

## Advanced Techniques for Cultivation of Sugarcane

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Sugarcane (*Saccharum* spp.) is the world's most important sugar-producing crop and it belongs to the 'Poaceae' family of true grasses. It is a tropical and perennial grass which attains a length of about 10 to 20 feet. Globally, 60 per cent of white crystal sugar comes from sugarcane and 40 per cent from Sugar-beet. Sugarcane is grown in 101 countries world over in diverse agro-ecological conditions. Brazil is the largest producer of sugarcane in the world, which is just followed by India. India is one of the major producers of sugarcane and sugar in the world. In India, sugar industry is one of the largest processing industries, next to cotton textiles. There are around 450 sugar factories in India with an average milling days of 135. The annual product value of this crop is estimated at INR 5 billion. Sugarcane employs over a million people directly or indirectly besides contributing significantly to the national exchequer. It is the main source of sugar in India and holds a prominent position as a cash crop. Sugarcane is a very important commercial crop, which is the basic raw material for the manufacture of sugar.



**Table No. 1: The world's top 10 sugarcane producing countries**

Rank	Countries	Production of Sugarcane in 2019 (Tons)
1	Brazil	752,895,389
2	India	405,416,180
3	Thailand	131,002,173
4	China	109,388,100
5	Pakistan	66,880,011
6	Mexico	59,334,059
7	Colombia	32,662,952
8	Australia	32,415,352
9	Indonesia	29,100,000
10	Guatemala	29,087,086
<b>Source: FAOSTAT, 2021</b>		

**Export of Sugarcane from India:**

India is one of the largest producers of sugarcane in the world and of the leading countries for the export of sugarcane. India exported sugar to 60 countries, around 60 per cent of the total shipments were to Iran, Somalia, Malaysia, Sri Lanka and Afghanistan. The government allowed the export of 60 lakh tonnes of sugar under the Maximum Admissible Export Quota (MAEQ) in 2019-20 marketing year to liquidate surplus sugar in global markets. The country exported 38 lakh tonnes of sugar in 2018-19 marketing year.

**Table No. 2: The largest sugarcane-producing states in India**

S.N.	STATE	AREA (lakh hectares)	YIELD (tonnes/ hectare)	PRODUCTION (lakh tonnes)
1.	Uttar Pradesh	21.72	62.4	1,333
2.	Maharashtra	9.36	77.4	753
3.	Tamil Nadu	2.32	107	375
4.	Karnataka	4.10	84.6	346
5.	Andhra Pradesh	1.91	78	149

6.	Bihar	2.66	56.8	122
7.	Gujarat	1.80	65	95.3
8.	Haryana	1.30	73	93.4
9.	Punjab	0.96	70	66
10.	Uttarakhand	1.22	61.2	64.3

### Planting Time:

The best time of planting the sugarcane setts for spring crop is the period when the atmospheric temperature records an average of 25°C. Therefore, the time of sowing in Tamil Nadu, Andhra Pradesh, Maharashtra and Karnataka is earlier (December -January) than the time of sowing in Punjab, Haryana, Uttar Pradesh (February -March). The crop can be sown round the year. Crop planted before winter season gives less sprouting and tillers due to cold weather, during early sprouting stage.

### There are 3 main seasons in Maharashtra:

Season	Planting time	Spacing	Plant population per acre	Crop duration (in months)
Adsali	June to August	25 sq.ft in 5x5, 6x4, 7x3 or 7x3.5 pattern	1700 – 1900	18
Pre-seasonal	October to November	28 sq.ft in 7x4 pattern	2000 – 2400	15-16
Suru	January to February	5-10 sq.ft	6000 – 9000	12

### There are 4 main seasons in India:

Season	Planting time	Particulars
Spring	February to March	<i>Suru</i> in Maharashtra, <i>Eksali</i> in Gujarat & AP
Autumn	September to October	13-15 months, supplies sugar for early crushing
Adsali	July to August	<ul style="list-style-type: none"> <li>▪ 16-18 months</li> <li>▪ Increase in yield &amp; sugar recovery</li> </ul>

		<ul style="list-style-type: none"> <li>▪ Though advantageous area is declining due to water problem</li> </ul>
Late planting	beyond March	Reduction in duration and yield

**Seed Rate:**

- Seed rate is depending up on the spacing
- Spacing varies due to
  - Climate
  - Method of establishment

