World Journal of Agricultural Sciences 16 (5): 312-317, 2020
ISSN 1817-3047

DOI: 10.5829/idosi.wjas.2020.312.317

Sugarcane Bud Chip Technology and its Mechanization

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Abstract: Sugarcane (*Saccharum* spp. hybrid) is commercially planted using cane setts (three bud setts) at the rate of 6-8 tonnes/ha amounting to around 10% of total produce. This large mass of planting material poses a great problem in seed treatment, transport and storage of seed cane as well as leads to reduced viability of buds resulting in poor bud sprouting. Besides, with the advent of new improved varieties, transportation of their bulk cane seed material and slow multiplication rate (ratio being 1:8 to 1: 10) is an important constraint to seed programme. The viable alternative to reduce the mass, quality and quick multiplication of seed is bud chip technique. In this technique, scooped bud chips with a viable bud and root primordial is used as a planting material and raised their nursery under field conditions after soaking in fungicide (Bavistin, 0.1% for 20 min) and growth promoting chemical (Ethrel @ 100 ppm). Within 25 days, settlings are ready for transplanting to raise sugarcane crop. Seed requirement for different methods of planting using various types of planting materials is given in Table 1. Seed cane requirement is comparatively very low, approximately 1.0 t/ha in bud chip method with high rate of bud sprouting (80-90 %) than three bud setts (6-8 t/ha) exhibiting nearly 30 percent bud sprouting. In this technique, seed multiplication rate is very high (bud chip, 1:60) as compared to conventional method (1:10). Bud chip technique saves the precious cane seed material, optimize initial shoot population, ensures higher NMC (number of millable canes) with a uniform crop stand and higher average cane weight. In bud chip technique, the left-over cane could be utilized for crushing since it remains a full cane except for the scooped up bud portions. In addition to this, bud chip transplanting with mechanical planter may save about 40 and 85 percent in cost and labour, respectively over manual planting.

Key words: Sugarcane · Bud chip · Mechanization · Technology

INTRODUCTION

Van Dillewijn [1] was the first suggested that a small volume of tissue and a single root primordium adhering to the bud are enough to ensure germination in sugarcane. He has also stated that where growing conditions are favorable, cutting with only one bud did well as seed material. Narasimha Rao and Satyanarayana [2] who were working on control of red rot in seed cane established that sugarcane can be grown from bud chip raised seedlings instead of setts. The bud chip machine was fabricated by Andhra Sugars and Ramaiah *et al*. [3] demonstrated the method for commercial planting by carrying out a detailed experiment at Andhra Sugars, Tanuku with three varieties, Co 419, Co 975 and Co 997 under bud chip and conventional three bud setts cultivation. Their analysis brought out the usefulness of the method in saving the seed cane enormously. Gokhale [4] conducted field experiment and reported that the bud of sugarcane removed with cortical portion, excluding the pith, could be successfully used as seed material for planting sugarcane.

Extensive work has been done using different types of seed cane materials such as single bud settlings, bud chip raised seedlings, 1-3 bud setts for crop establishment then determining the effect of the planting material on growth and yield of sugarcane in India [5]. It was observed that, due to saving in seed material, the maximum net returns were obtained with bud chips raised settlings.

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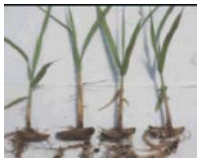
Table 1: Seed requirement for different methods of planting using various types of planting materials

Planting material	Method of planting	Seed requirement (t/ha)	Row spacing (cm)	Seed rate (in thousand/ha)
Setts (three bud setts) 	Flat	6	90	38-40
		7.2	75	46-48
		9	60	58-60
	Paired row trench planting	9	90:30	59-60
	Ring pit	15-18	75/90 cm (diameter) and 30 cm deep pit	22 three bud setts/pit 9, 000 pits/ha at 75 cm distance
	Furrow Irrigated Raised Bed (FIRB)	8	80 cm	44
Settlings 	STP	2	90x60 cm 75x60 cm	19 settlings 22 settlings
	Bud chip	1	90 cm x 30 cm spacing 75 cm x 30 cm spacing	30 settlings 40 settlings
	Poly bag raised settlings	1.5- 2	90 x45 cm	25-30 settlings

Modified from Solomon *et al*. [16]

At Mayiladuthurai in Tamil Nadu, Nagendran and Sekar [6] working at NPKRR Cooperative Sugar Mills reported that 'bud chip seedlings transplanting technique' as most suitable for adoption in the wet lands of Cauvery delta. The very good foundation laid earlier at Tanuku Sugars, encouraged Narendranath [7] for planting sugarcane with bud chip raised seedlings in 500 acres. According to him, one acre nursery was sufficient to produce seedlings for planting 100 acres.

