Standardization of nutrients required for raising pro tray chip budded sugarcane seedlings for Sustainable Sugarcane Initiative (SSI) technology

Abstract:

Field investigateions were carried out for the standardization for improving the quality of protray chip budded seedlings of sugarcane (*Saccharum officinarum* L.) for SSI (Sustainable Sugarcane Initiative). The research was conducted under shade net conditions at Sugarcane Research Station, Tamil Nadu Agricultural University, Sirugamani. The experiment was conducted in Randomized Block design (RBD) with three replications and 14 treatments including different combinations of nursery nutrient management and nutrient spraying on chip budded seedlings for finding out the standardizing the nutrients required for getting vigorous chib budded seedlings of sugarcane. The study on nutrients requirement for chip budded seedlings raised in protray with the nursery media of cocopeat & sugarcane trash compost at a 2:1 ratio found that application of 0.5 g urea/bud along with foliar spraying of 1% urea at 15 DAP recorded the higher vigour index of chip budded seedlings of sugarcane at 30 DAP.

Keywords: Chip Budded Seedlings, Economics, Nutrient Mixture, Protray, Sugarcane, Vigour Index,

1. Introduction

Sugarcane (*Saccharum officinarum* L.) is one of India's most significant commercial crops, used primarily to produce sugar with sugar beet. India ranks second in terms of sugarcane acreage and output, after only Brazil. The crop occupies almost 2.67% of total cultivated land area and accounts for approximately 7.5% of overall agricultural production in the country (DAC, 2020). In sugarcane production, seed cane used for planting is the most important ingredient in establishing a solid first crop stand, accounting for 20% of overall production costs (Galal, 2016). In India, sugarcane is traditionally cultivated from stem cuttings known as setts, which are short cane stalks containing one or more buds. According to the variety employed in this technique, a very high sugarcane seed rate of 7-10 t ha^{-1} is used as planting material, consisting of around 40,000 stalk pieces with 2-3 buds (Sarala, 2017). The use of a significant number of three-eyed setts per furrow resulted in intense competition among the main shoots, lowering the number of tillers per planting material utilized (Verma, 2004). Furthermore, in conventional sugarcane agriculture, the demand for a huge quantity of planting material creates a significant challenge in the shipping, processing, and storage of seed cane, which deteriorates quickly, lowering the viability of buds and, as a result, their germination. According to Van Dillewijn (1952), sugarcane propagation requires only a tiny amount of tissue with a single root primordium clinging to the bud to enable germination. He also suggested that clipping one bud is adequate as seed material under ideal growth circumstances. Furthermore, Narasimha and Satyanarayana (1974) and

Ramaiah *et al.*, (1977) demonstrated the viability of removing the internode component of the seed piece and planting solely buds for commercial purposes. This alternate planting strategy, which uses bud chips instead of 2/3 budded setts, decreases the amount of planting material while also boosting seed cane yield and quality.

The sugarcane seedlings' growth performance is influenced by the media and nutrients given to the chip budded seedlings. According to Roohi *et al.* (2021), the cane and sugar production over RDF are significantly increased by three foliar sprays of 2% NPK + 0.5% ZnSO4 + 1% FeSO4 applied at 15-day intervals during the months of May and June. With foliar spray, crops can achieve an approximate 90% efficiency in using fertilizers, and within 60 minutes, 95% of the nutrient solution will be present in the roots (Manasa and Devaranavadagi, 2015). According to Mohanty's (2016) research, straightforward native interventions, such as priming single-bud cane setts with a slurry made of cow dung and urine combined with water and then covering the setts with dry FYM, cane yields in Odisha that are comparable to those of traditional three-bud sett planting. Otto *et.al*.(2022) reported that New method of planting of sugarcane pre-sprouted seedling simprove the stalk yield and sugar yield of sugarcane. Sugarcane responds better to application of micaschist powder as fertilizer (Tetchou *et.al*., 2022). Supply of Silicon via nutrient solution in pre-sprouted sugarcane seedlings(Teixeira *et. al*.(2020) or silica solubilizer at a rate of 12.5 kg with 50 kg FYM/ha in soil with sett treatment of 0.5% K2SiO3,2.5% urea and potash foliar spray(Anitha *et al*., 2023) enabled sugarcane to mitigate water stress and enhance productivity.