**Table No. 3: Recommended seed rate and row spacing in various states**

States	Seed Rate (Q/ha)	Spacing between row (cm)
Eastern U.P.	50-60	90
Bihar	50-60	90
West Bengal	50-60	65
Orisa	70-80	90
Assam	65-70	-
Western U.P. & Uttarakhand	50-65	90
Punjab	75-90	60
Haryana	100	60
Rajasthan	75	90
Madhya Pradesh	75	90
Gujarat	60-80	90
Maharashtra	60-80	90
Karnataka	60-80	90
Andhra Pradesh	60-98	90
Tamil Nadu	60-80	90

**Note: Higher seed rate could be used under moisture stress, salinity and water-logging conditions.**

**Improved Varieties**

- After the introduction of hybridization programme in early 20th century many improved varieties are available
- Varieties for region and season are available in plenty
- SBI, Coimbatore in collaboration with NARS has set up breeding programme

**Table No. 4: Salient characteristics of Sugarcane varieties released in India (central releases) -**

Name of variety	Year of release	Cane yield (t/ha)	Sucrose content (%)	Area recommended	Genetic research for yield quality	Other specific characteristics of the variety
Co 8371 (Bhima)	2000	117.7	18.6	PZ	Biparental crossing followed by clonal selection	Midlate, resistant to smut, moderately susceptible to red rot, tolerant to drought and water logging
Co 85004 (Prabha)	2000	90.5	19.5	PZ	Biparental crossing followed by clonal selection	Early, resistant to smut, moderately susceptible to red rot, good ratooner
Co 86032 (Nayana)	2000	102.0	20.1	PZ	Biparental crossing followed by clonal selection	Midlate, resistant to smut, field resistant to red rot, tolerant to drought, good ratooner
Co 86249 (Bhavani)	2000	104.2	18.7	ECZ	Biparental crossing followed by clonal selection	Midlate, resistant to smut and red rot, good ratooner

Co 87025 (Kalyani)	2000	98.2	18.3	PZ	Biparental crossing followed by clonal selection	Midlate, resistant to smut, field resistant to red rot, tolerant to drought and water logging
Co 87044 (Uttara)	2000	101.0	18.3	PZ	Biparental crossing followed by clonal selection	Midlate, moderately resistant to smut, moderately susceptible to red rot
Co 87263 (Sarayu)	2000	66.3	17.4	NCZ	Biparental crossing followed by clonal selection	Early, resistant to smut and red rot, resistant to early shoot borer, tolerant to drought and water logging
Co 87268 (Moti)	2000	78.9	17.5	NCZ	Biparental crossing followed by clonal selection	Early, resistant to smut and moderately resistant to red rot, tolerant to drought and water logging
Co 91010 (Dhanush)	2000	116.0	19.1	PZ	Biparental crossing followed by clonal selection	Midlate, resistant to smut, moderately susceptible to red rot, tolerant to drought
CoM 88121 (Krishna)	2000	88.7	18.6	PZ	Biparental crossing followed by clonal selection	Midlate, resistant to smut, tolerant to drought, excellent jaggery quality



Co Pant 90223	2000	73.3	18.5	NWZ	Open pollination followed by clonal selection	Midlate, moderately resistant to red rot, resistant to smut, tolerant to drought, water logging and cold, excellent ratooner
CoS 1230 (Raseeli)	2000	68.2	18.8	NWZ	Biparental crossing followed by clonal selection	Midlate, moderately resistant to red rot, tolerant to top borer, shoot borer and stalk borer
BO 128 (Pramod)	2001	69.2	17.6	NCZ	Biparental crossing followed by clonal selection	Midlate, moderately resistant to red rot and smut, tolerant to water logging and saline- sodic soil
Co 89029 (Gandak)	2001	70.6	16.3	NCZ	Open pollination followed by clonal selection	Early, moderately resistant to red rot, resistant to top borer and shoot borer, non- flowering, tolerant to drought and water logging.
CoH 2201 (Haryana- 92)	2001	70.0	18.2	NWZ	Open pollination followed by clonal selection	Early, moderately resistant to red rot