Ramamoorthy and Ramanujam [8] developed simple chemical method for bud encapsulation. Encapsulation of a sugar cane propagule (bud chip) bearing an axillary bud with 2% agar gel slurry maintained viability and hastened the sprouting process to produce a relatively long shoot.

Tianco [9] in Philippines, used 40 days old seedlings raised in polybags and found that yields were 11 % higher due to 34 % higher single cane weight as compared to normal method of cultivation.

At Sugarcane Breeding Institute, Prasad and Sreenivasan [10] used the bud chip method as a low cost technology for exchange of cane seed material. This facilitated easy carrying and transport of Co canes as bud chips in carton boxes across the country for the regular varietal development programme.

The performance of budchips as seed materials was evaluated at the Bangladesh Sugarcane Research Institute using sugarcane cultivars Isd-16, Isd-18 and Isd-19 [11]. Greater germination was obtained with single budchips than with the conventional three-bud setts.

Field experiments conducted by Tamilselvan [12] using different planting methods, revealed that planting seedlings grown on raised bed or polybags for 40 days at 80 x 25 cm spacing could enhance cane productivity. These seedlings produced 63 % more early tillers, well-developed stalks with high juice content and cane yield of 108 tonnes ha^{-1} compared to 55 tonnes ha^{-1} with direct planting of chip buds.

In year 2009, Biksham Gujja and his Team have established the concept of 'Sustainable Sugarcane Initiative' (SSI) under the WWF-ICRISAT [13] project using bud chip raised settlings for seed saving, drip irrigation for water saving, intercropping for effective land utilization and ‘more with less’ [14].

A study also carried outthrough front line demonstration usingbud chip method of sugarcane cultivation in Angul district of Odisha by Samant [15]. Results obtained indicated 39.7 % higher cane yield (129.2 t ha^{-1}), production efficiency (421.8 kg ha^{-1} day^{-1}) and extension gap (36.7 t ha^{-1}) using bud chip technique than conventional method. It produced higher tillers plant-1 (17.3) and number of millable canes clump-1 (14.2) with 93% survival. The improved practice also recorded the higher gross return of Rs. 271320 ha^{-1}, B:C ratio (3.86) and profitability (Rs. 609.6 ha^{-1} day^{-1}) with additional net return of Rs.190080 ha^{-1} over local check. For sugarcane cultivation, in different methods of planting various types of planting materials are using with different seed requirement in subtropical India (Table 1).

MATERIALS AND METHODS

In view of manifold benefits of Bud chip technology, extensive research work has been carried out at the ICAR-Indian Institute of Sugarcane Research, Lucknow to explore the physio-biochemical basis of bud chip viability for long duration storage, its treatment, storability, raising of settlings and their establishment in farmers field. In recent past, several experiments were conducted to maintain the viability of bud chips for long duration storage. In sugarcane agriculture, bud chips can be used in two ways:

- Bud chip Encapsulation and direct planting
- Bud chip raised settlings

RESULTS AND DISCUSSION

Bud Chip Encapsulation and Direct Planting: Bud chip seed material has relatively low food reserves (1.2-1.8 g sugars /bud) compared to conventional 3 bud seed material (6.0-8.0 g sugars/ bud). The food reserves and moisture in the bud chip depletes at a faster rate compared to 2 or 3 bud sett which is reflected in their poor sprouting and early growth. Therefore to maintain moisture and viability of seed material, physical and chemical methods of bud chip encapsulation were performed to raise sugarcane crop by direct planting of bud chip seed material.

Chemical Method: For chemical method, bud chips were first soaked in sodium alginate (6%) solution and then in calcium chloride solution (100 mM) mixed with fungicide and PGR chemical (ethrel@ 100 ppm) for 10 min. Encapsulated bud chips showed lower rate of moisture loss and early and higher rate of bud germination (90%) under tray culture conditions if stored at low temperature conditions.

Physical Method: For improving water retention capacity and maintaining shelf life of bud chip seed material, bud chips after fungicide treatment (0.1% Bavistin) were encapsulated using a membrane. By this method, bud chip if stored at room temperature for 8 days, seed moisture was about 65 per cent as compared to control (30 per cent). Similarly, bud germination was comparatively higher (70%) than control (30%) under field conditions.

Bud Chip Raised Settlings: Selected freshly harvested sugarcane stalks free from disease /pests (at 10 month's age). Scoop out bud chips with the help of hand operated bud scooping device developed by IISR, Lucknow. Using scooping machine, a labour is able to scoop about 150 buds in an hour and price of machine is Rs 800/-. About 1t/ha cane stalk will be required to raise bud chip settlings for one hectare field. 10 m^2 area will be sufficient to raise settlings for one hectare field. Mechanised bud scooping device is required to enhance the efficiency of scooping and reduce labour cost.

