



# Standardization of Nutrients Required for Raising Pro Tray Chip Budded Sugarcane Seedlings for Sustainable Sugarcane Initiative (SSI) Technology

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Field investigations 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

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nursery nutrient management and nutrient spraying on chip budded seedlings for finding out the standardizing the nutrients required for getting vigorous chip 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 [1]. 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 [2]. 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<sup>-1</sup> is used as planting material, consisting of around 40,000 stalk pieces with 2-3 buds [3]. 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 [4]. 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 [5], 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 [6] and Ramaiah et al. [7] 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 [8,9]. According to Roohi et al. [10], the cane and sugar production over RDF are significantly increased by three foliar sprays of 2% NPK + 0.5% ZnSO<sub>4</sub> + 1% FeSO<sub>4</sub> 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 [11]. According to Mohanty's [12] 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. [13] reported that New method of planting of sugarcane pre-sprouted seedling improve the stalk yield and sugar yield of sugarcane. Sugarcane responds better to application of micaschist powder as fertilizer [14]. Supply of Silicon via nutrient solution in pre-sprouted sugarcane seedlings [15] or silica solubilizer at a rate of 12.5 kg with 50 kg FYM/ha in soil with sett treatment of 0.5% K<sub>2</sub>SiO<sub>3</sub>, 2.5% urea and potash foliar spray [16] 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.

