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AGRONOMIC PERFORMANCE OF SOME SUGARCANE HYBRID CLONES AT NATIONAL CEREALS RESEARCH INSTITUTE, BADEGGI, NIGERIA

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ABSTRACT

The need for indigenous, developed sugarcane varieties cannot be overstated, as the sugar estates in Nigeria depend heavily on exotic cultivars that suffer rapid yield decline due to non-adaptability in their new environment. Sugarcane production is significant in the country, as it plays a vital role in food and income security. A study was conducted to evaluate the performance of sixteen sugarcane hybrid clones at the National Cereals Research Institute (NCRI) in Badeggi, Niger State, Nigeria. The clones were planted using a Randomised Complete Block Design (RCBD) with three replications. Analysis of variance revealed significant differences among the clones for some traits. The highest cane yield (175.7 t ha^{-1}) was recorded in BD 1098-003m. BD1098-001m clone yielded the highest Brix (21.4%) and sugar yield (16.95 t ha^{-1}) among the studied hybrids. BD 1098-005m, BD 441-007m, and B 47419 possess better fibre, and such materials can be manipulated for energy cane varieties. Brix percentage also varied among the clones, increasing with crop age (from 8, 9, 10, and 12 months after planting), which can be used as an indicator of maturity. This evaluation has revealed the performance of some hybrid clones, and they will be nominated for further assessment (multi-location trial).

Key words: Clone, Brix, Hybrid, Sugarcane

INTRODUCTION

Sugarcane (*Saccharum officinarum L.*) is one of the most critical commercial and cash crops cultivated for sugar production across the world. It contributes approximately 75% of the world's sugar production, while sugar beets produce 25% (Mani *et al*., 2019). It is grown in Nigeria on a small scale for home use and a large industrial scale for refined sugar production and its byproducts (Takim *et al*., 2019). Sugarcane production is crucial for Nigeria's economic diversification; as substantial resources are annually invested in sugar imports. Its production in Nigeria is profitable, with a return of ₦1.88 for every ₦ 1 invested, as documented by Aina *et al*. (2015). Africa contributes only 5% to the global sugarcane production, with 83% of this in Sub-Saharan Africa. The sub-Saharan African region, with its tropical and subtropical climate, is well-suited for expanding sugarcane production in many ways.

Nigeria's annual raw sugar production averages 80,000 metric tons despite yearly consumption of 1.7 million metric tons. According to the Nigeria Sugar Annual (2019), the country imports approximately 1.6 million metric tons of raw sugar from Brazil, Thailand, and the United States to meet its demand. Ishaq *et al*. (2019) highlighted the lack of improved, high-yielding, and adaptable sugarcane varieties as a major setback for sugar production in the region. Olaoye (1999) has highlighted the need for locally improved sugarcane varieties that are also adapted to our ecology, as part of the constraints to sugar production in the country. The goal of sugarcane (*Saccharum species*) breeding is to develop genetically improved varieties with high sugar yield (cane yield and sucrose content) that will be economically sustainable over several ratoon crops. Sugarcane yield can be enhanced in Nigeria through hybridisation, evaluation, and adoption of promising clones that suit the country's ecology. Increased cane yield is a function of the higher genetic potential of the clones (Nazir *et al*., 1994) and can only be revealed through a progeny performance evaluation. The remedy for the problem of lower cane yield and sugar recovery relies on cultivating improved cane varieties (Chattha *et al*., 2006). Sugarcane cultivars vary in juice quality characteristics, cane yield, maturity, flowering and yield per hectare due to their inter-species hybridisation involving four species (*S. officinarum*, *S. barberi, S. sinense* and S. *spontaneum*) of the genus *Saccharum* (Moore *et al.,* 2014). The performance of various clones and their agronomic traits is paramount before a variety is accepted for commercial cultivation (Maqbool *et al*., 2001). Therefore, this study was conducted to evaluate and reveal the performance of some sugarcane hybrid clones at the National Cereals Research Institute, Badeggi, Nigeria.