In continuation of this, an experiment was done under shade net at Sugarcane Research Station, Tamil Nadu Agricultural University, Sirugamani during 2015-16 to standardize nutrient mixture for protray chip budded sugarcane seedlings for getting vigorous seedlings which are the main constituent of prerequisites of sustainable Sugarcane Initiative (SSI) for augmenting the cane and sugar yields .

2. Materials and Methods

An experiment was conducted at Sugarcane Research Station, Tamil Nadu Agricultural University, Sirugamani, Andhanallur Block, Tamil Nadu, India (Fig 1.), under shade net during 2015-16 to standardize suitable nursery medium for protray chip budded seedlings of sugarcane for SSI technology.

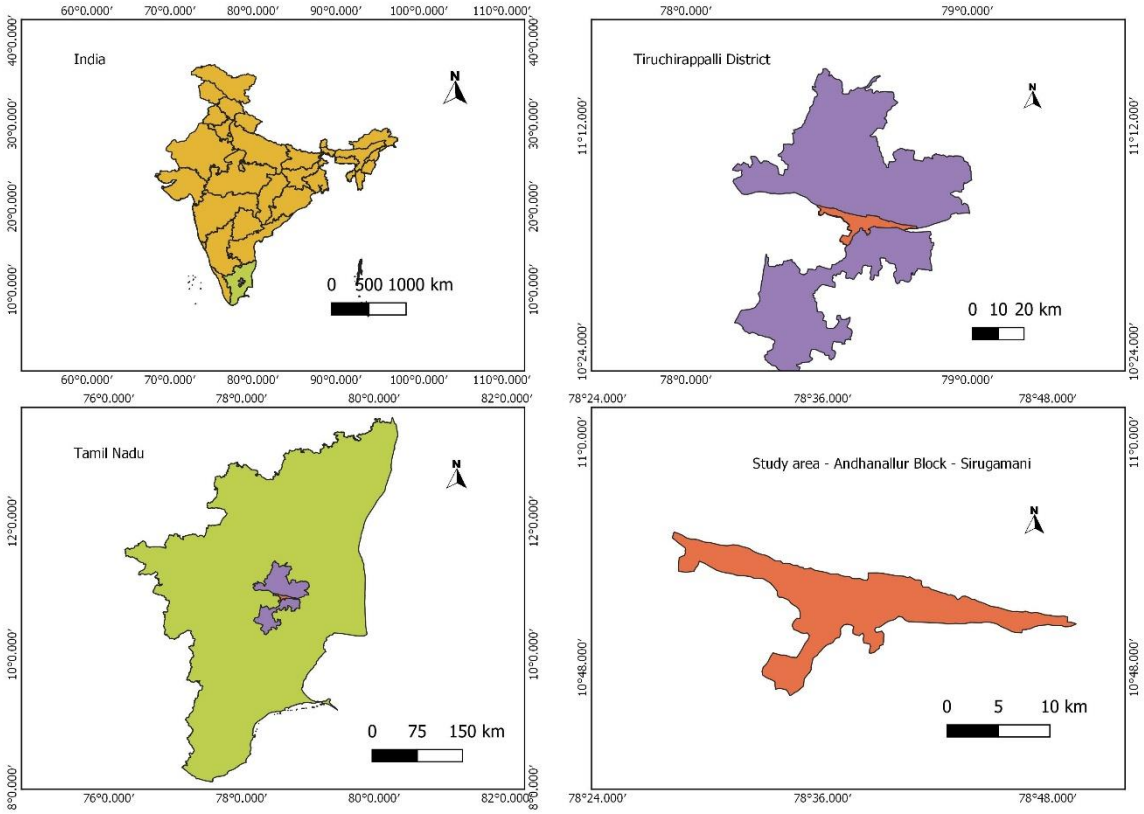

Fig 1. Study area map

Treatment details of nutrients requirement for raising pro tray chip budded sugarcane seedlings.

