# Effect of sugarcane propagation methods and varieties under drip fertigation system

**Anbumani, S. [1], R. Nagarajan[2], P.J. Pandian[2]**

[1]Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruvannamalai, Tamil Nadu, India.
[2]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
*Corresponding author's E-mail: anbuagro2011@gmail.com

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**ABSTRACT**

**A field experiment was conducted in farmer owned land located in Varaghanathi river basin to demonstrate the yield performance of sugarcane varieties grown with chip bud method of propagation in combination with drip fertigation system. The study revealed that sugarcane propagated using chip bud method expressed significant growth performance in sugarcane. The plant height and number of tillers did not express any significant results invariable to method of propagation and varieties. The chip bud method of propagation recorded significantly higher millable cane (74.0), cane girth (3.04cm), cane weight (2.47 kg) and cane yield (135.9 t ha$^{-1}$) at the time of harvest as compared to sett method. However, average cane yield was significantly higher under variety Co86032 (159.0 t ha$^{-1}$) as compared to other ruling varieties in the study region. The lowest cane yield was recorded in variety PI 1401. However, there was no interaction observed between the method of propagation and sugarcane varieties. It can be concluded that chip bud method of propagation in sugarcane would increase significant cane yield as influenced sub surface drip fertigation that lower the mortality of canes.**

**Key words:** Sugarcane, chip buds, setts and drip-fertigation.

Sugarcane has been traditionally cultivated in India using matured stems with 2 to 3 buds through vegetative propagation, which is otherwise called as stalk cuttings or sett cuttings (Jain *et al*., 2010).The matured stems or setts are directly planted on main-field that affects population geometry of plants due to its poor germination ability. In general, the germination percentage of sugarcane raised with 2 or 3 budded setts was considerably low and ranged between 40 to 50 per cent in sub-tropical to tropical regions respectively (Natarajan, 2011).In addition, millable cane or mature cane survival percentage was also considerably low in different agro climate region, which may be differs with cultivars. Hence, tiller mortality of 50 -60 per cent in sugarcane is considered to be optimum level for a selection of potential variety that criteria was widely adopted by breeders in India (Kapur*et al*., 2011).In particular, tiller survival of elite cultivars of sugarcane in Southern Peninsular India of early and mid-late maturing variety is 62.4 and 62.5 per cent respectively as compared to other region (Kapur*et al*., 2011).Hence, poor germination in the early growth stage and tiller survival during entire growth phase of sugarcane is considered to be important key issues in producing potential cane yield of sugarcane. Besides, the yield gap of sugarcane in Tamil Nadu region (India)is estimated to be 24.4 t ha$^{-1}$ under wide-row planting systems (Anonymous, 2015). Under existing sugarcane propagation method with 2 to 3 budded setts used for planting is become uneconomical that involve 20 per cent of the total cost of cultivation (Jain *et al*., 2010).In sugarcane, decrease in plant population and high mortality during dry season is most common that affect the yield drastically. Therefore, frequent irrigation through drip system in sugarcane may increase the potential yield by avoiding mortality of canes in entire growth phase. The study on the adoption of drip irrigation in sugarcane saved nearly 42.6 per cent irrigation water and increased the cane yield by 13.3 to 19.7 per cent (Singandhupe e*t al.*, 2008). In addition, drip irrigation at shorter interval period of 2 days gave higher cane yield as compared to longer interval period of 3 and 4 days. Consequently, water use efficiency was significantly higher under sub surface drip irrigation as compared to drip irrigation (Shih, 1998). Similarly, drip fertigation with conventional fertilizer promoted

earlier growth of sugarcane, increased tillers, increased elongation and increased diameter stalk at later growth stage and increase cane yield to 31.9 per cent as compared to drip irrigation without fertilization (Cheng *et al.*, 2012).The fertilizer will be applied through drip system would also improve the nutrient use efficiency in sugarcane. In this context, it is proposed to take up research study on evaluation of sugarcane varieties grown with chip bud seedlings under sub surface drip fertigation system through field experiments.

