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Bud chip method of sugarcane planting: A review

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Abstract
Sugarcane crop requires huge quantity of seed cane for planting under conventional method, which contributes a major share in cost of cultivation. Besides, large quantity of seed material poses a big challenge for transportation and handling. This problem can be effectively addressed through adoption of sustainable sugarcane initiative through planting of bud chips, which can save the cost and inconveniences associated with conventional planting methods. Several authors have reported advantages of planting single bud chips over conventional methods with respect to germination, crop establishment, growth and development of sugarcane crop. Sustainable sugarcane initiative technology favourably influenced various yield attributing factors such as plant stand, millable cane per clump and weight of single cane thereby resulting in higher yield. Some authors have also recorded higher brix value and higher juice weight at harvesting stage with planting of single chip bud seedlings of sugarcane. Compared with conventional method, economics of cultivation goes in favour of bud chip method of planting. Based on research findings by various workers, it can be said that planting of sugarcane by bud chip method is superior to planting by conventional methods.

Keywords: Sugarcane, bud chip method, sustainable sugarcane initiative

Introduction
Sugarcane (*Saccharum officinarum* L.) occupies an important position among commercial crops grown in the world. This crop is efficient in utilizing solar energy for production of sugar and other renewable energy (Mohanty *et al*., 2015) [14]. Sugarcane cultivation is facing several challenges due to increasing cost of input and labor (Loganandhan *et al*., 2013) [11]. Under conventional method, planting material occupies a major chunk in cost involved in sugarcane cultivation. Depending on variety and method of growing, there is need for huge quantity of seed cane for planting of sugarcane. Requirement of huge quantity of seed material also poses a big challenge for transportation, handling and planting (Kumar, 2020) [10]. Srivastava *et al*. (1981) [24] also mentioned that a large quantity (6-8 t/ha) of 3-budded setts are required for sugarcane planting, which is nearly 22 to 25 % of the total cost of production.

In order to reduce the overall cost of production and the drudgery involved in handling huge quantity of planting materials, there is strong need to develop suitable technology for sugarcane cultivation. To address this situation, many authors have suggested adoption of sustainable sugarcane initiative (SSI) with Bud Chip Technology, which can save large quantities of seed canes (Loganandhan *et al.*, 2013; Parajuli *et al*., 2019) [11, 18]. Under farmers' field situation, Mishra (2019) [12] suggested use of axillary buds of sugarcane plant, generally known as bud chips, for reducing the volume of seed material and augmenting the quality of seed cane. In this method, a root primordium along with small volume of tissue adhering to the bud is used for regeneration of sugarcane plant. Bud chip method of sugarcane growing can save nearly 80% of the stalk material used for planting (Jain *et al*., 2010) [5, 6] that can be alternatively used for consumption purpose.

Arthi *et al*. (2016) [1] opined that sustainable Sugarcane Initiative (SSI) is a new method, which can boost the productivity of sugarcane by utilizing less resource such as seed, water and space. Shanthy and Ramanjaneyulu (2014) [23] described Sustainable Sugarcane Initiative (SSI) as a combination of many viable technologies in order to enhance the yield of sugarcane. Sugarcane production under sustainable sugarcane initiative technique minimizes the requirement of seed & water and enables the crop for proper utilization of plant nutrients to obtain higher yield (Loganandhan *et al*., 2013; Naik *et al.* 2015) [11, 16]. As per Parajuli *et al*. (2019) [18], Sustainable Sugarcane Initiative aims at providing valuable solutions to the farmers for enhancement of productivity of land, water and human labour.

Crop establishment

Crop establishment with proper plant stand plays a vital role in deciding the yield of sugarcane crop. Under agronomic management practices, adequate effort is necessary to maintain desired plant population and number of millable canes/ha so as to obtain desired yield from sugarcane crop. Chand *et al*. (2011) [3] mentioned that germination is a major concern in sugarcane cultivation that requires proper attention through selection of suitable planting materials.

Various authors have reported higher germination rate from bud chip method of planting as compared to traditional planting method of sugarcane. Iqbal *et al*. (2002) [4] observed higher germination percentage with use of single bud chips for planting as compared with the conventional planting of three budded setts. Mohanty *et al*. (2015) [14] from Odisha reported that survival rate of seedling was 88 % in case of SSI technology as compared to 55.81 % germination of buds in case of conventional method thereby creating a sizeable gap in plant population. Mishra (2019) [12] observed higher percentage of survival (92.6%) of plants in bud chip method as compared with conventional method. Similarly, Sugeerthi *et al*. (2018) [25] obtained higher establishment of 87.01% plants with planting of chip bud seedlings as compared to 70.51% establishment with planting of single bud setts.

