000/ha), number of millable cane (x1000/ha), stalk length (cm), stalk diameter (cm), single cane weight (kg), cane yield (t/ha), brix per cent, sucrose (%), purity (%), extraction CCS (%), and sugar yield (t/ha). From the results, it could be concluded that the early maturing clone, CoC 15336, was found to be the best among the test clones for sucrose per cent and sugar yield with resistance to red rot disease. Another clone, CoC 15340, was the next-best entry, with higher cane yield, CCS yield, and sucrose percent compared to the better standards. As a result, clones CoC 15338 and CoC 15336 were identified as the best entries and could be forwarded for further yield evaluation trials to be released as a new sugarcane variety suitable for East Coast Zone of India.

Key Words: Sugarcane, early clones, cane yield, sugar yield and red rot resistance

1. INTRODUCTION

Sugarcane (*Saccharum* spp. hybrid) is a major commercial crop grown for sugar production in both tropical and subtropical regions of the world. Sugarcane is the main source of sugar in India, and in addition to sugar production, it creates a larger industrial base by producing by-products such as molasses, filter cakes, bagasse, and so on for further use in other sectors, as well as green fodder and concentrates for cattle. This creates jobs in agriculture and industry. India is the second-largest producer of sugarcane next to Brazil in terms of area (48.67 lakh ha) and production (376.91 million metric tonnes). In India, Tamil Nadu ranks fourth in area and production next to Uttar Pradesh, Maharashtra, and Bihar and ranks first in productivity. In Tamil Nadu, sugarcane was grown in an area of 1.31 lakh hectares, producing 14.12 million tonnes of sugarcane with a productivity of 105.62 t/ha [1].

High-yielding varieties play an important role in achieving self-sufficiency in local sugar consumption as well as producing surplus sugar for export. The lower yield from the sugarcane is attributed to varietal degeneration after a certain amount of time, the development of new races of pathogens, and changes in the environment. Hence, replacement of the existing varieties with new ones is needed for sustainable yield in sugarcane [2].

Varietal development for different maturity groups is critical in sugarcane cultivation to achieve higher recoveries in sugar mills. Sugarcane production relies heavily on the proper selection of varieties, season, and appropriate agronomic technologies, as well as balanced nutrients application **[3].** Non-adoption of any of the components leads to a reduction in sugarcane production, which affects not only cane growers and sugar mills, but also the national economy. Sugarcane red rot disease, caused by *Collectotrichumfalcatum* Went, is prevalent in all sugarcane growing areas. Most high yielding and high sugared varieties, such as CoC 671, CoC 90063, CoC 8001, CoC 85061, and CoC 92061, are susceptible to the disease [4].

The early maturing sugarcane varieties are chosen in the beginning of crushing season for higher sugar recoveries. Besides, the influence of season is less pronounced on early maturing varieties and in late planted conditions, growing of early maturing clones facilitate recovery of higher sugar yield. Hence it is imperative to identify new sugarcane varieties to replace the deteriorating commercial varieties through which the overall productivity could be stabilized. Therefore, to meet the immediate need of sugarcane farming community and sugar factory, there is a need of more number of early maturing, high sugar varieties having high tonnage, good ratooning ability to meet the challenges for improving sugar recovery, especially during the beginning of the crushing season. **[5].**

Hence, the present investigation was conducted to evaluate the early maturing sugarcane clones for high cane yield, high sucrose e content, CCS yield and their contributing traits along with red rot resistance in the Zonal Varietal Trials of the AICRP on sugarcane.

2. MATERIALS AND METHODS

The field experiment was conducted at the Sugarcane Research Station (TNAU), Cuddalore, India (latitude: 11°46'N; longitude: 79°46'E; altitude: 4.60 m MSL) during 2017–18. Four early maturing CoC 15336, CoC 153337, CoC 15338 and CoV 15356 along with three standards CoA 92081, CoC 01061 and CoOr 03151 were evaluated in a random block design with three replications. With a seed rate of 12 buds per metre, the plot included six rows of five metres each, spaced 90 cm apart. There was uniform adherence to advised agronomic procedures and need-based plant protection measures.

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Data on germination percentage was recorded on the 30th day after planting, tiller counts on the 120th day following planting, and number of millable canes (x1000/ha) and other parameters were recorded at harvest. Each test clone's cane sample was collected for quality analysis, and juice was extracted using a power crusher and tested for Brix percent and sucrose percent using a method recommended by **[6].** Sucrose per cent was calculated as per Schmitz's tables. CCS per cent was determined as per the following formula.

