

Sweet sorghum breeding - 2011

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Executive summary

Trial 1a: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Kharif 2011

1. Twenty IASSVHT trial entries comprising 13 varieties, 5 hybrids along with 2 checks (CSV 19SS & CSH 22 SS) were evaluated at 12 locations during kharif 2011.
2. SPH 1711 with a flowering of 72 days was the most early test entry in the entire trial and had 10% superiority for early flowering over the check hybrid (80 days)
3. For total fresh biomass, among hybrids, SPH 1670 had a numerical superiority of 9%. SPV 2074 among the varieties recorded a significant superiority of 13% while SPV 2075 (10%), SPV 2135 and SPV 2068 (7%) had a numerical superiority over CSV 19SS and these entries were promising for fresh stalk yields too.
4. For grain yield, none of the test hybrids were significantly superior to the check CSH 22SS. Among the test varieties SPV 2137 (24%), SPV 2074 (24%), SPV 2134 (20%), SPV 2070 (14%) and SPV 2135 (10%) were numerically superior to the check.
5. All the hybrids except SPH 1670 and SPV 2137 recorded more than 5% numerical superiority for juice brix over respective checks.
6. For juice yield, the hybrid SPH 1670 exhibited a superiority of 7% while the varieties SPV 2075 and SPV 2074 recorded a numerical superiority of 9% over respective checks.

7. For total sugar yield, hybrids SPH 1713 and SPH 1711 were superior to the check CSH 22SS by 23% and 17% respectively and among the varieties, SPV 2135 and SPV 2074 were superior to varietal check CSV 19SS by 14%.
8. For calculated bioethanol yields, the hybrids SPH 1713 (23%) and SPH 1711 (18%) recorded superiority over the check hybrid and the test varieties, SPV 2135 and SPV 2074 were superior to check variety by 14% and 13% respectively.

Trial 1b: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Rabi 2011-12

1. The check variety CSV 19SS was the earliest to flower in the entire trial
2. SPH 1670 among hybrids and CSV 19SS among varieties were early maturing (113 days).
3. For total biomass, SPH 1669 and SPH 1670 had a marginal superiority while almost all the test varieties except SPV 2075, SPSSV 40 and SPV 2070 had superiority over the check variety
4. For fresh stalk yields, the hybrid SPH 1670 had a superiority of 10% over the check hybrid. Among varieties, SPV 2133 (25%), SPV 2076 (19%) and SPV 2068 (11%) were superior to the check
5. For juice brix, SPH 1670 recorded a significant superiority of 33% over the check hybrid
6. With respect to juice yields, the hybrids SPH 1669 (19%), SPH 1670 (27%), varieties SPV 2074 (20%), SPV 2133 (15%), SPV 2137 (14%) and SPV 2069 (12%) were superior to the respective checks.
7. For total soluble sugars (TSS), the hybrids SPH 1669, SPH 1670 and SPH 1711 and variety SPV 2068 were superior to the respective checks
8. For computed ethanol yields, the hybrids SPH 1711 (12%) and SPH 1713 (10%) were superior. While among the varieties, SPV 2133 and SPV 2069 were promising.

Detailed report

Trial 1a: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)-Kharif 2011

Twenty IASSVHT trial entries comprising 13 varieties, 5 hybrids along with 2 checks (CSV 19SS & CSH 22SS) were evaluated at 12 locations during kharif 2011. The promising entries for different traits are presented in Table 1.

Morpho-phenological traits

Days to 50% flowering varied from 72-85 days. All the test hybrids except SPH 1713 were significantly early compared to the check CSH 22SS. SPH 1711 with a flowering of 72 days was the most early test entry in the entire trial and had 10% superiority for early flowering over the check hybrid (80 days). SPV 2076 (85 days), SPSSV 40 (82 days), SPV 2074 (82 days), SPV 2133 (82 days) and SPV 2135 (81 days) were significantly late compared to the check variety CSV 19SS (76 days). Variation among locations revealed that average days to flowering was the lower at Coimbatore followed by Palem. Delayed flowering was experienced at Pantnagar location (Mean - 92 days).

Days to maturity of test entries ranged from 113 to 124 days. The hybrids which flowered early were also significantly early maturing (5-7%) compared to the hybrid check. The hybrid SPH 1711 was quite early and matured in 113 days. Among the varieties, SPV 2076, SPSSV 40, SPV 2133, SPV 2074 and SPV 2135 were significantly late maturing.

Plant height varied from 254 cm (SPH 1712) to 329 cm (SPV 2076) with a mean of 303 cm. Among the hybrids, SPH 1670 had a significant superiority of 7% while among varieties, SPV 2076 and SPV 2068 were significantly superior to the check variety by 7% and 6% respectively.

