

Kharif grain sorghum - 2013

Sujay Rakshit Co-ordinating with scientists at several SAUs

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Executive summary

During 2013, towards improvement of grain sorghum basic and applied researches were undertaken at DSR and All India Coordinated Sorghum Improvement Project (AICSIP) centers. Multi-location yield trials newly developed varieties and hybrids from the centers of AICSIP and private companies were carried out as part of applied research. Basic and strategic researches focused on development of new MS and R lines, breeding for earliness, drought tolerance, cold tolerance, resistance against key insects and diseases etc. Biotechnological tools as well as conventional breeding methodologies were employed towards this direction. New initiatives on inter-institutional hybrid development and testing, and multi-location testing of segregating generations from various centers have yielded promising outcomes.

Multi-location AICSIP trials

During kharif 2012 6 multi-location trials were conducted, out of which 4 (Advanced Hybrid Trial, Advanced Variety Trial, Initial Hybrid Trial and Initial Variety Trial) were conducted during kharif season across 9 (initial trials) to 25 locations (AHT), and 2 trials (Late Kharif Advanced Hybrid Trial and Late Kharif Advanced Variety Trial) were conducted at 6 locations.

Advanced Hybrid Trial (Tables 1, 1A and 1B)

In AHT 9 test hybrids (6 in AHT I and 3 in AHT II, respectively) along with 4 checks were evaluated across 25 locations.

- *Zone I (Table 1A):* In Zone I SPH 1702 (4316 kg/ha) and SPH 1703 (4356 kg/ha) performed better than best performing check, CSH 25 (4170 kg/ha) in terms of grain yield, while SPH 1724 recorded superior fodder yield (12905 kg/ha) than best performing check, CSH 30 (11886 kg/ha). However, none of them recorded more than 10% yield superiority.
- *Zone II (Table 1b):* SPH 1736 (4633 kg/ha) and SPH 1702 (4398 kg/ha) performed better than CSH 25 in terms of grain yield and SPH 1724 (12666 kg/ha), SPH 1731 (12665 kg/ha) and SPH 1736 (14462 kg/ha) gave better fodder yield than CSH 25 (11489 kg/ha). SPH 1703 (3966 kg/ha), SPH 1705 (4131 kg/ha), SPH 1724 (4098 kg/ha) and SPH 1737 (3907 kg/ha) were comparable to early check, CSH 23 and recorded more than 10% yield superiority than observed in it (3454 kg/ha).

Advanced Variety Trial (Table 2, 2A and 2B)

In AVT 21 test varieties (4 in AVT II and 17 in AVT I) along with 5 checks were evaluated across 22 locations in Zone I and Zone II.

- *Zone I (Table 2A):* In Zone I for grain yield SPV 2122 (3389 kg/ha) and SPV 2110 (3235 kg/ha) in AVT II and SPV 2165 (3229 kg/ha) in AVT I out yielded best performing check, CSV 27 (2925 kg/ha) by more than 10%. However, none of these could out yield CSV 27 in terms of fodder yield.
- *Zone II (Table 2B):* In Zone II SPV 2178 (3322 kg/ha) recorded better yield than CSV 20 or CSV 23 (3197 kg/ha). Only two test varieties viz., SPV 2178 (13367 kg/ha) and SPV 2122 (13258 kg/ha) recorded marginal superiority over checks in terms of fodder yield.

Initial Hybrid Trial (Table 3A and 3B)

In IHT 16 hybrids and four checks were evaluated at 9 locations.

- *Zone I (Table 3A):* None of the test hybrids recorded more than 10% grain yield superiority over the check, while SPH 1748 recorded nearly 19% fodder yield superiority over checks.
- *Zone II (Table 3B):* In Zone II SPH 1751 (3916 kg/ha) recorded marginal grain yield advantage over best check CSH 25 (3806 kg/ha). SPH 1748 was highest fodder yielder (14808 kg/ha) with 15.5% superiority over best check.

Initial Variety Trial (Table 4A and 4B)

In IVT 15 varieties and 5 checks were evaluated at 9 locations.

- SPV 2243 recorded highest grain yield (3776 kg/ha) but it was marginally superior (4.5%) than the best check, CSV 23 (3613 kg/ha). In terms of fodder yield none were superior than the best check, CSV 23 (12359 kg/ha).

- *Zone II (Table 4B):* SPV 2242 (3209 kg/ha) and SPV 2250 (3081 kg/ha) yielded better than best performing check, CSV 23 (2936 kg/ha), with SPV 2242 recording 9.3% superiority and SPV 2250 with 4.9% superiority. Both these varieties recorded marginal superiority (2.5% and 4.6%, respectively) for fodder yield as compared to best check CSV 27 (13517 kg/ha). SPV 2249 was highest fodder yielder (14671 kg/ha) with 8.5% superiority over CSV 27.

Late kharif

Late kharif Advanced Hybrid Trial (Table 5A)

In AHT - LK trial 9 hybrids (3 in AHT) and 5 checks were evaluated across 6 locations.

- None of the test hybrids recorded more than 10% grain yield superiority, while only two hybrids, viz., SPH 1705 and SPH 173 recorded numerical fodder yield advantage over best performing check.

Late kharif Advanced Variety Trial (Table 5B)

In IAVT - LK 16 varieties (4 in AVT) and 5 checks were evaluated across 6 locations.

- SPV 2122 (3914 kg/ha) recorded marginal grain yield superiority over best check, CSV 20 (3766 kg/ha). In terms of fodder yield SPV 2175 (9908 kg/ha) ranked first followed by SPV 2181 (9815 kg/ha), SPV 2164 (9772 kg/ha), SPV 1822 (9722 kg/ha), which performed better than the best check, CSV 23 (9015 kg/ha).

Coordinated sorghum breeding research

Inter-institutional hybrids developed through pooled MS lines from different centers were tested at Indore, Parbhani, Akola, Hyderabad and Coimbatore. In this 18 experimental hybrids along with 5 checks were tested. 1158A x C43, 3025A x DSR 1150 and AKMS 30A x AKR 73 found to be promising hybrids as compared to best performing checks, CSH 25.

F2 populations of 11 crosses provided by four centers (Kovilpatti, Dharwad, Akola and Parbhani) were evaluated at 8 Akola, Coimbatore, Deesa, Dharwad, Indore, Palem, Surat and Udaipur. A total of 262 single plant selections were made.

Kharif sorghum breeding at DSR

Development of kharif grain sorghum genotypes with improved yield, grain quality and grain mould tolerance

- Eighty experimental hybrids were tested for grain yield superiority and nine hybrids yielded more than 10% over CSH25. The hybrids based on the MS line 2911A (2911A x R44, 2911A x R48 and 2911A x R50) recorded more than 20% increase over CSH 25.
- Twenty advanced breeding lines were evaluated for grain yield and quality and the genotype PVT 2-13 recorded significant improvement in grain yield over the check, CSV20 (3783 kg/ha).
- Sixty sorghum genotypes were tested for high semolina recovery along with the other grain quality traits. Semolina recovery ranged from 19.77 to 47.82%. Seven genotypes recorded semolina recovery of more than 45%.

Genetic studies for grain yield and quality traits in elite sorghum genotypes

- Grain protein digestibility and other quality traits in sorghum ~200 experimental hybrids were evaluated. The GCA/SCA ratio was less than unity for most of yield and quality traits indicating preponderance of non-additive gene action in the expression of these traits. Hybrid combinations like C 43 x BN 535, BN 535 x 206B, KR 196 x RS 29, RS 585 x SPV 1775, RS 585 x IS 31706, RS 585 x SPV 462 were superior for grain yield with more than 100g grain yield/plant, and hybrid combinations, viz., IS 31706 x IS 19153, RS 585 x IS 31706, IS 31706 x SPV 462 were promising for 100 seed weight with more than 4.5g/100 seed weight, and cross combinations BN 535 x SPV 1775 and BN 535 x RS 585 were superior for grain protein digestibility (>65%).

Genetic improvement of single cut forage genotypes for fodder yield and quality

- Four genotypes designated as DSR-SC-2 (504q/ha), DSR-SC-7 (454q/ha), DSR-SC-8(470q/ha) and DSR-SC-11(445q/ha) were found to more than 15% superior to HC 308 and more than 20% compared to CSV 21F for green fodder yield. The genotypes were also superior for brix content during flowering and other forage attributes.

- Among 100 germplasm and elite lines evaluated for forage yield and related traits, the lines, *viz.*, IS 27887, IS 27034, IS 28747, SPV 2056, SPV 2058, SPV 2131, HC 260, AKSSV 22, HC 136, Afzalpur local, GFS 5 were found superior for overall forage yield and attributes.
- The cross combinations Rampur Local × CSV 21F, Rampur Local × SSV 74, HC 308 × SSV 74, SSV 74 × IS 23992, CSV 21F × IS 23992 and HC 260 × AKSSV 22 were superior for green fodder yield and related attributes.

Developing early duration and photoperiod insensitive grain sorghum MS and R lines

- Out of a total of 55 F₅ derivatives (B × B and R × R) and 11 checks (AKMS 14B, 2219 B, CS 3541, 467B, CSV 17, 7B, CSV 15, 27B, C 43, 296B and 2077B) evaluated for earliness 33 recorded earliness coupled with superior performance for grain yield as compared to the early checks (CSV 17, AKMS 14B, 2219B, CS 3541 and 467B).
- Fifty four advance breeding lines were used for test crossing with 27A and a total of 95 test cross seeds were harvested during *rabi* 2012-13.

Genetic augmentation of parental lines for grain yield and tolerance of shoot pests and hybrid development in kharif sorghum

- Out of 95 crosses, more than 25 were found to be fertile or partially sterile, while the remaining test crosses which were completely sterile and were backcrossed with the respective maintainer lines for advancement to develop new MS lines.
- 90 superior and genetically uniform advance breeding lines from restorer × restorer crosses were evaluated for performance *per se* performances. Three advance breeding lines *viz.*, DSR 949 (5318 kg/ha), DSR 950 (5023 kg/ha) and DSR 993 (4981 kg/ha) recorded more than 10% grain yield advantage over CSV 216R.
- Comparison of mean performance over *kharif* and *rabi* seasons, showed that DSR 971 (CS 3541 × CB 87) was the highest yielder (3933 kg/ha) closely followed by DSR 926 (RS 29 × ICSR 9) and DSR 908 (RS 673 × ICSR 93001).
- Six entries (DSR 1118, DSR 1175, DSR 1121, DSR 1145, DSR 1128 and DSR 1144) had significantly higher grain yield (25-33%) over the check.
- Forty-six superior derivatives isolated from 22 maintainer × maintainer crosses were evaluated and 13 entries recorded significantly higher grain yield (3689-5355 kg/ha) compared to 27B (2889 kg/ha)

Collation, evaluation, documentation and utilization of sorghum genetic stocks

- 75 established R lines and 21 B lines were evaluated under replicated trials. Out of these 15 R lines and 9 B lines found promising. Promising lines were DUS characterized.
- A total of 109 experimental hybrids were tested under three station trials, and RS1100A2 × RSCN 5028, RS2309A2 × RSCN 5028, RS1215A2 × KR 199, RS1215A2 × RS 4004, RS2313-2A2 × RSCN 5031, RS2309A2 × RS among others found promising.

Studies on sucrose accumulation in sweet sorghum for efficient ethanol production

- Biomass and green cane are maximum in summer season in case of all sweet sorghum genotypes compared to *rabi* and *kharif* seasons. Genotypes Wray, Urja, SSV 74 and CSH 22SS showed maximum biomass in all seasons at maturity stage and these genotypes can be considered as stable genotypes across seasons.
- Five genotypes (Keller, Urja, Wray, BJ 248 and SSV 74) recorded the maximum sucrose content and total fermentable sugars at physiological maturity stage, in all the three seasons.
- Highest brix content was recorded in Wray, Urja, SSV 74, BJ 248 and CSH 22 SS at physiological maturity stage in all the three seasons.
- Sucrose synthase activity is high at milky stage of the crop in all genotypes in all the three seasons. Sucrose synthase activity is expressed equally in all seasons in 4 genotypes (Keller, Wray, Urja and BJ 248).
- Sucrose phosphate synthase activity is highest in milky stage in summer and Indian sweet sorghum genotypes showed highest activity in *kharif* at milky stage and at physiological maturity

in summer season. The invertases are lowest in kharif at physiological maturity stage and in summer season the invertase activity is maximum at physiological maturity stage

Studying the therapeutic properties and establishing sorghum grain as a functional food

- Grain quality of the 127 genotypes analyzed and 10 genotypes were identified with starch content above 69%. Some promising ones are IS2397, SPV1244, EP22, EP64, NSJB6625, IS8348, IS16151, IS19445.
- Amylose content varied from 15.05% in IS 16151 to 28.11% in SPV1471.

Genetic enhancement of sweet and high biomass sorghums for traits related to 1st and 2nd generation biofuel production and shoot pest tolerance

- DSRV8 exhibited significant superiority of 88.8 t/ha (13.52%) for total fresh biomass over the check CSV 19SS (78.2 t/ha).
- Significant and higher brix was observed in DSRV17 (23.2%) over the check (19.2%)
- DSRV7, DSRV13 and DSRV17 and exhibited significantly higher juice yield (10-36%) over the check.
- DSRV17 exhibited significant superior performance for ethanol yield, TSS, TSI and brix (%) and had significant positive heterosis of 33%, 21%, 33% and 21% respectively
- DSRH5 (20.10%) recorded higher brix over the check (14.95%).
- DSRH1, DSRH2, DSRH5, DSRH7 and DSRH10 yielded significantly higher juice and ethanol yields over the check and a standard heterosis of more than 40 per cent.
- The hybrid DSRH5 had a standard heterosis of 93.14% for ethanol yield and 45.17% for juice yield.

Development of novel pre-breeding lines through wide hybridization in sorghum

- De novo variation was created through repeated inter generic pollination between sorghum and maize. A set of variants showed high biomass traits such as juicy thick stems, very tall plants, and greater leaf area . Twenty four such high biomass lines were subjected to in house evaluation in the field along with two checks SSV84 and CSV22S. Significant differences among the genotypes were observed. Comparative evaluation of the data for two consecutive Kharif seasons showed four promising lines , 2114-3, 2127-6, 2288-3 and 2289-1-6. These two are derived from two parental lines.

Kharif sorghum breeding at AICSIP centers

- At Akola total 54 individual plant selection were made in R line development programme while in B line development programme 65 IPS were selected. Total 118 BC pairs were made in grain breeding programme. In grain mold resistance breeding programme, total 45 IPS were selected in R line development programme while in B line development programme 15 IPS were selected. Total 105 BC pairs were made in grain breeding programme. In shoot fly resistance breeding programme, total 3 IPS were selected in R line development programme while in B line development programme 19 IPS were selected. Total 44 BC pairs were made in grain breeding programme. In drought tolerance breeding programme, 7 IPS were selected in two R × R crosses received from the Project under group efforts on sharing of breeding material. Total 6 Station Hybrid/Varietal Trials were successfully conducted. Besides these trials, one Private Hybrid Testing Trial consisting of three hybrids from the private companies were evaluated. Total 7 AICSIP trials were allotted to this centre and were conducted successfully and data submitted to project. One Ph.D. and two M.Sc. students completed their research programme at this unit during the last year. This unit has undertaken four training programmes for the farmers. Total six research papers have been published in the NAAS rated journals. Similarly, 16 abstracts have been published in different international and national seminars during the year 2013-14. Seven popular articles and two books were also published. This centre received two awards, viz., the “Best Performing Centre Award-2012” during the AGM at Hyderabad on 21/04/2013 and the Best Poster Presentation Award during the Global Consultation on Millets on 21/12/2013.
- At Coimbatore in *Grain sorghum breeding* programme in UVT I(S), eight cultures were tested and TNS 644 excelled the check variety CO 30 by recording grain yield of 2854 kg/ha with increased

yield of 6.37 percent. In UVT II, Three entries viz., TNS 647, TNS 648 and TNS 649 were found to be superior with grain yield potential of 3457, 3604 and 3669 kg/ha with increased yield of 11, 14 and 16 % over the CO 30. Seven new cultures viz., TNS 651, TNS 652, TNS 653, TNS 654, TNS 655, TNS 656 and TNS 657 selected from non replicated trials were raised and the crop is early seedling stage. Two hybrids ICS12A x ICSR 89020 and ICS90001A x CO 30 recorded highest grain yield of 2839 and 3332 kg of grain yield/ha with fodder yield potential of 7.5 and 9.7 tons/ha respectively. They possessed grain yield advantage of 14 and 34 per cent over Local Check Co5. The plant heights recorded in these entries were of 188 and 200 cm respectively. Under R line development programme a total of 38 crosses were evaluated under different generation and 260 families has been forwarded. Under trait specific development programmer 4 crosses for drought and 4 crosses for shoot fly has been evaluated in F₂ and 50 families each has been selected for further evaluation. Under B line development programme B x B and B X R crosses has been effected. The resistant entry identified in AICSIP trials viz., CSV 17 for shoot fly, SPV 2175 for mite, SPV 2176 and SPV 2177 for head bug were utilized in making new crosses. A total quantity of 500 kg of CO 30 sorghum TFL seeds were distributed to the farmers. In *Forage and sweet sorghum breeding* programme SPV 2242 promoted to AVT - I, 2014 as it recorded first rank on an average over Zone I and II. Forage sorghum single cut superior cultures namely TNFS 213, 215 identified for testing in AICSIP 2014 as it recorded 9-12 % higher GFY than CO 30 under UVT Trial. Sweet sorghum culture TNSS 214 recorded 11 % higher cane yield than CSV 24 SS with 18 % brix under UVT Trial and identified for AICSIP 2014 Trial. Forage sorghum multi cut superior cultures namely TNFS 210, TNFS 211 found to be 7 % higher than local check CO FS 29 under UVT Trial. 60 Hybrids combination in sweet and forage sorghum evaluated for Hybrid identification and 55 new combinations were synthesized. Four hybrids combinations identified as promising advanced to second year testing. Forage sorghum and sweet sorghum segregating material were evaluated and superior single plants identified in F₅, F₆ families for seed multiplication. A total of 39 new emasculation crosses 17 and 22 in Forage and sweet sorghum and segregating materials F₂ - F₆ were evaluated. Twenty one crosses studied and 315 single plants selected for further evaluation in R line improvement program. Mutation material from Co 11 Variety involving treatments Gamma, EMS and Sodium Azide were developed and M2 generation evaluated for forage traits. Working germplasm 300 accessions raised for maintenance and utilized in breeding program and a part characterized for qualitative and quantitative traits. All four Forage and sweet sorghum Trial successfully conducted, sucrose analysis done and data loaded.

- At Deesa during the *Kharif* 2013, total rainfall received 1171.7 mm. The maximum rainfall received in September followed by July. The most of the *kharif* trials was sown in first fortnight of July. Total five state trials, two station trials and seven coordinated trials were conducted during *Kharif* 2013. Under crop improvement programme 317 segregating materials & SPS of dual and forage type sorghum were evaluated and 1096 selections were made on the basis of yield, earliness, shoot fly resistance and agronomic superiority. A total of 392 accessions of forage and dual type sorghum were maintained under germplasm maintenance programme. The summary of research programmes and achievements during *Kharif* 2013 are presented as below.
- At Dharwad sorghum improvement work is carried out with the objective of developing varieties/hybrids with good grain quality; short duration and resistance to biotic stresses like shoot fly tolerance and grain mold resistance. In order to achieve set objectives, as many as five ICAR Viz., AVT, IVT, AHT, IHT and PPHT trials were conducted apart from eight station trials including private hybrid testing. *Multilocation Varietal trial*: In this trial, a total of twenty entries comprising of 15 from Dharwad and five from DSR, Hyderabad were tested at Dharwad centre, out of these, entry from Dharwad SPV-2172 (undergoing AVT) recorded significantly superior grain yield of 4236.00 kg/ha compared to superior check DSV-6 (3212 kg/ha). This was followed by SVD-1203 (3888.0 kg/ha) and SVD-744 entries. The entry SVD-1203 also exhibited highest 1000 seed weight of 32.0 g. compared to 24.0 g. of DSV-6. None of the DSR entries were superior to local check (DSV-6). The trial was also conducted in ARS, Bailhongal, Hanamanamatti, ARS, Bidar and ARS Gulburga. *Multilocation Hybrid trial*: The six new hybrids along with four checks were tested in multilocation hybrid trial at six locations. The results of Dharwad location revealed superior performance of CSH-30 (3779.0 kg/ha) and SHD-6 (3648 kg/ha) compared to check hybrids like CSH-14 (2298 kg/ha) and CSH-16 (2940.0 kg/ha). *Station varietal trial*: Among twelve

entries tested, two entries SVD-1124 and SVD-1130 recorded significantly superior grain yield and on par fodder yield with DSV-6 (2352.0 kg/ha). *Station Hybrid Trial-I*: Among 15 hybrids tested including checks, SHD-34 recorded significantly superior grain yield of 5611.0 kg/ha over high yielding check CSH-16 (3296.0 kg/ha) and numerical superiority over recently released hybrid CSH-30 (4723 kg/ha). *Station Hybrid Trial- III* : Out of 13 hybrids tested, SHD-6 exhibited significantly superior grain yield of 4681.00 kg/ha and on par fodder yield with high yielding check CSH-16 (3431 kg/ha) but highest grain yield was recorded by CSH-30 hybrid (5167.0 kg/ha). *Testing of private hybrids*: Among six entries tested along with two checks, NSH-54 was superior hybrid compared to CSH-14 and CSH-16 check hybrids. *Generation of breeding material*: As many as 18 fresh crosses were made and 123 selections were made in various generations from F₂ to F₆ and 120 M 3 progenies were evaluated for grain mold tolerance and grain size.

- In Indore the season was not favourable due to heavy and continuous rains and after that there was heavy infestation of shoot fly and stem borer. Six AICSIP and four station trials were conducted, and other breeding works taken up.
- In Kovilpatti a high yielding dual purpose sorghum culture TKS_V 0809 developed from this centre has recorded an average grain yield of 2999 kg/ ha over 141 yield trials of different location and registering 16.9% and 24.7% increase over the checks K 8 (Local) and CSV 17 (National) respectively. TKS_V 0809 recorded the dry fodder yield of 11.56t/ ha which is 34.2% and 41.3% increase yield over K8 and CSV 17 respectively. Hence, this culture was proposed for released as K 12 for the winter rainfed vertisol tracts of Tamil Nadu during 2014-15. Two high yielding single cut forage sorghum cultures TKFS 1047 and TKFS 1052 are being proposed to Multilocation testing in the winter rainfed vertisol tracts of Tamil Nadu. During winter 2013-14, a total of 6 fresh crosses were effected with midge resistance donars. In F₂ populations three single plants were selected with grade 1 resistance. Similarly four single plants from F₃ progenies were selected with grade 1 and two single plants from F₄ progenies were selected with grade 1 resistance. The susceptible check K8 has recorded 90% midge incidence. During the summer 2013 - 14 a total of 16 fresh crosses were effected with Mite resistance donars. In F₂, 4 single plants were selected with grade 1 resistance. In F₃, 6 single plants were selected with grade 1 resistance. In F₄, 5 single plants were selected with grade 1 resistance. The susceptible check K 4 has 95% Mite incidence.
- At Palem towards varietal improvement programme, PSV-56, a high yielding dual purpose sorghum variety with tolerance to grain mold disease, was released in the name of SRISAILA by State Varietal Release Committee, Andhra Pradesh. The notification proposals of the variety were also submitted to Government of India. Two high yielding and grain mold tolerant dual purpose sorghum entries PSVGS-106 (SPV2122) and PSVGS-210 (SPV 2110) are in Advanced Varietal Trial - II stage in Coordinated Trials at All India Level. A high yielding and grain mold tolerant culture, PSVGS-113 is in Advanced Varietal Trial - I stage in Coordinated Trials at All India Level. Two sorghum cultures *viz.*, PSVDP-306 and PSVDP-316 are evaluated in Initial Varietal Trial stage in Coordinated Trials at All India Level. In Hybrid development programme, 14 R lines and 17 B lines for various important characters are in F₆/F₅ stage of development. These lines are derived from the material supplied by Directorate of Sorghum Research under Network Breeding Programme. Further, four yellow pericarp sorghum land races were submitted to National Bureau of Plant Genetic Resources for registration. Of these landraces, PYPS-2 was accepted for registration whereas the other lines *viz.*, PYPS-8, PYPS-13 and PYPS-14, were asked for submitting check performance data. In Grain Sorghum, three Station Trials were conducted during *khariif* 2013-14. In AVTGS - II - 6 entries, in AVTGS-I - 8 entries and in IVTGS - 8 entries were found to be superior for grain and fodder yields compared to the checks PSV-56 and PSV-1. All the All India Coordinated Sorghum Improvement Project breeding trials were conducted during *khariif* 2013 without any deficiency.
- At Pantnagar 346 fodder/dual purpose, sweet sorghum and grain type germplasm lines were maintained. A set of 14 diverse genotypes was planted in crossing block for attempting new crosses through diallel crossing with the objective of improvement in foliar disease resistance, fodder yield and quality. Thirty three CMS lines (A/B pairs) of A₁ and A₂ cytoplasm were maintained. Fifty three new crosses were attempted through emasculation and hand pollination for genetic improvement in terms of fodder yield, quality and foliar disease resistance. Inter generic crosses between sorghum x maize, sorghum x teosinte and maize x teosinte were

attempted between three CMS lines of sorghum, one variety (African Tall) of maize and one local variety of Teosinte. A total of 773 SPS/ progeny bulks of 155 crosses/families (from F₁ to F₇ onward generations) were evaluated, of which 740 SPS/progeny bulks of 143 crosses/families were selected for desirable traits. Selected lines will be used as restorers and open pollinated varieties. The multicut experimental hybrid SPH 1697 (UTMCH 1310) which has completed three years of testing showed 10 per cent superiority for green and dry fodder yield and per day productivity, over checks, besides good nutritional quality. The identification proposal of this hybrid will be submitted for its consideration for release in the 44th AGM. The multicut experimental hybrid SPH 1748 (UTMCH 1311) was tested in IVT multicut during Kharif 2013. It had better quality in terms of protein percent, protein yield and DDM yield as compared to both the checks therefore, promoted to AVT I. For evaluation of yield and quality in forage sorghum and sweet sorghum, 8 All India Coordinated Trials, two State Trials, three Station Trials and three Students' Thesis Research Trials were conducted during Kharif 2013. Two entries viz. SPV 2201 (UTFS 71), SPV 2262 (UTFS 74) were incorporated from the centre in IVT single cut. Both these entries showed superiority of 17-18% for green fodder and 20-23% for dry fodder yield over best check CSV 21 F. In the State Varietal Trials single cut varieties UTFS 83 and UTFS 79 showed 26% and 20 % superiority, respectively for green fodder yield and 35% and 29 % for dry fodder yield over check CSV 21F. Whereas multicut varieties UTMCH 545 and UTMCH 548 were better for green as well as dry fodder yield to the tune of 37% and 30%, respectively, than check Pant Chari 6. Amongst the experimental multicut hybrid tested in Station Trials the hybrid EHT 2013-16 was most promising showing dry fodder yield almost *at par* with best check CSH 20 MF. Result of single cut Station Varietal Trial indicated that the entry ESVT 2013-9 was most promising showing numerical superiority over best check CSV 21F. Out of 12 single and three way cross hybrids tested as single cut entry, the most promising was TWCT-2013-5 showing green and dry fodder yield to the tune of 755.48 q/ha and 211.53q/ha, respectively in one cut.