An experiment was conducted under a shade net at Sugarcane Research Station, Tamil Nadu Agricultural University, Sirugamani during 2015-16 to standardize suitable nutrients for protray chip budded seedlings of sugarcane. The experiment was laid out in a Randomized Block Design with 14 treatments as follows in Table 1 with three replications.

Table 1. Details of treatments

Treatments	Nutrients added/sprayed
T_1	0.5 g urea/ chip bud (25 g/50 wells portray)
T_2	0.5 g Diammonium Phosphate(DAP) / chip bud
T_3	T1+0.5 g $ZnSo_4$/ chip bud (25 g/50 wells portray
T_4	0.5 g urea + 1% urea foliar spray on 15 DAP
T_5	0.5 g urea + 1% DAP foliar spray on 15 DAP
T_6	0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP
T_7	0.5 g DAP + 1% urea foliar spray on 15 DAP

T_8	0.5 g DAP + 1% DAP foliar spray on 15 DAP
T_9	-0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP
T_{10}	.0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP
T_{11}	0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP
T_{12}	0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP
T_{13}	Panchakavya 3% spray on 15 and 25 DAP
T_{14}	Control

Black polythene protrays with 50 cavity round cells of 0.8 mm thickness was used for raising the seedlings. The filling nursery media was prepared as per the treatments and the respective media were used in the protrays for raising 5000 seedlings for each treatment. The test variety used for this study was TNAU Sugarcane Si(Sc) 8. Chip buds were collected from 6-8 months old nursery cane using a chip bud machine. The chip buds were treated with Carbendazim (50g), Urea (1kg) and Malathion (200ml) in 100 liters of water for 15 minutes. The different nutrients were collected and chip buds of TNAU sugarcane Si 8 variety were collected using motorized bud chipper. The buds were planted in protrays containing the composted coir pith : vermicompost @ 2:1 ratio. The media was mixed with the nutrients as per the treatments viz., 0.5 g urea/chip bud (25 g/50 wells portray) i.e., 6.2 kg urea for 12,500 seedlings which is needed to plant in an area of one hectare. Similarly, 6.25 kg of $ZnSo_4$ and 6.25 kg of DAP were mixed with the media at basal before sowing of chip buds in the protray as per the treatments. The foliar spraying of different nutrients were done on 15 DAP. The nutrient solutions with 0.5% and 1% spray were prepared with 1.25 and 2.50 kg of nutrient materials respectively, in 25 litres of water for spraying on 12500 seedlings which are required to plant in one hectare. Then, the treated chip buds were planted in protrays and allowed for incubation in the dark room for 5 days. Then the protrays were moved to shade net .The seedlings were maintained under shade net for 30 days.

Observations on germination shoot and root parameters of chip budded seedlings at a 10 days interval and vigour index was calculated and the economics was worked out (Rehman*et al*., 2021).The seedlings were observed for germination, shoot length, root length, vigour index, number of leaves produced and root volume at 10, 20 and 30 DAP.

3 Results and Discussion

The germination % was significantly influenced by different nutrients mixed in the media and foliar spraying of nutrients at all the stages. Application of 6.25 kg of DAP/ha at basal and spaying of 1% DAP (T_8) on 15 DAP recorded the highest germination % of 72.7, 80.9 and 84 respectively, at 10, 20 and 30 DAP. It was followed by the application of 6.25 kg of $ZnSo_4$ at basal and spraying of 1% DAP on 15 DAP (T_{11})

which recorded 80% germination on 30 DAP. Application of 0.5 g urea (6.25 kg/ha) for one hectare seedlings along with spraying of 1% urea on 15DAP recorded significantly higher seedlings height at 10DAP (20.30cm), 20 DAP (39.4cm) and 30 DAP (59.7 cm).Application of 0.5 g urea as basal (6.25 kg/ha seedlings) along with 1% urea spraying at 15DAP recorded significantly higher root length of 2.1cm, 21.9cm and 21.1 cm, respectively, at 10,20 and 30 DAP. Significantly highest vigour index of 1475, 4900 and 6787 was recorded by application of urea 0.5 g/bud (6.25 kg/ha seedlings) and spraying of 1% urea on 15 DAP at 10, 20 and 30 DAP respectively. The Economics chip budded seedlings produced with different nutrients is provided in the Table 8.

