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<b>Topic-</b>	Cultivation of Sorghum Crop
<b>Sub-Topic-</b>	IMPORTANCE, ORIGIN, DISTRIBUTION, CLIMATE, VARIETIES, SOIL PRACTICES MAIN FIELD PREPARATION MANURING AND IRRIGATION PLANT PROTECTION RATOON SORGHUM RAINFED SORGHUM HARVESTING AND YIELD.
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## **Sorghum bicolor L.**

**(2n=20)**

**Vernacular name:** Great millet, sorgo, kafir corn, guinea com, milo (English): Jowar (Hindi): Cholam (Tamil): Jonna (Telugu): Jola (Kannada): Jowari. Jondhla (Marathi): Juara (Oriya).

### **Importance:**

The word sorghum is derived from the Italian word “**Sorgo**” which means rising above i.e. above its growth other crops in the field. It is also known as “**Great millet**”, It is called “**Camel of crops**” because of its exceptional ability to tolerate drought. Sorghum is one of the four major food grains in the world after rice, wheat and maize. It's a staple food crop of poor in arid and semiarid areas of the world.

### **Origin:**

Sorghum is originated in the region of the northeast Africa comprising Ethiopia, the Egyptian - Sudan border and East Africa. Indian sub - continent is its secondary center of origin.

### **Distribution:**

It is grown extensively in India, Sudan, Nigeria, China and Manchuria, Asia Minor, Iran and South European countries, Japan, Korea, Argentina, United States of America and Australia. Among the sorghum growing countries, India ranks the first in acreage but second in production, USA being the largest producer. In India, the major sorghum producing states are Maharashtra which occupies 49% share in total production followed by Karnataka (21%), Madhya Pradesh (9%), Rajasthan (7%), and Andhra Pradesh (4%). Uttar Pradesh (3%) and Gujarat (2%).

### **Botany:**

The height of the plant varies from 0.5 to over 4 m. The stems are erect and solid. The culms are made up of 7-18 nodes and internodes. The leaf number on main stem varies from 7 to 24. Most of the roots are confined to the upper 15 cm of soil and the penetration is from 0.5 to 0.75 m. The inflorescence of sorghum is a panicle. The panicles are commonly known as 'heads'. They may be compact or loose. The peduncle (the uppermost internodes which bears the inflorescence) is commonly known as the 'neck' may be straight or curved downwards (goose - necked). The blooming takes place chiefly in early morning, the maximum being between 12 midnight and 2 a.m. and sometimes anthesis may continue up to 8 a.m. to 10 a.m. It is self - pollinated crop although cross pollination up to 6% is reported depended on the extent of openness of the panicle. The plant is propagated through sexual deed. The fruit is a free caryopsis between the glumes. It is commonly called the grain or seed.

### **Classification:**

Classification of sorghum based on use as:

- Grain sorghum which is grown for grain.
- Forage sorghum grown mainly for fodder, hay and silage.
- Grass sorghum is wild sorghum e.g. Sudan grass.
- Broom corn sorghum used for making brooms.

- Waxy sorghum has waxy endosperm and is used for starch manufacture.
- Sweet sorghum for ethanol production, making sorghum syrup and silage.

Snowden classification of cultivated sorghum based on spiklet types: There are seven basic spiklet types namely wild types, shatter cane, bicolor, guinea, caudatum, kafir and dura.