MATERIALS AND METHODS

This study was conducted by the sugarcane research program of the National Cereals Research Institute, Badeggi, Niger State, Nigeria (NCRI). The trial was established at the sugarcane research field (Lat 9 ° 3'0" N and Long 6 ° 9'0" E) of NCRI, and fourteen promising clones (Table 1) were advanced from the Progeny Testing II series to a preliminary yield trial. The fourteen clones, including two commercial varieties (B 47419 and N 27), were planted in a randomised complete block design (RCBD). Each clone was planted on a 5 m x 5 m plot and replicated three times. Sixty cane sets (three budded) were planted per plot. The preliminary yield trial was established on October 9, 2018, and all cultural practices for sugarcane production were adopted according to the recommendations of NCRI Badeggi. Juice analysis was carried out at the NCRI laboratory for qualitative traits.

Data were collected on germination and establishment (%) at 21 and 42 days after planting, respectively, tiller count at 3 months after planting, stalk girth, plant height at 6 months, stool per plot, stalk per plot, milleable cane per plot, and cane yield (ton/ha) at maturity. Brix (sugar content) was measured using a refractometer at the 8th, 9th, 10th, and 12th months after planting. A hand punch was used to extract juice from the cane stalk, and the juice was dropped onto the refractometer lens for viewing. Data were also recorded for Moisture, Fibre, Glucose, Sucrose, Polarity and Purity. Recovery sucrose% % and Sugar formulae are given below.

Recoverable Sucrose percent (RS)

$$RS(\%) = \left[\text{Polarity \%} - \frac{(\text{Brix} - \text{polarity})}{2} \right] \times \text{Juice Factor.}$$

Juice Factor = 0.65

$$\text{Sugar Yield (t/ha)} = \frac{\text{Cane Yield tha}^{-1} \times \text{Recovery Sucrose}}{100}$$

(Islam *et al*., 2011).

The data collected were subjected to analysis of variance (ANOVA) using the Crop Stat (version 7.2) package. Means were separated using the Least Significant Difference test ($P \leq 0.05$) where differences occurred among clones.

Table 1: List of Sugarcane Hybrid Clone and their Parentage

Genotypes	Parents (Female X Male)	Status
BD 140-02m	M 1551/80 X F77790	Progeny of Mauritius fuzz
BD 140-011m	M 1551/80 X F77790	Progeny of Mauritius fuzz
BD 140-014m	M 1551/80 X F77790	Progeny of Mauritius fuzz
BD 1098-001m	M 2256/88 X POLYCROSS	Progeny of Mauritius fuzz
BD 1098-003m	M 2256/88 X POLYCROSS	Progeny of Mauritius fuzz
BD 1098-005m	M 2256/88 X POLYCROSS	Progeny of Mauritius fuzz
BD 1098-014m	M 2256/88 X POLYCROSS	Progeny of Mauritius fuzz
BD 441-004m	M 1489/91 X POLYCROSS	Progeny of Mauritius fuzz
BD 441-007m	M 1489/91 X POLYCROSS	Progeny of Mauritius fuzz
BD 575-007m	M 422/91 X R570	Progeny of Mauritius fuzz
BD 1354-20m	M1672/90 X R570	Progeny of Mauritius fuzz
BD 1576-31m	M2256/88 X R570	Progeny of Mauritius fuzz
BD 1576-07m	M2256/88 X R570	Progeny of Mauritius fuzz
BD 1576-14m	M2256/88 X R570	Progeny of Mauritius fuzz
N 27		Commercial Variety
B 47419		Commercial Variety