CCS% = (Sucrose % - 0.4 (Brix % - Sucrose %)) x 0.75.

The sugar yield was estimated based on CCS per cent and cane yield. All the collected data were statistically analysed by statistical procedures described by **[7].**

2.1.Screening of sugarcane clones for red rot disease resistance

Plug method

The test clones were planted in two rows red rot screening and two canes of each 20 clumps were inoculated by plug method. The inoculums of *Colletotricumfalcatum*pathotypes *CF 06* (CoC 67I) was prepared with sterile distilled water with spore load of 10^6cfu /ml and inoculated in the middle of the third exposed inter-node from bottom with a IISR inoculator in each cane and sealed with China clay. After two months of incubation, the inoculated canes were split open longitudinally along the point of inoculation and graded on a 0-9 scale. The top condition was scored as green 0; yellow / Dry 1. Lesion widths above inoculated internodes were scored 1, 2, and 3. White spots are assigned a 1 for restricted type and a 2 for progressive type. The number of nodes crossed above the inoculated inter-node was scored as 1 if one node crossed, 2 if two nodes crossed, and 3 if three nodes crossed. The disease reaction was classified using the average score. The clones were classified as Resistant (0 to 2.0), Moderately Resistant (2.1 to 4.0), Moderately Susceptible (4.1 to 6.0), Susceptible (6.1 to 8.0) and Highly Susceptible (above 8.0) **[8].**

2.2 Nodal method

The nodal cotton swab approach was used to inoculate two canes in each of 20 clumps. The cane's leaf sheath was as nearly removed as feasible, and the lowermost node was inoculated by wrapping cotton swabs dipped in freshly made inoculum suspension around the cane and covering the nodal region. The cotton swab was held in place by parafilm being wrapped around it. Two months after inoculation the cotton was removed and the nodal region was scraped with a knife. The reaction was recorded as susceptible (S) if the lesion spread into the stalk and as resistant (R) if no lesions developed (R) [9].

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3. RESULTS AND DISCUSSION

The analysis of variance in the present study revealed that all characters in the study were significantly different among treatment mean squares. The results revealed that there was ample opportunity for selecting a better genotype. The variation in cane yield and yield components among genotypes may be attributed to genetic differences. The data on cane yield and yield contributing traits are furnished in Table 1 and quality characters were presented in Table 2.

3.1. Growth and Yield Traits

In this trial, for germination per cent was maximum in the entry CoC 01061 (59.42 %) and minimum by the the clone CoV 15356 (48.25%). Among the clones evaluated, none of the clones were recorded higher germination percentage over the standard CoC 01061 (59.42%). The germination percent directly influences the number of tillers and shoots and similar reports on germination percent for early sugarcane clones by **[10].**For number of tillers, the highest number of tillers (x1000/ha) was recorded by CoC 01061 (125.25 /ha) and the lowest number by CoC 15337 (107.38/ha). No test clone recorded a higher number of tillers than the better standard CoC 01061 (125.25 /ha). The number of tillers per cane directly influences cane yield as it is a function of the interaction between the number of shoots in a unit area. Tillering potential of a clone ultimately effects cane yield positively. Similar reports were already reported by **[11].**

3.2 Evaluation of yield and yield contributing characters

In the present study results revealed that, CoV 15356 (112.07) recorded the highest number of millable cane populations (x1000/ ha), and CoC 15337 the lowest (99.84). only one test clone recorded higher millable cane over the standard CoC 01061. Number of millablecane directly influences the cane yield as it is the combined interaction of tillers and shoot numbers[11].

Accordingto[12] in good growing conditions, individual seedling clones can generate up to 2.0 m of cane, which can be planted to the following selection stage. In this trial, stalk length ranged from 267.00 cm to 292.33 cm. The clone CoC 15338 recorded higher cane length (292.33 cm) and minimum by check CoOr 13151 (267.00 cm). Among the four clones, three clones recorded superior performance over the better standard CoC 01061(271.67 cm). The similar research work was carried out by**[13].**

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The stalk diameter (thickness) ranged from 2.53 cm (CoC 01061) to 3.05 cm (CoC 15338). All the four clones exceeded the better standard CoA 92081, which was 2.81 cm. Canes that grow tall and thin may be more prone to lodging; tall clones with thick stalked canes that resist lodging may have a significant potential to be the high yielding variety in the future. Stalk diameter is an important yield contributing character, and higher stalk diameter would improve farmer acceptability of varieties. [14].

