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Research Article

METHODS AND PROCEDURES FOR HIGH YIELDING SEED CANE PRODUCTION

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Abstract: Sugarcane is one of the main cash crops used for production of sugar on large scale and other by products like ethanol. Sugar is a product which is largely consumed by the people and with the increasing population; the consumption rate will be increased. To fulfil the consumption needs enhancement in sugar production could be done by enhancing either yield or production. This will be achieved by using the proper method and procedure of seed during planting. Techniques like bud chip transplanting, spaced transplanting could be beneficial in this aspect. Also, usage of disease free cane seed through various effective treatments will also help in increasing the production. Besides multiplication of better yielding commercial varieties through three tier system developed by Indian Institute of Sugarcane Research, Lucknow is like an icing on the cake for enhancing yield and productivity through increased seed production. Thus, this review paper highlights on the methods, procedures and techniques required for increased seed production with higher quality.

Keywords: Sugarcane, cane seed, bud chip, 3 tier system, nucleus, breeder seed

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Introduction

Sugarcane is a large, perennial, tropical or sub-tropical grass which is worldwide grown crop, grown at latitudes of 30°N and 30°S of the equator. It is a crop that is vegetative propagated through its auxiliary buds present on its stem (or stalk) cuttings [1]. This crop attains its maturity in 12 to 24 months after planting. This crop has also unique feature of ratoon ability. The ratoon crop requires lesser time or almost same time span for attaining its maturity. About 17-20 percent of sucrose content is present in mature cane stalks which contribute to the 75 percent of world's sugar production. Besides a major source of sugar, this crop is being used as animal feed, antibiotics, bio-fertilizer and as a raw material in paper industries, alcohol production and electricity producer [2]. Production of good quality seed cane is an important criterion for raising and producing an economically good sugarcane crop. Several seed cane production techniques have been adopted for better growth, higher yields as well as high crop quality. The major reason for adverse effect on cane yield and quality is the seed obtained from commercial crops suffering with multiple diseases which is the sole factor for rapid multiplication of disease affected canes. It is therefore rising of healthy and vigorous sugarcane crops for seed purpose is essential and recommended. The paper highlights the various methods and procedures adopted for high seed cane production.

Planting Material

Sugarcane is vegetative propagated for commercial cultivation. In a year, sugarcane seed can be sowed thrice, i.e., autumn, spring and late planting [Table-1]. Different kinds of planting materials, *viz*., cane setts; settlings and bud chips are used for raising seed cane crop.

Table-1 Time of sowing and number of seed required

Time of sowing	Three eyed cane setts	Weight/Area
Autumn	37000- 40000 pieces	5.0-5.5 t ha^{-1}
Spring	40000-45000 pieces	6.0-6.5 t ha^{-1}
Late Planted (April sown)	50000-55000 pieces	7.5-8.0 t ha^{-1}

Cane Setts: Setts are sections of cane stalk or stalk cuttings possessing buds for germination. The three budded setts having three buds in a section of cane stalk are generally used for planting purposes in major portions of cane growing areas in India [3]. Although two bud setts have also being used in certain portions but setts possessing three buds have higher germination rate rather than the ones possessing either more than two or less than two buds in a set. The reason behind is the highest germination capacity of the middle bud in comparison to the other two in three budded sett. Using single bud set for planting purposes have also lower rate of germination due to the high moisture loss from both the cut ends causing low yield. Furthermore, the usage of whole stalk as a planting material is a completely wrong way as topical dominance effect comes into action where germination of only few buds will takes place therefore the idea of cutting the stalks into setts for germination came into light, although the practice of whole cane stalk has been preferred in colder cane growing countries such as Lousiana so as to avoid cold stress and stem rot infection [4, 5]

Method of using cane sett as seed

While using cane sett as planting material following points should be kept in mind:

- Distance from cut end to the nearest node should not be <4
- Not less than 60 percent moisture content (on dry weight basis) should be present in lower internodes of cane stalk used for cane sett
- Not less than 66 percent moisture content (on dry weight basis) should be present in any other internodes of cane stalk used for cane sett
- After every two to three seasons, the seed material should be changed for better growth

Procedure

Following procedure should be followed for preparing the setts as a seed:

- ✓ Prior to planting, cane setts should be prepared a day before. Even the treatment should be given before planting the setts.
- ✓ No aerial roots and splits should be present in cane setts used as seed.
- ✓ While cutting setts, damage to buds should be avoided.

