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P Sreelatha
Department of Crop Physiology, S.V. Agricultural College, Tirupati, Andhra Pradesh, India

V Umamahesh
Department of Crop Physiology, S.V. Agricultural College, Tirupati, Andhra Pradesh, India

D Subramanyam
Department of Agronomy, S.V. Agricultural College, Tirupati, Andhra Pradesh, India

NV Sarala
Department of Agronomy, A.R.S Perumallapalli, Andhra Pradesh, India

Correspondence
V Umamahesh
Department of Crop Physiology, S.V. Agricultural College, Tirupati, Andhra Pradesh, India

Effect of different chemical treatments on field performance of sugarcane planting materials

P Sreelatha, V Umamahesh, D Subramanyam and NV Sarala

Abstract
The present study was aimed at improving growth and development of two planting materials (bud chips and three budded setts) of sugarcane cultivar 2003T121 by pre-planting soaking in growth-promoting chemicals viz Cow dung slurry (20%), Ethereal (100ppm), Calcium chloride (2g/lit), CEPA (5ppm), Calcium chloride+CEPA, along with control and water soaking for 24 hrs. Treated planting materials showed better results in all growth and biochemical attributes. Leaf area index and crop growth rate were found to be more in water soaking (1.33,9.75) and $CaCl_2$+CEPA (1.27,9.68) in three budded setts where as in bud chip raised seedlings LAI was recorded highest with water soaking (0.43) treatment, lowest values were seen in Cow dung slurry (0.22) CGR recorded highest with $CaCl_2$+CEPA (2.61). Reducing sugars and brix values were also recorded high in $CaCl_2$+CEPA (2.87) and T_2 Water soaking (2.87) whereas lowest values were recorded in T_1 (Control) (1.62)and T_3 (Cow dung slurry) (1.74).

Keywords: Chemical treatments, field performance, sugarcane planting materials

Introduction
Sugarcane is an oldest crop known to man, a major crop of tropical and sub-tropical regions worldwide. It is a glycophyte, sucrose storing member of tall growing perennial monocotyledonous grass. Across the world 70% sugar is manufactured from sugarcane. India is the second largest country in sugarcane production in the world. The sugarcane cultivation and sugar industry in India plays a vital role towards socio-economic development in the rural areas by mobilizing rural resources and generating higher income and employment opportunities.

Sugarcane is commercially planted using stalk cuttings or setts. In conventional system prevailing in India, about 6-8 tonnes of seed cane per hectare (nearly 10 per cent of produce) is used as planting material. This method of cultivation is gradually becoming uneconomical, as it accounts for over 20 per cent of the total cost of production besides this large mass of planting material poses a great problem in transport, handling and storage of seed cane and undergoes rapid deterioration and decrease viability of buds.

A viable alternative to reduce the mass and improve the quality of seed cane would be the plant excised auxillary buds of cane stalk called bud chips, which are less bulky, more economical and more easily transportable seed material. Through bud chip method bud chip raised seedlings shall be transplanted instead of the normal sett planting. This component itself has evolved over a period of around 60 years. The noted Sugarcane Physiologist, Van Dillewijn. (1952) [17] was first to suggest that a small volume of tissue and a single root primordium adhering to the bud are enough to ensure germination in sugarcane. However, this technology has not been scaled up at commercial level due to poor survival of bud chips under field conditions. Bud chips consist of lower food reserves (1.2 -1.8g sugar) per bud compared to conventional three budded sett material (6-8 g sugar per bud). The food reserves and moisture content in bud chips depletes faster compared to 2-3 bud setts which reflects in their poor sprouting and early growth.

Further, 2003T121 is a popular pre release cultivar of sugarcane from southern agroclimatic zone of AP with higher yield potential, non flowering habit and good quality jaggery. But it has a specific problem related to field emergence both in setts and bud chips. Germination percentage in this cultivar is very poor (as low as 40 per cent) with a prolonged spread of germination period.

Thus, the present study was conducted to know the effect of various growth promoting substances on growth and development of different planting materials of sugarcane cultivar 2003T121.

Material and Methods

Two separate layouts were laid side by side with Randomized Block Design (RBD) with 7 treatments and replicated three times. Two planting materials were used one is three budded sett and another one is bud chip raised seedling. These two planting materials were planted in two different blocks.

Seven treatments were imposed before planting in both planting materials. The treatments were. T_1 - Control (untreated), T_2 - Water soaking for 24hrs, T_3 - Soaking with 20% of Cow dung slurry for 24hrs, T_4 - 100 ppm Etherel for 24hrs, T_5 – soaking with 20mg lit^{-1} of $CaCl_2$ for 30 min, T_6 – soaking with CEPA (5ppm) for 30 min, T_7 - soaking with $CaCl_2$+CEPA for 30 min. Treated bud chips were maintained up to 45 days in green house, then transferred in to field. Sampling was done at 15 days interval. For this purpose three randomly labeled plants from each replication for each treatment were dug out with roots. Data was recorded on the following parameters.

