SVU-IJAS SVU-International Journal of Agricultural Sciences
Volume 3 Issue (4) pp.: 159-171, 2021
Print ISSN 2636-3801 | Online ISSN 2636-381X
Doi: 10.21608/svuijas.2021. 97093.1143

RESEARCH ARTICLE

Evaluation and path-coefficient analysis of some sugarcane clones under Upper Egypt region conditions

Ali, M.A.[1]*, M.S. Hassan[1], B.D. Mohamed[2] and A.H. Ali[2]
[1]*Department of Agronomy, Faculty of Agriculture, South Valley University, Qena, Egypt.*
[2]*Sugar Crops Research Institute, Agriculture Research Center, Giza, Egypt.*

Abstract

Evaluation of sugarcane clones is an important step to choose selection criteria for improvement of cane yield. This study was carried at Kom-Ombo Agric. Res., Station, Aswan governorate, ARC, Egypt to study the performance, phenotypic correlation and path-coefficient analysis of some sugarcane clones. Twenty four clones of sugarcane along with their parents and the check variety (G-T-54-9) were investigated in a Randomized Complete Block Design with three replicates for the two years; 2018/2019 and 2019/2020. In each season and over seasons, the differences were highly significant among clones for all the studied traits; stalk length, stalk diameter, cane yield, brix, sucrose, purity, sugar recovery and sugar yield. In addition, mean squares due to years and years × clones interactions were significant ($p<0.01$) for all the studied traits, except brix. The combined mean demonstrated that the clone No. 281 produced the highest cane yield and sugar yield compared to the check variety (G-T-54-9). This clone is promising and could be take steps as new sugarcane clone for Upper Egypt based on cane yield and sugar yield. All studied traits were high in broad sense heritability except sucrose percent was moderate. Cane yield recorded positive correlation with stalk length, stalk diameter and sugar yield, and it was negative with the other traits under study. Path analysis exhibited that sugar yield and brix were the two important traits for cane yield improvement.

Keywords: Sugarcane; Evaluation; Correlation; Path analysis.

1. Introduction

Sugarcane (*Saccharum spp.*) is a major sugar crop in tropical and sub-tropical countries. In Egypt, sugarcane is an important cash crop it plays a crucial role in the economics of farmers and provides the mainstay to sugar industry in southern Egypt and raw material to many allied industries (Mehareb *et al.*, 2015). It forms essential items for industries like sugar, chip board, paper, baggase, confectionary, and use in chemicals, plastics, paints, synthetics, fiber, insecticides, and detergents (Alam and Khan, 2001).

Sugarcane is cultivated on 250600 faddan (Faddan = 4200 m^2) for delivery to sugar factories in addition to, another 74452 faddan for other purpose. Egypt produced 2282000 tons of sugar from cane and beet. However, Egyptian consumption was 3250000 tons in 2020 season. The gap between the production and consumption was 968000 ton in 2020 season that needs to be met by increasing sugar production (Annual Report of Sugar Crops Council, 2019).

Average yield in Egypt, however, is much lower than the achievable potential of our existing sugarcane varieties. There are several reasons for lower cane yield and one of those is the lack of the commercial varieties. Furthermore, Egyptian sugarcane breeding program is working hard to develop a new appropriate sugarcane varieties characterized by high yielding ability, cane yield, juice quality, age group, suitability to the growing condition (that is, soil type, irrigation level, ratooning potential, resistance to diseases and pests and adverse growing conditions. New sugarcane

***Corresponding author: M. A. Ali,**
Email: mohamed_agr@yahoo.com
Received: September 20, 2021; Accepted: October 24, 2021; Published online: November 12, 2021.
©*Published by South Valley University.*
This is an open access article licensed under CC BY-NC-SA

cultivars are developed through the selection of vegetative propagated genotypes (clones) obtained from true seed, derived from the hybridization of superior parents (Mahmoud *et al.*, 2012).

The studied genetic variability, heritability, correlation and path analysis are helpful to the breeder to select superior parents and articulate selection criteria for improvement the yield-associated parameter (Khan *et al*., 2004; Tena *et al*., 2016). Moderate to high heritability for stalk length, stalk diameter, cane yield, brix, sucrose, purity, sugar recovery and sugar yield were observed by Sanghera *et al.* (2014), Masri and Amein (2015), Gowda *et al.* (2016) and Abu-Ellail *et al.* (2017). Keeping these viewpoints, the present study was undertaken to evaluate twenty-four of sugarcane clones for two seasons, to know the nature of association of cane and sugar yields with their attributing characters and also to investigate the direct and indirect effects of different component traits of cane yield under overall seasons.

2. Materials and Methods

Twenty-four sugarcane clones traced back to the population (CO-284 × CP-44-101), their parents and the cultivar G-T-54-9 (check cultivar) were evaluated during the two seasons *i.e.*, 2018 and 2019 at Kom-Ombo Agric. Res., Station, Aswan governorate, ARC, Egypt. These clones were produced by Sugar Crop Research Institute, ARC, Egypt, as true seeds in 2016/2017 growing season. The seeds were grown at the same Institute as plant-cane crop in 2017/2018.

The materials were taken from the plant-cane crop after discard off type plants and grown as plant-cane crop at Kom-Ombo Agric. Res., Station, ARC, Aswan governorate, Egypt, during the two growing seasons (2018/2019 and 2019/2020) to evaluate these clones of sugarcane (*Saccharum spp.* L.).

All clones were planted in the first week of 23rd of March in 2018/2019 and 2019/2020 seasons. The harvesting date was 12 month-old from planting for each season.

Three replications were used in a randomized complete block design using two-row plots, 3.0 m long and 1 m between rows. Cuttings containing three buds each and spaced 30 cm within a row were used in planting for each clone. The two parents and the check variety G-T-54-9 were planted at the same density. The recommended cultural practices for sugarcane production were adopted throughout the growing seasons.

2.1. Mean performance

The following traits at harvesting were: stalk length, stalk diameter, cane yield, brix, sucrose, purity, sugar recovery and sugar yield.

2.2. Statistical analysis

The analysis of variance of RCBD design was performed according to Gomez and Gomez (1984). The homogeneity tests according to Bartlett' test (1937) demonstrated the validity of conducting the combined analysis of variance was performed by the MSTAT-C Computer program. Genotypes were considered as fixed effects, whereas years and replications were taken as random effects in the statistical model. Differences among means were computed by the revised least significant differences (LSD') at 5 and 1% levels of probability according to (El-Rawi and Khalafalla, 1980) as follow:

For each season: $RLSD = t'\alpha \times \sqrt{\frac{2MSerror}{r}}$

For over seasons: $RLSD = t'\alpha \times \sqrt{\frac{2MSerror}{yr}}$

Where t' from the minimum-average-risk table.