- At Parbhani during 2013-14 total 18 AICSIP project trials, 4 state level trials and 18 station trials were conducted during kharif and rabi season. One kharif based hybrid SPH 1735 and two rabi based varieties SPV 2144 and SPV 2221 from Parbhani are in advance testing trial. Four thousand germplasm lines received from DSR were evaluated during rabi 2014 for shoot fly reaction, grain and fodder yield and yield attributing traits. 122 accessions for shoot fly tolerance, 45 accessions for grain quality and 62 accessions for yield potential and agronomic performance were selected. Eighty five single plant selection/families from 39 crosses of kharif based segregating populations and 205 single plant selection/ families from 57 crosses of rabi based segregating populations were made for R line development. KR 211, KR 225, KR 235 and KR 911 are promising kharif based restorers identified from advance generations. Selections for grain mold tolerance (65 for R lines and 78 for B lines), shoot fly tolerance (83 for R lines and 97 for B lines) and drought tolerance (78) were made in F₂, F₃ and F₄ populations. Thirty eight and 54 marker assisted F₃ and F₄ progenies were evaluated for shootfly tolerance coupled with high grain & fodder yield and 12 & 14 promising progenies were selected. Five isolines of PMS 20 B genetic background, differ for shoot fly resistant QTLs introgression were crossed with PMS 20A. 29 pairwise crosses were made in BC₁F₁ generation of 5 F₁s.
- At Phaltan different crosses between parents after considering desired traits had been made following diallel mating design in previous years. All the progenies in different generations were evaluated for the characters like plant height, total biomass, stripped stalk weight, juice yield, brix of juice and grain yield. One hundred thirty two F₅ progenies evolved from six different families evaluated in Kharif 2013 were subjected to single plant selection. In all, 197 single plant selections based upon high biomass, brix of juice and grain yield were made in the promising families. In F₇ generation, 20 progenies evolved from six promising crosses were evaluated during Kharif 2013. Among them line DC-32-31 gave significantly highest brix of juice (19 %), total sugar index (3.34 t/ha) and grain yield (2.01 q/ha) as against the check cultivar CSV-24-SS with 17 % brix of juice, 1.71 t/ha total sugar index and 0.43 q/ha grain yield. The same line also exhibited superior performance for the characters like shoot fly damage (36.67 %) and stem borer incidence (16.87 %) compared to the check cultivar CSV-24-SS which showed higher shoot fly (59.93 %) and stem borer (23.74 %) damage. The DSR had supplied F₂ populations to all the centers in Kharif 2010 under network breeding programme and this material has been advanced to F₇ generation at NARI centre. Thirty four advanced F₇ progenies evolved from two different crosses were

evaluated during Kharif 2013. Out of these, 10 lines showed significantly higher total biomass and juice brix than the check CSV-24-SS. The line 10R-SS-20-61-8-5 gave the highest biomass (20.71 t/ha) and juice brix (24 %) followed by line 10R-SS-20-61-1-5 which had 20.27 t/ha total biomass and 23.33 % juice brix, line 10R-SS-19-16-5-2 which had 19.76 t/ha total biomass and 20.67 % juice brix as against the check CSV-24-SS which showed relatively lower total biomass (17.04 t/ha) and juice brix (19.67 %). Fifty five uniform lines which are almost stable were tested as PVT (Pre-varietal trial) entries along with two national checks viz., CSV-19-SS and CSV-24-SS in four different trials. In the first trial out of the 13 lines evaluated almost all were numerically higher in plant height, stripping % and brix of juice than both the checks. Line D-91-29-4 recorded the highest value of juice brix (22.83 %) among all the tested entries. Similarly lines D-91-9-2 recorded the highest values of grain yield (4.85 q/ha) and juice brix (21.83%) followed by lines D-91-9-5 (grain yield 2.38 q/ha and juice brix 22.17 %) and D-91-29-2 (grain yield 2.29 q/ha and juice brix 20.50 %) compared to the check CSV-24-SS (grain yield 1.62 q/ha and brix 19 %). In the second trial out of the 15 lines evaluated only four lines recorded greater plant height than the check where line D-141-34 showed significantly highest value for plant height (274.73 cm) with the check CSV-19-SS having plant height of 248.60 cm. Four lines viz., D-18-7-10-2 (Biomass 25.17 t/ha, juice yield 4.79 t/ha and brix 19.17 %), D-77-15-1 (Biomass 21.08 t/ha, juice yield 5.24 t/ha and brix 19.33 %), D-141-33 (Biomass 24.48 t/ha, juice yield 4.46 t/ha and brix 18.50 %) and line D-18-7-8-1 (Biomass 22.44 t/ha, juice yield 4.64 t/ha and brix 19.83 %) reported numerically higher values than the check CSV-24-SS (Biomass 20.49 t/ha, juice yield 4.21 t/ha and brix 18.50 %). Similarly line D-49-53 recorded the highest grain yield (7.10 q/ha) along with a higher brix of juice (19.00 %) than the check CSV-24-SS (Grain yield 2.22 t/ha and brix of juice 18.50 %). In the third trial again 15 entries were evaluated out of which almost all the lines reported greater plant height than the check CSV-24-SS (233.14 cm) with the line D-91-60 reporting maximum plant height (327.40 cm). Line D-94-74 (Biomass 32.35 t/ha, stripped stalk weight 21.54 t/ha and brix 20.50 %) gave numerically higher values than the check CSV-24-SS (Biomass 21.64 t/ha, stripped stalk weight 17.48 t/ha and brix 17.83 %). Almost all the 15 lines reported higher juice brix values than the check CSV-19-SS (17.83 %) with lines D-91-9 and D-91-35 (both 21.83 %) reporting the highest. In the fourth trial, 12 lines were tested out of which four lines were numerically superior in plant height to the check CSV-24-SS (240.27 cm) where line D-23-28-10-2-4 (354.67 cm) reported maximum plant height. Line D-34-20-2-5 (Plant height 286.67 cm, total biomass 30.10 t/ha, stripped stalk weight 20.23 t/ha) exhibited numerically higher values for the mentioned traits than the check CSV-24-SS (Plant height 240.27 cm, total biomass 25.21 t/ha, stripped stalk weight 13.97 t/ha). Almost all the lines which were evaluated in the trial were numerically higher in juice brix than the check CSV-24-SS where lines D-44-3-3 and D-44-3-11 reported the highest brix values (both 21.8 %) and grain yields 5.10 t/ha and 6.04 t/ha respectively compared to the check CSV-24-SS which had juice brix 17.8 % and grain yield 0.96 t/ha. B line development programme at the center was initiated during Kharif 2010 and this material was supplied by the DSR under network breeding programme. Total of 55 F₆ progenies produced from seven different crosses were evaluated in three different trials (Groups A, B & C) during Kharif 2013 (Table: 2). Similarly, another 34 lines which were derived from 11 different crosses and are in F₈ generation were also evaluated under B line development programme during the same season. In the first trial of the 15 F₆ entries evaluated three lines viz. 10B-AGR-46-45-2-4 (7.18 t/ha), 10B-AGR-46-52-5-1 (6.67 t/ha) and 10B-AGR-46-86-3-5 (5.88 t/ha) showed promising performance for stripped stalk weight as compared to the check 296B (4.66 t/ha) while line 10B-AGR-46-45-2-4 reported maximum grain yield (8.16 t/ha), juice yield (2.31 t/ha) and stripped stalk weight (7.18 t/ha) compared to the check CSV-24-SS (Grain yield 1.75 t/ha and juice yield 1.28 t/ha). In the second trial, among 17 F₆ progenies evaluated three lines gave numerically higher plant height than the check 296B (176.33 cm) where line 10B-AGR-47-24-1-1 (225 cm) gave the maximum plant height. Lines 10B-AGR-48-1-5-3 (Stripped stalk weight 9.05 t/ha and juice yield 2.27 t/ha) and 10B-AGR-48-14-4-2 (Stripped stalk weight 8.66 t/ha and juice yield 2.30 t/ha) recorded the highest values for the mentioned traits as compared to the check 296B (7.06 t/ha Stripped stalk weight and 1.24 t/ha juice yield). In the third trial, line 10B-AGR-61-37-1-2 reported the numerically highest total biomass (14.64 t/ha) and stripped stalk weight (5.42 t/ha) compared to the check 296B (13.04 t/ha biomass and 5.41 t/ha stripped stalk weight). Line 10B-AGR-61-36-1-3 exhibited significantly higher juice yield (3.47 t/ha) as compared to the check 296B (1.38 t/ha). Similarly, lines 10B-AGR-

66-49-3-2 showed numerically higher juice brix of 16% followed by the lines 10B-AGR-61-8-2-6 and 10B-AGR-66-49-3-1 (both 15.17 %) than the check 296B (15%). Again under B line development programme during the same season 34 lines which were derived from 11 different crosses and were in F₈ generation were tested for the different characters along with the promising parental lines NARI-SS-5 B and NARI-SS-11 B. Out of the 34 lines evaluated line NARI-54-1-2-3B reported significantly highest biomass of 15.04 t/ha as against that of the check NARI-SS-5 B (13.78 t/ha). Twenty two lines gave significantly higher juice yield as compared to the check NARI-SS-5B (18.05 t/ha). They were NARI-36-5-2-1-1B (53.38 t/ha) followed by NARI-54-1-1-1B (40.77 t/ha). Four lines viz., NARI-36-5-4-2B (21.08 %), NARI-5-1-3-2-1B (21.00 %), NARI-39-7-1-4-2B and NARI-41-5-2-1-1B (both 20.8 %) gave significantly higher juice brix than the check NARI-SS-5 B (17.5 %).

- At Rahuri during kharif season crop condition of sweet sorghum crop was satisfactory. The cane yield and brix % level in all the experiments was recorded satisfactorily. In general kharif season is favorable to sweet sorghum crop. The center has released the forage sorghum variety SPV 2057 under number CSV 30F by 43rd AGM held at DSR Hyderabad for zone I (Haryana, Uttarakhand, Gujarat, Uttar Pradesh, Rajasthan and Punjab) and Zone II (Tamilnadu, Karnataka and Maharashtra) for single cut purpose for kharif season. The notification proposal has been submitted to CVRC, New Delhi on 6/3/2014. Identified the Sweet sorghum Hybrid RSSH-50 for green cane yield coupled with high ethanol and tolerant to shootfly. The pre release proposal of this variety has been submitted to the University RRC meeting during 2013-14. This hybrid is proposed for kharif season for western Maharashtra.
- At Udaipur total rainfall received at the center till November was 811 mm against average rainfall 620 mm with continuous drizzling for a long period. More or less the same situation prevailed in all the sorghum growing regions of Rajasthan. Crop growth and yield in general was below satisfactory in all the disciplines. Centre has contributed 10 entries in coordinated trials. Out of these SPV 2061 was for testing of Agronomy & Pathology and SPV 1822 for re-verification of performance, two grain and DP genotypes viz. SPV 2164 and SPV 2165 and two single cut forage genotypes viz. SPV 2185 and SPV 2186 were for advance testing (AVT I), two grain and DP genotypes viz. SU 1426 and SU 1429 and two forage single cut genotypes viz. SU 1454 and SU 1465 for initial testing (IVT). Two varieties CSV 17 and CSV 23 of this centre was also used as check in coordinated trials. One hundred twenty Germplasm were evaluated in augmented RBD. The 20 parents involving agronomically superior, insect resistant, drought resistant, early lines/germplasm were planted in SPT to attempt fresh crosses for different attributes as per mandate. Apart from this 6 parental diallel was attempted between multi cut and single cut genotypes. 16 Hybrids were developed using different MS lines. The 30 F₁s and 3 back crosses were evaluation and advanced. The 152 crosses having 396 progenies including trait specific crosses were evaluated and progenies were identified for evaluation in next generation. Apart from coordinated trials 2 grain varietal, 1 grain hybrid, 3 forage (SC) and 2 forage (MC) trials were conducted during summer and rainy season. Breeder seed production programme for CSV 17, CSV 23 and PC 1080, and nucleus seed production programme of SPV245, CSV15, CSV10, CSV17, PJ1430, CSV23, PC1080, SPV1822, SU45, SU 52, SPV1753, AKMS 14A, AKMS 14B and AKR 150 was under taken.

Publications

During 2012-13 on grain, forage and sweet sorghum improvement all total 32 publications have been made, out of which 3 are in International journals.

Detailed report

Introduction

During 2013, both basic and applied researches towards improvement of grain sorghum were undertaken. Applied researches dealt with multi-location yield trials of finished or near finished products (varieties and hybrids) from the centers of All India Coordinated Sorghum Improvement Project (AICSIP) and private companies. Basic and strategic researches focused on various aspects including new MS and R line development, breeding for earliness, drought tolerance, cold tolerance, resistance against key insects and diseases etc. Efforts were made to use biotechnological tools as well towards improvement of grain sorghum. Efforts were also made to develop inter-institutional hybrids, under which promising MS lines were shared across centers and new experimental hybrids were developed, which were tested under multi-location trials. The progresses made during the kharif 2013 are discussed under the following heads:

- I. Multi-location AICSIP trials
- II. Coordinated sorghum breeding research
- III. Kharif sorghum breeding at DSR
- IV. Kharif sorghum breeding at AICSIP centers
- V. Publications

Kharif – 2013

I Multi-location AICSIP trials

During kharif 2013 4 trials, viz., Advanced Hybrid Trial (AHT), Advanced Variety Trial (AVT), Initial Hybrid Trial (IHT) and Initial Variety Trial (IVT) were conducted across 9 (initial trials) to 25 locations (AHT). For late kharif 2 trials, viz., Late Kharif Advanced Hybrid Trial (LK AHT) and Late Kharif Advanced Variety Trial (LK IAVT) were conducted at 6 locations.

Advanced Hybrid Trial (Tables 1, 1A and 1B)

In this trial 9 hybrids and 4 checks were evaluated across 8 and 17 locations in Zone I and Zone II, respectively. Out of 9 test hybrids 3 were in AHT II. Performances of hybrids in AHT for 2 years are shown in Table 1. Best checks for grain and fodder yields in Zone I were CSH 16 and CSH 25, respectively, and none of the test hybrids performed better than these in terms of grain yield, while for fodder yield SHP 1705 performed better than the best performing check. In Zone II check, CSH 25 out yielded all the checks both for grain and fodder yields, and none of the entries could out perform this check.

Table 1. Performance of hybrids in Advanced Hybrid Trial (AHT) during kharif 2012 and 2013

Sl. No	Entry	Center	Grain yield (kg/ha)			% ± over CSH 16	% ± over CSH 25	Fodder yield (kg/ha)			% ± over CSH 16	% ± over CSH 25
			2012	2013	Mean			2012	2013	Mean		
Zone I												
1	SPH 1702	Hytech	4069	4316	4192	-3.8	-2.7	13220	12362	12791	3.8	4.8
2	SPH 1703	Nuziveedu	4272	4356	4314	-1.0	0.1	12355	12294	12325	0.1	1.0
3	SPH 1705	Akola	4401	4155	4278	-1.8	-0.7	14350	12592	13471	9.4	10.3
4	CSH 16	Check	4734	3979	4357	0.0	1.1	13361	11273	12317	0.0	0.9
5	CSH 23	Check	3572	3799	3686	-15.4	-14.5	9954	11558	10756	-12.7	-11.9
6	CSH 25	Check	4449	4170	4309	-1.1	0.0	12659	11757	12208	-0.9	0.0
7	CSH 30	Check		3847	3847	-11.7	-10.7		11886	11886	-3.5	-2.6
Zone II												
1	SPH 1702	Hytech	4585	4398	4491	17.7	-1.0	12388	12473	12430	12.5	-6.1
2	SPH 1703	Nuziveedu	3737	3966	3852	1.0	-15.1	11129	10926	11027	-0.2	-16.7
3	SPH 1705	Akola	4131	4131	4131	8.3	-9.0	12185	11600	11893	7.7	-10.1
4	CSH 16	Check	4004	3625	3814	0.0	-15.9	10871	11224	11048	0.0	-16.5
5	CSH 23	Check	2795	3454	3125	-18.1	-31.1	8952	9942	9447	-14.5	-28.6
6	CSH 25	Check	4809	4267	4538	19.0	0.0	14977	11489	13233	19.8	0.0
7	CSH 30	Check		3423	3423	-10.3	-24.6		9865	9865	-10.7	-25.5

Zone I (Table 1A)

- *Days to flowering and maturity* – Flowering among hybrids ranged from 62 (CSH 30) to 67 days (SPH 1731 and SPH 1733). Early checks, CSH 23 and CSH 30 matured earliest (96 days), and check CSH 25 took longest time to mature (103 days).
- *Plant height* – Plant height ranged from 168 (CSH 30) to 188 cm (SPH 1736).
- *Grain yield* – CSH 25 was the best performing check (4170 kg/ha) and four among 9 test hybrids, viz., SSPH 1736, SPH 1703, PH 1702 and SPH 1731 performed better than best performing check. Three hybrids, SPH 1702, SPH 1703 and SPH 1724 were statistically of same maturity to early checks but all recorded higher yield than these checks.

- *Fodder yield* – Among checks, CSH 30 recorded maximum yield (11886 kg/ha). Except SPH 1731 among test hybrids all recorded better yield than CSH 30. Compared to best grain yielding check, CSH 25, SPH 1724 recorded almost 10% yield superiority.
- *Grain size* – Grain size ranged from 2.53 g/100 grain (SPH 1731) to 3.38 g/100 grain (SPH 1736).
- *Remarks* – In Zone I SPH 1702 (4316 kg/ha) and SPH 1703 (4356 kg/ha) performed better than best performing check, CSH 25 (4170 kg/ha) in terms of grain yield, while SPH 1724 recorded superior fodder yield (12905 kg/ha) than best performing check, CSH 30 (11886 kg/ha). However, none of them recorded more than 10% yield superiority.

Table 1A. Performance of hybrids in Advanced Hybrid Trial (AHT) – Zone I during kharif 2013

Sl No	Entry	Center	Zone of testing	GY	R	% ± over CSH 16	% ± over CSH 25	FY	R	% ± over CSH 16	% ± over CSH 25	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPH 1702 (2)	Hyletech	II	4316	3	8.5	3.5	12362	5	9.7	5.2	65	100	177	3.00	4.1	3.8	77.3
2	SPH 1703 (2)	Nuziveedu	I	4356	2	9.5	4.5	12294	6	9.1	4.6	64	99	173	2.90	3.7	3.5	62.1
3	SPH 1705 (2)	Akola	II	4155	7	4.4	-0.4	12592	3	11.7	7.1	66	101	181	2.82	5.3	5.2	73.1
4	SPH 1724	DSR	I	3992	10	0.3	-4.3	12905	1	14.5	9.8	65	99	181	2.86	5.1	4.8	69.4
5	SPH 1730	Nuziveedu	II	4141	8	4.1	-0.7	12055	8	6.9	2.5	66	100	177	2.83	5.7	5.6	75.6
6	SPH 1731	Prabhat Agri	I & II	4297	4	8.0	3.1	11677	12	3.6	-0.7	67	101	181	2.53	5.3	5.2	76.1
7	SPH 1733	Hyletech	II	4157	6	4.5	-0.3	11940	9	5.9	1.6	67	102	169	2.75	4.7	4.4	77.7
8	SPH 1736	Devgen	II	4456	1	12.0	6.9	12426	4	10.2	5.7	66	99	188	3.38	4.0	3.8	77.6
9	SPH 1737	MSSC Ltd	I & II	4133	9	3.9	-0.9	12782	2	13.4	8.7	66	101	176	3.01	3.0	2.8	72.0
10	CSH 16	Check		3979	11	0.0	-4.6	11273	14	0.0	-4.1	65	99	184	3.09	3.9	3.7	78.0
11	CSH 23	Check		3799	13	-4.5	-8.9	11558	13	2.5	-1.7	63	96	170	3.03	5.3	5.0	71.1
12	CSH 25	Check		4170	5	4.8	0.0	11757	11	4.3	0.0	68	103	188	2.91	5.3	5.0	77.2
13	CSH 30	Check		3847	12	-3.3	-7.7	11886	10	5.4	1.1	62	96	168	3.08	5.3	5.1	75.7
14	Local Check	Check		3281	14	-17.5	-21.3	12150	7	7.8	3.3	68	101	183	2.83	2.3	2.0	70.3
	Gen. Mean			4077				12118				66	100	178	2.93	4.4	4.2	72.6
	CV(%)			13.80				10.04				4.22	3.24	8.64	10.72	25.9	27.7	12.5
	CD(5%)			668				1211				3	3	14	0.26	1.9	1.9	10.4
	CD(1%)			894				1621				4	4	18	0.34	2.5	2.6	13.8

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Zone II (Table 1B)

- *Days to flowering* – Flowering among hybrids ranged from 70 (CSH 23) to 78 days (CSH 25). Early check, CSH 23 matured earliest (108 days), and CSH 25 followed by SPH 1733, SPH 1736 and others took longest time to mature.
- *Plant height* – Plant height ranged from 175 (SPH 1703) to 225 cm (SPH 1736).
- *Grain yield* – CSH 25 was the best performing check (4267 kg/ha) and only two hybrids (SPH 1736) and SPH 1702 performed better than CSH 25 with grain yield of 4633 and 4398 kg/ha, respectively. SPH 1703, SPH 1705, SPH 1724 and SPH 1737 were comparable to early checks and recorded more than 10% yield superiority.
- *Fodder yield* – CSH 25 also ranked first among the checks in terms of fodder yield (11489 kg/ha). Three hybrids, SPH 1724 (12666 kg/ha), SPH 1731 (12665 kg/ha) and SPH 1736 (14462 kg/ha) out yielded this check.
- *Grain size* – Grain size ranged from 2.72 g/100 grain (SPH 1703) to 3.20 g/100 grain (SPH 1736).
- *Remarks* – SPH 1736 (4633 kg/ha) and SPH 1702 (4398 kg/ha) performed better than CSH 25 in terms of grain yield and SPH 1724 (12666 kg/ha), SPH 1731 (12665 kg/ha) and SPH 1736 (14462 kg/ha) gave better fodder yield than CSH 25 (11489 kg/ha). SPH 1703 (3966 kg/ha), SPH 1705 (4131 kg/ha), SPH 1724 (4098 kg/ha) and SPH 1737 (3907 kg/ha) were comparable to early check, CSH 23 and recorded more than 10% yield superiority than observed in it (3454 kg/ha).

Table 1B. Performance of hybrids in Advanced Hybrid Trial (AHT) – Zone II during kharif 2013

Sl No	Entry	Center	Zone of testing	GY	R	% ± over CSH 16	% ± over CSH 25	FY	R	% ± over CSH 16	% ± over CSH 25	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPH 1702 (2)	Hyletech	II	4398	2	21.3	3.1	12473	5	11.1	8.6	76	113	195	2.91	4.0	4.9	77.3
2	SPH 1703 (2)	Nuziveedu	I	3966	10	9.4	-7.1	10926	11	-2.7	-4.9	70	108	175	2.72	4.0	4.8	62.1
3	SPH 1705 (2)	Akola	II	4131	8	13.9	-3.2	11600	7	3.4	1.0	72	110	197	2.84	4.9	5.8	73.1
4	SPH 1724	DSR	I	4098	9	13.1	-4.0	12666	2	12.8	10.2	71	109	204	2.90	3.3	4.5	69.4
5	SPH 1730	Nuziveedu	II	4170	7	15.0	-2.3	12323	6	9.8	7.3	75	113	189	2.98	3.8	4.8	75.6
6	SPH 1731	Prabhat Agri	I & II	4235	6	16.8	-0.8	12665	3	12.8	10.2	76	114	188	3.01	3.4	4.3	76.1
7	SPH 1733	Hyletech	II	4253	4	17.3	-0.3	10585	12	-5.7	-7.9	77	115	179	2.81	4.7	5.9	77.7
8	SPH 1736	Devgen	II	4633	1	27.8	8.6	14462	1	28.8	25.9	76	114	225	3.20	3.5	4.6	77.6
9	SPH 1737	MSSC Ltd	I & II	3907	11	7.8	-8.4	11224	9	0.0	-2.3	74	111	187	2.95	3.8	5.2	72.0
10	CSH 16	Check		3625	12	0.0	-15.1	11224	10	0.0	-2.3	73	111	193	3.16	2.9	3.8	78.0
11	CSH 23	Check		3454	13	-4.7	-19.0	9942	13	-11.4	-13.5	70	108	176	3.04	4.0	5.2	71.1
12	CSH 25	Check		4267	3	17.7	0.0	11489	8	2.4	0.0	78	116	213	2.76	4.1	5.2	77.2
13	CSH 30	Check		3423	14	-5.6	-19.8	9865	14	-12.1	-14.1	71	109	179	3.07	4.5	5.3	75.7
14	Local Check	Check		4240	5	17.0	-0.6	12536	4	11.7	9.1	73	112	199	2.88	3.4	4.6	70.3
	General Mean			3882				11675				73	111	195	2.95	3.8	4.8	72.6
	CV(%)			14.26				14.47				4.51	3.04	9.16	8.68	27.6	16.5	12.5
	CD(5%)			472				1287				3	3	10	0.18	1.4	1.9	10.4
	CD(1%)			623				1701				3	4	14	0.23	1.9	2.6	13.8

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Advanced Variety Trial (Table 2, 2A and 2B)

In this trial 21 varieties including 5 checks were evaluated across 8 and 14 locations in Zone I and Zone II, respectively. Out of 16 test varieties 4 were in AVT II and remaining in AVT I. Performances of varieties in AVT II over 2 years are shown in Table 2. In both Zone I and II CSV 27 was the best performing check, and compared to it all the four varieties in AVT II in Zone I recorded more than 10% superiority for grain yield. For fodder yield none of the varieties performed better than CSV 27. In Zone II SPV 2114 recorded 10% grain yield advantage over CSV 27, however none recorded better fodder yield than CSV 27.

Table 2. Performance of hybrids in Advanced Variety Trial (AVT) during kharif 2012 and 2013

Sl. No.	Entry	Center	Grain yield (kg/ha)			% ± over CSV 27	Fodder yield (kg/ha)			% ± over CSV 27
			2012	2013	Mean		2012	2013	Mean	
Zone I										
1	SPV 1822 (2)	Udaipur		3202	3202	27.3		11862	11862	-13.1
2	SPV 2110 (2)	Palem	2514	3235	2875	14.3	12990	10520	11755	-13.8
3	SPV 2114 (2)	DSR	2562	3016	2789	10.9	13509	12034	12772	-6.4
4	SPV 2122 (2)	Palem	2713	3389	3051	21.3	13201	11855	12528	-8.2
5	CSV 17	Check	1993	2854	2424	-3.7	8812	8587	8699	-36.2
6	CSV 20	Check	1699	2863	2281	-9.3	11395	12198	11797	-13.5
7	CSV 23	Check	2088	2633	2360	-6.2	13926	11873	12899	-5.5
8	CSV 27	Check	2106	2925	2515	0.0	14220	13066	13643	0.0
Zone II										
1	SPV 1822 (2)	Udaipur		3116	3116	-3.2		12579	12579	-13.8
2	SPV 2110 (2)	Palem	3549	3109	3329	3.5	14502	12639	13570	-7.0
3	SPV 2114 (2)	DSR	3943	3135	3539	10.0	14878	12365	13621	-6.6
4	SPV 2122 (2)	Palem	3524	3029	3277	1.8	15675	13258	14467	-0.8
5	CSV 17	Check	3039	2896	2967	-7.8	7633	9106	8370	-42.6
6	CSV 20	Check	2654	3197	2926	-9.1	11318	13071	12195	-16.4
7	CSV 23	Check	2767	3197	2982	-7.3	13763	12392	13077	-10.4
8	CSV 27	Check	3329	3106	3218	0.0	16942	12238	14590	0.0

Zone I (Table 2A)

- *Days to flowering* – Flowering among varieties ranged from 61 (CSV 17) to 70 days (CSV 23, CSV 27, SPV 2170). Early check, CSV 17 matured earliest (93 days), and CSV 27 took longest time to mature (103 days). Among the test varieties, SPV 2110 and SPV 2174 were comparable to early check, CSV 17.
- *Plant height* – Plant height ranged from 145 (CSV 17) to 204 cm (SPV 2114, SPV 2172).
- *Grain yield* – Among check varieties CSV 27 recorded highest grain yield (2925 kg/ha). Three varieties, viz., SPV 2110, SPV 2122 and SPV 2165 out yielded CSV 27 by over 10%. Highest yield was recorded in SPV 2122 (3389 kg/ha) followed by SPV 2110 (3235 kg/ha) and SPV 2165 (3229 kg/ha).
- *Fodder yield* – For fodder yield CSV 27 out yielded all the checks and all but one test varieties. SPV 2178 recorded marginal advantage (0.5%) over CSV 27.
- *Grain size* – Grain size ranged from 2.65 g/100 grain (SPV 2165) to 3.44 g/100 grain (SPV 2181).
- *Remarks* – In Zone I for grain yield SPV 2122 (3389 kg/ha) and SPV 2110 (3235 kg/ha) in AVT II and SPV 2165 (3229 kg/ha) in AVT I out yielded best performing check, CSV 27 (2925 kg/ha) by more than 10%. However, none of these could out yield CSV 27 in terms of fodder yield.

Table 2A. Performance of varieties in Advanced Variety Trial (AVT) – Zone I during kharif 2013

Sl No	Entry	Center	Zone of testing	GY	R	% ± over CSV 20	% ± over CSV 27	FY	R	% ± over CSV 20	% ± over CSV 27	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPV 1822 (2)	Udaipur		3202	4	11.9	9.5	11862	7	-2.8	-9.2	67	98	196	2.73	4.8	4.4	74.4
2	SPV 2110 (2)	Palem	I	3235	2	13.0	10.6	10520	16	-13.8	-19.5	64	98	194	2.83	4.8	4.4	68.7
3	SPV 2114 (2)	DSR	I & II	3016	8	5.4	3.1	12034	5	-1.3	-7.9	68	101	204	3.18	3.9	3.6	73.2
4	SPV 2122 (2)	Palem	I & II	3389	1	18.4	15.9	11855	8	-2.8	-9.3	65	97	196	2.81	4.3	3.8	78.2
5	SPV 2164	Udaipur	I & II	3109	5	8.6	6.3	11806	9	-3.2	-9.6	65	97	201	2.71	3.2	2.9	69.6
6	SPV 2165	Udaipur	II	3229	3	12.8	10.4	11671	10	-4.3	-10.7	65	98	188	2.65	4.0	3.6	70.2
7	SPV 2170	DSR	II	2720	18	-5.0	-7.0	11630	11	-4.7	-11.0	70	101	199	3.13	4.5	4.1	76.0
8	SPV 2172	Dharwad	I & II	3028	7	5.8	3.5	11563	12	-5.2	-11.5	68	101	204	2.68	4.5	4.1	75.8
9	SPV 2174	Coimbat	II	2778	17	-3.0	-5.0	9435	20	-22.7	-27.8	64	97	168	2.87	4.3	3.9	76.0
10	SPV 2175	Coimbat	I & II	2633	20	-8.0	-10.0	9845	18	-19.3	-24.6	66	97	177	2.66	5.1	4.9	69.5
11	SPV 2178	Palem	I & II	2892	13	1.0	-1.1	13132	1	7.7	0.5	68	100	200	2.87	3.7	3.4	70.9
12	SPV 2179	Palem	II	2638	19	-7.8	-9.8	11161	15	-8.5	-14.6	67	101	185	3.29	2.7	2.4	69.5
13	SPV 2181	Akola	II	2969	9	3.7	1.5	11367	13	-6.8	-13.0	68	100	195	3.44	3.0	2.4	66.4
14	SPV 2182	Akola	II	3035	6	6.0	3.8	11285	14	-7.5	-13.6	66	98	187	2.94	4.8	4.5	69.8
15	SPV 2183	Akola	II	2932	10	2.4	0.2	10215	17	-16.3	-21.8	65	97	192	2.80	4.5	4.2	71.4
16	SPV 2184	Akola	I & II	2902	12	1.4	-0.8	13006	3	6.6	-0.5	69	101	194	2.88	4.0	3.7	67.1

Sl No	Entry	Center	Zone of testing	GY	R	% ± over CSV 20	% ± over CSV 27	FY	R	% ± over CSV 20	% ± over CSV 27	DTF	DTM	PH	GW	GM FG	GM TG	SF
17	CSV 17	Check		2854	16	-0.3	-2.4	8587	21	-29.6	-34.3	61	93	145	2.78	3.5	3.3	74.4
18	CSV 20	Check		2863	14	0.0	-2.1	12198	4	0.0	-6.6	67	98	200	2.93	3.6	3.3	73.6
19	CSV 23	Check		2633	21	-8.0	-10.0	11873	6	-2.7	-9.1	70	102	193	2.84	4.2	3.9	70.7
20	CSV 27	Check		2925	11	2.2	0.0	13066	2	7.1	0.0	70	103	205	2.90	4.0	3.7	72.7
21	Local Check	Check		2856	15	-0.2	-2.3	9785	19	-19.8	-25.1	64	96	205	2.90	1.7	1.3	65.9
	General Mean			2945				11033				67	99	192	2.90	4.0	3.7	70.6
	CV(%)			17.81				13.69				5.30	3.39	8.88	11.39	27.9	30.6	12.1
	CD(5%)			539				2031				3	4	19	0.34	1.8	1.8	9.0
	CD(1%)			717				2701				4	5	25	0.45	2.4	2.5	11.9

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Zone II (Table 2B)

- *Days to flowering* – Flowering among varieties ranged from 69 (CSV 17) to 79 days (CSV 27, SPV 2170). Early check, CSV 17 to mature earliest (110 days), and CSV 27 took longest time to mature (119 days). None of the test varieties were comparable to early check, CSV 17.
- *Plant height* – Plant height ranged from 149 (CSV 17) to 230 cm (SPV 2178).
- *Grain yield* – CSV 20 and CSV 23 recorded highest grain yield 3197 kg/ha among the checks. Only one test variety, SPV 2178 recorded better yield than CSV 20 or CSV 23 with 3.9% superiority.
- *Fodder yield* – For fodder yield CSV 20 recorded highest yield among the checks (13071 kg/ha). Only two test varieties, viz., SPV 2178 (13367 kg/ha) and SPV 2122 (13258 kg/ha) marginally out yielded the checks.
- *Grain size* – Grain size ranged from 2.57 g/100 grain (SPV 2174) to 3.05 g/100 grain (SPV 2181).
- *Remarks* – In Zone II SPV 2178 (3322 kg/ha) recorded better yield than CSV 20 or CSV 23 (3197 kg/ha). Only two test varieties viz., SPV 2178 (13367 kg/ha) and SPV 2122 (13258 kg/ha) recorded marginal superiority over checks in terms of fodder yield.