1. Shoot length (cm)

Shoot length was measured from the base of the plant to tip of the leaf at 15, 30 and 45 DAP and was expressed in centimeters.

2. Root length (cm)

Root length was measured from the base of the plant to the tip of the longer root at 15, 30 and 45 DAP and were expressed in centimeters.

3. Leaf area (LA) (cm2plant-1)

After separation of leaves from the plant, leaf area was estimated using leaf area meter (Li-COR model LI 3000) and expressed as cm2plant-1.

4. Leaf area index (LAI)

The leaf area index was calculated by dividing the total leaf area with the corresponding ground area.

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Ground area}}$$

5. Crop growth rate (CGR) (g m^{-2} day^{-1})

Crop growth rate was calculated as per the formula.

$$\text{CGR} = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{1}{P}$$

6. Number of tillers and leaves

Number of tillers and leaves were count for each plant at different growth stages from randomly labelled three plants in each replication.

Biochemical Observations

1. Reducing sugars

Reducing sugars were estimated by the method suggested by the Nelson (1944) [15].

For the estimation of reducing sugars, 250 mg finely chopped buds were grinded with 10 ml of boiling ethanol (80%) and the material was centrifuged at 6,000 rpm at room temperature.

After the centrifugation the supernatant was collected and to this 5ml of distilled water was added. The tubes were kept in boiling water bath for 15 min at 70 ºC. 0.5 ml of aliquot was drawn from this aqueous phase and mixed with 0.5ml of copper reagent. After cooling, 0.5 ml arsenomolybdate reagent was added, the volume was made up to 25 ml with distilled water, and the absorbance was measured at 540 nm. The results were expressed as mg g^{-1}.

2. Brix per cent

The brix represents the percentage by weight of solute (sucrose) content and was measured by using hand Refractometer.

Results and discussion

1. Number of tillers

Number of tillers of bud chip raised seedlings was affected significantly by different chemical treatments. Significantly higher tillers was observed in T_2 (water soaking) (5) followed by T_7 (CEPA+$CaCl_2$) (4), T_4 (ethrel) (4), T_6 (CEPA) (4) and T_5 (Calcium chloride) (4). There were no tillers observed at all growth stages in control and T_3 till 90 DAP.

Number of tillers of three budded setts was affected significantly by different chemical treatments. Significantly higher number of tillers was observed in T_7 (CEPA+$CaCl_2$) (7) but it was on par with T_6 (CEPA) (7) and T_5 (Calicum chloride) (7). T_2 (water soaking) (4), T_3 (cow dung slurry) (4) and T_4 (ethrel) (4) were found to be at par with control at 90 DAP. Venkataramana *et al*, (1991) also revealed that ethephon treatment in genotypes co1148 and co998 increased the tiller number an extent of 15-17 %. Due to ethephon promoted the differentiation of vascular bundles and enlarged the areas of epigenetic vessels and phloem in the leaves. It is there by improved the inner transport system, root activity, absorption ability of the plant and produced more number of tillers (17% more) when compared to control.

2. Crop growth rate (g m^2 day^{-1})

CGR was slow in the early stages i.e., up to 120 days age of the crop and then increased rapidly up to 180-240 DAP. During maturity phase 300-360 DAP CGR was very low (Venkataramana *et al.*, 1991).

Effect of different chemical treatments on CGR at different growth stages of bud chip raised seedlings, Significant difference was observed among treatments from 60 to 90 DAP. At 60 to 75 DAP T_2 (water soaking) recorded highest CGR (4.49 g $m^2 day^{-1}$) compared to control followed by T_7 (CEPA+$CaCl_2$) (2.99 g $m^2 day^{-1}$) and T_5 (calcium chloride) (2.38 g $m^2 day^{-1}$). T_3 (cow dung slurry) was found to be on par (0.64 g $m^2 day^{-1}$) with control (0.16 g $m^2 day^{-1}$).

Data on effect of different chemical treatments on CGR of three budded setts, was, the mean crop growth rate was slow in the early stages. CGR showed significant differences among different treatments at all the stages of crop growth. After imposition of different chemical treatments increase in CGR was observed between 60 to 90 DAP with all treatments. Among the treatments T_2 (water soaking) showed highly superior in crop growth rate (9.75 g $m^2 day^{-1}$) compared to control (2.56) which was on par with T_7 ($CaCl_2$+CEPA) (9.68 g $m^2 day^{-1}$) followed by T_5 (Calcium chloride) (8.87 g $m^2 day^{-1}$), T_4 (ethrel) (5.87 g $m^2 day^{-1}$). T_3 (cow dung slurry) recorded least CGR (1.83 g m^2 day^{-1}).

