

SWEET SORGHUM BREEDING – 2016-17

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Executive summary

Trial 1: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Kharif 2016

- Eighteen IASSVHT trial entries comprising eight varieties, seven hybrids along with 3 checks (CSV 24SS, CSV 19SS & CSH 22 SS) were evaluated at 12 locations during Kharif 2016.
- SPV 2460, SPV 2459 and SPV 2462 among varieties were significantly early (8-12%) compared to the check CSV 24SS while hybrids SPH 1862 and SPH 1861 had a significant superiority (>5%) over CSH 22SS.
- For total biomass and fresh stalk yields, SPH 1798 had a superiority of 15% over CSH 22SS.

- With respect to brix content, SPV 2462, SPH 1858 and SPH 1861 recorded a numerical superiority of 5% over respective checks
- For juice yield, SPV 2324 and SPV 2462 exhibited a significant superiority of more than 30% over the check CSV 24SS. SPH 1825 and SPH 1859 were better for this trait.
- SPV 2462, SPV 2324 and SPH 1825 were promising for sugar yields and calculated ethanol yields.

Trial 2: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Rabi 2016-17

- SPV 2459, SPH 1861 and SPH 1862 were significant for early flowering
- For total biomass and fresh stalk yields, the entries SPV 2457 and SPV 2456 showed superiority over check. The hybrid SPH 1798 with a fresh stalk yield of 19.9 t/ha was 20% superior to the check hybrid CSH 22SS
- For juice brix, all varieties except SPV 2461 and SPV 2324 and SPH 1798 were promising.
- With respect to juice yields, the variety SPV 2457 and hybrid SPH 1861 were superior to respective checks.
- For total sugar yields and calculated ethanol yields, all varieties except SPV 2459, SPV 2324 and SPV 2461 and SPH 1798 were promising.

Trial 3: Identification of high biomass sorghums for lignocellulosic biofuel traits-Kharif 2016

- SPH 1798 and SPV 2402 were promising for total fresh biomass and dry biomass.

Detailed report

Trial 1: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Kharif 2016

Eighteen IASSVHT trial entries comprising eight varieties, seven hybrids along with 3 checks (CSV 24SS, CSV 19SS & CSH 22 SS) were evaluated at 12 locations during Kharif 2016. The data from Rahuri and Gulbarga was not considered for analysis as per the recommendations of the Kharif monitoring team. The promising entries for different traits are presented in Table 1.

Morpho-phenological traits

Days to 50% flowering varied from 75-93 days. The variety SPV 2460 (75 days) was the earliest to flower. Among the test hybrids SPH 1862 (76 days) followed by the hybrid SPH 1861 (78 days) had a significant superiority of more than 5% for early flowering compared to the check hybrid CSH 22SS. Among the varieties SPV 2459 (77 days) followed by SPV 2462 (79 days) were significantly early (8-9%) compared to the check CSV 24SS (85 days). Variation among locations revealed that average days to flowering was lower (70 days) at Coimbatore. Delayed flowering was experienced at Akola location (Mean - 95 days).

Days to maturity of test entries ranged from 116 to 127 days. The hybrids viz., SPH 1862, SPH 1861, SPH 1858 and SPH 1859 were earlier to mature compared to the check hybrid. Among the varieties SPV no's 2459, 2460, 2462, 2458 and 2324 were significantly early maturing compared to CSV 24SS.

Plant height varied from 268 cm (CSV 24SS) to 321 cm (SPH 1798) with a mean of 289 cm. Among the hybrids, SPH 1798 recorded a significant superiority of 13% over the check hybrid. Among varieties, SPV 2462 recorded significant superiority (8-13%) compared to the both the checks CSV 19SS and CSV 24SS. The other varieties with significant superiority over CSV 24SS were SPV 2457, SPV 2458 and SPV 2459.

Biomass traits

Total fresh biomass varied from 34.3 to 54 t/ha (mean of 44 t/ha). Among the hybrids, SPH 1798 had a significant superiority of 15% over the check CSH 22SS. None of the varieties had significant superiority over the

checks. However, SPV 2462 was 5% more yielding than CSV 24SS. Lowest mean biomass yields were reported from Surat while highest mean biomass yields were observed at Akola.

Fresh stalk yield ranged from 31.5 to 47.1 t/ha with a mean of 39.8 t/ha. SPH 1798 with a fresh stalk yield of 47.1 t/ha was 16% superior to the check hybrid CSH 22SS (40.5 t/ha). None of the varieties had a significant superiority over both the checks for this trait. However, SPV 2457 (8%) followed by SPV 2461 (6%) and SPV 2462 (6%) recorded marginal superiority over CSV 24SS.

