

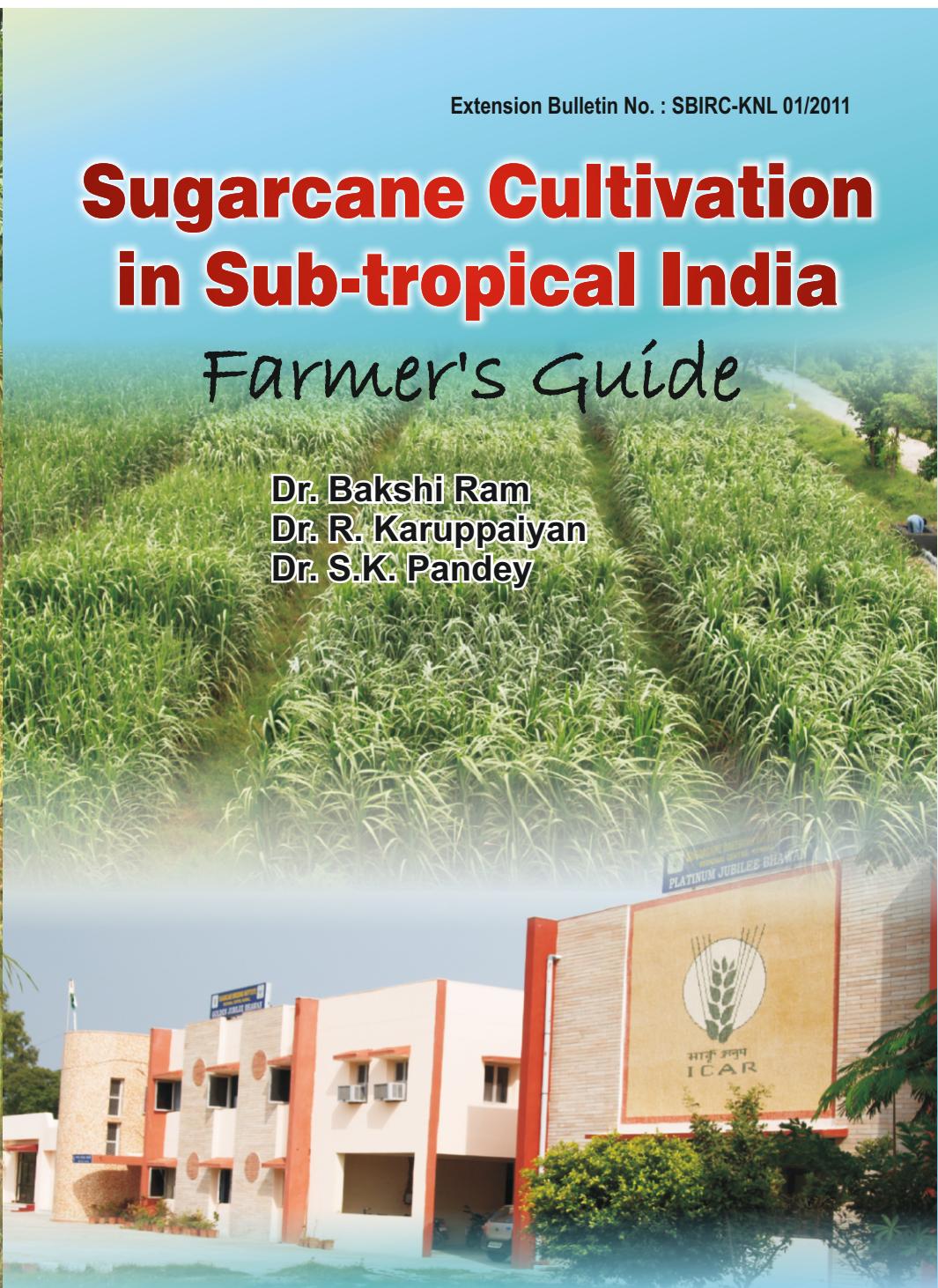
# Sugarcane Cultivation in Sub-tropical India

## Farmer's Guide

Dr. Bakshi Ram

Dr. R. Karuppaiyan

Dr. S.K. Pandey



**Sugarcane Breeding Institute**  
(Indian Council of Agricultural Research)  
Regional Centre, Karnal-132001



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Published by : Dr. N. Vijayan Nair  
Director  
Sugarcane Breeding Institute  
Coimbatore-641 007, Tamil Nadu

### **For further information contact :-**

Dr. Bakshi Ram  
Head  
Sugarcane Breeding Institute  
Regional Centre, Karnal-132 001 (Haryana)  
Phone: 0184-2268096, 2265567-20  
Fax: 0184-2265723  
Email: [headsbirc@dataone.in](mailto:headsbirc@dataone.in)



## PREFACE

Sugar is produced commercially in 114 countries from two different sources, sugarcane and sugar beet. Both the crops produce identical refined sugar. Sugar beet is grown in temperate countries whereas sugarcane in semi-tropical countries. Cane sugar accounts for 79.8% of world's crystal sugar production whereas beet sugar accounts 20.2%. In India, sugar is produced from sugarcane alone. Sugar is an essential commodity and has great demand throughout the world. The world sugar production during 2010-11 is estimated at 174 million tonnes whereas sugar consumption during the period was 172 million tonnes, resulting in surplus of 2 million tonnes. The leading sugar producers in the globe are Brazil (41.06 million tonnes), India (18.91 million tonnes), EU (17.38 million tonnes) and China (13.36 million tonnes). India ranks 2<sup>nd</sup> in sugarcane area and production after Brazil, contributing 14-15% world white sugar production. In 2010-11 India's white sugar production has reached 18.91 million tonnes, *gur* and *khangsari* 5.92 million tonnes, molasses 8.4 million tonnes, export of white sugar 2 lakh tonnes and import 42 lakh tonnes. Sugar consumption rate is the highest in India. At present, the per capita consumption is 23 kg (sugar 17 kg + *gur* and *khangsari* 5 kg), amounting to the tune of 21 million tonnes.

The sub-tropical region of India, despite covering 59.60% of sugarcane area in the country (mean of 2001-2011) contributes only 49.33% of sugarcane production and 36.98% of white sugar production. The low sugarcane production in this region could be attributed to low productivity (51.82 t/ha in the sub-tropical States (mean of 2001-2011) vs. 71.91 t/ha in tropical States) and low sugar output to low sugar recovery (8.97% in the sub-tropical States vs. 9.76% in tropical States) both of which could be attributed to extremes of weather prevailing in the region. From April to June, the sub-tropical weather is very hot and dry and from December to January the weather is very cold touching zero degree and often combined with frost. Therefore, the active growth of sugarcane is restricted to hardly 4 or 5 months, resulting in poor stalk yield and low sugar recovery.

Notwithstanding the extremes of sub-tropical weather, there are instances in this region where farmers are obtaining as much as 450-650 quintals cane yield per acre by adopting improved package of practices. There are also instances of improvement in sugar recovery in U.P., Punjab and Haryana by increasing the area under early maturing varieties. All these have clearly indicated that even with the currently available production technologies it is possible to increase the sugarcane productivity and sugar recovery from the present level. The need of the hour is to disseminate those farmers friendly production technologies generated in various research institutions to the farmers. In this endeavour, the scientists at the Sugarcane Breeding Institute, Regional Centre, Karnal has brought out a manual on sugarcane production for the benefit of farming communities in the sub-tropical region of India. I hope the manual will be useful to the farmers and extension personnel and I congratulate the authors for their efforts.

