



Precision Farming
COTTON
With Jain Technology™



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Jain Irrigation Systems Ltd.

Small Ideas. Big Revolutions.®



Cotton Cultivation - Jain Technology™



Cotton is one of the important plant fibre used since the beginning of civilization. India is growing cotton and manufacturing yarn and cloth from the very olden days. India has been an important exporter in cotton since when trading among countries started.

Cotton is *Gossypium* sp. belonging to Malvaceae family. The cultivated species; G. herbaceum and G. arboreum and G. hirsutum and G. barbedense.

Habit of the Crop:

Cotton is a perennial crop which can be grown continuously like trees. It stays evergreen in tropical conditions and produces continuously. However, all commercial production is grown as an annual crop which is planted every year, to maintain high yields, and to keep the insect population under check by destroying all plant residues after each growing season. **Management of soil fertility & irrigation water will play a major role in increasing Cotton productivity.**

Cotton Life Cycle:

The life cycle can be divided into 4 main stages:

1. Germination to first true leaf
2. First true leaf to first square
3. First square to opening of first flower
4. First flower to end of boll opening

Every stage of this cycle is affected by climate- temperature, evaporation, precipitation or irrigation etc. and the very complex interactions of these factors.

Accumulated heat units decide the duration of each growth stage and therefore the calendar time of each stage is different for different sowing dates (see Table 1). **Because of this the cultivation practices can not be standardized universally.**

Table 1 – Relation between sowing date and crop duration in Cotton. Duration of each growth stage of Cotton with different dates of sowing, an Example:

Date of Sowing	Intervals of plant growth and development from sowing date to;			
	True leaf	Square	Flower	Open boll
Apr-01	27	74	98	156
Apr-15	25	68	89	145
Apr-29	23	63	81	141
May-13	19	56	75	133
May-27	18	50	71	135

Sunshine is vital to cotton and areas with more than 50% cloud cover is not suitable for cotton production.

As for moisture availability cotton requires at least 500 mm of water to grow a crop of minimum acceptable yield. Yield level is a function of water supply at successive growth stages when other factors are optimum. **With the adoption of drip irrigation, yields can be doubled with actual water use halved.**

Soil type and management:

Cotton can grow in any soil type. However highly clayey and very sandy soils are not suitable for high yields. The management of drainage is critical in clayey soils to avoid water saturation and lack of oxygen. Cotton roots stop functioning when soil oxygen falls below 10%. In sandy soils shorter water holding duration makes frequent small irrigations a necessity. Poor drainage in clayey soils also results in K deficiency even when soil K is sufficient. **Actually with drip irrigation both these types of soils can be put for cotton cultivation.**



Crop rotation:

In drip irrigated situation using the same drip line a high value crop like vegetables like Tomato, Chilly, Capsicum (short duration), banana (long duration) etc. can be taken up as rotation crops.

Seedbed preparation:

Soil should be plowed to a depth of 30-40 cm. Once in 3-4 years a sub-soiler should be used to loosen up to a depth of 70 cm. After plowing or discing a harrow should run to make the soil level and friable without clods. **In drip irrigated cotton, seed-beds should not contain any clods that will obstruct moisture movement.**

Sowing can be done on flat bed, ridges or on raised broad beds. Ridge or bed system will allow rapid soil drainage in heavier clay situations and maintenance of optimum temperature for germination, which is in the range of 15 to 42 oC. **By practising drip irrigation soil crusting can be prevented which acts as a barrier for seedling emergence.**

Cotton varieties:

- For irrigated Cotton production varieties from G. hirsutum or hybrids of G. hirsutum X G. hirsutum or G. hirsutum X G. barbedense are preferred for AP and southern states.
DCH-32, Varalaxmi, Savita, Suvin, HB 224, MCU 5 are ideal for AP.
- For Mungari (May end sowing);
Aravinda, Srisailam, Pandarpur Mundari.
- For Late Kharif (Sowing in August)
Raghavendra, Jayadhar, Narasimha, MCU 5, and LRA 5166. NHH 44, Nhh 390, JKHY-1.

Seeds:

Certified seeds should only be used. 1 to 1.2 kg seed per acre is recommended. Seed should be treated with Thiram @ 2g/kg seed.

Plant Spacing and drip line alignment:

The recommended spacing for drip irrigated Cotton is as follows: For heavy soils it is 3' x 6' x 3' (3200 plants/acre) and for light soils it is 2' x 6' x 2' (5000 plants/acre) as paired row to optimize the drip system cost. Extra seeds after planting should be used to raise polybag seedlings for gap filling.