## MATERIALS AND METHODS

Field experiment was conducted in farmer's field (Kattrampakkam, Vanur Taluk, Villupuram district), which is located in Varaghanathi river basin. The location is categorized as North Eastern agro climate zone of Tamil Nadu region based on the prevailing climate with mean maximum temperature of 36$^{o}$C; mean minimum temperature of 20$^{o}$C; with average annual rainfall of 1011.6 mm which is mostly received in post monsoon season of India (Oct-Dec). The soil is sandy loam in texture with low in organic carbon (1.5gkg$^{-1}$); medium in available nitrogen (211.8kg ha$^{-1}$);medium in available phosphorus (19.0kg ha$^{-1}$); and high in available potassium(378.3kg ha$^{-1}$).The pH of the soil was 7.21 and electrical conductivity was 0.3dS/m.The sugarcane seedlings using chip buds were raised in the nursery. The one month chip bud seedlings and 2 budded setts were planted in the main-field with a spacing of 120 cm x 50 cm x 80cm in two row paired system. In sub-surface drip-fertigation, laterals (16 mm dia) were laid out with a spacing of 150 cm part between paired rows and leaving 40 cm spacing between drippers. The laterals were installed to a depth of 20 cm. The chip bud seedlings and settlings from five sugarcane cultivars(Co86032; PI 1110; CoC24; PI 1401 and CoSi33) were used for the study. The experiment was conducted in a factorial randomized block design and replicated four times. The fertilizers such as mono-ammonium phosphate (MAP) (water soluble grade), sulphate of potash (SOP)(water soluble grade) and urea were used for fertigation. The recommended dose of fertilizers of 275: 62.5: 120 kgha$^{-1}$ of NPK were used for fertigation in a specified dose and period of interval (Table 1).The growth characters and cane yield was estimated at the time of harvest. The growth and yield data were statistically analyzed using method suggested by Gomez and Gomez (1984). The benefit cost analysis was done based on the cost of cultivation and market value of harvested produce to study the economic feasibility.

## RESULTS AND DISCUSSION

The results obtained from the field experiments revealed that sugarcane raised with seedlings propagated with chip bud method expressed significant growth performance especially in number of millable canes, cane girth, cane weight, clump weight and yield of cane at the time of harvest (Table 2). In contrast, plant height and number of tillers were not significant at during the harvest in any of the treatment.

The average value of millable canes observed under chip bud method (73.8) of propagation significantly higher at the time of harvest as compared to sett method (59.2).In the case of varieties, mean value of millable canes was significantly higher with the sugarcane variety Co86032 as compared to other four varieties. Millable cane was lower in sugarcane variety PI 1401.The mean value of cane girth was observed under chip bud method (3.04cm)was also significantly higher as compared to sett method (2.99cm).The mean value of cane girth was significantly higher in sugarcane variety Co86032, which was on par with variety CoC24. The sugarcane variety PI 1401 recorded significantly lower cane girth similar to millable cane value.

The average cane weight of sugarcane observed at the time of harvest was significantly higher in the case of chip bud method of propagation (2.47 kg) as compared to settling method (2.10).Theaverage cane weight observed under different sugarcane varieties revealed that significantly higher cane weight was recorded under variety Co86032 (2.88 kg). It was followed by a variety CoC 24. The cane weight registered under CoC24 was on par with two varieties viz., PI 1110 and CoSi33. The lowest cane girth was registered with variety PI 1401.Similar trend was observed with clump weight. The average yield of cane at the time of harvest shown significantly higher cane yield observed under chip bud method of propagation (135.9 t ha$^{-1}$) as compared to sett method (116.4tha$^{-1}$).

**Table 1. Fertigation scheduling adopted in sugarcane after transplanting (NPK ha$^{-1}$)**

| S. No. | Fertigation scheduling (Days) | Fertilizers (NPK) | | | S. No. | Fertigation scheduling (Days) | Fertilizers (NPK) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MAP (12:61:00) | SOP (0:0:50) | Urea (50:0:0) | | | MAP (12:61:00) | SOP (0:0:50) | Urea (50:0:0) |
| 1 | 7 | 2 | 4 | 10 | 16 | 112 | 6 | 6 | 30 |
| 2 | 14 | 2 | 4 | 10 | 17 | 119 | 6 | 8 | 30 |
| 3 | 21 | 5 | 4 | 10 | 18 | 126 | 3 | 8 | 30 |
| 4 | 28 | 5 | 4 | 15 | 19 | 133 | - | 10 | 30 |
| 5 | 35 | 5 | 4 | 15 | 20 | 140 | - | 10 | 30 |
| 6 | 42 | 5 | 4 | 25 | 21 | 147 | - | 10 | 20 |
| 7 | 49 | 8 | 5 | 25 | 22 | 154 | - | 10 | 20 |
| 8 | 56 | 8 | 5 | 30 | 23 | 161 | - | 10 | 20 |
| 9 | 63 | 8 | 5 | 30 | 24 | 168 | - | 10 | 11.8 |
| 10 | 70 | 8 | 5 | 30 | 25 | 175 | - | 10 | - |
| 11 | 77 | 8 | 5 | 30 | 26 | 182 | - | 12 | - |
| 12 | 84 | 6 | 6 | 30 | 27 | 189 | - | 12 | - |
| 13 | 91 | 6 | 6 | 30 | 28 | 196 | - | 12 | - |
| 14 | 98 | 6 | 6 | 30 | 29 | 203 | - | 12 | - |
| 15 | 105 | 6 | 6 | 30 | 30 | 210 | - | 12 | - |