Grain yield ranged from 1701 to 2539 kg/ha with a mean of 2155 kg/ha. The hybrid SPH 1825 was 13% numerically superior to CSH 22SS. Among the varieties, SPV 2457, SPV 2461, SPV 2324 and SPV 2456 recorded a numerical superiority of more than 10% over the check CSV 19SS.

Quality traits

Juice brix at physiological maturity varied between 14.9 and 17.2 % (mean of 16.0%). Among the hybrids SPH 1858 and SPH 1861 recorded a superiority of 5% over CSH 22SS while among test varieties, SPV 2462 recorded a superiority of 5% over CSV 24SS. Highest mean brix content (18.8%) was recorded at Parbhani.

Juice extraction ranged from 32.9 to 42.4% (mean of 37.6%). Among the test varieties, SPV 2324 (22%) and SPV 2461 (15%) recorded significant superiority over CSV 24SS. Among the hybrids, SPH 1825 exhibited a significant superiority of 12% over the check hybrid.

Juice yield ranged from 15393 L/ha to 21276 L/ha with a mean of 18518 L/ha. The varieties SPV 2324 with a juice yield of 21165 L/ha and SPV 2462 with a juice yield of 20189 L/ha were 38% and 31% significantly superior to the check CSV 24SS. The other varieties with numerical superiority of > 10% over CSV 24SS were SPV 2460, SPV 2458 and SPV 2459. Among the hybrids, SPH 1825 and SPH 1859 had a numerical superiority of > 10% over CSH 22SS.

Components of total sugars

Total soluble sugars (TSS) ranged from 12.9 to 14.6% with an average of 13.7%. SPV 2458 recorded the highest TSS (14.6%) and was 6% superior to the checks. Among hybrids, SPH 1861, SPH 1862 and SPH 1858 had a superiority of more than 5%. The range of **reducing sugars** was 1.3 to 2.1% while the range of **non-reducing sugars** was 9.2 to 12.6%. SPV 2458 was superior to both the check varieties while among the hybrids SPH 1862 was superior to the check.

Total sugar yields: Sugar yields ranged from 2.27 to 3.37 t/ha with a mean of 2.96 t/ha. Among the varieties, SPV 2462 recorded the highest total sugar yield of 3.37 t/ha followed by SPV 2324 (3.34 t/ha). Among the test hybrids, SPH 1825 recorded the highest total sugar yield of 3.24 t/ha.

Ethanol yield: Calculated bioethanol yields ranged from 1211 to 1793 L/ha with mean of 1578 L/ha. SPV 2462 among varieties recorded the highest computed ethanol content of 1793 L/ha followed by SPV 2324 which showed the ethanol yields of 1777 L/ha. These two varieties exhibited a numerical superiority of 7% and 6% over CSV 19SS and a significant superiority of 48% and 47% over CSV 24SS. All other varieties except SPV 2461 recorded a superiority of >15% over CSV 24SS. Among hybrids, SPH 1825 exhibited a superiority of 7% over the check for this trait.

Resistance to biotic stresses

Insects:

- Shoot fly resistance: The entries SPH 1861 and SPH 1862 were on par to the resistant check.
- Stem borer resistance: SPH 1861, SPV 2462 and SH1859 recorded low damage.

Diseases

- SPH 1798, SPH 1859 and SPV 2458 were promising for grain mold resistance.

Conclusions

- For total biomass and fresh stalk yields, SPH 1798 was superior to CSH 22SS
- SPV 2462 was promising for a range of characters like brix, juice yield, total sugar yields and calculated ethanol yields. It was also promising for stem borer tolerance.

Trial 2: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Rabi 2016-17

The genotypes which were tested during Kharif 2016 were tested again for their performance during rabi 2016-17 so as to identify genotypes with stable yields across kharif and rabi seasons. The trial was conducted at 4 locations viz., Parbhani, Rahuri, Phaltan and Hyderabad.

Morpho-phenological traits

Days to 50% flowering ranged from 83-100 days with a mean of 90 days. SPV 2459 was the earliest to flower with a flowering of 83 days and was 7% significantly superior to both the varietal checks (90 days). Among hybrids, SPH 1861 and SPH 1862 were early flowering with 83 and 85 days and a significant superiority of 12% and 10 % respectively over the check hybrid CSH 22SS (95 days). Flowering was early at Phaltan compared to the other locations. The range of flowering was similar to kharif.

Days to maturity of test entries differed across locations. The entries which flowered early were the first to mature in the trial and the trend was similar to days to flowering.