The above spacing considers high canopy Indian hybrids. If Puma based varieties or Hybrids, which have low canopies are used the spacing between plants can be reduced to 1'(2' x 6 x 1') or (3' x 6' x 1'). Here also the space between paired rows is not reduced because of the restriction imposed by the lateral spacing which is also fixed at 1.82 m.

Planting season:

Actually Cotton can be grown in all three seasons.

- Kharif (June-July),
- Rabi (Sept.- Oct.) and
- Summer (Jan-Feb).

Rabi and Summer crops will give high quality lint. In irrigated cotton planting date is crucial. In case of delayed planting, the crop suffers increased pest attack and loss in yield.

Timely sowing is critical for cotton:

Summer crop will usually have less pest problems. Still sowing should be early as the temperatures will exceed 42 °C at boll opening time if sowing is delayed.

- Kharif- Sowing before June 10.
- Rabi- Sowing before September 5
- Summer- Sowing before Jan 5.

Irrigation Management:

Drip method of irrigation is most suitable for Cotton:

If water application method is precise and regular, an average of 4mm daily irrigation is sufficient for cotton. This precision is achieved by adopting quality drip system. **If drip is utilized properly precision irrigation can result up to 2.4kg lint/acre/mm water used. i.e 120 days irrigation with average 4mm daily will give about a ton lint per acre, provided manuring and fertigation are followed strictly as per schedule and an IPM approach is adopted for pest control.**

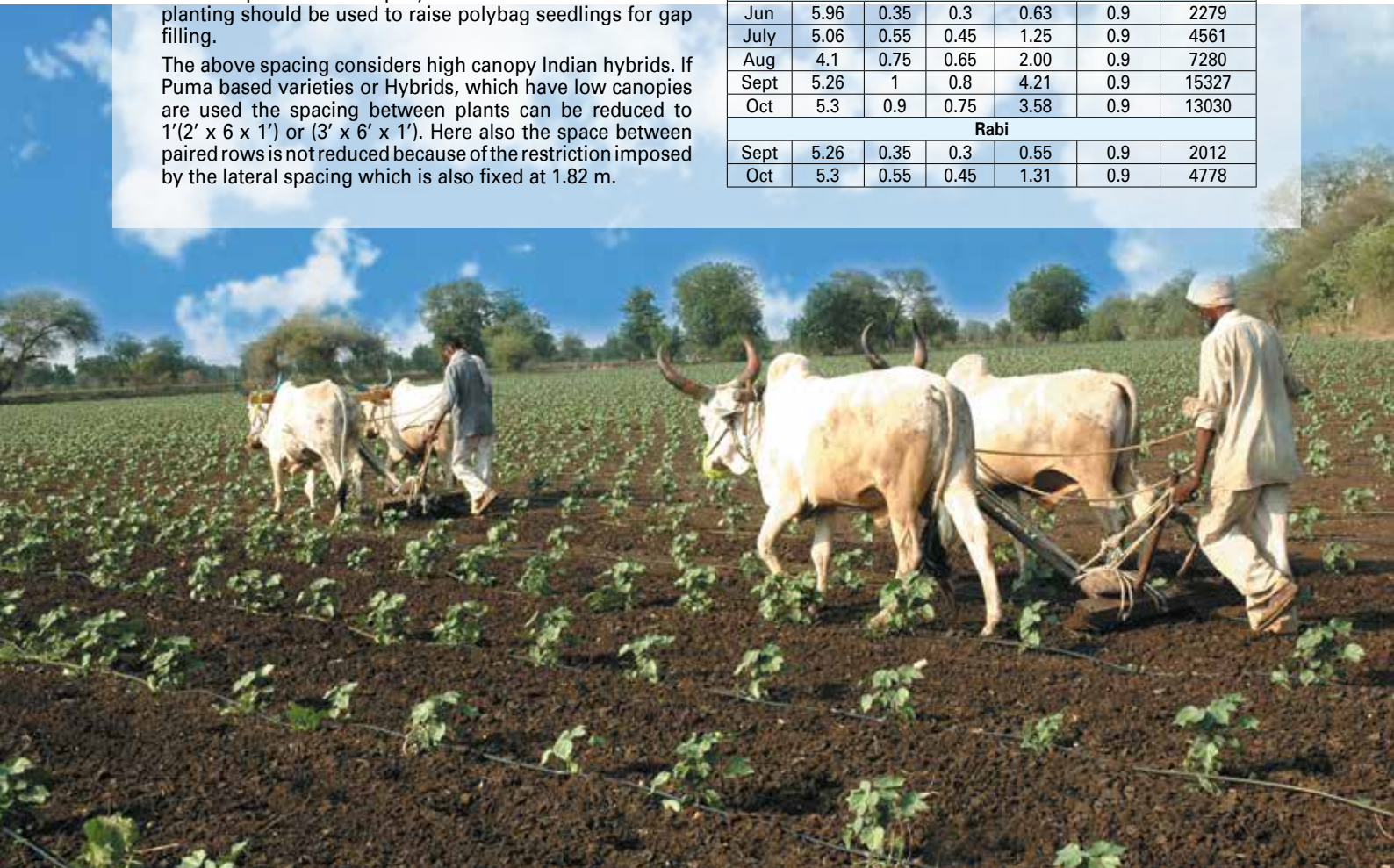
For seed germination the field should be kept just below field capacity by continuous operation of drip for 12-16 hours.