3. Leaf area index

Effect of different chemical treatments on LAI at different growth stages (60, 75 and 90 DAP) of bud chip seedlings was, observed a significant difference in LAI among treatments was observed at all the growth stages. Except at 75DAP. At 90 DAP T_2 (Water soaking) recorded highest LAI (0.43) followed T_7 ($CaCl_2$+CEPA) (0.39) which was on par with T_4 (Ethrel) (0.36) followed by T_5 (calcium chloride) (0.29) which was on par with T_6 (CEPA) (0.29).

Effect of different chemical treatments on LAI at different growth stages (60, 75 and 90 DAP) of three budded setts was observed a significant difference in LAI among treatments was observed at all the growth stages. At 90 DAP T_2 (water soaking) recorded highest LAI (1.33) over the control (0.33) followed by T_7 (CEPA+$CaCl_2$) (1.27), T_6 (CEPA) (1.03) and T_5 ($CaCl_2$) (0.63). T_4 (ethrel) (0.59) was found to be on par with T_3 (cow dung slurry) (0.58). Similar results were found by Sundara and Thirupal. (1994) where in foliar application of growth regulators increased the LAI. Application of GA_3 and NAA increased LAI to maximum compared to control and other plant growth regulators (IAA, Kinetin).

4. Leaf area (cm^2 $plant^{-1}$)

Effect of different chemical treatments on leaf area of sugarcane bud chip raised seedlings was observed, the data on leaf area at different growth stages indicated that leaf area was gradually increased from 60 DAP to 90 DAP in both bud chip seedlings and three budded setts, but compared to bud chip seedlings three budded setts showed more leaf area.

At 90 DAP T_2 recorded highest leaf Area (1085.64 cm^2 $plant^{-1}$) followed by T_7 (959.95 cm^2 $plant^{-1}$), T_4 (908.13 cm^2 $plant^{-1}$). Effect of different chemical treatments on leaf area of sugarcane three budded setts was observed At 90 DAP T_2 recorded highest leaf area (3330.25) followed by T_7 (3180.34 cm^2 $plant^{-1}$), T_6 (2577.78 cm^2 $plant^{-1}$).Similar results were found by Jain *et al*. (2010) [8] leaf area was increased with the treatment of 50-200 mg lit^{-1} of ethephon.

5. Shoot length (cm)

There was a significant difference observed among different chemical treatments with respect to shoot length. A continuous increase in shoot length was recorded from 60 DAP to 90 DAP. At 90DAP compare to control all treatments showed significant difference. Among these treatments T_2 (24.97cm), T_4 (24.17cm), T_5 (22.07cm), T_6 (21.70cm), T_7 (21.15cm) were found to be on par, followed by T_3 (cow dung slurry) (16.97cm) was found to be on par with control (14.83cm).

Results pertaining to the effect of different chemicals on shoot length of three budded setts of sugarcane was observed Significant difference was observed among all the treatments at all the growth stages. At 90 DAP T_7 ($CaCl_2$+CEPA) (37.9cm) showed highest significant difference, followed by T_2 (water soaking) (35.3cm), T_6 (CEPA) (32.63cm), T_4 (ethrel) (32.42cm). T_3 (cow dung slurry) (30.15cm), T_5 (calcium chloride) (31.3cm) were recorded lowest shoot length compared control (33cm).

6. Root length (cm)

In bud chip raised seedlings T_2 (water soaking) recorded significantly highest root length (28.30cm) compared to control (23.07cm) followed by T_7 (CEPA+$CACL_2$) (27.33cm), T_4 (ethrel) (26.83cm) and T_5 (calcium chloride) (21.57cm) at 90 DAP.

Ethephon and calcium chloride solutions enhanced root length in sugarcane by altering some of the key biochemical attributes essential for the early growth and also helped better establishment of bud chips under field conditions which is otherwise poor in untreated chips (Jain *et al*., 2011) [9]. Ethylene stimulates the root activity by enhancing the auxins concentration. In three budded setts T_2 (water soaking) recorded significantly highest root length (48.23 cm) compared to control (39.77 cm) followed by T_7 (CEPA+CACL2) (42.5 cm), T_5 (calcium chloride) (41.93 cm) and T_6 (CEPA) (41.22cm) at 90 DAP.

