Recommended package of practices: Kharif sorghum

Preparation of land

One deep ploughing with mould board plough in summer followed by 3 to 4 harrowings to maintain weed free conditions. Making compartmental bunds of 10m × 10m in the month of August for soil moisture conservation.

Selection of high yielding hybrids and varieties

Region/state	Production condition	Recommended Hybrid	Recommended Variety
Maharashtra	Medium to heavy soil areas	CSH 16, CSH 18, SPH 388, CSH 23, CSH 25, CSH 30	CSV 15, PVK 400, CSV 17, CSV 20, CSV 23
Karnataka	Low rainfall areas	CSH 14, CSH 17, CSH 30,	CSV 17
	Normal rainfall areas	CSH 16, CSH 13, CSH 18, CSH 23, CSH 30	CSV 15, DSV 2, DSV 3
Andhra Pradesh	Low rainfall areas	CSH 14, PSH 1	CSV 15, CSV 17, CSV 20, CSV 23
	Normal rainfall areas	CSH 23, CSH 25, CSH 30	CSV 15, CSV 20, CSV 23
Madhya Pradesh	Entire state	CSH 16, CSH 17, CSH 18 , CSH 23, CSH 25	CSV 15, CSV 17SPV 235, JJ 741, JJ 938,
Gujarat	Normal rainfall areas	CSH 16, CSH 17, CSH 18, CSH 23, CSH 27	CSV 15, GJ 38, GJ 40
	Low rainfall areas (North Gujarat and Saurashtra)	CSH 17, CSH 13, CSH 16, CSH 18	CSV 15, CSV 17, GJ 38, GJ 39, GJ 40, GJ 41
Rajasthan	Medium to heavy soil zone	CSH 14, CSH 23, CSH 25, CSH 27	CSV 15, CSV 17, CSV 20, CSV 23
	Semi arid & transitional zones	CSH 16, CSH 18, CSH 23	
Tamil Nadu	Coimbatore & Madurai districts	CSH 14, CSH 17	CO 26, CSV 15 , CSV 17, CSV 20, CSV 23
	Entire state	CSH 16, CSH 17, CSH 18, COH 2, COH 4, CSH 27	
Uttar Pradesh	Entire State	CSH 14, CSH 16, CSH 18, CSH 23, CSH 25, CSH 27	CSV 15 , CSV 17, CSV 20, CSV 23
Sweet Sorghum All India	All above sorghum growing states	CSH 22 SS	SSV 84, CSV 19 SS
Forage sorghum All India	All above sorghum growing states	SSG 59-3, PC 106, CSH 20 MF, CSH 24 MF	HC 308, HC 171, HC 136, HC 260, CSV 15, CSV 20 (SPV 1616)

Method of sowing

The crop is sown by bullock drawn seed drills with 2 or 3 coulters at 7 cm depth in the soil. The seeds are covered by one harrowing after sowing by seed drill. It is also sown by tractor drown seed drill with 4 coulters with simultaneous covering of seeds by blade attached to the seed drill.

Time of sowing

The optimum sowing time for Kharif sorghum is Last week of May to2nd fortnight of July.

Seed rate spacing and plant population

Seed rate 8-10 kg/ha

Spacing	Row to row 45 cm and plant to plant 15 cm
Plant population	2.1 to 2.2 lakh /ha

Nutrient management

80 kg N, 40 kg P_2O_5/ ha.
50% N and full P_2O_5 at sowing, balance 50% 30 days after sowing.

Inter-cultivation and weed control

Intercultivation 2 or 3 time at 3, 5 and 7 weeks after sowing to check the weed growth and also helps conserve soil moisture by providing top soil mulch.

Weed management

Application of Atrazine @ 0.5 kg a.l/ha is recommended for spraying on the soil as pre-emergence application ie., on 2nd or 3rd day of sowing.