2.3. Components of variances

According to Al-Jibouri *et al* (1958), the phenotypic (σ^2p) and genotypic (σ^2g) variance were estimated. Broad-sense heritability estimates (H) for cane yield and related traits as the ratio of genotypic variance (σ^2g) to phenotypic variance (σ^2p) (Hanson *et al*., 1956).

2.4. Phenotypic correlation

The Phenotypic correlation coefficient among different pairs of the studied traits was calculated according to Steel and Torrie (1980).

2.5. Path-coefficient analysis

Path-coefficient analysis was performed according to the procedure suggested by Dewey and Lu (1959).

3. Results and Discussion

3.1. Mean performance of the studied traits

3.1.1. Analysis of variance

Individual and combined analyses of variances for all the studied traits *i.e.*, stalk length, stalk diameter, cane yield, brix percent, sucrose percent, purity percent, sugar recovery and sugar yield in each season and over seasons for twenty-seven genotypes (twenty-four clones, two parents and the check variety; G-T-54-9) are depicted in Table 1. Variances due to genotypes were highly significant in each season and their combined over growing seasons for all the traits under investigated. There was a wide range of variations among the genotypes for all studied traits.

The effect of years was significant (P≤0.01) for all the studied traits, reflecting the large differences in climatic changes prevailing in the two seasons.

The effect of clones × years interaction was significant (P<0.01) for these traits, except brix percentage. This reveals that these clones varied from season to another. Genetic make-up and diverse nature of origin suggest differences of the genotype (Thippeswamy *et al*., 2003). These results are in accordance with the findings of Guruprasad *et al.* (2015), Mehareb *et al.* (2015), Ftwi *et al.* (2016), Gowda *et al.* (2016), Tena *et al.* (2016), Shikanda *et al.* (2017), Shitahun *et al*. (2017), Shanmuganathan *et al.* (2017), Osman and Salem (2018), Sarwar *et al.* (2019), Ali *et al.* (2020), Mehareb and El-Mansoub (2020) and Reddy *et al*. (2020).

3.1.2. Stalk length

The stalk length is an important character which directly influences the cane yield. Mean performance of various clones (Table 2) demonstrated that the average of clones varied from 155.0 (No. 286) to 225.0 (No. 287) with trail mean 193.5 cm in 2018/2019, while it ranged from 125.0 (No. 285) to 250.0 (No. 279) with trail mean 170.3 cm in 2019/2020, however, it ranged from 148.3 (No. 270) to 232.5 (No. 279) with trail mean 181.9 cm over years.

For each season and combined over seasons, all clones were shorter (P≤0.01) than the check variety (G-T-54-9) in the first, second and over seasons. This reveals that these clones had accumulated unfavorable alleles for shortness. Analysis of variance exhibited the existence of genetic variability on evaluated sugarcane clones for stalk length.

These results in these clones are not in accordance with Abu-Elenen *et al*. (2018) found that the stalk length was between 58.00 to 259.00 cm. In agreement with this finding, variation due to clones were also reported by Soomro *et al.* (2006), Junejo *et al.* (2009), Junejo *et al.* (2010), Arain *et al.* (2011), Prabhakar *et al.* (2012), Khan *et al.* (2013), Sanghera *et al.* (2014), Tadesse *et al.* (2014), Getaneh *et al.* (2015), Masri and Amein (2015), Mehareb *et al.* (2015), Ftwi *et al.* (2016), Shanmuganathan *et al.* (2017), Shitahun *et al.* (2017), Shikanda *et al.* (2017), Osman and Salem (2018), Ali *et al.* (2020), Belwal and Ahmad (2020) and Reddy *et al*. (2020).

3.1.3. Stalk diameter

The average stalk diameter (Table 2) ranged from 2.13 (No. 275) to 3.23 (No. 280 and 286) with an average of 2.53 cm in the first season. In the second seasons, it ranged from 1.77 (No. 270) to 3.17 (No. 285) with an average of 2.46 cm.

Comparing all clones with the check variety (G-T-54-9) for each season (Table 2), it was found that four and three clones were higher (P<0.01) than the check variety (G-T-54-9) in 2018/2019 and 2019/2020 growing seasons, respectively. Moreover, data showed that three and one clones, which had insignificantly higher than the check variety in the same respective seasons. On the other hand, the results indicated that the rest clones had significantly and insignificantly lower than the check variety (G-T-54-9) in both seasons.

Over all years, the average stalk diameter varied from 1.98 (No. 271) to 3.15 (No. 286) with an average of 2.46 cm. Comparing all clones with the check variety (G-T-54-9) over all years, it was evident that six clones had significantly and insignificantly higher than the check variety (G-T-54-9); however, the rest clones were significantly and insignificantly lower than one (Table 2). Significant difference for the trait for each season and combined analysis revealed presence genotypic variability among tested clones for stalk diameter.

This result is in conformity with to be result obtained by Soomro *et al.* (2006), Junejo *et al.* (2009), Junejo *et al.* (2010), Prabhakar *et al.* (2012), Sanghera *et al.* (2014), Tadesse *et al.* (2014), Masri and Amein (2015), Ftwi *et al.* (2016), Shanmuganathan *et al.* (2017), Mehareb *et al.* (2015), Abu-Ellail *et al.* (2017), Shitahun *et al.* (2017), Shikanda *et al.* (2017), Osman and Salem (2018), Ali *et al.* (2020), Belwal and Ahmad (2020), Mehareb and El-Mansoub (2020) and Reddy *et al*. (2020).

Table 1. Mean squares of the studied traits of 27 sugarcane genotypes for 2018/2019, 2019/2020 and over the growing seasons.

S.O.V	df	Mean squares							
		Stalk length (cm)	Stalk diameter (cm)	Cane yield (t/fad)	Brix (%)	Sucrose (%)	Purity (%)	Sugar recovery (%)	Sugar yield (t/fad)
				2018/2019					
Reps	2	237.04	0.001	52.56*	7.83*	0.83	1.63	0.08	0.77
Genotypes (G)	26	1925.00**	0.247**	212.86**	5.88**	3.47**	80.85**	2.96**	3.20**
Clones (C)	23	1095.59**	0.274**	194.31**	5.99**	2.84**	83.10**	2.55**	2.65**
Error (G)	52	303.38	0.014	11.90	1.82	0.32	2.51	0.47	0.26
Error (C)	46	265.52	0.014	10.41	1.95	0.32	2.83	0.48	0.23
				2019/2020					
Reps	2	184.26	0.034	24.34	13.55**	0.73	1.19	1.66	1.13
Genotypes (G)	26	3879.06**	0.349**	356.71**	4.20**	4.28**	83.38**	3.83**	4.84**
Clones (C)	23	2336.71**	0.387**	364.65**	4.67**	4.28**	87.06**	3.83**	5.05**
Error (G)	52	110.54	0.027	12.97	1.55	0.34	1.10	0.54	0.37
Error (C)	46	119.37	0.029	16.48	1.69	0.29	1.23	0.48	0.37
				Combined					
Years (Y)	1	16501.39**	0.681**	1701.00**	2.30	16.74**	149.82**	13.97**	42.67**
Error (a)	4	210.65	0.030	39.05	10.63	0.78	1.41	0.87	0.95
Genotypes (G)	26	4854.59**	0.440**	513.01**	8.26**	5.35**	138.34**	4.96**	7.51**
Clones (C)	23	2664.22**	0.519**	535.53**	9.19**	5.14**	141.62**	4.73**	7.14**
Y × G	26	949.47**	0.134**	31.12**	1.82	2.39**	25.90**	1.83**	0.54*
Y × C	23	768.09**	0.142**	23.43*	1.47	1.98**	28.53**	1.64**	0.55*
Error (b) for (G)	104	206.96	0.024	14.19	1.76	0.33	1.80	0.51	0.31
Error (b) for (C)	92	211.47	0.022	13.45	1.82	0.31	2.03	0.48	0.30
$\sigma^2 g$		316.02	0.06	85.35	1.29	0.53	18.85	0.52	1.10
$\sigma^2 p$		413.11	0.08	88.70	1.55	0.76	22.13	0.72	1.18
H		0.76	0.79	0.96	0.83	0.69	0.85	0.71	0.93