Table 2. Effect of different nutrients on germination % of sugar cane chip buds

Treatments	Germination @ 10 DAP	Germination @ 20 DAP	Germination @ 30 DAP
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	68.8	71.6	61.3
T_2 -0.5 g DAP / chip bud "	65.6	68.7	70.7
T_3 -0.5 g $ZnSo_4$ / chip bud "	61.9	63.6	66.0
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	59.1	64.8	70.7
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	61.9	62.4	62.0
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	61.5	63.0	65.3
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	75.1	80.0	77.3
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	**72.7**	**80.0**	**84.0**
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	71.9	79.2	77.3
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	71.5	75.5	78.7
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	**71.6**	**76.5**	**80.0**
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	71.2	74.8	69.3
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	73.7	76.5	73.3
T_{14} –Control	69.9	74.1	64.7
SEd	2.85	3.16	3.20
CD (P=0.05)	5.85	6.50	6.59

Germination of sugarcane bud chips were investigated between 10 days interval upto 30 DAP. At 10 DAP, highest germination was recorded in treatment T_7 (0.5 g DAP + 1% urea foliar spray on 15 DAP) as 75.1 % than any other treatments. Similar results were also reported by adding various nitogenous materials to nursery growing media for chip budded seedlings (Masukume, 2016 and Loganathan *et al.* 2012). At the same time there was no significant difference between T_1, T_7, T_8, T_9, T_{10}, T_{11}, T_{12}, T_{13} and T_{14}. The lower germination was observed in T4 (0.5 g urea + 1% urea foliar spray on 15 DAP) with 59.1 %. The same trend was found on 20 DAS on sugarcane bud chip germination. The higher germination of 80 % was recorded in T_7 (0.5 g DAP + 1% urea foliar spray on 15 DAP) and T_8 (0.5 g DAP + 1% DAP foliar spray on 15 DAP). These were on par with T_9, T_{10}, T_{11}, T_{12}, T_{13} and T_{14}. Treatment T_5 (0.5 g urea + 1% DAP foliar spray on 15 DAP) gave lower germination of 62.4 %. The trend of sugarcane bud chip germination was varied slightly at 30 DAP. Treatments T8 gave highest germination as 84 % and it was comparable with T_{11} (.0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP) and T_{10} (0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP). Next to that, T_7 (0. .5 g DAP + 1% urea foliar spray on 15 DAP) obtained higher germination of 77.3 %. The lowest germination was recorded in T_1 (0.5 g urea/ chip bud (25 g/50 wells portray)(Table 2).

Table 3. Effect of different nutrients on seedling height (cm) of chip budded seedlings

Treatments	Seedling height (cm)		
	10 DAP	**20 DAP**	**30 DAP**
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	16.44	37.2	47.6
T_2 -0.5 g DAP / chip bud "	14.70	39.1	52.3
T_3 -0.5 g $ZnSo_4$ / chip bud "	17.29	37.2	57.1
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	**20.39**	**39.4**	**59.7**
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	14.19	37.3	52.1
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	16.83	39.3	50.1
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	13.88	37.0	54.5
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	13.93	43.9	52.7
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	12.50	44.5	58.5
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	13.33	43.6	57.4
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	14.23	36.0	54.8
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	14.47	40.4	53.3
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	12.57	33.8	55.3
T_{14} –Control	14.60	29.0	53.1
SEd	**0.87**	**1.66**	**1.54**
CD (P=0.05)	**1.80**	**3.41**	**3.10**