N. Vijayan Nair  
Director  
Sugarcane Breeding Institute  
Coimbatore-641 007

## Sugarcane Breeding Institute Regional Centre Karnal-At a Glance

The Regional Centre of Sugarcane Breeding Institute (SBIRC) of the Indian Council of Agricultural Research (ICAR) is located at Agarsen Marg, near Model Town in Karnal (Haryana). It is one of a premier sugarcane research stations in India, established in 1932 with the funds provided by the then Imperial Council of Agricultural Research (now the ICAR, Ministry of Agriculture, New Delhi). Between 1932 and 1935, elites clones selected at Coimbatore (Tamil Nadu) were supplied to the Karnal Centre for evaluation under sub-tropical condition. Varieties such as Co 205, Co 285, Co 312, Co 341, Co 356, Co 419, Co 975, Co 1148, Co 1158 and Co 6425 were the result of such efforts and were recommended from the SBI Karnal Centre for commercial cultivation in the sub-tropical India. Subsequently, the activity of the Centre have been broadened from mere evaluation of clones to undertaking full fledged breeding programme.

The first variety bred at this Centre, CoK 26 (CoK stand for Coimbatore-Karnal) was released during 1940 for commercial cultivation in the sub-tropical region. This variety has occupied fairly large area in Uttar Pradesh. Three years later, another variety CoK 30 was released. It performed well in Punjab and Central Uttar Pradesh. In 1946, CoK 32 was released which then occupied a sizeable area in Bihar. During 1950-51, CoK 41 was released for Punjab, Bihar and Uttar Pradesh. As the SBI RC Karnal is being a part of the Sugarcane Breeding Institute, Coimbatore, sugarcane varieties released from Karnal Centre after 1961 is bearing prefix 'Co' instead of 'CoK'. Between 1960 and 1970, four varieties namely, Co 1328, Co 1341, Co 62399 and Co 6618 were released. The release of Co 7717 in 1978 was a landmark in the history of this Centre. This variety became popular among the farmers of Haryana in a short period. Whosoever grew the variety was getting assured return. By virtue of its high yield farmers described this variety as कर्जा पाड़ किरस (variety for prosperity). Co 89003, a selection from the cross Co 7314 x Co 775 was found to give 31-42% improvement in cane yield and 3.56-5.56% improvement in sucrose% over CoJ 64. Therefore, Co 89003 was recommended for commercial cultivation in Punjab in 1997 and Haryana in 2001.

At present the mandates of the Centre are:

1. To conduct inheritance studies in sugarcane varietal crosses, sugar yield components, biotic and abiotic stresses in sub-tropical climatic condition.
2. To evaluate sugarcane germplasm under sub-tropical condition and to identify potential donors for biotic and abiotic stresses, yield and juice quality.
3. To evaluate sugarcane varieties for the sub-tropical condition of the country.
4. To produce breeder seed of elite sugarcane varieties for supplying to sugar mills and farmers.

The latest varieties from the Centre are Co 98014, Co 0118, Co 0238, Co 0239 and Co 0124. Of these Co 98014, Co 0118, Co 0238, Co 0239 were high sugared, high yielding and early maturing varieties while Co 0124 is a midlate variety. These varieties were released by the Central Variety Release Committee for commercial cultivation in North Western Zone (Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan). About 2500-3000 quintal seeds of these varieties are being produced per annum for sale among farmers and sugar mills in the Zone. Seeds are sold during October and during February-March. The Head of this Centre may be contacted to reserve seed canes (Phone: 0184-2268096 Fax: 0184-2265723; email: headsbir@dataone.in). Apart from breeding sugarcane varieties, the Centre is also engaged in developing and standardizing sugarcane cultivation technologies befitting to the sub-tropical soil and climate. A glimpse of farmers friendly sugarcane production technologies are presented in the manual for the benefit of farming community.

# Varieties

## Co 89003

- Co 89003 is a **high sugared high yielding early maturing clone**, selected from the progeny of the cross Co 7314 x Co 775 at Sugarcane Breeding Institute, Coimbatore and tested at Sugarcane Breeding Institute, Regional Centre, Karnal
- Due to high sugar and high yield, Co 89003 was recommended for commercial cultivation in Punjab in 1997 and Haryana in 2001
- Co 89003 has medium thick greenish yellow canes. Sheath splitting is common. Bud groove is prominent and is extended to 3/4<sup>th</sup> or even entire length of internodes. The clone is free from spines, splits and pith.
- Co 89003 has about 11% fibre. The jaggery is of golden yellow colour of A1 grade.
- It is a soft cane and hence also suitable for chewing.
- Co 89003 showed 31% and 42% improvement of cane yield over CoJ 64 during autumn and spring, respectively. The improvement for sucrose% over CoJ 64 was 3.56% during autumn and 5.56% during spring season.
- Co 89003 gives good ratoon.
- Co 89003 is moderately resistant to the prevalent races of red rot pathogen. However, it is susceptible to wilt disease. The wilt infection in Co 89003 is associated with root borer and termite infestations. Therefore, the disease can be minimised by applying Chlorpyrifos @ 2 litre/acre at the time of planting /ratooning as well as during August.



Performance of Co 89003 at SBI, Regional Centre, Karnal

Parameters	Autumn Season		Spring Season	
	Co 89003	CoJ 64	Co 89003	CoJ 64
Cane yield (t/ha)	90.48	68.81	69.55	49.09
% increase over CoJ 64	31.49		41.68	
Sugar yield (t/ha)	10.28	7.40	9.50	6.29
% increase over CoJ 64	38.92		51.03	
Sucrose %	16.60	16.03	19.56	18.53
% Increase over CoJ 64	3.56		5.56	



## Co 98014

- Co 98014 (*Karan 1*) is an **early variety** bred at the Sugarcane Breeding Institute, Regional Centre, Karnal from the cross Co 8316 x Co 8213.
- Co 98014 was released in 2007 by the Central Varietal Release Committee for commercial cultivation in North Western Zone (NWZ) comprising States of Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan.
- Co 98014 is a very tall, medium thin cane bearing greenish yellow canes with cylindrical internodes and long lanceolate auricle. The clone is free from leaf sheath spines, splits and pith formation.
- Leaf tip drying is common during summer months and farmers need not worry about it.
- The fibre content is about 14%. The jaggery is of brown colour (B grade).
- This variety is moderately resistant to the prevalent races of red rot pathogen. Co 98014 has hard rind hence less damaged by insect pests and non-insect pest like rat, wild animals, etc.
- This variety is suitable for normal environment, less fertile soil and water logging conditions. It gives comparatively good ratoon under these conditions and even when harvested during winter.
- Co 98014 gives 22% higher cane yield and 8% higher sugar yield than CoJ 64.



Performance of Co 98014 in All India Coordinated trials conducted in NWZ

Parameters	Co 98014	CoJ 64	CoPant 84211
Cane yield (t/ha)	76.29	62.71	67.75
% increase over checks		21.66	12.94
Sugar yield (t/ha)	9.26	7.90	8.31
% increase over checks		17.22	11.43
Sucrose %	17.59	18.18	17.98
% Increase over checks		-3.24	-2.17



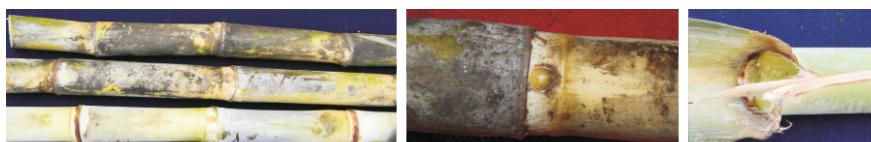
## Co 0118

- Co 0118 ([Karan 2](#)) is a **high sugared early variety** bred at the Sugarcane Breeding Institute, Regional Centre, Karnal from the cross Co 8347 x Co 86011.
- Co 0118 was released in 2009 by the Central Varietal Release Committee for commercial cultivation in North Western Zone (Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan).
- It is a tall, medium thick variety bearing grey purple cylindrical to obconoidal internodes. It bears self de-trashing type of leaf sheath. Bud shape is oval to obovate. Inner auricle is long lanceolate while outer is shorter. Leaf sheath has spines but stalk is free from splits and pith.
- The fibre content is about 12.78%. The jaggery is of A-1 quality (light yellow colour).
- Co 0118 is moderately resistant to the prevalent races of red rot and is a substitute for CoJ 64.
- Co 0118 has recorded 15% higher cane and sugar yields and 3.7% higher sucrose over CoJ 64.
- In the All India Co-ordinated Research Project trials conducted in North Western Zone (NWZ), Co 0118 has ranked 3<sup>rd</sup> in the zone for cane yield, sugar yield and sucrose % in juice.
- The performance of Co 0118 was better than the ruling standards under water stress and water logging conditions.
- It requires less Nitrogen than those required for CoS 8436. Co 0118 gives good ratoon yield and showed better sprouting even when harvested during winter.