Treatment of sugarcane bud chips with growth promoting chemicals contributed immensely for obtaining higher rate of germination of the buds. It also improved seedling vigour, which ultimately enhanced the rate of seedling survival resulting in optimum plant stand. Kathiresan and Balasubramanian (1995) [9] reported increase in germination rate by treating the bud chips with 150 ppm NAA. Jain and Solomon (2010) [5, 6] recorded higher bud sprouting and early plant growth with soaking of bud chips in ethephon solution @ 50-200 mg/l for 24 hours. Similarly, Jamuna (2019) [8] recorded maximum germination of 98 per cent with treatment of the bud chips in the medium containing cocopeat, vermicompost and 2% micronutrient mixture in combination with 1% AM fungi + 0.1% *G diazotrophicus* due to the combined effect of the bio-inoculants and organic manure. Jain *et al*. (2011) [7] obtained higher rate of bud sprouting, root growth and plant vigor by soaking the bud chips in growth promoting chemicals such as ethephon (0.1 g/dm³) and calcium chloride (1 g/dm³) solutions. The size and age of bud chips have a bog role on germination and growth of seedlings. Loganandhan *et al*. (2013) [11] recommended normal size bud chips from 4–6 month old canes for successful raising of seedlings.

Growth and Development

The growth and development of sugarcane plant directly affects the yield attributing factors and yield of the crop. There are diversified reports regarding effect of planting methods on growth and development of sugarcane. Bhanupriya *et al*. (2014) [2] from Madurai recorded the highest no. of tillers (2,70,690/ha) at 90 DAP and maximum leaf area index (8.8) at 210 DAP with planting of single chip bud seedlings. Under farmers' field situation, Mishra (2019) [12] recorded higher number of tillers/plant and millable canes/clump by adopting bud chip method of planting as compared to conventional planting method. Loganandhan *et al*. (2013) [11] also recorded 55% more tillers and 29% heavier canes in SSI method as compared to conventional method. Sugeerthi *et al*. (2018) [25] obtained the tallest plants (229.46 cm), maximum number of tillers (113010/ha) and the highest dry matter production (85.87 t/ha) with planting of chip bud seedlings because of abundant light interception, aeration and lesser competition among plants. Selvan (2001) [21] reported the highest dry matter production at 30, 90 and 150 DAP (1.17, 2.73 and 9.05 t/ha, respectively) with planting of 40-day old chip bud seedlings raised in polybags. Sugeerthi *et al*. (2018) [25] opined that proper care and well maintenance of seedlings under shadenet, in case of SSI technology, resulted in initial crop vigour and production of profuse root mass for effective absorption of nutrients and moisture by the crop.

There are several reports indicating early growth of sugarcane plant when bud chips are treated with growth promoting chemicals. Jain and Solomon (2010) [5, 6] opined that soaking of bud chips with ethephon @ 50-200 mg/l resulted in better performance of rooting activity, plant growth, tillering and photosynthesis through modification of some of the biochemical activities responsible for early plant growth than use of untreated seed materials.

Yield attributes

Sugarcane yield is largely influenced by various yield attributing factors such as plant stand, millable cane per clump and weight of single cane. Weight of cane is highly influenced by the length and girth of the cane. To obtain desired yield from the crop, it is necessary to enhance the yield attributes during various stages of crop growth.

Bud chip method of planting has direct effect on various yield attributing factors of sugarcane. Sugeerthi *et al*. (2018) [25] reported that wider spacing in SSI method enables the seedlings for better interception of solar radiation for enhanced production of photosynthates, which ultimately contributes to the storage in the cane stalk. Under Madurai situation, Bhanupriya *et al*. (2014) [2] obtained the highest cane length of 1.91 m and cane girth of 13.27 cm at harvest with planting of single chip bud seedlings. Under Odisha situation, Mohanty (2013) [13] obtained more millable canes (9.6/clump) in SSI technology than conventional method (5.2/clump) of planting because of better availability of air, water, sunlight and nutrition under wider spaced (120 cm x 60 cm) crop grown with SSI technology. Besides, there was longer (205.2 cm), thicker (3.1 cm) and heavier (1.12 kg/cane) canes in SSI technology as compared to conventional method of planting. Sugeerthi *et al*. (2018) [25] recorded heavier canes (1.80 kg/cane) with planting of chip budded seedlings as compared to other methods of planting. But, Iqbal *et al*. (2002) [4] did not find any difference between bud chip planting and planting of three bud setts with respect to single cane weight.

