

PERFORMANCE OF NEW PROMISING SUGARCANE VARIETY YT-55 UNDER DIFFERENT AGRO-CLIMATIC CONDITIONS OF PAKISTAN

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ABSTRACT

In Pakistan commercial sugarcane gene pool is scanty. Hence seven sugarcane germplasm lines including YT-55 were acquired from China in 2009-10. After quarantine and evaluation in different areas of Sindh, Punjab and KPK the variety YT-55 (product of YN73-204×CP72-1210) was selected as worth for introduction. On an average, it had cane yield of 112.35 ton ha⁻¹. This value is 13.22% more than the standard check varieties (Thatta-10, CPF-246, CPF-247, HSF-240, SPF-234 and/or CP-77/400). It had sugar recovery 11.01% and sugar yield 12.23 ton ha⁻¹ which was 6.88 and 19.67% higher than the standard check varieties, respectively. Hence it showed a net income of Rs. 59,040/- per hectare with the boosting of cane yield over check varieties. The variety also showed resistant traits against major diseases of sugarcane (whip smut, red rot, Pokkah boeing and mosaic diseases) as well as sugarcane borers complex. It was found to have distinct characters of intermediate in growth habit with medium-thin canes, no splits, cylindrical shaped internodes, mid season cane maturity and high tillering capability. Its commercial cultivation in the country can benefit farmers, millers and the country in maximizing cane yield and sugar production.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is an important cash crop of Pakistan and occupies important position in cane producing countries of the world. With respect to its cultivated area (1.15 million hectare) and cane production (63.2 million tons), Pakistan ranks 5th in cane growing countries of the world (PSMA, 2015). However, our cane yield (54.96 ton ha⁻¹) are one of the lowest among leading cane growing countries like Egypt 114 ton ha⁻¹, Australia 82 ton ha⁻¹, USA 76 ton ha⁻¹, Brazil 75 ton ha⁻¹, China 71 ton ha⁻¹ and India 67 ton ha⁻¹ (FAO, 2015). Our sugar factories have hardly achieved sugar recoveries of 10.12 % as

against 13.5% in Australia, 11.0% in Mauritius and 12.0% in China. In other words we are getting 5.56 ton sugar ha⁻¹ as against 10-12 ton in leading cane growing countries. It is established fact that sugarcane varieties play distinct role in enhancing cane yield at farmers' fields and sugar recovery at mills. The cultural operations just provide a suitable environment to trigger the inherent potential of cane varieties for better production. In Pakistan the varieties like HSF-240, Th-10, CPF-237, CP-77-400, SPF-234, CPF-247, CPF-246 and few others are under commercial cultivation (Majid, 2007). However, a number of varieties like SPF-234, HSF-240 and many others are

losing their potential due to admixture and/or susceptibility to a-biotic and biotic stresses like diseases, frost, insects etc. It necessitated releasing new varieties of better potential with respect to yield, sugar contents and resistance against such stresses. Pakistan is lacking its proper sugarcane breeding program to produce desirable varieties hence have to depend the exotic material. The objective of this work was to identify the best sugarcane varieties out of sugarcane germplasm lines (RoC-1, RoC-16, RoC-20, RoC-22, YT-55, YT-53, YT-236) acquired from China for our agro-climatic conditions.