- I. **Wild type:** Grain is small, linear, oblong and symmetrical dorso - ventrally. completely covered by the glumes racemes fragile and spiklets deciduous.
- II. **Shatter cane:** It is similar to above, but grains are large and round occasionally slightly exposed at the tip. Spiklets deciduous.
- III. **Bicolor:** Bicolor race consists of several distinct sub - races. Sudan grass, sorgo, broomcom and bicolor is the main ones. The long glumes clasping the grain, elongate seed and open panicles are considered to be primitive characters, glumes clasping the grain, which may be completely covered or exposed as much as 44 of its length at the tip: spiklets persistent.
- IV. **Guinea:** Guinea race is basically a West African race. A secondary center is found in East Africa, primarily in Malawi. It is most convenient to divide the race into three sub races based on the seed size viz. conspicium (large seeds), guinea (medium seeds) and maragaritiferum (small seeds). The grain is flattened dorso - ventrally. sublenticular in outline, twisting at maturity nearly 90<sup>0</sup> between gaping involutes glumes that are from nearly as long as to longer than the grain.
- V. **Caudatum:** The caudatum race with its characteristics turtle backed grains is dominant in Sudan, Chad, Nigeria and Uganda. The grain is asymmetrical, the side next to the lower glumes flat or in extreme cases even somewhat concave, the opposite side rounded and bulging; the persistent style often at the tip of a beak pointing towards the lower glume; glumes y length of the grain or less.
- VI. **Kafir:** The kafir race is a major race in East Africa from Tanzania Southward. The name is derived from the Arabic for 'unbeliever' or pagan refers to the blacks who grow it. The grain is approximately symmetrical, more or less spherical: glumes clasping and variable in length.
- VII. **Durra:** The name durra is derived from the Arabic for sorghum (or millets). The durras are dominant in the Ethiopia. Durra is drought resistant or at the least drought evading. Durras are known as milo in the United States. The grain is rounded, obvate, wedge shaped at the base and broadest slightly above the middle: glumes very wide.

### **Growth stages:**

The growth stages for sorghum of different crop duration are furnished in.

- **Seedling stage:** Seedling emergence takes 3-10 days. Leaves/nodes develop at the rate of one in 3 to 6 days. Early maturity hybrids typically produce 15 leaves per plant, while medium and late maturity hybrids produce 17 and 19 leaves each
- **Tillering stage:** Tillering occurs when the plants are in the 4 to 6 leaf stage.
- **Booting stage:** About 6 to 10 days before flowering, the boot forms a bulge in the sheath of the flag leaf (uppermost leaf). This stage is called boot leaf stage.

- **Flowering stage:** Sorghum usually flowers 55 to 70 days. The maximum flowering takes place on 3rd or 4th day after panicle exertion. It takes 6 days for the whole inflorescence to complete flowering. Individual panicles start flowering from the tip downwards and flowering may extend over 4 to 9 days.
- **Milky stage:** The soft dough stage occurs approximately 15 to 25 days after flowering and the seed attains 50% of its weight. Kernels reach their maximum volume approximately 10 days after flowering. The seed is soft and a white milky fluid appears when the seed is squeezed.
- **Hard dough stage:** When the seed is in the hard dough stage, the grain cannot be squeezed with the fingers and approximately 75% of the seed weight has been reached.
- **Physiological maturity:** The physiological maturity attains 25 to 45 day period after flowering and 30 to 35 days after fertilization. Grain moisture content a physiological maturity is between 25 and 35% moisture. Grain harvest can begin at approximately 20 to 24% moisture.

### Climate:

Sorghum is essentially a crop of the tropics and dry temperate areas of the world. It is grown in 40 ° N to 40 ° S up to an altitude of 1500 m from MSL. It is suited to regions receiving annual rainfall of 600 to 1000 mm. A rainfall of 500-800 mm evenly distributed over the cropping season is normally adequate for cultivars maturing in 3-4 months. Sorghum tolerates waterlogging and can also be grown in areas of high rainfall. It is a short day plant Sorghum requires solar radiation of 400 to 450 cal cm<sup>2</sup> day<sup>-1</sup> it is in extremely drought resistant crop next to pearl millet. It tolerates heat and dry conditions better than com It is susceptible to frost. The cardinal temperature at different growth phases of sorghum is presented in Table.

Cardinal temperature for growth and development of sorghum

Critical Stage	Germination	Vegetative Phase	Reproductive phase
Minimum	7-10 <sup>0</sup> C	15 <sup>0</sup> C	13 <sup>0</sup> C
Optimum	18-21 <sup>0</sup> C	26-30 <sup>0</sup> C	22-35 <sup>0</sup> C
Maximum	38 <sup>0</sup> C	40 <sup>0</sup> C	40 <sup>0</sup> C

### Soils:

Sorghum is grown in red sandy, red loamy, alluvial and coastal alluvial soils as well as on mixed black and red and medium black soils. It grows well in pH range of 6.0 to 8.5 as it tolerates considerable salinity and alkalinity.