7. Brix

In bud chip raised seedlings different chemicals showed a continuously increased brix values. All treatments showed significant difference at all growth stages. At 90 DAP T_7 ($CaCl_2$+CEPA) recorded highest significant difference in brix percentage (6.87) compared to control (5.83) but this treatment was on par with T_5 (calcium chloride) (6.83).

In three budded setts At 90DAP T_7 (CEPA+$CaCl_2$) recorded highly significant brix percentage (6.9) compared to control (5.7). However T_7 (CEPA+$CaCl_2$) was found to be on par with T_5 (calcium chloride) (6.83) followed by T_2 (Water soaking) (6.3). T_3 (cow dung slurry) (5.83) was found to be on par with control (5.8), where as CEPA recorded lowest value (3.73).

8. Reducing sugars

Effect of different chemicals on reducing sugars of bud chip raised seedlings was decreased continuously from days after planting till 90 DAP. All treatments were showed significant difference at all the growth stages. At 60 DAP among all the treatments T_7 (CEPA+$CaCl_2$) showed highly significant difference (2.87 mg g^{-1}) compared to control (1.62 mg g^{-1}) but on par with T_2 (water soaking) (2.87 mg g^{-1}). Similar results were found by Jain *et al*. (2011) [9] Increase in reducing sugars when treated with ethephon (0.1g lit^{-1}) and calcium chloride (1g lit^{-1}) was observed in sprouted buds. Ethephon and Calcium chloride improve the activity of acid invertase and ATPase enzymes. Acid invertase hydrolyses sucrose in to hexoses, increases the concentration of reducing sugars.

Effect of different chemicals on reducing sugars of of three budded setts was decreased continuously from days after planting till 90 DAP. At 60 DAP T_7 recorded highly significant difference (5.85 mg g^{-1}) compared to control (2.99 mg g^{-1}), followed by T_2 (Water soaking) (4.86 mg g^{-1}), T_4 (Ethrel) (4.51 mg g^{-1}) and T_5 (calcium chloride) (4.45 mg g^{-1}). T_3 (cow dung slurry) (2.88 mg g^{-1}) and T_6 (CEPA) (3.91 mg g^{-1}) were on par with control (2.99 mg g^{-1}).

Table 1: effect of different chemical treatments on growth of bud chip raised seedlings

S. No	Treatments	Shoot length	Root length	Leaf area	No. of leaves	LAI	CGR	No. of tillers	Reducing sugars
T_1	Control	33	39.77	1078.51	8.67	0.43	2.56	4.00	2.99
T_2	Water soaking	35.3	48.23	3330.25	8.67	1.33	9.75	4.00	4.86
T_3	Cow dung slurry	30.15	39.77	1458.59	8.33	0.58	1.83	4.00	2.88
T_4	Ethrel	32.63	30.6	1471.86	9.00	0.59	5.87	4.00	4.51
T_5	$CaCl_2$	31.3	41.93	1567.52	9.00	0.63	8.87	7.00	4.45
T_6	CEPA	32.42	41.22	2577.78	9.00	1.03	3.16	7.00	3.91
T_7	$CaCl_2$+CEPA	37.9	42.5	3180.34	10.00	1.27	9.68	7.00	5.85

	MEAN	33.24	40.57	2094.98	8.95	0.84	5.96	5.29	4.21
	CD	0.69	0.77	16.70	0.60	0.01	2.09	0.68	0.963
	SEm ±	0.22	0.25	5.26	0.19	0.00	0.68	0.22	0.309

Table 2: Effect of different chemical treatments on growth of three budded setts.

S. No	Treatments	Shoot length	Root length	Leaf area	No.of leaves	LAI	CGR	No.of tillers	Reducing sugars
T_1	Control	14.83	23.07	352.03	7.00	0.14	0.92	0.00	1.62
T_2	Water soaking	24.97	28.30	1085.64	8.00	0.43	1.20	5.00	2.87
T_3	Cow dung slurry	16.97	23.66	555.42	7.00	0.22	1.63	0.00	1.74
T_4	Ethrel	24.17	26.83	908.13	7.00	0.36	1.58	4.00	1.49
T_5	$CaCl_2$	22.07	21.57	733.87	7.00	0.29	2.02	4.00	2.05
T_6	CEPA	21.70	20.33	720.28	7.00	0.29	1.12	4.00	1.80
T_7	$CaCl_2$+CEPA	21.15	27.33	959.95	8.00	0.39	2.61	4.00	2.87
	MEAN	20.84	24.44	759.33	7.29	0.30	1.58	3	2.06
	CD	5.011	3.05	20.23	NS	0.01	0.74	0.393	0.199
	SEm ±	1.608	0.99	6.56	0.192	0.00	0.24	0.126	0.064

