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RESEARCH ARTICLE

Characterization and evaluation of sugarcane genotypes

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Abstract

The only crop providing raw materials for sugar and jaggery production in Nepal is sugarcane, and its introduction and adaptation is the only route for its development commercially. The research was carried out to check the adaptability and yield potential of sugarcane genotypes tested under Initial evaluation Trial just after the introduction, and then under Advanced Varietal Trial, Coordinated Varietal Trial, and Coordinated Farmers Field trial simultaneously from the year 2012-18. The method used was RCBD with three replication in every of the trial. Analyzing all the cane yield attributing characters, and ratooning potential and ratoon yield, Co 0232, CoLk 94184 and CoSe 03234 were found superior to all other tested genotypes. Similarly, sugarcane juice quality (sugar recovery, CCS (t/ha) and Sucrose %) were found significantly higher in these three genotypes, so these genotypes Co 0232, CoLk 94184 and CoSe 03234 were registered in gadgets of Nepal Government as variety Jitpur-5, Jitpur-6 and Jitpur-7 respectively. Based on sugarcane DUS descriptor's Jitpur-5, 6, and 7 were considered different from each other based on morphological traits.

Key words: Sugarcane, genotypes, adaptability, ratoon, yield

Introduction

Sugarcane (*Saccharum officinarum*), principal crop in tropical and sub-tropical region of Nepal, is cultivated for its high rate of sucrose accumulation, with a production of 78,609 metric ton per annum having the annual productivity of 46.81 mt/ha. The total area coverage is 78,609ha, which is about 2.54% of total cultivable land (MoALd, 2019). Therefore, in Nepal, sugarcane (*Saccharum officinarum* L.) is one of the largest cash and industrial crop that plays a pivotal role in national economy. Today's sugarcane are the complex hybrids obtained after crossing between diverse species of Saccharum (Srivastava and Gupta, 2008). The size and complexity of its genome is a major limitation in genetic improvement, however morphological traits, pedigree record and molecular markers can be used to estimate genetic diversity (Rao et al., 2016). For the country like Nepal, where breeding is just at a nascent stage, there is a great need for the evaluation of introduced sugarcane varieties for morphological characteristics for their identification, distinctiveness, uniformity and stability, for its use in breeding and selection of suitable canes for the commercial sugarcane production. Plant's ability to adapt to environmental stresses, better quality, and high yielding varieties are the desirable traits, and these desirable traits are revealed by plant characterization, which are an important assets for both farmers and breeders (Mwenda, 2019).

Since sugarcane is the only crop providing raw materials for the production of sugar to fourteen sugarmills, and about a dozen of jaggery mills in the country; its average production is very low compared to neighboring and other developed countries which is due to lack of highly productive genotypes and poor adaptation of improved technologies, thus there is an urgent need to replace old and low productive varieties with high yielding clones. Therefore, this research was carried out with the sole objective to understand the actual morphological characteristics of introduced varieties of different domain at appropriate growth and developmental stage for their identification and distinctness from the rest cultivar.

Materials and methods

In the present study, three varieties named Jitpur-5, 6, and 7 were taken for observation of morphological traits which were characterized using 27 morphological DUS descriptors of sugarcane.

Varietal Improvement trails of sugarcane clones: For varietal selection for high yielding and juice content, there was a sequence of varietal evaluation from Initial Evaluation trials to Coordinated Farmers Field Trials and are as follows-

Initial Evaluation Trials (IET): It is the first step in varietal improvement as per guidelines of National Sugarcane Research Program. This trial consisted 16 genotypes, laid in RCBD design with three replication in two years. The plot size was 5 m long, 4 rows with spacing 90 cm. Here, all the yield and yield attributes character was observed and the best genotypes was further tested in advanced varietal trials.

Advanced Varietal trials (AVT): This is the second steps of varietal improvement where the best genotypes will be kept as treatment with replication in RCBD design in one year. The plot size was 5m long, 6 rows with spacing 90 cm. Again, the best was selected for CVT trials.

Coordinated varietal trials (CVT): The third steps of varietal improvement where, selected varieties was evaluated in different location for their genotypic and environment interaction and their stability. This trial was also conducted in RCBD design with 3 replication in different location. High yielding and stable genotypes were selected for CFFT trials.