### Improved and Hybrids varieties:

Crop	Variety	Recommended Zone	Avg. Yield ( q/ha )	Salient features
Sorghum	SR-2917 (GNJ-1)	Gujarat	34.0	Suitable for <i>kharif</i> sorghum growing area of Gujarat, maturity: 114 days, resistant to grain mold with less incidence of ergot disease and stem borer.
	CSH 36F (Dairy Green) (SPH 1752) DFSH 109) Hybrid	Punjab, Haryana, Uttar Pradesh, Uttarakhand,	GFY: 642.0 DFY: 169.0	Suitable for irrigated, medium to high soil fertility condition under normal sowing, protein 11.4q/ha, digestible dry matter 77.5q/ha, maturity: 115-120

	Rajasthan and Gujarat		days, tolerant to lodging and fertilizer responsive, resistant to grey leaf spot, tolerant to shoot fly dead hearts and stem borer dead hearts.
CSH 38 (HTJH 3301) (SPH 1779) Hybrid	Tamil Nadu, Gujarat, Telangana, Maharashtra, Karnataka, AP, MP, Rajasthan	45.5 (grain yield) FY: 139.8	Suitable for rainfed <i>kharif</i> with protective irrigation, grain sorghum hybrid, maturity: 106 days, shoot fly and grain mold tolerant, non-lodging.
CSH 37 (HTJH 3208) (SPH 1778) Hybrid	Tamil Nadu, Gujarat, Telangana, Maharashtra, Karnataka, AP, MP, Rajasthan	46.8 (grain yield) FY: 145.3	Suitable for rainfed <i>kharif</i> with protective irrigation, grain sorghum hybrid, maturity: 104-114 days, tolerant to downy mildew and grain mold under natural conditions, non-lodging, fertilizer responsive.
K-12	Tamil Nadu	31.0	Suitable for rainfed situation and also perform well during summer irrigated condition, maturity: 95 days, non-lodging, non shattering
SPV-2217	Karnataka	15.0-18.0 (grain yield) FY: 65.0- 70.0	Suitable for <i>rabi</i> season for deep soils of Karnataka, bold and round grains with lustrous bright colour, stay green, maturity: 124 days, tolerant to lodging and charcoal rot disease.
CSV 34 (SPV 2307)	Maharashtra, Karnataka, Madhya Pradesh and Gujarat	45.0 (grain yield) 129.0 (stover yield)	Suitable for timely sown rainfed conditions of <i>kharif</i> season, grain protein 10.39%; starch 62.54%, maturity: 110-112 days, tolerant to grain mold, <i>Fusarium</i> and zonate leaf spot, tolerant to shoot fly, dead aphid hearts stem borer, non-lodging, non-shattering
Jaicar Heera (CSV 36/SPV 2301)	Gujarat, Rajasthan, Andhra Pradesh and Tamil Nadu.	33.0 (grain yield) FY: 122.0	Maturity: 106-110 days, moderately tolerant to major diseases like grain molds, anthracnose, leaf blight and zonate leaf spot, tolerant to downy mildew, shoot fly and stem borer.
Jaicar Sona (CSV 39/SPV 2358)	Tamil Nadu, Telangana, Andhra Pradesh, Rajasthan and Gujarat.	34.0 (grain yield) FY: 115.0	Maturity: 102-110 days, moderately tolerant to major diseases like grain molds, anthracnose, leaf blight and zonate leaf spot, tolerant to downy mildew, shoot fly and stem borer.
Jaicar Gold (CSV 41)(SPH 1820)	Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Telangana and Tamil Nadu.	47.3	Suitable for rainfed <i>kharif</i> and irrigated summer, medium to highly fertile soil, timely sowing, good agronomic management conditions, maturity: 106-110 days, tolerance to foliar diseases, shoot fly, stem borer and mites, resistant to midge.

**Season:** Sorghum is sown in 3rd week of June to 1<sup>st</sup> week of July with onset of monsoon during *kharif* season; 15 September 15 October during *rabi* season and 36 week of January to 1<sup>st</sup> week of February during summer season.