*, **; Significant at 0.05 and 0.01 levels of probability, respectively, H= heritability in broad sense.

3.1.4. Cane yield tons/fed

Cane yield is a function of combined effects of genes controlling yield components and influenced by growing seasons and agricultural practices applied. Therefore, any variation or change in both them is liable to bring a change in attained yield. Results indicated that there was a wide variation in cane yield.

In 2018/2019 season, mean of cane yield for the clones under investigated (Table 2) was 33.87 t/fed., which varied from 22.23 (No. 280) to 49.66 (No. 283). During this season, the clone No. 283, which is followed by the clones No. 281, No. 285, No. 278, No. 277, 284 and No. 287 produced 49.66, 46.33, 44.27, 43.39, 43.31, 42.26, and 41.25 t/faddan, respectively. All these clones were at par with the check variety (G-T-54-9), except the clone 283 which outyielded significantly the check variety (G-T-54-9).

Average cane yield in 2019/2020 (Table 2), average clones varied from 21.00 (No. 280) to 58.80 (No. 285) with an average of 41.04 t/fed. The clone No. 285 produced higher cane yield (58.80 t/fed.) followed by the clones No. 281 (57.20 t/fed.), No. 284 (54.80 t/fed.), No. 283 (54.67 t/fed.), No. 287 (54.60 t/fed.), No. 277 (52.13 t/fed.) and No. 278 (51.40 t/fed.), however these clones were at par with the check variety (G-T-54-9), except the clones No. 285 and No. 281, which produced significantly higher than the check variety.

Regarding combined mean for cane yield (Table 2), clone No. 283 gave the highest cane yield recording 52.16 t/fd., followed by the clones No. 281 (51.77 t/fed.), No. 285 (51.54 t/fed.), No. 284 (48.53 t/fed.), No. 287 (47.93 t/fed.), No. 277 (47.72 t/fed.) and No. 278 (47.40 t/fed.). However, all these clones were at par with the check variety (G-T-54-9).

The cane yield is a result of a number of independent traits, which include stalk length, stalk diameter, internode length and number of nodes (Khan *et al*., 2018). These findings are correlated with Soomro *et al* (2006), Castillo *et al.* (2007), Junejo *et al.* (2009), Junejo *et al.* (2010), Charumathi *et al.* (2011), Mari *et al.* (2011), Prabhakar *et al*. (2012), Ahmed *et al*. (2014), Sanghera *et al*. (2014), Tadesse *et al*. (2014), Getaneh *et al.* (2015), Masri and Amein (2015), Ftwi *et al*. (2016), Mehareb *et al*. (2015), Gowda *et*

Table 2. Separate and combined averages of stalk length, stalk diameter, cane yield and brix percentage for the studied sugarcane genotypes in 2018/2019, 2019/2020 and over the growing seasons.

Genotypes	Stalk length (cm)			Stalk diameter (cm)			Cane yield (t/fed.)			Brix (%)		
	2018/2019	2019/2020	Combined	2018/2019	2019/2020	Combined	2018/2019	2019/2020	Combined	2018/2019	2019/2020	Combined
Clones												
264	190.0	148.3	169.2	2.90	3.00	2.95	28.71	36.02	32.37	22.98	22.27	22.63
265	208.3	215.0	211.7	2.50	2.30	2.40	33.74	39.63	36.69	20.20	22.78	21.49
266	165.0	148.3	156.7	2.43	2.40	2.42	28.58	30.24	29.41	22.47	23.32	22.90
267	216.7	201.7	209.2	2.60	2.60	2.60	36.33	47.07	41.70	22.17	21.61	21.89
268	208.3	185.0	196.7	2.47	2.30	2.38	26.59	33.60	30.09	22.98	21.65	22.32
269	183.3	180.0	181.7	2.40	2.17	2.28	27.55	35.20	31.38	22.07	22.96	22.52
270	160.0	136.7	148.3	2.50	2.50	2.53	22.93	21.13	22.03	21.48	22.12	21.80
271	210.0	158.3	184.2	2.00	1.77	1.98	37.35	44.13	40.74	21.55	20.85	21.20
272	198.3	158.3	178.3	2.43	2.13	2.28	22.58	27.80	25.19	21.98	22.47	22.23
273	198.3	191.7	195.0	2.30	2.23	2.32	30.74	36.54	33.64	21.41	20.95	21.18
274	175.0	131.7	153.3	2.90	2.83	2.87	31.80	40.60	36.20	21.30	22.15	21.73
275	165.0	155.0	160.0	2.13	2.17	2.15	28.22	33.60	30.91	23.06	23.58	23.32
276	210.0	158.3	184.2	2.53	1.93	2.23	30.35	39.73	35.04	21.08	21.95	21.52
277	200.0	175.0	187.5	2.60	2.27	2.43	43.31	52.13	47.72	20.25	21.39	20.82
278	186.7	168.3	177.5	2.40	2.03	2.22	43.39	51.40	47.40	21.55	21.20	21.38
279	215.0	250.0	232.5	2.70	2.10	2.40	34.28	42.00	38.14	23.06	23.58	23.32
280	186.7	156.7	171.7	3.23	2.60	2.92	22.23	21.00	21.62	21.48	20.20	20.84
281	193.3	178.3	185.8	2.43	2.40	2.42	46.33	57.20	51.77	21.64	20.36	21.00
282	196.7	181.7	189.2	2.50	2.10	2.30	25.82	31.13	28.48	21.88	22.39	22.14
283	215.0	191.7	203.3	2.23	2.13	2.18	49.66	54.67	52.16	25.09	24.58	24.84
284	185.0	150.0	167.5	2.40	2.63	2.52	42.26	54.80	48.53	23.06	23.48	23.27
285	196.7	125.0	160.8	2.37	3.17	2.77	44.27	58.80	51.54	18.26	19.41	18.84
286	155.0	160.0	157.5	3.23	3.07	3.15	34.70	42.00	38.35	20.92	22.05	21.49
287	225.0	181.7	203.3	2.20	2.40	2.30	41.25	54.60	47.93	24.59	23.48	24.04
Parents												
P_1	160.0	180.0	170.0	2.53	2.40	2.47	40.32	42.00	41.16	21.29	22.51	21.90
P_2	241.7	203.3	222.5	2.30	2.37	2.33	50.60	45.02	47.81	20.19	22.64	21.42
Check												
G-T-54-9	265.0	295.0	280.0	2.53	2.63	2.58	42.28	49.09	45.69	23.20	21.70	22.45
Mean (C)	193.5	170.3	181.9	2.52	2.38	2.46	33.87	41.04	37.46	21.94	22.12	22.03
Mean (G)	196.7	176.5	186.6	2.51	2.39	2.46	35.04	41.52	38.28	21.90	22.13	22.02
$RLSD_{05}$(C)	28.20	16.41	16.04	0.18	0.27	0.16	4.84	6.09	3.90	2.60	2.42	1.55
$RLSD_{01}$(C)	38.44	21.76	21.34	0.24	0.34	0.21	6.42	8.08	5.17	3.60	3.69	2.09
$RLSD_{05}$(G)	28.30	15.70	15.29	0.19	0.27	0.16	5.19	6.11	7.64	2.50	2.61	1.53
$RLSD_{01}$(G)	38.11	20.85	20.28	0.25	0.35	0.22	6.88	8.10	10.29	3.43	3.68	2.06