Coordinated farmer field trials (CFFT): 4 genotypes with check was selected for evaluating their performance in farmer field as design by scientist and management by farmer. DUS test was conducted in farmer field in participation of farmers, sugar industries, and extension officer for selecting their varieties as per their requirement. Then selected varieties was proposed for release and register process.

Study sites and planting materials

Three different field experiments were conducted during 2012/13 to 2017/18 in National Sugarcane Research Program (NSRP). The soil of the experimental fields was sandy loam, slightly acidic, low in total nitrogen and organic carbon and medium in available phosphorus and potassium. Three budded sett of healthy canes were planted in furrow methods. Seed treatment was done with solution of Carbendazim 45% WP at rate of 1.5 gm. per liter water and with Chlorpyrifos 25% EC at 1.5 ml per liter water each dipped for five minutes. The fertilizer was applied at the rate of 150:60:40 and 200: 60: 40 kg NPK per hectare for plant cane and ratoon crop respectively. Before planting, half dose of N and full dose of phosphorus and potassium were applied and mixed with soil as basal. Remaining half dose was applied as two split top dressed each at 60 and 90 days after planting.

Data collection and analysis

The central three row of the plot were harvested and various parameters like yield and number of millable canes were recorded. Five canes were randomly selected for measuring single cane weight and stalk length. Three canes were randomly selected for measuring cane diameter and sugarcane juice analysis. Horne's Dry Lead method was used for sugar recovery (sugar content) quantification.

$$Pol\,\% = \frac{Pol\ reading}{\{0.00576\ x\ brix(brix + 0.014752) + 3.83545)]}$$

$$Sugar\ recovery\ (\%) = [Pol\,\% - 0.4\ x\ (brix - Pol\%\ )x\ 0.74]$$

Where, Pol % mean sucrose content in sugarcane juice. Pol reading was optical rotation of juice extract solution, measured by manual Polarimeter (± 130^0). Brix (total soluble solute) was measured by digital brix refractometer and data calibrated in 20^0C ambient temperature.

All recorded data were processed and accomplished statistics in Minitab 17 (Minitab Inc.) and Rstudio (R Core Team 2013). Arithmetic mean of the respective data file per plot was taken for statistical analysis. Analysis of variance (ANOVA) of sugarcane yield, and yield attributing parameter were calculated with generalized least square model with replications (nlme package (Pinheiro *et al.*, 2014) to access the treatments effect. The differences were considered significant at 0.05 probability level. Model residuals were checked for normality and homoscedasticity prior to ANOVA analysis.

Results and discussion

Plant morphological traits and observation recorded

In the present study, three varieties viz., Jitpur-5, 6, and 7 were considered for observation of morphological traits which were characterized using 27 morphological DUS descriptors. The morphological traits observation were taken in between 9 to 10 months after plantation. Improved sugarcane varieties were the basic requirements for sustaining sugarcane and sugar production in any country, and they must be introduced in the country where breeding is not possible. Therefore, Introduced varieties needed to be evaluated for their morphological, cane yield and quality characteristics for selection of suitable varieties for production and breeding. These characters could be used as descriptors for identification, distinctiveness, uniformity and stability performance of varieties and maintaining purity in sugarcane seed and commercial production (Khan *et al.*, 2017). Almeida and Crocorno (1994a) stated that the width of the medium leaf blade, dewlap shape, ligule and sheath auricles are the outstanding characters of value for identification of different sugarcane cultivars. Piscitelli (1994) reported that the most important exomorphological characteristics of sugarcane varieties are shape, colour and wax of aerial organs. Almeida and Crocorno (1994b) reported that the most outstanding, organographic characters of the sugarcane stalk were the bud shape.

Initial Evaluation Trial (IET) (2012/13 and 2013/14) of different genotypes for yield characters

Initial Evaluation Trial was conducted as on station trial for variety stability among 16 most promising genotypes, which were evaluated for cane weight, its diameter and height, number of millable cane, and the weight of single cane, and shown visually on table 2.