**Table 2. Growth performance of sugarcane varieties under different propagation methods**

| Treatments | Plant height (cm) | Tillers (000 ha$^{-1}$) | NMC (000 ha$^{-1}$) | Cane girth (cm) | Cane weight (kg) | Clump weight (kg clump$^{-1}$) | Yield (t ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Propagation methods | | | | | | | |
| Sett method | 283.2 | 77.0 | 59.2$^{b}$ | 2.99$^{b}$ | 2.10$^{b}$ | 19.2$^{b}$ | 116.4$^{b}$ |
| Chip bud method | 308.2 | 82.9 | 73.8$^{a}$ | 3.40$^{a}$ | 2.47$^{a}$ | 21.9$^{a}$ | 135.9$^{a}$ |
| SE.d | 16.4 | 4.16 | 2.94 | 0.168 | 0.119 | 1.04 | 3.64 |
| CD (p=0.05) | NS | NS | 6.02 | 0.345 | 0.244 | 2.13 | 7.47 |
| Varieties | | | | | | | |
| Co86032 | 340 | 88.8 | 82.1$^{a}$ | 3.75$^{a}$ | 2.88$^{a}$ | 25.7$^{a}$ | 159.0$^{a}$ |
| PI 1110 | 286.4 | 78.5 | 67.8$^{b}$ | 3.19$^{b}$ | 2.47$^{b}$ | 20.8$^{b}$ | 127.2$^{b}$ |
| CoC 24 | 291 | 81.4 | 69.9$^{b}$ | 3.49$^{ab}$ | 2.49$^{b}$ | 21.1$^{b}$ | 130.7$^{b}$ |
| PI 1401 | 275.5 | 70.8 | 47.6$^{c}$ | 2.54$^{c}$ | 1.58$^{c}$ | 15.1$^{c}$ | 86.6$^{c}$ |
| CoSi 33 | 285.5 | 80.2 | 65.0$^{b}$ | 3.00$^{bc}$ | 2.15$^{b}$ | 19.9$^{b}$ | 127.4$^{b}$ |
| SE.d | 25.9 | 6.59 | 4.64 | 0.266 | 0.188 | 1.64 | 5.76 |
| **CD (p=0.05)** | **NS** | **NS** | **9.52** | **0.546** | **0.385** | **3.37** | **11.8** |

**Table 3. Water productivity and economics of sugarcane under two methods of planting**

| Treatments | Cost of Cultivation (Rs. $ha^{-1}$) | Gross return (Rs. $ha^{-1}$) | Net return (Rs. $ha^{-1}$) | B:C. ratio (Rs. $ha^{-1}$) | Total water consumed incl. effective rain($m^3$/ha) | Water productivity (Kg/$M^3$) |
|---|---|---|---|---|---|---|
| *Propagation methods* | | | | | | |
| Sett method | 1,34,650 | 2,57,140 | 1,22,490 | 1.90 | 17,950 | 6.23 |
| Chip bud method | 1,23,400 | 3,12,570 | 1,89,170 | 2.53 | 17,400 | 7.81 |
| *Varieties* | | | | | | |
| Co86032 | 1,23,025 | 3,13,950 | 1,84,925 | 2.43 | | |
| PI 1110 | 1,29,025 | 2,80,140 | 1,51,115 | 2.17 | | |
| CoC 24 | 1,29,025 | 3,42,700 | 2,13,675 | 2.67 | | |
| PI 1401 | 1,29,025 | 2,22,180 | 93,155 | 1.72 | | |
| CoSi 33 | 1.29,025 | 2,65,420 | 1,36,395 | 2.06 | | |

