SCREENING AND COMPARISON OF SUGARCANE GENOTYPES FOR CANE AND SUGAR YIELD TRAITS

Salahuddin Junejo*, Abdul Fatah Soomro*, Riaz Noor Panhwar*, M. Chohan*, Abdul Ghani Soomro*, Ali Hassan Mari*, Illahi Bux Bhatti*, Ghulam Moheyuddin Kaloi*, Samia Arain* and Zainab Zahoor**
***PARC-National Sugar and Tropical Horticulture Research Institute, Thatta
****University of Agriculture, Faisalabad

ABSTRACT

The trials were conducted during autumn sugarcane sowing season (August-September) for two consecutive years (2014-15, and 2015-16) to screen out the most promising sugarcane lines in a three replicated RCBD (Factorial). Eight sugarcane lines Th-1201, Th-1205, Th-1206, Th-1208, Th-1210, Th-1211, Th-1223, and Th-1238 were tested, and their overall performance concerning cane yield, and sugar content related traits was compared with commercial check Th-10. The results revealed that cane yield was significantly highest (P<0.05) in new variety Th-1201 (213.92 t ha^{-1}), followed by varieties Th-1238 (195.23 t ha^{-1}), Th-10 (195.23 t ha^{-1}), Th-1205 (193.54 t ha^{-1}), Th-1211 (178.26 t ha^{-1}), Th-1208 (143.46 t ha^{-1}), Th-1206 (136.67 t ha^{-1}), Th-1223 (115.44 t ha^{-1}). New promising variety Th-1201 surpassed commercial check-in cane yield, while varieties Th-1238 and Th-1205 were at par with the commercial check (Th-10) for cane yield ha^{-1}. In case of CCS, it was significantly higher in sugarcane variety Th-1210 (14.45 t ha^{-1}) as compared to varieties Th-1201 (14.31 t ha^{-1}), Th-1206 (13.90 t ha^{-1}), Th-10 (13.73 t ha^{-1}), Th-1238 (13.40 t ha^{-1}), and Th-1223 (13.38 t ha^{-1}). In CCS, the varieties Th-1210, Th-1201, and Th-1206 exceeded commercial check (Th-10), while the rest of the varieties were slightly inferior in CCS to commercial check.

Keywords: *Sugarcane, cane yield, Juice quality, Brix, Pol, Purity, Fiber, CCS*

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) belongs to the grass family Gramineae (Miller, and Gilbert, 2010);, and source of livelihood for millions of people in Pakistan (Afghan *et al*., 2010). Pakistan has the 5th largest sugarcane growing area in the world and is the 15th biggest global producer of sugar. Sugarcane has a 2.9 percent share in value addition to agriculture, and a 0.5 percent contribution to GDP (GoP, 2019). It provides raw material to sugar, and allied industries, and reportedly, more than 4 million peoples of Pakistan are engaged with this industry (Ghaffar *et al*., 2011). This crop provides raw material to the sugar factories, but the yields are lower than the yields reported from developing countries of the world.

The cane yield obtained in Pakistan is 60.956 t ha^{-1} (GoP, 2019) against the yield achieved in Australia (82.4 t ha^{-1}), Brazil (78.85 t ha^{-1}), Mexico (78.2 t ha^{-1}), Thail, and (75.7 t ha^{-1}), USA (75.7 t ha^{-1}), Brazil (75.2 t ha^{-1}), Philippines (73.2 t ha^{-1}), China (68.08 t ha^{-1}), India (67.4 t ha^{-1}), and Argentine (64.1 t ha^{-1}). The cane yield can be increased substantially by the development of new high yielding sugarcane varieties and by the adoption of a variety of specific improved crop production practices (FAO Stat., 2018; Tahir, and Ismail, 2016). During 2018-19, 1102 thous, and hectares were reported under sugarcane cultivation producing 67.174 million tons of cane, showing a considerable decrease (17.9%) over the preceding year (GoP, 2019).

The average yield of sugarcane in Pakistan is much lower (60.956 t ha^{-1}) than that of the world average (65 t ha^{-1}). The reasons for low yield mainly include the adoption of unapproved sugarcane varieties by the growers, and lack of variety-specific production technologies (Khan *et al.,* 2009; Gholve *et al.,* 2001; Zafar *et al.,* 2010).