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Table 1: Morphological Descriptor of Sugarcane

Morphological traits	Co 0232 (Jitpur-5)	CoLk 94184 (Jitpur-6)	CoSe 03234 (Jitpur-7)
Parentage	CoLk 8102 x Co 87267	CoLk 8001 self	BO 91x PCGC
Stool Habits	Erect	Lean outward	Erect
Stalks	Straight	Straight	Straight
Emergence of Shoot	Very close to each other Tall and spindy	Spreading nature Tall and spindy	Very close to each other Tall and spindy
Aerial roots	Absent	Absent	Absent
Tops	Heavy	Light	Medium
Arrowing	Nill	Nill	Nill
Tillering	Rhixonomatous	Rhixonomatous	Rhixonomatous
Trashing	Moderate	Medium	Medium
Ratooning	Vigorous	Moderate	Vigorous
Maturity	Early	Early	Early
Leave appearance	Pointed upwards	Droop at middle	Droop towards the middle
Color of leaves	Green	Green	Green
Leaf sheath Length Breadth	36 cm 115 cm 1.6 cm	33.6 cm 129.6 cm 4.24 cm	45 cm 138 cm 5.6 cm
Leaf sheath color	Green	Purplish leaf sheath	Green
Prevalence of Pubescence	Absent	Present	Present
Location of Pubescence	Absent	Middle of sheath	Lower to middle of sheath
Adherence leaf sheath	Medium	Medium	Strong
Leaf sheath clasping	Semi-clasping	Semi-clasping	Strong clasping
Leaf blade texture	Present	Present	Absent
Stem color (exposed)	Reddish orange	Purple	Green
Stem color (unexposed)	Red	Greenish purple	Yellowish-green
Ivory marks	Absent	Absent	Absent
Corky patches	Absent	Absents	Absent
Internode shape	Conoidal	Bobbin	Conoidal
Internode alignment	Straight	Straight	Straight
Pithiness	Absent	Absent	Absent
Wax on internodes	Heavy	Heavy	Heavy
Root band color (exposed)	Brown	Brownish Green	Green
Root band color (unexposed)	Purple	Yellowish green	Brown
Arrangement of root eyes	Irregular	Irregular	Irregular
Bud Shape	Ovate	Ovate with wings	Ovate
Bud Cushion (Present/Absent)	Absent	Absent	Absent
Bud germpore position	Sub-apical	Sub-Apical	Apical
Bud groove	Absent	Absent	Absent

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Continuation of the table

Morphological traits	Co 0232 (Jitpur-5)	CoLk 94184 (Jitpur-6)	CoSe 03234 (Jitpur-7)
Growth ring color (exposed)	Yellowish green	yellowish greenish	Green
Growth ring color (unexposed)	Green	Yellow	Brown
Dewlap color	Green	Greenish yellow	Brown
Dewlap shape	Deltoid	Ligular	Deltoid
Dewlap pubescence	Absent	Sparse	Smooth
Dewlap waxiness	Absent	Moderate	Medium
Auricle Shapes	Incipient	Both sides lanceolate	Incipient
Auricle scarious border	Medium	Medium	Medium
Auricle hair distribution	Dorsal	Dorsal	Lateral
Ligule shape	Crescent	Deltoid	Crescent
Flowering type	Non flowering	Non flowering	Non-flowering
Sucrose percentage	19.41%	19.36%	18.52%
Sucrose content	19.36%	19.36%	8.52%

Table 2: Yield and yield attributes character of sugarcane in Initial Evaluation Trial