Sorghum-based cropping systems in kharif

Sorghum with red-gram as an intercrop is found practicable in 2:1 or 3:3 row proportions. Alternatively the sorghum and fodder cowpea as an intercrop in the ratio of 2:2 is also 40% more profitable. Soybean is also becoming other important intercrop with sorghum. In the intercropping systems the yield of grain and fodder from the sorghum crop is similar to its sole cropping. Therefore, the gains from the intercrop are additional. In the deep black soils having adequate rainfall, sunflower or bengal-gram can be grown after kharif sorghum

Insect pests and disease management

Insect-pests

a) Shoot fly

Damage symptoms: It is a seedling pest and normally occurs in the 1st- 4th week after germination. Maggot feeds on the growing tip causing wilting of leaf and later drying of central leaf giving a typical appearance of 'dead heart' symptoms. If the infestation occurs a little later, damaged plants produce side tillers which again are infested increasing the population build up. To schedule the chemical control, the shoot fly infestation can be monitored by checking the egg-laying on the lower surface of the seedling leaves before the formation of dead heart.

Cultural control: Shoot fly can be avoided by suitable adjustment of the planting time so that the vulnerable stage of the crop does not coincide with its active period. In rabi, planting towards the September end to October first week is ideal to escape shoot fly damage. Another important practice is to increase the seed rate and destroy the 'deadheart' seedlings after removal, to maintain the optimum plant stand.

Chemical control: When planted late, the pest can effectively be controlled by seed treatment with Furadan 50 SP @ 100 g/kg seed. Under moderate levels of infestation, a mixture of 60% treated and 40% untreated seed could be used. Besides, any of the granular formulations of Furadan 3G or Phorate 10 G at the time of sowing as soil application in the seed furrows @ 20 kg/ha can also effectively check the pest incidence. In case soil granular application is not done, damage can be

minimized by spraying seedling at 7 and 14 days stages with endosulfan @ 2 ml/liter water.

Stem borer

Damage symptoms: It infests the crop from 2nd week till maturity. Initially, the larvae feed on the upper surface of whorl leaves leaving the lower surface intact as transparent windows. As the severity of the feeding increases, blend of punctures and scratches of epidermal feeding appears prominently. Sometimes 'dead heart' symptoms also develop in younger plants due to early attack. Subsequently, the larvae bore into the stem resulting in extensive stem tunneling. Peduncle tunneling results in either breakage or complete or partial chaffy panicles.

Cultural control: The carryover of the pest form one season to another is through stubbles left in the field as well as the stems/stalks kept for use as fodder after harvest. Uprooting and burning of stubbles and chopping of stems prevent its carryover.

*Chemical control***:** Effective control of the borer can be achieved by application of any of the following insecticides in to the whorl i.e. Endosulfan 4G / 4D, Carbaryl 3G, Malathion 10D or Furadan 3 G @ 8-12 kg/ha at 20 and 35 days after emergence. The treatment should only be given after ascertaining the infestation levels as evidenced by leaf injury symptoms.

Shoot bug

Damage symptoms: Being a sporadic pest, under favourable conditions, it produces several generations and can cause heavy damage to sorghum. However, heavy infestation is seen on the rabi crop, when rain occurs at seedling stage. Both the adult type (Branchypterous and Macropterous) and nymphs suck the plant sap causing reduced plant vigour and yellowing. In severe cases, the younger leaves start dryling and gradually extens to older leaves. Sometimes, complete plant death occurs. Heavy infestation at vegetative stage may twist the top leaves and prevent either the formation or emergence of panicles.

Chemical control: Application of Endosulfan 4G or Carbaryl 3G @ 8 kg/ha in the whorls can effectively check the incidence of the pest.

Aphids

Damage symptoms: Occasionally, they cause damage to seedling sorghum. Attack during boot stage may result in poor panicle exertion. However, after panicle emergence, their population rapidly declines. Bigger plants in boot and later stages generally tolerate larger populations without any significant damage. Both the adults and nymphs suck the sap and heavily infested leaves show yellowish blotches and necrosis may occur on leaf edges. They produce abundant honeydew which predisposes the plant to sooty and other sporadic fungal pathogens. The honeydew excretion hinders harvesting process and result in poor quality grain. Severe damage was noticed under moisture stress conditions resulting in drying of leaves as well as plant death. Unlike the corn leaf aphid, sugarcane aphid predominantly is a serious

pest in rabi and prefers to feed on older leaves and also infest younger leaves including panicle at flowering stage. Adults are yellow to buff coloured. Both adults and nymphs suck the plant sap and cause stunted growth.

Chemical control: Spraying of Metasystox 35 EC (@ 1 lt/ha in 500 lt water) effectively control aphids.

