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Evaluation Of Sugarcane Clones Based On The Performance In Preliminary Yield Trials

Naeem Ahmad[1], Muhammad Shahzad Afzal[1], Hafiz Basheer Ahmad[1], Abdul Khaliq[1], Mubashra Yasin[1], Salma Niaz[1], Mahmood ul Hassan[1], Imran Rasheed[1], Muhammad Younus[1], Humaira Kausar[2], Amina[3], Muhammad Rizwan Khursheed[4]

[1]Sugarcane Research Institute, AARI, Faisalabad (38850), PAKISTAN.
[2]Food Technology Post Harvest Research Center, AARI, Faisalabad (38850), PAKISTAN.
[3]Horticultural Research Institute, AARI, Faisalabad (38850), PAKISTAN.
[4.] Agronomic Research Institute (FC), AARI, Faisalabad (38850), PAKISTAN.
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Corresponding author Abdul Khaliq

ABSTRACT

Current study was conducted at Sugarcane Research Institute, Faisalabad during 2019-20. Preliminary Yield Trials is an important stage of varietal development program comprising on 4th year of study. Current study was conducted to evaluate the performance of twenty six clones in comparison to two check varieties deploying randomized complete block design (RCBD) using three replications. All these clones were developed from fuzz imported from Srilanka as natural conditions are not conducive for flowering and hybridization of sugarcane in country. The data was subjected to principle component analysis based on five parameter (tillers per plant, no. of canes per hectare, yield (t/ha), sugar recovery (%) and single cane weight) and analysis of variance. The characters tillers per plant, no. of canes per hectare and single cane weight had positive association with yield per hectare. These character should be focused during selection process. The data was interpreted based on 66 percent information contained in PC-2. The linkage cluster analysis placed the clones into six major groups which were genetically different. The variation in cluster can be utilized in breeding program for further improvement. Based on superior performance, nine clones were selected and promoted to next selection stage named semifinal varietal trial for further evaluation. A clone S-2016-SL-284 outclassed all the clones in term of performance of all parameters under study which will be bright future hope to be recommended a variety for commercial release in coming years. The clone was from the fuzz of local parents exchanged with Srilanka, so local germplasm should be given key importance while choosing the parents for crossing purpose in breeding program of sugarcane. Local hybridization program may serve the purpose of desired parents having suitability in adaptation in local climatic conditions.

KEY WORDS: Sugarcane; preliminary yield trial; promising clones; varietal development program.

INTRODUCTION

Sugarcane (Saccharum officinarum L.) is an important cash crop and plays vital role in the economic uplift of the growers and viability of sugar industry. Sugarcane accounts for approximately 75% sugar produced in world (FAO Statistics, 2015). Among agricultural crops, it has been a major contributor in GDP of the country during past years. During 2020-21 total production of country stood 81.009 million tonnes occupying area of 1.165 million hectare. The average yield was observed 695 maunds/acre of whole country. Its contribution to GDP found 0.7 percent (Govt. of Pakistan). Sugarcane Research Institute, Faisalabad is major institute to develop sugarcane varieties to boost sugarcane crop. Its mandate is to develop new and improved sugarcane varieties and site specific production technologies. Normally varieties are developed by raising fuzz followed by its testing, advancement and evaluation at different clonal stages. In local climatic conditions, it's difficult to produce enough fuzz (sugarcane true seed) for varietal development program due to extreme variation in climatic conditions.