MATERIALS AND METHODS

Seven germplasm lines (RoC-01, RoC-16, RoC-20, RoC-22, YT-53, YT-55 (YT-55) and YT-236) were acquired from China in 2009-10. These lines along with a check Thatta-10 were tested initially at NSTHRI and Qadir Bux Jamali Farms, district Thatta. The seed rate was kept as 80,000 DBS ha⁻¹. Proper cultural practices and fertilizers dosage (250:125:150 kg ha⁻¹ N: P₂O₅: K₂O in the form of urea, DAP and SOP) were followed. Then in the next year the trials were conducted at four locations viz NSTHRI farm, Qadir Bux Jamali Farm Jhirk Site, Sarfarz Nizamani Farm Jhirksite and Agha Humayon Farm, Thatta, district Thatta following the similar methodologies. From these trials three prominent lines (YT-53, YT-55 and YT-236) were selected out of Chinese germplasm and were tested in National Uniform Yield trials and different sugar mills trials along with check varieties. Yield and quality data of each location was recorded. Sugarcane quality data was recorded in the Labs of different sugar mills and research Institutes. For this purpose brix% juice, Pol % juice and fiber % cane of healthy canes was determined. Then sugar recovery was calculated following CCS (Commercial Cane Sugar) formula (King, 1965) in different research institutes and SJM (Sugar-Juice-Molasses) formula (Wright *et al.* 2007) in sugar mills.

RESULTS AND DISCUSSION

Performance of YT-55 (2011-12) in Thatta District

At NSTHRI Farm, Thatta germination was recorded as maximum for YT-55 (59.8%), followed by 54.5 % in YT-236 and 51.2% in YT- 53 on 70 days after planting (Table 1). The canes of Th-10 variety attained the maximum height of 252.2 cm followed by YT-53 (246.7 cm) and YT-55 (241.1 cm). Number of millable canes (126.67 '000' ha⁻¹) and cane yield (120.0 ton ha⁻¹) were recorded as maximum for YT-55. Cane yield and number of canes of each of YT-53 and Th-10 remained almost similar (115.0 ton ha⁻¹ and 116.67 '000' ha⁻¹). At Farmers Fields, germination (61.5±2.0%), cane height (246.8±18.6 cm), cane girth (28.69±0.28 mm), number of millable canes (128.89 ± 11.10) and cane yield (131.53± 17.43 ton ha⁻¹) were maximum for variety YT-55 followed by YT-53 and check Th-10. The data in Table 1 also showed that among prominent Chinese lines (YT-53, YT-236, YT-55), the line YT-55 (YT-55) exhibited best performance in terms sugar recovery (12.03 %) and sugar yield (14.44 ton ha⁻¹) at NSTHRI Farm followed by YT-53 (11.67%, 13.42 ton ha⁻¹) and Th- 10 (11.65%, 13.40 ton ha⁻¹) at this site. At farmers' fields, the sugar recovery of YT-55 (12.04 ± 0.35%) followed by YT-53 (11.92 ± 0.32%) and Th-10 (11.69±0.26%). YT-55 had sugar yield of 16.81±1.86 ton ha⁻¹ while check variety

Th-10 had brix sugar yield of 14.51 ± 1.95 ton ha⁻¹.

Regional Performance of YT-55 During 2012-15

a) Performance of YT-55 in different Research Institutes trials

During 2012-14, YT-55 was tested at four locations viz. 1) Sugarcane Research Institute (SRI), AARI, Faisalabad, 2) National sugar & Tropical Horticulture Research Institute (NSTHRI), Thatta, 3) Sugar Crops Research Program (SCRIP), National Agri. Research Center, Islamabad and 4) Shakkarganj Sugar Research Institute, SML, Jhang. In these trials Table 2 reveals that YT-55 had germination (58.41%), tillers (2.4 per plant), millable canes (101.9 '000' ha⁻¹) as well as cane yield (108.5 ton ha⁻¹). Other following varieties were for cane yield were BPTH-804 (104.4 ton ha⁻¹) and CSSG-33 (103.7 ton ha⁻¹). These values were more than other sugarcane varieties including standard check varieties. Cane yield of sugarcane variety YT- 55 was 13.1 ton ha⁻¹ higher than the standard varieties. In case of sugar recovery, it was 12.60% for YT-55 while those of standard varieties it was 12.33%. The sugar yield of YT-55 was 13.76 ton ha⁻¹ and check varieties was 11.69 ton ha⁻¹.

b) Performance of YT-55 in sugar mills trials (2014-15)

