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NOVEL HIGH CANE, SUGAR RESILIENT AND EARLY MATURING SUGARCANE VARIETY CPF 250 FOR PUNJAB PROVINCE

Abdul Khaliq*[1], Naeem Ahmad[1], Muhammad Yasin[1], Hafiz Muhammad Bashir[1], Muhammad Shahzad Afzal[1], Arshad Mahmood[1]

[1]Sugarcane Research Institute, Faisalabad, Pakistan.
*Corresponding author email: khaliq1775@gmail.com

Abstract:

CPF-250 Sugarcane cultivar developed through the research conducted by Sugarcane Research Institute, Faisalabad and released for growers other than river belt of Punjab Province during 2019. The parentage of the variety is CP 89-879 X CP 90-956. The fuzz of the variety imported during 2002 from Sugarcane Breeding Research Station, Canal Point, USA. The seedling number assigned in 2003 as S2003-US-127 and put in the preliminary replicated National Uniform yield Trial and adaptability trials for comparison with reference cultivars HSF-240, CPF-249 and SPF-234 and CPF-246. It matures in 240 – 270 days. Its planting time is 15th February to 15th March & whole month of September. It has 111.3 t ha^{-1} cane yield, 14.1 t ha^{-1} sugar yield, 12.72 % sugar recovery and higher economic Index. CPF 250 is resistant to red rot and smut. As it matures earlier thus, farmers can grow wheat crop timely. Cultivation of this CPF 250 prolong the crushing season being early maturing variety.

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Key Word: Early maturing, crushing season, economic Index, Seedling, zonal trials

Introduction

Sugarcane is an imperative crop of immense economic importance. It plays an important role in the uplift of socioeconomic conditions and prosperity of the people of sugarcane community in 115 countries of the world including Pakistan. It generates three fourth sugar of the world. In global scenario, the region Americas and Asia produces 52.3% and (39.9%) of world sugarcane respectively (FAO, 2016). The contribution of sugarcane in agriculture value additions is 3.4 % and share in GDP is 0.7 % in Pakistan economy. The share of Punjab and Sindh in sugarcane area is 62% and 28% and in sugarcane production is 65% and 27% respectively (GOP, 2017).

The research system of Sugarcane Research Institute (SRI), Faisalabad has developed and released 25 sugarcane varieties for general cultivation in Punjab. The variety development programme of the institute is an incessant process keeping in view the continually changing climatic, biotic scenario and needs of sugar industry. Sugarcane varieties developed by SRI Research System have been widely esteemed and opted by the sugarcane farmers in Punjab. The share of SRI varieties in sugarcane farming of the Province of Punjab is 92% percent (CRS, 2017).

From 1947 to 2017, sugarcane area, production, average yield and number of sugar mills was increased from 189.4 thousand hectares to 1217 thousand hectares, from 5.5 million tons to 73.60 million tons, from 29.19 tons / hectare to 60.40 tons/hectare, from 2 to 90 respectively (Tabassum, M.I., 2018). The annual crushing capacity of Pakistan sugar industry is 6.1 million tons (PSMA, 2016).

Pakistan has significant position in Sugar world. But, the average yield is far below than world. Main cause for low cane and sugar yield is absence of high potential varieties. The varieties already in field lose their potential with passage of time (Khan et al., 2017). Among the three cane producing provinces, Punjab is the leading province in variety development programme in Pakistan.

The sugarcane varieties released by SRI, Faisalabad for general cultivation in Punjab includes CoL 29, CoL 54, BL-4, CP 77-400, SPF 213, SPF-234 (for southern Punjab), CPF 237, HSF 240, CPF 246, CPF 247, CPF 248 and CPF 249 etc. Cane varieties plays an important role in increasing cane and sugar yield (Afghan et al., 2013). The sugar recovery of cane variety is the only single dominant factor that may affects sustainability and viability of Sugar industry. Cane cultivars SPF 213, SPF-234, CPF 237, HSF 240, CPF 247, CPF 248 and CPF 249 are the medium maturing varieties while SPF-238, COJ-84 are late maturing varieties (Ahmad et al., 2011).

The Sugarcane varieties have significant impacts on country economics. HSF 240 and CP 77-400, SPF 234, among all the sugarcane varieties generated maximum economic impact on Punjab's economy with an average of Rs. 15.85 billion annually from 2001-01 to 2016-17 (Tabassum, M.I., 2018).

The vast expansion of sugar industry necessitates the prolongation of crushing season by introducing early maturing varieties. Therefore, the study made for sugarcane variety CPF-250 that matures earlier with higher cane and sugar yield than existing varieties.