al. (2016), Sarwar *et al*. (2016), Tyagi and Naidu (2016), Shanmuganathan *et al*. (2017), Abu-Ellail *et al*. (2017), Shitahun *et al*. (2017), Shikanda *et al*. (2017), Ali *et al*. (2018), Abdul-Khaliq *et al*. (2018), Yasin *et al*. (2017), Osman and Salem (2018), Sarwar *et al*. (2019), Ali *et al*. (2020), Belwal and Ahmad (2020), Mehareb and El-Mansoub (2020) and Reddy *et al*. (2020) has expressed variation in different cane yield parameters of cane clones.

3.1.5. Brix percentage

Brix percentage is an important factor on determining the yield of sugarcane crop and basically it is a genetic trait but may also be affected by growing seasons.

Data in Table 2 showed that the highest clone was No. 283, which had 25.09, 24.58 and 24.84%, while the lowest clone was No. 285 which gave 18.26, 19.41 and 18.84% with an average of 21.94, 22.12 and 22.03% in the first, second and over seasons, respectively. Most of clones were at par with the check variety (G-T-54-9) in the first, second and over seasons. The clone No. 283 was significantly higher in brix percentage than the check variety in the second and over seasons.

These results in line with those of Charumathi *et al.* (2011), Masri and Amein (2015), Mehareb *et al.* (2015), Ftwi *et al.* (2016), Abu-Ellail *et al.* (2017), Shanmuganathan *et al.* (2017), Shitahun *et al.* (2017), Shikanda *et al.* (2017), Ali *et al.* (2018), Osman and Salem (2018), Ali *et al.* (2020), Belwal and Ahmad (2020), Mehareb and El-Mansoub (2020) and Reddy *et al.* (2020).

3.1.6. Sucrose percentage

In the first, second and over the two seasons (Table 3), the highest clone in sucrose percentage was No. 269, which had 19.88, 21.31 and 20.60%, while, the lowest clone was No. 285, which gave 15.77, 16.55 and 15.53% with an average of 20.83, 19.37 and 20.10%, respectively.

Comparison between all clones and the check variety (G-T-54-9) for each season, it was found that all clones were significantly lower in sucrose percentage than the check variety in 2018/2019 growing seasons. In 2019/2020 season, the clones no. 269 produced higher sucrose percentage (21.31%), followed by No. 266 (21.24%), No. 264 (19.95%), No. 265 (19.93%), No. 287 (19.87%), No. 267 (19.76%), No. 268 (19.66%) and No. 272 (19.58%), however these clones were at par with the check variety (G-T-54-9), except clones No.269 and No. 266, which produced significantly higher than the check variety.

Combined mean over growing seasons exhibited that the clone No. 269 produced higher sucrose percentage (20.60%), followed by No. 267 (19.63%), however these clones were at par with the check variety (G-T-54-9). The remainder clones were significantly lower than the check variety (Table 3). These results were obtained by Charumathi *et al*. (2011), Prabhakar *et al*. (2012), Ahmed *et al*. (2014), Sanghera *et al*. (2014), Tadesse *et al*. (2014), Masri and Amein (2015), Mehareb *et al*. (2015), Abu-Ellail *et al*. (2017), Shikanda *et al*. (2017), Osman of 85.15% in 2019/2020 season.

3.1.7. Purity percentage

Over all years, average purity percentage of all clones was 84.20%. Among the clones, clone No. 267 produced high purity percentage (91.09%), which had statistically at par with the clone No. 269 (89.88%), lowest purity percentage (70.83%) was produced by the clone No. 283 (Table 3).

Comparing all clones with the check variety (G-T-54-9) for each season and overall years, it was recorded that four and one clones were significantly higher in purity percentage than the check variety in 2019/2020 and over seasons, respectively. However, six, four and one clones were statistically at par with the check variety (G-T-54-9) in 2018/2019, 2019/2020 and over seasons, respectively. In contrast, the results demonstrated that remain clones were significantly lower in purity percentage than the check variety in the respective seasons. A large range of variation was observed for this trait among clones of sugarcane. These results is in conformity with the results reported by

Charumathi *et al*. (2011), Ahmed *et al*. (2014), Sanghera *et al*. (2014), Masri and Amein (2015), Ftwi *et al*. (2016), Mehareb *et al*. (2015), Abu-Ellail *et al*. (2017), Shitahum *et al*. (2017), Shikanda *et al*. (2017), Osman and Salem (2018), Ali *et al* (2020), Belwal and Ahmad (2020), Mehareb and El-Mansoub (2020) and Reddy *et al* (2020).

3.1.8. Sugar recovery (%)

In 2018/2019 season (Table 3), mean of sugar recovery of the tested sugarcane clones was 12.21%, which varied from 10.79 (No. 285) to 13.84 (No. 267). During this season, all clones were significantly lower in sugar recovery than the check variety (G-T-54-9), except two clones; No. 267 and No. 269 were at par with the check variety.