Table 2B. Performance of varieties in Advanced Variety Trial (AVT) – Zone II during kharif 2013

Sl No	Entry	Center	Zone of testing	GY	R	% ± over CSV 20/23	% ± over CSV 27	FY	R	% ± over CSV 20	% ± over CSV 27	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPV 1822 (2)	Udaipur		3116	9	-2.5	0.3	12579	9	-3.8	2.8	77	117	217	2.67	3.6	4.6	74.4
2	SPV 2110 (2)	Palem	I	3109	10	-2.8	0.1	12639	8	-3.3	3.3	76	116	216	2.78	4.1	5.4	68.7
3	SPV 2114 (2)	DSR	I & II	3135	6	-2.0	0.9	12365	13	-5.4	1.0	75	116	211	2.78	3.7	4.7	73.2
4	SPV 2122 (2)	Palem	I & II	3029	15	-5.3	-2.5	13258	2	1.4	8.3	76	116	220	2.66	3.7	4.6	78.2
5	SPV 2164	Udaipur	I & II	3072	12	-3.9	-1.1	12022	16	-8.0	-1.8	76	116	212	2.76	3.6	4.9	69.6
6	SPV 2165	Udaipur	II	2983	18	-6.7	-4.0	12441	10	-4.8	1.7	76	116	211	2.66	3.6	4.1	70.2
7	SPV 2170	DSR	II	2927	20	-8.4	-5.8	12903	5	-1.3	5.4	79	118	212	2.97	4.3	4.6	76.0
8	SPV 2172	Dharwad	I & II	3167	5	-1.0	1.9	12860	6	-1.6	5.1	77	117	221	2.59	3.9	4.8	75.8
9	SPV 2174	Coimbat	II	3128	7	-2.2	0.7	11692	18	-10.5	-4.5	74	114	183	2.57	3.2	3.8	76.0
10	SPV 2175	Coimbat	I & II	2997	17	-6.3	-3.5	11409	19	-12.7	-6.8	76	117	188	2.63	3.6	4.3	69.5
11	SPV 2178	Palem	I & II	3322	1	3.9	6.9	13367	1	2.3	9.2	78	118	230	2.60	3.9	4.4	70.9
12	SPV 2179	Palem	II	3029	16	-5.3	-2.5	12111	15	-7.3	-1.0	77	118	206	2.94	3.6	4.4	69.5
13	SPV 2181	Akola	II	2948	19	-7.8	-5.1	12376	12	-5.3	1.1	76	117	201	3.05	3.2	3.7	66.4
14	SPV 2182	Akola	II	3119	8	-2.4	0.4	12756	7	-2.4	4.2	76	116	211	2.60	4.2	4.6	69.8
15	SPV 2183	Akola	II	3046	14	-4.7	-1.9	11310	20	-13.5	-7.6	76	116	209	2.64	3.7	4.8	71.4
16	SPV 2184	Akola	I & II	3070	13	-4.0	-1.2	12943	4	-1.0	5.8	77	117	218	2.73	3.4	4.7	67.1
17	CSV 17	Check		2896	21	-9.4	-6.8	9106	21	-30.3	-25.6	69	110	149	2.68	3.8	3.2	74.4
18	CSV 20	Check		3197	2	0.0	2.9	13071	3	0.0	6.8	76	116	220	2.65	4.0	4.4	73.6
19	CSV 23	Check		3197	3	0.0	2.9	12392	11	-5.2	1.3	77	118	218	2.75	4.1	3.6	70.7
20	CSV 27	Check		3106	11	-2.8	0.0	12238	14	-6.4	0.0	79	119	218	2.67	3.4	3.3	72.7
21	Local Check	Check		3174	4	-0.7	2.2	11779	17	-9.9	-3.8	76	117	185	2.83	3.7	4.6	65.9
	General Mean			2891				11988				75	115	209	2.76	3.7	4.2	70.6
	CV(%)			17.61				14.89				4.32	2.88	10.04	10.45	-	30.9	12.1
	CD(5%)			414				1392				3	3	12	0.19	-	2.4	9.0
	CD(1%)			546				1837				3	3	16	0.25	-	3.2	11.9

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Initial Hybrid Trial (Table 3A and 3B)

In this trial four hybrids and checks each were evaluated in RCBD for grain yield, fodder yield and other agronomic traits across 9 locations.

Zone I (Table 3A)

- *Days to flowering* – Flowering in hybrids ranged from 58-66 days. CSH 30 was the earliest check (58 days) with 89 days for maturity, and CSH 25 took maximum time (66 days) to flower as well as to mature (99 days).
- *Plant height* – Plant height ranged from 179 cm in CSH 23 to 204 cm in SPH 1751.

- *Grain yield* – SPH 1750 recorded highest grain yield (4126 kg/ha), recording 3.3% superiority over best performing check, CSH 30 (3993 kg/ha). SPH 1748 recorded marginal superiority (1.1%) over this check.
- *Fodder yield* – CSH 23 was lowest fodder yielder (8678 kg/ha), while CSH 30 was highest fodder yielding check (10617 kg/ha). SPH 1748 recorded highest fodder yield of 12611 kg/ha.
- *Grain size* – Maximum grain size was recorded in SPH 1748 (3.33 g/100 seeds) and lowest in SPH 1749 (2.81 g/100 seeds).
- *Remarks* – None of the test hybrids recorded more than 10% grain yield superiority over the check, while SPH 1748 recorded nearly 19% fodder yield superiority over checks.

Table 3A. Performance of hybrids in Initial Hybrid Trial (IHT) – Zone I during kharif 2013

SI No	Entry	Center	GY	R	% ± over CSH 16	% ± over CSH 30	FY	R	% ± over CSH 16	% ± over CSH 30	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPH 1748	DSR	4035	2	4.2	1.1	12611	1	19.5	18.8	63	93	199	3.33	3.7	3.2	68.3
2	SPH 1749	DSR	3962	4	2.3	-0.8	9887	7	-6.3	-6.9	60	91	189	2.81	5.0	4.6	73.1
3	SPH 1750	Nuziveedu	4126	1	6.6	3.3	10399	5	-1.5	-2.1	64	95	182	3.29	6.0	5.3	76.4
4	SPH 1751	Indore	3352	8	-13.4	-16.0	10651	2	0.9	0.3	64	95	204	2.96	3.3	4.8	78.1
5	CSH 16	Check	3872	5	0.0	-3.0	10556	4	0.0	-0.6	63	94	193	3.09	5.7	4.8	78.8
6	CSH 23	Check	3386	7	-12.5	-15.2	8678	8	-17.8	-18.3	62	92	179	3.11	4.7	5.1	73.7
7	CSH 25	Check	3481	6	-10.1	-12.8	10295	6	-2.5	-3.0	66	99	200	2.95	5.3	4.4	77.6
8	CSH 30	Check	3993	3	3.1	0.0	10617	3	0.6	0.0	58	89	194	3.20	3.3	3.9	70.9
	Gen. Mean		3776				10462				62	94	193	3.09	4.4	4.3	74.6
	CV(%)		11.10				11.52				2.40	2.26	5.49	9.33	24.1	23.6	11.8
	CD(5%)		573				1310				2	4	14	0	1.8	2.0	10.1
	CD(1%)		780				1784				3	6	18	0	2.4	2.8	13.5

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Zone II (Table 3B)

- *Days to flowering* – Flowering in hybrids ranged from 68-80 days. CSH 30 followed by SPH 1749 were earliest (68 and 69 days), while SPH 1749 matured earliest (112 days). CSH 25 took maximum time to flower (80 days) as well as to mature (122 days).
- *Plant height* – Plant height ranged from 186 cm in SPH 1749 to 225 cm in SPH 1751.
- *Grain yield* – Among checks, CSH 25 was highest yielder (3806 kg/ha), while among entries SPH 1751 yielded maximum (3916 kg/ha) with 2.9% yield superiority over best check.
- *Fodder yield* – Best fodder yielding check was CSH 16 (12819 kg/ha), while among test hybrids SPH 1748 yielded maximum (14808 kg/ha), recording 15.5% superiority over CSH 16.
- *Grain size* – Maximum grain size was recorded in CSH 23 (3.02 g/100 seeds) and lowest in SPH 1749 (2.45 g/100 seeds).
- *Remarks* – In Zone II SPH 1751 (3916 kg/ha) recorded marginal grain yield advantage over best check CSH 25 (3806 kg/ha). SPH 1748 was highest fodder yielder (14808 kg/ha) with 15.5% superiority over best check.

Table 3B. Performance of hybrids in Initial Hybrid Trial (IHT) – Zone II during kharif 2013

SI No	Entry	Center	GY	R	% ± over CSH 16	% ± over CSH 25	FY	R	% ± over CSH 16	% ± over CSH 25	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPH 1748	DSR	3136	8	-15.4	-17.6	14808	1	15.5	18.5	73	115	213	2.84	2.5	4.0	68.3
2	SPH 1749	DSR	3356	6	-9.4	-11.8	11057	8	-13.7	-11.5	69	112	186	2.45	3.9	5.3	73.1
3	SPH 1750	Nuziveedu	3702	4	-0.1	-2.7	13185	3	2.9	5.5	76	118	196	2.91	4.8	6.3	76.4
4	SPH 1751	Indore	3916	1	5.7	2.9	13867	2	8.2	10.9	76	118	225	2.63	3.5	3.7	78.1
5	CSH 16	Check	3704	3	0.0	-2.7	12819	4	0.0	2.6	73	115	194	2.92	4.4	5.7	78.8
6	CSH 23	Check	3338	7	-9.9	-12.3	11198	6	-12.6	-10.4	70	114	186	3.02	4.5	5.0	73.7
7	CSH 25	Check	3806	2	2.7	0.0	12500	5	-2.5	0.0	80	122	224	2.56	4.0	5.7	77.6
8	CSH 30	Check	3369	5	-9.1	-11.5	11095	7	-13.5	-11.2	68	121	195	2.77	3.3	3.7	70.9
	Gen Mean		3541				12566				73	117	202	2.76	3.7	4.6	74.6
	CV(%)		12.71				11.25				1.73	8.55	5.49	6.31	25.2	21.7	11.8
	CD(5%)		713				1980				4	8	18	0	1.2	1.7	10.1
	CD(1%)		971				2696				6	12	24	0	1.7	2.3	13.5

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Initial Variety Trial (Table 4A and 4B)

In this trial 15 varieties and 5 checks were evaluated in RCBD for grain yield, fodder yield and other agronomic traits across 9 locations.

Zone I (Table 4A)

- *Days to flowering* – Flowering dates ranged from 54-72 days. CSV 17 was earliest to flower with 89 days for maturity, and SPV 2247 took maximum time to flower (72) as well as to mature (106 days)

- *Plant height* – Plant height ranged from 141 cm in CSV 17 to 293 cm in SPV 2244.
- *Grain yield* – CSV 23 recorded highest grain yield (3613 kg/ha) among the checks and only SPV 2243 recorded better yield (3776 kg/ha) with 4.5% superiority over the best check.
- *Fodder yield* – CSV 23 recorded highest fodder yield (12359 kg/ha) among all entries and none of the test varieties yielded better than this.
- *Grain size* – Maximum grain size was recorded in SPV 2255 (3.32 g/100 seeds) and lowest in SPV 2248 (2.19 g/100 seeds).
- *Remarks* – SPV 2243 recorded highest grain yield (3776 kg/ha) but it was marginally superior (4.5%) than the best check, CSV 23 (3613 kg/ha). In terms of fodder yield none were superior than the best check, CSV 23 (12359 kg/ha).

Table 4A. Performance of varieties in Initial Variety Trial (IVT) – Zone I during kharif 2013

Sl No	Entry	Center	GY	R	% ± over CSV 23	% ± over CSV 17	FY	R	% ± over CSV 23	% ± over CSV 20	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPV 2242	Palem	3359	6	-7.0	1.5	10763	8	-12.9	-0.3	66	99	234	2.38	4.7	4.3	59.7
2	SPV 2243	Palem	3776	1	4.5	14.1	10814	6	-12.5	0.2	66	100	241	2.60	4.0	3.3	60.8
3	SPV 2244	Udaipur	3290	9	-9.0	-0.6	10337	11	-16.4	-4.2	68	100	293	2.49	3.3	3.0	61.9
4	SPV 2245	Udaipur	3169	12	-12.3	-4.2	9879	16	-20.1	-8.5	68	101	237	2.32	6.0	5.7	64.5
5	SPV 2246	Indore	2974	17	-17.7	-10.1	11789	3	-4.6	9.2	67	101	268	2.64	3.3	2.7	65.0
6	SPV 2247	Indore	3038	16	-15.9	-8.2	9503	17	-23.1	-11.9	72	106	241	2.70	2.7	2.7	61.6
7	SPV 2248	DSR	2817	19	-22.0	-14.9	9960	14	-19.4	-7.7	69	104	212	2.19	3.3	3.0	69.6
8	SPV 2249	DSR	3154	13	-12.7	-4.7	12313	2	-0.4	14.1	72	105	268	2.35	4.7	4.0	62.1
9	SPV 2250	Dharwad	3184	11	-11.9	-3.7	10480	10	-15.2	-2.9	64	98	244	3.02	4.0	3.7	60.5
10	SPV 2251	Coimbat	3481	3	-3.7	5.2	9915	15	-19.8	-8.1	68	101	240	2.63	4.0	3.7	63.6
11	SPV 2252	Coimbat	3342	7	-7.5	1.0	8930	19	-27.7	-17.3	64	98	233	2.61	3.0	3.0	66.5
12	SPV 2253	Surat	3465	4	-4.1	4.7	11356	5	-8.1	5.2	67	101	249	2.44	3.7	3.7	65.0
13	SPV 2254	Akola	3405	5	-5.8	2.9	11676	4	-5.5	8.2	67	100	250	2.62	3.7	3.7	61.0
14	SPV 2255	Akola	3227	10	-10.7	-2.4	10260	12	-17.0	-4.9	61	96	229	3.32	3.0	3.0	63.7
15	SPV 2256	Parbhani	2760	20	-23.6	-16.6	10242	13	-17.1	-5.1	67	101	217	3.23	2.7	3.0	60.8
16	CSV 17	Udaipur	3308	8	-8.4	0.0	7959	20	-35.6	-26.2	54	89	141	2.69	6.0	5.7	64.5
17	CSV 20	AVU	3090	15	-14.5	-6.6	10792	7	-12.7	0.0	66	100	248	2.59	4.3	4.3	63.0
18	CSV 23	Udaipur	3613	2	0.0	9.2	12359	1	0.0	14.5	70	103	236	2.97	4.0	3.3	66.7
19	CSV 27	AVU	2857	18	-20.9	-13.6	10736	9	-13.1	-0.5	72	105	253	2.73	2.0	2.0	61.6
20	L. Check		3103	14	-14.1	-6.2	9348	18	-24.4	-13.4	64	98	224	2.58	1.7	1.3	63.0
	Gen Mean		3221				10361				66	100	238	2.66	3.8	3.6	63.0
	CV(%)		14.00				13.20				3.08	2.37	6.61	10.48	25.9	23.1	13.0
	CD(5%)		902				2531				3	3	23	0.39	1.6	1.4	7.6
	CD(1%)		1209				3368				4	4	30	0.51	2.1	1.8	10.0

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Zone II (Table 4B)

- *Days to flowering* – Flowering in varieties ranged from 66-84 days. CSV 17 was the earliest to flower (66 days) with 110 days for maturity. SPV 2247 and SPV 2249 were entries taking maximum time to flower(84 days) as well as mature (125 days).
- *Plant height* – Plant height ranged from 140 cm in CSV 17 to 282 cm in SPV 2244.
- *Grain yield* – Among checks CSV 23 was highest yielder (2936 kg/ha). Only two test varieties, SPV 2242 and SPV 2250 yielded more than the checks with 9.3% and 4.9% yield superiority over CSV 23.
- *Fodder yield* – CSV 27 was highest fodder yielder (13517 kg/ha) among the checks. Five varieties, viz., SPV 2249, SPV 2250, SPV 2247, SPV 2246 and SPV 2242 yielded more than CSV 27. Out of these SPV 2249 yielded maximum (14671 kg/ha).
- *Grain size* – Maximum grain size was recorded in SPV 2248 (2.10 g/100 seeds) and lowest in SPV 2256 (2.99 g/100 seeds).
- *Remarks* – SPV 2242 (3209 kg/ha) and SPV 2250 (3081 kg/ha) yielded better than best performing check, CSV 23 (2936 kg/ha), with SPV 2242 recording 9.3% superiority and SPV 2250 with 4.9% superiority. Both these varieties recorded marginal superiority (2.5% and 4.6%, respectively) for fodder yield as compared to best check CSV 27 (13517 kg/ha). SPV 2249 was highest fodder yielder (14671 kg/ha) with 8.5% superiority over CSV 27.

Table 4B. Performance of varieties in Initial Variety Trial (IVT) – Zone II during kharif 2013

Sl No	Entry	Center	GY	R	% ± over CSV 23	% ± over CSV 20	FY	R	% ± over CSV 23	% ± over CSV 27	DTF	DTM	PH	GW	GM FG	GM TG	SF
1	SPV 2242	Palem	3209	2	9.3	12.3	13860	5	3.3	2.5	79	122	235	2.48	4.3	4.6	59.7
2	SPV 2243	Palem	2843	8	-3.2	-0.5	13169	9	-1.9	-2.6	79	121	240	2.60	3.3	3.6	60.8
3	SPV 2244	Udaipur	2639	15	-10.1	-7.6	12833	12	-4.4	-5.1	82	123	282	2.65	3.8	4.3	61.9
4	SPV 2245	Udaipur	2874	6	-2.1	0.6	12597	15	-6.1	-6.8	81	122	244	2.39	4.3	4.8	64.5
5	SPV 2246	Indore	2674	14	-8.9	-6.4	13968	4	4.1	3.3	82	123	262	2.54	3.3	3.5	65.0
6	SPV 2247	Indore	2794	11	-4.8	-2.2	14033	3	4.6	3.8	84	125	246	2.60	3.6	3.6	61.6
7	SPV 2248	DSR	2696	13	-8.2	-5.6	12814	14	-4.5	-5.2	81	122	216	2.10	3.5	3.8	69.6
8	SPV 2249	DSR	2575	17	-12.3	-9.9	14671	1	9.3	8.5	84	124	254	2.47	3.7	3.3	62.1
9	SPV 2250	Dharwad	3081	3	4.9	7.8	14138	2	5.4	4.6	79	121	235	2.82	3.7	3.8	60.5

Sl No	Entry	Center	GY	R	% ± over CSV 23	% ± over CSV 20	FY	R	% ± over CSV 23	% ± over CSV 27	DTF	DTM	PH	GW	GM FG	GM TG	SF
10	SPV 2251	Coimbat	2817	10	-4.0	-1.4	12877	11	-4.0	-4.7	82	122	238	2.49	3.3	3.8	63.6
11	SPV 2252	Coimbat	2625	16	-10.6	-8.1	10539	19	-21.5	-22.0	78	121	224	2.46	3.1	3.1	66.5
12	SPV 2253	Surat	2442	19	-16.8	-14.5	12171	16	-9.3	-10.0	78	120	231	2.34	4.0	4.3	65.0
13	SPV 2254	Akola	2924	5	-0.4	2.3	12005	17	-10.5	-11.2	80	122	242	2.51	2.9	3.4	61.0
14	SPV 2255	Akola	2818	9	-4.0	-1.3	12938	10	-3.6	-4.3	75	117	233	2.96	3.9	4.3	63.7
15	SPV 2256	Parbhani	2379	20	-18.9	-16.7	11292	18	-15.9	-16.5	80	123	224	2.99	3.7	3.8	60.8
16	CSV 17	Udaipur	2560	18	-12.8	-10.4	7961	20	-40.7	-41.1	66	110	140	2.43	2.9	3.1	64.5
17	CSV 20	AVU	2857	7	-2.7	0.0	12825	13	-4.4	-5.1	81	122	243	2.77	3.2	3.2	63.0
18	CSV 23	Udaipur	2936	4	0.0	2.8	13420	7	0.0	-0.7	80	123	228	2.54	3.7	3.9	66.7
19	CSV 27	AVU	2746	12	-6.5	-3.9	13517	6	0.7	0.0	83	124	248	2.53	2.6	2.6	61.6
20	Local Check		3325	1	13.3	16.4	13213	8	-1.5	-2.2	82	121	209	2.79	3.4	3.9	63.0
	Gen mean		2775				12724				80	121	235	2.57	3.6	3.8	63.0
	CV(%)		17.03				14.23				3.40	2.51	6.31	12.62	32.8	31.2	13.0
	CD(5%)		614				2691				3	4	15	0.32	1.2	1.5	7.6
	CD(1%)		818				3582				5	5	20	0.43	1.6	2.0	10.0

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Late kharif Advanced Hybrid Trial (Table 5A)

In this trial 9 hybrids and 5 checks were evaluated across 6 locations in RCBD for grain yield, fodder yield and other agronomic traits. Out of the 9 test hybrids 3 were in second year of advanced trial.

- *Days to flowering* – Flowering in hybrids ranged from 62-68 days. SPH 1731 was earliest (62 days) with 96 days for maturity. Nine more hybrids, viz., SPH 1702, SPH 1724 and SPH 1737 were also early. CSH 16 took maximum time to flower (68 days) as well as to mature (102 days).
- *Plant height* – Plant height ranged from 1462 cm in SPH 1737 to 176 cm in SPH 1730.
- *Grain yield* – Among checks CSH 30 was highest yielder (3157 kg/ha). SPH 1731 recorded 6.4% yield superiority than the best check (3359 kg/ha).
- *Fodder yield* – Among test hybrids SPH 1705 recorded highest fodder yield (10425 kg/ha) followed by SPH 1737 (10266 kg/ha). Among checks CSH 25 performed best (9601 kg/ha).
- *Grain size* – Maximum grain size was recorded in SPH 1702 (2.76 g/100 seeds) and lowest in SPH 1737 (2.46 g/100 seeds).
- *Remarks* – None of the test hybrids recorded more than 10% grain yield superiority, while only two hybrids, viz., SPH 1705 and SPH 173 recorded numerical fodder yield advantage over best performing check.

Table 5A. Performance of hybrids in Advanced Hybrid Trial (AHT) – Late kharif 2013

Sl. No	Entry	Center	GY	R	% ± over CSH 30	% ± over CSH 16	FY	R	% ± over CSH 30	% ± over CSH 25	DTF	DTM	PH	GW
1	SPH 1702 (2)	Hylech	3030	4	-4.0	6.9	9200	7	11.3	-4.2	63	98	158	2.76
2	SPH 1703 (2)	Nuziveedu	2529	14	-19.9	-10.7	9160	8	10.8	-4.6	67	100	164	2.61
3	SPH 1705 (2)	Akola	2834	8	-10.2	0.0	10425	1	26.1	8.6	65	100	156	2.63
4	SPH 1724	DSR	2766	11	-12.4	-2.4	8273	13	0.1	-13.8	63	98	162	2.54
5	SPH 1730	Nuziveedu	2836	7	-10.2	0.1	9535	5	15.3	-0.7	66	101	171	2.60
6	SPH 1731	Prabhali Agri	3359	1	6.4	18.6	8495	12	2.7	-11.5	62	96	166	2.65
7	SPH 1733	Hylech	2949	6	-6.6	4.1	8791	11	6.3	-8.4	65	99	163	2.51
8	SPH 1736	Devgen	3121	3	-1.1	10.1	9159	9	10.8	-4.6	67	101	168	2.73
9	SPH 1737	MSSC Ltd	2794	10	-11.5	-1.4	10266	2	24.2	6.9	63	98	146	2.46
10	CSH 16	Check	2833	9	-10.2	0.0	9438	6	14.1	-1.7	68	102	158	2.48
11	CSH 23	Check	3020	5	-4.3	6.6	8941	10	8.1	-6.9	64	98	159	2.70
12	CSH 25	Check	2629	13	-16.7	-7.2	9601	4	16.1	0.0	66	100	162	2.70
13	CSH 30	Check	3157	2	0.0	11.4	8268	14	0.0	-13.9	65	98	156	2.74
14	Local Check	Check	2725	12	-13.7	-3.8	9957	3	20.4	3.7	68	102	165	2.68
	Gen. Mean		2899				9251			-4.2	65	99	161	2.63
	CV(%)		17.96				12.69			-4.6	5.10	3.78	11.40	12.70
	CD(5%)		596				1784				3	3	15	0.27
	CD(1%)		798				2388				4	4	20	0.37

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

Late kharif Advanced Variety Trial (Table 5B)

In this trial 16 varieties and 5 checks were evaluated in RCBD for grain yield, fodder yield and other agronomic traits. Out of the 16 test varieties 4 were in second year of advanced trial.

- *Days to flowering* – Flowering in varieties ranged from 63-71 days. Early check, CSV 17 was earliest to flower, followed by CSV 23 (65 days). Among test varieties SPV 2122, SPV 2174 and SPV 2184 were earliest to flower (67 days) with 101-103 days for maturity. SPV 2172 took maximum time to flower (71 days) as well as to mature (105 days).
- *Plant height* – Plant height ranged from 165 cm in SPV 2179 to 197 cm in SPV 2164.
- *Grain yield* – Among checks CSV 20 was highest yielder (3766 kg/ha) followed by CSV 17 (3675 kg/ha). Only one test variety, SPV 2122 recorded higher grain yield (3914 kg/ha) than this check.

- *Fodder yield* – Among checks CSV 23 was the highest yielder (9015 kg/ha). Six test varieties yielded better than this. SPV 2175 highest fodder yielder (9908 kg/ha) followed by SPV 2181 (9815 kg/ha), SPV 2164 (9772 kg/ha), SPV 1822 (9722 kg/ha) and others.
- *Grain size* – Maximum grain size was recorded in CSV 23 (2.66 g/100 seeds) and lowest in SPV 2178 (2.27 g/100 seeds).
- *Remarks* – SPV 2122 (3914 kg/ha) recorded marginal grain yield superiority over best check, CSV 20 (3766 kg/ha). In terms of fodder yield SPV 2175 (9908 kg/ha) ranked first followed by SPV 2181 (9815 kg/ha), SPV 2164 (9772 kg/ha), SPV 1822 (9722 kg/ha), which performed better than the best check, CSV 23 (9015 kg/ha).

Table 5B. Performance of varieties in Initial and Advanced Variety Trial (IAVT) – Late kharif 2013

Sl. No	Entry	Center	GY	R	% ± over CSV 20	% ± over CSV 17	FY	R	% ± over CSV 20	% ± over CSV 23	DTF	DTM	PH	GW
1	SPV 1822	Udaipur	3163	19	-16.0	-13.9	9722	5	8.3	7.8	70	104	188	2.61
2	SPV 2110	Palem	3204	17	-14.9	-12.8	8873	13	-1.2	-1.6	70	104	181	2.38
3	SPV 2114	DSR	3510	7	-6.8	-4.5	8706	14	-3.1	-3.4	69	103	178	2.34
4	SPV 2122	Palem	3914	1	3.9	6.5	8476	16	-5.6	-6.0	67	101	188	2.62
5	SPV 2164	Udaipur	3547	6	-5.8	-3.5	9772	4	8.8	8.4	68	102	197	2.52
6	SPV 2165	Udaipur	3464	10	-8.0	-5.8	8546	15	-4.8	-5.2	66	101	184	2.41
7	SPV 2170	DSR	3435	12	-8.8	-6.6	7699	17	-14.3	-14.6	68	102	179	2.49
8	SPV 2172	Dharwad	3060	20	-18.7	-16.7	9652	6	7.5	7.1	71	105	188	2.44
9	SPV 2174	Coimb	3451	11	-8.4	-6.1	8903	12	-0.9	-1.2	67	101	179	2.39
10	SPV 2175	Coimb	3474	8	-7.8	-5.5	9908	1	10.3	9.9	69	104	187	2.63
11	SPV 2178	Palem	3318	16	-11.9	-9.7	7639	19	-14.9	-15.3	69	103	167	2.27
12	SPV 2179	Palem	3345	14	-11.2	-9.0	8916	11	-0.7	-1.1	67	102	165	2.32
13	SPV 2181	Akola	3665	5	-2.7	-0.3	9815	2	9.3	8.9	66	103	181	2.35
14	SPV 2182	Akola	3330	15	-11.6	-9.4	7653	18	-14.8	-15.1	66	101	183	2.40
15	SPV 2183	Akola	3696	3	-1.8	0.6	9799	3	9.1	8.7	68	103	191	2.49
16	SPV 2184	Akola	3352	13	-11.0	-8.8	6893	21	-23.2	-23.5	67	103	181	2.43
17	CSV 17	Check	3675	4	-2.4	0.0	7421	20	-17.4	-17.7	63	101	167	2.41
18	CSV 20	Check	3766	2	0.0	2.5	8980	9	0.0	-0.4	68	103	173	2.34
19	CSV 23	Check	2994	21	-20.5	-18.6	9015	8	0.4	0.0	65	101	179	2.66
20	CSV 27	Check	3170	18	-15.8	-13.8	8961	10	-0.2	-0.6	69	104	176	2.32
21	Local Check	Check	3470	9	-7.8	-5.6	9595	7	6.9	6.4	66	102	183	2.57
	General Mean		3429				8807				68	102	181	2.45
	CV(%)		18.87				19.98				7.81	4.99	14.23	12.29
	CD(5%)		786				2008				4	4	18	0.31
	CD(1%)		1051				2670				5	5	23	0.41

Note: R - Ranking; GY - Grain Yield (kg/ha); FY - Fodder Yield (kg/ha); DTF - Days to flowering; DTM - Days to maturity; PH - Plant height (cm); GW - 100 grain weight (g); SF - Shoot fly dead heart percentage at 28 DAE; GMFG - Grain mold field grade (1-9); GMTG - Grain mold threshed grade (1-9)

II Coordinated sorghum breeding research

During 2013, the coordinated sorghum breeding research comprised of inter-institutional hybrid programme, multi-location evaluation of segregating material and public-private hybrid trial. Details of the report are given below.