The weight of a single cane is the product of its length and girth are contributes directly to cane yield[14].The results of the present trial ranged from 0.99 kg (CoC 01061) to 1.32 kg (CoC 15338). All the test clones, recorded higher single cane weight over the better standard variety CoOr 03151, which recorded 1.19 kg. This results are also confirmed by [14].

Cane yield is a major character to find out the economic potential of a genotype. It is the combination of functions like environmental response and genetic potential of a genotype. High cane yielding varieties showed best environmental response and hence revealed good performance of cane yield as compared to the other varieties[13].In the present trial, the maximum cane yield was recorded in CoC 15338 (138.64 t/ha) and minimum in CoC 01061 (113.45 t/ha). All the test clones were recorded numerically superior yield over the best standard variety CoA 92081 (123.17t/ha). The similar work was already reported by**[15].**

3.3 Evaluation of sugarcane clones on the CCS yield and Quality attributes

Brix per cent (Total Soluble Solids) at maturity stage plays an important role in determinethe sugar recovery per cent of the genotype. In the present study, the brix per cent was rangedfrom 21.60 (CoC 15336) to 20.53 (CoOr 03151). The two test entries CoC 15336 (21.60%) and CoV15356 (21.41%) recorded superior performance over the best standard CoC 01061 (21.40 %). These results are in agreement with the findings of [14]and studied a number of early maturing sugarcaneclones and found different levels of Brix per cent.

The sucrose per cent is useful trait to identify the quality sugarcane genotype and it influences the sugar recovery and sugar production. In the results, sucrose per cent during harvest ranged from 18.00 (CoC 15336) to 17.42 (CoOr 03151). Among the test clones, onlytwotest clones CoC 15336 and CoC 15338were recorded superior performance over the better standard CoC 01061, which recorded 17.83 per cent. The results are almostsimilar as demonstrated by **[16].**

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Commercial cane sugar (CCS) per cent is the best tool for breeders and millers for identification of high quality genotypes. CCS per cent at harvest is important quality character, it was deciding the quality of genotype and it influences the sugar recovery and sugar production in sugar mills. In the present study, it was ranged from 12.52 % (CoOr 03151) to 13.01 % (CoC 15336). Only two clones were recorded superior values over the best standard CoC 01061 (12.87%). This discussion shows a close succinctness with**[16].**In the present revealed that, purity per cent varied from 90.41 (CoC 15336) to 88.52 (CoOr 03151). Among the test clones, three test clones expressed higher values over the better check variety CoC 01061 (90.09 %).

In the present study, extractionper cent varied from 55.26 (CoC 15336) to 52.51 (CoOr 03151). Among the clones evaluated, three test clones showed superior value over the best check variety CoC 01061 (54.54 %).In the present experiment results revealed that, pole per cent at harvest ranged from 14.09 (CoC 15336) to 13.67 (CoOr 03151). Among the clones only two clones CoC 15336 and CoC 15338 (14.08 %) were expressed superior performance over the better standard CoC 01061, which recorded 13.96 per cent.

In the present study, commercial cane sugar (CCS) yield was ranged from 17.95 t/ha (CoC 15338) to 14.60 t/ha (CoC 01061). Among the test clones evaluated, all the test clones were recorded numerically superior value over the best standard CoA 92081 (15.64 t/ha). This discussion shows a close conciseness with those of [17, 16].The higher CCS yield of clones may be attributed to relatively more average cane yield and commercial cane sugar percent[13].

3.4 Reaction of sugarcane clone to red rot disease

The results of red rot reaction for different early maturing clones are given in Table 3.The clones *viz*., CoC 15337, CoC 15338 and CoV 153456were found to be moderately resistant, CoC 15336 was moderately susceptible by plug method of inoculation. In Nodal method of screening, all the test clones were found resistant and one check variety showed highly susceptible by nodal method of inoculation. The similar results were already reported by [18].

4. CONCLUSION

Identification of promising sugarcane clones that, besides having desirable characteristics, exhibit high sugar yield is an important aspect in sugarcane breeding. Sugar recovery stands the factor of prime importance both from millers and breeding point of view.

