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Assessment of sugarcane (*Saccharum officinarum* L.) short duration clones for yield, quality and contributing characters

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Abstract
The present investigation was carried out to assess genetic potential of short duration sugarcane clones for yield and quality related characters. The Experimental materials consist of seven test clones *viz*., C 30027, C 30031, C 30035, C 29336, C 29373, C 29374, C 29442 and three standards (CoC (Sc) 24, TNAU Si 7 and CoC 671) in Advanced Yield Trial – Plant -I (AYT-I), Advanced Yield Trial Plant-II (AYT-II) and AYT- ratoon. Observations were recorded for tillers numbers per hectare (x1000/ha), millable cane numbers (x1000/ha), cane yield (t/ha), Brix (%), sucrose (%), Commercial Cane Sugar (%) and sugar yield (t/ha). The overall performance of the test clones for yield and quality traits in all the three evaluation trials (AYT I, AYT II and AYT ratoon) revealed that, the two clones (C 29442 and C 29374) were identified as better forming clones, since they showed higher cane yield, sucrose %, CCS percent, sugar yield, and number of millable canes per hectare over the best check variety of CoC (Sc) 24. Hence these two clones C 29442 and C 29374 are to be promoted for further evaluation trials for release as a new short duration sugarcane variety.

Keywords: Sugarcane, cane yield, short duration, CCS %, sucrose %, sugar yield

Introduction
Sugarcane (*Saccharum spp*.) is the world's largest cash crop for producing sugar, primarily sucrose, which is planted in both tropical and subtropical regions. The most common type of table sugar consumed worldwide is sucrose. It is utilized as a component in the creation of numerous medications and beverages, as well as in the confectionery and related sectors as a sweetener [1]. A perennial member of the Poaceae (Grass family), sugarcane has jointed fibrous stem and can grow heights of five to six meters. It was cultivated mostly using vegetative setts to preserve the varieties for longer generations [2]. India is the world's second-largest producer of sugarcane behind Brazil in terms of both production (376.91 m. tonnes) and area (48.67 lakh acres). In India, Tamil Nadu is the most productive state and ranks first in both area and production behind Uttar Pradesh (UP), Maharashtra, and Bihar. With a productivity of 107.62 t/ha, it was planted in Tamil Nadu on an area of 1.31 lakh hectors, yielding 14.12 million tonnes of sugarcane [3].

To achieve higher recoveries in sugar mills, the evolution of cultivars for various maturity groups is of utmost importance in sugarcane production. In order to produce sugarcane, it is vital to choose the right high yielding varieties, apply the right agronomic techniques, and balanced application of nutrients [4]. Sugarcane production decreases as a result of not adopting any of the components, which impacts cane growers and sugar mills as well [5].

Evolution of varieties is a continues process and numerous varieties for early and mid-late season have been released. Sugarcane being a long duration crop it occupies the land for 12-13 months. By developing varieties of eight months duration the productivity of the cane per unit area can be increased by raising three crops in two years. This also enables high sugar production by supplying cane for running the sugar factory for quite a long period. Keeping view in this, the present study was conducted with the objective of evaluation of short duration sugarcane clones for high cane yield, quality and other economic characters.

Materials and Methods
Experimental Materials, Layout and raising a crop
The field experiments were conducted in early season of Tamil Nadu at Sugarcane Research Station, (TNAU), Cuddalore, Tamil Nadu, India (latitude; 11º 46’ North; longitude: 79º.46’

East; altitude: 4.60 m MSL). The Advanced Varietal Trial-Plant-I (AVT-plant-I), Advanced Varietal Trial-plant-II (AVT-plant-II) and AVT-Ratoon are the three experimental trials that make up the current investigation. After the AYT plant- I crop was harvested, the ratoon crop was maintained in order to study the performance of the clones in the next year. Seven test clones *viz*., C 30027, C 30031, C 30035, C 29336, C 29373, C 29374, and C 29442 as well as three standards CoC (Sc) 24, TNAU Si 7, and CoC 671 were used in each of the three field evaluation trials.

During the early growing season in the same soil type (clay loamy), all test clones relevant to the various evaluation trials were planted in Randomised Block Design with three replications. Each entry had a plot with five rows, each five metres long, spaced 90 cm apart, and sixteen buds per metre of seeding. Agronomic best practises were faithfully implemented. For the duration of the cropping cycle, uniform application of need-based plant protection methods for pest and disease management helped to maintain healthy crop stand.

Characters Studied and Design

The data on number of tillers (x1000/ha), number of millable cane (NMC) (x1000/ha), cane yield (t/ha), Brix (%), sucrose (%), Commercial Cane Sugar (CCS) percent and sugar yield (t/ha) were recorded during the entire cropping period. Among these characters, data on number of tillers (x1000/ha) was recorded at 120th days after planting, while all other parameters were recorded during harvest. For quality analysis, the cane samples were taken from each clone and juice was extracted by power crusher and analysed for Brix (%) and sucrose (%) as per the method suggested by [6]. Sucrose percent was calculated as per Schmitz's tables. CCS percent was calculated as per the following formula. CCS%= (Sucrose% - 0.4 (Brix % - Sucrose %)) x 0.75. Then, the sugar yield was calculated based on CCS percent and cane yield of the particular clone. All the collected data were statistically analysed by statistical method described by Gomez and Gomez [7].