Materials and Methods:

Release of a new cane variety started from sowing of Fuzz imported during 2002 from Sugarcane Breeding Research Station, Canal Point, USA. The seedling number assigned in 2003 as S2003-US-127 and put in the preliminary varietal trial for comparison with other sugarcane varieties. Therefore, it was promoted and tested under semi-final and final varietal trials. The variety also tested in different zones at farmers' fields and National Uniform Sugarcane Yield Trials (NUSYT) to test the adaptability of variety before release as commercial variety. The candidate variety was evaluated by spot examination committee and case was submitted to expert sub-committee and then finally to Punjab Seed Council (PSC) for approval during 2019. The sugarcane varietal development programme is comprised of following stages:

S.No.	Stages	Activities
1	Import of Fuzz	➢ The fuzz of the variety imported during 2002 from Sugarcane Breeding Research Station, Canal Point, USA.
2	Raising of fuzz	➢ Fuzz is sown during Month of July-August. ➢ Fuzz germination requires: T 25-38Cº and more than 60 % humidity.
3	Selection of Seedlings	➢ Fuzz is transplanted in field during autumn and spring. ➢ Selection Depends upon Quality of material (about 5%).
4	Nursery I	➢ Visual selection based on previous record ➢ No Red Rot checking at this stage ➢ Non replicated single row of 4 meter is planted. ➢ Compared with at least three check varieties for growth, crop stand, pith or tube, lodging tendency, disease and insect pest attacks. Brix% of each clone is recorded by hand referectometer during selection.
5	Nursery II	➢ Visual selection based on previous record ➢ Red Rot checked at this stage after artificial inoculation of Red Rot. ➢ Non replicated trial is planted and compared with at least three check varieties for growth, crop stand, pith or tube, lodging tendency, disease and insect pest attacks. Brix% of each clone is recorded by hand referectometer during selection.
6	Nursery III / Preliminary Yield Trials	➢ Critical stage, Decision based seed multiplication ➢ Checking of Red Rot after artificial inoculation of Red Rot. ➢ Most probable clone should be decided
8	Semifinal and Final varietal trial	➢ Selection based on metric data and previous record ➢ Periodic Juice Analysis
9	National Uniform Yield Trial (NUSYT) and DUS	➢ Most important as competition between different institutes. ➢ 02 years trial. ➢ Study of Distinctness Uniformity and stability (DUS) should be side by side as it takes 02 consecutive years by Federal Seed Certification and Registration Department (FSC&RD). ➢ Spot examination conducted during 2nd year of NUSYT trial.
10	Adaptability / Zonal and outfield trails	➢ Zonal Trials is conducted for categorization of site specific varieties.
11	Preparation of varietal approval case	➢ Preparation of varietal approval case and submitted to expert sub-committee and then finally to Punjab seed council for approval.

Breeding History

The breeding history of elite clone S2003-US-127 is as under:

1.1	Name of variety	CPF 250
1.2	Clone number	S2003-US-127
1.3	Varieties compared	CPF 249, CPF 246, SPF 234 & HSF240
1.4	Areas of adaptation	Whole Punjab other than River belt
1.5	Parentage	CP 89-879 X CP 90-956
1.6	Variety Origin	Canal Point, USA.
1.7	Type of variety	Pure line
1.8	Days to maturity (range)	240 – 270 days
1.9	Maturity duration	Early maturing
1.10	Planting date	15th February to 15th March & whole month of September
1.11	Ratoonability	Good
1.12	Average cane yield	111.3 t ha^{-1}
2.1	Average Sugar Recovery	12.72 %
2.2	Average sugar yield	14.1 t ha^{-1}

Results and discussion

Agronomic Trials:

The test variety has good germination and tillering potential. It is tolerant to lodging and its tiller mortality is less. The said variety is early in maturity and maintains its quality throughout the season. The ratooning potential of the variety is very good. The test variety CPF 250 exhibited better no. of canes per unit area and cane weight than standard varieties HSF 240 & CPF 246 (Table 1). These results are in line with the results of Afghan et al., 2013.

Table 1: Performance of CPF 250 in comparison with HSF 240 and CPF 246

Variety	Germination (%)	Tillers/plant	Millable Canes (000 ha^{-1})	Per cane weight (kg)
CPF 250	40.2	1.72	122.9	0.90
HSF 240	42.8	2.24	126.8	0.77
CPF 246	37.3	1.52	73.9	0.92

Adaptability / Zonal trials

a) Performance CPF 250 at SRI, Faisalabad

The cane yield performance of candidate sugarcane variety CPF 250 in comparison with standard variety HSF 240 from 2008 to 2012 is given in Table 2. The data showed that the test variety CPF 250 gave 13% more stripped cane yield than standard variety HSF 240. Whereas, it showed 5.93% more sugar recovery than HSF-240. Similar results were reported by Afghan et al., 2013.