Biomass traits

Total fresh biomass differed across locations and it varied from 43.3 to 60 t/ha (mean of 50.2 t/ha). None of the test hybrids were significantly superior to the check CSH22 SS. However, SPH 1670 had a numerical superiority of 9%. Among the varieties, SPV 2074 recorded a significant superiority of 13% while SPV 2075 (10%), SPV 2135 and SPV 2068 (7%) had a numerical superiority over CSV 19SS. Lowest mean biomass yields were reported from Akola followed by Coimbatore and Palem. Highest mean biomass yields were observed at Hyderabad followed by Surat.

Fresh stalk yield ranged from 27.6 to 40.4 t/ha with a mean of 34.1 t/ha. None of the test hybrids were significantly superior to the check CSH 22SS. However, SPH 1670 recorded a numerical superiority of 7% over the check hybrid. Among the varieties, SPV 2076 (9%), SPV 2075 (8%), SPV 2074 (8%) and SPSSV 40 (7%) recorded a numerical superiority over CSV 19SS.

Per day stalk yield ranged from 226 to 338 kg/ha/day (average of 275). SPH 1670 and SPV 2075 recorded a numerical superiority of 13% and 11% over respective checks.

Grain yield ranged from 1609 to 3082 kg/ha with a mean of 2393 kg/ha. None of the test hybrids were significantly superior to the check CSH 22SS. The varieties SPV 2137 (24%), SPV 2074 (24%), SPV 2134 (20%), SPV 2070 (14%) and SPV 2135 (10%) recorded numerical superiority over CSV 19SS.

Quality traits

Juice brix at physiological maturity varied between 15.9 and 18.3 % (mean of 17.1%). All the hybrids except SPH 1670 recorded more than 5% numerical superiority over CSH 22SS while among test varieties, SPV 2137 recorded a numerical superiority of 5% than the check CSV 19SS. Highest mean brix content (19.7%) was recorded at Parbhani.

Juice extraction ranged from 37.2% to 44.2% (mean of 39.6%). Among the test varieties, SPV 2070 recorded the numerical superiority of 7% compared to the check.

Juice yield ranged from 9764 L/ha to 15417 L/ha with a mean of 12238 L/ha. The hybrid SPH 1670 exhibited a superiority of 7% while the varieties SPV 2075 and SPV 2074 recorded a numerical superiority of 9% over respective checks.

Components of total sugars

Total soluble sugars (TSS) ranged from 12.2 to 15.1% with an average of 13.6%. All of the hybrids were superior to the check hybrid by 5-12%. SPV 2137 recorded the highest TSS (15.1%) while CSH 22SS recorded the lowest TSS (12.2%). The range of **reducing sugars** was 1.79 to 2.46% while the range of **non-reducing sugars** was 10.0 to 13.2%. All of the hybrids were superior (7-23%) to the check while among varieties, similar to TSS, SPV 2137 recorded the highest non reducing sugar content of 13.2%. The **CCS (%)** and **CCS (t/ha)** ranged from 6.81-8.26% and 2.24-3.63 t/ha.

Total sugar yields: Sugar yields ranged from 1.43 to 2.25 t/ha with a mean of 1.81 t/ha. The hybrids SPH 1713 and SPH 1711 were superior to the check CSH22 SS by 23% and 17% respectively. Among the varieties, SPV 2135 and SPV 2074 were superior to varietal check CSV 19SS by 14%.

Ethanol yield: Calculated bioethanol yields ranged from 760 to 1199 L/ha with mean of 962 L/ha. The hybrids SPH 1713 followed by SPH 1711 recorded a superiority of 23% and 18% over the check hybrid. Among the test varieties, SPV 2135, SPV 2074 and SPV 2070 were numerically superior to CSV 19SS by 14%, 13% and 9% respectively.

Resistance to biotic stresses

Insects:

1. For shoot fly resistance, across the zones and genotypes the entry SPV 2136 recorded lowest deadhearts % and was on par with resistant check
2. For stem borer resistance, the test entries SPSSV 39, SPV 2068, SPV 2075, SPV 2076, SPH1669, SPH 1711, SPH 1712, SPH 1713, SPV 2074, SPV 2133 and SPV 2137 were on par with resistant check IS 2205

Diseases: SPH 1669 recorded lowest panicle grain mold rating and threshed grain mold rating. Resistance to downy mildew could be found in SPH 1669, SPH 2074, SPH 1670, SPV 2135

Conclusions

1. SPH 1670 and SPV 2075 were promising for total biomass, fresh stalk and juice yields
2. For total sugar yields and computed bioethanol yields, the hybrids SPH 1713 and SPH 1711 and varieties SPV 2135 and SPV 2074 were superior to respective checks

Trial 1b: Evaluation of initial and advanced sweet sorghum varieties and hybrids (IASSVHT)

The entries which were tested during kharif 2011 were evaluated again for their performance during rabi 2011-12 so as to identify genotypes which are stable across seasons. The trial was conducted at 3 locations viz., Rahuri, Phaltan and Hyderabad.