In Fatima Sugar Mills, Muzaffargarh, YT-55

produced 133.0 ton ha⁻¹ sugarcane with juice purity of 84.73%, sugar recovery 11.04% and sugar yield of 14.68 ton ha⁻¹ (Table 3). The check variety HSF-240 had much less cane yield (92.0 ton ha⁻¹), sugar recovery (10.11%) and sugar yield (9.30 ton ha⁻¹). In Noon Sugar Mills, Bhalwal, Sargodha, YT-55 produced 90.0 ton ha⁻¹ sugarcane with juice purity of 88.8%, sugar recovery 8.43% and sugar yield of 7.59 ton ha⁻¹. The check variety CPF-247 had less sugar recovery of 8.01% at that time. In Ashraf Sugar Mills, Bahawalpur, YT-55 attained juice purity of 88.1% and sugar recovery of 9.63%, whereas the check variety SPF-234 had less juice purity (87.17) and sugar recovery (8.38%) at the time of analysis. In Al-Moiz Sugar Mills, Dera Ismail Khan (D.I. Khan), the plant crop of candidate variety YT-55 produced 85.3 ton ha⁻¹ sugarcane with juice purity of 87.2%, sugar recovery 10.06% and sugar yield of 8.58 ton ha⁻¹ (Table 3). The ratoon crop of YT-55 produced 98.8 ton ha⁻¹ sugarcane with juice purity of 86.6%, sugar recovery 10.58% and sugar yield of 10.45 ton ha⁻¹.

However, the check varieties CPF-246 and CPF-247 had much less cane yield (70.4 & 78.9 ton ha⁻¹) and sugar yield (7.25 & 7.44 ton ha⁻¹). The juice purity and sugar recovery of CPF-246 were relatively more (88.25 & 10.30 %) than the juice purity and sugar recovery of plant crop of YT-55 whereas CPF-

247 had less sugar recovery (9.43%) in both the cases. In Faran Sugar Mills, Tando Muhammad Khan, YT-55 had 58% germination and produced 106.3 ton ha⁻¹ sugarcane with sugar recovery of 10.33% and sugar yield of 10.98 ton ha⁻¹ (Table 4).

The germination of three comparable/check varieties (Th-2109, Th -326 (newly approved by Sindh Seed Council) and CPF-237 was less than the candidate line YT-55. The variety Th-326 also had less cane and sugar yield while Th-2109 had less sugar recovery than YT-55. The other check variety CPF-237 had relatively more cane yield as well as sugar recovery than YT-55. In Mehran Sugar Mills, Tando Allahyar, YT- 55 had 72.4% germination and sugar recovery of 10.15% (Table 4). The germination of all the three comparable/check varieties (Th-2109, Th-326 and CPF-247) was less than YT-55. However Th-326 and CPF-246 had less sugar recovery while Th-2109 had only a little more sugar recovery over YT-55. In Army Welfare Sugar Mills, Badin, sugar recovery of YT-55 was 8.74% that was much more than the sugar recovery (7.60%) of standard check variety HSF- 240 (Table 4). At this location only YT-53 and NIA-2012 had more sugar recovery than YT-55. Similarly in Sindh Abadgar Sugar Mills, Tando Muhammad Khan, sugar recovery of YT-55 was 7.08% that was much more than the standard check varieties CPF-246 (7.02%),

Th-326 (5.43%) and Th-2109 (5.00%). The check variety CPF-237 had only a little higher sugar recovery (7.37%) than YT-55. However, these data were recorded at early stage of crop maturity.

Comparison of YT-55 with check varieties

Overall, 25 trials were conducted to evaluate YT-55 at different locations of Pakistan during 2009 to 2016. Summarizing the results of these trials it was found that sugarcane yield of YT-55 decreased only at two locations as compared to checks/commercial varieties (Table 5). This decrease in cane yield was 3.0% in the ratoon at Qadir Bux Jamali Farm, Jhirksite, Thatta against Th -10 check variety and 16.0% in the plant crop at Faran Sugar Mills Farm, Tando Muhammad Khan against CPF-237 commercial/check variety.