Treatment	Cane weight (t/ha)	Diameter (cm)	Height (m)	Millable cane ha^{-1}	Single cane (kg)
BO 139	107.7a	2.009b	2.342abcd	112557abcde	0.775bc
BO 141	81.5bc	1.987b	2.469ab	122278abcd	0.824bc
BO 146	88.8b	2.104ab	2.464abc	107354abcde	1.071a
BO 147	45.9d	2.096ab	2.337abcd	67684j	0.897abc
Co 0232	74.5bc	2.014b	1.975de	133378a	0.663c
Co 0233	69.7bc	2.016b	2.311abcd	96420efghi	0.871abc
Co 0239	85.3bc	2.139ab	2.011cde	127581ab	0.766bc
Co 07250	74.6bc	2.203ab	2.020bcde	99900defgh	0.817bc
Co 97016	45.7d	2.160ab	2.306abcd	78534hij	0.855abc
CoJ 85	68.7bc	2.270a	2.529a	83763ghij	1.078a
CoLk 94184	82.3bc	1.972b	2.204abcd	126059abc	0.728bc
CoS 8432	45.0d	2.128ab	1.614e	76326ij	0.664c
CoSe 03234	73.3bc	2.139ab	2.420abcd	100497defgh	0.927ab
CoSe 1434	72.0bc	1.965b	2.288abcd	104183cdefg	0.771bc
Cose 98231	78.1bc	2.163ab	2.209abcd	112073abcde	0.861abc
CoSe 98259	66.3c	2.196ab	2.186abcd	87313fghij	0.909ab
Grand mean	72.5	2.098	2.230	102244	0.842
SEM	6.38	0.0715	0.1350	7190	0.07
LSD	18.05***	NS	0.382**	20339.5***	0.1981**
C.V.	19.7	7.6	13.5	15.7	18.6

Information given on table 1 showed highly significant variation on cane weight, indicating highest yield on genotype BO 139, yielding 107.7 t/ha followed by BO 146 (88.8 t/ha), while the least of 45t/ha in CoS 8432. Similarly, data on the table 1 suggested Co 0232 as the genotype having maximum number of millable cane numbering 133378 cane per hector, while Co 0239 was observed at par with Co 0232 (127581). However, BO 147 bears the lowest number of millable cane consisting 67684 per hector. Also, there observed a significant variation for the weight of a single cane, depicting CoJ 85 and BO 146 as the genotype with highest weight of a single cane weighing 1.078 kg and 1.071 kg respectively, whereas, Co 0232 and CoS 8432 weighed lowest showing 0.663 kg and 0.664 kg respectively.

Similarly, analysis of variance for diameter showed non-significance among all those 16 genotypes, where all of these plants bearing width of average 2 cm. However, there was a significant differences in the height among these genotypes, where the maximum height was attained in the genotype CoJ 85, having it's at par relation with BO 141 (2.529 m), CoSe 98259 (2.469m), whilst the lowest height (1.614m) was observed in CoS 8432.

Initial Evaluation and Cultivated Varietal Trial is conducted generally as on-farm trial, maintaining all the necessary requirement for the evaluation of crop for any specific traits, however, Kadivendi *et al.,* (2015) and Ghimire *et al.,* (2015) mentioned there is lack of suitable technologies to meet location specific demand of farming community and to enhance their adoption rate there is need to undertake dissemination, field demonstration, and farmers" participatory research and training programs. Pith is considered to be associated with reduced sugar yield, therefore selection against pith is one of the major criteria to eliminate sugarcane cultivars of inferior quality (Gravois et al., 1990). Similalry, flowering in sugarcane is also one of those physiological process affecting both quality and yield (Berding and Hurney, 2005). Therefore, it is essential for the development and introduction of cultivars with low flowering ability.

Performance of the genotypes in Advanced Varietal Trial (AVT)

In the Table 3 shows evaluation of 9 different genotypes for yield attributing characters viz. total yield per hectar, number of millable cane, single cane weight, plant height and its diameter.

Table 3: Performance of the genotypes in Advanced Varietal Trial

Genotypes	MC	Yield	PH	SCW	Diameter
BO 120	138889^{a}	62.2^{cde}	2.100^{c}	0.665^{b}	2.033^{cd}
Co 0232	144259^{a}	86.1^{ab}	2.129^{bc}	0.684^{b}	1.983^{d}
Co 0238	68827^{c}	58.5^{e}	2.089^{c}	1.035^{a}	2.398^{a}
CoJ 64	103210^{b}	91.3^{a}	2.388^{a}	0.974^{a}	2.213^{bc}
CoLk 94184	158148^{a}	85.9^{ab}	2.394^{a}	0.725^{b}	1.856^{d}
CoS 8432	100556^{b}	64.7^{cde}	1.714^{d}	0.733^{b}	2.289^{ab}
CoSe 03234	112901^{b}	84.7^{abc}	2.295^{abc}	0.798^{b}	2.044^{d}
CoSe 95436	149074^{a}	80.7^{abcd}	2.322^{ab}	0.717^{b}	1.922^{d}
CoSe 98231	102346^{b}	69.5^{bcde}	2.122^{bc}	0.783^{b}	2.037^{cd}
CoSe 98259	86852^{bc}	82.9^{abc}	2.080^{c}	0.980^{a}	2.437^{a}
Grand mean	116506	76.7	2.163	0.809	2.121
SEM	8767.1	6.32	0.0671	0.0495	0.0589
LSD	24972.1***	18*	0.1911***	0.01410***	0.1679***
C.V.	18.4	20.2	7.6	15	6.8