**Performance of Co 0118 in All India Coordinated trials conducted in NWZ**

Parameters	Co 0118	CoJ 64	CoPant 84211
Cane yield (t/ha)	78.20	67.59	66.84
% increase over checks		15.70	17.00
Sugar yield (t/ha)	9.88	8.59	8.28
% increase over checks		15.01	19.32
Sucrose %	18.45	17.90	17.65
% Increase over checks		3.07	4.53



## Co 0238

- Co 0238 ([Karan 4](#)) is a high yielding, high sugared early variety bred at the Sugarcane Breeding Institute, Regional Centre, Karnal from the cross CoLk 8102 x Co 775. It was released in 2009 by the Central Varietal Release Committee for commercial cultivation in North Western Zone (Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan).
- It is a tall, medium thick variety bearing grey brown cylindrical internodes. It bears self de-trashing type of leaf sheath. Shallow bud groove is present. The stalk is free from spines, splits and hollow pith but spongy pith can be seen under water stress conditions.
- Leaf tip drying (sun scaled injury) is common during summer months. Farmers need not worry about it.
- The fibre content is about 13.05%. The jaggery is of A-1 quality with light yellow colour.
- Co 0238 is moderately resistant to the prevalent races of red rot and is a better substitute for CoJ 64. Top borer management is essential for this variety.
- In comparison with CoJ 64, Co 0238 showed 20%, 16% and 0.50% improvement of cane yield, sugar yield and sucrose %, respectively.
- In the All India Co-ordinated Research Project trials conducted in North Western Zone, Co 0238 has ranked 1<sup>st</sup> for cane yield, 2<sup>nd</sup> for sugar yield and 5<sup>th</sup> for sucrose % in juice in the zone.
- The performance of Co 0238 was better than the ruling standards under water stress, water logging and saline conditions.
- Co 0238 requires less Nitrogen than those required for CoS 8436. Co 0238 gives good ratoon yield and showed better sprouting even when harvested during winter.



**Performance of Co 0238 in All India Coordinated Trials conducted in NWZ**

Parameters	Co 0238	CoJ 64	CoPant 84211
Cane yield (t/ha)	81.08	67.59	66.84
% increase over checks		19.96	21.30
Sugar yield (t/ha)	9.95	8.59	8.28
% increase over checks		15.83	20.17
Sucrose %	17.99	17.90	17.65
% Increase over checks		0.50	1.93



## Co 0239

- Co 0239 ([Karan 6](#)) is a **high sugared early variety** selected from the progeny of Co 93016 GC at the Sugarcane Breeding Institute, Regional Centre, Karnal.
- Co 0239 was released in 2010 by the Central Varietal Release Committee for commercial cultivation in North Western Zone (Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan).
- Co 0239 bears medium thick greenish purple canes, obconoidal internodes, shallow bud groove, oval to rhomboid buds, lanceolate auricle and spines on leaf sheath. The clone is free from splits, pith and bud cushion.
- The fibre content is about 12.79%. The jaggery is of A-1 quality with light yellow colour. This variety is moderately resistant to the prevalent races of red rot.
- This clone was evaluated under All India Co-ordinated Research Project in the North Western Zone. It ranked 1<sup>st</sup> for sugar yield, 2<sup>nd</sup> for cane yield and 4<sup>th</sup> for sucrose % in juice in the zone.
- In comparison to the check CoJ 64, it showed about 17%, 21% and 3.8% improvement in cane yield, sugar yield and sucrose % in juice, respectively.
- Co 0239 gives fairly good ratoon.



**Performance of Co 0239 in All India Coordinated Trials conducted in NWZ**

Item	Co 0239	CoJ 64	CoPant 84211
Cane yield (t/ha)	79.23	67.59	66.84
% increase over checks		17.22	18.54
Sugar yield (t/ha)	9.88	8.59	8.28
% increase over checks		20.72	25.24
Sucrose %	18.45	17.90	17.65
% Increase over checks		3.80	5.27



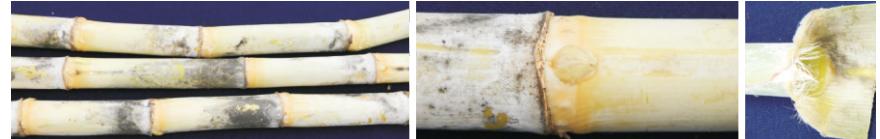
## Co 0237

- Co 0237 ([Karan 8](#)) is a **high sugared early variety** selected from the progeny of Co 93016 GC at the Sugarcane Breeding Institute, Regional Centre, Karnal.
- Co 0237 was identified in 2010 by the Varietal Identification Committee of All India Coordinated Research Project (Sugarcane) for commercial cultivation in North Western Zone (Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan).
- Co 0237 bear medium thick yellow canes with cylindrical internodes, ovate buds, small lanceolate auricle, bud cushion and deep bud groove. The clone is free from splits and spines on leaf sheath. Arrangement of root primordial is regular (generally single row).
- The fibre content is about 12.98%. The jaggery is of A<sub>1</sub> quality with light yellow colour. This variety is moderately resistant to the prevalent races of red rot.
- This clone was evaluated under All India Co-ordinated Research Project in the North Western Zone. It ranked 1<sup>st</sup> for sucrose % in juice, 4<sup>th</sup> for sugar yield and 5<sup>th</sup> for cane yield in the zone.
- In comparison to the check CoJ 64, it showed about 5.53%, 8.73% and 4.92% improvement in cane yield, sugar yield and sucrose % in juice, respectively.



**Performance of Co 0237 in All India Coordinated Trials conducted in NWZ**

Item	Co 0237	CoJ 64	CoPant 84211
Cane yield (t/ha)	71.33	67.59	66.84
%increase over checks		5.53	6.72
Sugar yield (t/ha)	9.34	8.59	8.28
% increase over checks		8.73	12.80
Sucrose %	18.78	17.90	17.65
% Increase over checks		4.92	6.40



## Co 05011

- Co 05011 ([Karan 9](#)) is a **high yielding midlate variety** selected from the progeny of the cross CoS 8436 x Co 89003 at the Sugarcane Breeding Institute, Regional Centre, Karnal.
- Co 05011 was identified in 2011 by the Varietal Identification Committee of All India Coordinated Research Project (Sugarcane) for commercial cultivation in North Western Zone (Haryana, Punjab, Western and Central U.P., Uttarakhand and Rajasthan).
- Co 05011 is erect growing medium thick cane with cylindrical internodes. The colour of internode exposed to sun is purple but unexposed internode colour shall be greenish yellow. Co 05011 has round buds, incipient auricle, internode is having small corky patches and feeble ivory markings. The clone is generally free from splits and spines on leaf sheath. But these traits can be seen in few canes.
- The fibre content is about 12.75%. This variety is moderately resistant to the prevalent races of red rot.
- This clone was evaluated under All India Co-ordinated Research Project in North Western Zone. It ranked 2<sup>nd</sup> for sugar yield and 3<sup>rd</sup> for cane yield and sucrose% in the zone. The average cane yield of Co 05011 was 82.47 t/ha. In comparison to the check CoS 767, it showed 13.75% improvement in cane yield, 3.99% improvement in sucrose% and 18.24% improvement in commercial cane sugar yield.