Inter-institutional hybrid programme

(Sujay Rakshit, C Aruna, RB Ghorade, B Selvi and HV Kalpande)

During 2013 18 experimental hybrids (6 from Akola and 12 from DSR) along with four checks were tested at Indore, Parbhani, Akola, Hyderabad and Coimbatore. Data has not been reported from Parbhani and Indore as the experiment got vitiated.

- *Days to flowering* – Flowering dates ranged from 63-73 days. 3011A x DSR 926 was earliest (63 days) with 104 days for maturity. It was earlier than early check, CSH 23 (68 DTF and 106 DTM) and CSH 30 (67 DTF and 108 DTM).
- *Plant height* – Plant height ranged from 134 cm in ICS 9A x AKR 515 to 238 cm in 27A x DSR 863.
- *Grain yield* – Best checks were CSH 25 followed by CSH 16. Nine experimental hybrids performed better than these. Best was 3011A x DSR 926 followed by 1158A x C43, 27A x R 206, 3011A x DSR 863, 1158A x C43 among others.
- *Fodder yield* – 3017A x DSR 1146 topped with 14626 kg/ha fodder yield, this was followed by 1158A x C43 (14534 kg/ha) and CSH 16 (14487 kg/ha).
- *Grain size* – Maximum grain size was recorded in CSH 16 (3.38 g/100 seeds) and lowest in AKMS 30A x AKR 513 (2.76 g/100 seeds).
- *Remarks* – 1158A x C43, 3025A x DSR 1150 and AKMS 30A x AKR 73 found to be promising hybrids.

Table 6. Summary of experimental hybrids in Inter-institutional Hybrid Nursery

Sr. No.	Treatment	GY		% ± over CSH 25	% ± over CSH 16	FY		% ± over CSH 25	% ± over CSH 16	DTF	DTM	PH	SW
1	AKMS 30A x AKR 513	3062	20	-16.6	-15.7	13527	14	-3.8	-6.6	69	109	179	2.76
2	3011A x DSR 926	3886	4	5.8	6.9	13298	18	-5.4	-8.2	63	104	176	2.82
3	3017A x DSR 926	3622	12	-1.4	-0.3	13884	7	-1.3	-4.2	67	106	184	3.08
4	3017A x DSR 953	3739	8	1.8	2.9	13700	11	-2.6	-5.4	67	107	170	2.90
5	3017A x DSR 981	3876	6	5.5	6.7	13847	8	-1.5	-4.4	67	108	179	2.78
6	3017A x DSR 1146	3539	14	-3.6	-2.6	14626	1	4.0	1.0	65	105	188	2.99
7	3025A x DSR 907	3814	7	3.8	5.0	13425	15	-4.5	-7.3	67	107	176	2.86
8	3025A x DSR 1150	3977	2	8.3	9.5	13619	12	-3.1	-6.0	65	105	185	3.03
9	27A x R 206	3877	5	5.6	6.7	13316	17	-5.3	-8.1	70	110	186	3.34
10	1158A x C43	4041	1	10.0	11.2	14534	2	3.4	0.3	68	108	170	3.00
11	AKMS 30A x AKR 462-1	3509	15	-4.5	-3.4	13952	6	-0.8	-3.7	66	106	183	2.78
12	AKMS 30A x AKR 514	3370	19	-8.2	-7.2	13970	5	-0.6	-3.6	70	109	195	2.98
13	AKMS 30A x AKR 73	3899	3	6.2	7.3	13758	9	-2.1	-5.0	68	108	186	2.81
14	ICS 26003A x AKR 515	2804	21	-23.7	-22.8	13080	20	-7.0	-9.7	67	107	163	2.88
15	ICS 9A x AKR 515	2539	22	-30.9	-30.1	13097	19	-6.8	-9.6	69	108	134	2.94
16	27A x DSR 863	3604	13	-1.9	-0.8	12794	22	-9.0	-11.7	70	111	238	3.05
17	279A x DSR 907	3433	16	-6.5	-5.5	13709	10	-2.5	-5.4	68	108	198	3.15
18	3011A x DSR 863	3715	9	1.2	2.3	13419	16	-4.6	-7.4	67	107	196	2.95
19	CSH 16	3634	11	-1.1	0.0	14487	3	3.0	0.0	67	107	178	3.38
20	CSH 23	3374	18	-8.1	-7.1	13062	21	-7.1	-9.8	69	110	159	3.20
21	CSH 25	3673	10	0.0	1.1	14060	4	0.0	-3.0	68	106	200	2.94
22	CSH 30	3387	17	-7.8	-6.8	13599	13	-3.3	-6.1	67	108	178	3.23
	General Mean	3562				13681				67	107	182	2.99
	CV(%)	39.0				13.8				6.8	10.8	7.4	2.8
	CD(5%)	18				1246				6	5	18	0.37
	CD(1%)	23				1696				8	7	23	0.50
	P-Value	0.00				0.43				0.75	0.81	0.00	0.04

Multi-location evaluation of segregating material

(Sujay Rakshit, ST Kajjidoni, RB Ghorade, HV Kalpande and R Shankarpandian)

F2 populations of 11 crosses were provided by four centers (Kovilpatti, Dharwad, Akola and Parbhani). Seeds were provided to 9 centers for evaluation and selection. Details of the programme are given in Table 7 and single plants selections made at various centers are given in Table 8.

Table 7. Summary of multi-location evaluation of segregating materials

Sl. No	Cross	Developing center	Trait	Evaluated at
1	GMN 46 x DSV 6	Dharwad	Grain mold	Akola, Indore, Surat
2	DSV 6 x M 35-1	Dharwad	Grain quality	Akola, Palem, Udaipur
3	AKR 456 x AKR 150	Akola	Grain yield	Dharwad, Udaipur, Indore
4	AKR 456-1 x AKR 196	Akola	Grain yield	Dharwad, Palem, Surat
5	PVR 904 X KR 196	Parbhani	High grain and fodder yield, tolerance to grain mould	Deesa, Coimbatore
6	PMS 8B X PMS 71B	Parbhani	High grain and fodder yield, tolerance to grain mould	Deesa, Coimbatore
7	K11 x CSV 21F	Kovilpatti	Dual purpose	Deesa
8	K11 x SPV 2056	Kovilpatti	Dual purpose	Deesa
9	K8 x CSV 15	Kovilpatti	Grain & short duration	Deesa
10	CSV 17 x SPV 2133	Kovilpatti	Grain & short duration	Deesa
11	CSV 17 x SPV 2109	Kovilpatti	Grain & short duration	Deesa

Table 8. Selections made from different crosses at various centers

Sl. No.	Cross	Number of selections
Akola		
1	GMN 46 x DSV 6	4
2	DSV 6 x M-35-1	6
Coimbatore		
1	PVR 904 x KR 196	5
2	PMS 8B x PMS 71B	5
Deesa		
1	PVR 904 x KR 196	Poor performance, no selection
2	PMS 8B x PMS 71B	7
3	CSV 17 x SPV 2109	16
4	CSV 17 x SPV 2133	63
5	K-11 x CSV 21F	14
6	K- 11 x CSV 15	30
7	K- 8 x CSV 15	6
Dharwad		
1	AKR-456 x AKR-150	5

Sl. No.	Cross	Number of selections
2	AKR-462-1 x AKR-196	5
Indore		
1	GMN 46 x DSV6	12
2	AKR 456 x AKR 150	18
Palem		
1	DSV-6 X M 35-1	10
2	AKR 426-2 X AKR 196	6
Surat		
1	GMN 46 x DSV 6	25
2	AKR 456-1 x AKR 196	25

III Kharif sorghum breeding at DSR

Development of kharif grain sorghum genotypes with improved yield, grain quality and grain mould tolerance

(C Aruna, IK Das & CV Ratnavathi)

1. Evaluation of grain sorghum hybrids in the station trials

Eighty experimental hybrids based on 25 ms and 11 R lines were evaluated in RCBD with three replications along with the checks, CSH16, CSH25 and CSH30. Data was recorded on days to flower, plant height, grain yield, 100 seed weight and grain mould score. Of the 80 hybrids evaluated, 9 hybrids recorded significant improvement over the best check, CSH 25, and nine more hybrids yielded more than 10% over CSH25 (Table 1). The hybrids based on the MS line 2911A (2911A x R44, 2911A x R48 and 2911A x R50) recorded more than 20% increase over CSH 25. All these are having better grain quality with bold grains and better level of tolerance to grain moulds compared to CSH 25. The hybrid, R93 x C43, besides showing significant improvement over CSH 25, recorded bold seed with 100 seed weight of 3.68g while it was 2.91g in CSH 25 and 3.36g in CSH 16.

Table 1. Performance of promising sorghum hybrids during kharif 2013

Hybrid	Days to flower	Plant ht (cm)	Panicle length (cm)	Grain Yield (kg/ha)	% increase over CSH 25	100 seed wt(gms)	Grainmold Score (1-9)
600A x R40	70.0	27.45	299.5	5815.3	11.5	2.94	5.33
600A x R44	70.0	28.00	280.6	5815.3	11.5	3.15	5.67
600A x R46	69.0	27.67	283.9	4903.2	-6.0	3.42	5.00
1182A x CB25	69.0	27.44	199.4	4685.6	-10.1	3.36	5.50
1182A x R40	68.7	26.67	257.8	5111.5	-2.0	3.32	5.17
1182A x R44	74.0	29.44	254.5	5704.2	9.4	3.32	5.00
1182A x R46	69.0	27.78	242.8	6278.3	20.4	3.31	5.33
3054A x R44	71.3	27.56	243.3	5463.4	4.8	2.88	5.83
3054A x R46	71.3	25.33	234.4	6269.0	20.2	3.26	6.00
2911A x CB25	70.0	28.00	237.2	4981.9	-4.4	2.90	4.67
2911A x R37	80.7	36.11	207.8	4878.0	-6.4	2.96	5.00
2911A x R42	70.0	33.67	201.1	5241.2	0.5	2.61	5.00
2911A x R44	70.7	31.22	249.4	7185.8*	37.8	3.06	5.00
2911A x R48	77.0	29.00	222.8	6537.6*	25.4	3.01	4.33
2911A x R50	70.7	29.67	217.2	6472.7*	24.2	2.63	5.17
2911A x R51	70.3	25.67	191.1	5815.3	11.5	2.54	5.50
27A x CB25	69.0	30.78	227.8	6074.6	16.5	3.25	4.67
636A x CB25	65.0	25.78	246.1	5704.1	9.4	3.58	6.33
360A x R49	82.7	28.11	167.8	4190.2	-19.6	2.45	5.00
1182A x R37	79.0	33.78	200.6	5273.6	1.2	3.05	4.83
1182A x R43	69.0	32.56	202.8	5032.8	-3.5	2.69	5.00
1182A x R47	74.3	31.89	228.3	5444.9	4.4	3.54	5.17
1182A x R48	69.0	27.44	241.1	5912.5	13.4	3.29	5.17
3054A x R42	70.0	31.11	186.1	5338.4	2.4	2.58	5.67
1194A x R47	77.7	29.33	207.2	5310.6	1.9	3.00	7.33
636A x R36	64.0	28.11	243.9	4741.1	-9.1	3.23	6.33
R87 x C43	68.7	31.11	218.3	6482*	24.3	3.06	7.33
R88 x C43	68.7	31.11	196.7	5634.7	8.1	2.90	7.00
R92 x C43	69.3	37.67	215.6	5403.1	3.6	3.25	5.83
R93 x C43	67.3	30.78	227.2	7060.7*	35.4	3.68	5.67
R93 x CB11	69.0	37.56	256.1	6472.8*	24.2	3.04	6.00
R94 x C43	73.3	32.22	226.1	5481.9	5.2	3.16	6.33
R97 x C43	69.7	32.11	205.6	5542.1	6.3	3.18	6.33
R99 x C43	66.3	32.89	209.5	6884.8*	32.1	3.21	6.00
R101 x C43	69.3	30.89	209.5	5731.9	9.9	2.78	7.33
R102 x C43	68.3	30.67	209.5	5958.8	14.3	3.39	7.00
R105 x C43	70.3	39.33	221.1	6269*	20.2	2.97	7.00
R106 x C43	69.0	34.00	226.1	6694.9*	28.4	3.27	6.00

Hybrid	Days to flower	Plant ht (cm)	Panicle length (cm)	Grain Yield (kg/ha)	% increase over CSH 25	100 seed wt(gms)	Grainmold Score (1-9)
R111 x C43	68.7	33.89	231.1	4259.6	-18.3	3.31	6.67
600A x R38	70.7	33.11	247.2	5407.8	3.7	2.87	5.67
PVT HYD	76.0	27.55	225.5	4880.0		3.04	5.50
CSH 25	78.3	34.56	237.2	5213.4		2.91	5.67
CSH 16	68.7	35.89	220.5	5037.4		3.36	5.67
CSH 30	68.0	30.33	232.2	5074.5		2.82	6.33
C.V.	3.89	9.67	9.07	13.92		10.75	12.55
C.D. 5%	4.56	4.54	34.80	1219.90		0.52	1.13
C.D. 1%	6.07	6.05	46.32	1623.80		0.69	1.51

2. Evaluation of advanced breeding nursery lines for grain yield and quality

Twenty advanced breeding nursery lines were evaluated for grain yield and quality over the check, CSV20 in RCBD with three replications to identify better varieties with improved grain yield. The genotype PVT 2-13 recorded significant improvement in grain yield over the check, CSV20 (3783 kg/ha). It had bold seed with 100 seed weight of 2.86g. Three more genotypes (PVT 4-13, PVT 15-13 and PVT 1-13) recorded more than 20% increase in grain yield over CSV 20. Low grain mould score was observed in PVT 5-13 (5.33), PVT 2-13 (5.67) and PVT 4-13 (5.67), while CSV 20 recorded 6.33 grain mould score.

Table 2. Performance of advanced breeding nursery lines in preliminary varietal trial for grain yield and quality

Genotype	Yield (kg ha)	% increase over CSV 20	Plant height (cm)	Days to flower	Grain mould score	100 seed weight (g)
PVT 1-13	4620.8	22.16	269.4	73.0	7.00	2.20
PVT 2-13	5472.7*	44.68	273.9	69.0	5.67	2.86
PVT 3-13	4255.0	12.48	253.3	73.0	6.33	2.04
PVT 4-13	4834.6	27.81	248.9	73.3	5.67	2.15
PVT 5-13	4384.6	15.91	258.9	69.7	5.33	2.73
PVT 9-13	4514.3	19.34	250.0	77.7	7.00	2.44
PVT 13-13	4458.7	17.87	223.3	78.3	5.67	2.84
PVT 15-13	4713.4	24.60	163.9	71.7	7.67	1.97
CSV 20	3782.7		286.1	77.3	6.33	2.75
CSV 27	2657.6		282.2	76.0	4.67	2.44
C.V.	26.89		6.94	2.48	13.84	9.04
C.D. 5%	1558.70		27.75	3.06	1.37	0.36
C.D. 1%	2082.23		37.06	4.08	1.82	0.48

3. Evaluation of sorghum genotypes for semolina recovery and associated grain quality traits

Sorghum is gaining importance as health food because of its slow digestibility and high fibre content. In order to make sorghum suitable for different food forms, it is important to improve the milling properties of the grain. Semolina recovery of the genotypes gives an indication on the usage of the genotype for different types of foods. An experiment was conducted with 60 sorghum genotypes including the selected germplasm lines from minicore collection and the elite lines, to identify the genotypes with high semolina recovery along with the other grain quality traits. These 60 genotypes were grown in RCBD with three replications during rabi 2012. The lines were evaluated for days to flowering, plant height, yield per plant, 100 seed weight, seed hardness, grain density, endosperm texture and semolina recovery. The semolina recovery of these genotypes ranged from 19.77 to 47.82% indicating significant variability in the material studied (Table 3). Seven genotypes recorded semolina recovery of more than 45%. 100 seed weight of more than 4 gm was observed in three genotypes. Lines with high semolina percentage were identified among the germplasm and elite lines. Semolina recovery was found to have significant positive correlation with corneous endosperm texture and the grain hardness and grain density. It had non significant negative correlation with 100 seed weight which indicates that there is scope to develop bold seed with high semolina recovery.

Table 3. Variation for grain yield and quality traits in sorghum

Trait	Min	Max	Mean	CD5%	CV
Semolina recovery (%)	19.77	47.82	31.44	4.41	6.92
Days to flowering	67	95	77.7	2.93	2.33
Plant height(cm)	90	306.33	117.96	23.51	8.17
Panicle length(cm)	6.87	47.63	23.01	3.04	8.18
Panicle weight(g)	31	117.5	59.26	18.17	18.96
Seed yield/pl (g)	20	76.33	44.0	15.49	21.53
100 seed weight (g)	1.58	4.11	2.81	.98	21.57
Endosperm texture (%)	25	100	55.06	11.23	12.61
Grain density(g/ml)	.91	1.39	1.13	.05	2.99
Grain hardness(Kg)	2.29	13.54	6.88	.96	8.67

Genetic studies for grain yield and quality traits in elite sorghum genotypes

(Ganapathy KN, S Audilakshmi, Sujay Rakshit and K Hariprasanna)

For genetic studies of grain protein digestibility and other quality traits in sorghum, 15 genotypes (IS 31706, IS 19153, SPV 1775, SPV 462, RS 585, RS 29, C43, BN 535, KR 196, KR 199, 296B, PMS 28B, 206 B, 27B and AKMS 14B) were crossed in 15 x 15 Diallel fashion. About 200 experimental hybrids were evaluated during *rabi* 2012 -13 for grain yield and quality attributes. The GCA/SCA ratio was less than unity for most of yield and quality traits indicating preponderance of non-additive gene action in the expression of these traits. The hybrid combinations viz., C 43 x BN 535, BN 535 x 206B, KR 196 x RS 29, RS 585 x SPV 1775, RS 585 x IS 31706, RS 585 x SPV 462 were found superior for grain yield with more than 100g grain yield/plant. Hybrid combinations viz., IS 31706 x IS 19153, RS 585 x IS 31706, IS 31706 x SPV 462 were found promising for 100 seed weight with more than 4.5g/100 seed weight and cross combinations BN 535 x SPV 1775 and BN 535 x RS 585 were superior for grain protein digestibility (>65%). More than 100 selections were made from the above crosses are in the F₃ stage of testing.

Genetic improvement of single cut forage genotypes for fodder yield and quality

(Ganapathy KN, BV Bhat and AV Umakanth)

1. Evaluation of advanced single cut forage lines

Thirteen advanced lines derived from crosses involving (SPV 1616 x PC 5) x (SPV 1616 x PVK 809) were evaluated for green fodder yield and related traits along with checks CSV 21F and HC 308. Four genotypes designated as DSR-SC-2 (504q/ha), DSR-SC-7 (454q/ha), DSR-SC-8(470q/ha) and DSR-SC-11(445q/ha) were found to more than 15% superior to HC 308 and more than 20% compared to CSV 21F for green fodder yield. The genotypes were also superior for brix content during flowering and other forage attributes.

2. Evaluation of germplasm lines

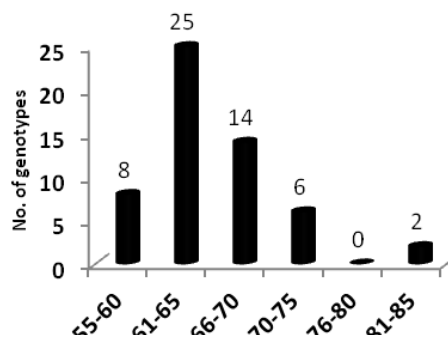
Among 100 germplasm and elite lines evaluated for forage yield and related traits, the lines viz., were superior for forage yield and related traits. The lines viz., IS 27887, IS 27034, IS 28747, SPV 2056, SPV 2058, SPV 2131, HC 260, AKSSV 22, HC 136, Afzalpur local, GFS 5 were found superior for overall forage yield and attributes.

3. Evaluation of experimental F₁ hybrids

A total of 34 new experimental hybrids involving lines CSV 21F, HC 260, AKSSV 22, HC 308, Rampur local, S 541, SSV 74 were raised during kharif, 2013. The cross combinations Rampur Local x CSV 21F, Rampur Local x SSV 74, HC 308 x SSV 74, SSV 74 x IS 23992, CSV 21F x IS 23992 and HC 260 x AKSSV 22 were superior for green fodder yield and related attributes. The hybrids are being advanced to later generations for identification of superior segregants and to development improved lines with desirable forage attributes.

4. Selection and advancement of segregating lines

Seventeen F₂S and 51 F₃S from derived from crosses involving elite forage lines, sweet sorghum lines and brown midrib lines were raised during kharif, 2013. About 150 selections were made from different crosses and are being advanced to later generations.



Developing early duration and photoperiod insensitive grain sorghum MS and R lines

(Sunil S. Gomashe, Sujay Rakshit, T Nageshwar Rao and MY Samdur)

During kharif 2013, a total of 55 F₅ derivatives (B x B and R x R) and 11 checks (AKMS 14B, 2219 B, CS 3541, 467B, CSV 17, 7B, CSV 15, 27B, C 43, 296B and 2077B) were evaluated in RBD with two replications. The derivatives were evaluated for days to 50% flowering, plant height (cm) and grain yield per plant (g). All the genotypes exhibited significant differences for these characters (Fig.1-3). A total of 33(B x B and R x R) derivatives recorded earliness coupled with superior performance for grain yield as compared to the early checks (CSV 17, AKMS 14B, 2219B, CS 3541 and 467B). Ten genotypes recorded >70g grain yield per plant.

The derivatives exhibited superior mean performance over the early and late checks for the three traits analyzed. In addition to this programme, 18 test crosses were evaluated and the crosses exhibiting complete sterility were back crossed to respective male parents for developing new male sterile lines. Five R x R derivatives were selfed and advanced to F₆ generation.

Genetic augmentation of parental lines for grain yield and tolerance of shoot pests and hybrid development in kharif sorghum

(Hariprasanna K, P Rajendrakumar, VR Bhagwat and RR Chapke)

Genetic augmentation of parental lines is essential for enhancing the level of heterosis in hybrids. Along with enhancing the grain yield potential incorporation of tolerance of shoot pests is also indispensable for achieving higher yield levels. With this objective new crosses were effected between elite parental lines/varieties and advance breeding lines for isolation of superior segregants and development of new parental lines. Promising selections made out of maintainer × maintainer and restorer × restorer crosses are being evaluated for testing the fertility restorability and also performance *per se*. Phenotypically superior selections from the restorer × restorer derivatives were evaluated along with checks in replicated trials to identify promising breeding lines that can be promoted as OPVs as well as further utilized in hybrid development as fertility restorer lines. During *kharif* 2013 five advance breeding lines each were sent for evaluation in station trials at Akola (DSR Nos. 911, 924, 972, 983, 1151), Dharwad (DSR Nos. 907, 908, 922, 951, 1173), Palem (DSR Nos. 867, 917, 922, 983, 1145) and Parbhani (DSR Nos. 906, 928, 983, 1142, 1146). From the new crosses made F₂ seeds of 95 crosses were harvested based on phenotypic performance for further advancement.

1. New male sterile line development

For the development of new male sterile lines in the background of superior maintainer × maintainer derivatives, 54 advance breeding lines were used for test crossing with 27A and a total of 95 test cross seeds were harvested during *rabi* 2012-13. These test crosses were planted along with the pollinator parent in paired rows for identifying complete sterile crosses and backcrossing for conversion programme during *kharif* 2013. Out of 95 crosses, more than 25 were found to be fertile or partially sterile, while the remaining test crosses which were completely sterile were backcrossed with the respective maintainer lines for advancement. Another set of about 40 new male sterile lines in the genetic background of promising maintainer × maintainer derivatives are in different stages of backcrossing.

2. Performance of advance breeding lines

Superior segregants from restorer × restorer crosses were evaluated in two separate trials. In the first trial, 90 superior and genetically uniform advance breeding lines were evaluated for performance *per se* along with three checks in a RBD during *rabi* 2012-13. Observations on grain yield and related traits were recorded. The flowering duration varied from 73 to 96 days. The mean plant height ranged from 110 to 288 cm and panicle length from 19 to 33 cm. Grain yield ranged from 1995 to 5318 kg/ha. The best check for grain yield was CSV 216R (4359 kg/ha) and 10 advance breeding lines recorded numerically higher yield than the check. Three advance breeding lines *viz.*, DSR 949 (5318 kg/ha), DSR 950 (5023 kg/ha) and DSR 993 (4981 kg/ha) recorded more than 10% grain yield advantage over CSV 216R. Seed size was the highest in CSV 22R (4.11 g/100 seeds) followed by CSV 216R (3.98 g/100 seeds) and none of the test entries exhibited superiority over the checks.

Pooled analysis of performance of the advance breeding lines during *rabi* 2011-12 and *rabi* 2012-13 showed that the grain yield ranged from 1784 to 4597 kg/ha. The best check for grain yield was CSV 216R (4099 kg/ha) and two entries (DSR 949 and DSR 960) recorded yield advantage of 4 to 12% over the check. Comparison of mean performance over *kharif* and *rabi* seasons, showed that DSR 971 (CS 3541 × CB 87) was the highest yielder (3933 kg/ha) closely followed by DSR 926 (RS 29 × ICSR 9) and DSR 908 (RS 673 × ICSR 93001). The yield advantage over common *kharif* check CSV 20 ranged from 3 to 75% with 22 advance breeding lines recording above 50% grain yield advantage.

In the second trial, 67 superior advance breeding lines isolated from about 20 crosses were evaluated along with three checks during *rabi* 2012-13. The days to flowering had a wide range from 71 to 95 days. Plant height also varied widely from 93 to 240 cm. The panicle weight per plant ranged from 59 to 152 g. Total 36 genotypes had above 100 g/plant panicle weight. The grain yield ranged from as low as 1924 kg/ha to as high as 5377 kg/ha. The best check for grain yield was CSV 216R (4044 kg/ha) and six entries (DSR 1118, DSR 1175, DSR 1121, DSR 1145, DSR 1128 and DSR 1144) had significantly higher grain yield (25-33%) over the check (Table 4). Seed size was the highest in CSV 216R (3.87 g/100 seeds⁻¹) and none of the entries had 100-seed weight more than the check. Some of the genotypes with better seed size were DSR 1133 (3.76 g/100 seeds), DSR 1152 (3.75 g/100 seeds) and DSR 1121 (3.72 g/100 seeds).

Table 4. Performance of selected advance breeding lines

Sl. No.	Adv. breeding line	Days to flower	Plant Height (cm)	Panicle length (cm)	Panicle weight (g/plant)	100-seed weight (g)	Grain yield	
							Mean (kg/ha)	Adv. over CSV 216R (%)
1	DSR 1144	90.0	167.5	27.6	150.9	3.30	5377	33.0
2	DSR 1128	81.0	171.3	30.1	152.1	2.37	5373	32.9
3	DSR 1145	94.5	166.9	28.4	148.0	3.32	5266	30.2
4	DSR 1121	91.5	132.5	29.4	150.8	3.72	5137	27.0
5	DSR 1175	86.0	206.9	26.3	145.2	3.43	5102	26.2
6	DSR 1118	94.5	154.4	29.6	145.2	2.38	5044	24.7
7	DSR 1143	90.0	136.3	29.1	136.0	2.75	4755	17.6
8	DSR 1140	82.5	165.0	31.9	133.7	2.22	4751	17.5
9	DSR 1113	91.0	204.4	27.9	131.0	2.68	4700	16.2

10	DSR 1116	87.5	151.3	26.9	136.7	2.92	4640	14.7
	CSV 216R	87.5	168.8	25.3	117.5	3.87	4044	
	CSV 20	75.0	163.8	22.5	86.6	2.45	2308	
	CD (0.05)	11.4	18.3	4.3	13.0	0.64	960	

Comparison of results obtained for the same set of genotypes during *kharif* season indicated that the top yielders were different in the two seasons. The genotypes which ranked top 5 during *kharif* season evaluation (DSR 1145, DSR 1151, DSR 1146, DSR 1173 and DSR 1142) had 3rd, 25th, 21st, 51st and 18th position during *rabi* evaluation. Similarly, the genotypes which performed in the top 5 positions (DSR 1144, DSR 1128, DSR 1145, DSR 1121 and DSR 1175) during *rabi* were far below in position during *kharif* season except DSR 1145. The plant height in all the genotypes was higher in *kharif* season compared to *rabi* though there was no fixed trend indicating seasonal difference in the phenotypic expression (Fig. 4). Nevertheless, the results indicate that yield levels in both the seasons are on a par in some of the genotypes like DSR 1148, DSR 1142 and DSR 1145. Hence, though same genotype may not be the best in both the seasons, it may be possible to identify common genotypes that perform satisfactorily well and suitable for both seasons by advancement and selection in alternate seasons.

3. Identification of promising maintainer lines:

Forty-six superior derivatives isolated from 22 maintainer × maintainer crosses were evaluated in a replicated trial along with 27B as check during *rabi* 2012-13. Flowering duration ranged from 73 to 92 days, and 25 genotypes were early by 2-10 days compared to 27B. Plant height varied between 108 to 245 cm and none of the entries were significantly shorter compared to 27B. Panicle weight had a wide range from 62.2 to 148.3 g/plant with a mean of 97.8 g/plant, while grain yield per plant ranged from 45.5 to 120.5 g with a mean of 75.5 g. Thirteen entries recorded significantly higher grain yield (3689-5355 kg/ha) compared to 27B (2889 kg/ha) (Table 5) with an advantage of 28-87%. The promising B × B derivatives with desirable height and flowering duration will be used for development of new CMS lines.