Table 2: Performance of CPF 250 at Sugarcane Research Institute (SRI), Faisalabad

Year	CPF 250		Check variety HSF 240		Percent increase/ decrease over check	
	Cane yield (t/ha)	S. Rec. (%)	Cane yield (t/ha)	S. Rec. (%)	Cane yield (%)	S. Rec. (%)
2008-09	149.6	12.89	129.9	12.42	15.1	3.78
2009-10	98.0	12.94	90.7	12.08	8.07	7.12
2010-11	101.9	13.39	88.1	12.80	15.6	4.61
2011-12	92.7	13.62	82.6	12.60	12.2	8.09
Avg.	**110.6**	**13.21**	**97.8**	**12.47**	**13.0**	**5.93**

b) Performance of CPF 250 at Sugarcane Research Station (SRS), Khanpur

The variety was tested with standard varieties SPF 234 and CPF 246 for four years at Sugarcane Research Station (SRS), Khanpur (Table 3). The data revealed that the candidate variety CPF 250 gave 1.46% more stripped cane yield and 6.03% more sugar recovery than the standard varieties SPF 234/CPF 246. These results are in line with the results of Ahmad et al., 2011.

Table 3: Performance of CPF 250 at SRS, Khanpur

Year	CPF 250		Check varieties SPF 234 / CPF 246		Percent increase/ decrease over check	
	Cane yield (t/ha)	S. Rec. (%)	Cane yield (t/ha)	S. Rec. (%)	Cane yield (%)	S. Rec. (%)
2009-10	102.3	11.97	101.5	11.48	0.83	4.27
2010-11	120.9	12.86	117.8	11.11	2.67	15.7
2011-12	101.3	12.12	102.3	12.04	-0.99	0.66
2012-13	106.4	12.12	103.1	11.65	3.14	4.03
Avg.	**107.7**	**12.27**	**106.2**	**11.57**	**1.46**	**6.03**

c) Zonal Trials at farmers' fields

The out-field trials were conducted at 29 locations of Punjab province during three years from 2017 to 2019. The progressive farmers were selected randomly for zonal trials of candidate variety against check HSF-240 and CPF- 249. These trials are very important to conduct in various locations of the province, minimizing the chance of failure of the variety in a region. The candidate variety CPF 250 exhibited 9.70 & 7.0% higher cane yield than check varieties CPF 249 & HSF 240 (Table 4). In addition, it showed 6.20 & 11.4% more sugar recovery against standard varieties. These results are in line with the results of Afghan et al., 2013.

Table 4: Performance of CPF 250 in Zonal field trials at 29 Locations of Punjab

Year	No. of sites	CPF 250		Check Varieties				Percent increase/ decrease over CPF 249		Percent increase/ decrease over HSF 240	
				CPF 249		HSF 240					
		Cane yield	S. Rec.	Cane yield	S. Rec.	Cane yield	S. Rec.	Cane yield	S. Rec.	Cane yield	S. Rec.
		(t ha^{-1})	(%)	(t ha^{-1})	(%)	(t ha^{-1})	(%)	(%)	(%)	(%)	(%)
2016-17	9	116.0	12.8	102.7	11.8	109.3	11.5	13.0	9.00	6.10	11.5
2017-18	11	121.2	12.5	104.5	11.4	104.5	11.2	15.9	9.30	15.9	11.3
2018-19	9	110.0	12.7	109.3	12.6	110.6	11.4	0.60	0.80	-0.50	11.4
Avg.		**115.7**	**12.7**	**105.5**	**11.9**	**108.1**	**11.4**	**9.70**	**6.20**	**7.00**	**11.4**

d) **Performance of CPF 250 in National Uniform Yield Trial**

The performance of candidate variety was also tested in national uniform sugarcane yield trial (NUSYT) and was evaluated at 13 locations during 2016-17 and 2017-18 and results are given in table 5. The results showed that CPF-250 produced 25.35 % and 9.93 % higher cane yield and sugar recovery over check variety. These results are in line with the findings of Ahmad et al., 2011.