- ✓ Change the seed material after every two to three seasons. In case, if it is inevitable to use mature cane as seed, the top one-third portion can be used satisfactorily.
- ✓ Fresh, genetically pure, pest and disease free setts as seed material should always be used.

Settlings

Cane setts with roots and shoots are known as settlings. Settlings can be raised either in nursery beds or in polythene bags. Single node settlings are used as a planting material in spaced transplanting technique of raising sugarcane crop.

Spaced transplanting technique: Indian Institute of Sugarcane Research, Lucknow evolved a planting method namely, Spaced transplanting technique (STP) [6 & 7]. Settlings are raised by planting single bud setts in nursery about a month before transplanting in the main field. For transplanting one hectare of field, approx. 50 m^2 area of land and 2 tons of seed cane are required. This technique ensures higher stalk population (>1.2 Lakh canes ha^{-1}) with uniform crop stand and higher average cane weight. Lower incidence of pests and diseases and reduced crop lodging. It improves the ratio of seed cane to output from 1:10 to 1:40. This technique saves seed cane to the tune of 4t/ha.

Method: Following steps are followed for this technique:

Raising settling nursery: Nursery raised in small area of 5 x 10 m nearly a month before the transplanting procedure to be followed. Land having a depth of 15 cm or small plots having 1 sq. meter is made prior to planting. Application of Chloropyriphos at the rate of 1 kg a.i. ha^{-1} is also applied on the soil. Upper half portion of the cane stalk is preferred for single bud setts which are being cut just above the growth ring and 9-10 cm below the bud. Setts are thereafter soaked in a suspension of Bavistin (0.2% Carbendazim). Normal irrigation is supplied for proper germination. Trash is covered over the setts and then mulched with pulverised soil. After 3-4 weeks, most buds are sprouted and produce three to four leaves. This time is considered the right time for transplanting the settling.

Transplanting method: Preparation of land is done as per the normal conventional method. Settling is detopped before transplanting and application of 0.2 percent suspension of Bavistin for 30 minutes were performed. Settlings are transplanted in rows for 90 x 60 cm spacing for 19,000 settlings; 75 x 45 cm spacing for 29,000 settlings are required for one ha. Settlings are dipped in the soil leaving at least 5 cm of the shoot above the soil surface. Normally 5-10 percent of mortality takes place in this method which may be overcome by gap filling.

Polythene bag technique: Usage of polythene bag for raising the settlings to produce abundant sugarcane crop is called as polythene bags technique. Studies had showed that using this method for rapid seed multiplication requires almost same cost but enhanced seed multiplication rate as compared to the normal practice of planting [8].

Method: A mixture of 1:1:1 of soil, sand and FYM/press mud should be filled in polythene bags having size of 10 x 15 cm. For proper aeration and drainage of excessive water, holes are made at certain places in polythene bags. Healthy seed canes are dipped in 0.2 percent Bavistin for 20 minutes after which the setts are planted vertically in the soil mixture contained in polythene bags. Poly-bags are then placed on ground levelled properly. Mulching with dried leaves of cane and paddy straw is performed. Over the much, dried loose spoil is sprayed so as to prevent the seed sett from lodging by winds. Either daily or alternate irrigation should be done. Water stagnation should be avoided. By this technique, 95 percent germination may be achieved if proper management methods are being adopted. After three weeks/one month, three to four leaves are being seen that depicts the settling is ready for transplanting. For transplanting the settling, normal transplanting method is adopted.