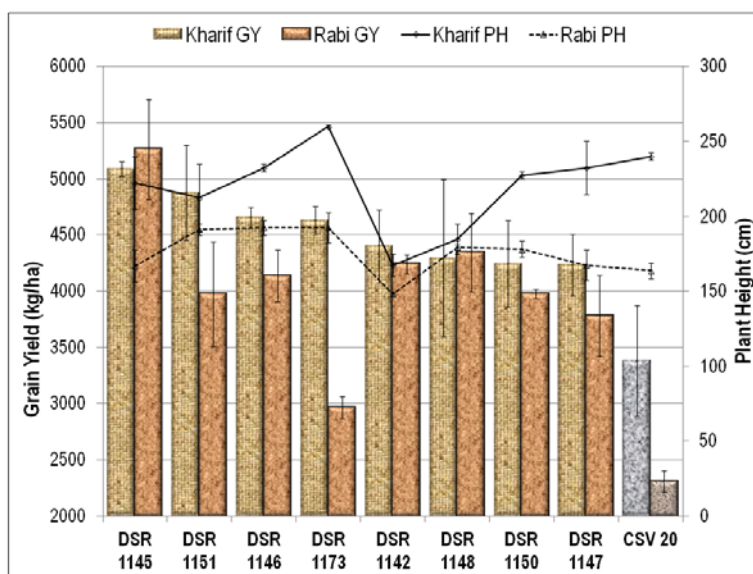


Figure 4. Comparison of grain yield and plant height of selected advance breeding lines

Table 5. Performance of selected maintainer lines

Sl. No.	Adv. breeding line	Days to flower	Plant Height (cm)	Panicle length (cm)	Panicle weight (g/plant)	Grain yield (kg/ha)	100-seed weight (g)
1	DSR 1213	81	150.0	31.9	148.3	5355	3.32
2	DSR 1212	81	153.8	31.4	135.7	4914	3.21
3	DSR 1209	80	131.3	29.0	125.8	4644	3.36
4	DSR 1211	77	137.5	31.4	127.6	4451	3.31
5	DSR 968	87	244.5	28.0	138.0	4388	3.11
6	DSR 1199	81	155.7	28.3	120.7	4294	3.66
7	DSR 967	88	210.5	29.1	126.1	3924	3.38
8	DSR 1208	84	125.7	29.0	105.7	3915	3.25
9	DSR 964	84	177.0	27.8	126.0	3881	2.62
10	DSR 969	92	137.5	24.6	131.3	3819	2.60
11	DSR 1200	73	144.4	28.2	110.0	3804	3.42
11	DSR 1198	84	162.5	23.1	108.9	3733	3.19
	DSR 1188	83	129.4	29.9	108.8	3689	3.92
	DSR 1213	81	150.0	31.9	148.3	5355	3.32
	27B	83	119.8	31.4	86.5	2889	2.82
	CD (0.05)	12	18.3	4.4	18.6	748	0.60

Collation, evaluation, documentation and utilization of sorghum genetic stocks

(*Sujay Rakshit, Sunil S Gomashe, KN Ganapathy, VR Bhagwat, IK Das*)

During kharif season 75 established R lines and 21 established B lines were evaluated under replicated trials. Out of these 15 R lines and 9 B lines found promising. Some of the promising R lines are RS 673, RSCN 2103, MR 750, RSCN 5016, RSCN 5014, RS 4003, RSCN 5031-44, RSCN 5010, RSCN 5029-42, RSCN 4005, RS 4007, RSCN 2118, RSCN 2117, RS 629 and RSCN 5011 among others. RS 115B2, RS 74B2, RS 301B2, RS 924B2, RS 127B2, RS 1223B2, RS 1126B2, RS 97B2 etc. are the promising B lines. Promising lines were DUS characterized.

A total of 109 experimental hybrids were tested under three trials, each comprising of 37, 32 and 40 hybrids, respectively. Station Hybrid Trial I and II were conducted in RBD, while the SHT III was conducted in augmented design. Performances of top 10 experimental hybrids are presented in Table 6a. RS1100A2 × RSCN 5028 flowered early but yielded maximum. In SHT II RS2309A2 × RSCN 5028 followed by RS1215A2 × KR 199 were the best hybrids (Table 6b). In SHT III RS1215A2 × RS 4004 followed by RS2313-2A2 × RSCN 5031 and RS2309A2 × RS 795 were the best (Table 6c).

Table 6a. Performance of top ten experimental hybrids in Station Hybrid Trial I

Sl. No.	Hybrids	GY	DTF	DTM	PH
1	RS1100A2 × RSCN 5028	2613	63	108	203
2	RS2308A2 × KR 199	2435	66	106	175
3	RS2308A2 × AKR 436	2392	68	109	213
4	RS1223A2 × RSCN 5028	2336	68	108	195
5	RS1223A2 × RSCN 5026	2332	67	108	210
6	296A × RS 795	2210	68	110	323
7	RS1100A2 × KR 199	2200	69	108	200
8	RS2309A2 × RSCN 5007	2129	66	107	175
9	RS2308A2 × RSCN 5026	2114	70	107	175
10	RS1100A2 × RSCN 5031	2078	67	107	183
11	CSH 25	1938	69	110	243
12	CSH 16	1889	62	108	205
13	CSH 27	1835	67	107	190
	General Mean	1645	67	108	211
	LSD at 5%	1242	4	4	24
	p-Value	0.00	<.0001	0.03	<.0001

Table 6b. Performance of top ten experimental hybrids in Station Hybrid Trial II

Sl. No.	Hybrids	GY	DTF	PH
1	RS2309A2 × RSCN 5028	3489	66	185
2	RS1215A2 × KR 199	2950	67	203
3	RS2309A2 × RSCN 5031	2904	65	170
4	296A × RSCN 5026	2715	64	250
5	RS2313-2A2 × RSCN 50	2507	68	208
6	RS2313-2A2 × RSCN 50	2485	65	190
7	RS2309A2 × KR 199	2411	67	173
8	RS1100A2 × RSCN 5026	2365	67	205
9	RS1215A2 × RSCN 5026	2281	68	195
10	RS2308A2 × KR 196	2261	68	190
11	CSH 27	2857	63	200
12	CSH 25	2415	68	235
13	CSH 16	2365	61	215
	General Mean	2033	66	208
	LSD at 5%	617	3	2
	p-Value	0	<.0001	<.0001

Table 6c. Performance of top ten experimental hybrids in Station Hybrid Trial III

Sl. No.	Treatment	GY	DTF	PH
1	RS1215A2 × RS 4004	3583	72	184
2	RS2313-2A2 × RSCN 5031	3494	65	174
3	RS2309A2 × RS 795	3073	69	301
4	RS1223A2 × KR 199	2873	68	166
5	RS2308A2 × RS 4002	2584	75	131
6	296A × RS 647	2572	65	214
7	RS1126A2 × RS 795	2551	74	231
8	RS1215A2 × KR 196	2328	69	181
9	27A × KR 196	2272	65	219
10	RS2313-2A2 × KR 196	2228	69	206
	RS1223A2 × AKR 436	2117	68	176
	296A × KR 196	1983	70	249
11	CSH 25	2500	72	228
12	CSH 27	2194	67	188
13	CSH 16	2183	67	228
	General mean	1802	69	198
	Test Treatment not in the same Block	1481	4	17
	Test Treatment in the same Block	1418	4	16
	Test Treatment and a Control Treatment	1247	4	14
	Control Treatment Means	1003	3	12

Studies on Sucrose Accumulation in sweet sorghum for efficient ethanol production

(CV Ratnavathi, C Aruna)

- A total of 8 sweet sorghum genotypes (Kellar, Urja, CSV 19SS, Wray, BJ- 248, SSV 84, SSV 74, and CSH 22SS) were compared for biomass, green cane and juice yield in kharif, rabi and summer seasons at different crop growth stages with grain and forage sorghum genotypes.
- At physiological maturity maximum yields of biomass, green cane and juice yields were obtained in all the crop seasons. However the crop duration for each stage varied in each season and maximum duration for the crop in summer was upto 140 days to attain harvest maturity stage for grain.
- Biomass and green cane are maximum in summer season in case of all sweet sorghum genotypes compared to rabi and kharif seasons. Genotypes Wray, Urja, SSV 74 and CSH 22SS showed maximum biomass in all seasons at maturity stage and these genotypes can be considered as stable genotypes across seasons.
- Five genotypes (Keller, Urja, Wray, BJ 248 and SSV 74 recorded the maximum sucrose content and total fermentable sugars at physiological maturity stage, in all the three seasons.
- Highest brix content was recorded in Wray, Urja, SSV 74, BJ 248 and CSH 22 SS at physiological maturity stage in all the three seasons.
- Sucrose synthase activity is high at milky stage of the crop in all genotypes in all the three seasons. Sucrose synthase activity is expressed equally in all seasons in 4 genotypes (Keller, Wray, Urja and BJ 248).
- Sucrose phosphate synthase activity) is highest in milky stage in summer and Indian sweet sorghum genotypes showed highest activity in kharif at milky stage and at physiological maturity in summer season. The invertases are lowest in kharif at physiological maturity stage and in summer season the invertase activity is maximum at physiological maturity stage

Studying the therapeutic properties and establishing sorghum grain as a functional food

(CV Ratnavathi, C Aruna and R Karuna University)

- Grain quality of the 127 genotypes analyzed and 10 genotypes were identified with starch content above 69%. IS2397, SPV1244, EP22, EP64, NSJB6625, IS8348, IS16151, IS19445. Out of 127 genotypes amylose content varied from 15.05% in IS 16151 to 28.11% in SPV1471. In fourteen genotypes amylose content varied from 17.26% in IS2413 followed by 17.84% in 296B to 19.79% in IS14861. Whereas, seventy four genotypes showed amylose content 20.05% in IS20697 to 24.95% in SPV1750 followed by 24.89% in RS627. However seventeen genotypes showed amylose content varied from 25.21% in SPV1749 to 28.11% in SPV1471 (Table 7). The amylose and amylopectin ratio of the genotypes varied from 0.310 (IS 9108) to 0.950 (SPV 711). In SPV 711 the amylose and amylopectin contents are equal. Out of 69 genotypes % of fat content ranges from 1.66 to 3.66 (EP81-IS602). 15 genotypes showed % of fat above 2.5 and 18 genotypes showed % of fat above 3. Out of 127 genotypes the mean protein content varied from 8.50% in IS19445 to 16.30% in IS30450. In forty one genotypes protein content varied from 8.50% in IS19445 to 9.98% in IS2397.

Table 7 Genotypes with high amylose

1	SPV1749	25.05	25.37	25.21	0.22
2	SPV933	25.37	25.79	25.58	0.30
3	K8	25.58	25.26	25.42	0.22
4	EP120	25.79	25.26	25.53	0.37
5	IS2389	25.79	26.84	26.32	0.74
6	IS27912	26.00	26.00	26.00	0.00
7	IS28451	26.84	25.37	26.11	1.04
8	SPV1775	25.68	26.32	26.00	0.45
9	EP84	26.42	25.89	26.16	0.37
10	IS715	26.21	27.16	26.68	0.67
11	7B	26.53	26.00	26.26	0.37
12	SPV711	27.68	28.00	27.84	0.22
13	SPV1244	26.84	27.16	27.00	0.22
14	296B	20.53	20.00	20.26	0.37
15	463B	27.47	28.32	27.89	0.60
16	EP82	28.21	27.89	28.05	0.22
17	SPV1471	28.21	28.00	28.11	0.15

Genetic enhancement of sweet and high biomass sorghums for traits related to 1st and 2nd generation biofuel production and shoot pest tolerance

(A V Umakanth, B Venkatesh Bhat and P G Padmaja)

Evaluation of Advanced Varietal progenies and Hybrids

During Kharif, 2013, a trial with advanced varietal progenies and hybrids was carried out. The material included 12 hybrids, 18 varieties and CSH 22SS and CSV 19SS which were used as hybrid and varietal checks respectively. Observations on days to flower, plant height, stem girth, total biomass (fresh & dry), brix (%), juice yield, total sugar content, total sugar index and computed ethanol yields were recorded (Tables 8-9).

Highlights of Results in varieties:

1. The analysis of variance revealed significant variability for all the important characters like total biomass, juice yield, TSS, brix and computed ethanol yield.
2. DSRV8 exhibited significant superiority of 88.8 t/ha (13.52%) for total fresh biomass over the check CSV 19SS (78.2 t/ha).
3. Significant and higher brix was observed in DSRV17 (23.2%) over the check (19.2%)
4. The varieties DSRV7, DSRV13 and DSRV17 and exhibited significantly higher juice yield (10-36%) over the check.
5. The variety DSRV17 exhibited significant superior performance for ethanol yield, TSS, TSI and brix (%) and had significant positive heterosis of 33%, 21%, 33% and 21% respectively

Highlights of Results in Hybrids:

1. The analysis of variance for revealed significant variability for all the important characters like total biomass, juice yield, TSS, brix and computed ethanol yield.
2. All the hybrids flowered (66-81 days) significantly earlier than the check CSH 22SS (85 days)
3. The hybrid DSRH5 (20.10%) recorded higher brix over the check (14.95%).
4. DSRH1, DSRH2, DSRH5, DSRH7 and DSRH10 yielded significantly higher juice and ethanol yields over the check and a standard heterosis of more than 40 per cent.
5. The hybrid DSRH5 had a standard heterosis of 93.14% for ethanol yield and 45.17% for juice yield.

Table 8. Performance of varieties for sweet sorghum productivity traits

S.No	Entry	Days to flowering	Plant height (cm)	Total fresh biomass (t/ha)	Brix (%)	Stem girth (cm)	Juice yield (kL/ha)	TSS	TSI	Ethanol yield (L/ha)
1	DSRV1	71	262.50	54.5	11.7	1.64	7.9	10.41	0.82	436.5
2	DSRV2	79	301.00	73.5	20.3	1.83	12.2	17.89	2.20	1170.9
3	DSRV3	72	304.50	65.5	18.1	1.86	9.9	15.96	1.58	844.7
4	DSRV4	76	238.50	55.3	14.1	1.65	6.9	12.46	0.85	454.0
5	DSRV5	76	229.50	48.3	13.8	1.60	5.7	12.20	0.73	387.0
6	DSRV6	75	336.00	72.4	19.6	2.03*	14.0	17.32	2.42	1288.9
7	DSRV7	79	315.50	85.5	17.5	2.02*	16.9**	15.44	2.60	1384.7
8	DSRV8	81	282.50	88.8*	18.6	2.23**	14.3	16.40	2.35	1253.6
9	DSRV9	74	371.00**	52.6	16.6	1.69	3.4	14.69	0.50	268.5
10	DSRV10	77	326.00	62.9	19.3	1.81	9.8	17.06	1.67	886.6
11	DSRV11	91	309.50	81.9	17.3	1.99	13.2	15.31	2.00	1061.8
12	DSRV12	91	324.50	76.0	18.1	1.83	13.5	15.96	2.16	1150.7
13	DSRV13	79	284.50	87.3	15.7	2.05	17.0**	13.91	2.37	1260.0
14	DSRV14	88	291.50	83.7	15.9	1.89	15.7*	14.04	2.18	1163.3
15	DSRV15	79	260.00	56.4	17.5	1.97	3.8	15.48	0.58	309.1

S.No	Entry	Days to flowering	Plant height (cm)	Total fresh biomass (t/ha)	Brix (%)	Stem girth (cm)	Juice yield (kL/ha)	TSS	TSI	Ethanol yield (L/ha)
16	DSRV16	93	279.50	84.1	18.3	2.03	11.3	16.14	1.82	967.0
17	DSRV17	73	267.50	61.1	23.2**	1.77	13.6	20.42**	2.80*	1490.3*
18	DSRV18	78	367.50**	81.2	15.1	1.71	17.3**	13.38	2.32	1235.5
19	CSV 19 SS (C)	72	319.50	78.2	19.2	1.79	12.4	16.92	2.11	1121.0
	Mean	76.6	292.35	69.2	17.1	1.83	11.5	15.12	1.76	937.3
	C.D. 5%	2.5	30.74	10.5	2.02	0.21	2.8	1.76	0.53	284.3

Table 9. Performance of hybrids for sweet sorghum productivity traits

Sl. No.	Entry	Days to flowering	Plant height (cm)	Total fresh biomass (t/ha)	Brix (%)	Stem girth (cm)	Juice yield (kL/ha)	TSS	TSI	Ethanol yield (L/ha)
1	DSRH1	73**	309.50	61.5	16.5	1.81	14.17**	14.56	2.10**	1120.6**
2	DSRH2	81**	283.50	69.5	15.6	1.79	13.61**	13.78	1.87*	999.1*
3	DSRH3	73**	280.00	60.7	17.3*	1.65	8.75	15.31*	1.34	710.0
4	DSRH4	66**	221.50	52.3	13.6	1.83	6.21	12.07	0.75	399.2
5	DSRH5	68**	322.50**	73.9	20.1**	1.85	13.36**	17.71**	2.37**	1259.4**
6	DSRH6	69**	250.50	57.8	15.7	1.73	8.92	13.91	1.24	660.2
7	DSRH7	71**	299.00	73.5	16.8	1.84	13.02**	14.83	1.94**	1030.8**
8	DSRH8	75**	267.50	58.9	19.6**	1.56	8.81	17.27**	1.52	808.0
9	DSRH9	74**	295.50	60.7	15.7	1.65	10.65	13.86	1.48	786.8
10	DSRH10	73**	314.00*	79.0	16.6	1.92	13.88**	14.65	2.06**	1097.7**
11	DSRH11	80**	308.50	73.9	16.5	1.88	15.79**	14.61	2.30**	1225.9**
12	DSRH12	68**	233.00	67.3	17.5*	1.66	9.15	15.44*	1.41	750.5
13	CSH 22 SS (C)	85	279.00	69.8	14.9	1.81	9.20	13.21	1.22	652.1
	Mean	76.61	292.35	69.2	17.1	1.83	11.49	15.12	1.76	937.3
	C.D. 5%	2.50	30.74	10.5	2.02	0.21	2.83	1.76	0.53	284.3

Development of novel pre-breeding lines through wide hybridization in sorghum

(KBRS Visarada, P Sanjana, P. Rajendra Kumar)

De novo variation was created through repeated inter generic pollination between sorghum and maize. A set of variants showed high biomass traits such as juicy thick stems, very tall plants, and greater leaf area. Twenty four such high biomass lines were subjected to in house evaluation in the field along with two checks SSV84 and CSV22S. Significant differences among the genotypes were observed. Comparative evaluation of the data for two consecutive Kharif seasons showed four promising lines, 2114-3, 2127-6, 2288-3 and 2289-1-6. These two are derived from two parental lines.

Table 10. High biomass traits in novel lines during two Kharif seasons (2013 and14)

Genotype	Brix	Fresh wt kgs/15 plants	Plant height cm	Stem girth cm	Leaf area L x W 0.75
2101-20-1	12.1	9.9	310	7.4	581.7
2101-20-2	14.2	8.6	304	7.7	477.2
2111-20	15.7	8.9	238	7.8	468.0
2114-3	17.4	13.9	314	8.9	476.6
2117-23	16.3	10.8	255	7.4	578.0
2127-6	16.9	11.8	307	7.3	554.7
2129-2	13.3	14.2	337	8.3	609.4
2129-4	12.9	10.3	328	7.9	508.8
2143-10	12.7	10.7	268	8.8	644.9
2144-18	17.8	10.8	276	7.2	539.4
2169-15	12.8	10.7	271	9.3	641.3
2169-14	12.7	9.7	255	8.5	611.8
2169-19	13.0	9.3	248	8.9	575.7
2169-2	10.1	9.5	273	8.7	602.0
2169-22	12.7	11.1	273	8.8	567.6
2172-9-12	11.9	13.0	307	8.7	531.5
2172-9-15	14.0	8.3	240	6.9	435.5
2172-9-5	12.0	9.1	265	7.3	464.7
2212-8	15.9	12.7	294	8.4	423.6
2214-1	10.0	8.8	263	7.5	556.8
2224-10-1	17.1	13.0	270	6.8	482.4
2288-3	16.9	13.8	328	8.5	589.2
2289-1-3	16.7	12.2	227	8.3	611.1
2289-1-6	16.6	9.8	257	8.0	635.5
CSV22S (Check 1)	18.5	13.5	276	8.5	526.9
SSV84 (Check 2)	17.8	17.8	269	9.9	650.9
Mean	14.5	11.2	279	8.1	551.7
LSD	1.9	2.4	20.6	1.29	102.0

Table 11. ANOVA for high biomass traits in the trials conducted during two Kharif seasons

Source of variation		Brix	Fresh wt Kgs/ 15 plants	Plant height cm	Stem girth cm	Total leaf area cm ³
Genotype	25	37.964**	30.64**	16.51**	2.85*	5.48**
Year	1	28.686	5.566	13.95**	1.07	0.31
Gen X Year	25	9.841**	20.276**	5.14**	1.15	5.56**
Error	102	2.734	4.245	323.5	1.266	4990

IV Kharif sorghum breeding at AICSIP centers

1. AKOLA

During kharif 2013-14, in grain breeding programme total 54 individual plant selection were made in R line development programme while in B line development programme 65 IPS were selected. Total 118 BC pairs were made in grain breeding programme. In grain mold resistance breeding programme, total 45 IPS were selected in R line development programme while in B line development programme 15 IPS were selected. Total 105 BC pairs were made in grain breeding programme. In shoot fly resistance breeding programme, total 3 IPS were selected in R line development programme while in B line development programme 19 IPS were selected. Total 44 BC pairs were made in grain breeding programme. In drought tolerance breeding programme, 7 IPS were selected in two R × R crosses received from the Project under group efforts on sharing of breeding material. Total 6 Station Hybrid/Varietal Trials were successfully conducted. Besides these trials, one Private Hybrid Testing Trial consisting of three hybrids from the private companies were evaluated. Total 7 AICSIP trials were allotted to this centre and were conducted successfully and data submitted to project. One Ph.D. and two M.Sc. students completed their research programme at this unit during the last year. This unit has undertaken four training programmes for the farmers. Total six research papers have been published in the NAAS rated journals. Similarly, 16 abstracts have been published in different international and national seminars during the year 2013-14. Seven popular articles and two books were also published. During kharif 2013, the maintenance of A, B, R lines, experimental hybridization programme and varietal selection programme was carried out. This centre received two awards, viz., the "Best Performing Centre Award-2012" during the AGM at Hyderabad on 21/04/2013 and the Best Poster Presentation Award during the Global Consultation on Millets on 21/12/2013.

1. Grain sorghum R line development programme: Total 54 selections were made from 23 crosses in different segregating generations.

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₅ (RxR)	6	54
F ₁ (RxR)	17 (New crosses)	Bulk harvested
Total	23	54

2. Grain sorghum B line development programme: Total 65 selections were made in 19 different B×B and B×R crosses in different generations.

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₈ (BxB)	7	19
F ₅ (BxB)	3	24
F ₇ (BxR)	9	22
Total	19	65

3. Grain sorghum MS Conversion programme: Total 118 BC pairs were made during Kh-2013.

Generation	No. of crosses evaluated	No. of families/single plant selected (Advancement of BC pairs made during the year)
BC ₁	5	4
BC ₂	7	6
BC ₃	4	20
BC ₄	2	18
BC ₅	8	13
BC ₆	3	16
BC ₇	11	18
BC ₈	9	23
Total	49	118

4. Development of lines resistant to various stresses

a. Grain mold resistance R line development programme: Seventeen crosses in different generations involving grain mold resistance sources like SVD-9601, STR-93, GMPR-65 and GM-9219 were evaluated and 45 single plant selections showing low Field Grain Mold Rating (FGMR) and good grain hardness (above 9) were selected.

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₉ (RxR)	8	18
F ₈ (RxR)	9	27
Total	17	45

b. Grain mold resistance B line development programme: Eight crosses in F₈ generation involving grain mold resistant B line i.e. B-58586 and the susceptible line MS-296 were handled and 15 selections showing low Field Grain Mold Rating (FGMR) and good grain hardness (above 9) were selected.

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₈ (BxR)	8	15
Total	8	15

c. Grain mold resistance MS conversion programme: In MS line development programme total 105 BC pairs involving the 23 crosses having grain mold resistant lines were made during Kh-2013.

Generation	No. of crosses evaluated	No. of families/single plant selected(Advancement of BC pairs made during the year)
BC ₁	4	13
BC ₂	2	7
BC ₃	3	17
BC ₄	2	9
BC ₅	5	27
BC ₆	3	15
BC ₇	4	17
Total	23	105

d. Shoot fly resistance R line development programme: Total three restorers involving one cross showing shoot fly resistance were selected.

e. Shoot fly resistance B line development programme: Nineteen selections were made from BxB cross in F₇ generation.

f. Shoot fly resistance MS conversion programme: In MS line development programme total 44 BC pairs involving the 16 crosses and showing shoot fly resistance were selected during Kh-2013.

Generation	No. of crosses evaluated	No. of families/single plant selected
BC ₁	2	2
BC ₂	4	5
BC ₃	3	11
BC ₄	1	6
BC ₅	2	14
BC ₆	4	6
Total	16	44

g. Drought tolerant R line development programme: Total seven selections were made in two R x R crosses in F₉ generation received from the Project under group efforts on sharing of breeding material. Selections were made for earliness and stay green traits.

5. Station hybrid/variatal trial: Total six station trials as per the detail below were successfully conducted. Besides these trials, one Private Hybrid Testing Trial of three hybrids from the private companies was also carried out during the Kharif 2013.

Name of trial	No. of entries tested	Checks used	Superior entries
Multilocation Varietal cum Hybrid Trial (MVHT)	26	PVK-809, CSV-20, CSH-14, CSH-9, SPH-1635	AKSH-612, AKSH-618, AKSH-639, AKSV-181, AKSV-182, AKSV-194, AKSV-221.
Multilocation Hybrid Trial (MHT)	20	CSH-14, CSH-9, SPH-1635, SPH-840	AKSH-643, AKSH-644, AKSH-646, AKSH-650, AKSH-654
Multilocation Varietal Trial-I (MVT-I)	20	PVK-809, CSV-20, SPV-669, CSV-23	AKSV-182-1, AKSV-161, AKSV-180, AKSV-267, AKSV-296
Multilocation Varietal Trial-II (MVT-II)	20	PVK-809, CSV-20, SPV-669, CSV-23	AKSV-306, AKSV-307, AKSV-311, AKSV-314, AKSV-317, AKSV-318, AKSV-320
Multilocation Wani Trial (MWT)	10	Malkapur Wani, PKV Ashwini	Wani-103, Wani-101, Wani-102, Wani-104
State Multilocation Varietal cum Hybrid Trial (SMVHT)	16	Coded	1310, 1301, 1318, 1317, 1307, 1312, 1309, 1316,

6. AICSIP trial: Seven AICSIP trials, viz., AHT, AVT, IHT, IVT, PPHT, HN and Germplasm Evaluation Trial of 4000 germplasm lines were allocated and successfully conducted.

7. Other activities

- Maintenance of line** – A&B pairs: 29, R lines: 450, New experimental hybrids: 42, New varietal selections: 141 and Wani sorghum selections: 52
- Student guidance** – Ph.D.-1 students and M.Sc.-3 students
- Training organized**- Four
 - 1) One week training programme on “Sorghum Value Addition and Processing” at Village- Kalambeshwar Dist-Akola on 22-26 Jan. 2013
 - 2) One day training programme on “Field Day cum Farmers Training Programme on -Rabi Seed Production Techniques” at Village Shivapur Dist.Akola on 24/02/2014

- 3) One day training programme on "Field Day cum Farmers Training Programme on -Rabi Seed Production Techniques" at Village Karanja Lad Dist.Washim on 25/02/2014
 4) One day training programme on "Field Day cum Farmers Training Programme on -Rabi Seed Production Techniques" at Regional Research Centre (RRC), Amravati on 01/03/2014

8. Publications: Research Papers: Six; Abstracts: 16; **Popular Articles: 07; Book: One** Marathi- (Jwari lagwad tantradyan), One English-(Sorghum Research at Dr.PDKV,Akoa);

Other Important Points: This center has received following two awards

- 1) Best Performing Centre Award-2012 during the AGM at Hyderabad on 21/04/2013.
- 2) Best Poster Presentation Award during the Global Consultation on Millets on 21/12/2013.

2. BIJAPUR

All five allocated AICSIP trials were conducted successfully. In station Breeding evaluation programme three preliminary varietal trials (PVT), one B line trial (BLT), one R line trial (RLT) and one MLT were conducted. In addition a public cum private hybrid trial was conducted. A total of 15 lines from PVT, 10 from BLT and 13 from RLT were selected. In station breeding programme, 20 newly derived F₆ generation R lines were evaluated and of them eight were found superior and retained. In B line programme 8 lines were found exceedingly superior to checks. In conversion programme 10 lines are at BC₄ stage. In trait specific breeding programme, ten families belonging to BC₂ and BC₁F₁ were evaluated for drought stress and four were found promising. In the breeding for charcoal rot tolerance 23 lines derived from BC₂F₃ and straight F₃ were evaluated and a total of 20 promising plants were selected. To develop medium dwarf non lodging coupled with CSV216R yielding ability 18 BC₂F₄ families were selected. To develop early maturing lines with maldandi yielding ability 10 F₇ lines were evaluated and a total of 5 families were selected. A total of 33 F₃s derived from different cross combination were grown. Of them a total of 150 plants were selected for different combination of traits. Four F₂s contributed by different centers were grown and 30 plants were selected. A total of 650 germplasm were maintained.

1. R line development programme: In restorer line development programme 23 newly derived F₆ generation lines were evaluated and of them eight families were found superior and retained.

2. B line development programme: With an objective of developing Maldandi grain quality B lines 19 F₆ lines were evaluated and 10 families were found exceedingly superior to checks.

3. MS Conversion programme: Ten promising B lines with near maldandi grain quality types were advanced to backcross 4 generation.

4. Development of lines resistant to various stresses

a. Yield improvement under drought: Ten families belonging to BC₂ and BC₁F₁ were evaluated for drought stress and of them four families were found superior.

b. Charcoal rot tolerance: To derive charcoal rot tolerant lines 23 families and crosses derived from BC₂F₂ and straight F₂ were subjected to evaluation. A total of 20 plants were selected.

c. CSV216R yielding ability with nonlodging medium dwarf: With an objective of developing medium dwarf and CSV216R yielding ability 20BC₂F₃ families were evaluated along with checks. A total of 18 plants were selected.

d. Yield and earliness: To develop early maturing lines with maldandi yielding ability 10 F₇ generation lines were evaluated and total of 5 families selected.

e. Yield and charcoal rot tolerance: To develop high yielding lines with charcoal rot tolerance 40 F₇ generation lines were evaluated and a total of 20 plants were selected.

f. Combination of traits (yield +charcoal rot +earliness +SF tolerance): To develop early charcoal rot tolerance and SF tolerance with maldandi yielding ability 20F₃ of different cross combinations were grown. A total of 150 plants were selected with different combination of traits.

5. Station trials: Total seven station trials were conducted as per the detail below:

Trial	No of entries	checks	No. of families superior to checks
PVT-I	14	DSV5,M35-1 BJV44	05
PVT-II	14	DSV5,M35-1 BJV44	07
PVTIII	14	DSV4,DSV5,M31-2B,BJV44	03
BLT	20	104B,CSV22,BJV44,BRJ204B	10
RLT	26	R354,BJV44 and M35-1	13
PPHT	10	BJV44,CSV22	Yet to be ascertained
MLT	15	CSV22,BJV44	Yet to be ascertained

6. AICSIP trials: How many trials allocated and how many were successfully conducted. Five trials were allotted and all the five were conducted successfully.