The novel genetic variability among desired crosses pave the way for selecting improved cultivars to be released for successful commercial cultivation. In any breeding program the breeder makes efforts to find out superior clones with good sugar contents and tonnage giving more profit for growers and processors of sugarcane (Jackson, 2005). The 1st step of varietal development starts with hybridization (Heinz and Tew, 1987; Breaux, 1987). The maintenance of broad genetic base is key to develop wide cross combinations (Birding and Roach, 1987; Deren, 1995). A significant yield gap exist between Sugarcane Research Institute and farmer's field. The institute is striving to bridge up this yield gap by producing new sugarcane verities and production technologies. It is dire need of the time to release well suited, site specific and superior varieties to enhance the economy of nation as well as of the farmers. The sugarcane growing area has been divided into three zones keeping in view the climatic and soil conditions of the province of Punjab. For the development of variety of any crop, genetic variability plays the key role to be manipulated by the breeders. The production of fuzz plays the role to give opportunity for the utilization of genetic variability for varietal development program. The climatic condition in country are not favorable to produce enough fuzz for the varietal development program. Efforts are under way to enhance the viability of local sugarcane fuzz at Murree (Ahmed et at., 2019). Most of varieties under cultivation have been developed from exotic fuzz (Khan et al., 2015). So the institute has to depend upon imported fuzz from different countries for evolution of new varieties.

The clones are tested at various selection stages to evaluate the performance in comparison with check varieties. The clones exhibiting better performance while testing in preliminary varietal trial were promoted/ advanced to semi-final and final varietal trials for further evaluation. The recommended seed rate, fertilizer and irrigations are applied. The data on tillering, No. of cane, cane yield, single cane weight and sugar recovery was recorded timely.

The preliminary yield trials (N-III) is considered crucial stage for varietal development program as this stage decides the fate of clones to be taken in other agronomic, pathologic and breeding trials. The number of clones range about thirty so principle component analysis plays important role for the description of better performer clones. It also becomes easy to classify the clones based on their overall performance for right decision. Following study will help to identify best performer clones and to sort out the clones which needs further attention for screening in remaining varietal developmental stages.

MATERIALS AND METHODS

The experiment was planted at coordinate 31.392° N and 73.055° E, at Sugarcane Research Institute, Faisalabad, Pakistan. The field was remained fallow for six months to avoid any contamination of previously sown crop. The soil of experiment field was chemically analyzed from Soil and Water Testing Laboratory, Ayub Agricultural Research Institute, Faisalabad. The analysis report showed that there was 35% saturation, pH; 7.7, EC; 1.8 dS m^{-1}, organic matter; 0.93%, total N; 0.57 g Kg^{-1}, available P; 6.8.0 mg Kg^{-1} and available K; 1.41 mg Kg^{-1}. The data on weather for whole crop season was recorded at observatory of plant physiology section, Agronomic Research Institute-AARI, Faisalabad (Table 1).

Table 1: Data of weather for whole crop season (2018-19) of sugarcane cultivation

	Mean temperature (C^o)		Mean relative humidity (%)		Total rainfall
	Maximum	Minimum	8am	5 pm	
October	32.9	18.4	73.5	46.7	0.6
November	27.6	12.2	77.4	50.5	Traces
December	22.3	5.7	88.5	53.3	0.4
January	19.3	5.7	86.5	54.6	18.4
February	20.5	8.0	84.3	55.2	56.8
March	26.1	12.7	74.8	46.9	39.6
April	35.2	20.1	62.0	39.7	33.6
May	38.7	23.0	46.7	31.3	31.6
June	41.4	26.3	43.6	31.6	29.3
July	37.0	26.7	73.7	58.5	144.6
August	37.2	26.9	76.0	61.2	84.0
September	36.9	26.4	75.5	56.4	48.1
October	32.9	18.9	78.4	50.8	22.4
November	26.3	12.8	82.2	55.4	3.0
December	17.0	6.0	87.0	67.0	7.0