RESULTS AND DISCUSSION

Results from Table 2 below reveal significant differences ($P \leq 0.05$) among the hybrid clones for certain growth traits. BD 140-014m has a significantly higher sprout percentage than other clones, except for BD 1098-014m ($P < 0.05$). The result on sprout percentage conforms with the report by Mohammed *et al*. (2019), which observed differences in sprouting for the Assessment of some sugarcane genotypes for juice, sugar, and cane yield at Badeggi, Nigeria. According to the Table 2 below, 1098-014m significantly (P≤5%) has more established plants (68.3) than some studied clones (BD 1098-001m, BD1098-005m, BD441-004m, BD 575-007m, BD 1354-20m, BD 1576-31m, BD 1576-07m and BD 1576-14m) and lowest establishment was recorded in BD 1576-31m. BD 1098-014m has the highest number of tillers and was significantly superior to the number of tillers recorded for all the studied clones

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Table 2: Mean values for growth performance of selected hybrid sugarcane genotypes evaluated at NCRI Badeggi (2018/2019)

GENOTYPE	SPROUT	TILLER	ESTAB	PLH 6
BD 140-02m	52.7	70.7	62.7	161.9
BD 140-011m	39.7	70.0	57.0	196.1
BD 140-014m	64.0	106.3	62.7	223.3
BD 1098-001m	37.0	59.0	51.0	188.5
BD 1098-003m	46.0	100.3	59.7	204.5
BD 1098-005m	43.0	26.7	44.0	145.9
BD 1098-014m	58.0	161.7	68.3	165.6
BD 441-004m	41.7	71.3	40.0	186.3
BD 441-007m	54.0	127.0	66.3	158.9
BD 575-007m	19.0	73.3	47.7	151.0
BD 1354-20m	18.0	59.0	26.0	162.3
BD 1576-31m	12.3	27.3	22.0	157.6
BD 1576-07m	20.3	82.3	39.7	159.8
BD 1576-14m	23.7	86.7	46.0	206.1
N27	50.0	100.0	62.0	212.7
B47419 (check)	46.3	78.3	62.7	202.9
LSD @ 5 %	8.7	17.4	13.7	23.8
CV%	13.3	12.8	16.1	7.9

Means were separated using Least Significant Difference (LSD) at P≤5%.

Note: sprout (%), Tiller= number of tillers per plot, Estab= establishment count, PLH 6= plant height at six months after planting

Significant differences were recorded among the studied sugarcane hybrid clones for yield attributes (Table 3). BD 140-011m recorded the highest stalks per stool, which was significantly greater than the number of stalks per stool recorded for BD 140-02m, BD 140-014m, BD 1576-14m and B 47419. However, BD 1098-014m has a greater number of milleable stalks (140.6) per plot and 1576-07 BD has the lowest milleable cane (67.30) per plot. The maximum stalk girth (2.8 cm) was recorded for BD 140-014m and BD 1098-005m, which compared significantly ($P \leq 0.05$) better than the girth of B47419 (commercial check). The variation noted in the stalk girth conformed to the results of Soomro *et al*. (2006), which documented differences among twelve promising sugarcane varieties in Thatta, Pakistan. The highest cane yield (186.5 t/ha) was recorded in BD 1098-003m, which was significantly the same as the yield recorded for N 27, and the lowest yield was noted in BD 441-004m. Khan *et al*. (2004) had also reported a higher cane yield of 174.4 t/ha. The higher cane yield exhibited by some studied clones may be attributed to the inherent genetic potential of the progenies. Higher cane yield is also known to be a function of a variety's higher genetic potential, as documented by Nazir *et al.* (1997). Variability among the clones for yield per hectare is in agreement with the reports of other researchers (Getaneh *et al*., 2015; Ali *et al*., 2017; and Islam *et al*., 2011).

The results in Table 4 show significant differences among the studied clones for Brix percentage at 10 and 12 months after planting. BD 1098-001m and 1576-31 BD yielded the highest Brix (21.4% and 21.1%), while the lowest Brix was noted in BD 441-007m. In some studied clones (BD 140-02m, BD 140-011m, BD 1098-001m, BD 1098-003m, BD 1098-005m, BD 1098-014m, BD 441-004m, BD 575-007m, BD 1576-31m, BD 1576-07m, BD 1576-14m, B 47419) the brix percent tend to increase as the age of the crops increases. Most of the studied genotypes exhibit higher Brix percentages than the check (B47419), which is in agreement with the results of Ali *et al*. (2020), who investigated the performance and stability analysis of several sugarcane genotypes across different environments. It has also been suggested that the brix accumulation of genotypes depends on crop age and environment (Mebrahtom *et al*., 2017). The time of highest Brix percent of a sugarcane clone can serve as an indicator for crop maturity in non-flowering condition.