7. Other activities

- a. Student guidance: M.Sc-three
- b. Training organized: Nil

8. Publications: Research paper – one, Abstract – 2, Thesis – 4

3. COIMBATORE

Grain sorghum breeding: In UVT I(S), eight cultures were tested and TNS 644 excelled the check variety CO 30 by recording grain yield of 2854 kg/ha with increased yield of 6.37 percent. In UVT II, Three entries viz., TNS 647, TNS 648 and TNS 649 were found to be superior with grain yield potential of 3457, 3604 and 3669 kg/ha with increased yield of 11, 14 and 16 % over the CO 30. Seven new cultures viz., TNS 651, TNS 652, TNS 653, TNS 654, TNS 655, TNS 656 and TNS 657 selected from non replicated trials were raised and the crop is early seedling stage. Two hybrids ICS12A x ICSR 89020 and ICS90001A x CO 30 recorded highest grain yield of 2839 and 3332 kg of grain yield/ha with fodder yield potential of 7.5 and 9.7 tons/ha respectively. They possessed grain yield advantage of 14 and 34 per cent over Local Check Co5. The plant height recorded in these entries were of 188 and 200 cm respectively. Under R line development programme a total of 38 crosses were evaluated under different generation and 260 families has been forwarded. Under trait specific development programme 4 crosses for drought and 4 crosses for shoot fly has been evaluated in F₂ and 50 families each has been selected for further evaluation. Under B line development programme B x B and B X R crosses has been effected. The resistant entry identified in AICSIP trials viz., CSV 17 for shoot fly, SPV 2175 for mite, SPV 2176 and SPV 2177 for head bug were utilized in making new crosses. A total quantity of 500 kg of CO 30 sorghum TFL seeds were distributed to the farmers

Forage and sweet sorghum breeding: Coimbatore entry multicut varietal line SPV 2242 promoted to AVT – I, 2014 as it recorded first rank on an average over Zone I and II. Forage sorghum single cut superior cultures namely TNFS 213, 215 identified for testing in AICSIP 2014 as it recorded 9-12 % higher GFY than CO 30 under UVT Trial. Sweet sorghum culture TNSS 214 recorded 11 % higher cane yield than CSV 24 SS with 18 % brix under UVT Trial and identified for AICSIP 2014 Trial. Forage sorghum multi cut superior cultures namely TNFS 210, TNFS 211 found to be 7 % higher than local check CO FS 29 under UVT Trial. 60 Hybrids combination in sweet and forage sorghum evaluated for Hybrid identification and 55 new combinations were synthesized. Four hybrids combinations identified as promising advanced to second year testing. Forage sorghum and sweet sorghum segregating material were evaluated and superior single plants identified in F₅, F₆ families for seed multiplication. A total of 39 new emasculation crosses 17 and 22 in Forage and sweet sorghum and segregating materials F₂ - F₆ were evaluated. Twenty one crosses studied and 315 single plants selected for further evaluation in R line improvement program. Mutation material from Co 11 Variety involving treatments Gamma, EMS and Sodium Azide were developed and M₂ generation evaluated for forage traits. Working germplasm 300 accessions raised for maintenance and utilized in breeding program and a part characterized for qualitative and quantitative traits. All four Forage and sweet sorghum Trial successfully conducted, sucrose analysis done and data loaded.

A. Grain sorghum breeding

1. R line development programme: Total 83 crosses in different generations were evaluated and 260 selections were made.

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₁	45	Evaluted in Kharif 2014
F ₂	16	93
F ₄	7	31
F ₅	7	115
F ₅	4	5
F ₆	4	16
Total	83	260

2. B line development programme: Six crosses in F₁ generation were evaluated.

3. Trait-specific line development programme

a. Shoot fly resistant R line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₁	7	Evaluated during kharif 2014
F ₂	4	50
Total	11	50+

b. *Drought tolerant R line development programme*: Four crosses in F₂ generation were evaluated and 50 selections were made.

c. *Mite resistant B line development programme*: Six crosses (ICS 29003 B x SPV2175, PBT 30305B x SPV2175, ABT A₂1002B x SPV2175, ABT1001B x SPV2175, ICS51B x SPV2175, ICS29006B x SPV2175) in F₁ generations were evaluated.

d. *Head bug resistant B line development programme*: 18 crosses (ICS 29003 B x SPV2176, PBT30305Bx 2176, ABT A₂1002B x 2176, ABT1001B x 2176, ICS51Bx SPV2176, ICS29006B x SPV 2176, ICS 29003 B xSPV2177, PBT30305BxSPV2177, ABTA₂1002BxSPV2177, ABT1001BxSPV 2177, ICS51B x SPV 2177, ICS29006B x SPV 2177, ICS 29003BxSPV2178, PBT30305Bx SPV2178, ABTA₂1002B x SPV2178, BT1001BxSPV2178, ICS51B x SPV2178, ICS29006B x SPV21) in F₁ generation were evaluated.

4. Station hybrid/variety trial: Nine station trials as per the detail below were conducted,

Name of trial	No. of entries tested	Checks used	Superior entries
UVT I (S) 2013	8	CO 30, C O 28	Among the eight cultures tested only TNS 644 excelled the check variety CO 30 by recording grain yield of 2854 kg/ha with increased yield of 6.37 percent.
UVTII (S)2013	8	CO 30, APK 1, K8	Three entries viz., TNS 647, TNS 648 and TNS 649 were found to be superior with grain yield potential of 3457, 3604 and 3669 kg/ha with increased yield of 11, 14 and 16 % over the CO 30.
UVT -I(S) 2014	4	CO 30, APK 1, K8	Four cultures viz., TNS 643, TNS 644, TNS 645, TNS 646 have been raised and crop is in early seedling stage
UVT -II(S) 2014	4	CO 30, APK 1, K8,	Four cultures viz., TNS 647, TNS 648, TNS 649 and TNS 650 have been raised and the crop is in early seedling stage
UVT-III (S) 2014	7	Co 30, APK 1, K8	Seven new cultures viz., TNS 651, TNS 652, TNS 653, TNS 654, TNS 655, TNS 656 and TNS 657 selected from non replicated trials were raised and the crop is early seedling stage
MLT (S)2014	9	Co 30, APK 1, K8, CSV 17	TNS 638 an TNS 648 along with other station entries were raised and crop is early seedling stage
UHT-2 (S) 2013	5	Co 5	The five hybrids viz., were evaluated. ICS 29001 A x TNS 627, ICS 29012 A x K8 ICS 29012 A x TNS 623, ICS 29009 A x TNS 627 And ICS 29011 A x APK 1 None of the entries out yielded the check Co 5
UHT 1 (S) 2013	11	Co 5	Eleven hybrids were evaluated. Only two hybrids ICS12A x ICSR 89020 and ICS90001A x CO 30 recorded highest grain yield of 2839 and 3332 kg /ha with fodder yield potential of 7.5 and 9.7 tons/ha respectively. They possessed grain yield advantage of 14 and 34 per cent over Local Check Co5. The plant height recorded in these entries were of 188 and 200 cm respectively.
A x R crosses	15	Co 5	15 A x R crosses viz., ABTA1 1006 x Co 26, ABTA1 1006 x SPV 2083, ABTA1 1006 x IVT4001, ICS 29006 x TNS 645, ICS 29014 A x TNS 644, x K8, PBT 30370 A x Co 25, PBT 30370 A x Co 30, PBT 30370 A x TKS V 0809, PBT 30370 A x TKS V 0902, PBT 30370 A x IVT 4001, PBT 30370 A x IVT 4015, ICS 88010 A x TNS 657, ICS 88010 A x TNS 640, and ICS 88010 A x TNS 641 has been raised during summer 2014

5. AICSIP trial: Five kharif and two late kharif trials were allocated and conducted successfully.

B. Forage sorghum programme

1. R line development programme: 26 crosses in F₂-F₅ generations were evaluated and number of selections made given below:

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₂	7	108 single plants selected
F ₃	12	185 single plants selected for organizing families
F ₅	7	22 Single plants selected for evaluating families
Total	26	

The following segregating materials were evaluated for forage traits and selected lines advanced to F₃ generation.

Cross combinations	No of single plants selected in F ₂
TNS 599 X SSG 211	45
TNS 599 X COFS 29	33
TNS 599 X ICSV 700	27
TNS 598 X SSG 211	29
TNS 598 X COFS 29	24
TNS 598 X ICSV 700	33
Co S 28 X COFS 29	34
Co S 28 X GD 65174-2	23
Co S 28 X ICSV 700	34
Co S 28 X SSG 211	30
COFS 29 X IS 21813	23
CO FS 29 X Co S 28	33

In addition seventeen crosses as per detail below were developed: COS 28 x RSV 9, TNS 631 x CO FS 29, COS 28 x CSV 24SS, TKS 0809 x CO FS 29, TNS 599 x RSV 9, TNS 623 x CO FS 29, TNS 598 x RSV 9, TNS 627 x CO FS 29, TNS 598 x CSV 24SS, TNS 640 x CO FS 29, TNS 631x CSV 24SS, TNS 640 x RSV 9, RSV 9 x TNS 599, TNS 640 x CSV 24SS, RSV 9 x CSV 24SS, TNS 641 x CSV 24SS, TNS 641 x RSV 9

2. Mutation Breeding: The promising fodder yielding variety, CO 11 was subjected to physical and chemical mutation studies involving gamma, Sodium Azide and EMS to generate variation for forage traits. Numbers of plants against different treatments are given below:

Treatments	No of Plants in M2
Gamma 30 KR	652
Gamma 45 KR	520
EMS 0.05 %	950
EMS 0.1 %	730
Sodium Azide 25 mM	760
Sodium Azide 35 mM	670

3. Station hybrid/variety trial: Three station trials were conducted as per the detail below:

Name of trial	No. of entries tested	Checks used	Superior entries
UVT- Forage sorghum Single cut	4	Co 27, Co, 30	TNFS 213, TNFS 215, (9, 11 % higher than checks)
UVT- Forage sorghum Multi cut	5	Co Fs 29,	TNFS 210, TNFA 211 (7% higher than checks)
UVT-Sweet sorghum variety Trial	3	CSV 19, 24 SS, SSV 84	TNSS 214 (11 % higher than check CSV 24 SS)

4. AICSIP Trials: Five AICSIP trials, viz., IAVHT – SS, IAHT – MC, IVT – SC, AVT – SC, SYT, were conducted successfully.

C. Sweet sorghum breeding

1. Evaluation of segregating sweet lines: Selection has been done in F₃ involving 17 different crosses of sweet sorghum combinations specifically for biomass and sugar related traits and selected materials were advanced to F₄ generation.

Cross combination in F ₃	Number of single plants selected in F ₃
SS 303 X SS 253	13
SS 303 X SS 262	12
SS 303 X SS 1094	14
SS 303 X SS 192	-
SPSSV 6 X SS 172	11
SPSSV 6 X SS 253	12
SS 1607 X SS 253	12
SS 179 X SS 449	-
SS 179 X SS 172	13
SS 179 X SS 917	-
SSV 84 X SS 262	14
SSV 84 X SS 192	13
SSV 84 X SS 917	16
SSV 84 X SS 172	14
GR 317 X SS 262	13
GR 317 X SS 172	12
GR 317 X SS 215	-

2. Evaluation of segregating materials for sugar traits: The following cross combinations were evaluated for morphological traits of plant height, stem girth and brix reading and advanced to next generation were given below.

Generation	Cross combinations	No of plants studied	No of single plants selected	Average Brix %
F ₅	CO 25 x Indore 12-3-2-2-2	5	3	16
F ₅	CO 25 x Indore 12-3-4-2-2	5	2	12
F ₅	CO 25 x Indore 12-3-4-2-3	1	1	20
F ₅	CO 25 x Indore 12-4-3-2-2	3	-	-
F ₅	COS 28 x Indore 12-1-1-2-1	-	-	-
F ₅	COS 28 x Indore 12-1-1-2-2	-	-	-
F ₅	APK 1 x S 35-3-2-2-1	-	-	-
F ₅	APK 1 x S 35-4-1-1-2	-	-	-
F ₅	CSV 15 x S 35-4-1-1-1	-	-	-
F ₅	TNS 603 x SPV 462-4-2-1-1	2	2	16
F ₅	TNS 603 x SPV 462-4-2-1-2	-	-	-
F ₅	TNS 603 x SPV 462-4-2-1-4	4	1	15
F ₅	CO 26 x IS 18551-4-4-1-1	-	-	-
F ₅	CO 26 x IS 18551-4-4-2-1	5	2	21
F ₅	COS 28 x SPV 1041-5-1-2-1	-	-	-
F ₅	COS 28 x SPV 1041-5-1-2-4	-	-	-
F ₅	TNS 603 x EP 60-2-1-1-1	-	-	-
F ₅	TNS 603 x IS 3436-4-1-3-1	-	-	-
F ₅	TNS 603 x SPV 881-1-2-1-1	-	-	-

Generation	Cross combinations	No of plants studied	No of single plants selected	Average Brix %
F ₅	TNS 603 x SPV 881-1-2-1-2	-	-	-
F ₅	TNS 603 x SPV 881-1-3-1-2	4	2	14
F ₅	TNS 603 x SPV 881-1-3-1-1	-	-	-
F ₅	TNS 603 x SPV 881-1-3-1-2	2	1	14
F ₅	TNS 603 x SPV 881-2-1-2-3	-	-	-
F ₅	TNS 603 x SPV 881-3-2-1-1	5	2	15
F ₅	TNS 603 x SPV 881-3-2-1-2	3	-	-
F ₅	TNS 603 x SPV 881-3-2-1-3	5	3	16
F ₅	TNS 603 x SPV 881-1-2-2-1	-	-	-
F ₅	TNS 603 x SPV 881-3-1-1-1	2	2	21
F ₅	TNS 603 x SPV 881-3-1-1-2	4	1	20
F ₅	TNS 603 x SPV 881-3-1-1-3	2	1	19
F ₅	TNS 603 x SPV 462-5-1-1-1	-	-	-
F ₅	TNS 603 x SPV 462-5-1-1-2	2	1	15
F ₅	TNS 603 x SPV 462-5-1-1-3	4	2	13
F ₅	TNS 603 x SPV 462-5-1-2-1	4	3	21
F ₅	TNS 603 x SPV 462-5-1-2-2	-	-	-
F ₅	TNS 603 x SPV 462-1-1-2-1	-	-	-
F ₅	TNS 603 x SPV 462-1-1-2-2	4	2	16
F ₅	CO 26 x IS 18551- 4-4-2-2	-	-	-
F ₅	COS 28 x EP 88-4-1-1-2	-	-	-
F ₅	COS 28 x EP 88-4-1-1-3	-	-	-
F ₅	COS 28 x EP 58-5-1-1-2	-	-	-
F ₆	APK 1 x M 35-1-2-2-2-1	-	-	-
F ₆	SPV 1234 x RS 673-1-1-1-1	2	1	21
F ₆	IS 18417x CO 25-4-3-1-3	2	2	20
F ₆	TNS 603 x SPV 881-4-1-1-1	3	1	18
F ₆	TNS 603 x SPV 881-4-1-1-2	5	2	18

3. Promising lines identified in advanced yield trial: The following lines from F₇ generation were advanced to the yield trial and evaluated for cane biomass yield during summer 2013 and the details given below.

Cross combination	Days 50% Flowering	Plant Height (cm)	Brix %	Total Biomass yield per ha
TNS 603 X SPV 881-4-1-1-1-1	69	294	19.1	40.1
TNS 603 X SPV 881-4-1-1-1-2	68	284	19.5	39.2
TNS 603 X SPV 881-4-1-1-1-3	67	273	18.1	40.2
TNS 603 X SPV 881-4-1-1-2-1	69	278	18.2	39.4
TNS 603 X SPV 881-4-1-1-2-2	68	255	19.2	37.7
TNS 603 X SPV 881-4-1-1-2-3	68	268	18.4	36.5

4. Synthesis of new hybrids for evaluation of sugar yield: A total of 55 experimental hybrids were synthesized during summer 2013 and seeds collected and kept for evaluation in summer 2014.

5. Promising combinations identified for high brix and cane yield: The following cms line based hybrids selected among the 60 hybrids evaluated and these hybrid combinations would be again evaluated in summer 2014 for taking up advanced stages of evaluation.

Cross combinations	Brix %	Remarks
ICS 12 A x K05 69	20.2	Thick cane and plant height
ICS 12 A x K05 156	19.5	Thick cane and plant height
ICS 12 A x K05 238	18.3	Thick cane and plant height
Ms 2219 X K05 50	19.3	Thick cane and plant height

6. Generation of new crosses involving sweet lines: During summer 2013, 22 crosses were carried out and seeds were collected for raising F₁ generation summer 2014.

Cross combination	No of plants	No of plants	
TNS 627 X CSV 19 SS	34	CO 30 X CSV 19 SS	5
TNS 627 X CSV 24 SS	8	CO 30 X CSV 24 SS	9
TNS 627 X ICSV 700	4	CO 30 X ICSV 700	7
TNS 631 X CSV 19 SS	5	TNS 636 X CSV 19 SS	6
TNS 647 X CSV 19 SS	2	TNS 636 X CSV 24 SS	5
TNS 647 X CSV 24 SS	5	TNS 636 X ICSV 700	6
TNS 647 X ICSV 700	8	CO 11 X CSV 19 SS	4
TNS 636 X CSV 19 SS	3	CO 11 X CSV 24 SS	5

7. Other activities-

- i) Maintenance of line: A&B pairs – 152, R lines – 60, experimental hybrids – 2, varietal selections – 15
- ii) Student guidance – 4

- iii) Training organized – Under part II plan Scheme on millet promotion Five training programme and 15 demonstration were organized
iv) Teaching – 2

8. Publications: Nil

4. DEESA

During the *Kharif* 2013, total rainfall received 1171.7 mm. The maximum rainfall received in September followed by July. The most of the *kharif* trials was sown in first fortnight of July. Total five state trials, two station trials and seven coordinated trials were conducted during *Kharif* 2013. Under crop improvement programme 317 segregating materials & SPS of dual and forage type sorghum were evaluated and 1096 selections were made on the basis of yield, earliness, shoot fly resistance and agronomic superiority. A total of 392 accessions of forage and dual type sorghum were maintained under germplasm maintenance programme. The summary of research programmes and achievements during *Kharif* 2013 are presented as below.

1. Development of dual sorghum lines: Traits: Good combining ability, agronomical superiority and per se performance

S. N.	Generation	No. of families (No. of crosses) evaluated	No. of families/single plant selected
1	F ₁	21	21
2	F ₂	17	353

2. Development of fodder sorghum lines: Traits: Shoot fly resistance, agronomic superiority, forage type

Sl. No.	Generation	No. of families (No. of crosses) evaluated	No. of families/single plant selected
1	F ₁	10	Fresh Cross made
2	F ₃	44	109
3	F ₄	15	63
4	SPS	105	320

3. Segregating materials evaluated under national crossing programme: Traits: Earliness, shoot fly resistance, agronomic superiority, forage and dual type

S. N.	Generation	No. of families (No. of crosses) evaluated	No. of families/single plant selected
1	F ₅	61	126
2	F ₆	44	104
3	F ₇	44	40

4. Germplasm maintenance programme: A total of 392 accessions of forage and dual type sorghum are maintained under the center.

5. Station/State trial: Total five state trials and two station trials were conducted and result are summarized below.

Name of the Trial	No. of entries tested	Checks	Superior entries over the best check
Small Scale Varietal Trial (Dual Sorghum)	16	CSV-15, GJ-38 and GJ-42	SR 2805, SPV 1871 and DS 2570
Large Scale Varietal Trial (Dual Sorghum)	12	CSV-15, GJ-38 and GJ-42	SR 2897
Small Scale Varietal Trial Mid late (Forage Sorghum)	12	CSV-21F and GFS-5	DSF 0105, SRF 317
Large Scale Varietal Trial (E) (Forage sorghum)	8	CSV-21F and GFS-5	SRF 319, SRF 1663, SRF 328, SRF 316 and SRF 288
Large Scale Varietal Trial (M) (Forage sorghum)	10	GFS-5 and CSV-21F	SRF 289, SRF 308 and SRF 284
Preliminary Evaluation Trial (Dual Sorghum)	14	GJ-39 and CSV-23	DS 0109, DS 0113, DS 0114, DS 0105, and DS 0103
Preliminary Evaluation Trial (Forage Sorghum)	11	CSV-21F and GFS-5.	DSF 0110 and DSF 0112

6. AICSIP trial: Seven coordinated trials, four under grain viz., AVT, IVT, AHT and IHT and three under forage sorghum viz., AVT (SC), IAVHT (MC) and IVHT (SC) were allotted. All the trials were successfully conducted and data was reported to DSR Hyderabad.

7. Seed production programme: Other than the experimental trials we produced 1500 kg truthful seed of sorghum variety GJ 39 and distributed to farmers.

8. Publications/Honours/Recognitions/Awards: Research papers – 4; Abstract – 1

5. DHARWAD

Kharif sorghum improvement work is carried out with the objective of developing varieties/hybrids with good grain quality; short duration and resistance to biotic stresses like shoot fly tolerance and grain mold resistance. In order to achieve set objectives, as many as five ICAR Viz., AVT, IVT, AHT, IHT and PPHT trials were conducted apart from eight station trials including private hybrid testing.

Multilocation Varietal trial: In this trial, a total of twenty entries comprising of 15 from Dharwad and five from DSR, Hyderabad were tested at Dharwad centre, out of these, entry from Dharwad SPV-2172 (undergoing AVT) recorded significantly superior grain yield of 4236.00 kg/ha compared to superior check DSV-6 (3212 kg/ha). This was followed by SVD-1203 (3888.0 kg/ha) and SVD-744 entries. The entry SVD-1203 also exhibited highest 1000 seed weight of 32.0 g. compared to 24.0 g. of DSV-6. None of the DSR entries were superior to local check (DSV-6). The trial was also conducted in ARS, Bailhongal, Hanamanamatti, ARS, Bidar and ARS Gulburga.

Multilocation Hybrid trial: The six new hybrids along with four checks were tested in multilocation hybrid trial at six locations. The results of Dharwad location revealed superior performance of CSH-30 (3779.0 kg/ha) and SHD-6 (3648 kg/ha) compared to check hybrids like CSH-14 (2298 kg/ha) and CSH-16 (2940.0 kg/ha).

Station varietal trial: Among twelve entries tested, two entries SVD-1124 and SVD-1130 recorded significantly superior grain yield and on par fodder yield with DSV-6 (2352.0 kg/ha).

Station Hybrid Trial-I : Among 15 hybrids tested including checks, SHD-34 recorded significantly superior grain yield of 5611.0 kg/ha over high yielding check CSH-16 (3296.0 kg/ha) and numerical superiority over recently released hybrid CSH-30 (4723 kg/ha).

Station Hybrid Trial- III : Out of 13 hybrids tested, SHD-6 exhibited significantly superior grain yield of 4681.00 kg/ha and on par fodder yield with high yielding check CSH-16 (3431 kg/ha) but highest grain yield was recorded by CSH-30 hybrid (5167.0 kg/ha).

Testing of private hybrids: Among six entries tested along with two checks, NSH-54 was superior hybrid compared to CSH-14 and CSH-16 check hybrids.

Generation of breeding material: As many as 18 fresh crosses were made and 123 selections were made in various generations from F₂ to F₆ and 120 M₃ progenies were evaluated for grain mold tolerance and grain size.

Grain sorghum

1. R line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₂	6	21
F ₅	2	3
Total		

2. B line development programme - Nil

3. MS Conversion programme

Generation	No. of crosses evaluated	No. of families/single plant selected(Advancement of BC pairs made during the year)
F ₁	2	-

4. Trait-specific line development programme

A. Shoot fly resistant R line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₂	6	15
F ₆	6	25
Total	12	40

B. Grain mold resistant R line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₂	8	22
F ₆	2	9
Total	10	31

C. R line with grain quality development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₆	1	9
Total	1	9

5. Station hybrid/variatal trial

Name of trial	No. of entries tested	Checks used	Superior entries
Station Varietal trial	22	DSV-6	SVD-1124 AND SVD-1130
Station Hybrid trial-I	19	CSH-14, CSH-16 & CSH-30	SHD-34B AND CSH-30

Name of trial	No. of entries tested	Checks used	Superior entries
Station Hybrid trial-II	19	CSH-14, CSH-16 & CSH-30	None
Station Hybrid trial-III	16	CSH-14, CSH-16 & CSH-30	SHD-6
Testing of private hybrids	8	CSH-14, CSH-16	NSH-54
Multilocation Varietal trial	15 (5 locations)	DSV-6	SPV-2172, SVD-1203, SVD-744 & SVD-203
Multilocation hybrid trial	10(5 locations)	CSH-14, CSH-16 & CSH-30	CSH-30 & SHD-6
Demonstration of promising varieties, hybrids and fodder varieties.	8	CSH-14, CSH-16 DSV-6 & SSV-74	CSH-30, SPV-2172, SVD-1202, SVD-0726

6. AICSIP trial:

No. of AICSIP trials allotted	No. of AICSIP trials successfully conducted
AVT, IVT, AHT, PPHT & IHT (5)	All five trials were conducted

7. Other activities

Student guidance – M. Sc. (Ag.) – Two;

Maintenance of A B lines- 32

No. of Restorer lines-34

No. of experimental hybrids-25

No. of varietal selections- 22

Other Important Points: As many as 120 M3 progenies were evaluated for grain mold tolerance, grain size apart from productivity related traits; F₂ progenies of two cross supplied by DSR Hyderabad VIZ., AKR-456XAKR-150 and AKR-462XAKR-196 was grown but a limited variability was observed in both progenies

8. Training / field day organized-

1. A training programme was organized on 10.2.2014 in collaboration with Joint Director of Agriculture Gadag for the benefit of KSDA staff of Gadag district on identification of rabi sorghum varieties on the basis of grain characters for procurement under Anna Bhagya Yojana (GOK) at KVK, Hulkoti.

2. A similar training programme was organized on 11.2.2014 in collaboration with Joint Director of Agriculture, Dharwad for benefit of KSDA and food and civil supplies department staff members of Dharwad district at JDA office Dharwad.

3. A field day on SPV-2217 (post rainy) was organized in farmers field on 3-3-2014 at Narenda village, nearly 107 farmers from in and around village attended field day and expressed their satisfaction about new variety developed by our centre. The performance this variety has been appreciated by Hon'ble Vice Chancellor, UAS Dharwad, Director, DSR Hyderabad & Director of Research, UAS Dharwad. Later breeders from ICRISAT also visited large scale trials in the farmers field and expressed their satisfaction about new variety and willingness to spread new variety in farmers' field.

9. Publications: Research Papers- 4, Popular Articles- One, Folder- One

6. HISAR

1. **Germplasm:** Out of 157 germplasm lines, 90 genotypes were multicut type while, 67 were single cut. These lines will be evaluated separately in *kharif* 2014. The maximum plant height was of ST-5 and GP-61 i.e. 233.76 cm and 225.67 cm, respectively.

2. **Male sterile based hybrids:** Sixty one new male sterile based hybrids were developed with following MS lines which will further be evaluated in *Kharif* 2014.

MS Lines	No. of Crosses	MS Lines	No. of Crosses
9A	5	725A	5
14A	8	733A	7
56A	8	753A	2
465A	4	2219A	8
467A	1	Pant A	1
637A	9	Total	61
687A	3		

Out of total 65 hybrids tested, 14A x 651 (237.3 q/ha), 467A X SSG59-3 (237 q/ha) and 733A X 2389 (204 q/ha) for green fodder yield; 465A X SSG (PSSG) (10.9%), 95A X S 437-1 (10.2%), 95A X 2389 and 56A X SSG (PSSG) (10.1%) for crude protein; 14A X SSG 59-3 (61.6%), 14A X 651 (52.8%) and 14A X HJ 541 (50.4%) for IVDMD % and 14A X SSG 9, 467A X G 46, 14A X 2389, 631A X SGL 89 and 687A X G 46 (traces) for HCN were found promising.

3. **Breeding material:** In *Kharif* 2013, nine new crosses viz., HJ 513 X COFS 29, HJ 513 X IS 2205, HJ 541 X HJ 513, HJ 541 X COFS 29, HJ 541 X IS 2205, HJ 541 X SSG 59-3, HJ 541 X SSG (PSSG), CSV 21F X HJ 541, and ST X HJ 541 were attempted. The seed of 7 F₁ crosses was advanced to F₂ generation. Out of 23 F₄ generation crosses, plants were selected in 13 crosses, out of 14 F₅ generation crosses, plants were selected in all the 14 crosses. Fourteen crosses in F₆, 8 in F₇ and 6 in F₈ were bulked which will further be evaluated in PRT and SST trials against the standard checks for fodder yield and quality.

4. **SSG Breeding Trial:** Eighteen genotypes were tested in SSG trial for multicut traits. The genotype SSG 18 (GFY (two cuts): 805.2 q/ha; DFY (two cuts): 262.3 q/ha; Protein yield: 12.7 q/ha; DDM yield: 28.7 q/ha) was the best genotype followed by SSG 9 for GFY (523.9 q/ha) and SSG 11 for DFY (102.1 q/ha), protein yield (8.74 q/ha) and DDM yield (23.5 q/ha).

5. **FABN Breeding Trial:** In this trial 11 genotypes were tested out of which FABN 1, FABN 6 and FABN 8 were found promising for green fodder yield i.e. 687.5 q/ha, 395 q/ha and 375 q/ha, respectively. In protein yield FABN 1, FABN 11 and FABN 9 were found promising with 26.43 q/ha, 12.5 q/ha and 11.63q/ha protein yield, respectively. The DDM yield of FABN 1 and FABN 8 were found best i.e. 109.10 q/ha and 48.15 q/ha, respectively.

6. **BMR Breeding Trial:** Eighteen genotypes were tested in BMR trial. Out of these, the genotype BMR 1 had highest plant height and lowest leaf: stem ratio which are important fodder parameters. The genotype BMR 12 had 2 tillers. In this trial most of the genotypes had poor expression of brown midrib.

7. **Publications:** Research papers – 3; Abstract – 1

7. INDORE

Season was not favourable due to heavy and continuous rains and after that there was heavy infestation of shoot fly and stem borer. Six AICSIP and four station trials were conducted, and other breeding works taken up.