Table 5: Performance of CPF 250 in NUSYT at 13 Locations

Sr.	Year	Locations	CPF 250		Check variety(s)		Percent increase/ decrease over check	
			Cane yield (t ha^{-1})	S. Rec. (%)	Cane yield (t ha^{-1})	S. Rec. (%)	Cane yield (%)	S. Rec. (%)
1	2016-17	06	118.92	12.32	90.22	10.93	32.68	13.19
1	2017-18	07	112.84	12.67	96.46	11.93	18.39	6.67
Avg.			**115.88**	**12.49**	93.34	11.43	25.53	9.93

Economic benefits

The study of economics of coming variety is of the importance because farmers see the economic benefits before adopting the new variety. The economic data showed that on an average CPF 250 produced 1.75 t ha^{-1} more sugar yield than standard variety HSF 240, CPF 249, SPF 234 and CPF 246. On an average, CPF-250 gave an additional benefit of Rs. 105000 over standard varieties HSF 240, CPF 249, SPF 234 and CPF 246 (Table 6). These results are in line with the results of Afghan et al., 2013.

Table 6: Economic benefits of CPF 250 over Reference Varieties

Locations	Variety	Cane yield (t ha^{-1})	S. Rec. (%)	Sugar Cane yield (t ha^{-1})	Difference (t ha^{-1})	Increased over local checks (Rs. ha^{-1})
SRI, Faisalabad, SRS, Khan Pur and 29 zonal / out field trials	CPF 250	111.3	12.72	14.15	-	-
	HSF 240, CPF 249, SPF 234, CPF 246	104.9	11.8	12.4	1.75	105000

Sugar @ Rs. 60000/t

Ratooning ability

Sugarcane growers prefer the variety giving more ratoons. Ratooning ability of candidate variety CPF 250 was studied at SRI, Faisalabad (table 7). It was depicted from the data mentioned below that in ratoon crop, candidate variety produced 6 t/ha more cane yield over HSF-240 and these results are in line with the results of Afghan et al., 2013 and Ahmad et al., 2011.

Table 7: Ratooning ability of CPF 250 (2009-10)

Cane yield (t/ha)		Difference (t/ha) with HSF 240	Percent variation over HSF 240
CPF 250	HSF 240		
95.0	89.0	6.0	6.7

Disease reaction

The disease reaction was started to check from third stage of nursery in varietal development programme and continues to final selection stage. The candidate variety is resistant to diseases in sugarcane growing areas of Punjab other than river belt (Table 8). In four years as mentioned in table, reaction of candidate variety against red rot and mosaic is mild resistant and against other diseases it is resistant. These results are in line with the results of Afghan et al., 2013.

Table 8: Reaction against different diseases in CPF 250

Year	Variety	Reaction to diseases					
		Red rot	Whip Smut	Pokkah Boeng	Red stripe	Rust	Mosaic virus
2015-16	CPF 250	MR	R	R	R	R	MR
2016-17	CPF 250	MR	R	R	R	R	MR
2017-18	CPF 250	MR	R	R	R	R	MR
2018-19	CPF 250	MR	R	R	R	R	MR

Grading scale for red rot disease (0-9) 0: I (Immune), 1:HR, 2: R, 3-4: MR, 5-6: MS, 7-8: S, 9: HS: Whip smut/ Red stripe:0-5%: R, 5.1-15%: MR, 15.1-30%: MS, Above 30%: S: Rust 1 R, 2 MR, 3 MS, 4 S: Mosaic 0.1-2.5% HR, 2.6-5 R, 5.1-10 MR, 10.1-20 MR, 20.1-35 MS, 35.1-50 S, 50.1-75 HS, 75.1-100 HS

Borer infestation

The candidate variety CPF 250 is resistant to all the borers on dead heart and cumulative internode damage basis under field conditions (Table 9). These results are in line with the results of Ahmad et al., 2011.

Table 9: Borer infestation of CPF 250 and HSF 240

Year	CPF 250		HSF 240	
	Dead heart (%)	Cumulative internode damage (%)	Dead heart (%)	Cumulative internode damage (%)
2014-2015	0.31	7.19	5.06	8.47
2015-2016	5.2	7.3	4.01	5.95
2016-2017	5.7	7.4	3.76	6.72
2017-2018	6.4	8.6	5.88	7.45
Avg.	**3.24**	**8.48**	**4.73**	**7.05**
Reaction	**R**	**R**	**R**	**R**

Criteria for Resistance: 1-10: R, 10.1-20: MR, 20.1-30: MS, 30.1-40: S, Above 40: HS

Conclusion

The candidate variety CPF-250 was tested in preliminary and semi-final trials and then in semi-final and final varietal trials for 4 years from 2008-09 to 2011-12. It is an early maturing variety with high tonnage and more recovery as compared with medium maturing variety HSF 240. It is a disease and insect resistant variety and will prove to be a good substitute of SPF 234 and HSF 240. CPF-250 gave higher economic index of Rs. 105000 over standards.

Recommendations:

CPF-250 is recommended for general cultivation for the growers in sugarcane areas other than river belt of Punjab Province.

Conflict of Interest:

There is no conflict of Interest among authors.

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