In 2019/2020 growing season (Table 3), data exhibited that the clone No. 269 which is followed by No. 266, No. 264, No. 267, No. 268 and No.265, which produced 15.00, 14.97, 13.88, 13.88, 13.77 and 13.71%, respectively. All these clones were statistically at par with the check variety (G-T-54-9), except the clones no. 269 and No. 266 were significantly higher than the check cultivar in sugar recovery. The combined means indicated that none of the studied clones exceeded significantly the check cultivar. In agreement with this finding, variations on sugar recovery due to clones were also reported by Castillo *et al* (2007), Masri and Amein (2015), Mehareb *et al*. (2015), Shitahun *et al*. (2017), Yasin *et al*. (2017), Ali *et al*. (2018), Osman and Salem (2018) and Ali *et al*. (2020).

Table 3. Separate and combined averages of sucrose percent, purity percent, sugar recovery and sugar yield for the studied sugarcane genotypes in 2018/2019, 2019/2020 and over the growing seasons.

	Sucrose percentge			Purity percentage			Sugar recovery			Sugar yield (t/fed)		
Genotypes	2018 /2019	2019 /2020	Combined	2018 /2019	2019 /2020	Combined	2018 /2019	2019 /2020	Combined	2018 /2019	2019 /2020	Combined
Clones												
264	18.12	19.95	19.04	78.85	89.58	84.22	11.81	13.88	12.85	3.40	5.03	4.21
265	17.36	19.93	18.65	85.94	87.49	86.72	11.85	13.71	12.78	4.00	5.44	4.72
266	17.39	21.24	19.32	77.39	91.38	84.39	11.21	14.97	13.09	3.22	4.53	3.87
267	19.49	19.76	19.63	89.67	92.51	91.09	13.84	13.88	13.86	5.03	6.56	5.79
268	18.80	19.66	19.23	81.81	90.81	86.31	12.50	13.77	13.14	3.34	4.63	3.98
269	19.88	21.31	20.60	88.31	91.44	89.88	13.47	15.00	14.24	3.71	5.28	4.49
270	16.89	17.33	17.11	78.63	78.35	78.49	10.99	11.25	11.12	2.53	2.38	2.45
271	18.86	18.44	18.65	87.52	88.44	87.98	12.98	12.76	12.87	4.87	5.63	5.25
272	19.18	19.58	19.38	87.26	87.14	87.20	13.18	13.45	13.32	2.98	3.72	3.35
273	18.89	17.88	18.39	88.23	85.35	86.79	13.05	12.16	12.61	4.00	4.46	4.23
274	18.15	19.04	18.60	85.21	85.96	85.59	12.33	12.99	12.66	3.93	5.26	4.59
275	17.46	18.19	17.83	75.72	77.14	76.43	11.11	11.70	11.41	3.14	3.94	3.54
276	18.65	19.00	18.83	88.47	86.56	87.52	12.90	13.01	12.96	3.92	5.17	4.54
277	17.23	18.43	17.83	85.09	86.16	85.63	11.70	12.59	12.14	5.07	6.58	5.82
278	18.81	18.06	18.44	87.29	84.79	86.04	12.93	12.27	12.60	5.62	6.31	5.96
279	18.11	19.02	18.57	78.53	80.66	79.60	11.77	12.55	12.16	4.04	5.27	4.65
280	18.70	17.84	18.27	87.06	88.32	87.69	12.84	12.33	12.59	2.85	2.58	2.72
281	18.78	18.11	18.45	86.78	88.95	87.87	12.88	12.56	12.72	5.96	7.34	6.65
282	19.24	19.01	19.13	87.93	84.90	86.42	13.28	12.89	13.08	3.44	4.02	3.73
283	17.76	17.42	17.59	70.79	70.87	70.83	10.82	10.63	10.73	5.35	5.81	5.58
284	17.85	17.89	17.87	77.41	76.19	76.80	11.51	11.43	11.47	4.85	6.26	5.55
285	15.77	16.55	16.16	86.36	85.27	85.82	10.79	11.25	11.02	4.78	6.66	5.72
286	16.94	17.80	17.37	80.98	80.73	80.86	11.20	11.75	11.48	3.89	4.94	4.41
287	18.84	19.87	19.36	76.62	84.63	80.63	12.07	13.45	12.76	4.98	7.16	6.07
Parents												
P_1	18.79	20.43	19.61	88.26	90.76	89.51	12.99	14.31	13.65	5.23	6.00	5.62
P_2	17.09	20.11	18.60	84.65	88.83	86.74	11.57	13.94	12.76	5.87	6.28	6.08
Check												
G-T-54-9	20.83	19.37	20.10	89.78	89.26	89.52	14.52	13.46	13.99	6.12	6.58	6.35
Mean (C)	18.22	18.81	18.51	83.24	85.15	84.20	12.21	12.76	12.49	4.12	5.20	4.66
Mean (G)	18.29	18.93	18.61	83.72	85.65	84.69	12.30	12.89	12.59	4.30	5.33	4.81
$RLSD_{05}$(C)	0.88	0.84	0.61	2.52	1.63	1.47	1.13	1.09	0.76	0.78	0.93	0.59
$RLSD_{01}$(C)	1.19	1.14	0.83	3.34	2.17	1.95	1.53	1.45	1.02	1.03	1.23	0.78
$RLSD_{05}$(G)	0.88	0.92	0.63	2.38	1.52	1.38	1.13	1.19	0.78	0.76	0.96	0.59
$RLSD_{01}$(G)	1.16	1.09	0.85	3.16	2.01	1.82	1.52	1.60	1.03	1.02	1.27	0.78

3.1.9. Sugar yield (t/fad)

Sugar yield is the function of the cane yield and corresponding recoverable sugar percentage. Means of sugar yield of the clones in 2018/2019 and 2019/2020 as well as the combined means over seasons are presented in Table 3.

The average of sugar yield for the clones showed that the highest averages were 5.96, 7.34 and 6.65 t/feddan for the clone No. 281, but the lowest averages were 2.53, 2.38 and 2.45 t/feddan for the clone No. 270 in 2018/2019, 2019/2020 and the combined mean, respectively. The average sugar yield for all clones was 4.12, 5.20 and 4.66 t/fed. in the first, second and over seasons, respectively.

Comparing all clones with the check variety (G-T-54-9) for each season and the combined means over seasons, it was found that all clones were significantly lower in sugar yield than the check variety, except two clones (No. 278 and No. 281) which were at par with the check variety in 2018/2019 season.

Mean sugar yield in 2019/2020 season, the clone No. 281, which was followed by No. 287 and No. 285 were higher yielding clones produced mean yields of 7.34, 7.16 and 6.66 t/fed., respectively. However, these clones were at par with the check variety. On the other hand, the remainder clones were lower significantly yielding clones except six clones (No. 267, No. 271, No. 277, No. 278, No. 283 and No. 284) were at par with the check variety.