## 2.1 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.

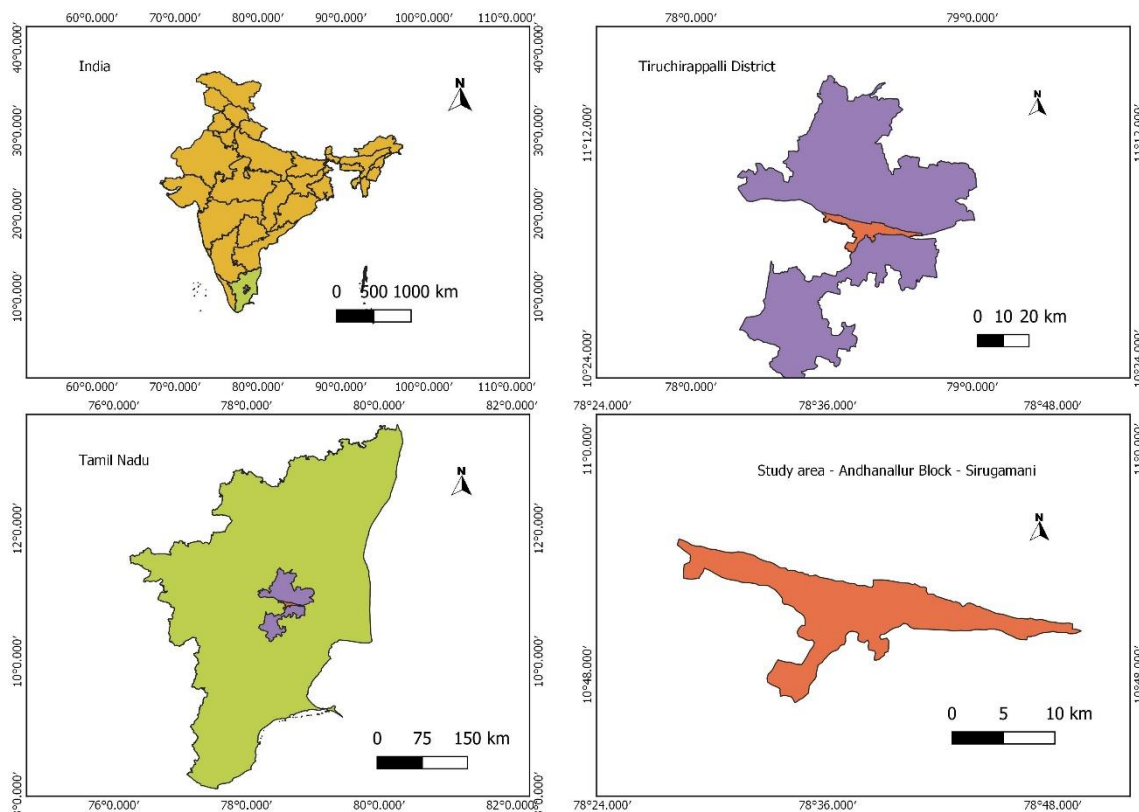


Fig. 1. Study area map

Table 1. Details of treatments

Treatments	Nutrients added/sprayed
T <sub>1</sub>	0.5 g urea/ chip bud (25 g/50 wells portray)
T <sub>2</sub>	0.5 g Diammonium Phosphate(DAP) / chip bud
T <sub>3</sub>	T <sub>1</sub> +0.5 g ZnSo <sub>4</sub> / chip bud (25 g/50 wells portray)
T <sub>4</sub>	0.5 g urea + 1% urea foliar spray on 15 DAP
T <sub>5</sub>	0.5 g urea + 1% DAP foliar spray on 15 DAP
T <sub>6</sub>	0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP
T <sub>7</sub>	0.5 g DAP + 1% urea foliar spray on 15 DAP
T <sub>8</sub>	0.5 g DAP + 1% DAP foliar spray on 15 DAP
T <sub>9</sub>	-0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP
T <sub>10</sub>	-0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP
T <sub>11</sub>	0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP
T <sub>12</sub>	0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP
T <sub>13</sub>	Panchakavya 3% spray on 15 and 25 DAP
T <sub>14</sub>	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<sub>4</sub> 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 [17]. 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 spraying of 1% DAP (T<sub>8</sub>) 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<sub>4</sub> at basal and spraying of 1% DAP on 15 DAP (T<sub>11</sub>) 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 <sub>1</sub> -0.5 g urea/ chip bud (25 g/50 wells portray)	68.8	71.6	61.3
T <sub>2</sub> -0.5 g DAP / chip bud "	65.6	68.7	70.7
T <sub>3</sub> -0.5 g ZnSo <sub>4</sub> / chip bud "	61.9	63.6	66.0
T <sub>4</sub> -0.5 g urea + 1% urea foliar spray on 15 DAP	59.1	64.8	70.7
T <sub>5</sub> -0.5 g urea + 1% DAP foliar spray on 15 DAP	61.9	62.4	62.0
T <sub>6</sub> -0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	61.5	63.0	65.3
T <sub>7</sub> -0.5 g DAP + 1% urea foliar spray on 15 DAP	75.1	80.0	77.3
T <sub>8</sub> -0.5 g DAP + 1% DAP foliar spray on 15 DAP	<b>72.7</b>	<b>80.0</b>	<b>84.0</b>
T <sub>9</sub> -0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	71.9	79.2	77.3
T <sub>10</sub> -0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP	71.5	75.5	78.7
T <sub>11</sub> -0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP	<b>71.6</b>	<b>76.5</b>	<b>80.0</b>
T <sub>12</sub> -0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	71.2	74.8	69.3
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	73.7	76.5	73.3
T <sub>14</sub> -Control	69.9	74.1	64.7
<b>SEd</b>	2.85	3.16	3.20
<b>CD (P=0.05)</b>	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<sub>7</sub> (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 nitrogenous materials to nursery growing media for chip budded seedlings [18,19]. At the same time there was no significant difference between T<sub>1</sub>, T<sub>7</sub>, T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub>, T<sub>12</sub>, T<sub>13</sub> and T<sub>14</sub>. The lower germination was observed in T<sub>4</sub> (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<sub>7</sub> (0.5 g DAP + 1% urea foliar spray on 15 DAP) and T<sub>8</sub> (0.5 g DAP + 1% DAP foliar spray on 15 DAP). These were on par with T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub>, T<sub>12</sub>, T<sub>13</sub> and T<sub>14</sub>. Treatment T<sub>5</sub> (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 T<sub>8</sub> gave highest germination as 84 % and it was comparable with T<sub>11</sub> (0.5 g ZnSO<sub>4</sub> + 1% DAP foliar spray on 15 DAP) and T<sub>10</sub> (0.5 g ZnSO<sub>4</sub> + 1% urea foliar spray on 15 DAP). Next to that, T<sub>7</sub> (0.5 g DAP + 1% urea foliar spray on 15 DAP) obtained higher germination of 77.3 %. The lowest germination was recorded in T<sub>1</sub> (0.5 g urea/ chip bud (25 g/50 wells portray)) (Table 2).