Grain and dual purpose sorghum breeding

1. R line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₅	2	4
F ₃	2	21
Total	4	25

2. B line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₅	7	13
F ₃	1	11
Total	8	24

3. MS Conversion programme

Generation	No. of crosses evaluated	No. of families/single plant selected(Advancement of BC pairs made during the year)
BC ₃	2	38
BC ₄	2	15
Total	4	53

4. Dual purpose Variety development programme

Generation	No. of crosses evaluated	No. of families/single plant selected(Advancement of BC pairs made during the year)
F ₅	19	45
F ₃	2	30
F ₂	2	18
Total	23	93

6. Trait-specific line development programme

a. R line development with sweetness:

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₄	2	8
Total	2	8

b. Grain mold resistant R line development programme

Generation	No. of crosses evaluated	No. of families/single plant selected
F ₂	1	16
Total	1	16

6. Station hybrid/variety trial

Name of trial	No. of entries tested	Checks used	Superior entries
SVT-I	20	CSV25, JJ 1041	(IS 22557 x I12) 3-11-2-3-3, (SRT 18 xSR 836) x No. 531)3-1-4-1-3
SVT-II	20	CSV23, JJ 1041	2-2-1-3-6, 681-2-1-11-8
SHT-I	48	CSH18, SPH 1653	
SHT II	40	CSH18, SPH 1653	30317A x I12, SP 1014 A x I12, IMS10 A x I12, 30351 Ax I27, IMS10 A x I27

7. **AICSIP trial:** Six AICSIP trials were allocated and all were conducted but due to heavy and continuous rainfall the all trials failed.

8. Other activities

- i) Maintenance of lines: AP pairs – 5, R lines – 30, experimental hybrids – 20; varietal selection – 5
- ii) Student guidance – 3
- iii) Training organized – *nil*

9. Publications: Research Papers – one, popular articles – 2, folder – 1

8. KOVILPATTI

A high yielding dual purpose sorghum culture TKS_V 0809 developed from this centre has recorded an average grain yield of 2999 kg/ha over 141 yield trials of different location and registering 16.9% and 24.7% increase over the checks K 8 (Local) and CSV 17 (National) respectively. TKS_V 0809 recorded the dry fodder yield of 11.56t/ha which is 34.2% and 41.3% increase yield over K8 and CSV 17 respectively. Hence, this culture was proposed for released as K 12 for the winter rainfed vertisol tracts of Tamil Nadu during 2014–15. Two high yielding single cut forage sorghum cultures TKFS 1047 and TKFS 1052 are being proposed to Multilocation testing in the winter rainfed vertisol tracts of Tamil Nadu. During winter 2013-14, a total of 6 fresh crosses were effected with midge resistance donars. In F₂ populations three single plants were selected with grade 1 resistance. Similarly four single plants from F₃ progenies were selected with grade 1 and two single plants from F₄ progenies were selected with grade 1 resistance. The susceptible check K8 has recorded 90% midge incidence. During the summer 2013 – 14 a total of 16 fresh crosses were effected with Mite resistance donars. In F₂, 4 single plants were selected with grade 1 resistance. In F₃, 6 single plants were selected with grade 1 resistance. In F₄, 5 single plants were selected with grade 1 resistance. The susceptible check K 4 has 95% Mite incidence.

1. Hybrid development programme: Evolution of high yielding hybrids better than CSH 23 and private hybrid JKSH 22

Generation	No. of crosses evaluated	No. of Hybrid selected
F ₁	156	12 Grain Sorghum Hybrids
F ₁	22	6 Forage Sorghum Hybrids

2. R line development better than K 8 and CSV 17 for Grain Sorghum and K 11 for forage sorghum (SC)

Generation	No. of crosses evaluated	No. of families / single plant selected	Purpose of selection
F ₁	23	--	Dual purpose, Grain type and forage type (SC)
F ₂	46	54	Grain Sorghum
		13	Forage Sorghum
F ₃	29	14	Grain Sorghum
		5	Forage Sorghum
F ₄	18	14	Grain Sorghum
		6	Forage Sorghum
F ₅	24	15 Bulk, 3 SPS	Grain Sorghum
		4 Bulk, 7 SPS	Forage Sorghum

3. Traits specific line development programme

a. Midge resistance breeding

Generation	No. of crosses evaluated	No. of families / single plant selected	Purpose of selection
F ₁	6	--	Midge resistance
F ₂	7	3	Midge resistance
F ₃	20	4	Midge resistance
F ₄	6	2	Midge resistance

b. Mite resistance breeding

Generation	No. of crosses evaluated	No. of families / single plant selected	Purpose of selection
F ₁	16	--	Mite resistance
F ₂	23	4	Mite resistance
F ₃	15	6	Mite resistance
F ₄	9	5	Mite resistance

4. Station Hybrid / Varietal Trial:

Name of the Trial	No. of entries evaluated	Checks used	Superior entries
Station trial – Grain Sorghum	21	5	TKSV 1001, TKS _V 1036, TKS _V 1032, TKS _V 1029,
Station Forage Sorghum Trial (SC)	9	2	TKFS 1047, TKFS 1052
Multilocation Trial – Grain Sorghum	11	3	MLT-G 02-04-13, MLT-G 02-01-13
Multilocation Trial – Sweet Sorghum	5	1	SS 1313, SS 1311
Multilocation Trial – Forage Sorghum	5	1	1301, 1304
Preliminary Yield Trial – I Grain Sorghum	36	4	TKSV 1105, TKS _V 1106 & TKS _V 1120
Preliminary Yield Trial – II Grain Sorghum	14	4	TKSV 1140, TKS _V 1145
Preliminary Yield Trial – III Grain Sorghum	30	5	TKSV 1166, TKS _V 1181
Preliminary Yield Trial – I Forage Sorghum	16	2	TKFS 1194, TKFS 11100
Preliminary Yield Trial – II Forage Sorghum	9	2	TKFS 11113, TKFS 11109

5. AICSIP trials: All three allocated trials were conducted successfully.

6. Other activities

- i) Maintenance of lines: AB pairs – 12, R lines – 159, experimental hybrids – 178, Varietal selections – 2 and wani sorghum selection – 1
- ii) Training organized – one

7. Publications: Research papers – one; popular articles – 4, folders – 2

9. PALEM

Regional Agricultural Research Station, Palem is one of the All India Coordinated Sorghum Improvement Project centers mainly working on *khariif* Sorghum Improvement with major emphasis on dual purpose sorghum breeding. During the year 2012-13, in varietal improvement programme, PSV-56, a high yielding dual purpose sorghum variety with tolerance to grain mold disease, was released in the name of SRISAILA by State Varietal Release Committee, Andhra Pradesh. The notification proposals of the variety were also submitted to Government of India. Two high yielding and grain mold tolerant dual purpose sorghum entries PSVGS-106 (SPV2122) and PSVGS-210 (SPV 2110) are in Advanced Varietal Trial – II stage in Coordinated Trials at All India Level. A high yielding and grain mold tolerant culture, PSVGS-113 is in Advanced Varietal Trial - I stage in Coordinated Trials at All India Level. Two sorghum cultures *viz.*, PSVDP-306 and PSVDP-316 are evaluated in Initial Varietal Trial stage in Coordinated Trials at All India Level. In Hybrid development programme, 14 R lines and 17 B lines for various important characters are in F6/F5 stage of development. These lines are derived from the material supplied by Directorate of Sorghum Research under Network Breeding Programme. Further, four yellow pericarp sorghum land races were submitted to National Bureau of Plant Genetic Resources for registration. Of these landraces, PYPS-2 was accepted for registration whereas the other lines *viz.*, PYPS-8, PYPS-13 and PYPS-14, were asked for submitting check performance data. In Grain Sorghum, three Station Trials were conducted during *khariif* 2013-14. In AVTGS – II - 6 entries, in AVTGS-I - 8 entries and in IVTGS - 8 entries were found to be superior for grain and fodder yields compared to the checks PSV-56 and PSV-1. All the All India Coordinated Sorghum Improvement Project breeding trials were conducted during *khariif* 2013 without any deficiency.

Grain sorghum breeding

1. R line development programme

Name of the cross/character	Generation	No. of families (crosses) evaluated	No. of families/single plants selected
09R-SF 61/Shoot fly resistance	F ₆	2	1
09R-SF63/ Shoot fly resistance	F ₆	2	2
09R-SF64/ Shoot fly resistance	F ₆	3	1
09R-SF65/ Shoot fly resistance	F ₆	2	2
09R-SF69/ Shoot fly resistance	F ₆	2	1
09R-SB14/Stem borer resistance	F ₆	2	2
09R-SB02/Stem borer resistance	F ₆	2	2
10R-SF25/SFRIL 36 x SFRIL 128	F ₅	3	2
10R-SF28/ICSR18 x RS29	F ₅	3	1
10R-SF30/C43 x ICSR90017	F ₅	2	2
10R-AGR18/RR9826 x AKR150	F ₅	2	2
10RAGR20/C43 x Indore12	F ₅	3	2
10RAGRQ9/CB11 x NR486	F ₅	2	1
10RAGRQ11/CB23 x NR486	F ₅	2	2

2. B line development programme

Name of the cross/character	Generation	No. of families (crosses) evaluated	No. of families/single plants selected
09B-AGR12/Agronomic superiority	F ₆	2	1
09B-AGR14/Agronomic superiority	F ₆	1	1
09B-AGR15/Agronomic superiority	F ₆	1	1
09B-AGR16/Agronomic superiority	F ₆	1	1
09B-AGR18/Agronomic superiority	F ₆	1	1
09B-AGR19/Agronomic superiority	F ₆	1	1
09B-AGR20/Agronomic superiority	F ₆	1	1
10B-SF1/415B x ICSR 13	F ₅	3	2
10B-SF2/418B x 2219 B	F ₅	2	2
10B-SF3/419B x ICSR 16	F ₅	3	1
10B-SF4/422B x ICSR 16	F ₅	2	1
10B-EAR3/CSV 17 x ICSB 11	F ₅	3	2
10B-EAR4/CSV 17 x ICSB 13	F ₅	2	1
10B-AGR37/ICSB 32 x ICSR 23	F ₅	3	2
10B-AGR38/ICSB 33 x ICSB 77	F ₅	2	1
10B-AGR49/279B x2077 B	F ₅	2	1
10B-AGR63/C 43 x 2077 B	F ₅	3	2

3. MS Conversion programme: In Yellow Pericarp Sorghum Improvement, conversion of YPS land races to male sterile lines was initiated during the year 2010-11 by using the lines YP2-2, YPS-8, YPS-13, YPS-14 and 296-B as recurrent parent. However, there was complete seed set in 296-B. This conversion programme is being continued in 2013-14 as few more yellow pericarp landraces were generated after continuous selfing. Satisfactory results were not obtained with the MS Conversion Programme due to the existence of partial sterility.

4. Trait-specific line development programme

a. *Development of lines resistant to various stresses/important characters:*

Trait	Generation	No. of lines
Shoot fly resistance	F ₆	7 R lines
	F ₅	5 R lines, 6 B lines
Stem borer resistance	F ₆	4 R lines
Agronomic superiority	F ₆	7 B lines
	F ₅	7 R lines, 6 B lines
Early maturity	F ₅	3 B lines
Yellow pericarp sorghum		4 lines

5. Station hybrid/variety trial

Trial name	Entries	Checks	Entries superior to check
AVT-Grain Sorghum -II/DP	10	PSV-56 and PSV-1	6 entries - PSVGS 105, PSVGS 106, PSVGS 112, PSVGS 114, PSVDP 206 and PSVDP 210
AVT-Grain Sorghum - I/DP	17	PSV-56 and PSV-1	8 entries - PSVGS 304, PSVGS 306, PSVGS 313, PSVGS 314, PSVGS 316, PSVGS 317, PSVGS 318 and PSVGS 320
IVT-Grain Sorghum/DP	17	PSV-56 and PSV-1	8 entries - PSVGS 406, PSVGS 409, PSVGS 412, PSVGS 416, PSVGS 417, PSVGS 418, PSVGS 419, PSVGS 421

6. AICSIP trial: All five allocated trials were conducted successfully.

7. Other activities

- i) Maintenance of lines: AB pairs – 22, R lines – 14, experimental hybrids – 7
- ii) Student guidance – Nil
- ii) Training organized- 2

Theme	Beneficiaries	No.	Sponsored by
Popularization of PSV-56 under Tribal Sub-Plan – Sorghum Field Day	Tribal farmers of Erragunta Thanda	120	Tribal Sub Plan 19 th September, 2013
Training regarding value added products of sorghum	Women Self Help Groups of Mahabubnagar	30	RKVY Project on Yellow Pericarp Sorghum 14 th March, 2014

8. Publications: Abstracts – 3

10. PANTNAGAR

346 fodder/dual purpose, sweet sorghum and grain type germplasm lines were maintained. A set of 14 diverse genotypes was planted in crossing block for attempting new crosses through diallel crossing with the objective of improvement in foliar disease resistance, fodder yield and quality. Thirty three CMS lines (A/B pairs) of A₁ and A₂ cytoplasm were maintained. Fifty three new crosses were attempted through emasculation and hand pollination for genetic improvement in terms of fodder yield, quality and foliar disease resistance. Inter generic crosses between sorghum x maize, sorghum x teosinte and maize x teosinte were attempted between three CMS lines of sorghum, one variety (African Tall) of maize and one local variety of Teosinte. A total of 773 SPS/ progeny bulks of 155 crosses/families (from F₁ to F₇ onward generations) were evaluated, of which 740 SPS/progeny bulks of 143 crosses/families were selected for desirable traits. Selected lines will be used as restorers and open pollinated varieties.

The multicut experimental hybrid SPH 1697 (UTMCH 1310) which has completed three years of testing showed 10 per cent superiority for green and dry fodder yield and per day productivity, over checks, besides good nutritional quality. The identification proposal of this hybrid will be submitted for its consideration for release in the 44th AGM. The multicut experimental hybrid SPH 1748 (UTMCH 1311) was tested in IVT multicut during Kharif 2013. It had better quality in terms of protein percent, protein yield and DDM yield as compared to both the checks therefore, promoted to AVT I.

For evaluation of yield and quality in forage sorghum and sweet sorghum, 8 All India Coordinated Trials, two State Trials, three Station Trials and three Students' Thesis Research Trials were conducted during Kharif 2013. Two entries viz. SPV 2201 (UTFS 71), SPV 2262 (UTFS 74) were incorporated from the centre in IVT single cut. Both these entries showed superiority of 17-18% for green fodder and 20-23% for dry fodder yield over best check CSV 21 F. In the State Varietal Trials single cut varieties UTFS 83 and UTFS 79 showed 26% and 20 % superiority, respectively for green fodder yield and 35% and 29 % for dry fodder yield over check CSV 21F. Whereas multicut varieties UTMCH 545 and UTMCH 548 were better

for green as well as dry fodder yield to the tune of 37% and 30%, respectively, than check Pant Chari 6. Amongst the experimental multicut hybrid tested in Station Trials the hybrid EHT 2013-16 was most promising showing dry fodder yield almost *at par* with best check CSH 20 MF. Result of single cut Station Varietal Trial indicated that the entry ESVT 2013-9 was most promising showing numerical superiority over best check CSV 21F. Out of 12 single and three way cross hybrids tested as single cut entry, the most promising was TWCT-2013-5 showing green and dry fodder yield to the tune of 755.48 q/ha and 211.53q/ha, respectively in one cut.

Forage sorghum breeding

1. **R line development programme:** Selection was practiced in various generations as per following details for development of restorers (R line) for multicut hybrid development as well as open pollinated varieties of single cut and multicut types.

Generation	No. of crosses/progenies evaluated	No. of families (crosses)/ single plants/progenies selected
F ₁	23 crosses	19 crosses
F ₂	8 crosses/6000 plants	8 /293 SPS
F ₃	21/287 (SPP)	18/139 SPP (288 SPS)
F ₄	12/91 (SPP)	10/56 SPP (123 SPS + 1 Bulk)
F ₅	17/62 (SPP)	15/41 progenies (2 SPS + 39 progeny bulks)
F ₆	27/197 (Progeny bulks)	26/114 (Progeny bulks)
F ₇	16/30 (progeny bulks)	16/28 (Progeny bulks)
Screening plots (F ₇ onwards)	31/106 (progeny plots)	31/69 (Progeny bulks)
Total	155/6773 (single plants + progenies)	143/740

2. **MS Conversion programme:** For MS conversion, out of 8, A x B crosses attempted during Kharif 2011 and tested in *Kharif* 2012, the following three crosses were evaluated during Off Season Nursery, Warangal. Two selected crosses showed complete sterility. These crosses will be further advanced by back pollinating with B line (maintainer) during *Kharif* 2014.

Generation	No. of crosses evaluated	No. of families/single plant selected (Advancement of BC pairs made during the year)
F ₁	3 (2219 A x ICSB 467); (104 A x ICSB 467); (ICSA 467 x 11 B ₂)	2 (2219 A x ICSB 467); (104 A x ICSB 467)

3. Trait-specific line development programme

a. **R line development programme with foliar disease resistance:** Selection was practiced as per following details for various foliar diseases (anthracnose, Zonate leaf spot and leaf blight etc.) resistant plants at flowering stage as well as at maturity for stay green trait.

Generation	No. of crosses/progenies evaluated	No. of families (crosses)/ single plant/progenies selected
F ₁	8 (crosses)	5 (crosses)
F ₂	3 (crosses)/2625 plants	3 (crosses)/36 (SPS)
F ₃	7 (crosses)/109 (SPP)	6 (crosses)/53 (SPS)
F ₄	1 (cross)/2 (SPP)	1 (cross)/2 progenies (2 SPS + 1 Bulk)
F ₅	8 (crosses)/27 (SPP)	7 (crosses)/23 (progeny bulks)
F ₆	6 (crosses)/57 (progeny bulks)	6 (crosses)/31 (progeny bulks)
F ₇	12 (crosses)/21 (progeny bulks)	12 (crosses)/20 (Progeny bulks)
Screening plots (F ₈ onwards)	13 (crosses)/44 (progeny bulks)	11 (crosses)/27 (progeny bulks)
Total	58/2825 (single plants + progenies)	51/192

b. **R line development programme with brown mid rib:** Selection was practiced for individual plants showing brown mid rib at flowering and brown stem with brown pith at maturity along with tan, early to medium, tall, juicy plants with less foliar diseases and white seed. Each selected plant will be evaluated for fodder quality trait *viz.* digestibility, protein per cent and fiber content in F₇.

Generation	No. of crosses/progenies evaluated	No. of families (crosses)/single plant/progenies selected
F ₁	-	-
F ₂	-	-
F ₃	-	-
F ₄	-	-
F ₅	3 (crosses)/11 (progenies)	2 (crosses)/8 (progeny bulks – DP/SC, Stay green, Sweet, BMR and Non BMR)
F ₆	7 (crosses)/65 (progeny bulks)	7 (crosses)/51 (progeny bulks- tan plants, non BMR juicy & sweet, BMR, stay green, SC type)
F ₇	-	-
Screening plots (F ₈ onwards)	-	-
Total	10/76	9/59

c. **R line development programme with sweetness and juiciness of stem:** Individual plants as well as bulk selections were practiced for juicy and sweet stemmed (TSS at maturity more than 12%), tall and leafy plants with foliar disease resistance.

d.

Generation	No. of crosses/progenies evaluated	No. of families (crosses)/single plant/progenies selected
F ₁	-	-
F ₂	-	-
F ₃	3 (crosses)/58 (SPP)	3 (crosses)/30 (SPS)
F ₄	-	-
F ₅	2 (crosses)/10 (SPP)	2 (crosses)/5 (progeny bulks –DP/SC, stay green, sweet, early)
F ₆	6 (crosses)/32 (progeny bulks)	5(crosses)/12 (progeny bulks- tan, tall plants, juicy & sweet, high TSS, stay green, SC/MC type)
F ₇	-	-
Screening plots (F ₈ onwards)	1 (cross)/5 (progeny bulks)	1 (cross)/4 progeny bulks, tan, juicy, sweet stem, high TSS, grain grass type)
Total	12/105	11/51

d. *R line development programme with multicut type (tillering and fast regeneration), juiciness and good seed yield*
Individual plants as well as bulk selections were practiced for juicy, tall, early, high tillering type plants with foliar disease resistance, to be used as restorers in multicut hybrid development programme as well as open pollinated multicut varieties.

Generation	No. of crosses/progenies/ single plants evaluated	No. of families (crosses)/single plants/progenies selected
F ₁	6 (crosses)	6 (crosses)
F ₂	1 (cross)/1050 plants	1 (cross)/31 (SPS-tan, tall, MC types)
F ₃	8 (crosses)/98 (SPP)	6 (crosses)/44 (SPS-early, juicy, MC types, disease resistant)
F ₄	5 (crosses)/35 (SPP)	4 (crosses)/21 progenies (44 SPS- early, juicy, MC types, disease resistant, high tillering)
F ₅	3 (crosses)/17 (SPP)	3 (crosses)/11 progeny bulks –MC types, very early, juicy, tan, tillering, grain grass type, stay green)
F ₆	4 (crosses)/20 (progeny bulks)	4 (crosses)/13 (progeny bulks- early, tan, good seed yield, tall, high tillering, juicy, less leaf diseases)
F ₇	1 (crosses)/2 (progeny bulks)	1 (crosses)/2 (progeny bulks- tan, tall, juicy, MC types, high TSS, less leaf diseases)
Screening plots (F ₈ onwards)	14 (cross)/51 (progeny bulks)	14 (cross)/31 progeny bulks (tan, tall, juicy, MC types, tillering, early to mid late, bold grain, grain grass type)
Total	42/1273 (single plants + progenies)	39/153

e. *R line development programme for single cut fodder /dual purpose*: Individual plants as well as bulk selections were practiced for juicy, tall, leafy, early to medium flowering plants with foliar disease resistant and good seed yield, to be used as open pollinated single cut/dual purpose varieties of forage sorghum.

Generation	No. of crosses/progenies/ single plants evaluated	No. of families (crosses)/single plants/progenies selected
F ₁	7 (crosses)	6 (crosses)
F ₂	4 (cross)/2325 plants	4 (cross)/172 (SPS-tall>350cm, juicy, SC types/dual purpose type tan/purple)
F ₃	5 (crosses)/60 (SPP)	5 (crosses)/29 (SPS-tall, SC/DP type, juicy, stay green)
F ₄	7 (crosses)/56 (SPP)	6 (crosses)/35 SPP (80 SPS- SC/DP type, Juicy, less disease)
F ₅	3 (crosses)/11 (SPP)	3 (crosses)/6 progeny bulks –DP/SC type, grain grass type, disease resistant, bold grain)
F ₆	4 (crosses)/24 (progeny bulks)	4 (crosses)/6 (progeny bulks-juicy, SC/DP type, tall, good seed yield)
F ₇	4 (crosses)/9 (progeny bulks)	4 (crosses)/8 (progeny bulks-tall, juicy, SC/DP type, stay green, sweet, high TSS, early, non lodging)
Screening plots (F ₈ onwards)	4 (cross)/11 (progeny bulks)	4 (cross)/11 progeny bulks (tan, tall> 375cm, juicy, medium late, sweet and high TSS 15-16%, broad leaves, thick stem, bold grain)
Total	38/2496 (single plants + progenies)	36/267

5 Station hybrid/variety trial

Three station trials on single cut and multicut forage sorghum as per following details were conducted to identify the promising experimental hybrids and elite lines for their testing in State as well as All India Coordinated Trials

Name of trial	No. of entries tested	Checks used	Superior entries
Evaluation of experimental hybrids (Multicut fodder)	24	CSH 20 MF and CSH 24 MF	EHT 2013-16 (<i>at par</i> with checks for green and dry fodder yield.
Evaluation of elite lines (Single cut fodder)	23	CSV 21 F and HC 308	ESVT 2013-9 (superior to best check CSV 21 F for green and dry fodder yield.
Evaluation of single and three way cross hybrid (Single cut fodder)	12	HC 308	TWCT 2013-5 (better than check).

Two State Trials (SVT) on single cut and multicut forage sorghum, as per following details, were conducted to identify the promising experimental hybrids and varieties for their release in the State through Uttarakhand State Variety Release Committee.

Name of trial	No. of entries tested	Checks used	Superior entries
SVT-Single cut (Single cut varietal Trial)	10	CSV 15 and CSV 21 F	UTFS 79, and UTFS 83 (significantly superior for green and dry fodder yield to both the checks)
SVT-Multicut (Multicut varietal/ Hybrid Trial)	10 (6 varieties and 4 hybrids)	Pant Chari 6 (varietal check) CSH 20 MF and CSH 24 MF (hybrid checks)	UTMC 545 and UTMC 548 (significantly superior for green and dry fodder yield than check) UTMC 1312 (<i>at par</i> with CSH 24 MF for green and dry fodder yield)

6 AICSIP trials:

Five AICSIP trials, viz., AVT SC, IVHT SC, AIVHT MC, SYT and IAVHT SS were allocated during Kharif 2013 and all were successfully conducted. Besides, three additional trials, viz., Evaluation of sudan grass germplasm lines-multicut with 18 entries, Evaluation of brown mid rib lines for yield and quality- Multicut with 18 entries, Evaluation of forage genotypes selected from the crosses made under inter institutional forage sorghum improvement programme-single cut with 12 entries were also conducted successfully.

7 Other activities

Maintenance of A/ B lines – 33 old + 123 new accessions from ICRISAT

No. of Restorer lines- 15 advanced breeding lines with high tillering for multicut hybrid development + 9 new accessions from ICRISAT

No. of experimental hybrids- 29 single crosses + 7 three way crosses

No. of varietal selections- 20 elite lines (single cut and multicut types)

Student guidance: Four Ph. D. Students and two M. Sc. students doing research work on sorghum breeding and sorghum seed technology as per following details.

Name of the Student	Major/Degree	Minor	Thesis title (Tentative)
Mr. Rajendra	Genetics & Plant Breeding/ Ph.D.	Seed Science & Technology	Genetic analysis of economic traits in forage sorghum [(<i>Sorghum bicolor</i> (L.) Moench)] through Diallel and Generation Mean Analysis
Mr. Pankaj	Genetics & Plant Breeding/ Ph.D.	Plant Pathology	Studies on molecular, genetical and biochemical diversity and development of heterotic hybrids in forage sorghum [<i>Sorghum bicolor</i> (L.) Moench]
Ms. Ankita*	Seed Science & Technology/ Ph.D.	Genetics & Plant Breeding	Assessment of seed quality parameters and DUS characterization of sorghum [<i>Sorghum bicolor</i> (L.) Moench] genotypes by morphological, biochemical and molecular markers
Ms. Priyamvada	Seed Science & Technology/ Ph.D.	Genetics & Plant Breeding	Heterosis and hybridity assessment for seed quality parameters through morphological and molecular methods in sorghum [<i>Sorghum bicolor</i> (L.) Moench]
Mr. M K. Dubey	Genetics & Plant Breeding/ M. Sc.	Nil	Study of variability, correlation and path coefficient in sorghum [<i>Sorghum bicolor</i> (L.) Moench]
Mr. B. Meena	Genetics & Plant Breeding/ M. Sc.	Nil	Genetic analysis for fodder yield and quality traits in sorghum [<i>S. bicolor</i> (L.) Moench] through diallel crossing

*Thesis submitted in February, 2014

8 Publications: Research papers – 3, Abstracts – 1

11. PARBHANI

During 2013-14 total 18 AICSIP project trials, 4 state level trials and 18 station trials were conducted during kharif and rabi season. One kharif based hybrid SPH 1735 and two rabi based varieties SPV 2144 and SPV 2221 from Parbhani are in advance testing trial. Four thousand germplasm lines received from DSR were evaluated during rabi 2014 for shoot fly reaction, grain and fodder yield and yield attributing traits. 122 accessions for shoot fly tolerance, 45 accessions for grain quality and 62 accessions for yield potential and agronomic performance were selected. Eighty five single plant selection/families from 39 crosses of kharif based segregating populations and 205 single plant selection/ families from 57 crosses of rabi based segregating populations were made for R line development. KR 211, KR 225, KR 235 and KR 911 are promising kharif based restorers identified from advance generations. Selections for grain mold tolerance (65 for R lines and 78 for B lines), shoot fly tolerance (83 for R lines and 97 for B lines) and drought tolerance (78) were made in F₂, F₃ and F₄ populations. Thirty eight and 54 marker assisted F₃ and F₄ progenies were evaluated for shootfly tolerance coupled with high grain & fodder yield and 12 & 14 promising progenies were selected. Five isolines of PMS 20 B genetic background, differ for shoot fly resistant QTLs introgression were crossed with PMS 20A. 29 pairwise crosses were made in BC₁F₁ generation of 5 F₁S.