Plant height ranged from 187 cm (CSV 24SS) to 256 cm (SPV 2459) with a mean of 223 cm. The varieties viz., SPV No's 2459, 2458 and 2462 recorded a significant superiority ranging between 13-21% over the check CSV 19SS.

It was gratifying to note that SPV 2462 recorded consistent superiority for this trait over both the checks across kharif and rabi seasons.

Biomass traits

Total fresh biomass varied from 24.3 to 37.3 t/ha (mean of 33.4 t/ha). The test variety SPV 2457 recorded the highest fresh biomass yield of 37.3 t/ha and was 28% superior to the best check CSV 19SS (29.2 t/ha). The next best varieties were SPV 2458 (35.8 t/ha), SPV 2456 (35.1 t/ha). Among the hybrids, SPH 1798 recorded fresh biomass on par to the check hybrid. Among the hybrids, SPH 1798 performed consistently across seasons.

Fresh stalk yield ranged from 11.4 to 21.8 t/ha with a mean of 18.2 t/ha. Among the varieties SPV 2458 (21.8 t/ha) followed by SPV 2457 (20.5 t/ha) and SPV 2456 (20.3 t/ha) recorded higher yields compared to both the checks. The hybrid SPH 1798 with a fresh stalk yield of 19.9 t/ha was 20% superior to the check hybrid CSH 22SS. SPH 1798 and SPV 2457 performed consistently over kharif and rabi seasons.

Grain yield ranged from 237 kg/ha (SPV 2467) to 1847 kg/ha (SPH 1862 kg/ha) with a mean of 614 kg/ha. The range for grain yields was lower during rabi compared to kharif. None of the varieties were superior to CSV 24SS. However, The varieties SPV 2458 (773 kg/ha) and SPV 2462 (742 kg/ha) were superior to CSV 19SS. Among hybrids, SPH 1862 with a grain yield of 1847 kg/ha was 216% significantly superior to CSH 22SS (584 kg/ha).

Quality traits

Juice brix at physiological maturity varied between 10.4 and 14.7 % (mean of 12.3%). All varieties except SPV 2461 and SPV 2324 recorded superiority of 5% and more than the checks. Among hybrids, SPH 1798 with a brix content of 14.7% was significantly superior (30%) to the check CSH 22SS (11.3%). SPH 1861 and SPV 2462 performed consistently across seasons for this trait.

Juice yield ranged from 4352 L/ha to 8517 L/ha with a mean of 7042 L/ha. The variety SPV 2457 recorded the highest juice yield of 8517 L/ha and was superior to both the check varieties viz., CSV 19SS (6555 L/ha) and CSV 24SS (4740 L/ha) by 30% and 80% respectively. The other varieties which performed better than the best check CSV 19SS were SPV 2458 and SPV 2456. Among the hybrids, SPH 1861 had a superiority of 18% over CSV 24SS. The varieties SPV 2324, SPV 2462, SPV 2458, SPV 2459 and SPV 2460 exhibited consistent superiority over both the seasons w.r.t the check CSV 24SS.

Juice extraction ranged from 29% to 39% (mean of 35%). SPV 2460 and SPV 2461 recorded more than 10% superiority over CSV 19SS while among hybrids SPH 1861 had a superiority of 14% over the check hybrid.

Components of total sugars

Total soluble sugars (TSS) ranged from 9.26 to 12.98% with an average of 10.92%. The range of **reducing sugars** was 1.33 to 2.71% while the range of **non-reducing sugars** was 8.11 to 10.37%. SPH 1862 recorded the highest non-reducing sugar content of 10.37%.

Total sugar yields: Sugar yields ranged from 0.41 to 0.74 t/ha with a mean of 0.55 t/ha. The hybrid SPH 1798 recorded a superiority of 10% over the check hybrid. All varieties except SPV 2459, SPV 2324 and SPV 2461 recorded more than 15% superiority over both the checks.

Ethanol yield: Calculated bioethanol yields ranged from 217 to 392 L/ha with mean of 290 L/ha. The trend was similar to total sugar yield. The hybrid SPH 1798 recorded a superiority of 10% over the check hybrid. All varieties except SPV 2459, SPV 2324 and SPV 2461 recorded more than 15% superiority over both the checks. SPV Nos 2456, 2457, 2458, 2460 and 2462 were superior to CSV 24SS for this trait in both the seasons.