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<sub>4</sub> (0.5 g urea

+ 1% urea foliar spray on 15 DAP), which produced 20.39 cm. Followed by T<sub>3</sub> produced 17.29 cm height seedlings and the lowest was recorded in T<sub>9</sub> (0.5 g DAP + 0.5% ZnSO<sub>4</sub> foliar spray on 15 DAP) as 12.50 cm. Against to this result, T<sub>9</sub> produced taller seedlings (44.5 cm) on 20 DAP, which is on par with T<sub>8</sub> (43.9 cm), T<sub>10</sub> (43.6 cm) and T<sub>12</sub> (40.4 cm). Next to this T<sub>4</sub> (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<sub>14</sub>). At 30 DAP, again T<sub>4</sub> (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<sub>3</sub>, T<sub>9</sub> and T<sub>10</sub>. The shorter seedlings were recorded in T<sub>1</sub> (0.5 g urea/ chip bud (25 g/50 wells portray)) with 47.6 cm seedling height (Table 3).

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<sub>4</sub> (0.5 g urea + 1% urea foliar spray on 15 DAP), which is comparable with T<sub>1</sub>, T<sub>3</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>7</sub> and T<sub>11</sub>. The same treatment (T<sub>4</sub>) was recorded longer root length at 20 DAP and it was comparable with T<sub>2</sub> (0.5 g DAP / chip bud (25 g/50 wells portray)). During 30 DAP, T<sub>10</sub> produced longer root length of 24.8 cm and it was on par with T<sub>11</sub> and T<sub>13</sub>. The shorter root length was recorded in T<sub>7</sub> as 14.6 cm at 30 DAP (Table 4).

**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 <sub>1</sub> -0.5 g urea/ chip bud (25 g/50 wells portray)	16.44	37.2	47.6
T <sub>2</sub> -0.5 g DAP / chip bud "	14.70	39.1	52.3
T <sub>3</sub> -0.5 g ZnSO <sub>4</sub> / chip bud "	17.29	37.2	57.1
T <sub>4</sub> -0.5 g urea + 1% urea foliar spray on 15 DAP	<b>20.39</b>	<b>39.4</b>	<b>59.7</b>
T <sub>5</sub> -0.5 g urea + 1% DAP foliar spray on 15 DAP	14.19	37.3	52.1
T <sub>6</sub> -0.5 g urea + 0.5% ZnSO <sub>4</sub> foliar spray on 15 DAP	16.83	39.3	50.1
T <sub>7</sub> -0.5 g DAP + 1% urea foliar spray on 15 DAP	13.88	37.0	54.5
T <sub>8</sub> -0.5 g DAP + 1% DAP foliar spray on 15 DAP	13.93	43.9	52.7
T <sub>9</sub> -0.5 g DAP + 0.5% ZnSO <sub>4</sub> foliar spray on 15 DAP	12.50	44.5	58.5
T <sub>10</sub> -0.5 g ZnSO <sub>4</sub> + 1% urea foliar spray on 15 DAP	13.33	43.6	57.4
T <sub>11</sub> -0.5 g ZnSO <sub>4</sub> + 1% DAP foliar spray on 15 DAP	14.23	36.0	54.8
T <sub>12</sub> -0.5 g ZnSO <sub>4</sub> + 0.5% ZnSO <sub>4</sub> foliar spray on 15 DAP	14.47	40.4	53.3
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	12.57	33.8	55.3
T <sub>14</sub> -Control	14.60	29.0	53.1
<b>SEd</b>	<b>0.87</b>	<b>1.66</b>	<b>1.54</b>
<b>CD (P=0.05)</b>	<b>1.80</b>	<b>3.41</b>	<b>3.10</b>