In current studies on performance of sugarcane clones twenty six clones (26) along with two check varieties HSF 240 and CPF 249 were sown using randomized complete block design (RCBD) in three replication adapting recommended planting method of four feet apart dual row trench planting. The trial as planted during October, 2018 keeping net plot size of 4m x 3.6m in each replication. The experiment was planted manually following recommended seed rate of 50000 triple budded sets per hectare. Balanced and recommended fertilizer consisting 168:112:112 kg/ha of N:P:K was applied. Phosphorus and Potash containing fertilizer was applied at the time of sowing while nitrogen fertilizer was broadcasted in three splits. The clones were from the fuzz imported from Srilanka after selection, advancement and promotion from various varietal developmental stages. The irrigation process continued and 2 delta of water used during whole crop season. The parameters were recorded at their respective stage, tillering per plant was recorded 120 days after planting while all other parameters under study were recorded at the time of harvest. The juice quality analysis was determined at Sugarcane Technology Laboratory, Faisalabad by the Australian commercial cane sugar formula.

$$CCS\% = 3P/2\{1-(F+5)/100\}-B/2\{1-(F+3)/100\}$$

Where, P for pol%, F for fiber% and B for brix% of extracted juice.

The pol% was determined by Horns dry lead sub-acetate method of sucrose analysis (Anonymous, 1970).

Statistical Analysis:

The data collected were subjected to statistical analysis employing Minitab and Statistix 8.1. The data was analyzed for principle component analysis and summarized results were tabulated for inferences. Least Significant Difference (LSD) were used for ranking all compared combinations (Steel et al., 1997) A dandogram was shaped for better interpretation of results in grouping.

RESULTS AND DISCUSSION

Evolution and development of new, genetically improved variety has always been a good contributor for sustainability of sugar industry in country. The study was carried out to evaluate the clones under semiarid conditions of Faisalabad, Pakistan (table-1). In present study twenty six clones and two check varieties were tested in preliminary yield trial, a vital stage of varietal development program of this institute. The data recorded was subjected to principle component analysis to compute their principle components. The principle component-2 contained 65.8 % information of recorded parameters of sugarcane crop. It was observed that the parameters tillers per plant, no. of canes per hectare, single cane weight and sugar recovery (%) has positive association with yield per hectare. It was illustrated in that no. of canes per hectare and tillers per plant has close association with yield (t/ha) but the single cane weight (kg) and sugar recovery (%) has loose association with yield (t/ha) (Table-2). The lines getting more distance are showing dissimilar behavior while the lines indicating less distance are more similar (figure-1). It is important to note that all these results are based on 65.8 % information computed by analyzed data under principle component analysis. The clones in the direction of yield are showing good performance for yield per hectare. Nadeem et al. (2011) found that yield of sugarcane has high dependency over no. of canes. EL-Geddway et al. (2002) also worked and fond results that artificially selected and promoted clones have good percentage of yield and sugar contents.

The germination of all the clones stood similar while comparing these with both check varieties i.e HSF240 and CPF 249. The tillering of clones S-2016-SL-104, S-2016-SL-131, S-2016-SL-182, S-2016-SL-234, S-2016-SL-296 and S-2016-SL-300 stood significantly lower as compared to HSF-240. While all the clones showed similar behavior in comparison of tillering with CPF 249. The no. of canes exhibited that S-2016-SL-80, S-2016-SL-124, S-2016-SL-128, S-2016-SL-131, S-2016-SL-143, S-2016-SL-171 and S-2016-SL-234 was significantly less than check variety HSF 240. A star clone S-2016-SL-284 surpassed all clones under study and has significant higher yield as compared to check varieties while all other clones were at par or significantly lower as compared to check varieties. The recovery %age of check varieties stood 11.8 while clones S-2016-SL-91, S-2016-SL-104, S-2016-SL-124, S-2016-SL-131, S-2016-SL-143, S-2016-SL-182, S-2016-SL-234, S-2016-SL-240, S-2016-SL-284, S-2016-SL-296, S-2016-SL-300 and S-2016-SL-306 showed significantly higher performance in this trait while all other clones were at par or significantly lower in comparison to check varieties. The check variety HSF 240 has thin cane but more tillering as its single cane weight stood 0.8 kg. The comparison of single weight with HSF 240 portrayed that the clones S-2016-SL-80, S-2016-SL-81, S-2016-SL-114, S-2016-SL-124, S-2016-SL-128, S-2016-SL-131, S-2016-SL-143, S-2016-SL-171, S-2016-SL-182, S-2016-SL-240, S-2016-SL-284 and S-2016-SL-290 were significantly higher in this trait as compared to check variety. All other clones were significantly inferior or at par with check variety. The comparison of CPF 249 with all clones depicted that S-2016-SL-02, S-2016-SL-127, S-2016-SL-218, S-2016-SL-234 and HSF-240 were significantly lower as compared to check variety while all other clones were at par with check variety (Table 3&4). Improved genetic makeup of clones have better response in specific set of climate (Arain et al., 2011). Researchers also found better response of quantitative and qualitative traits in specific set of climatic conditions (Mahmood-Ul-Hassan et al. 2020).