Item	Co 05011	CoS 767	CoS 8436
Cane yield (t/ha)	82.47	72.50	62.15
%increase over checks		13.75	32.70
Sugar yield (t/ha)	10.24	8.66	7.88
% increase over checks		18.24	29.95
Sucrose %	18.00	17.31	18.15
% Increase over checks		3.99	-0.83



## SEED PRODUCTION

**Seed standards:** The seed cane should have 100% genetic purity and 98% physical purity. Germination should not be less than 85%. Each node of seed cane shall bear one viable bud. The node without bud should not exceed 5% of the total buds in a cane. The number of buds which have swollen or projected beyond 1 cm from the rind surface should not exceed 5%. The seed cane should not have more than 10% lodged canes and should not have nodal roots except 5% permissible under water logged conditions. The seed crop should be free from designated diseases and pests.

**Seed Nursery Programme:** To maintain the genetic purity, seed health and quality, each sugar mills is expected to follow a three-tier seed nursery programme consisting of primary seed nursery, secondary seed nursery and commercial nursery. The primary nursery is maintained in the sugar mill farm itself. To raise primary nurseries, use the breeder seeds obtained from the research stations after Moist Hot Air Therapy (54 °C for 1 hr) + Carbendazim (0.1%). The crop should be given good management. Give higher dose of FYM and fertilizers. Planting of setts at closer spacing (60-75 cm wide) is expected to give higher plant population. Adopt 25% higher seed rate at primary nursery to compensate germination losses due to heat treatment. Inspect the nursery at 3 times i.e. 45-50, 120-130 days after planting and 15 days prior to harvest. Rogue out the diseased, infested plants and off-types. Harvest the crop at 6-12 months and distribute the seed canes to selected farmers for raising secondary seed nurseries under the supervision of an expert. Once heat treated at primary nursery, the seed will be free from grassy shoot disease (GSD) and ratoon stunting disease (RSD) for about 5 years. Therefore, a well planned programme such as dividing the mill zone area into 5 sectors and seeds in each sector is replaced every year so that the entire zone is covered in 5 years. The secondary seed nurseries are maintained like primary nursery. Harvesting of seeds is taken up at the age of 8-12 months and distributed to farmers for raising commercial seed nurseries. Commercial nurseries are also maintained and monitored like primary and secondary nurseries. Seed can be harvested after 6 months and continue till 12 months. The multiplication rate is 6-8 times.

### Tips for raising disease free vigorous commercial seed nurseries

**Growing condition:** Seed crop should be raised under ideal condition and under optimum environment. Avoid late planting and planting in problematic soils.

**Seed treatment:** One of the major objectives of seed production programme is to eliminate setts borne diseases like RSD and GSD. Therefore, seed cane should be treated in Moist Hot Aerated Therapy unit.

**Age of the crop:** Obtain setts from 8-10 month old crop. If the setts are to be taken from mature crop, use top 1/3<sup>rd</sup> portion of cane.

**Planting time:** Feb-April.

**Fertilizers:** 60: 20:20 kg NPK /acre. A faster growth is essential in the early stage. So apply full P & K at basal, N in 3 equal splits at 30, 60 and 90 days after planting. In addition, pre-fertilization 6-8 weeks prior to harvest with 20 kg Nitrogen /acre may be adopted to obtain healthy seeds with more moisture and higher reducing sugars.

**Plant protection:** Same as normal crop.



# PRODUCTION TECHNOLOGIES

## PACKAGE OF PRACTICES

### Planting Time

- Spring season : Mid February to end of March.
- Autumn season : Last fortnight of September to first fortnight of October.

### Row to Row spacing

- 75 cm in less fertile soil, late planting and under drought condition.
- 90 cm in fertile soil and under spring season.
- 120 cm during autumn season along with intercrops.

**Seed Rate:** At 90 cm row to row spacing and @ 12 setts /meter long row, seed requirement per acre would be 35-45 quintals.

Single budded setts (12 setts/meter)	: 53,000-53,500 setts /acre
Single budded setts (end to end)	: 31,000-31,500 setts/acre (40-50% seed saving)
Two budded setts (end to end)	: 26,500-27,000 setts/acre
Three budded setts	: 17,500-18,000 setts/acre

### Sett treatment

- Always use disease free quality setts for planting.
- Treat the setts for 5 minutes in 0.1% Carbendazim (100 g in 100 litre of water) before planting
- Seed crop: Treat the setts in Moist Hot Aerated Therapy unit at 54°C for 1 hr.

### Manures

Apply FYM or compost @ 4-5 tonnes /acre. Grow green manure crop like Dhaincha (13 kg seed /acre) or green gram (6 kg seed/ acre) before taking sugarcane and incorporate *in situ* using tractor drawn disc harrow. Soil application of *Azospirillum* or *Glucanoacetobacter* @ 4 kg/acre+*Phosphobacteria* @ 4 kg/acre in two split doses at 30 and 60 days after planting.

### Fertilizers

Apply fertilizers as per soil test report or State Govt. recommendation or follow blanket dose of 60: 20:20 kg NPK /acre for plant crop and 90: 20: 20 kg NPK/acre for ratoon.

- Apply 50 kg DAP and 33 kg MOP /acre before planting in furrows.
- Apply 50 kg urea/acre at 45 days after planting.
- Apply 50 kg urea/acre at 90 days after planting and give earthing up.

### Weed management

- Repeated ploughing before planting sugarcane and crop rotation with paddy would minimize weed problem. In highly weed infested area irrigate the field (or submerge) after ploughing. The weeds emerged out are got killed by spraying Paraquat @ 2.5 ml/litre water (non-selective contact herbicide). If the perennial weeds like Haryali grasses (*Cynodon*) and mothia (*Cyperus*) are

emerging spray Glyphosate (non-selective systemic herbicide) @ 2.5 ml/litre water instead of Paraquat.

- Immediately after planting apply pre-emergence herbicide Atrazine @ 2 kg/acre in 350-400 litre water. If vegetables, pulses and oilseeds are intercropped with sugarcane, do not use Atrazine. In this case, spray either Metribuzin (Sencor) @ 0.3 kg /acre or Alachlor or Oxyfluorfen (Goal) @ 0.5 litre/acre. In wheat + sugarcane cropping system use Isoproturon (Garaminon) @ 0.4 kg a.i./acre.
- Hand weeding at 45 days after planting followed by two time interculture at 60 and 90 days will control weeds.
- Post emergence application of 2,4-D @ 0.4 kg/acre or 1 litre/acre will control dicot weeds (broad leaved weed) in standing crop. If the problems of *Cyprus* persists use Ethoxy Sulfuron (sunrice) @150 g/acre alongwith 2,4-D.

### Irrigation

- At 10 days interval during pre-monsoon season.
- As per the need during monsoon season.
- At 25 days interval during post-monsoon season.

### Earthing up

- Light/partial earthing up at 90 days after planting.
- Final earthing up during June end or before the onset of monsoon.