**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 <sub>1</sub> -0.5 g urea/ chip bud (25 g/50 wells portray)	1.80	13.5	16.5
T <sub>2</sub> -0.5 g DAP / chip bud "	1.50	19.2	19.5
T <sub>3</sub> -0.5 g ZnSo <sub>4</sub> / chip bud "	1.90	3.9	16.7
T <sub>4</sub> 0.5 g urea + 1% urea foliar spray on 15 DAP	<b>2.10</b>	<b>21.9</b>	<b>21.1</b>
T <sub>5</sub> 0.5 g urea + 1% DAP foliar spray on 15 DAP	1.80	9.6	17.5
T <sub>6</sub> 0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1.80	13.3	19.6
T <sub>7</sub> -0.5 g DAP + 1% urea foliar spray on 15 DAP	1.80	13.3	14.6
T <sub>8</sub> -0.5 g DAP + 1% DAP foliar spray on 15 DAP	1.20	7.4	18.8
T <sub>9</sub> -0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1.50	9.7	20.3
T <sub>10</sub> 0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP	1.50	11.8	24.8
T <sub>11</sub> 0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP	1.90	10.6	23.3
T <sub>12</sub> 0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1.20	14.2	22.4
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	1.20	16.5	23.5
T <sub>14</sub> -Control	1.60	8.9	19.7
<b>SEd</b>	<b>0.20</b>	<b>1.88</b>	<b>0.94</b>
<b>CD (P=0.05)</b>	<b>0.41</b>	<b>3.87</b>	<b>1.98</b>

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

Treatments	Vigour Index		
	10 DAP	20 DAP	30 DAP
T <sub>1</sub> -0.5 g urea/ chip bud (25 g/50 wells portray)	1255	3627	3929
T <sub>2</sub> -0.5 g DAP / chip bud "	1216	4002	5076
T <sub>3</sub> -0.5 g ZnSo <sub>4</sub> / chip bud "	1187	2614	4871
T <sub>4</sub> 0.5 g urea + 1% urea foliar spray on 15 DAP	<b>1475</b>	<b>4900</b>	<b>6787</b>
T <sub>5</sub> 0.5 g urea + 1% DAP foliar spray on 15 DAP	989	2926	4315
T <sub>6</sub> 0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1145	3311	4551
T <sub>7</sub> -0.5 g DAP + 1% urea foliar spray on 15 DAP	926	3263	5341
T <sub>8</sub> -0.5 g DAP + 1% DAP foliar spray on 15 DAP	1099	4097	5055
T <sub>9</sub> -0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1006	4289	6091
T <sub>10</sub> 0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP	1060	4178	6469
T <sub>11</sub> 0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP	1155	3568	6248
T <sub>12</sub> 0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1116	4084	5246
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	1015	3851	5776
T <sub>14</sub> -Control	1132	2805	4710
<b>SEd</b>	<b>115</b>	<b>126</b>	<b>156</b>
<b>CD (P=0.05)</b>	<b>230</b>	<b>289</b>	<b>318</b>