**Seeds and sowing:** Good quality seeds are collected from disease and pests free fields. Seed rate is 7.5 and 10.0 kg / ha for transplanted and direct sown under irrigated condition whereas 15 kg / ha for direct sowing under rainfed condition. Treat the seeds 24 hours prior to sowing with Carbendazim or Captan or Thiram 75 @ 3 gm per kg of seed. Treat the seeds with 2% KH<sub>2</sub>PO<sub>4</sub>, for 6 hours and shade dry. Dissolve 20 g of KH<sub>2</sub>PO<sub>4</sub>, in one liter of water for soaking 5 kg of seeds. Dissolve 0.5 g of gum in 20 ml of water. Add 4 ml of chlorpyrifos 20EC or monocrotophos 35 WSC or phosalone 35EC. To this, add one kg of seed, pellet and shade dry. Seed hardening ensures high germination. The seeds are pre - soaked in 2% KH<sub>2</sub>PO<sub>4</sub>, solution for 6

hours in equal volume and then dried back to its original moisture content in shade and are used for sowing. Seed treatment with phospi solubilizing bacteria (PSB) @ 50 g / kg seed and azotobactor @ 25 g / kg seed can also be done. In the case of pure crop of sorghum, maintain the seed rate of 10 kg / ha. In the case of intercrop of sorghum with pulse crop, a seed rate of sorghum at 10 kg and pulse crop at 10 kg / ha are required. In the case of pure crop of sorghum sow the seeds with a spacing of 45 x 15 cm. Maintain one plant per hill. If shoot fly attack is there, remove the side shoots and retain one healthy shoot. Sow the seeds over the lines where fertilizers are placed. Sow the seeds at a depth of 2 cm and cover with soil. In the case of sorghum intercropped with pulses, sow one paired row of sorghum alternated with a single row of pulses. The spacing between the row of sorghum and pulse crop is 30 cm.

### **Nursery practices:**

For raising seedlings to plant one hectare, select 7.5 cents (300 m<sup>2</sup>) Near water source where water will not stagnate. Apply 750 kg of FYM or compost for 7.5 cents nursery and apply another 500 kg of FYM for covering the seeds after sowing. Spread the manure evenly on the unploughed soil and include by ploughing or apply just before last ploughing. Provide three separate units of size 2 m x 1.5 m with 30 cm space in between the plots and all around the unit for irrigation. Excavate the soil from the interspace and all around to depth of 15 cm to form channels and spread the soil removed on the bed and level. Make shallow rills, not deeper than 1 cm on the bed by passing the fingers vertically over it. Broadcast 7.5 kg of treated seeds evenly on the beds. Cover by leveling the rills by passing the hand lightly over the soil. Apply 2.5 kg of Lindane 10% dust over the seed beds and all around to prevent ants carrying seeds away and ensure that the seeds are not sown deep as germination will be affected. For water management in nursery, provide one inlet to each nursery unit. Allow water to enter through the inlet and cover all the channels till the raised bed are wet and then cut of water. First irrigation is given immediately after sowing and life irrigation on the fourth day. Subsequently once in five days. Four to five irrigations are required depending on soil types in the nursery. Do not keep the seedlings in the nursery for more than 18 days. If older seedlings are used, establishment and yield are adversely affected. Do not allow cracks to develop in the nursery by properly adjusting the quantity of irrigation water. Pull out the seedlings when they are 15 to 18 days old. Prepare slurry with 5 packets (1 kg per ha) of azospirillum in 40 liters of water and dip the root portion of the seedlings in the solution for 15 to 30 minutes and then transplant the seedlings. Let in water through the furrows.

Plant one seedling per hill. Plant the seedlings at a depth of 3 to 5 cm. Plant the seedlings on the side of the ridge, half the distance from the top of the ridge and the bottom. Maintain a spacing of 45 x 15 cm. Transplanted crop has a few advantages. Main field duration is reduced by 10 days. Shoot fly, which attacks direct sown crops during the first 3 weeks and which is difficult to control can be effectively and economically controlled in the nursery itself. Seedlings which show chlorotic and downy mildew symptoms can be eliminated; thereby incidents of downy mildew in the main field can be minimized. Optimum population can be maintained as only healthy seedlings are used for transplanting. Seed rate can also be reduced by 2.5 kg / ha.