### Propping

- First propping during July or August depending on growth of crop.
- Second propping during August end or before 2<sup>nd</sup> fortnight of September.

### Insect-Pest Management

- *At the time planting:* Using a rosecan apply 2 litre Chlorpyriphos per acre in 350-400 litre water over the setts placed on furrows to control termite and early shoot borer.
- *During April to July:* During April-May give root drenching of Rynaxypyr 20SC @ 150 ml/acre with 400 litre water to control top borer or apply Carbofuron @ 13 kg/acre during last week June or first week of July.
- *During August:* If root borer problem is noticed apply Chlorpyriphos @ 2 litre/acre with 400 litre of water.
- Follow Integrated Pest Management (IPM)

### Disease Management

Use of resistant varieties, healthy seeds and adoption of integrated disease management would minimize the incidence of major diseases.

**Yield:** Expected average yield shall be 350-400 quintals /acre



## Improved Planting Methods

### Dry planting in ridges and furrows

- Ridges and furrows are made at 90 cm distance using a tractor drawn-ridger.
- Sugarcane setts are planted manually. Setts are covered with spade followed by light irrigation in furrows. Subsequent irrigations are given as and when required.
- Spray Atrazine @ 2 kg/acre in 350-400 litre water after 2-3 days of planting.
- This method is better than the conventional flat system in terms of germination%, water use efficiency, aeration, interculture operations and yield.



### Paired row planting in trenches

- Trenches are opened using a tractor mounted trench-opener at 150 cm distance
- Sugarcane is planted in paired-rows at 30:30-90:30:30 cm spacing
- Interspaces between trenches can be used for taking intercrops
- Trench planting gives higher yield and return than ridges and furrow system



### Ring pit method

- About 2,700 circular pits of 60 cm diameter are dug to a depth of 30 cm with a tractor mounted digger; 60 cm gap is provided between adjacent pits on all sides.
- Before planting, pits are filled with loose soil and FYM to a depth of 15 cm; 22 two-budded setts are placed per pit and covered with soil to a height of 1-1½".
- It is possible to take 2-3 ratoons; 25-50% higher yield is obtained than ridges and furrow method; water use efficiency can be improved by installing drip irrigation.



## Single Budded Sett Planting

- Always obtain seed cane from healthy seed crop.
- Size the single budded-setts by a single cut at the center of each internode. Discard setts without a healthy bud or damaged bud.
- Open the furrows with a tractor-drawn ridger at a distance of 75-90 cm.
- Apply 1 bag of DAP + 33 kg MOP per acre in furrow or as per State Govt. recommendation.
- Treat single budded setts by dipping in 0.1% Carbendazim solution.
- Place the single budded setts (end to end). Small sized setts from top portion of cane may be space planted at a distance of 6-9" distance between buds. If possible, sideways or upward direction of buds may be ensured for better and quick germination.
- Apply Chlorpyrifos @ 2 litre /acre in 350-400 litre water using rose can over the setts.
- Cover the setts with soil (1- 1½") with spade.
- Give light irrigation in furrows.
- Spray Atrazine @ 2 kg/acre in 350-400 litre water on 3<sup>rd</sup> day of planting.
- Irrigate the field regularly as and when required.



### Advantages

- Saving of about 40-50 % of seed.
- Quick and higher germination percent.
- Uniform crop.
- Higher yields.



## Ratoon Management

**Variety:** Variety with good ratooning potential is a pre-requisite for good ratoon. Varieties like Co 89003, Co 98014, Co 0118, Co 0238, Co 0239 and Co 0124 are good ratooners.

**Plant crop and its harvest:** Good ratoon comes from good plant crop. Therefore, raise the plant crop following recommended package of practices. Harvest plant crop when weather condition is ideal for stubble sprouting. Autumn planted cane when harvested early in the crushing season gives better sprouting. Harvest the crop close to the ground level.

**Trash Management:** Most of the farmer burn the trashes in field itself but it can be conserved. Trashes adds nutrients to the soil. Remove the trashes and keep it near bunds till stubble shaving and off-barring operations are over and then spread it in the field. Trash mulching conserves soil moisture. Mulched trash can be incorporated into the soil at the time of earthing up.

**Stubble shaving or stubble pruning:** This is an indispensable operation to raise good ratoon crop. The stubbles protruding above ground level are cut close to the ground using a spade. It will induce underground buds to sprout and establish deeper root system. Apply Chlorpyriphos (2 litre/acre in 350-400 litre water) after stubble shaving.

**Off-baring or root pruning or shoulder breaking:** Cutting sides of the ridges, loosening soils between ridges are the other important operations in ratoon crop. It will reduce soil compaction. It can be done manually or using plough or tractor mounted ratoon management device (RMD). The RMD can do harrowing, weeding, dispensing FYM, pesticide, fungicide, fertilizers and earthing up in a single pass. About 1 acre ratoon field can be worked in 2 hrs. The implement costs Rs. 65,000/-.



**Water management:** Irrigate the field immediately after harvest. Ratoons are susceptible to water stress and water logging due to their shallow root. Give timely irrigation, avoid excess irrigation and provide proper drainage.

**Gap filling:** If there is no cane clump in a distance of 2 feet along a row, it is considered as gap and should be filled with pre-germinated single bud setts. A small nursery may be raised in one corner of the field, just a month before harvest of plant crop. The seedling may be used for gap filling. Alternatively, single bud setts can be germinated in polybags and used for gap filling.

**Increasing sprouting in winter harvested crop:** Spray stubbles with fungicide Carbendazim (1 ml/litre) + Etherel (growth hormone) @ 20 ml/acre (avoid skin contact as Etherel may cause allergy). Application of fresh sulphitation mud @ 8 tonnes /acre would increase soil temperature, resulting in higher winter sprouting *vis-a-vis* yield.

**Fertilizer application:** 90: 20: 20 kg NPK/acre or as per State Govt. recommendation. Apply full dose of P, K and 1/3 N at basal. Apply the remaining N in two split doses at 45 and 90 days after ratooning. If iron and zinc chlorosis are noticed, give foliar spray of  $\text{FeSO}_4$  @ 0.25% along with 1% urea +  $\text{ZnSO}_4$  (0.5%) twice.

**Other cultural practices:** Same as plant crop.

## Management Under Drought and Late Planting Situations

In North India sugarcane planting is usually done with the onset of warm weather after winter and is completed well before the onset of summer. On this basis, the more eastern is the longitude the earlier is the time suitable for planting. The 1<sup>st</sup> fortnight of March is the best time for planting sugarcane in the Punjab and Haryana, February in U.P. and January–February in Bihar. However, in all the places sugarcane planting is delayed due to delayed wheat sowing *vis-à-vis* wheat harvest. In this situation, farmers are either avoid planting sugarcane crop or going for late planting of sugarcane during April–May which always gives lesser yield and low sugar recovery as the crop is not germinating well and not getting enough time to attain chronological maturity. During April–June the sub-tropical weather is very hot and dry resulting in drought like situation. Some of the management techniques to mitigate the ill effects under such situations are given below.