Table 3: Mean values for yield performance of selected hybrid sugarcane genotypes evaluated at NCRI Badeggi (2018/2019)

GENOTYPE	STK/STUL	MIL/PLT	STL/PLOT	GIRTH (cm)	YIELD (ton/ha)
BD 140-02m	4.7	111.7	23.7	2.1	107.3
BD 140-011m	7.9	113.3	16.0	2.3	122.0
BD 140-014m	5.0	89.0	26.0	2.8	114.3
BD 1098-001m	6.1	130.3	17.3	2.2	164.0
BD 1098-003m	5.9	106.0	17.7	2.0	175.7
BD 1098-005m	6.2	70.3	10.3	2.8	91.0
BD 1098-014m	7.4	140.3	19.3	2.0	160.3
BD 441-004m	6.8	122.0	16.0	2.0	76.0
BD 441-007m	6.0	103.3	16.3	2.0	104.0
BD 575-007m	6.7	94.7	16.3	2.2	105.0
BD 1354-20m	7.6	77.0	21.3	2.4	124.7
BD 1576-31m	7.3	73.0	19.3	2.2	96.7
BD 1576-07m	7.0	67.3	15.7	2.4	97.7
BD 1576-14m	4.7	120.7	18.3	2.1	106.7
N27	6.9	130.7	18.3	2.4	169.0
B47419 (check)	5.1	131.0	15.7	1.9	97.3
LSD @ 5 %	2.2	13.6	4.5	0.5	19.3
CV%	21.0	7.7	15.1	12.1	9.5

Means were separated using Least Significant Difference (LSD) at $P \leq 5\%$.

Note: STK/STUL= stalk per stool, MIL/PLT= milleable stalk per plot, STL/PLOT=stool per plot

The qualitative analysis of the juice reveals significant ($P \leq 0.05$) differences among the studied clones (Table 5). High fibre was recorded in some clones (BD 1098 005m, BD 441-007m, BD 1576-31 and B 47419), and the lowest fibre per cent (5.69) was noted in BD 1098-003M. Those genotypes that possess high fibre can also be utilised as a source for energy cane varieties, since no variety has been released for this purpose in Nigeria.

Table 4: Trend of sucrose (brix) accumulation for hybrid sugarcane genotypes evaluated at NCRI Badeggi (2018/2019)

GENOTYPE	BRIX 8	BRIX 9	BRIX 10	BRIX 12
BD 140-02m	15.3	16.4	18.4	20.3
BD 140-011m	15.1	15.7	15.6	17.5
BD 140-014m	14.5	18.0	17.0	18.0
BD 1098-001m	17.1	18.1	20.7	21.4
BD 1098-003m	17.9	18.3	18.1	18.9
BD 1098-005m	14.3	16.7	18.4	20.6
BD 1098-014m	16.5	16.8	19.0	19.4
BD 441-004m	15.1	17.2	19.3	19.5
BD 441-007m	15.1	15.9	18.8	17.3
BD 575-007m	15.0	16.8	18.8	19.9
BD 1354-20m	9.9	15.9	16.7	16.9
BD 1576-31m	12.4	16.7	17.1	21.1
BD 1576-07m	14.1	18.4	18.2	20.0
BD 1576-14m	14.3	17.1	15.8	17.8
N27	16.7	16.4	19.1	18.6
B47419 (check)	14.3	15.3	16.7	18.0
LSD @ 5 %	4.9	3.2	2.7	2.5
CV%	19.8	11.2	9.1	7.8

Means were separated using Least Significant Difference (LSD) at P≤5%.