## **Main Field Preparation:**

### **Land Preparation:**

Plough the field with an iron plough once and twice with a country plough. Sorghum does not require fine tilth, since it adversely affects germination and yield in the case of direct sown crop. Form ridges and furrows using a ridger 6 m long and 45 cm apart. For irrigation channels across the furrows. Alternatively, form beds of size 10 m<sup>2</sup> or 20 m depending on the availability of water.

Field preparation depends on the system of sorghum sowing viz.

- Sowing on a flat surface, or
- Using ridge - and - furrow system, or
- On a broad bed - and - furrow system.

If sowing is done on a flat surface, the land should be leveled after final plowing using bullock - drawn or tractor - drawn levelers. In ridge and furrow system, ridges are made using either tractor drawn or animal drawn ridge ploughs. Broad beds and furrows are prepared by an animal - drawn ridger, mounted on a tool carrier, or by tractor - drawn implements with ridgers. The top of the bed is 1.2 m wide and the distance from the center of one furrow to the center of the next furrow is 1.5 m. The depth of furrows should be 15 cm or more. The broad bed - and - furrow system has many advantages over flat sowing. It helps in draining off excess water in the field and soil: provides more soil aeration for plant growth; greater in-situ moisture conservation; casier for weeding and mechanical harvesting.

### **After cultivation:**

Thin the seedlings and gap fill with the seedlings thinned out on 10-15 days after emergence and the second at 20-25 days after sowing. Maintain a spacing of 15 cm between plants after the first hand weeding on the 23rd day of sowing. Thin the pulse crop to a spacing of 10 cm between plants for all pulse crop except cowpea for which spacing is maintained at 20 cm between plants.

### **Weed management:**

Sorghum is slow growing in early stages and is adversely affected by weed competition. Therefore, keep the field free of weeds upto 45 days. Apply the pre emergence herbicide Atrazine 50% WP @ 500 g a/ha on 3 days after sowing as spray on the soil surface, with 900 lit of water per ha. Then one hand weeding may be given on 30 to 35 days after sowing. Pulse crop is to be raised as an intercrop in sorghum, do not use atrazine. Hand hoeing and weeding is taken on the 10 day after transplanting, if Berbicides are not used. Hand hoeing and weeding are taken up between 30-35 days after transplanting and between 35-40 days for a direct sown crop. The root parasite witch weed (*Striga asiatica* and *Striga hermonthica*) reduces sorghum grain yield, between 15 to 30% per - emergence application of atrazine at 0.5 kg ai / ha and post emergence application of 2,4 - D at 2 kg ai / ha around 30 days after planting provides excellent control of *Striga* weed. *Striga* flowering can begin within 2 weeks and seeds begin to mature 2-4 weeks later. The seed capsules may contain 400-500 seeds and a single plant may produce 20,000 seeds.

### **Manures and fertilizers application:**

Apply FYM or composted coir pith @ 12.5 V ha along with azospirillum (10 packets) @ 2 kg / ha on the unploughed field and include the manure in the soil by working a country plough.

- ❖ **Fertilizers application for direct sown crop:** Fertilizer dose of 90-45-45 kg of N, P and K per ha is recommended. Apply half of the dose of N and full dose of P and K as basal dressing. In the case of bed planted crop, mark lines to a depth of 5 cm and 45 cm apart. Place the fertilizer mixture at a depth of 5 cm along the lines. Cover the lines up to 2 cm from the top before sowing. In the case of sorghum raised as a mixed crop with a pulse crop (blackgram, greengram or cowpea), open furrows 30 cm apart to a depth of 5 cm. Apply fertilizer mixture in the two lines in which sorghum is to be raised and cover up to 2 cm. Skip the third row in which the pulse crop is to be raised and place fertilizer mixture in the next two rows and cover up to 2 cm with soil. When Azospirillum is used apply only 75% of recommended N for irrigated sorghum. Mix 12.5 kg of micronutrient mixture with enough sand to make up the total quantity of 50 kgs. Spread the mixture Evenly on the beds. Basal application of 25 kg ZnSO<sub>4</sub> per ha for the zinc deficient soils is recommended. Basal application of FeSO<sub>4</sub>. @ 50 kg / ha along FYM @ 12. t/ha for iron deficient soils is recommended.
- ❖ **Fertilizers application for transplanted crop:** Fertilizer dose of 90-45-45 kg of N, P and K per ha is recommended. Apply half the dose of N and full dose of P and K basally before planting. In the case of ridge planted crop, open a furrow of 5 cm depth in the side of the ridge at two thirds the distance from the top of the ridge and the bottom and place the fertilizer mixture along the furrow and cover with soil up to 2 cm. Apply the remaining 50% of N along the furrows on the 15 day of planting and irrigate, soil application of azospirillum 10 packets (2 kg / ha) after mixing with 25 kg of FYM + 25 kg of soil may be carried out before sowing / planting. Mix micronutrient mixture 12.5 kg / ha with enough sand to make a total quantity of 50 kg. Apply the mixture over the furrows and on top one third of the ridges. If micronutrient mixture is not available, mix 25 kg of zinc sulphate with sand to make a total quantity of 50 kg and apply on the furrows and on the top one third of the ridges. Soil application of 25 kg / ha of ferrous sulfate at the final ploughing is recommended in soils low in available iron. Foliar application of 0.5-1,0% ferrous sulfate solution corrects iron deficiency if noticed in a standing crop.