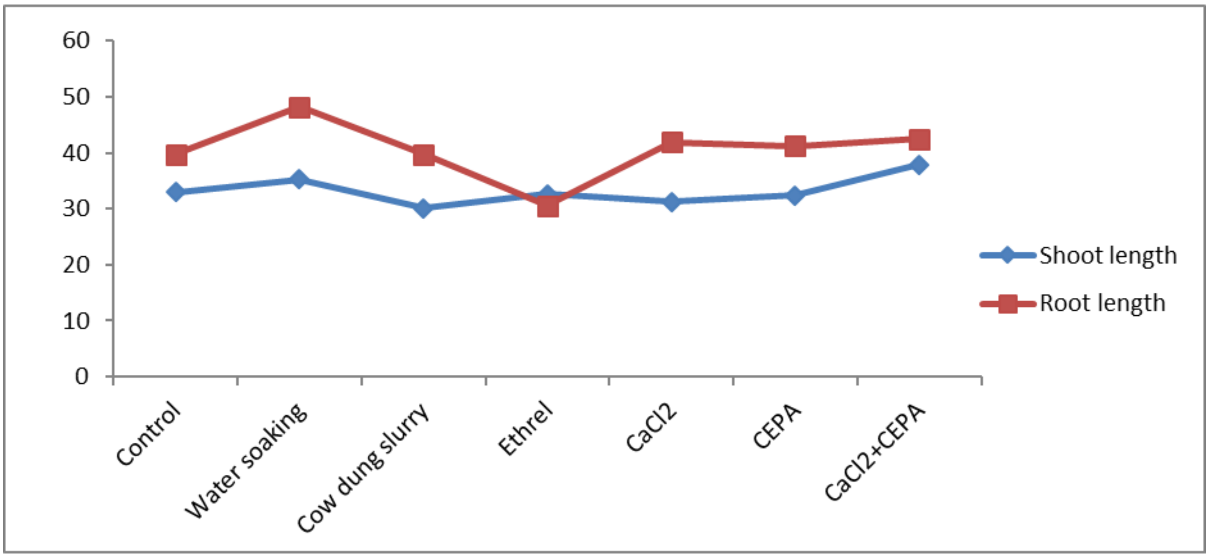

Fig 1: Effect of different chemical treatments on growth budchip raised seedlings

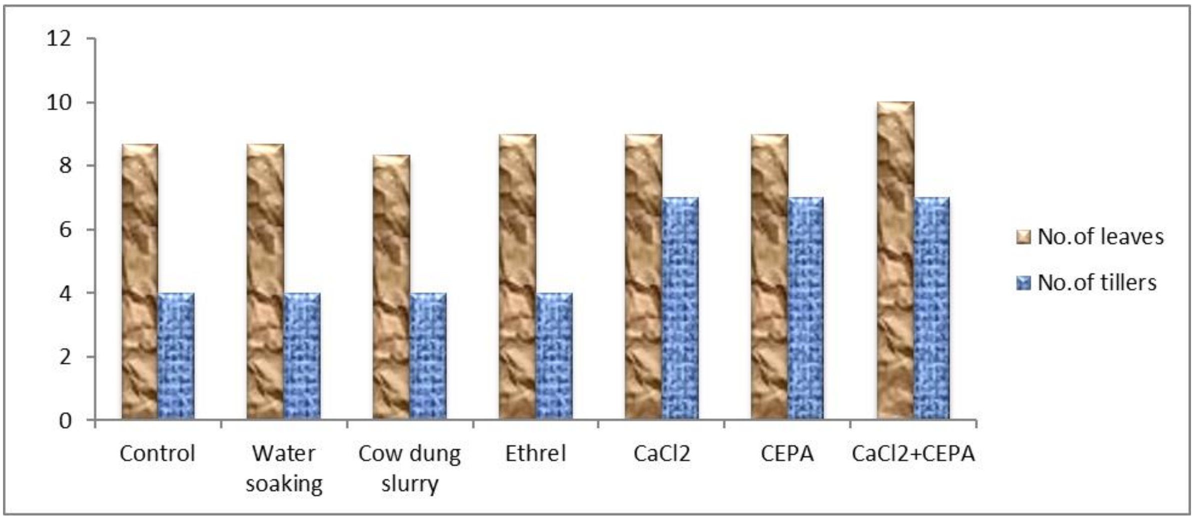

Fig 2: Effect of different chemical treatments on growth budchip raised seedlings