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In the present investigation, On the basis of overall performance of different clones evaluated, the test clones *viz.*, CoC 15338 and CoC 15326 were exhibited better performance in terms of cane yield, quality and its contributing traits along with red rot resistance. Hence it was concluded that the two sugarcane clones CoC 15338 and CoC 15336 could be evaluated in further breeding trials for confirmation and the best promising clone could be released as a new sugarcane variety for East Coast Zone of India.

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REFERENCES

[1] Sugarcane Statistics-India, 2020.https://www.statista.com

[2] Aslam,M., Javed,M.A.andMalik,K.B.Comparative performance of a promising cane variety SPF-243 in Southern Punjab**.** Pak. Sugar *J*.1998. 13 (2): 5-7.

[3] Ganapathy, S and Ravichandran, V. Evaluation of mid-late sugarcane clones for yield, quality and red rot resistance in zonal varietal trials. *Annals of Plant Protection Sci*. 2018. 26(1): 142-146.

[4] Kalaimani, T. and Natarajan,S. Screening of sugarcane clones/varieties against red rot (*Colletotrichum falcatum* Went). *Indian Sugar*. 1994. 44:496-497.

[5] Ganapathy, S. andPurushothaman,R.S. Evaluation of high yielding earlymaturing sugarcaneclones suitable for East Coast Zone. Advances life Sci.2016.5 (11): 4555-4559.

[6] Meade, C.P. and Chen,J.C.P.(1977). Cane sugar hand book, 10thEdn. *John Wiley & Sons Inc*, New York.

[7] Panse, V.G. andSukhatme, P.V (1978). Statistical methods for Agricultural Workers. ICAR, New Delhi.

[8] Srinivasan,K.V. and Bhat,N.R. Red rot of sugarcane: Criteria for grading resistance. *J. Indian Botanical Society*. 1961. 1: 566–577.

[9] Mohanraj, D., Padmanaban,P. and Viswanathan, R. Screening for Red Rot Resistance inSugarcane. *Functional Pl. Sci. Biotechnology. 2012.* Vol. 6 (S.I.), Pp. 51-62.

[10] Ganapathy, S and J, Jayakumar. Evaluation of Sugarcane (*Saccharum spp*. hybrids) Clones for Yield and Quality and its Contributing traits. J. Experimental Agric. Int. 2023. 45(7): 113-118.

[11] Ganapathy,S. and Purushothaman,R.S. Performance of Promising Early Maturing Sugarcane Clones for Yield and Quality Traits during Varietal Development Process**.** *Electronic J. Plant Breed*. 2017. 8(1): 279 - 282.

[12] Jackson, PandMc Rae,T.A.Selection of sugarcane clones in small plots- Effects of plot size and selection criteria. *Crop Sci*. 2001.41: 315-322.

[13] Ganapathy, S., Ravichandran, V. and Purushothaman, R.S. Evaluation of promising sugarcane clones for cane yield, sugar yield and resistance to red rot disease in zonal varietal trial. *Trends in Biosciences*, 2017. 10 (15): 2686-2689.

[14] Ganapathy, S. and Purushothaman, R.S. Evaluation of Early Maturing Sugarcane Clones for Yield, Quality and Its Contributing Traits in East Coast Zone of Tamil Nadu. Int. J. of Plant Soil. Sci. *2022. 34 (20), 575-581.*

[15] Elayaraja, K. and Shanthi, R.M. Identification of principal traits for ratooning ability associated with cane yield and juice quality in sugarcane genotypes from advanced varietal evaluation trials. J. Sugarcane Research, 2021; 11, 66-73.

[16] Nirmodh Prabha. Evaluation of Early Group of Sugarcane Genotypes for Yield and Quality Traits. Int. J. Curr. Microbiol. App. Sci. 2021; 10 (02): 648-652.

[17] Sadras Bhavana, M. Vijay Kumar, G., Madhu Bindu, S, Reddy, D.V.V. and Chiranjeev, K. Assessment of Quality Parameters in Different Clones of Sugarcane (*Saccharumofficinarum* L.). Int. J. of Environment and Climate Change. 2022;12(11): 3524-3530.

[18] Ravichandran, V., S. Ganapathy, M. Shanmuganathan, J. Jayakumar, G. Gayathry, P. A. Saravanan and P. Veeramani.Resistance of Sugarcane Clones (*Saccharum spp*.) to Red Rot Disease (*Collectorichumfalcatum*Went) and Analysis of Resistant clone by FTIR. 2023. *Int. J Plant & Soil Science*.35(18); 1250-1256.