According to the information given in the table 2, there was a very high significant differences in the number of millable canes, producing maximum number in the genotype CoLk 94184, CoSe 95436, Co 0232, and BO 120 (158148, 149074, 144259, and 138889 respectively). Similarly, analysis of variance showed differences with massive significant to single cane weight. However, Co 0238, CoSe 98259, and CoJ 64 were the one weighing maximum weight (1.035kg, 0.980kg and 0.974kg respectively); and minimum weight of 0.665kg was attained by BO 120. However, CoJ 64 was the genotype yielding maximum yield of 91.3t/ha, and Co 0238 with the minimum having 58.5t.ha only.

Performance of the genotypes under Co-ordinated Varietal Trial (CVT)

Cultivated Varietal Trial was conducted with plant cane on the year 2015/16 and 2016/17, following its ratoon on the year 2016/17 and 2017/18 respectively (Table 4).

Table 4: Performance of the genotypes under Co-ordinated Varietal Trial

Genotypes	Average cane yield (t/ha)	Average cane yield Ratoon	Average millable cane (000)	Average millable cane Ratoon	Average Stalk Length (m)	Average stalk length Ratoon	Cane diameter (cm)	Cane diameter Ratoon	Single Cane Weight (g)	Single cane weight Ratoon
Co 0238	73.66 a	40.38 b	86.314 b	53.611 b	2.16 a	1.475	2.437	2.15	1023.5	646.5
CoJ 64	74.29 a	29.62 b	93.33 b	45.399 b	2.33 a	1.385	2.32	1.90	1000	501
CoSe 03234	66.14 a	59.68 a	128.92a	78.497 a	2.3 a	1.68	2.15	1.955	825	618
Co 0232	74.77 a	71.59 a	150.61a	97.2 a	2.2 a	1.675	2.07	1.81	749.65	590.5
CoSe 95436	64.9 a	53.48 a	159.7 a	86.925 a	2.34 a	1.75	1.962	1.80	723.35	517.5
CoLk 94184	71.07 a	66.41 a	173.45a	95.106 a	2.43 a	1.91	1.897	1.68	731.65	520.5
CoSe 8432	58.3 ab	33.44 b	106.56b	50.557 b	1.8 b	1.125	2.372	2.47	785	493.5
CoSe 98231	56.42ab	37.63 b	101.47b	58.874 b	2.1 ab	1.605	2.174	1.92	771.65	558.5
BO 120 (Check)	47.12 b	31.14 b	128.91a	58.858 b	2.25 a	1.60	1.97	1.67	653.35	461
GM	64.60	46.12	125.79	106.36	2.195	1.58	2.165	1.94	801.97	548.5
CV(%)	24.94	13.55	21.96	19.42	7.83	8.58	6.36	13.69	15.35	16.08
LSD	26.02	19.41	46.95	34.56	0.295	0.54	0.23	0.43	214.7	151

Reasons of poor ratoon management and care, its production is relatively poor despite of its yielding capacity. Similar results can be observed on table 3, given maximum yield on Co 0232, CoLk 94184 and CoSe 03234 with production 74.77, 71.07 and 66.14 on cane but 71.9, 66.41 and 59.68 on ratoon respectively. Also, other yield attributing characters i.e. number of millable cane, weight of single cane, stalk length and diameter showed similar results. Sprouts of left stubbles in the field allows growth of ratooning, thus saving total production costs by saving on seed bed preparation, seed materials, and planting operations.

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And, naturally the productivity of ratoon is 10 to 30% less than the plant crop of sugarcane despite of its 20-25% higher requirement of nitrogenous fertilizers over normal recommended dose (Lal and Singh, 2008). Such reduced yield of ratoon crop is mainly due to low and differential ratooning potential of cultivars and sub-optimal crop management. Despite of its reduced yield, its production is even much lower losing 35 % of its productivity which is due to improper attention of farmers to the ratoons (Malik, 1997).