Results and Discussion

Advanced Yield Trial-I plant

In Advanced Yield Trial, seven test entries and three standard varieties were evaluated for growth, quality and yield attributes and presented in Table 1. For tillers counts in this trial, maximum was recorded in the clone C 29374 (1, 47,300/ha) and minimum was expressed by the check variety CoC 671 (1, 02,500/ha). The clone C 29374 recorded highest value of 1, 47,300/ha followed by the clone C 29442 (1, 40,550 /ha). and C 29373 (1,40,250 ha). In case of millable cane (NMC), clone C 29374 showed the higher NMC (1, 25,700/ha) followed by the Clone C 29442 (1, 17,250/ha) and Clone C 29373 (1, 15,500/ha). Millable cane directly influences cane yield as it is the combined interaction of germination percent and tillering potential [8]. In case of cane yield, the clone C 29442 recorded highest cane yield of 137.50 t/ha followed by the C 29374 (135.70 t/ha) and it was varied from 115.50 t/ha (C 30027) to 137.50 t/ha (C 29442). Regarding commercial cane sugar (CCS) percent, none of the clones recorded the superior over the standard variety CoC 671 (12.80%) except the one test clone C 29442 (12.81%). For brix readings at 8th month, only one test clone C 29442 recorded the highest brix readings (20.22%) over the standard variety CoC 671 (20.21). For sugar yield, the two test clones C 29442 (17.61 t/ha) and C 29374 (17.374 t/ha) were showed higher sugar yield per hectare over the best performing check variety CoC 24 which recorded 16.07 t/ha (Table 1). Similar kind of results on yield, quality and quality contributing traits for early duration sugarcane clones were already reported by [9].

Advanced Yield Trial-II plant

In this trial, seven advanced clones and three checks were evaluated for quality and yield attributes. The performance of clones are presented in Table 2 and revealed that highest cane yield was in the clone C 29422 (141.62 t/ha) after that C 29374 (136.20 t/ha) and C 29336 (135.78 t/ha). This type of evaluation of clones in sugarcane is in conformity with the finding of Nirmoth Prabha and Ravinder Sharma [10, 11]. For tillers counts, the clone C 29374 recorded highest value (1, 35,500/ha) followed by the clone C 29442 (1, 26,350 /ha). Regarding the millable cane, the clone C 29374 recorded the highest number of millable cane (1, 19,450 /ha) and next better forming clones are C 29373 (1, 11,750 /ha) and clone C 29442 (1, 10,300 /ha). For CCS percent, the clone C 29442 showed highest CCS percent of 12.85 followed by standard CoC 671 (12.83%) and C 29374 (12.82%). Regarding Brix percent at 8th month, the clone C 29442 has recorded the highest value of 20.85% over the check variety of CoC 671 (20.83) followed by test entry C 29374 (20.82%). In case of sucrose content the clone C 29442 recorded the highest sucrose percent (16.77%) and next best entry was CoC 671 (16.72%) and it was ranged from 15.80% to 16.77%. The sucrose and brix percent are the key characters for deciding the quality of sugarcane clones and it influences the sugar recovery and sugar production in sugar mills [8]. The same results are almost similar as demonstrated by [11]. For sugar yield, the clone C 29442 recorded highest sugar yield (18.17 t/ha) and next performing clones are C 29374 (17.46 t/ha) and C 29373 (16.81) over the standards CoC (Sc) 24 which recorded 15.73 t/ha [12, 13].

Advanced Yield Trial-Ratoon

In AYT ratoon trial, AYT I plant was allowed for ratoon crop to study the ratoon performance of seven clones along with three checks. The data on ratoon performance of clones are presented in Table 3. For tillers counts, test clone C 29374 recorded highest value of 1, 27,620/ha and followed by C 29442 (1, 23,750 /ha). For number of millable cane, the clone C 29374 recorded the highest NMC (1, 15,250 /ha) followed by the Clone C 29442 (1, 12,610/ ha) and clone C 29373 (1, 09,450/ ha) the tillering potential of a sugarcane variety ultimately increase cane yield positively and deciding the number of millable cane [8]. For cane yield, the clone C 29442 recorded highest cane yield of 135.40 t/ha followed by C 29374 (132.55 t/ha) and C 30031 (128.72 t/ha). For CCS percent, ranged from 12.87% (C 29442) to 12.31% (C 30035). The clone C 29442 recorded highest CCS percent of 12.87 followed by the standard variety CoC 671 (12.85%) and clone C 29374 (12.83%). Brix readings, the clone C 29442 recorded the higher brix value (20.85%) followed by the standard variety CoC 671 (20.82%). The sucrose percent was varied from 16.05% (CoC (Sc) 24) to 16.81% (C 29442). The test clone C 29442 recorded highest sucrose percent (16.81%) followed by the standard CoC 671 (16.77%). For sugar yield, the maximum sugar yield was observed in the clone C 29442 (17.43 t/ha) and minimum by the check variety TNAU Si 7 (13.91t/ha). The test clone C 29442 recorded highest sugar

yield (17.43 t/ha) followed by the clone C 29374 (17.01 t/ha) and C 30031 (16.10 t/ha). The higher sugar yield of clones may be attributed to relatively more cane yield and subsequent commercial cane sugar percent [14]. There are varieties capable of giving higher cane yields and fairly good recovery leading to higher per acre sugar production [14].