**Deficiency symptoms:**

**Zinc:** Deficiency symptoms first appear in the newly formed leaves at 20 to 30 days age. Older leaves have yellow streaks or chlorotic striping between veins.

**Iron:** Interveinal chlorosis will be observed. If the deficiency continues the entire leaf including the veins may exhibit chlorotic symptom. Newly formed leaves exhibit chlortic symptoms. The entire crop may exhibit bleached appearance, dry and may die.

**Water management:**

Water requirement is 400 mm for grain production and 500 mm for green fodder production. Irrigation is given at 50% available soil moisture. The IW / CPE ratio of 0.4 to 0.6 is recommended for grain production while 0.9 for green fodder



production. Adjust irrigation schedule according to the weather conditions and depending upon the receipt of rains. The critical growth stages of sorghum in relation to water requirement are viz., initiation of grand growth stage (20–25 DAS), flag - leaf stage or boot stage (50–55 DAS), flowering stage (70–75 DAS) and grain - filling stage 90–100 DAS. Spraying 3% kaolin (30 g in one liter of water) during periods of moisture stress will mitigate the ill effects.

### **Cropping systems:**

Sorghum can be intercropped with pigeon pea, green gram, cowpea, soybean and sunflower. Sorghum - based intercropping systems such as Sorghum + pigeonpea (2: 1 or 3: 3): Sorghum + soybean (3: 6 or 2: 4) and Forage sorghum + cowpea / clusterbean (2: 2) are promising in different states of India. After kharif sorghum, a sequence crop like chick pea, safflower and mustard are found most suitable in in rabi season.

Intercropping of soybean with sorghum in the ratio 4: 2 is recommended for kharif and summer seasons. Intercropping of sunflower with sorghum in 4: 2 ratio is recommended under rainfed conditions during northeast monsoon for black soils. Paired row planting of sorghum and sow one row blackgram / cowpea as intercrop or fodder sorghum + fodder cowpea at 3: 2 ratio can be practiced in rainfed black soils.

A sequence crop in rabi following sorghum in kharif is found to be profitable in those areas which receive rainfall above 700 mm and having moisture retentive medium to deep black soils. The promising sorghum based crop rotations are sorghum - wheat, sorghum - wheat - moong, sorghum - gram, sorghum - potato / wheat, sorghum raya, sorghum - potato / rape - wheat / tobacco, sorghum - cotton - groundnut, sorghum - wheat cowpea / pearl millet, sorghum - wheat - greengram, sorghum - pea / oat / berseem, sorghum - gram or barley, sorghum - lentil, sorghum - cotton, sorghum - sorghum (rabi), sorghum - tobacco, ground nut - sorghum (rabi) and sorghum - ragi - groundnut. The following techniques are suggested to make sequence cropping system economical and feasible.

- Kharif sorghum crop should be harvested at its physiological maturity to gain about one week's time in planting the winter crop.
- Practice of minimum tillage needs to be adopted. It helps to gain time, minimizes land preparatory costs and prevents soil moisture loss.
- Sowing of winter crop should be drilled without much opening of the soil.
- Inter cultivation should be done at appropriate time to minimize weeds and soil water loss.