Performance of the sugarcane genotypes under Coordinated Farmers Field trial (CFFT)

CFFT trial was conducted sequentially on the year 2017/18, 2018/19, and 2019/20 on Bara, Parsa and Rautahat district for the plant cane. Among the tested genotypes, CoSe 3234 was the most promising genotype yielding 77.61mt/ha on the farmer's field, followed by Co 0232 and CoLk 94184 giving76.97mt/ha and 76.38mt/ha respectively, which were significantly higher than the tested check variety BO 139. Earlier Tarik and Muhe (2020) identified superior wheat genotypyes under multi-environment evaluation trial in North Shewa, Ethiopia which supports our findings.

Table 5: Yield of sugarcane clone in Coordinated Farmers Field Trials (CFFT)

Genotypes	Cane yield (mt/ha)									Grand average
	Bara			Parsa			Rautahat			
	17/18	18/19	19/20	17/18	18/19	19/20	17/18	18/19	19/20	
Co 0232	67.5	69.4	68	72.3	71.1	69.4	96.0	99.0	80.0	76.97
CoLk 94184	66.0	76.6	70	68.3	69.9	74.6	90.0	96.0	76.0	76.38
CoSe 3234	70.0	79.5	82.6	69.0	68.0	75.4	84.0	90.0	80.0	77.61
BO 139	68.6	66.2	70.1	64.7	64.7	68.0	72.0	78.0	68.0	65.59

Juice quality of sugarcane genotypes

Different genotypes were evaluated for juice quality where they were tested for Brix, purity and sucrose content. Table 6 depicts the average data of three years of Brix, purity and sucrose content, and the result presented maximum Brix content in the genotypes Co 0232, CoLk 94184 and Co 0238 (21.38^0, 21.38^0 and21.08^0 respectively). Similarly, maximum purity of 95.56% was obtained in the genotype CoSe 03234, and genotype Co 0238 had highest sucrose content of 19.85%. Canes Pol %, cane Brix %, commercial cane sugar (CCS), and ton cane per hectare (TCH) are the sugar yield parameters which is usually used to determine cane maturity, however Hunsigi, 1993 and Mamet *et al.*, 1996 reported Pol % of cane as the mostly used parameter by the researchers, whose value ranges from 10.49 to 17.86. Also, Acland 1973) reported the cane with 16% or more and purity of more than 80 were considered equal to maturity and are commercially acceptable. Nisha et al., (2019) evaluated different hybrids for the traits like plant height, tillering, NMC, Brix %, internode length, pithiness and red rot reaction to differentiate variation, which is very necessary for effective selection. Stalk thickness and Brix are the most repeatable and important traits used as selection criteria in early selection stages of the sugarcane varietal improvement program. Earlier Miller and James (1974); Tai and Miller (1989) recorded same kind of observations which supports our findings.

Table 6: Average Juice quality of different sugarcane clones

Genotypes	°Brix	Purity %	Sucrose %
CoSe 98259	20.58	90.04	18.53
Co 0232	21.38	90.79	19.41
CoSe 98231	18.28	89.44	16.35
CoSe 03234	19.38	95.56	18.52
CoSe 95436	18.88	91.74	17.32
CoJ 64	18.98	87.83	16.67
CoS 8432	20.38	88.32	18.0
CoLk 94184	21.38	90.55	19.36
BO 120	20.08	91.04	18.28
Co 0238	21.08	94.17	19.85

Conclusion

Considering all the genotypes used in the experiment at different trial (IET, AVT, CVT and CFFT) and location, Co 0232, CoLk 94184 and CoSe 03234 were found excellent in both yielding ability and quality juice content, in both the plant cane and ratoon. Some other varieties also performed well in case of plant cane, but for the farmers ratoon is very important since maximum cost required for land preparation, sett requirement and labor cost for plantation is waived, and farmers can increase their comparative yield by reducing production cost. Seeing this fact, this three genotypes were best in all the conditions, and were released as variety by Nepal Government on the year 2020/21 as Jeetpur 5, Jeetpur 6 and Jeetpur 7 respectively.