Over all conclusions:

- With respect to total fresh biomass, SPH 1798 performed consistently across seasons
- For fresh stalk yields, SPH 1798 and SPV 2457 were better in both the seasons.
- For juice yield, the varieties SPV 2324, SPV 2462, SPV 2458, SPV 2459 and SPV 2460 exhibited consistent superiority over both the seasons w.r.t the check CSV 24SS
- SPH 1861 and SPV 2462 performed consistently across seasons for high brix (%).
- SPV Nos 2456, 2457, 2458, 2460 and 2462 were superior to CSV 24SS for total sugar yields and computed ethanol yields during both kharif and rabi seasons

Follow-up for kharif 2017

- Based on the performance, the promising lines in initial trials will be advanced to advanced varietal and hybrid trials

Table 1: Promising initial and advanced sweet sorghum varieties and hybrids for stalk yield, biomass, sugar content and bioethanol yields, Kharif 2016

S. No	Trait	Mean	Min	Max	Range	C D (0.05)	Var. check CSV 24SS	Hyb. Check CSH22SS	Promising hybrids and varieties superior to checks
1	Time to 50% flowering (d)	82.0	75.0	93.0	18	5.1	85	84	Hybrids: SPH 1861 and SPH 1862 (7-10%) Varieties: SPV 2460, SPV 2459, SPV 2462 (8-12% for early flowering)
2	Time to maturity (d)	121	116	127	11	4.4	125	123	Varieties: SPV 2459, SPV 2460, SPV 2459, SPV 2462, SPV 2458 and SPV 2324
3	Plant height (cm)	289	268	321	53	18.1	268	283	Hybrids: SPH 1798 (13%) Varieties: SPV 2462, SPV 2457, SPV 2458 and SPV 2459.
4	Total fresh biomass (t ha ⁻¹)	44	34	54	20	6.7	42	47	Hybrids: SPH 1798 (15%) Varieties: SPV 2462 (5%)
5	Fresh stalk yield (t ha ⁻¹)	40	31	47	16	6.7	38	40	Hybrids: SPH 1798 (16%) Varieties: SPV 2457 (8%), SPV 2461

S. No	Trait	Mean	Min	Max	Range	C D (0.05)	Var. check CSV 24SS	Hyb. Check CSH22SS	Promising hybrids and varieties superior to checks
									(6%), SPV 2462 (6%)
6	Grain yield (Kg ha ⁻¹)	2155	1701	2539	838	601	2263	2244	Hybrids: SPH 1825 (13%) Varieties: SPV 2457, SPV 2461, SPV 2324, SPV 2456 (>10%).
7	Juice brix %	16.0	14.9	17.2	2.3	1.69	16.5	15.7	Hybrids: SPH 1858 and SPH 1861 (5%) Varieties: SPV 2462 (5%)
8	Juice extraction (%)	37.6	32.9	42.4	9.5	4.2	33.8	37.7	Hybrids: SPH 1825 (12%) Varieties: SPV 2324 (22%), SPV 2461 (15%).
9	Juice yield (L ha ⁻¹)	18518	15393	21276	5883	4634	15393	18051	Hybrids: SPH 1825, SPH 1859 (>10%) Varieties: SPV 2324 (38%) and SPV 2462 (31%)
10	Total soluble sugars (%)	13.67	12.95	14.6	1.65	1.3	13.82	13.41	Hybrids: SPH 1861, SPH 1862 and SPH 1858 Varieties: SPV 2458
11	Non-reducing sugars (Sucrose) (%)	10.03	9.25	12.60	3.35	2.17	10.85	11.17	Hybrids: SPH 1862 Varieties: SPV 2458
12	Total sugar yield (t ha ⁻¹)	2.96	2.27	3.37	1.1	0.94	2.27	3.03	Hybrids: SPH 1825 Varieties: SPV 2462, SPV 2324
13	Computed ethanol yield (L ha ⁻¹)	1577	1211	1793	582	500	1211	1615	Hybrids: SPH 1825 Varieties: SPV 2462, SPV 2324

NB: Values in the parentheses indicate the percent superiority over check.

Trial 3: Identification of high biomass sorghums for lignocellulosic biofuel traits-Kharif 2016

Eleven trial entries including CSH 13 and sweet sorghum check CSH 22SS were evaluated at 5 locations viz., Deesa, Parbhani, Phaltan, Rahuri, Ludhiana, Hyderabad and Surat during kharif 2016.

Morpho-phenological traits

Days to 50% flowering varied from 79-99 days with a mean of 87 days. The entry SPV 2467 with a days to flowering of 79 days was significantly early (11%) compared to the check CSH 22SS (89 days). The next promising entry for early flowering was SPV 2462 (80 days). At Ludhiana and Rahuri, the flowering was delayed while it was early at Deesa.

Days to maturity of test entries ranged from 117 (SPV 2467) to 129 days (SPV 2402). The trend was similar to days to flower.