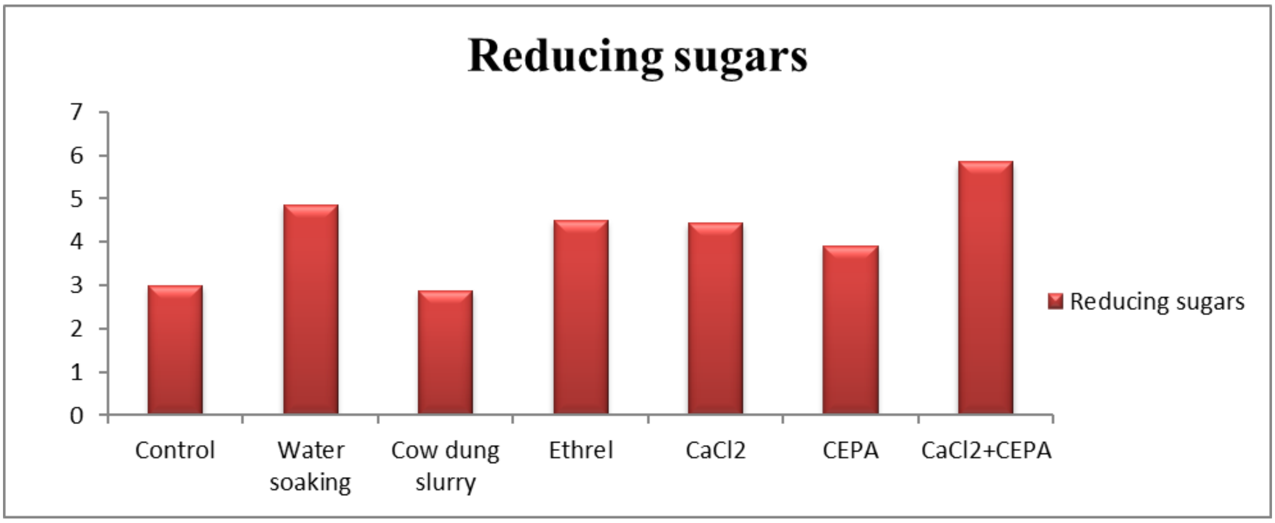

Fig 3: Effect of different chemical treatments on growth budchip raised seedlings