Fig-1 Spaced transplanting technique: a. Bed prepared after planting bud chip b. Nursery of single bud sett plantation ready for transplantation in field c. Germinated bud chip transplantation from nursery to field d. Irrigation supply in bud chip plantation e. Single row bud chip plantation f. Double row bud chip plantation

Bud Chips

In conventional system prevailing in India, about 6–8 tons seed cane ha^{-1} (nearly 10 percent of total produce) is used as planting material, which comprises of about 25-30 cm stalk pieces having 2-3 buds [9]. The elimination of internodal part of cane sett and using the bud portion only for germination have been showed by Narasimha Rao and Satyanarayana [10] and Ramaiah *et al*. [11]. These larger masses cause huge problems during transportation and even while handling and storing them. During the transportation and storing processing, the stalk pieces of canes losses their sucrose content and also bud viability. Furthermore under certain situation the buds of cane stalks start sprouting even before they were planted. For a solution to these problems bud chips came into existence which is easily transportable, less bulky and economically useful. Bud chips are nothing but excised axillary buds from the cane stalks [Fig-2]. Furthermore, this technology holds prominent assurance in enhancing the multiplication rate of new cane varieties that are now commercially being used [9]. Although several advantages have been known for this technology but there are limitations of this technology like poor survivability of bud chips under field condition and lower food reserves (1.2-1.8 g sugars/bud) in respect to three bud sett (6-8 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 without treatment. Using bud chip as a planting material has raised cane shoot population by 0.65 lakh/ha in comparison to the normal convention means [9].

Advantages of single bud chips: The usage of bud chips as a planting material has several advantages which are as follows:

•Easy transport and handling of seed material.
•Healthy and clean buds free of sett transmitted diseases can be selected.
•Relatively less expensive and reliable for seed multiplication.
•After removal of bud chips, lift canes can be used for crushing.
•500 kg of seed cane is sufficient for raising seedlings in an acre.
•Establishment of bud chip transplants will be almost 100 percent.

Fig-2 Sugarcane Bud chip

Micro-propagation: It is another alternative technique to solve the chronic problem of low multiplication of seed. It is the clonal propagation of sugarcane where planting material is multiplied rapidly without impairing the genetic purity [Fig-3]. Lee [12] showed that a better way of micro propagation is shoot tip culture as plant obtained from mother plants has similar phenotypic character. Besides studies have illustrated that there are many other benefits of using such a technique for development of cane by this method such as increase multiplication rate of new released varieties, better cane stalk health, diseases free plants, application of this technique especially for storing the germplasm of canes [13-16].

Methods: Following steps are followed for this technique

Step 1 Initial culture of shoot tip or meristem
Step 2 Auxiliary bud proliferation stage (can be repeated 6-8 times)
Step 3 Root initiation stage
Step 4 Acclimatization or hardening stage
Step 5 Transplanting and field establishment

Fig-3 Tissue culture raised sugarcane plantlets

Rayungans planting material: Rayungans are the shoots with attached internodes of cane stalk. In this method, cane stalks standing in the fields are topped off 4-6 weeks prior to planting. Consequently, lack of apical dominance causes lateral shoots to develop into tailed rayungans [17]. Tailed or long rayungan is a several nodes 40 cm top sett from seed cane having side shoots at the top. A new method of stratified rayungans has been developed wherein buds sprouted from 9-14 and 15-20 bud position had higher rate of sprouting than 9-20 bud position [18].

How to select the right cane seed as a planting material?

1. Healthy seed material, free from pests and diseases like red rot, wilt, smut, ratoon stunting, etc., and should be selected for using it as planting material.
2. The top one-third to half portion of a cane has been considered as best planting material as it is being comparatively immature and has buds of high viability leading to comparatively higher germination. The left over bottom portion should be used in production of jaggery as it possess high sugars content and with respect to germination, it takes longer time for germinate.
3. The material used as seed cane should be taken from well mannered, erect and healthy crop of not more than 10-12 months age.
4. Ratoon crop should be avoided for use as planting material as there is higher probability of transmission of diseases from previous plant crop.
5. Separate crop nurseries should be raised particularly for production of seed canes under good crop management practices to achieve the best results.