Irrigation Schedule:

As an example water requirement and irrigation requirement are worked out for one district using FAO data table for ETP and Crop factor.

Water requirement and irrigation schedule for drip irrigated Cotton:

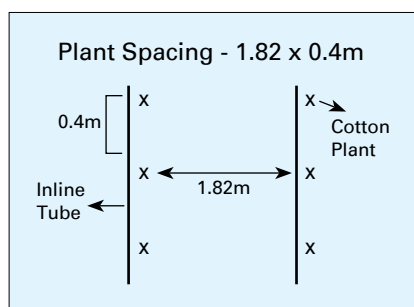
Season	Avg ETP mm/day	Crop Factor	Canopy Factor	Water requirement mm/acre	Irrigation Efficiency of Drip	Irrigation requirement l/acre/day
Kharif						
Jun	5.96	0.35	0.3	0.63	0.9	2279
July	5.06	0.55	0.45	1.25	0.9	4561
Aug	4.1	0.75	0.65	2.00	0.9	7280
Sept	5.26	1	0.8	4.21	0.9	15327
Oct	5.3	0.9	0.75	3.58	0.9	13030
Rabi						
Sept	5.26	0.35	0.3	0.55	0.9	2012
Oct	5.3	0.55	0.45	1.31	0.9	4778



Season	Avg ETP mm/day	Crop Factor	Canopy Factor	Water requirement mm/acre	Irrigation Efficiency of Drip	Irrigation requirement l/acre/day
Nov	4.63	0.75	0.6	2.08	0.9	7589
Dec	3.96	1	0.8	3.17	0.9	11539
Jan	4.35	0.9	0.75	2.94	0.9	10695
Summer						
Jan	5.26	0.35	0.3	0.55	0.9	2012
Feb	5.53	0.55	0.5	1.52	0.9	5539
Mar	6.54	0.75	0.7	3.43	0.9	12506
Apr	7.6	1	0.85	6.46	0.9	23529
May	8.26	0.9	0.8	5.95	0.9	21661

The rainfall events are very erratic and therefore not adjusted on a daily basis. The general recommendation is that if rain fall exceeds 10mm in any one day suspend drip irrigation for the next 3 to 4 days.

Drip layout and dripping schedule:



- | | |
|-------------------------------|--------|
| 1. Lateral to Lateral spacing | 1.82m |
| Dripper spacing | 0.40 m |
| 2. Total lateral /acre | 2230m |
| Total no. drippers/acre | 5575 |

Weeding and Interculture:

Timely weeding is essential as cotton growth will be affected by weeds. In a well prepared soil, use of drip irrigation will decrease weed germination as the wetted area is restricted. In the paired row system, the interspace between two pairs can be easily intercultivated by small implements.

Pre sowing soil incorporation of Basalin (Fluchloralin) @ 1.25-1.5 a. i. /ha is effective.

Apply Lasso (Alachlor) @ 1.5- 2.0 Kg a. i. /ha or Benthocarb



(Saturn) 2 1.5 kg a.i/ha or Pendamethlin (Stomp) 2 1.5- 2.0 kg a.i./ ha as pre-emergence spray.

Fertigation:

High yielding varieties of cotton require abundant quantities of nutrients. NPK and Mg are the major nutrients and Fe, B, S, and Zn are the microelements required by cotton.

Though the NPK doses are determined after a soil analysis, in general Cotton requires 50 kg N, 30 kg P, and 35 Kg of K per acre. But in high-tech cultivation the NPK can be varied based on the target yield to be achieved. Thus in drip irrigated crop N upto 120 Kg per acre; P up to 60 kg/acre; and K up to 100kg/acre when applied will improve the yield many fold.

Fertigation schedule:

- For normal fertilizer rates 50N: 30P: 35K per acre (Urea 116 kg; SSP 188 kg and 60 kg MOP)

Apply all SSP as soil basal dressing before planting . Use Urea ad MOP for fertigation.