In dandogram the grouping of clones based on pooled data under principal component analysis gives comprehensive information that which clone has similarity of what percent with other clones. The dendrogram showed 13 clusters at 66.7 similarity of all clones under study. It was depicted from figure-2 that S-2016-SL-284 lies outside the bound in direction of yield line shows that it is more performing in context of yield than any other clones under experiment. Similarly, the clone S-2016-SL-131 falls in most distant region opposite to yield that shows its poor performance of yield. This figure depicts clear image during selection process either to promote or reject a clone based on its performance of parameters under study. This information provides clear picture that which variety should be promoted to next selection stage for further evaluation (figure 3). At field condition reaction to disease is also given weightage during clonal selection process. Similar type of clusters were found in research experimentation (Tahir et al, 2013). The character also lost their individuality based on specific region due to pressure selection and human interferences (Singh and Bains, 1986). The formation of different cluster showed genetic variability among clones that can be exploit in breeding program for further improvement. Many researchers have used these techniques for explaining their results (Khodadadi et al., 2011; Ilyas, 2011; You et al., 2013). Based on all parameters under study, following clones S-2016-SL-41, S-2016-SL-83, S-2016-SL-91, S-2016-SL-104, S-2016-SL-109, S-2016-SL-114, S-2016-SL-127, S-2016-SL-306 and S-2016-SL-284 were promoted into next selection stage (semifinal varietal trial). The check varieties HSF-240 and CPF 249 were closely falling to each other showing similar performance in experiment. In addition to all these parameters, resistance reaction of these clones to major diseases was considered for evaluation. All these clones were superior or at par with check varieties except S-2016-SL-284 which performed exceptionally well to outclass all other clones. It may be future hope of institute to release variety after further assessment. The fuzz of these clones was taken from Srilanka from the crosses of varieties shared with Srilanka to get local cross combinations having more adaptability in our climatic conditions. It is also notable that S-2016-SL-284 has been developed from local parental cross combinations, hence showing outclass performance in comparison to other clones. While all other clones promoted in next selection stage needs further evaluation to be approved from Punjab Seed Council as variety.

Table 2: Principal Component Analysis of Biometric Parameters of Sugarcane Crop

Variable	PC1	PC2	PC3	PC4	PC5
Tillers per plant	0.407	-0.339	0.082	0.844	-0.019
No. of Canes per hectare	0.639	-0.285	0.088	-0.445	-0.552
Yield (t/ha)	0.646	0.380	-0.166	-0.128	0.628
Sugar Recovery (%)	0.041	0.323	0.945	0.018	0.017
Single Cane Weight (kg)	0.083	0.745	-0.254	0.271	-0.548
Cumulative	**0.347**	**0.658**	**0.845**	**0.993**	**1.000**