At rest of the locations cane yield of YT-55 increased and ranged from 0.5 to 48.2% with an average increase of 13.1% over the standard check/commercial varieties. Regarding sugar yield, it decreased against checks commercial varieties only at one location (Table 5). It was 16.6% in the plant crop at Faran Sugar Mills Farm, Tando Muhammad Khan against CPF-237 commercial/check variety. At all the other locations sugar yield of YT-55 increased from 1.4 to 57.9 % with an average increase of 15.0% over the standard check/commercial varieties.

Sugar recovery data of YT-55 was recorded at 24 locations and against 34 commercial/check varieties (1-4 checks at one location) either by CCS formula at the research institutes or SJM formula at sugar mills (Table 6). Accordingly sugar recovery of YT-55 increased against 24 check/commercial varieties.

The increase in sugar recovery of YT-55 was 0.4 to 30.9% at different locations. Sugar recovery was found to decrease at 7 locations against 1 or 2 checks while against other checks the sugar recovery of YT-55

remained higher even at the same site. The decrease in sugar recovery of YT-55 was 0.1 to 14.9% at these sites.

Periodic sugar contents (CCS or recovery) of YT-55

The CCS% or sugar recovery values of YT-55 increased with time at all the locations (Fig. 1). At NSTHRI, Thatta, the CCS value increased from 12.73 to 14.26% from October, 2015 to January 2016. The CCS in YT-55 was similar to Th-10 in October. CCS in YT-55 exceeded onward from November 2015 to January 2016 over Th-10.

Sugar recovery of YT-55 also increased with time at Mehran Sugar mills, Tando Allahyar, Sindh (Fig. 1). Sugar recovery of YT-55 remained slighter or similar to the check varieties (Th-2109, Th-326 & CPF-246) in September and October, 2015. In November to February it went almost higher than these check varieties. At Al-Abbas Sugar Mills, Mirpur Khas Sindh, sugar recovery of YT-55 increased from September to October and was more than