Effect of different nutrients on seedling height of chip budded sugarcane were examined on 10 DAP, 20 DAP and 30 DAP. Taller seedlings were measured at 10 DAP in treatment T_4 (0.5 g urea + 1% urea foliar spray on 15 DAP), which produced 20.39 cm. Followed by T_3 produced 17.29 cm height seedlings and the lowest was recorded in T_9 (0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP) as 12.50 cm. Against to this result, T_9 produced taller seedlings (44.5 cm) on 20 DAP, which is on par with T_8 (43.9 cm), T_{10} (43.6 cm) and T_{12} (40.4 cm). Next to this T_4 (0.5 g urea + 1% urea foliar spray on 15 DAP) was recorded taller seedlings with height of 39.4 cm. The shorter seedlings with 29 cm were recorded in control (T_{14}). At 30 DAP, again T_4 (0.5 g urea + 1% urea foliar spray on 15 DAP) were produced taller seedlings with 59.7 cm and it was comparable with treatments T_3, T_9 and T_{10}. The shorter seedlings were recorded in T_1 (0.5 g urea/ chip bud (25 g/50 wells portray)) with 47.6 cm seedling height(Table 3).

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Table 4. Effect of different nutrients on root length (cm) of chip budded seedlings

Treatments	Root length (cm)		
	10 DAP	**20 DAP**	**30 DAP**
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	1.80	13.5	16.5
T_2 -0.5 g DAP / chip bud "	1.50	19.2	19.5
T_3 -0.5 g $ZnSo_4$ / chip bud "	1.90	3.9	16.7
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	**2.10**	**21.9**	**21.1**
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	1.80	9.6	17.5
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1.80	13.3	19.6
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	1.80	13.3	14.6
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	1.20	7.4	18.8
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1.50	9.7	20.3
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	1.50	11.8	24.8
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	1.90	10.6	23.3
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1.20	14.2	22.4
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	1.20	16.5	23.5
T_{14} –Control	1.60	8.9	19.7
SEd	**0.20**	**1.88**	**0.94**
CD (P=0.05)	**0.41**	**3.87**	**1.98**

Root length is important criteria to consider healthy seedlings due to its direct relationship with seedling establishment. In this study root length of sugarcane bud chip was measured between the treatments for comparison. At 10 DAP, longer root length (2.10 cm) was measured in sugarcane budded chip in the treatment of T_4 (0.5 g urea + 1% urea foliar spray on 15 DAP), which is comparable with T_1, T_3, T_5, T_6, T_7 and T_{11}. The same treatment (T_4) was recorded longer root length at 20 DAP and it was comparable with T_2 (0.5 g DAP / chip bud (25 g/50 wells portray)). During 30 DAP, T10 produced longer root length of 24.8 cm and it was on par with T_{11} and T_{13}. The shorter root length was recorded in T_7 as 14.6 cm at 30 DAP(Table 4).

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Table.5. Effect of different nutrients on Vigour Index of chip budded seedlings

Treatments	Vigour Index		
	10 DAP	**20 DAP**	**30 DAP**
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	1255	3627	3929
T_2 -0.5 g DAP / chip bud "	1216	4002	5076
T_3 -0.5 g $ZnSo_4$ / chip bud "	1187	2614	4871
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	**1475**	**4900**	**6787**
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	989	2926	4315
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1145	3311	4551
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	926	3263	5341
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	1099	4097	5055
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1006	4289	6091
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	1060	4178	6469
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	1155	3568	6248
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1116	4084	5246
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	1015	3851	5776
T_{14} –Control	1132	2805	4710
SEd	**115**	126	**156**
CD (P=0.05)	**230**	289	**318**