Figure 1: Biplot of Recorded Parameters

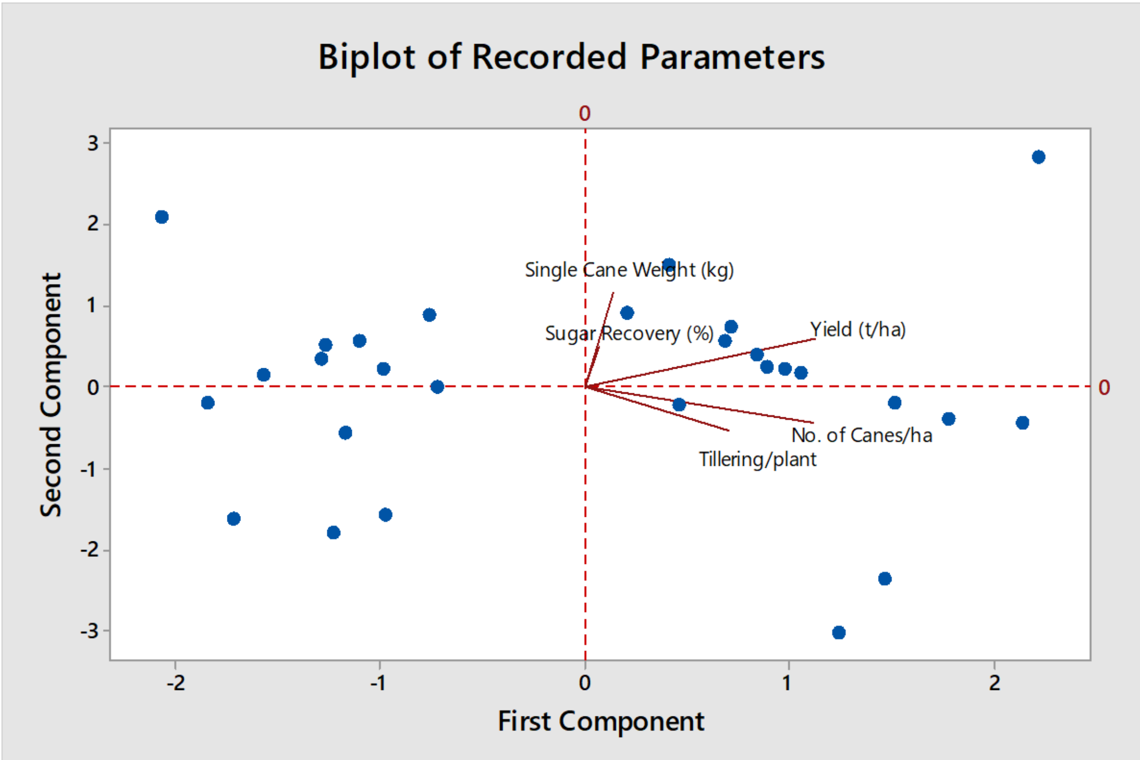

Figure 2: Score plot of Recorded Parameters

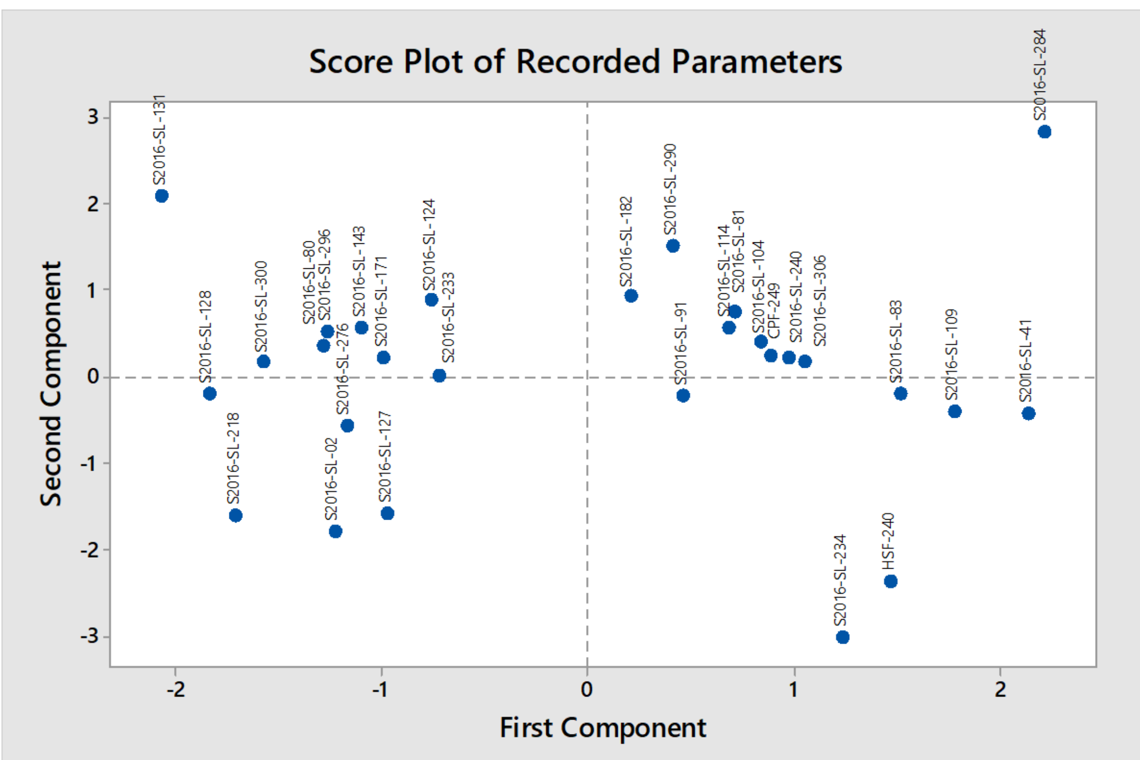

Table 3: Performance of clones in comparison to HSF 240

Sr#	Germination %	Tillering	No. of Canes	Yield (t/ha)	Recovery (%)	Single Cane Weight (kg)
S-2016-SL-02	36.5	1.0	103.3	86.3	10.7 *	0.8
S-2016-SL-41	32.7	1.4	144.3	149.0	11.9	1.0
S-2016-SL-80	36.5	1.4	76.0*	87.7	13.1*	1.1*
S-2016-SL-81	35.6	1.2	113.3	132.7	11.9	1.2*
S-2016-SL-83	38.8	1.3	133.7	140.3	11.1*	1.1
S-2016-SL-91	35.9	1.5	112.0	113.3	13.1*	1.0
S-2016-SL-104	23.8	0.7*	134.7	137.3	12.6*	1.0
S-2016-SL-109	28.5	1.5	133.0	143.3	10.9*	1.1
S-2016-SL-114	34.8	1.2	114.3	131.0	11.5	1.2*
S-2016-SL-124	36.4	1.0	91.7 *	107.3	12.1	1.2*
S-2016-SL-127	39.1	0.9	112.3	89.7	11.2*	0.8