Essential characters of seed quality: The essential characters of quality seed for germination have been defined [19] which are: i. Crop age at the time of harvesting should be ten months. ii. The plant crop should be the originator for the seed cane not the ratoon crop. iii. Healthy and clean cane should be used for seed. iv. Each node of the seed cane should possess undamaged eyes. v. Number of node without bud should not be exceeding five percent of the total number of buds. vi. Number of swollen eyes in buds should not be more than one cm from the rind surface. vii. Moisture content in cane setts should not be less than 65 percent on basis of weight. viii. Germination rate of the buds should not be less than 85 percent. ix. Genetic and physical purity of seed cane should be 100 percent x. Seed canes should lack nodal roots, however, in water logging conditions; five percent relaxation has been acceptable.

Sugarcane Seed production programme: Under sugarcane seed production programme, there are four types of seed production takes place [Table-2]. These are:

I.**Nucleus seed production:** Initial seed obtained from selected individual plants (clumps) of a particular variety/parental line for the purpose of purifying and maintaining that variety is termed as nucleus seed. Production of such a type of seed takes place in cane-to-row method of planting. If any morphological characteristic is being observed or any sort of incidence of pests and diseases being seen, complete row of nucleus seed should be uprooted and completely rejected. This forms the source for breeder seed production [20].

For production of healthy nucleus seed following points should be kept in mind:

- Seed should be produced at centre where the variety was developed.
- Planting should be done in clump to row method.
- Healthy and true to the type looking rows should be retained to raise the breeder seed.
- Rows with poor vigour and off type plant should be discarded.

Breeder seed: This seed is obtained from nucleus seed. It may be referred to as the propagating material. The breeder's seed is raised at the farms of research stations under the supervision of the scientists [20].

Foundation seed: This sort of seed is raised from that treated seed cane obtained from breeder's seed nurseries. The foundation seed is grown at the government seed multiplication, sugar factory or progressive grower's farm [20].

Certified seed: Certified seed referred as the progeny of foundation seed. Production of such type of seeds should be handled in a way so that specific genetic purity remains maintained. This type of seeds is identified according to standards prescribed by any certifying agency that gives certification to a crop [20].

Table-2 Classes of seeds applicable for sugarcane seed production programme

Category of seed	Seed Source	Place of production	Responsibility For maintaining purity
Nucleus	Research station or breeder who developed it. Use heat treated seed.	Research Centre	Concerned breeder or Research Centre
Breeder	Use heat treated seed, if not done at nucleus seed stage. The tissue culture derived planting material is designated as breeder seed.		
Foundation	Produced from breeder seed or tissue culture derived planting material.	Govt. Seed Farm, Sugar Factory & progressive farmers' field	Research Centre / State Agriculture & Cane Development Deptt. / Sugar Factories
Certified	Produced from foundation seed or tissue culture derived planting material.	Certified seed growers and progressive farmers	Farmers
Commercial	Produced from certified seed	Farmers field	

Seed Cane Treatment: Many farmers avoid the usage of treatment to seed cane, prior to planting, due to some or the other reason but this results in low plant population per unit area and reduction in overall yield. Prior to planting, the seed cane should be treated with prescribed chemicals for better growth, high yield and avoiding infestation of insects and pests. The major reason of applying treatment to the cane sett is to protect the crop from soil-borne diseases causing pathogens. These pathogens usually gain entry into the setts through the cut ends leading to set rotting and bud damage which thereafter causes poor germination rate. Application of 0.1 percent (at 1g/litre) Carbendazim solution for 15 minutes should be given to the cane setts as soon as cut. Grassy shoot disease, smut, Wilt and ratoon stunting disease are the three diseases which are generally passed on through the infected seed cane material to the plant crop thereby causing decrease in overall yield and also add up for degenerating the varieties used. To control these diseases, seed material (setts) should be treated with moist hot air treatment (MHAT) at 52°C for 2.30 hours. For controlling the insect pests (termites, early shoot borer and scale insects), setts should be treated with systemic insecticide, mainly Malathion 50 EC @ 2 ml/litre or Dimethoate 30 EC @ 3 ml/litre) for 15 minutes. For preventing the seed canes from fungal infections along with enhancement in germination rate application of 1.0 percent solution of Agallol or 0.25 percent solution of Aretan or Tafasan before planting for 15 minutes should be performed. The application of the former improves the germination rate and fungal infestation while the latter keeps away from the attack of termites and shoot borer [21]. Hot water treatment (HMT) is also other way of treating the cane seed prior to use wherein seed canes are treated at a temperature of 50ºC for 2-2.5 hours [20]. Even using this technology will also help in higher rate of survival during flood conditions [Fig-4]. IISR Lucknow had also developed a three tier system for seed production for replacement of old varieties with healthy seed of new varieties [Fig-5].