- Planting time:** Early planting (Feb-Mar) gives higher germination and yield than late planting after wheat harvest (April-May). Autumn planted crops withstand drought better than spring planted crop.
- Spacing:** Under drought closure spacing 60 or 75 cm between rows gives adequate population than wider spacing (90 cm).
- Increasing germination:** Poor germination is common under late planting and drought condition. To increase germination, soak the setts before planting for 1 hr in saturated lime solution (30 kg kiln burnt lime in 200 litre water). This technique would leads to quicker, higher germination and also enhances the ability of plants to withstand drought. Alternatively, seedlings may be raised during Feb–March in STP nurseries or in poly bags and transplanted in the main field after wheat harvest. This method will save time required for germination and increase tillering.
- Planting methods:** Of the various planting methods, pit and trench planting was found better under water stress condition.
- Plant Protection:** The problem of early shoot borer is more in late planted sugarcane crops. Therefore, it is advised to apply Chlorpyriphos @ 2 litre/acre in 350-400 litre water over the setts at the time of planting.
- Trash mulching:** Trash mulching after planting (10 cm thickness) conserves soil moisture, increase germination, and check weeds growth. The trashes can be ploughed *in situ* at the time of earthing up.
- Fertilizer Management:** Basal application of FYM @ 4-5 tonnes/acre, foliar application of 2.5% urea + 2.5% KCl (2.5 kg urea + 2.5 kg Muriate of potash+ 20 ml teepol in 100 litre water) at 90, 105 and 120 after planting / ratooning induce vigorous growth and higher yield.
- Irrigation:** If water available is less, give protective irrigation in alternate furrows (skip furrow). It is economical to install drip irrigation system in pit planting.



## Special Nursery Techniques

**Spaced transplanting (STP) method :** In STP method, raised nursery beds of 3 feet width and convenient length are prepared. FYM is added on nursery bed and mixed with soil. An area of 35-40 sq.m is required to raise nursery for planting one acre sugarcane. Disease free setts are selected from nursery crop. Single buds are prepared, dipped in 0.1% Carbendazim for 5 minute and then planted on the raised bed. Apply Chlorpyriphos or Imidacloprid (1 ml/litre of water) over the nursery beds. The setts are covered with loose soil and watered using rose can or irrigated immediately. Regular weeding and watering is essential to obtain good germination and weed free nursery. After 6-7 weeks, the settling are uprooted from the nursery with spade and transplanted after flooding main field. Some settling are retained in the nursery itself for gap filling. Evening time is ideal for transplanting. Generally, the settling are transplanted in paired row at wider row spacing (30:30-90:30:30 cm). About 16,000 single budded settling are required for planting one acre. With careful management of the transplanted field, the settling survival can be increased to 90%. STP method facilitates planting sugarcane after wheat harvest. There is saving of 25-35 days in the main field preparation, saving of 2-3 irrigation, better weed management, synchronous tillering and uniform maturity. Seed cane requirement is lesser (10 q/acre as against 35-40 q used in normal planting method) hence saving of seed cost.



**Poly bag nursery:** Disease free setts are selected from the seed nursery. Single budded setts are cut manually, dipped in 0.1% Carbendazim for 5 minute and then planted in perforated polybags (12x8 cm) filled with 1:1:1 mixture of sand, soil and FYM. The settling can be used for gap filling in ratoon and plant crop along with ball of earth. As there is no damage to the root system, field mortality of settling is very low (1-5%).

**Bud chip techniques:** In this method nursery is prepared using bud chips and settling are transplanted in the main field. Select disease free canes from seed nursery. Take out the bud along with a portion of the nodal region using the bud chipping machine designed at SBI Coimbatore. Only 6 quintals of bud chips are required for planting in one acre and the remaining portion of the stalk can be sent for milling. Treat the bud chips in Chlorpyriphos (2 ml/litre of water) + Carbendazim (1 g/litre of water) for 5 minutes and incubate in a moist gunny bag for overnight (priming). Prepare a homogenous mixture with equal quantity of soils, sand and FYM, fill in perforated polythene bags or cavity trays, plant the bud chips in upright position facing the bud up, cover it with soil mixture. Provide regular watering with rose can and spray 1% urea solution at 15<sup>th</sup> and 25<sup>th</sup> day after planting. The seedlings are ready for transplanting at 6-8 weeks. The survival rate of settling in the field would be high as it is transplanted along with ball of earth. Bud chips are easy to transport for long distance. There is saving of seed canes (quantity and cost), saving of 6-8 weeks time for preparation of main field, higher survival rate after transplanting, uniform tillering and higher yield.



## Intercropping in Sugarcane

- Planting sugarcane during autumn without intercrop is not remunerative practice. The net return will increase if sugarcane is grown with intercrops. Therefore, plant sugarcane along with intercrops.
- Mustard, wheat, potato, cauliflower, cabbage, radish, carrot, coriander, methi, gram, onion and garlic are suitable intercrops during autumn season.
- Mung, urd, okra, maize, sunflower, water melon, kakri (under broad bed system) are suitable intercrops in spring planted cane.
- Intercrops like garlic, onion and coriander was found to reduce insect-pest problems in sugarcane.



Simultaneous planting of wheat (3-5 rows) and sugarcane (1-2 rows) during autumn



Two rows of potato on raised bed and sugarcane (1-2 rows) in trenches



Onion on raised bed and sugarcane (2 rows) in trenches



Mustard on raised bed (2 rows) with trench planted sugarcane (2 rows)



Onion, carrot and fenugreek on raised bed and Sugarcane (1 row) on the edges of beds



Chenna (Gram) on raised bed and Sugarcane (1-2 rows) in trenches



## Mechanization in Sugarcane Cultivation

### Sugarcane Cutter Planter

#### Usage

To plant sugarcane automatically. This tractor drawn implement perform operations like furrow opening, cutting and placing of setts, dispensing fertilizers, fungicides and insecticides in furrows, covering setts with soil in a single pass

#### Efficiency

Planting one acre sugarcane in 6 hours using 4 persons.

Designed by : IISR, Lucknow

Cost : Rs. 65,000/-



### Raised Bed Sugarcane Planter

#### Usage

To plant sugarcane and wheat simultaneously. This tractor drawn implement open furrows for planting sugarcane, cut and place setts in furrows, dispense fertilizers, fungicides and insecticides, cover setts with soil in a single pass. The implement also prepare raised beds of 75 cm wide for sowing wheat. Wheat seeds along with fertilizers are dispensed in 2 rows on beds.

#### Efficiency

Possible to plant one acre of sugarcane and wheat in 6 hours using 4 persons.

Designed by : IISR, Lucknow

Cost : Rs. 72,000/-



## Intercultural Implements



### Two Row Tyne Cultivator

Usage: Harrowing and weeding

Coverage: 1 acre in 2 hrs. Can be used in crop planted at 90 cm wide upto 3-4 month.

Cost: Rs. 15,000/-

### Two Row Ridger

Usage: Earthing up

Coverage: 1 acre in 2 hrs. Can be used in crop planted at 90 cm wide upto 3-4 month.

Cost: Rs. 15,000/-

### Power Weeder

Usage: Harrowing and weeding in sugarcane crop (upto 3-4 month) planted at 90 cm row spacing.

Coverage: 1 acre in 1 hrs.

Cost: Rs. 75,000/-

## Insect Pest Management

### Early Shoot Borer (*Chilo infuscatus*)

#### Occurrence and Symptoms

1. Early shoot borer attacks sugarcane crop from germination phase till internodes are formed.
2. The larvae enter the shoots through one or more holes made on the shoot below the ground level and damage the growing point causing "dead heart" symptoms.
3. The dead hearts can be pulled out easily and emits an offensive odour.
4. The pest is active from March to June (pre- monsoon) and its incidence is more in light soils and under dry condition.
5. If pest attacks during germination phase, mother shoots are killed leading to gaps in the field.



#### Management

1. Autumn and early spring planted crop suffer less damage. Avoid late planting (May) during hot weather periods.
2. At the time of planting, apply Chlorpyrifos @ 2 litres/acre with 350-400 litres of water over the setts placed on furrows with the help of rose can. If the infestation exceeds 25% during tillering phase, give one more application of Chlorpyrifos @ 2 litres/acre with 350-400 litre water.
3. Remove the dead hearts as and when they are noticed and burn it. Kill the larvae hiding inside the base of affected shoots by piercing a small iron rods or a sharpened cycle spokes.
4. Avoid drying of field, give copious irrigation and light earthing up at early stage.
5. Inundative release of egg parasitoid *Trichogramma chilonis* @ 20,000 (1 cc) /acre.
6. If available, give four sprays of *Granulosis* virus preparation containing  $10^9$  virus granules/ ml at 40, 55, 70 and 85 days of planting.