Over the two years, the highest yielding clones No.281, No. 267, No.277, No. 278 and No.287 were at the par of the check, while the others were significantly lower than the check cultivar.

According to Aslam *et al*. (2013) Shanmuganathan *et al*. (2017), the differential behavior of sugarcane clones to produce sugar yield may be due to the variability in their genetic constitution to exploit in a given environment. In agreement with this finding, variations on sugar yield due to clones were also reported by Castillo *et al*. (2007), Mari *et al*. (2011), Prabhakar *et al*. (2012), Ahmed *et al*. (2014), Tadesse *et al*. (2014), Getaneh *et al*. (2015), Masri and Amein (2015), Mehareb *et al*. (2015), Ftwi *et al*. (2016), Sarwar *et al*. (2016), Gowda *et al*. (2016), Tyagi and Naidu (2016), Abu-Ellail *et al*. (2017), Shikanda *et al*. (2017), Shitahun *et al*. (2017), Yasin *et al*. (2017), Abdul-Khaliq *et al*. (2018), Osman and Salem (2018), Yasin *et al*. (2018), Ali *et al*. (2020) and Reddy *et al*. (2020).

3.2. Components of variance

The phenotypic variance was higher than genotypic ones for all traits under study (Table 1). Results showed that the difference between σ^2g and σ^2p was small for all studied traits except sucrose percent, demonstrating that the influence of environmental factors on their phenotypic expression was little. Consequently, heritability values in the broad-sense (H) were high for these traits. The phenotypic variance is a good index of genotypic variance in these traits. Selection is also easy for these traits. Similar results were also reported by Sanghera *et al.* (2014), Masri and Amein (2015), Gowda *et al.* (2016), Abu-Ellail *et al.* (2017), Mehareb and Galal (2017), Abo Elenen e*t al.* (2018) and Gadallah and Mehareb (2020).

3.3. Phenotypic correlation

Cane yield was positive correlated with each of stalk length, stalk diameter and sugar yield over the two seasons (Table 4). These results illustrate to importance of these traits for improvement cane yield through selection. In contrast, cane yield exhibited negative significant correlation with brix percentage, sucrose percentage, purity percentage and sugar recovery (Table 5). These results were agreement with those obtained by Elibox (2013), Khan *et al.* (2013), Sanghera *et al*. (2014), Guruprasad *et al.* (2015), Ftwi *et al*. (2016), Gowda *et al*. (2016), Tena *et al.* (2016), Shikanda *et al*. (2017) and Reddy *et al*. (2020).

3.4. Path coefficient analysis

Path analysis exhibiting the direct and indirect effects of the cane yield and sugar recovery on sugar yield over seasons is shown in Table 5 and Figure 1. Cane yield had the highest positive direct effect (1.053) on sugar yield followed by sugar recovery (0.309). This implies that cane yield and sugar recovery should be considered when selection for sugar yield.

A direct effect of cane yield on sugar yield was similar to the findings of Thippeswamy *et al.* (2003), Patel *et al.* (2006) Al-Sayed *et al.* (2012), Hussein *et al.* (2012), Khan *et al.* (2013), Guruprasad, *et al*. (2015), Ftwi *et al* (2016) and Gowda *et al.* (2016). Negative indirect effects of cane yield via sugar recovery, which was – 0.100. Also, sugar recovery showed negative indirect effects on sugar yield via cane yield was - 0.341. In this research, the residual effect at phenotypic level was 0.084, which indicate that there is no other traits directly or indirectly influenced the sugar yield other than those characters included in this study.

4. Conclusion

In this study, the clones illustrated a wide genetic diversity for all traits under investigated. The clone No. 281 were found promising and could be take steps as new sugarcane clones for Upper Egypt on the basis of cane yield and sugar yield. So, this clone should be put in further evaluation trials and should advance to uniform yield trials. Similarly, it is suggested that the poor performed sugarcane clone should be further tested under potential areas as two years screening is not sufficient to judge the performance of this clone and on the basis of that performance this clones should be utilized in future crop breeding program. Phenotypic correlation showed that cane yield was positive correlated with sugar yield, stalk length and stalk diameter, indicating that these components are most important for yield. However, all the studied traits showed high heritability, indicating low environmental effects. Therefore, selection based on these yield contributing traits may be fruitful in sugarcane breeding program. In these clones, based on path analysis, cane yield and sugar recovery were the most important traits for sugar yield improvement.

Table 4. Phenotypic correlation coefficients between each pairs of eight traits over the two growing seasons.

Traits	Stalk length	Stalk diameter	Cane yield	Brix	Sucrose	Purity	Sugar recovery	Sugar yield
Stalk length		0.022	0.148	-0.139	-0.663	-0.378	-0.633	-0.052
Stalk diameter			0.009	-0.093	-0.325	-0.162	-0.292	-0.066
Cane yield				-0.017	-0.325	-0.220	-0.333	0.953
Brix					0.364	-0.651	-0.040	-0.039
Sucrose						0.553	1.027	-0.039
Purity							0.860	0.028
Sugar recovery								-0.032

Table 5. Path coefficient analysis of sugar yield and its some components over the two seasons.

Effects	Combined over seasons
Correlation between cane yield and sugar yield	0.953
Direct effect of cane yield on sugar yield	1.053
Indirect effect of cane yield on sugar yield via sugar recovery	-0.100
Total	0.953
Correlation between sugar recovery and sugar yield	-0.032
Direct effect of sugar recovery on sugar yield	0.309
Indirect effect of sugar recovery on sugar yield via cane yield	-0.341
Total	-0.032
Residual effect	0.084

5. References

Abdul-Khaliq, Y.M., Shehzad, A.M. and Naeem, A. (2018) 'Evaluation of different exotic sugarcane genotypes' *RJOAS,* 4(76): pp. 296 – 301.

Abu Elenen; F.M. Fouz; E.M. Mehareb; M.A. Ghonema and A. El-Bakry (2018) 'Selection in sugarcane germplasm under the Egyptian conditions' Open Access J. of Agri. Res., 3(3): Pp. 1-13.

Abu-Ellail, F.F.B., El-Taib, A.B.A. and Masri, M. (2017) 'Broad-sense heritability, genetic correlation and genetic variability of sugarcane yield components at first selection stage' *Journal of Sugarcane Research*, 7(1) pp. 27 – 34.

Ahmed, Z.A., Ahmed, A.M. and El-Soghier, K.S. (2014) 'Evaluation of three sugarcane varieties grown under different number of irrigations', *Egypt. J. Agric. Res*., 92(2), pp. 765 – 778.

Alam. S.M. and Khan, M.A. (2001) 'The sugar industry plays a pivotal role in the national economy of our country', *Nuclear Institute of Agriculture, Tandojam, Pakistan*.

Ali, A., Khan, S., Tahir, A.M., Farid, A. Khan, A., Khan, S.M. and Ali, N. (2018) 'Evaluation of various sugarcane genotypes for association of quality characters with cane yield' *Adv. Crop. Sci. Tech. an open Access Journal*, 6(3): 1000371.