Variation among the studied hybrids for juice purity is in agreement with the report by Khan *et al*. (2017) on the differences noted in juice purity among sixteen varieties. Juice purity above 85% with relatively high pol per cent, as indicated in some varieties, suggests that these varieties attained maturity earlier than other varieties with lower purity per cent. Maximum purity per cent of 93.80 was obtained in BD 1576-14 and BD 1098-014m, which gave significantly (P≤5%) lower purity level (72.3).

he disparity in the recovery of sucrose in evaluated clones confirms the report of Khan *et al*. (2017), who suggested that varieties with high sugar content could be harvested at an earlier age (11-12 months) than other varieties. Sugar yield differs among the hybrid clones; BD 1098-001m, BD 1098-003m, and BD 1354-20m yielded significantly (P ≤ 0.05) better sugar yields than the check varieties (N 27 and B 47419). The family of BD 1098m clone performs better in terms of sugar yield per hectare, which can be attributed to the higher genetic potential of its parent for this trait.

Several workers have also reported significant differences among sugarcane varieties in terms of sugar yield per hectare (Khan *et al.,* 2017; Getaneh *et al*., 2015; Islam *et al*., 2011).

Table 5: Juice quality of selected hybrid sugarcane genotypes evaluated at NCRI Badeggi (2018/2019)

Genotypes	Moisture (%)	Fibre (%)	Brix (%)	Sucrose (%)	Glucose (%)	Polarity (%)	Purity (%)	Recoverable Sucrose	Sugar Yield (t/ha)
BD 140-02m	67.69	10.82	21.25	20.86	26.22	19.28	89.25	11.89	12.75
BD 140-011m	67.18	12.77	20.05	18.40	23.10	17.35	81.50	10.42	12.71
BD 140-014m	68.42	11.68	20.21	18.89	23.50	17.47	86.65	10.47	11.97
BD 1098-001m	63.16	13.90	23.10	20.45	25.25	18.30	80.40	10.33	16.95
BD 1098-003m	73.02	5.69	21.70	18.50	23.21	16.75	78.20	9.08	15.95
BD 1098-005m	57.95	16.75	25.10	22.73	28.23	21.82	85.35	13.12	11.94
BD 1098-014m	65.46	10.65	24.10	19.10	23.87	17.49	72.30	9.22	14.77
BD 441-004m	64.10	11.35	24.65	23.21	28.96	21.00	85.45	12.46	9.47
BD 441-007m	64.15	14.80	21.00	19.80	24.77	18.27	86.50	10.99	11.42
BD 575-007m	65.55	11.75	23.10	21.41	26.32	19.23	84.60	11.24	11.80
BD 1354-20m	60.48	13.13	26.75	24.70	31.17	22.48	85.20	13.22	16.49
BD 1576-31m	62.83	14.23	23.10	21.83	27.04	19.65	86.05	11.65	11.26
BD 1576-07m	66.24	12.77	21.00	18.52	23.17	17.26	81.95	10.00	9.77
BD 1576-14m	64.67	11.43	24.10	24.88	30.97	22.49	93.80	14.09	15.04
N 27	69.95	9.26	21.20	17.15	21.47	16.10	76.60	8.80	14.87
B 47419	63.65	15.31	21.25	18.39	22.84	16.81	79.85	9.48	9.22
LSD @ 5 %	0.28	0.35	0.26	0.41	0.48	0.45	0.76	0.51	0.71
CV %	0.20	1.30	0.50	0.90	0.90	1.10	0.40	2.10	2.60

Means were separated using Least Significant Difference (LSD) at P≤5%.

CONCLUSION AND RECOMMENDATION

This study revealed the differences in growth and yield components of the investigated hybrid clones. The promising hybrid clones' juice qualities were also documented, and some of the clones are good for dual purposes (for sugar and ethanol production). Those genotypes that perform better than the check varieties should be used for a multi-location trial to reveal their yield stability across different ecologies.

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