Morpho-phenological traits

Days to 50% flowering varied from 69-76 days. The check variety CSV 19SS was the earliest to flower in the entire trial. All the test hybrids flowered similar to the check hybrid. Flowering was early at Phaltan compared to the other locations. The range of flowering in rabi was less compared to kharif season.

Days to maturity of test entries differed across locations. The hybrid SPH 1670 (113 days) was early maturing amongst hybrids while among varieties, the check CSV 19SS matured early (113 days).

Plant height ranged from 172 cm (SPH 1712) to 275 cm (SPV 2076) with a mean of 231 cm. Height was reduced during rabi compared to kharif. None of the hybrids were superior compared to check hybrid while the varieties SPV 2076 (23%), SPV 2134 (17%), SPV 2068 (17%), SPV 2133 (16%) and SPV 2136 (15%) were significantly superior to the check variety. It was gratifying to note that the varieties SPV 2076 and SPV 2068 had superiority for this trait in Kharif too.

Biomass traits

Total fresh biomass varied from 21.9 to 38.4 t/ha (mean of 32.3 t/ha). A reduction of around 35% in mean biomass yields was observed in rabi as compared to kharif. None of the test hybrids were significantly superior to the check CSH22 SS. However, SPH 1669 and SPH 1670 had a marginal superiority. Almost all the test varieties except SPV 2075, SPSSV 40 and SPV 2070 had superiority over the check variety. The entries which performed consistently across seasons were SPV 2074, SPV 2135 and SPV 2068. Lowest mean biomass yields were reported from Phaltan while highest mean biomass yields were observed at Rahuri.

Fresh stalk yield ranged from 10.2 to 24.2 t/ha with a mean of 17.8 t/ha. The hybrid SPH 1670 had a superiority of 10% over the check hybrid. Among varieties, SPV 2133 (25%), SPV 2076 (19%) and SPV 2068 (11%) were superior to the check. SPH 1670 and SPV 2076 performed well in both the seasons.

Grain yield ranged from 2050 kg/ha (CSV 19SS) to 4590 kg/ha (SPV 2137 kg/ha) with a mean of 3371 kg/ha. The grain yields were higher during rabi compared to kharif. All of the test hybrids were inferior while all the test varieties were far superior compared to the check variety.

Quality traits

Juice brix at physiological maturity varied between 9.8 and 13.9 % (mean of 11.6%). Among hybrids, SPH 1670 recorded a significant superiority of 33% over the check hybrid. The other hybrids which were superior were SPH 1669 (29%) and SPH 1711 (10%). Among the varieties, SPV 2068 had a superiority of 6% over the check variety.

Juice extraction ranged from 22.4% to 37.3% (mean of 31.2%). The hybrids SPH 1711, SPH 1670 and SPH 1669 recorded >10% superiority over CSH 22SS. Among the test varieties, SPV 2069 recorded the significant superiority of 27% compared to the check. SPV 2070 was another variety with superiority of 24% which performed consistently over both the seasons.

Juice yield ranged from 2877 L/ha to 6363 L/ha with a mean of 4998 L/ha. The mean juice yields were reduced by 59% in rabi compared to kharif season. The hybrids SPH 1669 (19%), SPH 1670 (27%), varieties SPV 2074 (20%), SPV 2133 (15%), SPV 2137 (14%) and SPV 2069 (12%) were superior to the respective checks. The hybrid SPH 1670 and variety SPV 2074 performed consistently across seasons.

Components of total sugars

Total soluble sugars (TSS) ranged from 7.62 to 10.93% with an average of 9.14%. The hybrids SPH 1669, SPH 1670 and SPH 1711 and variety SPV 2068 were superior to the respective checks. SPV 2068 recorded the highest TSS (10.93%). The range of **reducing sugars** was 1.60 to 2.35% while the range of **non-reducing sugars** was 7.8 to 9.19%. None of the test hybrids and varieties were significantly superior to the checks. SPV 2075 recorded a numerical superiority of 11%.

Total sugar yields: Sugar yields ranged from 0.28 to 0.51 t/ha with a mean of 0.38 t/ha. The hybrid SPH 1711 and varieties SPV 2069, SPV 2133 had > 10% numerical superiority over the respective checks. SPH 1711 was promising for this trait in both the seasons.