Lack of genetic variability in traits of economic significance such as cane yield, recovery, resistance to an insect pest, and diseases in local germplasm delimits the development of new varieties (Chohan *et al.,* 2013; Subhan, 2013; Keshavaiah *et al.*, 2012; Ghaffar *et al.*, 2010; Arain *et al.,* 2011; Gilbert *et al.,* 2011; Bahadar *et al.,* 2012; Zafar *et al.,* 2012; Kalwar, 2014; Naidu *et al.,* 2015).

At present, Sindh province cannot afford further shifting of the area of other main crops towards sugarcane. Hence, it is the need of the time to plant high yielding and high sucrose content varieties to obtain maximum cane yield and sugar per unit area (Akhtar *et al.*, 2000). In Sindh, although conditions for the development of the breeding programs are favorable, especially in the coastal belt, due to the non-availability of basic laboratory facilities, i.e., greenhouse, photoperiod chamber, etc. development of new sugarcane varieties has become difficult. Thus, the introduction or development of varieties through selection from the available germplasm needs to be made more effective (Minhas, 2014). Amolo and Abayo (2007) developed sugarcane varieties found N-14 superior over KEN 82-216 in cane yield, and Muraro (2009) produced sugarcane variety RB72-454 with a high cane, and sugar yields; while Garside and Bell (2009) developed Q124, and Q155 sugarcane varieties with high production potential, and recovery. Getaneh *et al.* (2016) found that sugarcane variety B59 250 grew vigorously in both Luvisol, and Vertisol soil types, and N52 219, M202/46, and COK 30 in luvisol. The present study was mainly aimed at screening and comparison of sugarcane genotypes for cane and sugar yield traits.

MATERIALS AND METHODS

The field experiments were conducted during autumn seasons (August-September) 2014-15, and 2015-16 in a three replicated RCBD (Factorial). Factor A was comprised of nine sugarcane varieties, and factor B years. The experimental l, and was prepared by giving two deep ploughings by of chisel plow, followed by disc harrow to eradicate the weeds further rotavator was practiced to well pulverize the soil. A good seedbed was prepared.

Planting was done in furrows. After completion of germination, the weeds were removed using herbicides, while after completion of tillering, the intercultural, and earthing up was carried. The recommended cultural practices were operated in all the experimental units uniformly. The crop was irrigated at the weekly intervals in summer months, and fortnightly in winter months. The N (220 kg ha^{-1}), P (120 kg ha^{-1}), and K (250 Kg ha^{-1}) were applied as a uniform dose in all the treatments. All P and K were incorporated at the time of seedbed preparation, whereas N was applied in splits at the time of sowing, and irrigation as per treatments. The earthing up was done in March and April with the help of a tractor to eliminate the immature tillering and borer complex.

The necessary care was taken to control the weeds, insect pests, and diseases. At the physiological maturity of the crop, the agronomic observations were recorded using standard methods for different measurements; , and the samples from all the treatments were collected and brought to the laboratory for necessary observations following standard determination methods. Data collected were subjected to statistical analysis through Mstatc analyze the treatment variation LSD test was applied to observe the statistical difference within treatments according to the method developed by (Gomez, and Gomez, 1984).

RESULTS AND DISCUSSION

Internodes cane^{-1}

Averagely the canes of sugarcane variety Th-1223 consisted of the highest number of internodes (37.02), significantly ($P<0.05$) higher than varieties Th-1208 (29.88), Th-1210 (28.52), Th-1238 (28.52), Th-1211 (28.18), Th-

1201 (27.5), and Th-1206 (24.11) against the least internodes cane^{-1} (23.10) in case of commercial check Th-10. There has been a tremendous genetic variation in varieties with similar origins in the case of internodes cane-1, and morphology of the varieties evolved later than the development of Th-10 were distinctive (Fig 1).

Although the seasonal effect on internodes cane^{-1} was apparent, and 2015-16 the relatively greater number of internodes was seen over the year 2014-15. Statistically, the seasonal effect, and the interactive effect of varieties, and seasons were insignificant ($P>0.05$). Bughio *et al.* (2018) developed several sugarcane varieties from the USA and found that variety Thatta-2109 differed significan-tly ($P<0.05$) from standard commercial varieties CPF-237, SPF-234, and Thatta-10 in morphological, and yield traits.