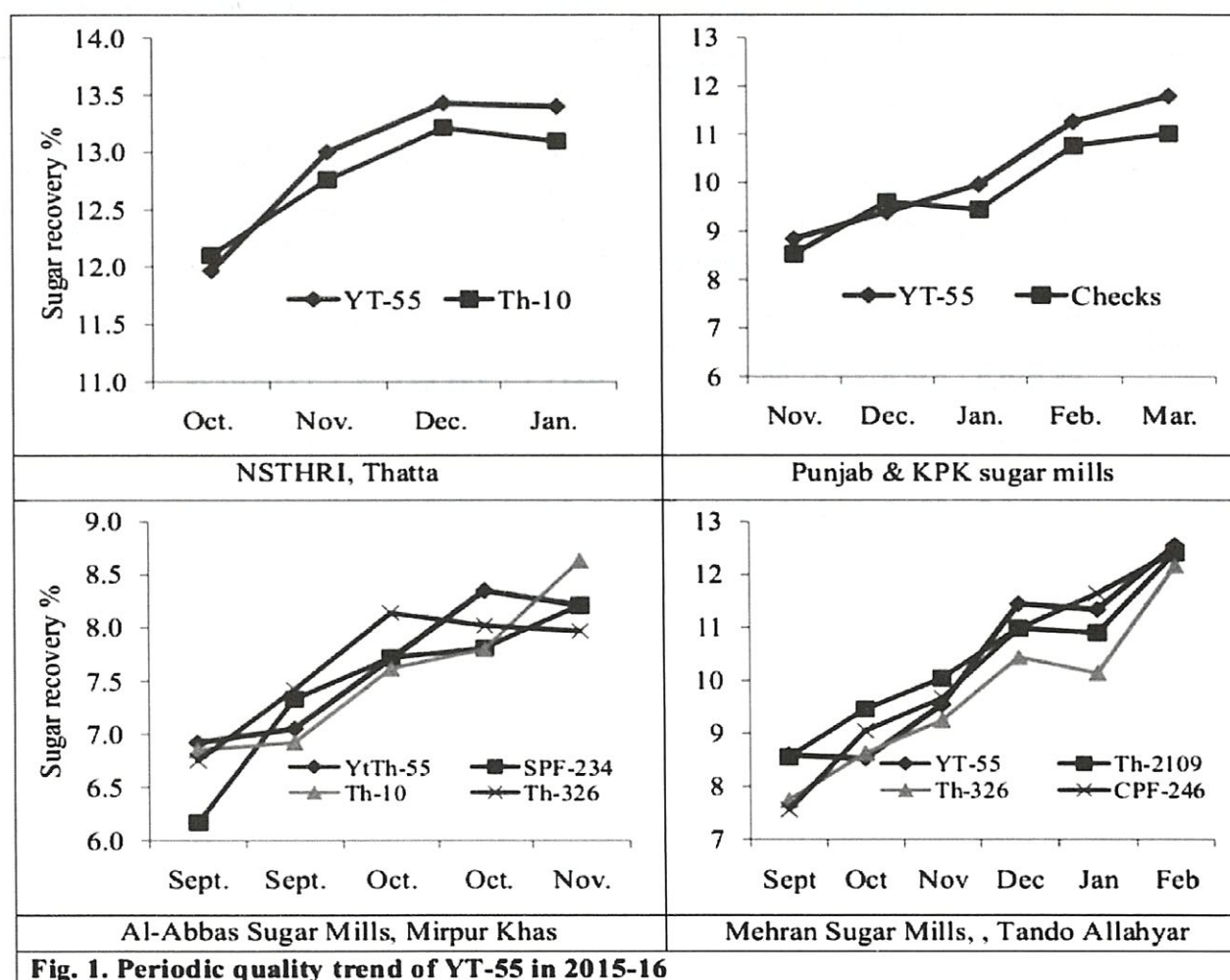


Fig. 1. Periodic quality trend of YT-55 in 2015-16

SPF-234 and Th-10 while comparable to Th-326 checks.

In Punjab & KPK sugar mills sugar recovery of YT-55 remained almost higher than the standard varieties (HSF-

Economics of candidate variety YT-55

The economic comparison of YT-55 with candidate varieties in Table 7 was made on the basis of overall average results of YT-55 and standard check varieties used

240, CPF-246, CPF-247, CPF-248, SPF-234) grown for comparison in Punjab and KPK provinces (Fig 1). Moreover, the difference of YT-55 over check varieties increased with the passage of

all over the trials conducted in the form of preliminary, NUYT, zonals / sugar mills' trials. It indicated that additional benefit of Rs. 59,040/- ha⁻¹ was for cane yield, Rs. 38,749/- ha⁻¹ for sugar recovery and Rs. 1,10,750/- went to the additional sugar

time for sugar recovery. Hence it is better to say that in order to get maximum advantage of this variety it could be harvested in mid season i.e. after mid of November each year.

produced from the candidate variety YT-55. This overall benefit was due to an increase in per hectare cane yield of 13.22%, sugar recovery of 6.88% and sugar yield of 19.67% over the cumulative average of check varieties.