Plant height varied from 250 cm (SPV 2464) to 334 cm (SPH 1798) with a mean of 278 cm. The mean plant height was more at Deesa followed by Hyderabad.

Biomass traits

Total fresh biomass differed across locations and it varied from 29 to 54 t/ha (mean of 40 t/ha). SPH 1798 recorded the highest biomass yields of 54 t/ha and was 16% superior to the check CSH 22SS (46 t/ha). SPV 2402 was another promising entry for biomass (50 t/ha) and had 8% superiority over the check. Lowest mean biomass yields were reported from Surat while highest mean biomass yields were observed at Ludhiana.

Dry biomass yield ranged from 20 to 34 t/ha with a mean of 26 t/ha. SPH 1798 recorded the highest dry biomass of 34 t/ha and was 16% superior to the check CSH 22SS (29 t/ha). The other promising genotype was SPV 2402 (30 t/ha) with 5% superiority.

Juice brix at physiological maturity varied between 15.1 and 17.6 % (mean of 15.5%). SPV 2465 recorded the highest brix of 17.6%.

Grain yield ranged from 423 to 1227 kg/ha with a mean of 985 kg/ha. CSH 13 recorded the highest grain yield of 1227 kg/ha. The other promising genotypes were SPV 2402 with a grain yield of 1208 kg/ha.

Coordinated sweet sorghum breeding research

In pursuance to the decisions taken during 46th AGM held at Udaipur, different centres have shared their male sterile and restorer lines under inter-institutional hybrid programme with IIMR for development of rabi hybrids. Around 90 hybrids were developed which were evaluated at different locations viz., Rahuri, Phaltan, Ludhiana and Hyderabad under different trials.

HNC-I: Thirty hybrids including check CSH 22SS were evaluated for sweet sorghum productivity traits at Rahuri, Ludhiana and Hyderabad. The data is summarized in Table 1. None of the hybrids were superior to the check hybrid CSH 22SS for total fresh biomass (107 t/ha). However, the hybrid NSS 1008 A X IS 18542 with a fresh biomass of 101 t/ha was at par to the check. The same hybrid had 4% superiority for fresh stalk yield. For juice yield, none of the hybrids were better than the check except NSS 1008 A X IS 18542 which was on par. With respect to the brix content, NSS 1008 A X (RSCN 2118 X ICS 705)-3-1 recorded the highest brix of 19.2 % and was 12% superior to the check hybrid. The hybrid NSS 1008 A X IS 18542 was on par to the check for total sugar index.

HNC-II: Similar to HNC-I, 30 hybrids were evaluated at the same locations viz., Rahuri, Ludhiana and Hyderabad. The data is summarized in Table 2. For fresh biomass, PMS 71 A X RSSV 138-1 recorded the highest biomass of 79.8 t/ha and was 21% significantly superior to the check CSH 22SS (65.9 t/ha). The same hybrid continued its superiority for fresh stalk yield too. PMS 71 A X NP BNM 7 recorded the highest brix content of 19.3% and was 14% significantly superior to the check hybrid CSH 22SS.

HNC-III: Thirty hybrids including check hybrid CSH 22SS were evaluated at Rahuri, Hyderabad and Phaltan. The data is summarized in Table 3. For total fresh biomass, the highest biomass of 113 t/ha was recorded NSS 1007 A X RSSV 138-1 followed by ICS 38 A X RSSV 138-1 (97 t/ha), ICS 675 A X RSSV 138-1 (68 t/ha) compared to the check CSH 22SS (42.5 t/ha). The trend was similar for Fresh stalk yield. ICS 38 A X RSSV 138-1 recorded the highest juice yield of 16613 L/ha. NSS 1008 A X SSV 84 was promising for brix content (16.9%).

Conclusions: NSS 1008 A X IS 18542 and ICS 38 A X RSSV 138-1 can be exploited further.