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Table 1. Mean performance of earlysugarcaneclones for yield and quality traits in Zonal Varietal Trial

S. No.	Clone	Germi-nation (%)	No. of tillers ('000/ha)	NMC ('000/ha) (10 m)	Stalk length (cm)	Stalk Diameter (cm)	Single Cane Wt. (kg)	Cane yield (t/ha)
1	CoC 15336	53.49	115.71	108.84	271.00	2.97	1.22	128.79
2	CoC 15337	55.44	107.38	99.84	274.00	2.87	1.24	124.27
3	CoC 15338	50.92	115.40	110.42	292.33	3.05	1.32	138.64
4	CoV 15356	48.25	118.48	112.07	282.33	2.89	1.24	129.66
Standard								
1.	CoA 92081	58.63	121.18	99.75	270.00	2.81	1.05	123.17
2.	CoC 01061	59.42	125.25	111.91	271.67	2.53	0.99	113.45
3.	CoOr 03151	52.08	114.69	101.36	267.00	2.74	1.19	117.78
	S.Ed.	3.08	4.63	5.07	7.01	0.7	0.06	4.66
	CD (0.05)	6.71	10.09	11.05	15.26	0.15	0.13	10.16
	CV (%)	6.98	4.86	5.80	3.11	3.02	6.38	4.57

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Table 2. Mean performance of early sugarcaneclones for juice quality traits in Zonal Varietal Trial

S. No.	Clone	Brix (%) (10 m)	Sucrose (%) (10 m)	CCS (%) (10 m)	Purity (%) (10 m)	Extrac -tion (%) (10 m)	Pol. (%) (cane) (10 m)	CCS (t/ha)
1	CoC 15336	21.60	18.00	13.01	90.41	55.26	14.09	16.75
2	CoC 15337	20.95	17.74	12.81	89.58	53.62	13.94	15.91
3	CoC 15338	21.31	17.94	12.95	90.11	54.82	14.08	17.95
4	CoV 15356	21.41	17.80	12.84	90.14	55.07	13.93	16.65
	Standard							
1.	CoA 92081	21.11	17.72	12.70	89.67	53.07	13.72	15.64
2.	CoC 01061	21.40	17.83	12.87	90.09	54.54	13.96	14.60
3.	CoOr 03151	20.53	17.42	12.52	88.52	52.51	13.67	14.76
	S.Ed.	0.27	0.05	0.05	0.45	0.49	0.12	0.63
	CD (0.05)	0.58	0.11	0.12	0.97	1.07	0.25	1.37
	CV (%)	1.54	0.35	0.52	0.61	1.02	1.01	4.82

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Table 3. Screening of sugarcane clones for resistance to red rot disease by plug method of Inoculation and nodal cotton swab method.

S. No	Entry	Red rot disease (Plug Method)		Nodal Method
		Score	Disease Reaction	
1.	CoC 15336	5.9	MS	R
2.	CoC 15337	4.0	MR	R
3.	CoC 15338	4.0	MR	R
4.	CoV 15356	3.3	MR	R
	Check			
6.	CoC 671 (S)	9.0	HS	S
7.	Co 86249 (R)	2.0	R	R

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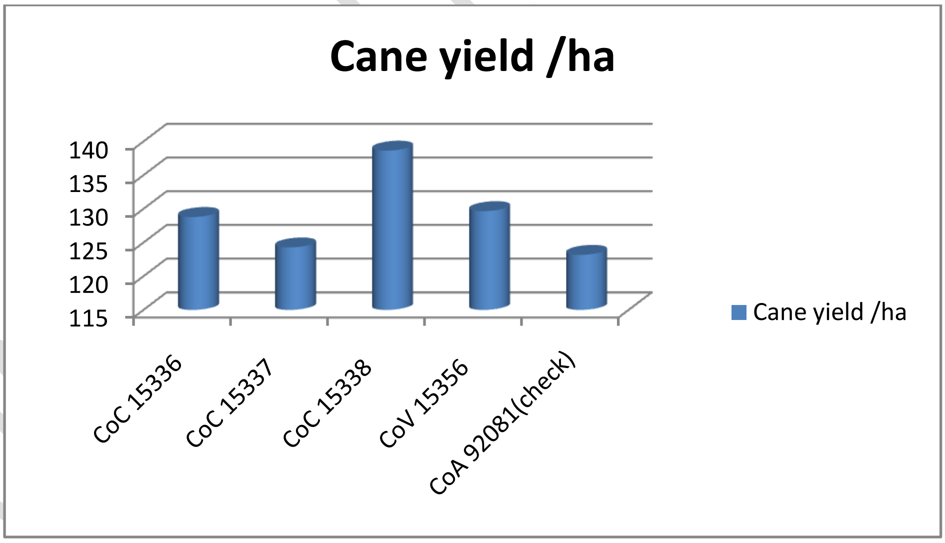