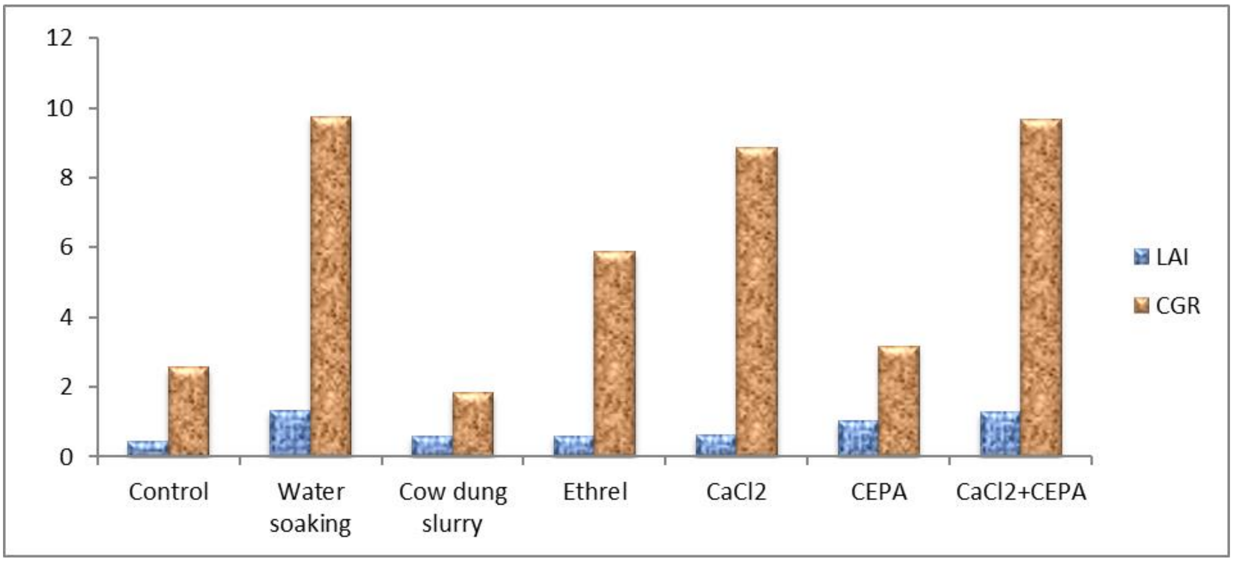

Fig 4: Effect of different chemical treatments on growth budchip raised seedling

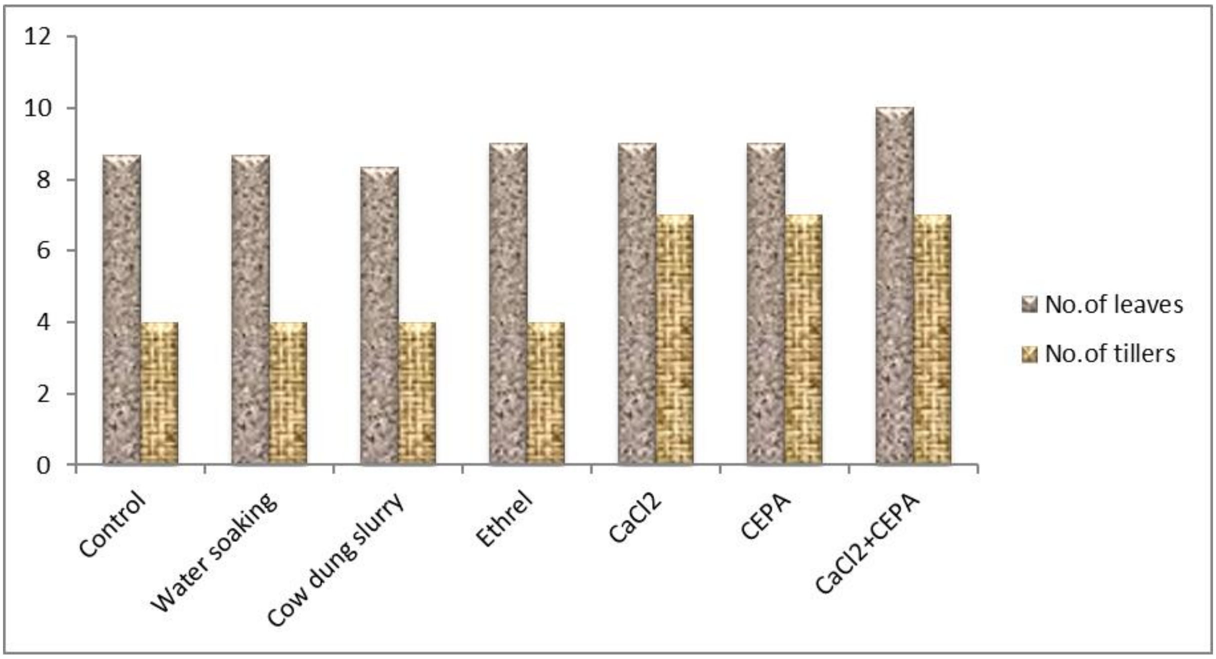

Fig 5: Effect of different chemical treatments on growth of three budded setts.