To raise bud chip settlings, transplanting and crop management upto maturity, several steps were involved:

Seed Preparation, Treatment and Raising Settlings:

- Selected freshly harvested sugarcane stalks free from disease /pests (at 10 month's age) (ii) Scooped out bud chips with the help of hand operated bud scooping device (Fig. 1).
- Soaked bud chips in specially formulated plant growth regulator (ethrel @100 ppm) solution for 2 hrs (iv) Treated with fungicide, Bavistin (0.1%) for 20 min (v) Kept under fan to dry if it is stored for long distance transport (even for 8-10 days) (vi) Stored in polyethylene bags after fungicide and hormonal treatment at low temperature conditions (10±1°C) (vii) Planted these pretreated bud chips in upright position in plastic cups/trays filled with soil mixture containing soil, organic matter and sand in a ratio of 1:1:1 (viii) Regular watering with a rose can is essential (x). To make this technology more economical, bud chip nursery was raised in mini-plot near experimental field and it is perfect for commercial plantation [17-19] (Fig. 2).

Fig. 1: Bud chip scooping machine and cutting

Fig. 2: Seed treatment and settlings raising

Fig. 3: Field preparation and settlings transplanting

Transplanting of Bud Chip Raised Settlings Underfield Conditions: Transplanting of healthy settlings of optimum age ensures better cane yield as growth and tillering proceed normally. In case of sugarcane, about 25-30 days old settlings may be transplanted to realize higher cane yield (Fig. 3). Transplanted settlings should be watered after every 15 days for their proper establishment at initial stage. After establishment of settlings, cultural practices similar to conventional method of sugarcane cultivation were followed.To reduce the cost of settlings transplanting, a tractor mounted two row mechanical planter has been developed by Central Institute of Agricultural Engineering-Regional Centre, Coimbatore and Sugarcane Breeding Institute, Coimbatore. This showed 40 and 85 %, saving in cost and labour, respectively over manual bud chip settling planting [20].

Transplanting Time: For autumn planting, second week of October and last week of February / first week of March for spring planting is optimum time for settling transplantation to ensure good plant vigor and higher tillering in sugarcane crop.

Plant Spacing: Healthy settlings were transplanted in well prepared field after 25-30 days with row spacing of 90x 30cm (autumn planting), at 75cm x 30cm (spring planting) and 60x 30 cm (late planting)in different planting conditions which helps to obtain higher tillering and uniform plant population.

Nutrient Management: Similar to conventional system of sugarcane planting, full dose of phosphorus (P) @ 80 kg P_2O_5 ha^{-1}, potassium (K) @ 80 kg K_2O ha^{-1} and 1/3rd of nitrogen (N) of full dose of 150kg ha^{-1} were applied at the time of planting. Rest 2/3rd of N in the form urea was top dressed in two equal splits before earthing up in the month of May and June.

Weed Management: An effective weed management program viz., mechanical or conventional method by laborers called hoeing was performed to manage weed flora in between settlings and rows to trigger early plant vigor and tillering in sugarcane.

Irrigation: In subtropical India, settlings were transplanted in furrow irrigated field. The critical stage of water requirement for sugarcane settlings is initial establishment and tillering phase before monsoon. Therefore, minimum five irrigations before monsoon is required for higher tillering, cane yield and good quality juice.

Harvesting: Crop raised using bud chip settlings was harvested in the month of November for autumn planting and February for spring planting. Delayed harvesting leads to over ripening and reduced sucrose recovery.

Finding obtained indicated many benefits of bud chip technology:

Fig. 4: Bud chips, left over cane, settlings and bud chip raised crop

- Bud chips raised in cups are less bulky, easily transportable seed material.
- It showed higher bud germination (90 per cent) as against 30-35 per cent in conventional system.
- Nearly 80 per cent (by weight) of the planting material can be saved by using bud chips as it requires about <1.0 ton seed per hectare while in conventional system of cane cultivation, 6-8 tonnes seed per hectare is needed.
- It showed higher tillering, cane height and cane weight as against setts planting method hence higher cane yield (100t/ha) as compared to conventional method (67t/ha)
- Higher seed multiplication rate (bud chip, 1:60) as compared to conventional method (1:10).
- Bud chip technology is most viable and economical alternative in reducing the cost of sugarcane production. Cost of cultivation further reduced if it is performed by mechanical ways (Fig. 4).
- The left-over cane may be utilized for juice/sugar / jaggery making.

Net benefit using bud chip technology:

- Seed cane saving (5 t ha^{-1}),
- Seed Multiplication rate (1: 60)
- Monetary gain: Rs 12, 960 ha^{-1} in terms of seed saving

CONCLUSIONS

Using bud chip settlings with application of improved production technology for nursery management, settling transplanting manually/with mechnical transplanter, good cane yield (>100t/ha) can be realized at farmers field and seed multiplication rate can be enhanced to 1:60 from conventional method of 1: 10 (using three bud setts). Farmers can increase their income as well as sugarcane yield using bud chip method of sugarcane planting with good management practices.

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