The effect of different nutrients on vigour index of chip budded seedlings were studied. Over different treatments, T_4 (0.5 g urea + 1% urea foliar spray on 15 DAP) gave higher vigour index of 1475, 4900 and 6787 in order to 10 DAP, 20 DAP and 30 DAP due to higher germination percentage, shoot length and root length recorded by this treatment(Indira *et al.*, 2018). Next to that, T1 (0.5 g urea/ chip bud (25 g/50 wells portray)), T9 (0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP) and T10 (0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP) were gave higher vigour index at 10 DAP, 20 DAP and 30 DAP respectively. In this, T1 and T10 were comparable with T4 at 10 DAP and 30 DAP respectively. The lower vigour index of budded chip was recorded in T7 (0.5 g DAP + 1% urea foliar spray on 15 DAP), T3 (0.5 g $ZnSo_4$ / chip bud (25 g/50 wells portray)) and T1 (0.5 g urea/ chip bud (25 g/50 wells portray)) at 10 DAP (926), 20 DAP (2614) and 30 DAP (4315) respectively(Table 5).

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Table 6. Effect of different nutrients on number of leaves per chip budded seedling

Treatments	10 DAP	20 DAP	30 DAP
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	1.80	2.80	3.60
T_2 -0.5 g DAP / chip bud "	2.10	3.00	3.80
T_3 -0.5 g $ZnSo_4$ / chip bud "	1.90	2.70	3.30
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	1.80	2.70	3.20
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	1.80	2.50	3.00
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1.80	2.70	3.80
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	1.50	2.80	3.70
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	1.20	2.70	3.70
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1.50	2.70	3.60
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	1.50	2.70	3.50
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	1.90	2.50	3.20
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	1.20	2.60	3.20
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	1.20	2.70	3.00
T_{14} –Control	1.60	2.40	2.90
SEd	**0.20**	**0.29**	**0.15**
CD (P=0.05)	**0.41**	**NS**	**0.32**

Among the different treatments, T_2 (0.5 g DAP / chip bud (25 g/50 wells portray)) was produced more number of leaves (2.10) on 10 DAP. This was comparable with T_1, T_3, T_4, T_5 and T_6. The less number of leaves recorded in T_8, T_{12} and T_{13}. At 20 DAP, T_2 (0.5 g DAP / chip bud (25 g/50 wells portray)) was recorded maximum number of leaves (3.0) and the lower no of leaves (2.40) were produced in T_{14} (Control). Subsequently, T_2 (0.5 g DAP / chip bud (25 g/50 wells portray)) & T_6 (0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP) were produced maximum number of leaves/plant on 30 DAP as 3.80 and these were on par with T_1, T_7, T_8, T_9 and T_{10}. While, T_{14} (Control) produced lower no of leaves (2.90) on 30 DAP(Table 6).

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Table. 7. Effect of different nutrients on root volume (cubic centimeter) of chip budded seedlings

Treatments	10 DAP	20 DAP	30 DAP
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	0.08	0.22	0.48
T_2 -0.5 g DAP / chip bud "	0.24	0.28	0.59
T_3 -0.5 g $ZnSo_4$ / chip bud "	0.13	0.28	0.13
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	0.44	0.19	0.40
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	0.22	0.18	0.41
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	0.26	0.16	0.42
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	0.25	0.27	0.87
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	0.23	0.30	0.34
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	0.18	0.18	0.49
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	0.30	0.18	0.79
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	0.25	0.26	0.42
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	0.30	0.25	0.59
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	0.36	0.19	0.67
T_{14} –Control	0.26	0.29	0.30
SEd	**0.06**	**0.06**	**0.15**
CD (P=0.05)	**0.12**	**NS**	**0.31**

Greater root volume of seedling (0.44 cm^3) was recorded in T_4 (0.5 g urea + 1% urea foliar spray on 15 DAP) during 10 DAP over different treatments and the lower root volume (0.13 cm^3) was recorded in T_3 (0.5 g $ZnSo_4$ / chip bud (25 g/50 wells portray)). This trend was varied at 20 DAP, when T_8 produced higher root volume of 0.30 cm^3. Followed by T_{14} (Control), T2 and T3 were produced higher root volume of 0.29 cm^3, 0.28 cm^3 and 0.28 cm^3 respectively. The lowest root volume of 0.16 cm^3 was recorded in T_6 (0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP). At final observation on 30 DAP, T_7 (0.5 g DAP + 1% urea foliar spray on 15 DAP) produced higher root volume of 0.87 cm^3 and the lowest root volume (0.13 cm^3) was recorded in T_3 (0.5 g $ZnSo_4$ / chip bud (25 g/50 wells portray)(Table 7).