## Top Borer (*Scirpophaga excerptalis*)

### Occurrence and symptoms

1. The pest attacks sugarcane crop from tillering phase to maturity phase. Under subtropical climate, the top borer completes six broods or generations in a year.
2. The first instar larvae tunnels into the midrib of leaves and causes white streak which later turns reddish brown. The larvae move to the centre of the spindle through the unopened leaves. Due to which rows of shot-holes can be seen when the leaves are unfurled.
3. If infestation occurs during tillering phase, the attacked shoots dies resulting in dead heart formation. The dead heart cannot be easily pulled out.
4. If the pest attacks the grown up canes, the crown with dead heart dries, apical growth is arrested, sprouting of lateral buds starts resulting in 'bunchy top' symptom.



Dead heart and shot holes



Bunchy top

### Management

- Controlling of first and second brood population is of most important.
- From the end of April to 1<sup>st</sup> week of May apply Rynayxypy 20SC @ 150 ml/acre with 350-400 lit of water as collar drench using rose can or apply Furadon @ 13 kg/acre during first week of July.
- Start collecting top borer egg masses at weekly intervals. The egg masses may contain its natural parasitoids. Therefore, instead of destroying the eggs, keep it inside a 60 mesh nylon bag and suspend at 4-6 places in the field itself.
- Water logging increases the incidence of top borer. So, give proper drainage.
- Inundative release of egg parasitoid *Trichogramma japonicum* from July onwards (2 cc cards/acre).

## Stalk Borer (*Chilo auricilius*)

### Occurrence and symptoms

1. The pest is more active from July onwards with the onset of monsoon and infestation continues from cane formation to harvest.
2. The 1<sup>st</sup> and 2<sup>nd</sup> instar larvae feed on the inner surface of leaf sheath and midrib. The 3<sup>rd</sup> instar larvae bore into the stalk. Upon removing leaf sheath the borer holes can be seen on the internodes.
3. The stalk borer attacks any region of the stalk and more than one larva can be seen in a single cane.



### Management

- Chemical control of stalk borer is rarely followed because of its peculiar feeding habits and overlapping of generations.
- Excess nitrogen application, water logging, lodging of cane, late shoots, presence of alternate host like Johnson grass would increase stalk borer incidence.
- The incidence can be minimized by providing earthing up, drainage, removal of water shoots, de-trashing (except seed crop).
- If available, release parasitoid, *Cotesia flavipes* @ 800 mated females/acre at weekly intervals from July to November.



## White Grub (*Holotrichia* spp.)

### Occurrence and symptoms

1. The grubs are active from July to September and feed on root system and underground stalks of sugarcane.
2. Extensive root feeding by 3<sup>rd</sup> instar larvae causes yellowing and drying of leaves. The symptoms of white grub damage would manifest after damage is done to the crop. In due course, the entire shoot dries up and gets dislodged easily.
3. In the initial stages the attack can be noticed in patches but later on the infestation spreads to the entire field.



### Management

- The adult beetles after the first shower emerges out from the soil and congregates on tree leaves in and around sugarcane fields. Therefore, the practical way of managing the pest is to collect and destroy the beetles on campaign basis. Using a hooked-pole, tree's branches can be shaken during the night to dislodge the beetle. The fallen beetles are hand picked, immersed in Kerosinized water and placed inside a bag till they got killed. Collections have to be began on the first night of first summer rain and can continue for a week.
- Adult beetles can be killed by mass spraying Monocrotophos or Imidacloprid @ 1 ml /litre of water on trees present nearby sugarcane fields.
- Flooding (submergence) of heavily infested field for 48 hrs, repeated deep ploughing before planting sugarcane exposes the pupae and quiescent adults to vertebrate predators.
- In endemic areas, it is suggested to go for crop rotation with paddy.
- In standing crop, collar application of Clothianidin @100 g/ha with 1000 litres of water using rose can control the grub.

## Root Borer (*Polyocha (Emmalocera) depressella*)

### Occurrence and symptoms

1. The borer larvae enter into the root zone of the shoot below the ground level. In young crop root borer infestation results in "dead heart" which can't be pulled out easily.
2. The infestation of root borer is more severe from July onwards in grown up canes. Yellowing of leaves from leaf apex to downwards along the margin is the typical external symptom of root borer damage.
3. Upon uprooting the infested plant along with underground stalk, entry hole of larvae can be seen near the root zone.



### Management

- At the time of planting apply Chlorpyriphos @ 2 litre/acre with 350-400 litre water over the setts placed on furrows using rose can.
- The infestation is higher in un-irrigated fields. So, keep the fields wet during July-August.
- Early earthing up at 90 days will reduce root borer incidence.
- If the infestation is noticed during May and August, apply Chlorpyriphos 20 EC @ 2 litre/ acre with 350-400 litres of water near the root zone using rose can or go for granular application of Quinolophos@ 8 kg per acre.
- Remove and destroy the affected shoots along with underground stalks.
- Release of egg parasitoid, *Trichogramma chilonis* @ 20,000/acre at weekly interval.



## Sucking Pests

### Pyrilla: *Pyrilla purpusilla*

1. The pest is becoming severe in North India after a cycle of 4-5 years. The adult and nymphs suck the leaf sap from the under surface of leaves resulting in yellowish white spots and withering.
2. The hopper secretes honey dew which attracts growth of sooty mould fungi. The sooty mould infested leaves become blackish hence photosynthesis would also be affected.
3. Hand collection and destruction of white-puffy egg masses of Pyrilla at regular intervals would reduce infestation.
4. The egg masses or cocoons of natural parasitoid *Epiricania melanoleuca* may be located in the Pyrilla affected nearby sugarcane fields. They may be collected along with leaf bits and tied in Pyrilla infested field.
5. Control: Spray Dimethoate or Acephate @ 1-1.5 ml/litre of water.



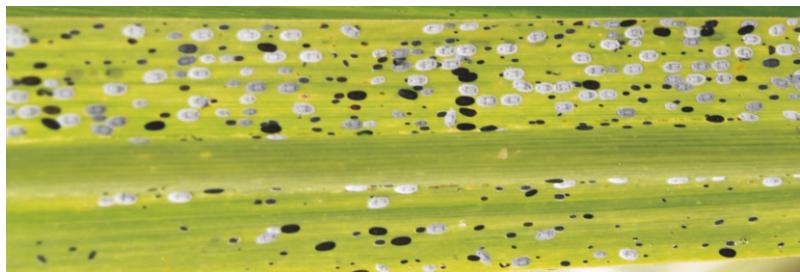
Pyrilla egg, nymph, adult



Pyrilla nymph with its parasite

### White flies: *Aleurolobus barodensis* & *Neomaskellia* spp.

- The nymphs suck the leaf sap from the under surface of leaves resulting in spindle shaped yellowish or sometimes pinkish spots in rows which may coalesce when the intensity of attack increases.
- White flies infested leaves may also show sooty mould infection/growth.
- In the initial stage white flies attack is found in field borders. So spray around border areas with Acephate or Dimethoate @ 1-1.5 ml/litre of water.