CoSe 92423 (Rajbhog)	2001	70.0	17.5	NCZ	Biparental crossing followed by clonal selection	Midlate, moderately resistant to red rot
CoSe 95422 (Rasbhari)	2001	67.8	17.7	NCZ	Biparental crossing followed by clonal selection	Early, moderately resistant to red rot
Co 94008 (Shyama)	2004	119.8	18.3	PZ	Biparental crossing followed by clonal selection	Early, moderately resistant to red rot, resistant to smut, tolerant to drought and salinity, good quality jaggery
CoS 94270 (Sweta)	2004	81.5	17.1	NWZ	Biparental crossing followed by clonal selection	Midlate, moderately resistant to red rot, tolerant to abiotic stress, excellent ratooner

<b>PZ</b>	Peninsular Zone	Chhattisgarh, Gujarat, Karnataka, Kerala, Maharashtra, interior Andhra Pradesh and plateau region of Tamil Nadu
<b>ECZ</b>	East Coast Zone	Orissa, coastal Andhra Pradesh and coastal Tamil Nadu
<b>NCZ</b>	North Central Zone	Bihar, West Bengal and Eastern Uttar Pradesh
<b>NWZ</b>	North West Zone	Haryana, Punjab, Rajasthan, Uttaranchal and Western and Central Uttar Pradesh

### Planting Materials:

#### Vegetative propagation -

- Known as seed pieces or setts



- Buds on sugarcane germinate and give plants

#### ***For sett planting...***

- Sugarcane setts are prepared from nursery cane
- Nursery cane is younger than (6-8 months) juice cane

#### **Ideal cane sett -**

Ultimate plant stands and yield depends on the type of seed material used. The characteristics of good seed cane material are

- Free from disease and pest infestation
- Age of seed crop is around eight months
- Setts should have healthy buds without any damage in handling and transport
- Buds with higher moisture content, adequate nutrients, higher amount of reducing sugars
- Cane should be free from aerial roots and splits
- Pure in quality

#### **Preparation of setts -**

- Use of sharp knife to cut setts
- Treat the setts immediately with fungicide solution
- Machine cutting and mechanical planting is also followed in developed countries

#### **Advanced Methods for Sugarcane Nursery Raising:**

##### **1. Single eye set (Chip-bud Method)**

- In this STP (Spaced transplanting) technique the bud along with a portion of the nodal region is chipped off using a bud chipping machine.
- Either direct sets or seedlings raised in polybag nurseries are transplanted into the field after 50-55 days.
- The bud chips are treated with fungicide and planted in the raised bed nursery or in polythene bags filled with FYM/press mud, soil and sand in 1:1:1 proportion.
- For this STP or single eyed set method 750-1MT seed per acre is required.
- For both furrow and flat method rows are made 90cm apart and settlings are spaced at 45–90cm.
- If any settlings fails to establish it is required to replace by the extra stock maintain in the nursery

- This method saves seed cost by 60-70%. In this method distance between two sets kept at 30cm.



### Single Eye Set Method

#### 2. Poly bag seedling transplanting

- This technique is also more or less same as STP technique.
- Here the seedlings are raised in perforated plastic bags of size 10x15 cm filled with FYM or press mud, soil and sand 1:1:1 proportion.
- In this technique field establishment of seedlings is better, around 95-99%, as there is no damage to the root system.
- In this method, a small pit is dug out at specified spacing (45cm).
- A small quantity of phosphatic fertilizer is placed and covered with some soil. Then the seedling is planted after clipping the green leaves.

#### 3. Tissue culture

- Micropropagation of seed cane through Tissue Culture technology is useful in developing large scale production of true to type and disease free sugarcane plantlets using apical meristem culture technique. Faster multiplication of a sugarcane variety can be done.

- Apical meristem (growing part of sugarcane) is dissected and inoculated on a growth medium having definite nutrient composition.
- The apical meristem starts producing tillers in the laboratory after about 45 days of incubation in temperature and light controlled conditions.
- one apical meristem one can develop millions of plantlets in a period of seven to eight months.
- The plantlets well established and hardened in plastic bags are transplanted to field condition.
- Apply 16.5 Kgs. of granular lindane per hectare in the soil after fifteen days of transplantation and irrigate the field. This helps in preventing early shoot borer infestation.
- If necessary main shoot may be removed 35-40 days after transplanting.
- The major earthing up needs to be done at 90-100 days after transplanting.
- A seed multiplication ratio of 1:25 (planting material for 25 hectares is obtained from one hectare seed nursery) is obtained from the seed nursery planted with tissue culture plantlets.
- The well hardened plantlets developed when used give 98 to 100 % survival under field condition.