Fig. 1. Evaluation of sugarcane clones for cane yield (t/ha)

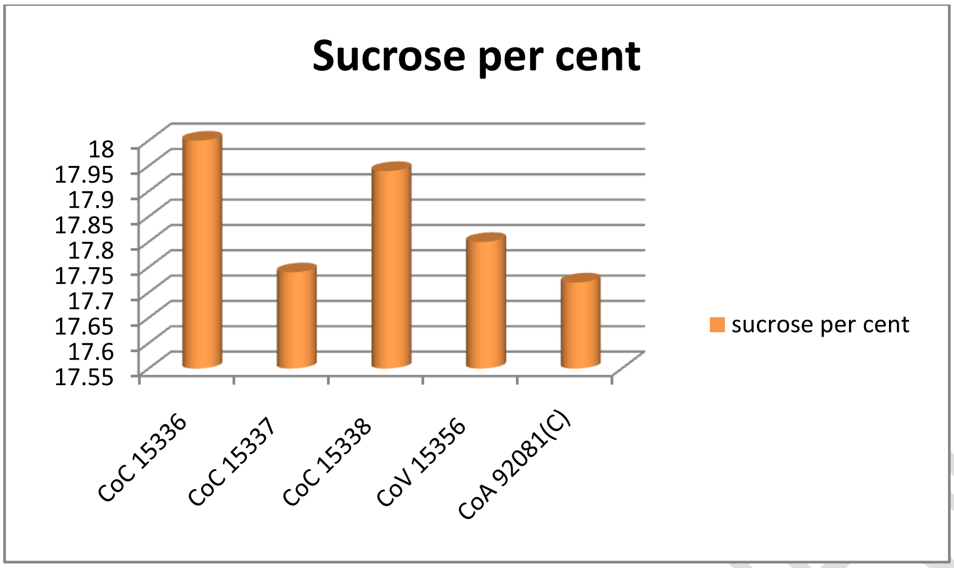

Fig. 2.Evaluation of sugarcane clones for Sucrose content (%)

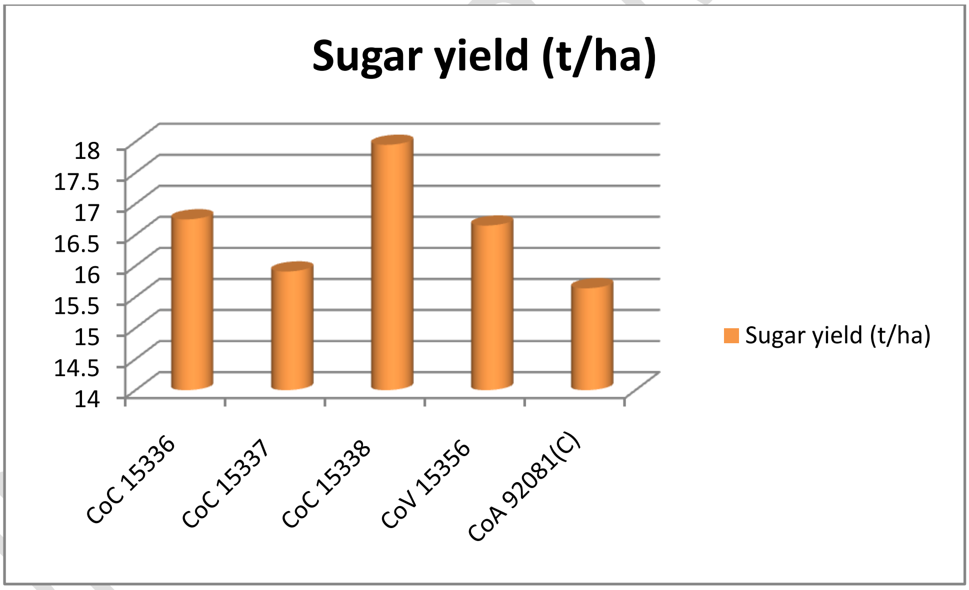

Fig. 3. Evaluation of sugarcane clones for sugar yield (t/ha)