S-2016-SL-128	48.3	1.0	77.7*	85.3	10.7*	1.1*
S-2016-SL-131	37.4	0.5*	73.3*	94.7	12.9*	1.3*
S-2016-SL-143	32.3	1.1	85.7*	97.0	12.9*	1.1*
S-2016-SL-171	36.4	1.2	87.0*	97.0	12.2	1.1*
S-2016-SL-182	46.4	0.7*	116.3	131.3	12.5*	1.1*
S-2016-SL-218	38.2	1.1	93.7	72.3	11.7	0.8
S-2016-SL-233	31.5	0.4	114.0	115.0	11.0*	1.0
S-2016-SL-234	46.7	1.3*	72.3*	94.0	12.5*	0.6
S-2016-SL-240	27.6	1.4	119.3	128.7	12.5*	1.1*
S-2016-SL-276	40.9	0.9	97.3	95.3	10.9*	1.0
S-2016-SL-284	37.6	0.9	129.7	179.0*	13.2*	1.4*
S-2016-SL-290	33.2	1.0	107.3	133.7	12.1	1.3*
S-2016-SL-296	40.6	0.4*	106.3	99.3	12.8*	1.0
S-2016-SL-300	46.1	0.6*	97.3	89.3	13.6*	0.9
S-2016-SL-306	46.3	1.4	124.7	125.0	13.9*	1.0
HSF-240	**41.9**	**2.1**	**132.0**	**111.3**	**11.8**	**0.8**
CPF-249	41.1	1.2	119.0	135.0	11.8	1.1
Critical Value	17.9	1.42	39.4	43.1	0.43	0.27