Ali, M.A., Hassan, M.S. Mohamed, B.D. and Ali, M.H. (2020) 'Performance and stability analysis of some sugarcane genotypes across different environments' SVU-International *Journal of Agricultural Sciences.* 2(2): pp. 192 – 213.

Al-Jibouri, H.A., Miller, P.A. and Robinson, H.F. (1958) 'Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin' *Agron. J.,* 50: Pp. 633 – 636.

Al-Sayed, H.M., Fateh, H.S., Fares, W.M. and Attaya, A.S. (2012) 'Multivariate analysis of sugar yield factors in sugar cane' *American-Eurasian Journal of Sustainable Agriculture,* 6(1): pp. 44 – 50.

Annual Report of Sugar Crops Council (in Arabi), 2019

Arain, M.Y., Panhwar, R.N., Gujar, N., Chohan, M., Rajput, M.A., Soomro A.F. and Junejo, S. (2011) 'Evaluation of new candidate sugarcane varieties for some qualitative and quantitative traits under Thatta agro-climatic conditions' *The Journal of Animal & Plant Sciences,* 21(2): pp. 226 – 230.

Aslam, M., Ahmed, N., Naseem, M. and Zahid, A.R. (2013) 'Exploring ratoon potential of various sugarcane varieties under southern Punjab conditions' *Pakistan Sugar Journal (Jan-Mar):* pp. 6-8.

Bartlett, M.S. (1937*) 'Properties of sufficiency and statistical tests'* Proc. Roy., Soc. London. Series A, 160: pp. 268 - 282.

Belwal, V. and Ahmad, S. (2020) 'Evaluation of sugarcane genotypes for morphological and quality traits under water logging conditions' *Int. J. Curr. Microbiol. App. Sci.,* 9(02): pp. 740 – 746.

Castillo, R.O., Silva, E. and Caicedo, W. (2007) 'Evaluation of three promising Ecuadorian clones in semi commercial trials' *Proc. Int. Soc. Sugar Cane Technol.,* 26, pp. 750 – 753.

Charumathi, M., Naidu, N.V. and prasada rao, K. (2011) 'Co A 05323 – A Promising Mid Late Clone for Andhra Pradesh' *Indian Journal of Sugarcane Technology,* 26(1): pp. 20 – 23.

Dewey, D.I. and Lu, K.H. (1959) 'A Correlation and path-coefficient analysis of components of crested Wheatgrass Seed Production' *Agronomy Journal,* 51, pp. 515 - 518.

Elibox, W. (2013) 'Associations between yield and quality parameters in sugarcane (*Saccharum spp.* hybrids) towards the development of multipurpose clones' *Trop. Agric. (Trinidad),* 90(3): pp. 118 – 128.

El-Rawi, K. and Khalafalla, A.M. (1980) *'Design and analysis of agricultural experiments',* El Mousel Univ., Iraq, 19.

Ftwi, M., Mekbib, F. and Abraha, E. (2016) 'Multivariate analysis of sugar yield contributing traits in sugarcane (*Saccharum officinarum* L.), *in Ethiopia' African Journal of Plant Science, 1*0(8): pp. 145 – 156.

Getaneh, A., Tadesse, F. and Ayele, N. (2015) 'Agronomic performance evaluation of ten sugarcane varieties under Wonji-Shoa Agro-Climatic conditions' *Scholarly Journal of Agricultural Science*, 5(1): pp. 16 – 21.

Gomez, K.A., and Gomez, A.A. (1984) *'Statistical Procedures for Agricultural Research'* John Wiley & Sons Inc. New York, USA.

Gowda, S.S.N., Saravanan, K. and Ravishankar, C.R. (2016) 'Correlation and path analysis for yield and quality attributes in sugarcane' *International Journal of Science Technology & Engineering.* 3(02): pp. 133 – 137.

Guruprasad, H., Nagaraja, T.E., Uma, M.S., Patel, V.N. and Anand, M. (2015) 'Character association and path analysis for cane and sugar yield in selected clones of sugarcane (*Saccharum officinarum* L.)' *Trends in Biosciences,* 8 (6): pp. 1466 – 1469.

Hanson, C.H., Robinson, H.F. and Comstock, R.E. (1956) 'Biometrical studies on yield in segregating population of Korean lespedesa' *Agron. J.* 48: pp. 268 - 272.

Hussein, M., Al-Sayed, H., Fateh, S., Fares, W.M. and Attaya, S. (2012) 'Crops multivariate analysis of sugar yield factors in sugar cane' *Sugar Res. Inst., Agricultural Researches Center, Giza, Egypt. Am. Eurasian J. Sustain. Agric.,* 6(1): pp. 44-50.

Junejo, S., Kaloi, G.M., Panhwar, R.N., Chohan, M., Junejo, A.A. and Soomro, A.F. (2010) 'Performance of some newly developed sugarcane genotypes for some quantitative and qualitative traits under Thatta conditions' *The Journal of Animal & Plant Sciences,* 20(1): pp. 40 – 43.

Junejo, S., Chohan, M., Junejo, A.A., Kaloi, G.M., Panhwar, R.N. and Arain, M.Y. (2009) 'Comparative performance of elite sugarcane genotypes in 4th cycle for cane yield, yield components, quality and borer complex infestation' *The Journal of Animal & Plant Sciences,* 19(4): pp. 197 – 201.

Khan, I. A., Seema, N., Raza, S., Yasmine, S. and Bibi, S. (2013) 'Environmental interactions of sugarcane genotypes and yield stability analysis of sugarcane' *Pak. J. Bot.,* 45(5): pp. 1617 – 1622.

Khan, I.A., Khatri, A., Siddiqui, M.A., Nizamani, G.S. and Raza, S. (2004) 'Performance of promising sugarcane clone for yield and quality traits in different ecological zones of Sindh' Pak. J. Bot., 36(1): Pp. 83-92.

Khan, M.T., Khan, I.A., Yasmeen, S., Seema, N. and Nizamani, G.S. (2018) 'Field evaluation of diverse sugarcane germplasm in agroclimatic conditions of Tandojam' *Sindh. Pak. J. Bot.,* 50(4): pp. 1441 – 1450.

Mahmoud, E.A., El-Hinnawy, H.H., Masri, M.I., Mohamed, B.D. and Mehareb, E.M. (2012) 'Performance and repeatability for some agronomic traits in sugarcane crosses at early selection stages' *Egypt. J. Plant Breed.,* 16(2): pp. 237 – 255.

Mari, A.H., Panhwar, R.N., Kaloi, G.M., Unar G.S., Junejo, S., Chohan, M. and Jagirani, A.W. (2011) 'Evaluation of some new sugarcane varieties for cane yield and quality in different agro-ecological zones of Sindh, *Pakistan Journal of Science,* 63 (01): pp. 32 – 36.