**Raise 6-7 months old nursery crop prior to main field planting as follows:**

Raise nursery crop during	Main field planting
June	December - January (Early season)
July	February - March (Mid-season)
August	April - May (Late season)
Dec – Apr	June - September (Special season)

### Precautions In Maintaining Nursery Crop:

- Adopt similar production techniques for raising short crop with the following modifications.
- Do not de-trash
- Do not prop
- Harvest at 6 to 7 months age
- Remove trash by hand while preparing setts
- Avoid bud damage
- Transport the seed material to other places in the forms of full canes with trash intact.
- Apply 50 kg of urea as top dressing additionally before one month of cutting the seed cane.

### Measures to obtain higher germination:

- Using disease free healthy setts
- Careful preparation of setts without damaging the buds or setts
- Planting freshly prepared and treated
- Trash mulching under moisture stress and hot weather and late planted conditions
- Seed treatment using a fungicide

### Method of planting

Planting is the most important and labour-intensive operation in sugarcane cultivation. Sugarcane germination as well as yield is affected by planting material, layout, plant-population, method of planting and placement of bud etc.

#### 1. Flat Planting

- In this method, shallow (8-10 cm deep) furrows are opened with a local plough or cultivator at a distance of 75 to 90 cm
- There should be adequate moisture in the field at the time of planting
- The setts are planted in them end to end
- Furrows are covered with 5-7 cm soil
- In most parts of northern India and some tracts of Maharashtra, cane is planted by this method





## 2. Furrow Planting

- In this method furrows are made with a sugarcane ridger about 10-15 cm deep in northern India and about 20 cm in south India
- Setts are planted end to end
- The furrows are covered with 5-6 cm soil, leaving upper portion of furrows unfilled
- Immediately after covering the setts water is let into furrows
- This method is practiced in parts of eastern UP and in Peninsular India, particularly in heavy soils



## 3. Trench or Java Method

- In some coastal areas as well as in other areas where the crop grows very tall and the strong winds during rainy season cause lodging of cane, trench method is adopted to save the crop from lodging
- It is very common in Java, some coastal areas and in areas where the crop grows very tall and strong winds are blown.
- 'U' shape trenches are made. The depth of trench is kept 20-25 cm and line to line space is kept 75-90 cm.
- Fertilizers (NPK) are spread uniformly in the trenches and mixed thoroughly in the soil
- Setts are planted in these trenches or in small furrows prepared in the centre of trenches by end to end method.



- The tractor-drawn sugarcane planter is a very suitable device for planting cane in trenches

#### 4. Modified trench system

- Ridges and furrows are opened at 120 cm using a tractor drawn ridger
- The furrow bottom is widened
- As the crop grows while each manuring, only slight earthing up is done so that a trough is maintained through the crop growth



- Here irrigation is given in the cane row itself

#### The system has been found highly useful under:

- Saline water irrigated and saline soil conditions.
- The salts are leached down from the root zone.
- Higher cane yield compared to conventional ridges and furrows
- FYM or press mud application and trash mulching in this system can further improve cane yield.

#### 5. Single bud direct planting

- In this system single bud setts are planted directly in the field in the furrows at 30-45 cm spacing
- This method is highly economical and sowing of seed material.
- The buds should be healthy
- Transplanting technique (STP technique)
  - Seedlings are raised in a nursery bed using single bud setts.
  - About 6 weeks old seedlings are transplanted
  - Advantages by adopting this system are
- Saving in the seed cost
  - Only about 2-3 t/ha against the normal 8-10 tonnes/ha.



- Synchronous tillering leading to uniformly maturity
- Sufficient time availability to prepare the main field
- Saving of 2-3 irrigations
- Possibility of increased cane yield
- Better weed management and efficient fertilizer management



### 6. Partha method

- A technique developed by Mr. S.V. Parthasaradhy an eminent sugarcane scientist.
- Suggested for water logged or excess soil moisture conditions (coastal Andhra Pradesh and Tamil Nadu during N-E monsoon period)

In this method

- three eye budded setts are planted in a slanting position, 60° to the vertical, in the wet furrow or half-way on the ridges
- Usually, one eye bud is thrust into the soil and the remaining two will be above, which will sprout
- Once the monsoon recedes, the in situ sprouted setts are pressed down into the soil and made to lie horizontally
- Soil is put to the base
- At this stage, the crop is manured



### 7. Rayungan Method:

- It is the Indonesian term meaning-a developed cane shoot with single sprouted bud.
- A portion of field is selected for Rayungan production is left at harvesting time.
- Seed stalks are decapitated (topped off) about 4 to 6 weeks, before planting time.