Table 4: Performance of clones in comparison to CPF 249

Sr#	Germination %	Tillering	No. of Canes	Yield (t/ha)	Recovery (%)	Single Cane Weight (kg)
S-2016-SL-02	36.5	1.0	103.3	86.3*	10.7*	0.8*
S-2016-SL-41	32.7	1.4	144.3	149.0	11.9	1.0
S-2016-SL-80	36.5	1.4	76.0*	87.7*	13.1*	1.1
S-2016-SL-81	35.6	1.2	113.3	132.7	11.9	1.2
S-2016-SL-83	38.8*	1.3	133.7	140.3	11.1*	1.1

S-2016-SL-91	35.9	1.5	112.0	113.3	13.1*	1.0
S-2016-SL-104	23.8	0.7	134.7	137.3	12.6*	1.0
S-2016-SL-109	28.5	1.5	133.0	143.3	10.9*	1.1
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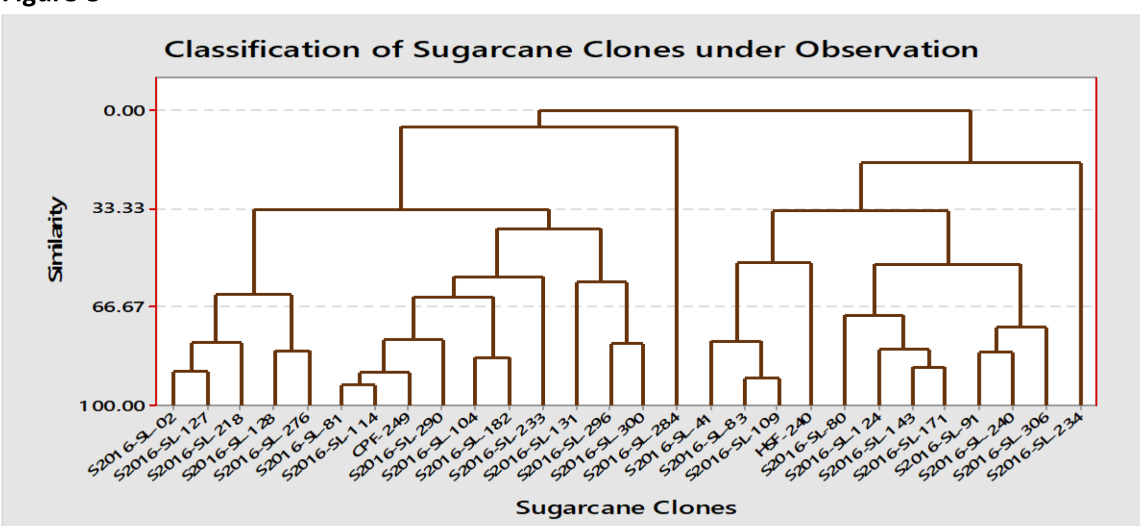
S-2016-SL-306	46.3	1.4	124.7	125.0	13.9*	1.0
HSF-240	41.9	2.1	132.0	111.3	11.8	0.8*
CPF-249	**41.1**	**1.2**	**119.0**	**135.0**	**11.8**	**1.1**
Critical Value	17.9	1.42	39.4	43.1	0.44	0.28

Figure-3



CONCLUSION

The clones dispersed in various clusters can be utilized for hybridization to get good combination in breeding program for further improvement. The better performing clones especially S-2016-SL-284 have excellent performance and may be recommended for commercial release after further experimentation in coming years. Local hybridization program needs to be established or international collaboration is required to get cross combination of desired parents having suitability in adaptation in local climatic conditions.