### **Pest and diseases management:**

The important sorghum insect pests are shoot fly, stem borer, midge, white grub, armyworm, cutworms, grasshopper, pyrilla, shoot bug, earhead caterpillars, earhead bug, spider mite, aphids and the diseases are grain mold, charcoal rot, downy mildew, anthracnose, loose smut, ergot, grain smut, red leaf spot, rust, etc. Set up light traps @ 1 trap / acre 15 cm above the crop canopy for monitoring and mass trapping insects. Light traps with exit option for natural enemies of smaller size should be installed and operate around the dusk time (6 pm to 10 pm). Apply Carbofuran 35 @ 20 kg / ha in seed rows to safe guard against shoot fly incidents. Stem borer is controlled with application of Endosulfan 4G or 3D in the whorls @ 8 and 12 kg / ha at 20 and 35 days after emergence. Dusting of Malathion 10D @ 20 kg / ha to control Head bug at pre - bloom and 50% flowering stage. Seed treatment is done with Thiram or Captan @ 3g per kg or metalayl

(Apronxl) @ 3 ml / kg of seed to control grain mold and charcoal rot. Sugary disease is managed by 2 sprays of propanazile (TILT 25 EC) @ 5.0 ml / lit at flowering and 15 days later on. Grain mold can be controlled with Aureofungin @ 30 g / 10l of water) + captan (@ 3%. Leaf spot such as rust can be controlled by spraying Dithane M 45 @ 3%.

### **Harvest:**

Physiological maturity can be determined by the black (dark) spot at the bottom of the grain. The Kharif sorghum should be harvested at its physiological maturity to avoid grain mold damage. Sorghum grains are usually harvested at a grain moisture content of 20 to 24%. The leaves turn yellow and a dried up appearance when the crop matures. The grains are hard and firm. At this stage, harvest the crop by cutting the earheads separately. Cut the straw after a week, allow it to dry and then stack. Sometimes, the stem is cut at 10 to 15 cm above ground level and subsequently separate the earheads and stack the straw. Dry the earheads. Thresh the grains using a mechanical thresher or by drawing a stone roller over the earheads or by using cattle and dry the produce and store. The threshed grain should be cleaned and dried in sun for 6-7 days to reduce the moisture content down to 12-15% for safe storage. Hundred seed weight is 3.0 to 3.5 g.

### **Yield:**

The average grain yield ranges between 2.5 to 3.5 t / ha, and that of hay between 15.0 to 17.0 t / ha under assured water supply. With improved cultural practices, it is possible to harvest nearly 5.0 t / ha of grain and about 10.0 to 12.5 t / ha of dry straw under irrigated conditions.

### **Utilization:**

Sorghum is a major source of staple food for the humans and for livestock feed. The grain is processed into starch paste, flour, dextrose, dextrose syrup, gluten meal, gluten feed, edible oil and alcoholic beverages. It is used in the brewing industry to make beer. The stems and foliage are used for green chop, hay, silage, and pasture.

### **RATOON SORGHUM:**

#### **Varieties for ratooning:**

CO 25, CO 26, CSH 5, K tall.

#### **Ratooning technique:**

Harvest the main crop leaving 15 cm stubbles. Remove the first formed two sprouts from the main crop and allow only the later formed two sprouts to grow. Allow two tiller per hill. The duration of the ratoon crop is about 15 days less than the main crop.

**Weed management:** Remove the weeds immediately after harvest of the main crop. Hoeing and weeding are carried out twice on 15th and 30th day after cutting.

#### **Manures and fertilizers application:**

Apply N @ 100 kg / ha in two split doses. Apply the first dose on 15th day after cutting and the second on 45th day after cutting. Apply P, Os @ 50 kg / per ha along with first application of nitrogen.

**Water management:** Irrigate immediately after cutting the main crop. Irrigation should not be delayed for more than 24 hours after cutting. Irrigate on 3 or 4th day after cutting. Subsequently irrigate once in 7 to 10 days. Stop irrigation on 70 to 80 days after ratooning.

**Harvest:**

Harvest the crop when the grain turns yellow.