Table-1 Performance of YT-55 at different locations of Thatta in 2011-12

Variety	Germination %	Cane height cm	Cane girth mm	Millable cane '000' ha ⁻¹	Cane yield ton ha ⁻¹	Sugar Recovery %	Sugar yield ton ha ⁻¹
NSTHRI-Farm							
YT-53	51.2	246.7	27.5	116.7	115.0	11.67	13.42
YT-55	59.8	241.1	28.2	126.7	120.0	12.03	14.44
YT-236	54.5	224.4	25.9	98.3	93.3	10.88	10.15
Th-10	49.7	252.2	27.2	116.7	115.0	11.65	13.40
Farmers fields							
YT-53	51.9±7.2	243.9±27.6	28.2±0.6	127.2±15.1	130.7±21.9	11.92±0.32	16.53±2.45
YT-55	61.5±2.0	246.8±18.6	28.7±0.3	128.9±11.1	131.5±17.4	12.04±0.35	16.81±1.86
YT-236	51.3±2.0	212.2±13.2	25.7±1.2	125.0±8.3	113.2±14.6	11.13±0.55	13.36±1.13
Th-10 (Ch)	51.8±2.5	229.9±21.8	27.2±0.7	117.2±8.2	116.7±16.1	11.69±0.26	14.51±1.95
A: Qadir Bux Jamali Farm; B: Sarfarz Nizamani Agriculture Farm Jhirksite, District Thatta; C: Agha Hamayoon Agriculture Farm Jhirksite, Thatta (2011-12) plant crop							

Table-2 Performance of YT-55 in Research Institutes during 2012-14 (Av. 7 trials)

Variety	Germination %	No. of Tillers Plant ⁻¹	No. of Canes '000' ha ⁻¹	Cane yield ton ha ⁻¹	Sugar Rec. %	Sugar Yield ton ha ⁻¹
CPSG-24	41.7±5.9	1.52±0.29	88.6±5.4	87.3±4.6	10.10±0.77	9.00±1.00
SPSG-27	50.8±5.2	2.08±0.06	100.4±5.9	94.3±12.5	10.92±0.67	10.75±1.98
SPSG-29	43.6±2.5	1.70±0.08	83.4±8.0	84.9±10.9	12.68±0.73	11.07±1.78
HoSG-31	45.4±5.8	1.71±0.14	84.5±3.9	82.7±5.2	11.37±0.72	9.58±0.95
CSSG-32	50.2±3.4	2.09±0.10	100.9±3.0	100.8±11.7	11.65±0.91	12.15±1.87
CSSG-33	49.6±4.8	1.95±0.03	97.2±7.7	103.7±10.2	13.15±0.52	13.72±1.73
BPTH-804	54.1±4.3	2.07±0.45	100.4±5.1	104.4±7.6	11.95±0.32	12.59±1.03
YT-55	58.6±4.1	2.44±0.52	101.9±5.9	108.5±7.1	12.60±0.24	13.76±0.92
Check (Th-10, CPF-247, HSF-240, CPF-237)	44.1±0.1	2.18±0.26	100.3±7.2	95.4±7.5	12.33±0.19	11.69±1.01

Table-3 Performance of YT-55 at sugar mills of Punjab and KPK (2014-15)

Sugar mill	Date of analysis	Variety	Yield	Recovery	Sugar yield
			ton ha ⁻¹	%	ton ha ⁻¹
Fatima Sugar Mills, Muzaffar Garh	Average	YT-55	133.0	11.04	14.68
		HSF-240	92.0	10.11	9.30
Noon Sugar Mills Bhalwal, Sargodha	31/1/16	YT-55	90.0	8.43	7.59
		CPF-248	--	8.01	--
		NSG-59	--	8.45	--
Ashraf Sugar Mills, Bahawalpur	28/10/15	YT-55	--	9.63	--
		SPF-234	--	8.38	--
Al-Moiz Sugar Mills, D.I. Khan	16/1/16	YT-55Plant	85.3	10.06	8.58
		CPF-246	70.4	10.30	7.25
		CPF-247	78.9	9.43	7.44
		YT-55ratoon	98.8	10.58	10.45