Cane girth (mm)

The canes of a maximum thickness (30.61mm) were recorded in variety Th-1208 ($P<0.05$), followed by varieties Th-1211 (28.86mm), Th-1201 (27.13mm), Th-1210 (26.89 mm), Th-1205 (26.86mm) and Th-1238 (26.19mm) against 26.89mm cane thickness in commercial check (Th-10). In cane thickness, a number of new genotypes produced canes of greater thickness as compared to check variety (Fig 2). Hassan *et al.* (2017) found that newly developed varieties differed significantly ($P<0.05$) to their competitors, and standard commercials in cane size, while Bughio *et al.* (2018), in their recent research, proved that varieties developed through fuzz surpassed commercial checks.

Plant height (cm)

The plant height among different sugarcane varieties was highest (369.77cm) in variety Th-1208 ($P<0.05$), followed by varieties Th-1210 (367.23cm), Th-1201 (353.13 cm), Th-1238 (347.69cm), Th-1211 (346.69cm) and Th-1205 (346.34cm) against 329.12cm height average of plants in commercial check (Th-10). Quite encouraging results were achieved for new lines, and most of the lines proved to be promising in plant height character when compared with a commercial check (Fig 3). Shahzad *et al.* (2016), and Suman *et al.* (2011) characterize local, and exotic sugarcane genotypes on the basis of morphological, and quality-related attributes, and found marked variation in cane sizes, and sugar contents.

Bughio *et al.* (2018) reported 236.11-293.14 cm cane length in different varieties developed through the fuzz. This indicates that the varieties reported in this study produced appreciably longer canes than generally referred to in different studies.

Millable canes ha^{-1}

The millable canes ha^{-1} were estimated on the basis of canes in each experimental unit. The results (Fig. 4) reveal that sugarcane variety Th-1201 as most promising ($P<0.05$) for this trait with 152.8 thous, and millable canes ha^{-1}, followed by varieties Th-1211 (137.52), Th-1206 (117.14), Th-1238 (117.14), Th-1205 (106.96), and Th-1223 (86.58) thous, and t ha^{-1} millable canes against 110.25 thous, and millable canes ha^{-1} in commercial check (Th-10).

All the new lines surpassed the commercial check-in millable canes ha^{-1} with the exception of Th-1223, Th-1210, and Th-1208. Junejo *et al.* (2012), and Khalid *et al.* (2016) reported marked variation in millable canes in different varieties they tested, while Bughio *et al.* (2018) reported 121.88-148.04 thous, and millable canes ha^{-1} in different types developed through the fuzz.

Canes yield (t ha^{-1})

Apparently, there was no linear association between independent traits, and cane yield ha^{-1}, and yield (Fig. 5) was significantly highest ($P<0.05$) in new variety Th-1201 (213.92 t ha^{-1}), followed by varieties Th-1238 (195.23 t ha^{-1}), Th-10 (195.23 t ha^{-1}), Th-1205 (193.54 t ha^{-1}), Th-1211 (178.26 t ha^{-1}), Th-1208 (143.46 t ha^{-1}), Th-1206 (136.67 t ha^{-1}), Th-1223 (115.44 t ha^{-1}). New promising variety Th-1201 surpassed commercial check-in cane yield, while varieties Th-1238 and Th-1205 were at par with the commercial check (Th-10) for cane yield ha^{-1}.

Bughio *et al.* (2018) *et al.* (2018) achieved cane yield of 113.0 t ha^{-1} in variety Th-2109 against cane yield of 105.03, 103.40, and 108.52 t ha^{-1} in CPF-237, SPF-234, and Thatta-10, respectively. However, in our study, the new cane variety Th-1201 produced cane yield of 213.92 t ha^{-1} that was exceptionally higher than any other variety under examination or being grown as commercial varieties at present.

Fiber content (%)

There was a significant varietal influence on fiber in juice (P<0.05) , and results (Table-2 Fig 6) indicated that on average, the fiber was higher in Th-1208 (15.88%) compared to Th-1201 (12.92%), Th-1211 (12.89%), Th-10 (12.84%), Th-1205 (12.74%), Th-1223 (12.76%), Th-1238 (12.72%), Th-1210 (12.63%) and Th-1206 (12.55%). Varieties Th-1208, Th-1201 and Th-1211 surpassed commercial check (Th-10) in fiber content, while varieties Th-1205, Th-1223, and Th-1238 were at par with a commercial check for this quality attribute.