Table 1: Performance of hybrids for various traits under HNC-I

S No	Entry	Days to flower	R	Plant height (cm)	R	Total fresh biomass (t/ha)	R	Fresh stalk yield (t/ha)	R	Juice yield (L/ha)	R	Brix (%)	R	Total sugars (%)	R	Total sugar Index (t/ha)	R
1	ICSA 14032 X ICSV 12012	87	17	264	16	47.2	23	32.5	22	10544	24	17.4	12	15.4	12	1.63	22
2	ICS 675 A X [(RSCN 2103 X SSV 84)-2-1-]-1	92	4	285	5	86.4	5	63.9	3	15156	15	16.0	26	14.1	27	2.93	7
3	NSS 13 A X SSV 84	89	10	264	15	76.1	9	41.2	18	15229	14	16.7	21	14.7	22	2.17	15
4	ICS 38 A X KR 135	89	8	234	26	67.4	14	42.4	14	14500	17	17.1	17	15.1	17	2.03	18
5	PMS 71 A X [(RSCN 2103 X SSV 84)-2-1-]-1	91	7	271	11	79.5	7	56.0	6	19711	7	17.8	8	15.7	8	2.50	11
6	ICSA 14032 X RSSV 466	87	17	260	19	65.9	15	45.1	11	16589	11	17.1	18	15.1	18	2.27	12
7	185 A X RSSV 138-1	93	3	310	2	-	-	-	-	-	-	17.3	14	15.3	14	-	-
8	ICS 675 A X RSSV 466	88	14	294	3	72.1	11	45.9	10	20951	5	16.0	25	14.1	26	2.67	9
9	ICS 38 A X RSSV 466	88	14	273	10	71.4	13	41.4	17	15282	13	16.2	24	14.3	25	2.03	17
10	NSS 1007 A X SSV 74	87	18	260	20	93.1	3	62.9	4	21771	4	17.7	10	15.6	10	3.47	3
11	NSS 1007 A X SSV 84	91	7	256	23	73.8	10	44.9	12	15442	12	17.9	7	15.8	7	2.23	13
12	NSS 1008 A X IS 18542	96	2	294	3	101.5	2	75.8	1	26491	2	17.2	16	15.1	16	4.07	2
13	NSS 13 A X (NSSV 258 X ICSV 93046)-1-3	87	17	260	20	56.3	21	34.7	21	10067	25	18.2	6	16.0	6	1.50	23
14	NSS 1007 A X [(RSCN 2103 X SSV 84)-2-1-]-1	92	5	261	18	71.6	12	44.4	13	14087	18	17.3	15	15.3	15	2.07	16
15	NSS 1008 A X RSSV 404	88	13	257	22	61.2	18	37.5	20	11142	22	17.8	9	15.7	9	1.70	21
16	IMS 9 A X ICSV 12015	88	11	278	9	44.4	25	26.1	26	8280	27	18.4	4	16.2	4	1.27	25
17	ICSA 14032 X (NR 486 X ICSR 103)-1-2-1-1	86	22	258	21	61.0	19	32.0	23	13175	19	17.0	19	15.0	20	1.83	20
18	ICS 675 A X PMS 130	89	8	219	27	52.1	22	25.1	27	8373	26	16.4	23	14.5	24	1.07	27
19	185 A X RSSV 466	85	23	286	4	46.4	24	29.6	25	10642	23	13.4	29	11.6	30	1.20	26
20	NSS 13 A X RSSV 138-1	100	1	313	1	-	-	-	-	-	-	17.7	11	15.6	11	-	-
21	ICS 38 A X ICSV 12012	87	19	263	17	-	-	-	-	-	-	18.3	5	16.2	5	-	-
22	ICS 675 A X IS 18542	92	6	283	6	91.4	4	58.0	5	14776	16	16.6	22	14.7	23	1.90	19
23	NSS 13 A X [ICSV 15X IS 21890)-1-1-1 X (HC 260 X B 35)-2-1-1]-3-2	86	20	253	25	63.2	16	41.5	16	17760	9	17.4	13	15.3	13	2.60	10
24	NSS 1008 A X (RSCN 2118 X ICS 705)-3-1	89	9	255	24	73.8	10	48.1	9	16900	10	19.2	1	16.9	1	2.97	5
25	PMS 71 A X RSSV 466	88	15	270	12	63.0	17	42.4	15	19829	6	16.9	20	14.9	21	2.77	8
26	27 A X (RSCN 2118 X ICS 705)-3-1	88	16	282	7	80.0	6	55.7	7	23240	3	15.7	27	13.9	28	2.93	6
27	NSS 1008 A X (NSSV 258 X ICSV 93046)-1-3	88	12	267	14	59.7	20	39.9	19	12680	20	18.8	2	16.5	2	2.20	14
28	27 A X PMS 130	86	21	257	22	41.7	26	29.8	24	12487	21	15.0	28	13.3	29	1.43	24
29	NSS 1008 A X [(RSCN 2103 X SSV 84)-2-1-]-1	91	7	280	8	76.5	8	53.5	8	19176	8	18.5	3	16.3	3	3.17	4
30	CSH 22SS	87	17	270	13	106.9	1	72.8	2	28884	1	17.1	18	15.1	19	4.13	1
	LOC. MEAN	89		269		69.8		45.3		16043		17.0		15.0		2.32	
	C.D. (5%)	5		32		9.2		7.7		4897		2.9		2.6		0.63	
	C.V. (%)	3.7		7.4		8.1		10.4		18.6		8.3		8.4		16.58	
	F (Probability)	0.02		0.00		0.00		0.00		0.00		0.16		0.17		0.00	