REFERENCES

Ahmed M. F., M. Siddique, N. Kamal and D. N. Ahmad. 2019. Sugarcane flowering at sugarcane breeding sub station (SBSS), Murree. Haya S. J. of Life Sci., 206-212

Anonymous, 1970. Laboratory Manual for Queens Land Sugar Mills. (5th Ed.) Watson, Ferguson and Co. pp. 94-150.

Anonymous. 2015. http://faostat.fao.org/

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

Birding, N., and B.T. Roach. 1987. Germplasm collection, maintenance, and use. Pages 143-210. In: Sugarcane Improvement Through Breeding, D.J. Heinz, ed. Elsevier, New York.

Breaux, R.D. 1987. Some breeding strategies with bi-parental and polycrosses. Pages 71-85. In: Proceedings of Copersucar Intern. Soc. Sugar Cane Technol. Sugarcane Breeding Workshop. May/June 1987.

Deren, C.W. 1995. Genetic base of U.S. mainland sugarcane. Crop Sci. 35:1195- 1199.

EL-Geddaway, I.H., D.G. Darwesh, A.A. El-Sherbiny, E. Eldin and A. El- Hadi. 2002. Effect of row spacing and number of buds/seed setts on growth characters of ratoon crops for some sugarcane varieties. Pak. Sugar J., 17: 7-14.

Govt. of Pakistan, 2021. Pakistan Economic Survey: Agriculture. pp: 22

Heinz, D. J., and T. L. Tew. 1987. Hybridization procedures. Pages 313-342. In: Developments in Crop Science 11: Sugarcane Improvement through Breeding, D.J. Heinz, ed. Elsevier, New York

Ilyas, M.K. 2011. Genetic variability and contribution of some morphological traits in cane yield and sucrose recovery in (Saccharum officinarum). Available online at http://agris.fao.org. AGRIS Record No. PK2004000303

Jackson PA. 2005. Breeding for improved sugar content in sugarcane. Field Crop. Res., 92:277-290

Khan, I.A., N. Seema, S. Raza and S.Yasmin. 2015. Comparative performance of sugarcane somaclones and exotic germplasm under agro-climatic conditions of Tandojam. Pak. J. Bot., 47(3): 1161-1166.

Khodadadi, M., M.H. Fotokian and M. Miransari. 2011. Genetic diversity of wheat (Triticum aestivum L.) genotypes based on cluster and principal component analyses for breeding strategies. Aus. J. Crop Sci., 5: 17-24.

Nadeem, M.A., M.A. Sarwar, A. Ghaffar, F. Ahmad and F. Hussain. 2011. Studies on the performance of some sugarcane genotypes at Faisalabad. Pak. Sugar J., 26(1): 14-18

Singh, R.B. and S.S. Bains. 1986. Genetic divergence for ginning out tern and its component in upland cotton

(Gossypium hirsutum L.) varieties obtained from different geographical locations. Indian J. Genet. and Plant Breed., 26: 262-268.

Steel, R.G.D., J.H. Torrie and D.A. Deekey. 1997. Principles and Procedures of Statistics: A Biometrical Approach, pp: 400–428. McGraw Hill Book Comp. New York, USA

Tahir, M., H. Rahman, R. Gul, A. Ali and M. Khalid. 2013. Genetic divergence in sugarcane genotypes. Am. J. Exp. Agric., 3: 102-109

You, Q., L. Xu, Y. Zheng and Y. Que. 2013. Genetic diversity analysis of sugarcane parents in Chinese breeding program using SSR markers. Sci. World J. doi.org/ 10.1155/2013/613062.

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