Table 1: Performance of short duration clones in Advanced Yield Trial-I (I-Plant)

S. No.	Clones	Tillers (‘000/ha)	NMC (‘000/ha)	HR brix (%)	Sucrose (%)	Cane yield (t/ha)	CCS (%)	Sugar yield (t/ha)
1	C 30027	130.10	108.75	20.10	16.55	115.50	12.72	14.69
2	C 30031	124.35	115.00	18.50	15.65	116.40	11.90	13.85
3	C 30035	126.45	117.45	19.50	16.20	122.50	12.20	14.95
4	C 29336	125.72	105.65	19.20	16.15	117.75	12.10	14.25
5	C 29373	140.25	115.50	19.90	16.25	115.60	12.60	14.57
6	C 29374	147.30	125.70	20.15	16.64	135.70	12.80	17.37
7	C 29442	140.55	117.25	20.22	16.75	137.50	12.81	17.61
	Standard							
8	CoC(Sc) 24	106.25	98.50	19.40	15.75	132.25	12.15	16.07
9	TNAU Si 7	113.45	101.15	20.20	16.35	125.50	12.70	15.93
10	CoC 671	102.50	96.42	20.21	16.65	121.60	12.80	15.56
CD (0.05%)		12.50	9.45	0.23	0.27	8.40	0.20	1.48
CV (%)		6.37	5.04	0.12	0.15	4.82	0.12	0.75

Table 2: Performance of short duration clones in Advanced Yield Trial-II (II - Plant)

S. No.	Clones	No. of Tillers (‘000/ha)	NMC (‘000/ha)	HR brix (%)	Sucrose (%)	Cane yield (t/ha)	CCS (%)	Sugar Yield (t/ha)
1	C 30027	115.45	105.60	20.80	16.65	128.42	12.70	16.31
2	C 30031	116.10	103.23	20.05	16.05	130.15	12.10	15.75
3	C 30035	127.35	118.35	19.85	16.25	125.85	12.25	15.42
4	C 29336	108.30	97.65	20.13	16.31	135.78	12.30	16.70
5	C 29373	125.62	111.75	19.27	16.52	131.82	12.75	16.81
6	C 29374	135.50	119.45	20.82	16.70	136.20	12.82	17.46
7	C 29442	126.35	110.30	20.85	16.77	141.62	12.85	18.20
	Standard							
8	CoC(Sc) 24	115.42	107.15	19.53	15.80	127.85	12.30	15.73
9	TNAU Si 7	114.85	108.16	20.50	16.45	122.70	12.75	15.64
10	CoC 671	110.15	104.85	20.83	16.72	120.47	12.83	15.48
CD (0.05%)		11.75	9.81	0.32	0.25	9.55	0.17	1.12
CV (%)		6.36	5.75	0.17	0.11	4.35	0.08	0.57

Table 3: Performance of short duration clones in Advanced Yield Trial – Ratoon

S. No.	Clones	No. of Tillers (‘000/ha)	NMC (‘000/ha)	HR brix readings (%)	Sucrose (%)	Cane yield (t/ha)	CCS (%)	Sugar yield (t/ha)
1	C 30027	111.34	103.45	20.73	16.71	121.54	12.80	15.56
2	C 30031	109.15	97.50	20.15	16.10	128.72	12.51	16.10
3	C 30035	122.65	116.33	20.15	16.27	120.47	12.31	14.83
4	C 29336	118.80	105.15	20.25	16.35	118.65	12.40	14.71
5	C 29373	123.35	109.45	19.55	16.42	125.25	12.77	16.08
6	C 29374	127.62	115.25	20.72	16.75	132.55	12.83	17.01
7	C 29442	123.75	112.61	20.85	16.81	135.40	12.87	17.43
	Standard							
8	CoC (Sc) 24	112.35	106.60	19.55	16.05	121.25	12.35	14.97
9	TNAU Si 7	110.55	105.45	20.60	16.42	109.45	12.71	13.91
10	CoC 671	106.71	98.35	20.82	16.77	115.35	12.85	14.82
CD (0.05%)		10.74	8.94	0.27	0.19	9.27	0.16	1.15
CV (%)		5.27	4.85	0.13	0.08	5.33	0.07	0.83

Conclusion

The results from the AYT - I, AYT - II and AYT ratoon crops for the yield and quality traits, revealed that, the test clones *viz*., C 29442 and C 29374 were found to be better performing clones, since they expressed higher cane yield, sugar yield, CCS percent, sucrose percent, number of tillers per hectare and number of millable canes per hectare over the best performing check variety of CoC (Sc) 24. Hence these two clones C 29442 and C 29374 are to be promoted for further evaluation trials and for release as a new short duration sugarcane variety.

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