Table 2: Performance of hybrids for various traits under HNC-II

S No	Entry	Days to flower	R	Plant height	R	Total fresh biomass (t/ha)	R	Fresh stalk yield (t/ha)	R	Brix (%)	R	Total sugars (%)	R
1	PMS 71 A X RSSV 138-1	94	5	248	7	79.8	1	54.1	1	18.1	6	16.0	6
2	NSS 13 A X ICSV 12012	92	13	231	14	42.7	7	24.4	14	18.7	3	16.4	3
3	PMS 71 A X NSSV 14	92	14	257	5	50.6	4	32.9	5	16.9	15	14.9	15
4	NSS 13 A X (NR 486 X ICSR 103)-1-2-1-1	90	19	211	27	32.6	18	17.5	22	18.0	7	15.9	7
5	NSS 1008 A X PMS 130	93	9	229	16	40.2	10	21.0	17	18.3	4	16.1	4
6	PMS 71 A X PMS 130	92	15	213	26	49.6	5	34.3	4	16.0	23	14.1	25
7	ICS 675 A X SSV 84	93	11	190	29	65.9	2	46.4	2	17.8	8	15.7	8
8	27 A X UK 81	94	7	227	19	36.1	14	25.9	10	18.2	5	16.1	5
9	PMS 71 A X NP BNM 7	95	3	214	25	-	-	-	-	19.3	1	17.0	1
10	ICSA 14032 X RSSV 404	98	1	258	4	26.1	21	18.3	21	17.2	13	15.1	13
11	NSS 13 A X IS 18542	95	4	261	1	42.4	8	29.1	7	15.2	26	13.4	28
12	27 A X RSSV 404	94	8	244	11	-	-	-	-	18.7	2	16.5	2
13	NSS 13 A X NNSV 14	89	22	246	9	40.3	9	25.7	11	16.5	20	14.5	21
14	185 A X (NR 486 X ICSR 103)-1-2-1-1	87	25	222	22	12.8	26	6.2	28	14.7	28	12.9	30
15	PMS 71 A X NP BNM 9	91	16	244	10	39.5	12	26.4	9	16.5	20	14.5	22
16	ICS 52 A X (SPV 1616 X SSV 74)-1-2	85	26	242	12	24.2	22	13.6	24	16.3	22	14.4	24
17	ICS 675 A X (NSSV 258 X ICSV 93046)-1-3	89	23	248	8	13.8	25	7.4	27	15.7	24	13.8	26
18	ICS 675 A X (CSV 15X IS 21890)-1-1-1 X (HC 260 X B 35)-2-1-1]-3-2	89	20	228	17	21.0	23	8.9	26	15.7	25	13.8	27
19	185 A X RSSV 404	84	27	214	24	33.8	16	18.8	19	14.7	27	13.0	29
20	ICS 52 A X (RSCN 2118 X ICS 705)-3-1	91	17	227	18	28.6	20	20.5	18	16.5	19	14.6	20
21	ICS 52 A X (NR 486 X ICSR 103)-1-2-1-1	92	12	244	10	43.2	6	21.2	16	16.9	14	14.9	14
22	ICS 52 A X KR 135	87	25	210	28	17.3	24	11.4	25	16.8	17	14.8	18
23	PMS 71 A X RSSV 404	88	24	249	6	35.8	15	23.9	15	17.3	12	15.3	12
24	PMS 71 A X IS 18542	92	13	260	2	57.5	3	30.1	6	16.9	16	14.9	17
25	NSS 1008 A X RSSV 138-1	94	6	235	13	37.5	13	24.7	13	16.4	21	14.5	23
26	ICS 675 A X NP BNM 9	93	10	222	23	31.4	19	18.5	20	16.6	18	14.7	19
27	PMS 71 A X (SPV 1616 X SSV 74)-1-2	93	9	227	20	31.4	19	17.0	23	17.7	9	15.6	9
28	NSS 13 A X NP BNM 7	96	2	230	15	39.7	11	28.9	8	17.7	10	15.6	10
29	NSS 1007 A X NP BNM 9	89	21	260	3	32.6	17	25.2	12	17.5	11	15.4	11
30	CSH 22 SS	91	18	224	21	65.9	2	45.9	3	16.9	16	14.9	16
	LOC. MEAN	90		234		38.3		24.2		16.8		14.9	
	C.D. (5%)	7		51		10.9		6.7		2.3		2.0	
	C.D. (1%)	9		67		14.6		8.9		3.1		2.7	
	C.V. (%)	4.6		13.1		17.5		17.0		6.6		6.5	
	F (Probability)	0.10		0.69		0.00						0.07	