- Lateral shoots developed into tailed Rayungan and they are cut off and planted out in the trench 30 cm deep trench.
- Vertical position is about 40-50 cm apart. At least 2-3 nodes must be underground.
- For quick and effective sprouting fertilizer especially nitrogen in heavy dose is applied and field is irrigated.
- It is costly hence is not commonly adopted in India however is usually used for filling gap.

### 8. Distant Planting Method:

- It was developed at Indian Institute of Sugarcane Research (IISR) Lucknow.
- In this method, single budded setts are planted in nursery @ 20 q/ha or 18000 setts/ha.
- After 45-60 days single budded setts are planted in the main field at a spacing of 90cm×50cm.



Pit Method of Sugarcane Planting

### 9. Pit Planting:

- This method is very popular in Tillah soil in Assam and also in Kerala hilly tracts.
- Pits are made at the interspacing of 20-30cm in rows along the contours with row to row spacing of 75 cm, organic manure is placed at bottom of the pits.
- Cane setts are placed in the triangle in pits and covered with soil.
- This system can be used in rainfed agriculture and very useful in conserving the soil.

### 10. Skip Furrow Planting:

- It is common in Orissa.
- It is hybrid of flat and trench method.
- In this method trenches are dug 45 cm apart and a gap of 90 cm is left after each two rows of cane.

### 11. Sabling or Sprouting Method:

- Plants are sown in fertile soil with wide spacing, shallow planting frequent irrigations and adequate fertilization.
- Tillers soon after they develop their own roots are separated from the mother plant and planted separately.
- It is very successful in Java and Cuba.

#### **12. Tjeblock Method:**

- Improved over Rayungan method because it takes care of proper availability of energy and nutrient to all the buds.
- Here stalks are cut off at its half-length and planted vertically with node in the soil for rooting.
- The planted ones and the mother stalks are adequately irrigated and fertilized.
- Now the upper buds of both Tjeblocks and mother cane, which sprout in due course of time, are planted by cutting them into setts, as Rayungans.

#### **13. Bud Transplanting:**

- Sugarcane buds with half of its stalk can be planted in small polythene sleeves filled with organic manure and soil and after they sprouted out, they can be transplanted in the main field.
- The polythene is tore at the bottom for the easy rooting.
- There is less mortality about 5 % only.

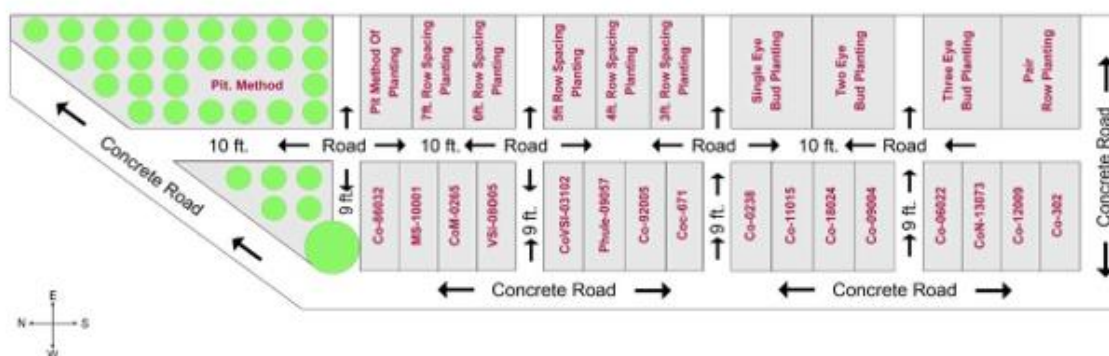
#### **14. Algin Method of Sugarcane Planting:**

- In this method, Upper most nodes are collected while striping the canes for crushing; then it is planted in wheat field in rows after every 4 rows of wheat at 90 cm × 50 cm.
- The method was developed by Allahabad Agriculture Institute, Allahabad.