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Table 8 : Economics chip budded seedlings produced with different nutrients

Treatments	Seed Cane Cost (Rs./Seedling) (A)	Labourer + Maintenance Cost (Rs./seedling) (B)	Media Cost (Rs./seedling) (C)	Input Cost (Rs./seedling) (D)	Total Cost (Rs./seedling) (E =A+B+C+D)	Sale Price (Rs./ seedling)	B:C
T_1 -0.5 g urea/ chip bud (25 g/50 wells portray)	0.22	0.65	0.17	0.03	1.07	1.50	1.40
T_2 -0.5 g DAP / chip bud "	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T_3 -0.5 g $ZnSo_4$ / chip bud "	0.22	0.65	0.17	0.04	1.08	1.50	1.39
T_4-0.5 g urea + 1% urea foliar spray on 15 DAP	0.21	0.65	0.17	0.03	1.06	1.50	1.42
T_5-0.5 g urea + 1% DAP foliar spray on 15 DAP	0.22	0.65	0.17	0.03	1.07	1.50	1.40
T_6-0.5 g urea + 0.5% $ZnSo_4$ foliar spray on 15 DAP	0.22	0.65	0.17	0.03	1.07	1.50	1.40
T_7 -0.5 g DAP + 1% urea foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T_8 -0.5 g DAP + 1% DAP foliar spray on 15 DAP	0.21	0.65	0.17	0.04	1.07	1.50	1.40
T_9 -0.5 g DAP + 0.5% $ZnSo_4$ foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T_{10}-0.5 g $ZnSo_4$ + 1% urea foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T_{11}-0.5 g $ZnSo_4$ + 1% DAP foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T_{12}-0.5 g $ZnSo_4$ + 0.5% $ZnSo_4$ foliar spray on 15 DAP	0.22	0.65	0.17	0.04	1.08	1.50	1.39
T_{13} -Panchakavya 3% spray on 15 and 25 DAP	0.21	0.65	0.17	0.04	1.07	1.50	1.40
T_{14} –Control	0.22	0.65	0.17	0.04	1.08	1.50	1.39

There was no significant difference in economics of different nutrients on sugarcane budded chip. Seed cane cost varied from Rs. 0.20 to 0.22/ seedling and there was no change in

maintenance and media cost for all treatments as Rs.0.65 and Rs. 0.17 respectively. Input cost varied from 0.03 to 0.04 and these were reflected on total production cost, which is minimum of 1.06 for treatments T_2, T_4, T_7, T_9, T_{10} and T_{11} to maximum of 1.08 for T_3, T_{12} and T_{14}. The sale price for single seedling is Rs. 1.50 and there was no difference in sale price according to production cost(Annadurai *et. al.*, 2024). The B:C was different at different treatments. The higher B:C was worked out T_2, T_4, T_7, T_9, T_{10} and T_{11}. Followed by B:C of 1.40 was recorded in treatments T_1, T_5, T_6, T_8 and T_{13}. The low B:C of 1.39 was recorded in T_3, T_{12} and T_{14}(Table 8).

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4 . Conclusion

From the above study, it could be concluded that addition of nutrients to the growing media and spraying of nutrients to the growing seedlings of chip budded seedlings in the protray under shade net nursery which could be transplanted in the main field at appropriate time. Application of 0.5 g urea/bud (6.25 kg of urea for 12500 seedlings required for planting 1.0 ha) along with foliar spraying of 1% urea at 15 DAP recorded highest vigour index of chip budded seedlings of sugarcane at 30 DAP. Hence, it was recommended that application of nitrogen in the form of urea to the growing media along with foliar spraying could be an appropriate method to get vigorous chip budded seedlings of sugarcane for planting under Sustainable Sugarcane Initiative(SSI).

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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