The average cane yield was significantly higher under variety Co86032 (159.0 t $ha^{-1}$).It was followed by a variety CoC24 (130.7 t $ha^{-1}$), which was on par with varieties such as PI 1110 (127.2 t $ha^{-1}$) and CoSi33 (127.4 t $ha^{-1}$) (Table 2).The lowest cane yield was recorded in variety PI 1401. There was no interaction observed between the method of propagation and sugarcane varieties. The results revealed that sugarcane cultivated with seedlings propagated through chip bud method significantly recorded higher millable canes, cane girth, cane weight, clump weight and cane yield at the time of harvest as compared to sett method. The matured stems planted directly in the main field as sett method of propagation has poor germination, which is ranged between 40 to 50 per cent (Natarajan, 2011). The sett method of cane propagation is considered to produce low yield as compared to chip bud method. In chip bud method propagation, plant population was maintained at optimum level and further increased the millable canes and cane yield. Hence, mean value of cane yield was observed under chip bud method (135.9 t $ha^{-1}$) of propagation was significantly higher as compared to sett method (116.4 t $ha^{-1}$).

In both methods, water is frequently supplied in a regular interval to the root zone through sub surface drip method. In addition, fertilizers were also applied through drip system as per the recommendation. Therefore, the optimum plant population maintained under chip bud method of propagation benefitted by the frequent supply of water and nutrient that increase number of millable canes, cane weight and cane yield. This might be due to optimum supply of adequate water and nutrients. The fertilizers applied as solution form as per level through drip fertigation in direct accumulation in the root zone coupled with adequate amount of soil moisture would enhance the mineralization rate and nutrient availability (Singandhupe *et el*., 2008). Similar findings were also reported in sugarcane as influenced by the introduction of sub-surface drip system (Shih, 1998; Pires *et al*., 2014; Prabhakar*et al.*, 2014). Similarly, higher cane yield as performed by the introduction of chip bud method over sett method in sugarcane was also reported in India (Raskar and Bhoi, 2003; Loganandhan *et al*., 2013).Though the chip bud propagation material has low food reserves that grows faster rate as compared to 2 or 3 bud sett (Jain *et al*., 2010).The increased yield under drip-fertigation might be due to continuous supply of nutrients enhance the yield. Kwong and Deville (1994) evaluated sugarcane grown under fertigation systems supplied with nitrogen registered higher yield as compared to without fertilizer nitrogen. Similarly, Wiedenfeld and Enciso (2008) emphasized that maximum possible sugarcane yield can be obtained at a linear trend with nitrogen fertilizer and optimum soil moisture level. In the drip fertigation system, supply of water on alternate days may enhance the growth and yield of crop by maintaining optimum soil moisture favour the higher yield. This work shows that maximum cane and sugar yields can be obtained, and responses to rate of N application are not reduced at less than optimum soil moisture conditions. The growth characters and cane yield of sugarcane may vary

between varieties under same drip fertigation system. Among the varieties Co86032 performed well under the chip bud method of propagation coupled with drip fertigation. The variation in cane yield may be varying due to genetic nature of the cultivar in terms of utilizing light energy, nutrients and water.

Total water consumption and water productivity was worked out for two methods of planting of sugarcane. Based on the overall mean values, sett method of cultivation of sugarcane consumed higher total water inclusive of effective rainfall (17,950 $m^3$/ha) as compared to drip-fertigation method of cultivation (17,400$m^3$/ha). Similar trend was also observed in the case of water productivity. In which, higher water productivity was observed under chip-bud method of cultivation under drip-fertigation system (7.81Kg/M $^3$). Similar to our results, Singh *et al*. (2007) indicated that water productivity values for sugarcane main and ratoon crops was 7.1 and 6.3 kg $m^{-3}$ respectively. To know the economic feasibility of proposed system, benefit cost analysis was done based on the produce cost and cost of cultivation. Though the cost of cultivation was higher under sett method (Rs.1,34,650 $ha^{-1}$) and however, the net return was higher under in chip bud method of propagation under drip-fetigation system. Similarly, the benefit cost ratio was higher under chip bud method (2.53). Among the varieties, CoC 24 registered higher net return (Rs. 2,13,675 $ha^{-1}$) and higher benefit cost ratio (2.67).There may be variation is the yield might contributed variation in net return registered under sugarcane drip fertigation system.

## CONCLUSION

The study concluded that sugarcane cultivated with seedlings raised as chip bud method of propagation would show increased growth characters such as millable canes, cane weight, cane girth and cane yield at the time of harvest. The average cane yield observed at the time of harvest under chip bud method was nearly 20 t $ha^{-1}$more than sett method that may reduce current yield gap. In particular, average cane yield was significantly higher under variety Co86032as compared to ruling other varieties in the study region. It can be concluded that chip bud method of propagation in sugarcane would increase significant cane yield as influenced sub surface drip fertigation that lower the mortality of canes.

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