Seed certification for sugarcane: The general seed certification standards have been laid down on its various aspects. These include for insect pests as well [Table-3].

Fig-4 MHAT treated sett sugarcane crop (a) Under flood conditions (b) After flood conditions

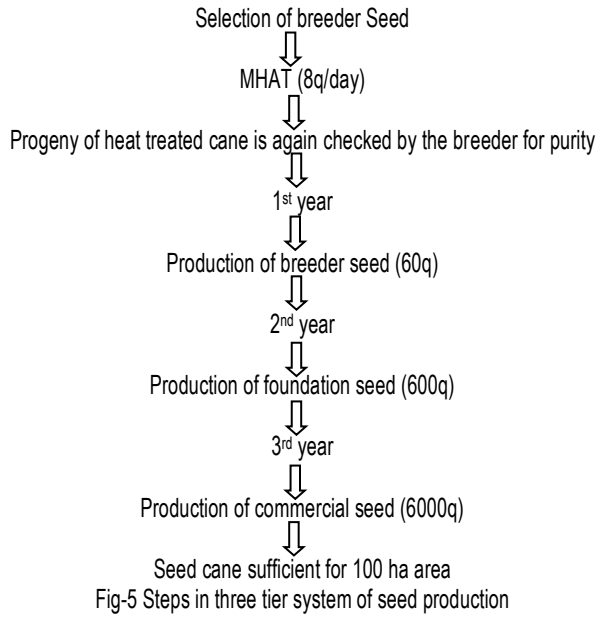

Fig-5 Steps in three tier system of seed production

Table-3 Seed crop certification standard of insect pests in sugarcane

Factors	Maximum permissible limits (%)	
	Foundation	Certified
Off types	None	None
Plants affected with designated diseases		
Red rot	0.02*	0.10*
Smut	0.01*	0.10*
	None	None
	0.05*	0.05*
Grassy shoot	None	None
	0.01*	0.01*
Wilt	0.01*	0.05*
leaf scald	None	None
Plants affected with designated insect pests		
Top borer	5.0	5.0
Internode borer	10.0#	10.0
	None	None
Stalk borer	20.0+	20.0
	None	None
Plassey & Gurdarspur borer, scale insect & mealy bug	5.0	5.0
	None**	None**

*# Around 10% affected internodes. * Subject to immediate rouging of the whole clump*
*+ Around 0.5% affected internodes. ** In area where the presence of the pest has not been recorded.*
(Source: Ministry of Agriculture and Farmers Welfare, 2013)

Conclusion

Seed production in sugarcane is important for high cane yield and production. Generally farmers practice normal convention means and planting material without realizing the importance of right practice and usage of good quality seed. There is a need to aware the farmers for use of right methods and procedures for seed production. With the right practice adoption and usage of good quality seed not only the farmers but the sugar millers too benefits as good seed cane will give good yield and so does high sugar recovery. Also, good quality seeds with MHAT treatment will help in germination of disease free canes that helps the farmers to keep sugarcane varieties for longer duration.

Application of research: Usage of good quality seeds as a planting material will help in good plant crop as well as ratoon crop.

Research Category: Cane seed

Abbreviations:

MHAT: Moist Hot Air Treatment

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