Diseases

Grainmold

Damage: Grain molds are severe during the years of prolonged rainfall at the time of grain maturity. It results in discoloration of grain, but severity of infection reduces grain weight and size leading to considerable loss of yields even upto 100%; reduces germination and acceptability of the harvested grain, nutritive value and market price. The toxins produced are harmful to animals

Cultural control: Avoiding cultivars that mature when there is likelihood of rains is a precaution that can be used to avoid grain molds. Harvesting of genotypes at physiological maturity and drying also reduces mold incidence. Delay in harvesting of matured crop should be avoided.

Chemical control: Effective control can be obtained by three sprays on the Earheads with Aureofungin (200ppm) and 0.2% Captan, starting from flowering with 10 days interval. But it is impracticable and uneconomical, except in seed plots. Spraying three times with Captan (0.3%) + Dithane M-45 (0.3%) at 10 days interval from flowering period can also control grain molds.

IPM Technology for shoot fly

Under IPM the following are the recommended practices.

I. Cultural control:

- Deep Ploughing to expose the larval and pupal stages of shoot fly.
- Early Sowing within 7 to 10 days of the onset of monsoon in kharif and rabi between last week of September to first week of October.
- High seed rate @ 10 to 12 kg/ha is recommended while normal seed rate is 8 – 10 kg/ha
- d) Inter cropping of sorghum + redgram in 2:2 ratio in Kharif and sorghum + safflower in 2:1 ratio in rabi.

Chemical control

- *Seed Treatment:* Seed treatment with imidacloprid @14 ml/kg of seed is recommended or alternativly Furadan/Carbofuran 50SP@100 g/kg of seed may also be used.
- *Soil and Foliar application*: Soil application of Carbofuran 3G granules@20kg/ha in furrows at the time of sowing or spraying the seedlings

Biological Control: Releasing egg parasite, *Trichogramma chilonis* Ishii@ 12.5 lakh/ha is reported to reduce shootfly incidence.

IV. Botanical insecticides: Spraying the crop with 5% neem kernel extract.

Potential niches

Introduction of sorghum in rice fallows

Introduction of sorghum in rice fallows, especially in non-conventional areas when water is insufficient for second crop of rice, appears to be potentially promising with planting in late December to January ensuring high quality fodder yield and much gain for feed industry.

Summer sorghum cultivation

There is an emerging trend for summer cultivation of sorghum apart from traditional kharif and rabi sorghum as an irrigated crop. It is being taken up with much enthusiasm in Nanded and Pune districts of Maharashtra and Bidar district of Karnataka. Usually kharif hybrids are opted for its cultivation which results in higher yields and the quality of the grain is high due to clean without any moisture its grain is highly priced owing to its good quality. It has tremendous scope for export purposes. Summer sorghum essentially caters the needs of fodder during peak shortages.

Red sorghum for feed and exports

Specialized red kharif sorghum farming for grain export to international market is another emerging option. In order to meet the feed demand in high rainfall regions red grain sorghum may be targeted as potential raw material for poultry which imparts rich yellowness to yolk of egg. The red grain types have good demand in many countries for feed purposes. Red grain sorghums are relatively more tolerant to grainmolds because of the presence of phenols and red pericarp. At NRCS we are screening and developing red grain sorghum cultivars with early maturity combining tolerance to grainmolds as well as resistance to major pests in high yield background.

Sweet-stalk sorghum

Demand for renewable energy sources and biofuel which would minimize pollution are expected to rise rapidly in coming years. Sorghum, by virtue of its C4 photosynthetic system and rapid dry matter accumulation is an excellent bioenergy crop. Therefore, sorghum is expected to gain importance in the coming years in bioenergy farming. Ethanol is a clean burning fuel with high octane rating and it can be blended easily with petrol to the extent of 15-20%. Juice from sweet sorghum stalks can be competitive raw material to molasses for producing ethanol. This can also be profitable crop during summer with irrigation or during monsoon season. Till date the SSV 84 and CSV 19SS were the only national released sweet-stalked varieties at national level. Realizing the importance of high yielding superior sweet sorghum hybrid, the national programme could release the first sweet stalked sorghum hybrid CSH 20SS which has attracted much attention internationally. Efforts are on for development of sweet stalked sorghums for various specific end-users such as production of alcohol, ethanol, and syrup.