The effect of different nutrients on vigour index of chip budded seedlings were studied. Over different treatments, T<sub>4</sub> (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 [20]. Next to that, T<sub>1</sub> (0.5 g urea/ chip bud (25 g/50 wells portray)), T<sub>9</sub> (0.5 g DAP + 0.5% ZnSo<sub>4</sub> foliar spray on 15 DAP) and T<sub>10</sub> (0.5 g ZnSo<sub>4</sub> + 1% urea foliar spray on 15 DAP) were gave higher vigour index at 10 DAP, 20 DAP and 30 DAP respectively. In this, T<sub>1</sub> and T<sub>10</sub> were comparable with T<sub>4</sub> at 10 DAP and 30 DAP respectively. The lower vigour index of budded chip was recorded in T<sub>7</sub> (0.5 g DAP + 1% urea foliar spray on 15 DAP), T<sub>3</sub> (0.5 g ZnSo<sub>4</sub> / chip bud (25 g/50 wells portray)) and T<sub>1</sub> (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).

Among the different treatments, T<sub>2</sub> (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<sub>1</sub>, T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>. The less number of leaves recorded in T<sub>8</sub>, T<sub>12</sub> and T<sub>13</sub>. At 20 DAP, T<sub>2</sub> (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<sub>14</sub> (Control). Subsequently, T<sub>2</sub> (0.5 g DAP / chip bud (25 g/50 wells portray)) & T<sub>6</sub> (0.5 g urea + 0.5% ZnSo<sub>4</sub> 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<sub>1</sub>, T<sub>7</sub>, T<sub>8</sub>, T<sub>9</sub> and T<sub>10</sub>. While, T<sub>14</sub> (Control) produced lower no of leaves (2.90) on 30 DAP (Table 6).

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

Treatments	10 DAP	20 DAP	30 DAP
T <sub>1</sub> -0.5 g urea/ chip bud (25 g/50 wells portray)	1.80	2.80	3.60
T <sub>2</sub> -0.5 g DAP / chip bud "	2.10	3.00	3.80
T <sub>3</sub> -0.5 g ZnSo <sub>4</sub> / chip bud "	1.90	2.70	3.30
T <sub>4</sub> -0.5 g urea + 1% urea foliar spray on 15 DAP	1.80	2.70	3.20
T <sub>5</sub> -0.5 g urea + 1% DAP foliar spray on 15 DAP	1.80	2.50	3.00
T <sub>6</sub> -0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1.80	2.70	3.80
T <sub>7</sub> -0.5 g DAP + 1% urea foliar spray on 15 DAP	1.50	2.80	3.70
T <sub>8</sub> -0.5 g DAP + 1% DAP foliar spray on 15 DAP	1.20	2.70	3.70
T <sub>9</sub> -0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1.50	2.70	3.60
T <sub>10</sub> -0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP	1.50	2.70	3.50
T <sub>11</sub> -0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP	1.90	2.50	3.20
T <sub>12</sub> -0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	1.20	2.60	3.20
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	1.20	2.70	3.00
T <sub>14</sub> -Control	1.60	2.40	2.90
<b>SEd</b>	<b>0.20</b>	<b>0.29</b>	<b>0.15</b>
<b>CD (P=0.05)</b>	<b>0.41</b>	<b>NS</b>	<b>0.32</b>

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

Treatments	10 DAP	20 DAP	30 DAP
T <sub>1</sub> -0.5 g urea/ chip bud (25 g/50 wells portray)	0.08	0.22	0.48
T <sub>2</sub> -0.5 g DAP / chip bud "	0.24	0.28	0.59
T <sub>3</sub> -0.5 g ZnSo <sub>4</sub> / chip bud "	0.13	0.28	0.13
T <sub>4</sub> -0.5 g urea + 1% urea foliar spray on 15 DAP	0.44	0.19	0.40
T <sub>5</sub> -0.5 g urea + 1% DAP foliar spray on 15 DAP	0.22	0.18	0.41
T <sub>6</sub> -0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	0.26	0.16	0.42
T <sub>7</sub> -0.5 g DAP + 1% urea foliar spray on 15 DAP	0.25	0.27	0.87
T <sub>8</sub> -0.5 g DAP + 1% DAP foliar spray on 15 DAP	0.23	0.30	0.34
T <sub>9</sub> -0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	0.18	0.18	0.49
T <sub>10</sub> -0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP	0.30	0.18	0.79
T <sub>11</sub> -0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP	0.25	0.26	0.42
T <sub>12</sub> -0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	0.30	0.25	0.59
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	0.36	0.19	0.67
T <sub>14</sub> -Control	0.26	0.29	0.30
<b>SEd</b>	<b>0.06</b>	<b>0.06</b>	<b>0.15</b>
<b>CD (P=0.05)</b>	<b>0.12</b>	<b>NS</b>	<b>0.31</b>