## Other Insects and Non-Insect Pests

### BLACK BUG (*Cavelerius sweeti*)

1. The incidence of black bug is more observed in ratoon crop where the trashes are left in the field over a long time.
2. The adult and nymphs attack the crop at early stages. Heavily infested plants show pale yellow leaves with irregular brown spots.
3. The nymphs and adult bugs do not prefer bright light / sunshine hence hide inside the whorl and leaf sheath.
4. The pest can be managed by removing trashes left after harvest of previous crops, boosting the growth of ratoon crop by foliar applications of urea and if necessary by spraying Dichlorvos (DDVP) @ 0.5 ml/litre of water.



### TERMITE

1. The termite attacks setts, shoots, internodes causing germination failure and yield losses. The infestation occurs after planting till harvest.
2. The termite problem is comparatively high in un-irrigated field and in light soil. So, give adequate irrigation.
3. Termite attacks can be prevented by dipping the setts in Imidacloprid solution for 2 min (4 ml in 10 litre water) or at the time of planting apply Chlorpyriphos (2 litre/acre) over the setts.
4. In standing crop, infestation may occur in patches. So, drench the affected clumps with Imidacloprid 4 ml in 10 litre of water or Chlorpyriphos 5 ml / 10 litre of water.



### Rat control

1. Identify the rat burrows inside and outside sugarcane fields. Place ½ tablet of Celphos (aluminum phosphide) inside a burrow and close the mouth of burrows with soil.
2. Baiting with zinc phosphide 1 part + 40 part bait with edible oil may be adopted in smaller or isolated fields.



# Disease Management

## Red Rot

### Symptoms

1. Red rot is caused by the fungi *Colletotrichum falcatum*.
2. The 3<sup>rd</sup> and 4<sup>th</sup> leaves (from the top) of the infected plants display yellowing and drying. At a later stage, show discoloured lesion on the rind. Fungal spores develop on rind and nodes.
3. If the diseased stalk split open, reddened internal tissues with intermingled white spots may be seen. The internal colour becomes brown, pith cavity become larger, greyish hyphae inside pith become visible. A sour and alcoholic smell emanates from the infected tissues.



Characteristic spindle leaf infection on midrib



Internal symptoms of red hot



Spores on internode

### Disease Management

Red rot is often referred as cancer of sugarcane and no effective method for its control is available yet. However, the diseases can be managed by adopting integrated red rot management practices.

1. Cultivation of resistant varieties like Co 89003, Co 98014, Co 0118, Co 0238, Co 0239, Co 0124, etc will contain the disease.
2. The disease spread through infected setts. Therefore, always select seed canes from a disease free healthy crop. Any setts showing reddening at the cut ends or at the nodal region should be discarded.
3. Raise seed crop from the seed canes treated in moist hot aerated therapy unit at 54°C for 1 hour or soak the setts overnight in Thiophanate Methyl (ROKO)+*Pseudomonas*.
4. Resort to crop rotation with paddy and green manure crops. Avoid ratooning.
5. During rainy season, the disease spreads fast. Bunding of affected field may be done to avoid movement of pathogen through rain or floodwater.
6. Roguing of diseased plants showing spindle leaf infection early during May-June and disinfecting soil around the diseased clumps with 0.1% Carbendazim solution.

## Wilt Complex

### Symptoms

1. Wilt is a vascular disease caused by the fungi *Fusarium sacchari*. The pathogen make entry into sugarcane plant through injuries. Biotic stresses like root borer, nematode, termite, abiotic stresses like drought and water logging conditions predispose the plants to wilt infection.
2. The symptoms appear during monsoon and post monsoon periods. Diffused reddish brown patches appear on the internal tissue. The crown leaves turn yellow, loose turgor and withers. Affected plant appears wilted and conspicuously stunted.
3. Wilt-affected canes lose their normal colour and light in weight. Boat shaped cavities appear in pith region and whole rind shrink.
4. Wilt disease would reduces germination, stalk yield and sugar recovery.



### Disease Management

1. The disease spreads through infected setts. Therefore, use healthy seeds for planting.
2. Seed treatment with Carbendazim (0.2%) + Boric acid (0.2%) for 10 minutes or Boric acid 0.2% + *Trichoderma viridae*.
3. Soil application of insecticides like Chlorpyriphos @ 2 litre/acre or Imidacloprid @ 500 ml/acre) against termites at the time of planting.
4. Apply Carbofuron @ 13 kg/acre during last week of June to control root borer. Application of Neem cake @ 1.5-2.0 quintals/acre followed by earthing up to reduce the incidence of root borer.
5. Application of Quinolphos @ 2 litre/acre during first week of August.
6. Occurrence of drought during May-June increases the incidence of root borer and termites. Hence, the crop should be irrigated regularly.
7. Intercropping of onion, garlic and coriander with sugarcane would reduce the disease.
8. Paddy -sugarcane crop rotation would also reduce the inoculum of wilt pathogen.



## Sugarcane Smut

1. Smut is a minor disease in sub-tropical India caused by fungi *Sperisorium scitanicum*. Ratoon crop is more affected by smut than plant crop.
2. The diseased plant produce long whip-like structure from the terminal bud of the stalk which is black in colour, contain powdery masses of smut spores covered by thin silvery membranes.
3. The infected plant produce excessive tillers, remain stunted and sprouts.

### Disease Management

1. Grow resistant varieties and do not take seed cane from infected plants
2. Remove and destroy infected plants before the silvery membrane of whip breaks and release spores.
3. Hot water treatment of setts at 50°C for 1 hr followed by dipping the setts in Bayleton 0.1% solution will eliminate sett borne infection



## Viral and Phytoplasma Diseases of Sugarcane

### Sugarcane Mosaic

- The disease is caused by sugarcane mosaic and sugarcane streak mosaic viruses and spread through infected setts.
- Mosaic affected plants show dark green patches on leaves alternated with green patches.

### Grassy Shoot Disease (GSD)

- GSD is caused by phytoplasma and transmitted through diseased setts.
- Infected plants show profuse tillering with narrow papery white leaves. Stunting and reduction of internodal length is common. No millable cane is formed in severely affected clumps.



### Yellow leaf disease (YLD)

- The disease is caused by sugarcane yellow leaf virus and spread through infected setts and Aphid vector.
- Diseased plants show yellow discolouration along midrib and adjoining laminar region followed by drying of leaf tip along the midrib.

### Diseases Management

These diseases assume significance in the neglected crops and where no seed nursery programmes are followed. No effective chemical control is available yet to eliminate these diseases. However, the incidence and spread can be minimized by:

1. Roguing of infected clumps as and when they are visible in the field.
2. Avoid ratooning and abiotic stresses.
3. Adopt three-tier seed nursery programmes.
4. Wherever viral diseases are severe, virus elimination through meristem tip culture is to be taken up to raise virus free sugarcane nurseries.



## Pokkah Boeng or Top Rot

1. *Pokkah boeng* is also a minor disease in North India.
2. It is an airborne disease caused by the fungi *Gibberella fujikuroi* (*Fusarium moniliforme*).
3. The symptoms can be seen during monsoon season (June-July). The diseased plants bear distorted and wrinkled leaves with chlorotic and or reddish patches at the base of leaf blade. Newly formed leaves become shortened and sword-like. This stage is called pokkah boeng stage.
4. As the disease advances, infection reaches the spindle and growing point gets killed, emitting a rotting smell. Due to the death of spindle lateral buds starts sprouting. This stage is called top rot stage.

### Disease Management

1. *Pokkah boeng* is seldom serious enough to warrant control. However, if control is desired, grow resistant varieties and use healthy setts for planting.
2. If top rot symptom is seen, spray Carbendazim (1 g / litre of water) or Copper oxychloride (2 g / litre of water) or Mancozeb at 0.3% (3 g / litre) to prevent its further spread.