However, Th-1210 and Th-1206 were found lower in fiber content in the juice. Panhwar *et al.* (2003) , and Chohan *et al.* (2013) found that sugarcane varieties either of the diverse origin or in similar germplasm may differ in physiological characteristics.

Brix (%)

The Brix content in the juice of different sugarcane genotypes differed significantly (P<0.05), and results (Table-2 Fig 7) showed that averagely the Brix content was higher in Th-1210 (23.94) as compared to Th-1201 (23.73), Th-10 (23.12), Th-1206 (22.41), Th-1238 (22.41) and Th-1223 (22.21). Varieties Th-1210, and Th-1201 surpassed commercial check (Th-10) in Brix content, while the rest of the varieties were relatively inferior to commercial check for Brix content.

Baloch (2016) reported great variation in the Brix content of different sugarcane genotypes, and some of them surpassed the commercial check. Similarly, Elamin *et al.* (2007) and Getaneh *et al.* (2016) found that Brix content of varieties is dependent on climatic conditions. Bughio *et al.* (2018) reported significant (P<0.05) variation in Brix content of varieties developed from the same fuzz imported from the USA.

Pol reading (%)

Pol reading of cane juice from sugarcane varieties developed at Thatta varied significantly (P<0.05) , and the data (Table-2 Fig 8) exhibited that on average the Pol reading was higher in Th-1210 (20.01%) as compared to Th-1201 (19.83%), Th-10 (19.15%), Th-1206 (19.06%), Th-1238 (18.63%) and Th-1223 (18.54%). Varieties Th-1210, and Th-1201 exceeded Th-10 (commercial check) in Pol reading, while other tested varieties showed decreased Pol reading as compared to commercial check. Patel *et al.* (2005) have reported similar results and found that with the climatic change, the juice quality characteristics may considerably alter when planted away from the climate of origin of varieties. Arain *et al.* (2011) reported a wide range of Pol reading in germplasm varieties.

Purity (%)

The purity of juice obtained from promising sugarcane varieties evolved through fuzz differed significantly (P<0.05), and the results (Table-2 Fig 9) demonstrated that highest purity was equally determined in the juice of varieties Th-1205, and Th-1206 (86.58%), followed by Th-1211 (85.50%), Th-1208 (85.43%), Th-1210 (85.16%), Th-1201 (85.12%) and Th-1223 (85.09%) against 84.35 percent purity in case of the commercial check (Th-10).

Similar results have also been reported by Bughio *et al.* (2018), who reported that most of the new sugarcane lines exceeded in juice purity over the commercial varieties. According to Junejo *et al.* (2012), sugarcane lines developed at Thatta from USA fuzz showed diversified quality characteristics.

Commercial Cane Sugar Percentage (CCS%)

It is obvious from the results (Table-2 Fig 10) that CCS was significantly higher in sugarcane variety Th-1210 (14.45 t ha^{-1}) as compared to varieties Th-1201 (14.31 t ha^{-1}), Th-1206 (13.90 t ha^{-1}), Th-10 (13.73 t ha^{-1}), Th-1238 (13.40 t ha^{-1}), and Th-1223 (13.38 t ha^{-1}). In CCS, the varieties Th-1210, Th-1201, and Th-1206 exceeded the CCS calculated for commercial check (Th-10), while the rest of the varieties were slightly inferior in CCS to commercial check.

The results regarding CCS achieved in this study are further in line with those of Panhwar *et al.,* 2003; Chohan *et al.* (2013); Baloch (2016); Elamin *et al.* (2007); Getaneh *et al.* (2016); Zafar *et al.* (2012); Patel *et al.* (2005); Bughio *et al.* (2018); Arain *et al.* (2011); Junejo *et al.* (2012); Khalid *et al.* (2016); Nawaz *et al.* (2013); Pinto *et al.* (2010); Memon *et al.* (2010); Shahzad *et al.* (2016); Suman *et al.* (2011); Hassan *et al.* (2017). They concluded that CCS is the major trait that describes the validity of new varieties in accordance with the set criteria.

CONCLUSIONS

There has been a tremendous genetic variation in varieties with a similar origin; the seasonal effect was apparent, and 2015-16 the overall varietal performance improved considerably over 2014-15 crop performance. Plant height, cane thickness, and millable canes ha^{-1} was higher in a number of new genotypes as compared to commercial check. New promising variety Th-1201 surpassed commercial check-in cane yield, while varieties Th-1238 and Th-1205 were at par with the commercial check (Th-10) for cane yield ha^{-1}. Varieties Th-1210, and Th-1201 surpassed commercial check (Th-10) in Brix content, while the rest of the varieties were relatively inferior to commercial check for Brix content.