Greater root volume of seedling (0.44 cm<sup>3</sup>) was recorded in T<sub>4</sub> (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<sup>3</sup>) was recorded in T<sub>3</sub> (0.5 g ZnSo<sub>4</sub> / chip bud (25 g/50 wells portray)). This trend was varied at 20 DAP, when T<sub>8</sub> produced higher root volume of 0.30 cm<sup>3</sup>. Followed by T<sub>14</sub> (Control), T<sub>2</sub> and T<sub>3</sub> were produced higher root volume of 0.29 cm<sup>3</sup>, 0.28 cm<sup>3</sup> and 0.28 cm<sup>3</sup> respectively. The lowest root volume of 0.16 cm<sup>3</sup> was recorded in T<sub>6</sub> (0.5 g urea + 0.5% ZnSo<sub>4</sub> foliar spray on 15 DAP). At final observation on 30 DAP, T<sub>7</sub> (0.5 g DAP + 1% urea foliar spray on 15 DAP) produced higher root volume of 0.87 cm<sup>3</sup> and the lowest root volume (0.13 cm<sup>3</sup>) was recorded in T<sub>3</sub> (0.5 g ZnSo<sub>4</sub> / chip bud (25 g/50 wells portray) (Table 7).

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<sub>2</sub>, T<sub>4</sub>, T<sub>7</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub> to maximum of 1.08 for T<sub>3</sub>, T<sub>12</sub> and T<sub>14</sub>. The sale price for single seedling is Rs. 1.50 and there was no difference in sale price according to production cost [21]. The B:C was different at different treatments. The higher B:C was worked out T<sub>2</sub>, T<sub>4</sub>, T<sub>7</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub>. Followed by B:C of 1.40 was recorded in treatments T<sub>1</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>8</sub> and T<sub>13</sub>. The low B:C of 1.39 was recorded in T<sub>3</sub>, T<sub>12</sub> and T<sub>14</sub> (Table 8).

**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 <sub>1</sub> -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 <sub>2</sub> -0.5 g DAP / chip bud "	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T <sub>3</sub> -0.5 g ZnSo <sub>4</sub> / chip bud "	0.22	0.65	0.17	0.04	1.08	1.50	1.39
T <sub>4</sub> -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 <sub>5</sub> -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 <sub>6</sub> -0.5 g urea + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	0.22	0.65	0.17	0.03	1.07	1.50	1.40
T <sub>7</sub> -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 <sub>8</sub> -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 <sub>9</sub> -0.5 g DAP + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T <sub>10</sub> -0.5 g ZnSo <sub>4</sub> + 1% urea foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T <sub>11</sub> -0.5 g ZnSo <sub>4</sub> + 1% DAP foliar spray on 15 DAP	0.20	0.65	0.17	0.04	1.06	1.50	1.42
T <sub>12</sub> -0.5 g ZnSo <sub>4</sub> + 0.5% ZnSo <sub>4</sub> foliar spray on 15 DAP	0.22	0.65	0.17	0.04	1.08	1.50	1.39
T <sub>13</sub> -Panchakavya 3% spray on 15 and 25 DAP	0.21	0.65	0.17	0.04	1.07	1.50	1.40
T <sub>14</sub> –Control	0.22	0.65	0.17	0.04	1.08	1.50	1.39



#### 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).

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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