Ethanol yield: Calculated bioethanol yields ranged from 150 to 270 L/ha with mean of 201 L/ha. The percentage reduction in ethanol yield from kharif to rabi was 79%. The hybrids SPH 1711 (12%) and SPH 1713 (10%) were superior. These two hybrids were also promising for this trait during kharif. Among the varieties, SPV 2133 and SPV 2069 were promising.

Shortfalls

- Non-uniformity in plot size, delay in receipt of data from some locations

Over all conclusions

- It was gratifying to note that the varieties SPV 2076 and SPV 2068 had superiority for plant height during both seasons.
- The entries which performed consistently for biomass yields across seasons were SPV 2074, SPV 2135 and SPV 2068.
- For fresh stalk yields, SPH 1670 and SPV 2076 performed well in both the seasons
- For juice yield, the hybrid SPH 1670 and variety SPV 2074 were better across seasons
- SPH 1711 and SPH 1713 were promising during both kharif and rabi seasons for computed ethanol yields

Follow-up for kharif 2012

1. Based on the performance, the promising lines in initial trials will be advanced to advanced varietal and hybrid trials
2. Introduction of CSV 24SS as new check in the trials

Table 1: Promising initial and advanced sweet sorghum varieties and hybrids for stalk yield, biomass, sugar content and bioethanol yields, Kharif 2011

S. No	Trait	Mean	Min	Max	Range	C D (0.05)	Var. check CSV 19SS	Hyb. Check CSH22SS	Promising hybrids and varieties superior to checks
1	Time to 50% flowering (d)	78.0	72.0	85.0	13	3.0	76	80	Hybrids: SPH 1711 was significantly early (10%) Varieties: Nil
2	Time to maturity (d)	118	113	124	11	3.0	116	122	Hybrids: SPH 1711, SPH 1712, SPH 1669, and SPH 1670 were significantly early to mature (5-7%) Varieties: SPV 2070 and SPV 2136 were early by 1 day compared to CSV 19SS.
3	Plant height (cm)	303	254	329	75	15	307	305	Hybrids: SPH 1670 were significantly superior (7%) Varieties: SPV 2076 and SPV 2068 were significantly (7% and 6%) superior.
4	Fresh biomass (t ha ⁻¹)	50.2	43.3	60.0	16.7	6.1	48.4	55.0	Hybrids: SPH 1670 was numerically superior (9%) Varieties: SPV 2074 (13%) and SPV 2075 (10%) recorded a numerical superiority
5	Fresh stalk yield (t ha ⁻¹)	34.1	27.6	40.4	12.8	4.2	33.3	37.9	Hybrids: SPH 1670 was numerically superior (9%) Varieties: SPV 2076 (9%), SPV 2075 (8%), and SPV 2074 (8%).
6	Grain yield (Kg ha ⁻¹)	2393	1609	3082	1473	1074	2097	2862	Hybrids: None Varieties: SPV 2137 (24%), SPV 2074 (24%), SPV 2134 (20%), SPV 2070 (14%) and SPV 2135 (10%).
7	Juice brix %	17.1	15.9	18.3	2.4	1.0	17.5	16.1	Hybrids: All the hybrids except SPH 1670 recorded more than 5% numerical superiority Varieties: SPV 2137 recorded a numerical superiority of 5%
8	Juice yield (L ha ⁻¹)	12238	9764	15417	5653	3732	12308	14445	Hybrids: SPH 1670 (numerical superiority of 7%) Varieties: SPV 2075 and SPV 2074 were numerically superior to CSV 19SS by 9%.
9	Juice extraction (%)	39.6	37.2	44.2	7.0	5.3	41.4	40.2	Hybrids: None Varieties: SPV 2070 was numerically superior by 7%.
10	Total soluble sugars (%)	13.6	12.2	15.1	2.9	1.7	14.0	12.2	Hybrids: All hybrids (5-12%) Varieties: SPV 2137 (8%)
11	Sucrose (%)	11.7	10.0	13.2	3.2	1.6	11.7	10.0	Hybrids: All (7-23%) Varieties: SPV 2137 (13%) and SPV 2135 (5%)
12	Sugar yield (t ha ⁻¹)	1.81	1.43	2.25	0.82	0.75	1.91	1.83	Hybrids: SPH 1713 (23%) and SPH 1711 were numerically superior (17%) Varieties: SPV 2135 and SPV 2074 were numerically superior (14%) to the check CSV 19SS
13	Bioethanol yield (L ha ⁻¹)	962	760	1199	439	398	1017	977	Hybrids: SPH 1713 (23%) and SPH 1711 (18%) were numerically superior Varieties: <u>Numerically superior</u> SPV 2135 (14%), SPV 2074 (13%) and SPV 2070 (9%)

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