5-30 days	20 kg Urea	7 kg /wk/acre for 3 weeks
	12 kg MOP	4 kg/wk/acre for 3 weeks
31-60 days	60 kg Urea	15 Kg/wk/acre for 4 weeks
	15 kg MOP	3.75 kg/wk/acre for 4 weeks
61-100 days	36 Kg Urea	12kg /wk/acre for 3 weeks
	33 Kg MOP	6.6 kg/wk/acre for 5 weeks

- For High-tech production use 120N:60P:100K per acre (Urea 280 kg; SSP 188 kg plus 58 kg Phosphoric Acid; and 167 kg MOP)

Apply all SSP as basal soil dose. Use Urea, Phosphoric acid and MOP for fertigation.

5-30 days	50 kg Urea	2kg /day/acre for 25 days
	20 kg MOP	1kg/day/acre for 20 days (10-30 days)
31-60 days	150 kg Urea	5kg/day/acre for 30 days
	50 kg MOP	1.7 kg/day/acre for 30 days
	45 kg H3PO4	1.5 kg/day/acre for 30 days
61-100 days	79 Kg urea	2kg/day/acre for 40 days
	97 kg MOP	
5-30 days	50 kg Urea	2kg /day/acre for 25 days
	20 kg MOP	1kg/day/acre for 20 days (10-30 days)
31-60 days	150 kg Urea	5kg/day/acre for 30 days
	50 kg MOP	1.7 kg/day/acre for 30 days
	45 kg H3PO4	1.5 kg/day/acre for 30 days
61-100 days	79 Kg urea	2kg/day/acre for 40 days
	97 kg MOP	2.4 kg/day/acre for 40 days
	13 kg H3PO4	1.3 kg/day/acre for the first 10 days.

Secondary and Micronutrients for Cotton production:

Addition of Ca, Mg, Iron , Boron and Zinc are required in locations where the soil shows deficiency of these minerals.

Pest and disease management:

Cotton production is often hampered by pests. Insect pests are more detrimental to cotton. The different diseases and insect pests and their control measures are listed in the following tables for ready reference and action in the field.

IPM measures for Cotton:

- Clean cultivation and destruction of crop residues (leaves, twigs etc.) before the onset of season.
- Plough deeply to expose the hibernating larve/pupae for predation.
- Practice early sowing that will help to escape the pest onslaught.

- Sun dry or hot water treatment of seeds up to 60 oC to kill any seed- borne larvae or fungi.
- Use tolerant variety of cotton.
- Control irrigation to reduce pest pressure. If drip is adopted it will help.
- Removal of reproductive parts (flower buds) during late season. Apply Chloroflurenol @ 1ml/l water to suppress formation of late flowers.
- Release egg parasitoids *Trichogramma chilonis* or larval parasitoids *Bracon gelechidae*, *B. greeni*, or *Chelonus pectinophorae*.
- Conserve the predators *Chrysoperla carnea* or *Scymnus sp.* or *Triphles tantilus* or release them in the fields.
- Use pheromone traps baited with insecticides to kill the pest.
- Apply bacterial formulations B.t.k. 21 kg/ha
- Do not use synthetic pyrethroids repeatedly.
- While spraying for sucking pests ensure that the spray reaches the lower side of the leaves.
- Do not grow Okra, Cucurbits, and solanaceous crops (Brinjal, Chilly etc.) near the cotton field.
- Compulsorily apply organic manure (FYM or Compost)@ 5t/acre and neem cake @ 1t/acre.
- Select high yielding, disease and pest tolerant hybrids.
- Prefer Rabi and Summer season for high-tech cultivation of cotton.
- Sow early in the season.
- Follow a planting pattern suitable for drip laying – Paired row method.
- Treat the seeds with fungicides before sowing.
- Irrigate with drip strictly following the schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ intercultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.
- Harvest on dry days. Store in dry cool place.

Benefits of Drip irrigation for Cotton :

- Increases yield upto 100%
- Reduces water used for irrigation up to 55%
- Allows uniform high % germination
- Drip is suitable for any type of seedbed- flat, ridges and furrows and bed and furrow.
- Helps in early planting which is a pre-requisite for IPM
- Allows for a Summer cotton crop (high quality lint)
- Early and uniform maturity
- Allows the user to control vegetative growth by precision irrigation and fertigation and increase flowering and boll formation.
- Controls weed growth as water is applied only to the root zone of cotton.
- Creates opportunity for high value rotation crops

Dos:

- Ensure good drainage in the field.
- Cotton field should not have any shading from trees or other structures.
- Adopt drip irrigation for irrigation.
- Compulsorily go for crop rotation.
- Prepare seedbed to fine tilth for good aeration and infiltration.

Don'ts:

- Don't over irrigate the crop at anytime except for germination.
- Don't cultivate co-host (Pigeon pea) for insects of cotton in or near the cotton field.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't make a fire near cotton field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Don't pick cotton when it is humid.

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