Table-4 Performance of YT-55 in Sugar Mills of Sindh

Sugar Mill	Variety	Cane yield ton ha ⁻¹	Recovery %	Sugar yield ton ha ⁻¹
Faran SM, Tando M. Khan	YT-55	106.3	10.33	10.98
	Th-2109	137.6	9.99	13.75
	Th-326	99.6	10.60	10.56
	CPF-237	126.5	10.41	13.17
Mehran SM, Tando Allahyar	YT-55		10.15	
	Th-2109		10.30	
	Th-326		9.61	
	CPF-246		10.09	
Army Welfare SM, Badin 28/10/2015	YT-55		8.74	
	HSF-240		7.60	
Sindh Abadgar, TMK 16/11/15	YT-55		7.08	
	CPF-237		7.37	
	CPF-246		7.02	
	Th-326		5.43	
	Th-2109		7.00	

Table-5 Comparison of cane and sugar yield of YT-55 with check varieties

Sr. No.	Check variety	No. of Locations / trials	Cane yield (ton ha ⁻¹)			Sugar yield (ton ha ⁻¹)		
			YT-55	Check	+/-	YT-55	Check	+/-
1	Th-10	8	119.3±5.5	109.8±4.3	+9.5	14.11±0.77	12.49±0.60	+1.62
		1	106.7	110.0	-3.3	13.22	13.04	+1.4
2	CPF-247	4	107.6±12.2	98.1±14.4	+9.5	13.07±1.74	11.77±2.17	+1.30
3	CPF-237	2	103.4±10.6	76.2±11.5	+27.1	13.29±0.82	11.23±1.41	+2.05
		1 (Faran SM)	106.3	126.5	-20.2	10.98	13.17	-2.19
4	HSF-240	2	123.5±9.5	95.8±3.8	+27.7	14.39±0.29	9.87±0.57	+4.52
5	CPF-246 CP-77-400 Th-326	1 each	94.8±6.1	77.5±11.3	+17.3	10.68±1.13	9.10±0.98	+1.57
Cumulative		21		+	19	+		20
				-	2	-		1

Table-6 Comparison of YT-55 for sugar recovery with check varieties

Sr. No.	Check variety	No. of trials	Sugar recovery (%)			Location/Sugar mill
			YT-55	Check	+/-	
1	Th-10	10	11.45±0.47	11.02±0.41	+0.42	Thatta district, Al-Abbass SM
2	HSF-240	03	10.72±1.06	9.40±0.91	+1.32	NARC, Fatima SM, Army W. SM
3	SPF-234	02	8.64±0.99	7.92±0.47	+0.73	Al-Abbass SM, Ashraf SM
4	CPF-248	01	8.43	8.01	+0.42	Noon SM
5	Th-326	02	8.62±1.54	7.52±2.09	+1.10	Mehran SM, Sindh Abadgar SM
		02	8.99±1.34	9.13±1.47	-0.14	Faran SM, Al-Abbass SM
		03	9.27±1.10	9.14±1.06	+0.13	Mehran SM, Sindh Abadgar SM, Al-Moiz SM (Ratoon)
6	CPF-246	01	10.06	10.30	-0.24	Al-Moiz SM
		04	12.09±1.02	11.83±1.20	+0.26	SRI- Fsd, SSRI- Jhang, Al-Moiz SM
7	CPF-247	01	11.74	11.97	-0.23	SRI- Fsd
		01	7.08	7	+0.08	Sindh Abadgar SM
8	Th-2109	01	10.15	10.30	-0.15	Mehran SM
		04	10.8±1.4	11.8±1.8	-1.03	NARC, Faran SM, Sindh Abadgar SM
9	CPF-237	01	13.46	15.2	-1.74	NARC Islamabad
10	CP-77-400	36		+		26
				-		10

Table-7 Economics of candidate variety YT-55

Parameter	Cane yield ton ha ⁻¹	Recovery %	Sugar yield ton ha ⁻¹
YT-55	112.35±18.17	11.01±1.77	12.23±2.66
Check varieties (across the country)	99.23±21.02	10.30±2.40	10.22±2.48
Increase in YT-55 over check	13.12	0.71	2.01
Profit (Rs ha ⁻¹)	59,040	38,749	110,550

Cane price = Rs. 180 per 40 kg; Sugar price = Rs. 55 per kg; Average of 25 locations

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