In CCS, the varieties Th-1210, Th-1201, and Th-1206 exceeded commercial check (Th-10); while the rest of the varieties were slightly inferior to commercial test.

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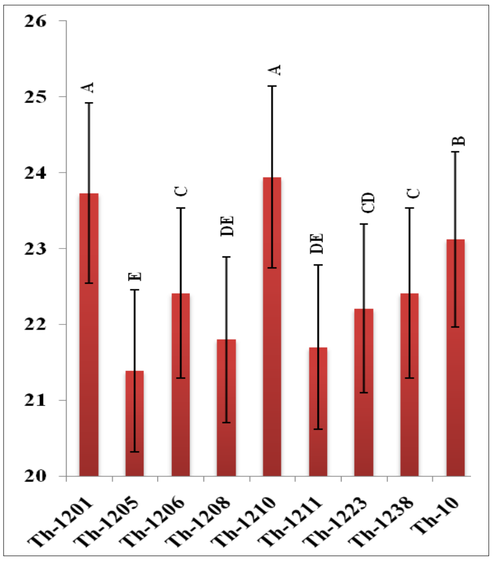

Fig.7: Brix content of sugarcane varieties

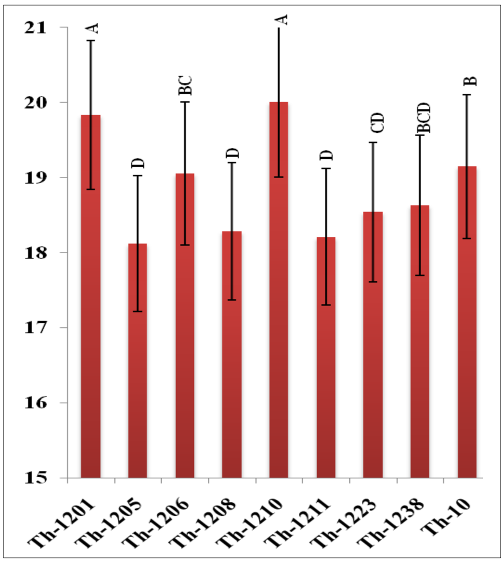

Fig.8: Pol (%)of sugarcane varieties

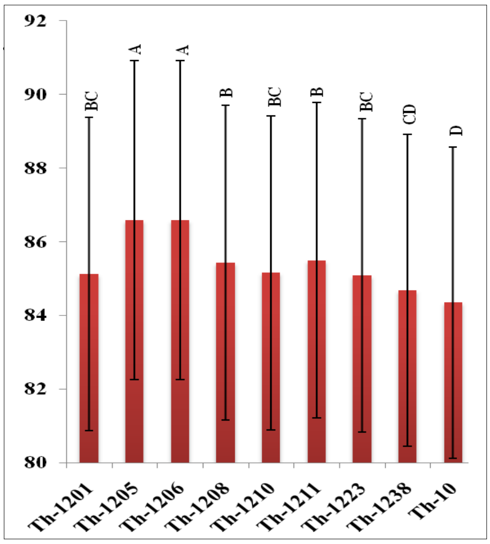

Fig.9: Purity (%) of sugarcane juice

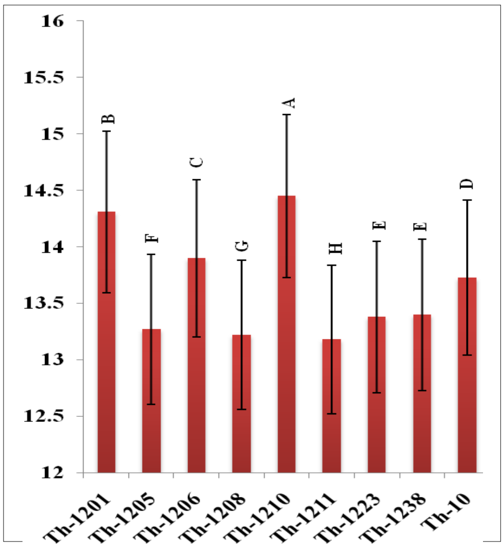

Fig.10: CCS (%) of sugarcane varieties

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