Table 3: Performance of hybrids for various traits under HNC-III

S No	Entry	Plant height (cm)	R	Total fresh biomass (t/ha)	R	Fresh stalk yield (t/ha)	R	Juice yield (L/ha)	R	Brix (%)	R	Total sugars (%)	R
1	NSS 1008 A X SSV 84	245	17	66.4	4	46.2	4	5304	10	16.9	1	14.9	1
2	ICS 52 A X NP BNM 7	255	12	32.1	13	18.3	17	4822	11	14.3	25	12.6	24
3	ICS 52 A X SSV 84	244	19	61.7	5	37.3	6	11849	2	15.9	9	14.0	9
4	ICS 675 A X ICSV 12012	253	13	24.4	20	14.8	21	3967	16	15.4	16	13.6	15
5	PMS 71 A X KR 135	222	25	24.2	21	17.0	20	4542	12	16.1	7	14.2	7
6	PMS 71 A X SSV 74	301	2	31.8	14	22.2	12	4180	14	16.2	6	14.3	6
7	27 A X IS 18542	308	1	39.5	8	22.9	11	5869	7	13.5	30	12.0	29
8	27 A X (SPV 1616 X SSV 74)-1-2	264	9	29.1	16	20.0	14	2182	21	14.2	26	12.6	25
9	ICS 52 A X IS 18542	243	20	-	-	-	-	-	-	15.3	17	13.5	16
10	NSS 1007 A X RSSV 138-1	291	3	112.6	1	78.5	1	10996	3	13.8	29	12.2	28
11	185 A X PMS 130	223	24	-	-	-	-	-	-	14.4	24	12.7	23
12	ICS 675 A X RSSV 138-1	274	7	67.6	3	52.6	3	10036	5	14.5	22	12.8	21
13	ICS 52 A X UK 81	256	11	28.4	17	19.5	15	1253	23	13.8	28	12.2	27
14	ICS 38 A X RSSV 138-1	282	5	97.0	2	68.1	2	16613	1	15.2	18	13.4	17
15	NSS 5A X KR 135	231	23	28.1	18	19.5	15	1604	22	16.5	2	14.6	2
16	27 A X NP BNM 9	250	14	-	-	-	-	-	-	14.8	20	13.1	19
17	PMS 71 A X UK 81	231	22	27.9	19	19.3	16	2471	19	16.4	3	14.5	3
18	NSS 1008 A X SSV 74	290	4	36.3	10	25.9	8	5709	9	15.5	14	13.7	13
19	27 A X SSV 84	276	6	31.6	15	18.0	19	4480	13	14.5	21	12.8	20
20	ICS 38 A X (NR 486 X ICSR 103)-1-2-1-1	214	28	16.3	23	3.5	23	1162	24	15.8	11	13.9	11
21	NSS 5A X ICSV 12012	261	10	17.0	22	11.9	22	2302	20	15.6	12	11.9	30
22	NSS 1008 A X NSSV 260	249	15	34.8	12	22.2	13	6713	6	15.4	15	13.6	14
23	NSS 1007 A X KR 135	199	30	38.0	9	25.9	9	3047	18	14.5	23	12.8	22
24	PMS 71 A X SSV 84	248	16	59.8	6	37.5	5	10858	4	15.5	13	13.7	12
25	185 A X KR 135	215	27	-	-	-	-	-	-	15.0	19	13.3	18
26	185 A X SSV 84	200	29	-	-	-	-	-	-	15.9	8	14.1	8
27	ICS 675 A X KR 135	222	26	35.1	11	24.2	10	3742	17	15.9	10	14.0	10
28	IMS 9 A X RSSV 466	265	8	28.1	18	18.0	18	5731	8	13.8	27	12.2	26
29	ICS 675 A X SSV 74	245	18	-	-	-	-	-	-	16.3	5	14.3	5
30	CSH 22 SS	241	21	42.5	7	29.4	7	4022	15	16.3	4	14.4	4
	LOC. MEAN	250		42.1		28.0		5561		15.2		13.3	
	C.D. (5%)	53		8.3		5.8		2287		2.4		2.3	
	C.D. (1%)	71		11.1		7.8		3053		3.2		3.1	
	C.V. (%)	12.9		12.1		12.7		24.9		9.7		10.5	