Yield

Yield is the most important factor for profitable cultivation of any crop. Yield of sugarcane is affected by varietal characteristics, physical factors and agronomic management practices. Yield of sugarcane grown with traditional planting method is adversely affected due to poor plant stand. Adoption of bud chip method of planting ensures adequate plant stand thereby resulting in higher yield. Bhanupriya *et al*. (2014) [2] recorded the maximum cane yield of 101.85 t/ha with planting of single chip bud seedlings under Madurai situation. Mohanty *et al*. (2015) [14] from Nayagarh in Odisha reported higher cane yield of 105.0 t/ha in SSI method as compared to 89.0 t/ha under traditional method of three bud setts planting. Sugeerthi *et al*. (2018) [25] from Cuddalore in Tamilnadu recorded the highest seed cane yield of 98.32 t/ha with chip budded seedlings planting as compared to other methods of sugarcane planting. But, Mote *et al*. (2016) [15] did not find any superiority

in cane yield by planting single bud setts over planting of scooped bud chips. On the contrary, Selvan and Nadanam (1999) [22] obtained maximum cane yield with conventional planting method, which was higher than the yield obtained with chip bud planting method.

Several workers have validated the SSI technology in the real farm situation under farmers' field. Loganandhan *et al*. (2013) [11] recorded 20% higher yield of cane from SSI method than conventional methods of sugarcane planting. Similarly, Mishra (2019) [12] obtained higher cane yield (122.6t/ha) in bud chip method of planting than conventional method (89.3t/ha) under farmers' field situation. Results from on-farm trials in farmers' field by Patnaik *et al*. (2017) [19] resulted in 13.86% more cane yield by planting with bud chip technology than the traditionally planted crop. Mohanty (2013) [13] also reported that the cane yield under SSI technology was 40.95% more than the yield obtained from conventional method of sugarcane cultivation under farmers' field situation.

Brix value

The brix value of sugarcane plays an important role in deciding the marketability of the harvested cane. Planting methods, as reported by various researchers, have marked influence on sucrose content of the cane. Bhanupriya *et al.* (2014) [2] recorded higher brix value (18.50%) and higher juice weight (1.68 kg/cane) at harvesting stage with planting of single chip bud seedlings. Similarly, Selvan (2000) [20] observed the highest CCS of 16.09% at harvesting stage with planting of 40-day old chip bud seedlings grown in polybags.

Economics

Economics of cultivation plays a critical role for sustainability of sugarcane crop. Higher profit encourages cane farmers to grow the crop in more areas with adoption of innovative technology. But, sugarcane production faces severe challenge due to increased cost of cultivation, especially the cost of seed material. To address the issue, various researchers have advocated bud chip method of planting to obtain higher profit from sugarcane cultivation. Narendranath (1992) [17] mentioned that use of seedlings raised from bud chips for planting of sugarcane was three times more cost-effective than use of conventional planting materials. Parajuli *et al*. (2019) [18] recorded a saving of 60-70 per cent of the seed cost when single bud seedlings were raised in nursery as compared to conventional method of planting. Mohanty *et al*. (2015) [14] recorded higher net return of Rs 84,300/ha under SSI technology of sugarcane planting as compared to conventional method of planting (Rs.30, 950/ha). Similarly, Arthi *et al*. (2016) [1] reported that the net return (Rs 123739/ha) obtained under SSI method was more than that of conventional method (Rs 87473/ha). Under farmers' field situation, Mishra (2019) [12] obtained higher gross return, net return and benefit-cost ratio by planting bud chips as compared with conventional method of planting. Sugeerthi *et al*. (2018) [25] opined that in spite of involvement of higher input cost, the economic benefit obtained from chip budded seedlings was much higher. They have reported the maximum net income of Rs.1,83,040 /ha and the highest B:C ratio of 2.63 with planting of chip bud seedlings. As reported by Patnaik *et al*. (2017) [19] from Odisha, bud chip technology realized 32.63% higher net profit than conventional method of sugarcane cultivation.

The research findings obtained by various workers across various agro-climatic situations indicated that the bud chip method of sugarcane planting is superior to conventional method of planting with respect to crop establishment, plant growth, yield and economics. These findings were also validated in the real farm situation by various researchers.

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