References

1. Abdul, Q. K., Kiya, A. T., and Berhanu, L. R. 2017. A study on morphological characters of introduced sugarcane varieties (*Saccharum spp*., hybrid) in Ethiopia. Int. J. Plant Breed. Genet., 11(1): 1-12.
2. Acland, J. D. 1971. East African Crops. An introduction to the production of field and plantation crops in Kenya, Tanzania and Uganda. 39.
3. Almeida, de M., and Corcomo, O.J. 1994a. Organografia dc dez cultivares de canade-acucar (Saccharum spp), I, COI. MO. Rev. de Agril.. Piracicaba. 69: 41-65.
4. Almeida, de M., and Corcomo, O.J.1994b. Organografia de dez cultivares de canade-acucar (Saccharum spp.), II, FOLHA. Rev. de Agril. Piracicaba. 69: 161-182.
5. Ghimire, R., Wen-Chi, H. U. A. N. G., and Shrestha, R. B. 2015. Factors affecting adoption of improved rice varieties among rural farm households in Central Nepal. Rice Sci., 22(1): 35-43.
6. Hungsigi, G. 1993. Production of sugarcane. Theory and Practice. Springer-Verlag. New York, 19-23.
7. Kadivendi, M., Maheswari, R., Ravikumar, R. K., Chauhan, M. M., Kinhekar, A., Kumar, V., and Kumar, V. 2015. Integrated approach for engaging farming community-Opportunities and challenges for low cost inputs. Int. J. Agric. Innov. Res, 3(6): 1691-1695.
8. Lal, M., and Singh, A. K. 2008. Multiple ratooning for high cane productivity and sugar recovery. In Proceedings of National Seminar on varietal planning for improving productivity and sugar recovery in sugarcane held at GBPUA and T. Pantnagar 14(15): 62-68.
9. Malik, K. B. 1997. Profitable cultivation of sugarcane. Directorate of Agricultural

Information, Agriculture Department of Punjab, Lahore, Pakistan, 49.

10. Mamet, L.D., Julien, M.H.R. and Galwey, N.W. 1996. Earliness of ripening in sugarcane in Mauritius: variation and inheritance studies. Sugar Cane, 4: 3-11.
11. Miller, J. D., & James, N. I. 1975. Selection in six crops of sugarcane. I. Repeatability of three characters. Crop Sci., 15(1): 23-25.
12. Mwenda, E. T. 2019. Phenotypic and biochemical screening of sorghum genotypes for growth and rice weevil resistance in Tanzania, P.h.D. Thesis Submitted to The Nelson Mandela African Institution of Science and Technology (NM-AIST), Arusha, Tanzania.
13. Nisha, M., Chandran, K., Manjunatha, T., Viswanatha, R., and Gireesan, P. P. 2019. Genetic variability for agro morphological traits among the interspecific hybrids of Saccharum. Sugarcane Res., 9: (1): 55 – 63.
14. Piscitelli, F.R. 1994. Principales caracteres exonrorfologicos dc los cuttivres de cana de azucar: TUG 80- 7 Y TUC 83- 4. Revista Industraly Agricola de / ucuman Tomo. 11: 49-57.
15. R Core Team 2013. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna. http://www.R-project.org/.
16. Rao, V. P., Singh, S., Chaudhary, R., Sharma, M. K., Sengar, R. S., Singh, U. M., & Sharma, V. 2016. Genetic variability in sugarcane (Saccharum spp. hybrid) genotypes through inter simple sequence repeats (ISSR) markers. J. App. Nat. Sci., 8(3):1404-1409.
17. Srivastava, S., and Gupta, P. S. 2008. Inter simple sequence repeat profile as a genetic marker system in sugarcane. Sugar Tech., 10(1): 48-52.
18. Tai, P. Y. P., and Miller, J. D. 1989. Family performance at early stages of selection and frequency of superior clones from crosses among Canal Point cultivars of sugarcane. J. American. Soc. Sugar Cane Techno., 9: 62-70.
19. Tarik, A., and Muhe, K.2020. Identification of superior bread wheat variety under multi-environment evaluation trial in North Shewa, Ethiopia using AMMI analysis, J. Genet., Genom. Plant Breed., 4(1): 29-36.