1. R line Development programme

Generation	No. of crosses evaluated/effected	No of families /single plant selected
Kharif		
F ₀	35	--
F ₁	11	--
F ₂	03	64
F ₃	22 from 3 crosses	13
F ₄	14 from KR 199 X C43	08
Total except F ₀ & F ₁	39	85
Rabi		
F ₀	15	--
F ₁	13	--
F ₂	10	180
F ₃	36 from 7 crosses	18
F ₄	11 from 4 crosses	07
Total except F ₀ & F ₁	57	205

2. B line Development programme

Generation	No. of crosses evaluated/effectuated	No of families /single plant selected
Kharif		
F ₀	12	--
F ₁	09	--
F ₂	04	127
F ₃	20 from 3 crosses	09
F ₄	15 from 2 crosses	08
Total except F ₀ & F ₁	39	144
Rabi		
F ₀	10	--
F ₁	32	--
F ₂	05	142
F ₃	28 from 3 crosses	16
F ₄	10 from 2 crosses	07
Total except F ₀ & F ₁	43	165

3. MS conversion programme

Name of back cross	BC generation	No. of pairs
{(PMS 20A X MAS 1076-1) X MAS 1076-1}	BC ₁ F ₁	5
{(PMS 20A X MAS 1062-5) X MAS 1062-5}	BC ₁ F ₁	4
{(PMS 20A X MAS 1261-3) X MAS 1261-3}	BC ₁ F ₁	6
{(PMS 20A X MAS 1061-4) X MAS 1061-4}	BC ₁ F ₁	5
{(PMS 20A X MAS 1071-1) X MAS 1071-1}	BC ₁ F ₁	4
{(PMS 20A X MAS 1264-3) X MAS 1264-3}	BC ₁ F ₁	5
TOTAL	6	29

4. Trait specific line development programme

a. R line Development programme

Generation	No. of crosses evaluated/effectuated	No of families /single plant selected
Grain mold		
F ₀	10	--
F ₁	09	--
F ₂	02	48
F ₃	28 from 3 crosses	09
F ₄	14 from KR 199 X C43	08
Total except F ₀ & F ₁	44	65
Shoot fly		
F ₀	15	--
F ₁	17	--
F ₂	03	57
F ₃	39 from 4 crosses	17
F ₄	19 from 3 crosses	09
Total except F ₀ & F ₁	61	83
Drought		
F ₀	15	--
F ₁	08	--
F ₂	03	57
F ₃	21 from 2 crosses	08
F ₄	19 from 3 crosses	09
Total except F ₀ & F ₁	43	74

b. B line Development programme

Generation	No. of crosses evaluated/effectuated	No of families /single plant selected
Grain mold		
F ₀	12	--
F ₁	07	--
F ₂	03	66
F ₃	25 from 5 crosses	12
Total except F ₀ & F ₁	28	78
Shoot fly		
F ₀	06	--
F ₁	05	--
F ₂	04	71
F ₃	38 from 2 crosses	12
F ₄	54 from 5 crosses	14
Total except F ₀ & F ₁	96	97

5. Station hybrid / varietal trial

Name of trial	No. of entries	checks
KHARIF		
State Multilocation Varietal cum Hybrid Trial	16	CSH 25, CSH 16; CSH 23, PVK 801; PVK809
State Multilocation Varietal cum Hybrid Trial (Private company)	15	CSH 25, CSH 16; CSH 23, PVK 801; PVK809
Preliminary Hybrid Evaluation Trial I	76	CSH 25, CSH 16
Preliminary Hybrid Evaluation Trial II	22	CSH 25, CSH 16
Evaluation of emasculated F ₁ s for grain and fodder yield.	40	CSH 25, PVK 801
Evaluation of emasculated F ₁ s for grain and fodder yield and grain mold tolerance.	20	CSH 25, PVK 801
RABI		
State Multilocation Varietal cum Hybrid Trial (rainfed)	20	P.Vasudha, P.Rewati, SPV1411
State Multilocation Varietal cum Hybrid Trial (irrigated)	20	P.Anuradha, P. vasudha, P. rewati CSV 18
Priliminary Varietal trial	21	SPV 1411, SPV 1595, M-35-1
PHT – I	69	SPV 1411, SPV 1595, M-35-1
PHT – II	85	SPV 1411, SPV 1595, M-35-1
PHT – III	15	SPV 1411, SPV 1595, M-35-1
Evaluation of F ₁ s for grain and fodder yield and shootfly tolerance.	61	SPV 1411, SPV 1595, M-35-1
Evaluation of F ₁ s for grain, fodder yield and shootfly & drought tolerance.	15	SPV 1411, SPV 1595, M-35-1

6. AICSIP Trials: Out of 18 allocated trials 13 were conducted successfully.

7. Other activities

Maintenance of A B lines: Kharif – 15, Rabi – 12
 No of restorer lines: Kharif – 16, Rabi – 14
 No of experimental hybrids: Kharif – 5, Rabi – 2
 No. of students guided: 7
 Trainings organized: 2

8. Publications: Research papers – 12, Folders – 7

12. PHALTAN

1. **R line development programme:** Different crosses between parents after considering desired traits had been made following diallel mating design in previous years. All the progenies in different generations were evaluated for the characters like plant height, total biomass, stripped stalk weight, juice yield, brix of juice and grain yield. One hundred thirty two F₅ progenies evolved from six different families evaluated in Kharif 2013 were subjected to single plant selection. In all, 197 single plant selections based upon high biomass, brix of juice and grain yield were made in the promising families. In F₇ generation, 20 progenies evolved from six promising crosses were evaluated during Kharif 2013. Among them line DC-32-31 gave significantly highest brix of juice (19 %), total sugar index (3.34 t/ha) and grain yield (2.01 q/ha) as against the check cultivar CSV-24-SS with 17 % brix of juice, 1.71 t/ha total sugar index and 0.43 q/ha grain yield. The same line also exhibited superior performance for the characters like shoot fly damage (36.67 %) and stem borer incidence (16.87 %) compared to the check cultivar CSV-24-SS which showed higher shoot fly (59.93 %) and stem borer (23.74 %) damage. The DSR had supplied F₂ populations to all the centers in Kharif 2010 under network breeding programme and this material has been advanced to F₇ generation at NARI centre. Thirty four advanced F₇ progenies evolved from two different crosses were evaluated during Kharif 2013. Out of these, 10 lines showed significantly higher total biomass and juice brix than the check CSV-24-SS. The line 10R-SS-20-61-8-5 gave the highest biomass (20.71 t/ha) and juice brix (24 %) followed by line 10R-SS-20-61-1-5 which had 20.27 t/ha total biomass and 23.33 % juice brix, line 10R-SS-19-16-5-2 which had 19.76 t/ha total biomass and 20.67 % juice brix as against the check CSV-24-SS which showed relatively lower total biomass (17.04 t/ha) and juice brix (19.67 %).

PVT trials: Fifty five uniform lines which are almost stable were tested as PVT (Pre-variety trial) entries along with two national checks viz., CSV-19-SS and CSV-24-SS in four different trials. In the first trial out of the 13 lines evaluated almost all were numerically higher in plant height, stripping % and brix of juice than both the checks. Line D-91-29-4 recorded the highest value of juice brix (22.83 %) among all the tested entries. Similarly lines D-91-9-2 recorded the highest values of grain yield (4.85 q/ha) and juice brix (21.83%) followed by lines D-91-9-5 (grain yield 2.38 q/ha and juice brix 22.17 %) and D-91-29-2 (grain yield 2.29 q/ha and juice brix 20.50 %) compared to the check CSV-24-SS (grain yield 1.62 q/ha and brix 19 %). In the second trial out of the 15 lines evaluated only four lines recorded greater plant height than the check where line D-141-34 showed significantly highest value for plant height (274.73 cm) with the check CSV-19-SS having plant height of 248.60 cm. Four lines viz., D-18-7-10-2 (Biomass 25.17 t/ha, juice yield 4.79 t/ha and brix 19.17 %), D-77-15-1 (Biomass 21.08 t/ha, juice yield 5.24 t/ha and brix 19.33 %), D-141-33 (Biomass 24.48 t/ha, juice yield 4.46 t/ha and brix 18.50 %) and line D-18-7-8-1 (Biomass 22.44 t/ha, juice yield 4.64 t/ha and brix 19.83 %) reported numerically higher values than the check CSV-24-SS (Biomass 20.49 t/ha, juice yield 4.21 t/ha and brix 18.50 %). Similarly line D-49-53 recorded the highest grain yield (7.10 q/ha) along with a higher brix of juice (19.00 %) than the check CSV-24-SS (Grain yield 2.22 t/ha and brix of

juice 18.50 %). In the third trial again 15 entries were evaluated out of which almost all the lines reported greater plant height than the check CSV-24-SS (233.14 cm) with the line D-91-60 reporting maximum plant height (327.40 cm). Line D-94-74 (Biomass 32.35 t/ha, stripped stalk weight 21.54 t/ha and brix 20.50 %) gave numerically higher values than the check CSV-24-SS (Biomass 21.64 t/ha, stripped stalk weight 17.48 t/ha and brix 17.83 %). Almost all the 15 lines reported higher juice brix values than the check CSV-19-SS (17.83 %) with lines D-91-9 and D-91-35 (both 21.83 %) reporting the highest. In the fourth trial, 12 lines were tested out of which four lines were numerically superior in plant height to the check CSV-24-SS (240.27 cm) where line D-23-28-10-2-4 (354.67 cm) reported maximum plant height. Line D-34-20-2-5 (Plant height 286.67 cm, total biomass 30.10 t/ha, stripped stalk weight 20.23 t/ha) exhibited numerically higher values for the mentioned traits than the check CSV-24-SS (Plant height 240.27 cm, total biomass 25.21 t/ha, stripped stalk weight 13.97 t/ha). Almost all the lines which were evaluated in the trial were numerically higher in juice brix than the check CSV-24-SS where lines D-44-3-3 and D-44-3-11 reported the highest brix values (both 21.8 %) and grain yields 5.10 t/ha and 6.04 t/ha respectively compared to the check CSV-24-SS which had juice brix 17.8 % and grain yield 0.96 t/ha.

2. B line development programme: B line development programme at the center was initiated during Kharif 2010 and this material was supplied by the DSR under network breeding programme. Total of 55 F₆ progenies produced from seven different crosses were evaluated in three different trials (Groups A, B & C) during Kharif 2013 (Table: 2). Similarly, another 34 lines which were derived from 11 different crosses and are in F₈ generation were also evaluated under B line development programme during the same season. In the first trial of the 15 F₆ entries evaluated three lines viz. 10B-AGR-46-45-2-4 (7.18 t/ha), 10B-AGR-46-52-5-1 (6.67 t/ha) and 10B-AGR-46-86-3-5 (5.88 t/ha) showed promising performance for stripped stalk weight as compared to the check 296B (4.66 t/ha) while line 10B-AGR-46-45-2-4 reported maximum grain yield (8.16 t/ha), juice yield (2.31 t/ha) and stripped stalk weight (7.18 t/ha) compared to the check CSV-24-SS (Grain yield 1.75 t/ha and juice yield 1.28 t/ha). In the second trial, among 17 F₆ progenies evaluated three lines gave numerically higher plant height than the check 296B (176.33 cm) where line 10B-AGR-47-24-1-1 (225 cm) gave the maximum plant height. Lines 10B-AGR-48-1-5-3 (Stripped stalk weight 9.05 t/ha and juice yield 2.27 t/ha) and 10B-AGR-48-14-4-2 (Stripped stalk weight 8.66 t/ha and juice yield 2.30 t/ha) recorded the highest values for the mentioned traits as compared to the check 296B (7.06 t/ha Stripped stalk weight and 1.24 t/ha juice yield). In the third trial, line 10B-AGR-61-37-1-2 reported the numerically highest total biomass (14.64 t/ha) and stripped stalk weight (5.42 t/ha) compared to the check 296B (13.04 t/ha biomass and 5.41 t/ha stripped stalk weight). Line 10B-AGR-61-36-1-3 exhibited significantly higher juice yield (3.47 t/ha) as compared to the check 296B (1.38 t/ha). Similarly, lines 10B-AGR-66-49-3-2 showed numerically higher juice brix of 16% followed by the lines 10B-AGR-61-8-2-6 and 10B-AGR-66-49-3-1 (both 15.17 %) than the check 296B (15%). Again under B line development programme during the same season 34 lines which were derived from 11 different crosses and were in F₈ generation were tested for the different characters along with the promising parental lines NARI-SS-5 B and NARI-SS-11 B. Out of the 34 lines evaluated line NARI-54-1-2-3B reported significantly highest biomass of 15.04 t/ha as against that of the check NARI-SS-5 B (13.78 t/ha). Twenty two lines gave significantly higher juice yield as compared to the check NARI-SS-5B (18.05 t/ha). They were NARI-36-5-2-1-1B (53.38 t/ha) followed by NARI-54-1-1-1B (40.77 t/ha). Four lines viz., NARI-36-5-4-2B (21.08 %), NARI-5-1-3-2-1B (21.00 %), NARI-39-7-1-4-2B and NARI-41-5-2-1-1B (both 20.8 %) gave significantly higher juice brix than the check NARI-SS-5 B (17.5 %).

Generation	No. of families (No. of crosses) evaluated	No. of progenies evaluated	No. of entries evaluated
F ₇ (Network breeding)	7	55	55
F ₈	11	34	34

3. MS conversion programme: In CMS development programme, a total of 36 pairwise crosses were evaluated during Kharif 2013. Among the 36 progenies, 33 promising combinations were advanced to Rabi 2013-14 season for evaluation.

Generation	No. of families (No. of crosses) evaluated	No. of progenies evaluated	No. of crosses made	No. of families/single plants selected
BC ₆	8	36	66	33

4. Station hybrid/variety trial: Towards evaluation of CMS-based sweet sorghum hybrids 38 hybrids along with two checks (CSH-22-SS and Madhura) were assessed in three different trials for high biomass, brix of juice and grain yield in Kharif 2013 season. In the first trial, out of the 17 hybrids evaluated hybrid SSRH-211 recorded the maximum biomass of 28.85 t/ha as against 25.77 t/ha in the check CSH-22-SS. Similarly, four hybrids SSKH-195 (19%), SSKH-202 (17.17 %), SSKH-214 and SSKH 215 (both 17%) reported significantly higher juice brix than both the checks CSH-22-SS and Madhura (both 16.67 %). In the second trial, seven hybrids were assessed of which four hybrids reported higher grain yield than the check CSH-22-SS (2.53 q/ha) with SSRH-219 recording significantly highest grain yield of 6.30 q/ha. In the third trial, out of the 14 hybrids assessed three hybrids SSKH-229 (30.67 t/ha), SSKH-239 (29.99 t/ha) and SSKH-227 (29.27 t/ha) gave significantly higher total biomass than the check CSH-22-SS (24.59 t/ha).

5. AICSIP trials: Three trials, viz., IAVHT SS, high biomass trial and Phenotyping *Kharif* sorghum germplasm for mid-season drought adaptation were allocated and were successfully conducted.

6. Publications: Research paper – one

13. RAHURI

The AICSIP MPKV, Rahuri is working on both kharif and rabi season. During kharif this center voluntary working on sweet sorghum while mandatory working on rabi sorghum during rabi season. Total 487 mm rainfall was received in 34 days as against average rainfall of 550 mm i.e deficit by 11.5 % during 2013-14. During kharif season crop condition of sweet sorghum crop was satisfactory. The cane yield and brix % level in all the experiments was recorded satisfactorily. In general kharif season is favorable to sweet sorghum crop. The center has released the forage sorghum variety SPV 2057 under number CSV 30F by 43rd AGM held at DSR Hyderabad for zone I (Haryana, Uttarakhand, Gujarat, Uttar Pradesh, Rajasthan and Punjab) and Zone II (Tamilnadu, Karnataka and Maharashtra) for single cut purpose for kharif season. The notification proposal has been submitted to CVRC, New Delhi on 6/3/2014. Identified the Sweet sorghum Hybrid RSSH-50 for green cane yield coupled with high ethanol and tolerant to shootfly. The pre release proposal of this variety has been submitted to the University RRC meeting during 2013-14. This hybrid is proposed for kharif season for western Maharashtra.

Sweet sorghum breeding

1. Varietal development programme: To develop a variety for high biomass coupled with shootfly tolerance and better juice quality parameters, the 21 crosses has been effected through 7 x 7 half diallel mating system during the rabi season. The F₁ to F₆ generations were evaluated and promising IPS were selected.

Generation	No. of crosses evaluated	No. of progenies	No. of Families /IPS selected
F ₁	15	-	F ₁ grown
F ₂	19	-	95
F ₃	30	134	102
F ₄	4	52	50
F ₅	3	20	18
F ₆	27	139	117
Total	119	345	382

2. Evaluation of sweet sorghum genotypes for cane yield and quality parameters: Different genotypes/ hybrids has been evaluated for cane yield and promising genotypes/hybrids has been given below:

Name of trial	Entries tested	Checks	Promising genotype
AICSIP Trials			
ISSAVHT- Kharif	23	CSH 22SS, CSV 19SS, CSV 24SS	8014, 8062, 8105
High biomass Trial	16	CSH 22SS, CSV 19SS	RSSH 50
University Trials			
Univ.MLT Sweet Sorghum	16	CSH 22SS, CSV 19SS	RSSH 50
Station varietal/Hybrids trials			
Station Trial Set I	20	CSV 19SS, SSV 84	RSSV 386
Station Trial Set II	20	CSV 19SS, SSV 84	RSSV 397
Station Trial Set III	20	CSV 19SS, SSV 84	R, RSSV 422
Station Trial Set IV	20	CSV 19SS, SSV 84	RSSV 438
Station Hybrid Trial	20	CSV 19SS, SSV 84, CSH 22SS	RSSH 89

3. Hybrid development programme: In order to develop sweet sorghum hybrids having high biomass with better quality parameters, 29 experimental hybrids has been developed on CMS 185A ,38A, and 479Aby utilizing elite sweet sorghum restorer during rabi season.

4. AICSIP Trials: Three breeding trials, AVT SC, IVHT SC and IAVHT SS were conducted successfully.

14. SURAT

During *kharif 2013* total ten project trials of sorghum were conducted at Surat. Out of these, six were of grain sorghum, three of forage sorghum and one of sweet sorghum. Where as at Mangrol two trials of grain sorghum were conducted. AVT of grain sorghum was viliated due to heavy and continuous rain at Mangrol. At Surat, total 1778.3 mm rain was received in 82 rainy days. During the month of July, August, and September 653.6, 103.6, and 476.5 mm rain was received in 29, 16 and 13 rainy days respectively. In AHT of grain sorghum, SPH 1736 and SPH 1703, in PPHT the hybrid NSH-54(CSH-28) for grain yield while in IAVHT(MC) trial SPH 1697 and SPV 2242, in IVHT (SC) trial SPH 1752 and SPV 2191 and in AVT (SC) trial SPV 2128 for green fodder yield observed promising. Total 31 trials of grain sorghum at eight locations and 18 forage sorghum trials at nine locations were conducted during *kharif 2013*. In grain sorghum, entries SR 1904, SR 2872, SR 2860, SR 2952, SR 2949, SR 2950 and SR 2964 found promising. While in forage sorghum SRF 289, DSF 0105, SRF 331, SRF 345 and SRF 342 appear promising for green fodder yield. In spite of prolong monsoon with continuous rain due to intensive efforts with constant follow-up the crop condition was maintained. Two entries, SR 2879 and SR 2872 are identified for entering in AICSIP trials. During *rabi 2013-14* three AICSIP trials at Tanchha and twelve state trials at six different locations were conducted. Due to prolong monsoon and continuous rain, crop will mature somewhat late hence results are awaited.

1. **R line development programme:** 48 new crosses were made during *kharif*-2013 and F₁'s were sown in *Rabi*-2013-14 for testing restoring fertility ability with combining ability, agronomical superiority and *per se* performance.

2. **MS conversion programme:** Six new crosses were made during *kharif*-2013 and F₁'s will be evaluated in *kharif*-14 for testing combining ability, agronomical superiority and *per se* performance. Beside this, back cross will be made for ms conversion in three cultivated varieties.

3. Trait specific line development programme:

a. **Grain mold resistance programme:** Twelve new crosses were made during late *kharif*-2013 and F₁'s will be evaluated in *kharif*-14 for testing grain mold resistance. Two grain mold resistance line were crossed with six promising line.

b. **Grain quality improvement programme:** Twenty eight new crosses were made during late *kharif*-2013 with hand emasculation and F₁'s will be evaluated in *kharif*-14 for improving roti quality nearer to Nizer goti (Which is most popular land race for roti quality). Two parents are resistant to grain mold in above breeding programme and same was mentioned earlier. The resultant hybrids of same parents will be evaluated separately for grain mold in *kharif*2014 .

c. **Grain yield and agronomical traits:** Twenty four new crosses (ms based) were made during late *kharif*-2013 using line X tester mating design including four lines viz; 296 A,AKMS 14A,ICSA 467A and PSM 28A and six tester (R line);RS 673,RS 627,AKR 354,C 43, CS 3541and UPMC 503. From the F₂ generation received from Akola 5 single plants have been selected.

d. **Grain quality and agronomical traits suitable Rabi season:** Thirty two crosses were made with hand emasculation during late *kharif*-2013 using line X tester design and will be evaluated next season. Selection will be made in segregating generation.

e. **Other segregating material evaluated:** The following segregating generations were evaluated during *kharif*-2013 as under:

Generation	No. of lines / crosses sown		Selection made			
	State		IPS		Bulk	
	Grain	Fodder	Grain	Fodder	Grain	Fodder
F ₃	413	-	145	-	-	-
F ₅	59	-	45	-	6	-
F ₆	121	14	85	29	10	-
F ₇	81	25	53	37	-	8
Bulk	-	-	-	-	124	44

4. Station hybrid/variety trial

Name of trial	No. of entries tested	Checks used	Superior entries
Kharif			
LSVT Grain (State trial)	27	5	SR 1904 and SR 2872
SSVT Grain (State trial)	39	5	SR 2860
PET Grain (Station trial)	57	6	SR 2952, SR 2949, SR 2950 and SR 2964
LSVT Forage (State trial)	14	2	SRF 289
SSVT Forage (State trial)	10	2	DSF 0105
PET Forage (Station trial)	12	2	SRF 331, SRF 345 and SRF 342
Rabi 2013-14			
LSVT Grain (State trial)	6	4	Results awaited
SSVT Grain (State trial)	18	6	
PET Grain	19	5	

5. **AICSIP trial:** Ten AICSIP trials allocated to Surat have been conducted successfully. Out of two trials allocated to Mangrol one could not be conducted, while all three rabi trials for Tancha have been conducted.

6. Other activities

Maintenance of A B pairs: 5

Maintenance of R lines: 6

Varietal selections made: 50 in Grain sorghum and 22 in forage sorghum

Germplasm maintained: grain sorghum – 517, forage sorghum – 93, rabi sorghum – 42 (45 new accessions were collected from tribal areas of sought Gujrat), sweet sorghum – 35

Seed production (Truthful): To fulfill the requirement of quality sorghum seeds for sorghum grower seed production programme were taken as under:

Season	Name of variety	Area (ha)	Season	Name of variety	Area (ha)
Kharif	GJ 42	0.50	Rabi/Summer	GJ 38	1.50
	GFS 5	1.00		CSV 21F	0.80
	GJ 38	1.20		GFS-5	1.00
	CSV 21F	2.00		CSV 21F	0.50
	GJ 42	0.50			

Student guidance: M.Sc. (Agri.) – 6, Ph.D. – 2

Training organized:

1. Training on "Sorghum mites" organized by Main Sorghum Research Station, Surat on 17-18 Oct.2013 under Golden Jubilee celebration of DSR.
2. Farmers' day on "Sorghum cultivation" organized by Main Sorghum Research Station, Surat on 19th Oct.2013 under TSP programme.

7. **Publications:** Abstracts – 4, popular articles – 3, folder – 14, posters – 13

15. UDAIPUR

Total rainfall received at the center till November was 811 mm against average rainfall 620 mm with continuous drizzling for a long period. More or less the same situation prevailed in all the sorghum growing regions of Rajasthan. Crop growth and yield in general was below satisfactory in all the disciplines. Centre has contributed 10 entries in coordinated trials. Out of these SPV 2061 was for testing of Agronomy & Pathology and SPV 1822 for re-verification of performance, two grain and DP genotypes viz. SPV 2164 and SPV 2165 and two single cut forage genotypes viz. SPV 2185 and SPV 2186 were for advance testing (AVT I), two grain and DP genotypes viz. SU 1426 and SU 1429 and two forage single cut genotypes viz. SU 1454 and SU 1465 for initial testing (IVT). Two varieties CSV 17 and CSV 23 of this centre was also used as check in coordinated trials. One hundred twenty Germplasm were evaluated in augmented RBD. The 20 parents involving agronomically superior, insect resistant, drought resistant, early lines/germplasm were planted in SPT to attempt fresh crosses for different attributes as per mandate. Apart from this 6 parental diallel was attempted between multi cut and single cut genotypes. 16 Hybrids were developed using different MS lines. The 30 F₁s and 3 back crosses were evaluation and advanced. The 152 crosses having 396 progenies including trait specific crosses were evaluated and progenies were identified for evaluation in next generation. Apart from coordinated trials 2 grain varietal, 1 grain hybrid, 3 forage (SC) and 2 forage (MC) trials were conducted during summer and rainy season. Breeder seed production programme for CSV 17, CSV 23 and PC 1080, and nucleus seed production programme of SPV245, CSV15, CSV10, CSV17, PJ1430, CSV23, PC1080, SPV1822, SU45, SU 52, SPV1753, AKMS 14A, AKMS 14B and AKR 150 was under taken.

A. Grain sorghum breeding: Mandate of the centre is Development of early maturing, insect pests and disease resistant dual-purpose hybrids / varieties along with their production technology. The major area under this crop in Rajasthan requires dual-purpose/ forage varieties. Accordingly major emphasis was on development of dual-purpose/ fodder varieties.

1. Evaluation, characterization, classification and utilization of germplasm: Under this 120 germplasm lines were evaluated along with 4 checks in 6 block augmented RBD.

2. Incorporation of novel genes in elite lines: The 20 parents involving agronomically superior, insect resistant, drought resistant, early lines/ germplasm were planted in SPT to attempt fresh crosses for different attributes as per mandate. To develop the F₁ for triple test cross crosses between SPV 245, SPV 1430 and SPV 1822 were also attempted. But, unfortunately could not get any F₁ seed on account of continues rainfall. These crosses will be again attempted during summer season.

3. Advancement and evaluation of F₁s: The 30 F₁s and 3 back crosses were planted for evaluation and advancement. Plants from all the crosses were self for retaining the seed for next season.

4. Evaluation and identification of desirable transgressive segregants: The 112 crosses having 396 progenies including trait specific crosses pertaining to different segregating generation (F₂-F₈) were planted and promising segregants were selected for advancement and stabilization. Lines from advance generation were selected for evaluation in station trials. All the crosses were evaluated under no plant protection measures.

Generation	No. of crosses evaluated	No. of families evaluated	No. of single plants selected
F ₂	38	-	74
F ₃	18	171	53
F ₄	13	67	31
F ₅	14	48	27
F ₆	18	40	19
F ₇	8	52	1
F ₈	3	18	1
F ₂ to F ₈	112	396	206

5. R line development programme: No separate R line development programme was under taken. However, 20 lines having height and flowering at par to MS lines were planted in SPT and 16 crosses were attempted to evaluate their combing ability.

6. B line development programme: The B lines were not involved in any crossing programme. However, crosses were attempted to test the combining ability of different genotypes. The lines with good combining ability will be tested for restoration ability. The lines lacking the restoration ability will be utilized for B line development programme.

B. Forage sorghum breeding: The 6 parental diallel including multi cut and single cut genotypes were attempted viz. SSG 59-3, COFS 29, HC 308, CSV 21F, CSV 23 and CSV 28 was also attempted to develop the lines with high biomass and good regeneration ability. The number of crosses and their progenies evaluated and identified for fodder purpose were given below:

Generation	No. of crosses	No. of progenies	No. of selection
F ₄	2	5	1
F ₆	3	17	3
F ₇	1	4	1

7. Trait-specific line development programme: No specific attempts were made but, in crossing programme and advancement of lines no plant protection measures were used and selections were exercised only for the genotypes having no infestation and better plants. Selections were made on the basis of days to maturity, seed and fodder yield and plant height.

8. Station hybrid/variety trial: One SHT (station hybrid trial), three SVT (station variety trials) and two SFT (station fodder trials) were conducted the details of trials were as follows:

Name of trial	No. of entries	Checks used	Superior entries
Station hybrid trial	15	SPH 837, CSH 16 & CSV 23	SHU 396, SHU 386, SHU 394 & SHU 400
Station Varietal Trial 1	37	CSV 15, CSV 17, CSV 23, CSV 28 & PJ 1430,	SU 1539 & SU1519
Station Varietal Trial 2	33	CSV 23, CSV 21F, PC 1080 & SU 45	PC1080-25 & PC1080-11
Station Varietal Trial 3	27	CSV 15, CSV 17, CSV 23, CSV 28 & PJ 1430	SU 1470 & SPV 1753-2
Station Fodder Trial 1	38	SU 45, PC 1080, SMU 1, SSG 59-3 & CSV 21F	SU 1490, SU 1595, SU 1493, SU 1484, SU 1485 & SU 1502
Station Fodder Trial 1	17	PC1080, SMU 1, SU 45 & CSV 21F	SU 1550, SU 1548, SU 1501, SU 1477 & SU 1545

9. AICSIP trial: All allocated 8 AICSIP trials were conducted successfully.

10. Other activities

Maintenance of A B lines- 16

No. of Restorer lines- 20

No. of experimental hybrids- 16

No. of varietal selections- 21

Student guidance : one M.Sc. (Ag.) student working on "Study of SSR Markers in Segregating Generations for Shoot Fly Resistance in Sorghum [*Sorghum bicolor* (L.) Moench]"

Training organized: National training on "Seed Production and Quality Regulations", Sponsored by National Seed Research and Training Centre, Varanasi organized from 16-20 December 2013.

Awards: Best University Team Award was awarded the to AICSIP, Udaipur team on 15th August 2013.

11. Publications: Research Papers – 6, folder – 1

V Publications

1. Aruna C. 2013. Forage sorghum breeding. In: S. Rakshit and JV Patil (eds). 2013. Basics of sorghum breeding and AICSIP data management. Directorate of Sorghum Research (DSR), Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India, 121 Pp. ISBN: 81-89335-45-6; 81-87.
2. Aruna C. 2013. Genetic improvement in kharif sorghum and latest kharif cultivars. In: Chapke RR, Bhagwat VR and Patil JV (eds.). 2013. Sorghum cultivation for value added diversified products and sweet sorghum perspectives. Directorate of Sorghum Research, ICAR, Hyderabad, India, ISBN: 81-89335-46-4: 175 pp. 15-21.
3. Aruna C. and P Sanjana. 2013. Cytoplasmic diversification in sorghum hybrid breeding. In: S. Rakshit and JV Patil (eds). 2013. Basics of sorghum breeding and AICSIP data management. Directorate of Sorghum Research (DSR), Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India, 121 Pp. ISBN: 81-89335-45-6; 28-34.
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6. Elangovan M, Jain SK and Patel NV. 2013. Genetic evaluation and characterization of Sorghum germplasm collected from Gujarat. *Indian Journal of Plant Genetic Resources*, **26**: 42-46.

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11. Ghorade RB, Kalpande VV, Bhongle SA and Band PA. 2013. Combining ability analysis for grain yield and yield components in post rainy season sorghum. *Plant Archive*, **13**(2): 693-696.
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13. Gomashe S and Ganapathy KN (2013) Sorghum types and their specific uses. In Chapke RR, Bhagwat VR and Patil JV. 2013. Sorghum cultivation for value-added diversified products and sweet sorghum perspectives, Directorate of Sorghum Research, Rajendranagar, Hyderabad, INDIA (ISBN: 81-89335-46-4).pp.173.175.
14. Hariprasanna K, Agte V, Elangovan M and Patil JV. 2014. Genetic variability for grain iron and zinc content in cultivars, breeding lines and selected germplasm accessions of sorghum [*Sorghum bicolor* (L.) Moench]. *Indian J Genet*. **74**: 42-49.
15. Jain SK and Patel PR. 2013. Combining ability and heterosis for grain yield, fodder yield and other agronomic traits in Sorghum [*Sorghum bicolor* (L.) Moench]. In: *Global Consultation on Millets Promotion for Health and Nutritional Security December 18-20, 2013 at DRR Hyderabad* PP 81-82.
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28. Sankarapandian R, Audilakshmi S, Sharma V, Ganesamurthy K, Talwar HS and Patil JV. 2013. Effect of morpho-physiological traits on grain yield of sorghum grown under stress at different growth stages and stability analysis. *Journal of Agricultural Sciences*, **10**: 1-18.
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