Under the guidance of Dr. Sanjay D. Patil (Chancellor, DYP-ATU, Talsande) demonstration plots of 16 different varieties and 10 different cultivation methods have been developed by Er. Amol Gatade (Head, DYP Farm, Talsande) at University Experimental field; covering total of 1.5 acres of area. The said plots are made available to the students of DYP campus for study, research and visiting farmers from the area.

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### LAYOUT OF SUGARCANE VARIETY PLANTING PLOT



#### Special Cultural operations:

Important cultural operations in sugarcane in addition to weeding, manuring and irrigation are

#### 1. Earthing-Up

Earthing up are 2-3times during crop period.

- The first earthing-up is known as "partial earthing-up and
  - To cover the fertilizers
  - To provide anchorage to root system
- The second operation is "full earthing-up".
  - Full earthing-up is done after final manuring (90-120 days coinciding with peak tillering)
  - The soil from the ridge is thrown on both sides towards cane rows and the furrows will become as ridges and ridges as furrows
  - The furrows so formed are used for irrigation

#### 2. Wet earthing up

- Done around 6 months age of the crop
- The furrows are irrigated and the wet soil from furrows is taken and plaster the ridges
  - It checks late tillering and watery shoots
- Heavy earthing up is useful during floods



- When the flood water recedes, the excess water from earthed-up soil drains out quickly thus providing aeration



### **Earthing up in Sugarcane**

#### **3. Hoeing**

- This operation is done where soil crust formation is very common
- In sub tropics hoeing is done after germination is over using a bullock drawn or a tractor - drawn harrows

#### **4. De-trashing**

- On an average a stalk may produce 30-35 leaves
- All are not useful for effective photosynthesis
  - Only the top 8-10 leaves are sufficient
  - Most of the bottom leaves are dried will not participate in photosynthesis
  - At the same time, they drain out the food materials which otherwise could be used for stalk growth
- Therefore, it is important to remove the dry and lower leaves
- This operation is known as de-trashing
- De-trashing helps in clean cultivation
- Easy movement of air within the crop canopy
- Reduce certain pests like scales mealy bugs, white fly etc.,
- Easy entry into the field
- Avoids bud germination due to accumulation of water in the leaf sheath

- Easy to take up cultural operations including sprayings
- Easy to harvest, obtaining clean canes for milling
- De-trashed leaves can be used for...
  - Mulching in the furrows or
  - Used for composting
  - Infested leaves with pest or disease may be burnt out

### **5. Propping**

- Tying the canes by using the lower bottom leaves to check lodging of cane
- Propping can be either done for each row or two rows can be brought together and tied
- It is for:
  - Prevention the lodging
  - Extensively followed in coastal belt where cyclone effect is very severe
  - Lodging also very common in
    - Tall varieties
    - Top growth is heavy and where the growth habit is not erect, and
    - The varieties with less fibre content

### **Lodging leads to several problems**

- Cane breakage and thus loss of stalk number at harvest loss
- Lodged canes are easily infested by certain pests and diseases
- Damage by rats and rodents
- Bud sprouting leads to reduced cane quality
- Aerial root formation affects cane quality
- difficult to irrigate and harvest the cup

### **To prevent lodging**

- Heavy earthing up
- Propping
- Paired row planting with earthing up
- Deep trench planting
- Selection of varieties resist lodging
- Raising wind breaks along the field borders
- Application of potassium





### De-trashing and Propping in Sugarcane

#### 6. Removal of water shoots

- Water shoots are late formed tillers or side shoots which are robust and fast growing.
- They originate mainly due to excess water supply, heavy and late manuring, inadequate earthing up
- These water shoots contain lot of water, low sucrose and more of reducing sugars
- Water shoots affect the growth of adjacent stalks
- They harbor insect pests and when they are milled sugar recoveries are low because of reduced juice quality
  - Therefore, removal of water shoots whenever they appear
  - Water shoots can be used as cattle feed



#### 7. Control of flowering

- In commercial sugarcane cultivation, flowering is not desirable
- Once the plant flowered the cane growth stops and starts ripening
- If not harvested immediately reversion of sugars, increase in fibre, pith formation, cane breakage etc.

- The deterioration is much faster if it is summer
- Solution
  - Non-flowering or shy flowering varieties can be used where flowering is a severe problem
  - Controlled irrigation
  - Change of planting period
  - Use of growth regulating substances
    - Spraying of ethrel at 500ppm, twice or 1000ppm once at floral initiation



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