Masri, M.I. and Amein, M.M.M. (2015) 'Yield potential and ratooning ability of some sugar cane genotypes' *Journal of Plant Breeding and Crop Science*, 7 (8): pp. 262 – 274.

Mehareb, E.M. and El-Mansoub, M.M.A. (2020) 'Genetic parameters and principal components analysis biplot for agronomical, insect and pathological traits in some sugarcane genotypes' *SVU-International Journal of Agricultural Sciences,* 2(2): pp. 60 – 77.

Mehareb, E.M., Abou-Elwafa, S.F. and Galal, M.O. A. (2015) 'Comparative performance of sugarcane genotypes for ratoonability in early clonal selection stages' *Journal of Sugarcane Research,* 5(2): pp. 11 – 21.

Mian, A.M. (2006) *'Sugarcane variety composition in Pakistan Proceedings of Seminars on Agriculture'* Organized by Pakistan Society of Sugar Technologists held at Faisalabad on 19th June, pp. 107-121.

Osman, M.A.M. and Salem, E.S.R. (2018) 'Productivity, quality, growth and pathological evaluation of some promising sugarcane genotypes in Egypt' *Alex. J. Agric. Sci*, 63(6): pp. 353 – 364.

Pandya, M.M. and Patel, P.B. (2017) 'Studies on correlation and path analysis for quality attributes in sugarcane [*Saccharum spp*. hybrid]' *Int. J. Pure App. Biosci.,* 5(6): pp. 1381 – 1388.

Patel, K.C., Patel, A.I. Mali, S.C., Patel, D.U. and Vashi, R.D. (2006) 'Variability, correlation and path coefficient analysis in sugarcane (*Saccharum Spp*)' *Crop Res.,* 32(2): pp. 213-218.

Prabhakar, K.M., Rao, S.K.V., Madhuri, N.K. and Karunasagar, R. S. G. (2012) 'Evaluation of promising sugarcane varieties for yield and quality in al • sols' *Journal of Sugarcane Research,* 2(1): pp. 54-56.

Reddy, G.E., Rakesh, G., Naik, P.J., Swapna, N., Swathi, Y., Bharathi, Y., Kumar, M.V. and Venkataiah, M. (2020) 'Character association among yield and quality traits in early maturing sugarcane clones' *Current Journal of Applied Science and Technology'* 39(30): pp. 137 – 143.

Sanghera, G.S., Tyagi, V., Kumar, R. and Thind, K.S. (2014) 'Genetic variability for cane yield, earliness and quality traits in sugarcane under Subtropical region of India' *International Journal of Current Research*, 6(8): pp. 7763 – 7765.

Sarwar, M., Mehmood, A. and Ahmad, N. (2016) 'Performance of promising sugarcane varieties/clones at farmers field in Punjab' *Pakistan Sugar Journal. XXXI* (04): pp. 6 – 8.

Sarwar, M., Muzaffar, W. and Arshad, W.R. (2019) 'Evaluation of promising and commercial sugarcane clones at different locations in Thal and Southern Punjab' *PSJ, XXXIV* (03): pp. 16 – 22.

Shanmuganathan, M., Baskaran, V. and Chandrasekaran, R. (2017) 'Evaluation of mid-late sugarcane clones for their yield and quality characters in advanced selection stage in plant and ratoon crops' *Electronic Journal of Plant Breeding,* 8 (3): pp. 992 – 997.

Shikanda, E., Jamoza, J. and Kiplagat, O. (2017) 'Genotypic evaluation of sugarcane (*Saccharum spp.* Hybrids) clones for sucrose content in western Kenya' *Journal of Plant Breeding and Crop Science.,* 9(3): pp. 30 – 36.

Shitahun, A., Feyissa, T., Abebech, S., Mabrahtom, F., Essaya, T., Melaku, T., Zinawu, D. and Dereje, S. (2017) 'Performances evaluation of sugarcane genotypes (Cuba 2012) at Finchaa sugar estate' *Int. J. adv. Res. Biol. Sci.,* 4(12): pp. 251 – 25.

Singh, A., Bhatnagar, P.K., Khan, A.Q. and Shrotria, P.K. (2003) 'Association of quality character with cane and commercial cane sugar yields in sugarcane' *Sugar Tech,* 5: pp. 197-198.

Singh, G., Mishra, S.K. and Sanghera, G.S. (2019) 'Variability and character association for commercial cane sugar and its components in early maturing sugarcane clones' *Agric Res J.,* 56(2): pp. 321 – 324.

Soomro, A.F., Junejo, S., ahmed, A. and Aslam, M. (2006) 'Evaluation of different promising sugarcane varieties for some quantitative and qualitative attributes under Thatta

(Pakistan) conditions' *International Journal of Agriculture & Biology,* 8(2): pp. 195 – 197.

Steel, R.G.D. and Torrie, T.H. (1980) *'Principles and procedures of statistics.* A biometrical approach, 2nd Ed. Graw-Hill Books Co. New York, USA.

Tadesse, F., Dilnesaw, Z., Mekonnenet, Y., Negi, T., Fetwi, M., Ayele, N. and Getanh, A. (2014) 'Performance evaluation of sugarcane varieties (Cuban origin) at Wonji-Shoa, Metahara and Finchaa Sugarcane Plantations of Ethiopia' *Global Advanced Research Journal of Physical and Applied Sciences*, 3(4) .

Tena, E., Mekbib, F. and Ayana, A. '2016. Correlation and path coefficient analyses in sugarcane genotypes of Ethiopia' *American Journal of Plant Sciences.*,7, pp. 1490 – 1497.

Thippeswamy, S., Kajjidoni, S.T., Salimath, P.M., Goud, J.V. (2003) 'Correlation and path analysis for cane yield, juice quality and their component traits in sugarcane' *Sugar Tech.*, 5 (½): pp. 65-72

Tyagi, A.P. and Lai, P. (2007) Correlation and path coefficient analysis in sugarcane' *South Pac. J. Nat. Sci.*, 1: pp. 1-10.

Tyagi, A.P. and Naidu, P. (2016) 'Sugarcane (*Saccharum officinarum*) variety evaluation for quantitative characters (Pure obtainable cane sugar, sucrose content and cane yield)' *Journal of South Pacific Agriculture,* 19 (1 & 2): pp. 44 – 55.

Yasin, M., Abdul Khaliq, Hassan, M.U.l. and Ahmad, N. (2017) 'Evaluation of different sugarcane genotypes under agro-climatic condition of Faisalabad' *Pakistan Sugar Journal, XXXII* (04): pp. 14 – 21.

Yasin, M., Abdul Khaliq and Ahmad, N. (2018) 'Evaluation of different sugarcane clones under third selection stage trial' *International Journal of Biology Research*, 3(1): pp. 278 – 280.