## **RAINFED SORGHUM**

**Soil:** Rainfed sorghum is grown under wide range of agro-climatic conditions in Vertisols, Entisols, Inceptisols and Alfisols. Post - rainy season sorghum is largely confined to Vertisols. Yield can be increased up to one tonne per ha with an increase in soil depth and moisture storage in the post rainy season. The yield difference between shallow 'and a' deeper 'soils is almost one tonne per ha.

Varieties: CO 21. CO 25, CO 26. K tall, COH-3.

**Land preparation:** It is done 5 days before to 10 days after daily precipitation is equal to 0.5 PET.

**Seeds and sowing:**

Seed rate is 15 kg / ha. Soak the seeds in 2%  $\text{KH}_2\text{PO}_4$ . (20 g in one liter of water) or 500 ppm of CCC (one ml in one liter of water) for six hours and shade dry the seeds for 5 hours. Use 350 ml of solution for soaking one kg of seed. The seed is pelletised with 15 g of chloropyrifos in 150 ml of gum and shade dried. Treat the seeds with three packets of azospirillum (600 g) and 3 packets of phosphobacterium. In the main field, apply azospirillum 2 kg (10 packets / ha) with phosphobacteria 2 kg with 25 kg FYM 25 kg soil. Sow the seeds well before onset of monsoon in Vertisols at 5 cm depth by seed drill or by country plough. Sow the hardened seeds at 5 cm depth with seed cum fertilizer drill to ensure uniform depth of sowing. Sow the sorghum seeds over the line where the fertilizers are placed. Sow the seeds at a depth of 5 cm and cover the soil. Sow the seeds with the spacings of 15 cm in the paired rows spaced 60 cm apart. Sow the pulse seeds to fall 10 cm apart in the furrows between the paired rows sorghum. Spacing for pure crop is 45 x 15 cm.

**Manures and fertilizer application:** Apply FYM or composted coir pith @ 12.5 U ha or enriched FYM @ 750 kg / ha along with 40-20-0 kg of N, P and K per ha as basal dressing.

**Weed management:**

Keep sorghum field free of weeds from second week after germinations till 5th week. If sufficient moisture is available spray atrazine @ 500 g per ha as pre - emergence application within 3 days after the receipt of the soaking rainfall for sole sorghum whereas Pendimethalin @ 3.0 litha for sorghum intercropped with pulses.

**Yield:**

Grain yield potentials of up to 5.5 tha in Entisols and Vertisols and of 3 to 4 tha in Alfisols can be obtained. The average yields of sorghum in areas with favorable rainfall and soils are around 2 to 2.5 tha, while the post rainy season sorghum grown under unfavorable conditions yield around 500 kg / ha.

**Sorghum injury / Sorghum effect:**

The growth and yield of crops following sorghum are depressed to certain extent and this is referred to as 'sorghum injury' or 'sorghum effect'. Sorghum stubbles ploughed into the soil contain sugars, which encourage microbial activity. The bacteria in the soil use all the available nitrogen for their growth and crops that follow are starved of nitrogen. The structure of the soil gets unfavorable when the sugars decompose actively and this also affects the following crop. This is only a temporary problem. This can be avoided with intercropping of legumes with sorghum and application of more nitrogenous fertilizers to the succeeding crop.

**Sorghum poisoning:**

Young sorghum plants and also ratoon sprouts from sorghum stubbles are poisonous and bring about death of the animals which graze them. These contain **cyanogenic glucoside** called "**dhurrin**" particularly in the plants which are stunted or affected by the drought. They can be used for feeding after drying or ensiling. The glucoside hydrolyses in the stomach of the cattle and produces hydrocyanic acid, or prussic acid which brings death to the animals. Young sorghum seedlings below fifty days old contain a high content of hydrocyanic acid (HCN) and it decreases from the early stages progressively until the plants attain the boot stage. Side tillers and axillary branches contain a higher percentage of the acid as compared to main shoots. The glucoside content decreases as the sorghum plant makes growth. The toxic level of HCN is above 200 ppm. Plants of more than 75 days old are nearly free of the glucoside.

<b>Reference Books</b>		
1.	Modern techniques of raising field crops	Chhidda Singh.
2.	Kharif crops.	Omprakash and Ahlawat
3.	Crop production	Nazir M. S.
4.	Principles of field crop production	Reddy, S.R.