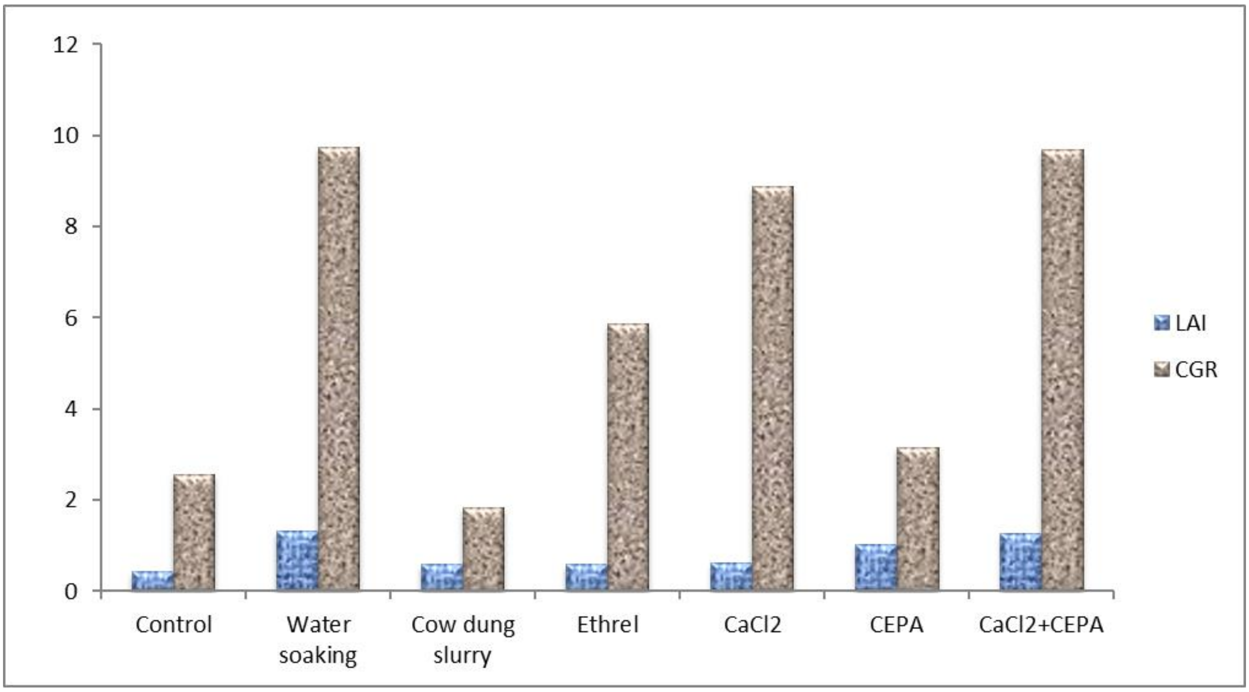

Fig 6: Effect of different chemical treatments on growth of three budded setts

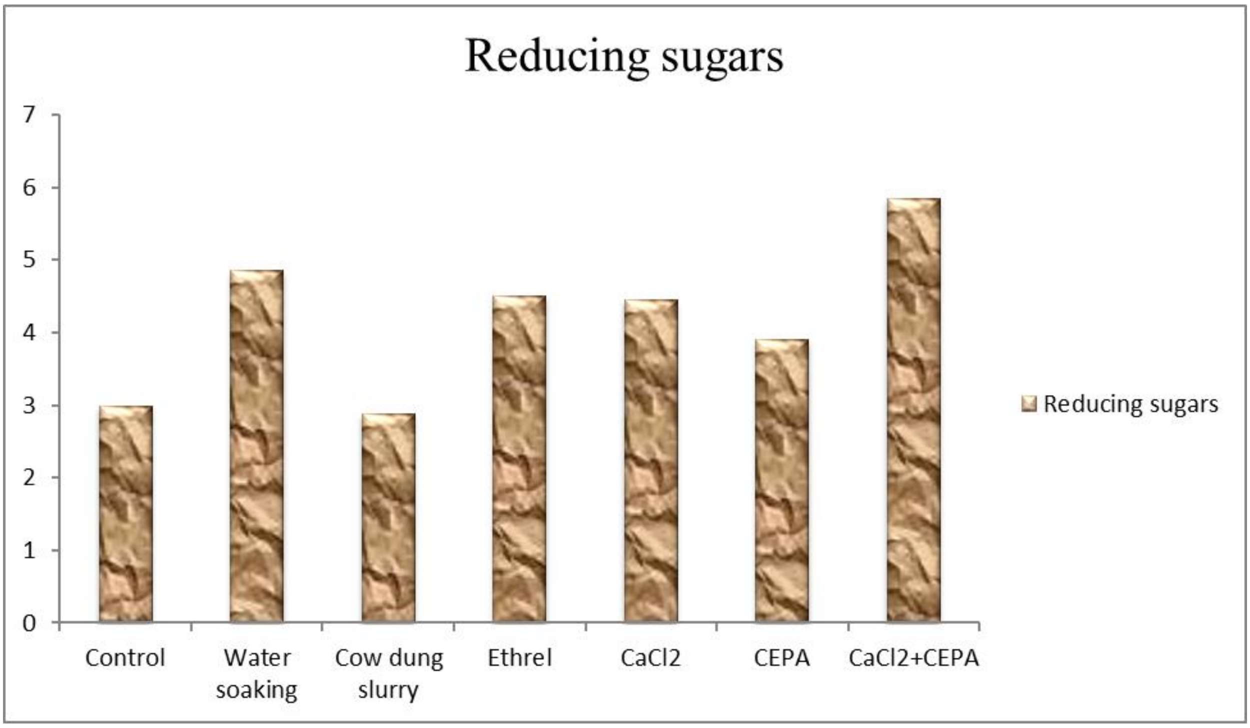

Fig 7: Effect of different chemical treatments on growth of three budded setts.

Conclusion

Various morpho-physiological, biochemical and growth parameters recorded in the field experiment for comparative evaluation of sugarcane crop raised through bud chips and three budded setts showed significant difference. Leaf area index and crop growth rate were found to be more in T_2 (water soaking) and T_7 ($CaCl_2$+CEPA), whereas lowest values were seen in T_1 (control) and T_3 (Cow dung slurry). Reducing sugars and brix values were also recorded high in T_7 ($CaCl_2$+CEPA) and T_2 (Water soaking) whereas lowest values were recorded in T_1 (Control) and T_3 (Cow dung slurry).

The present study revealed that, pre planting sett treatments with water soaking or combination of Calcium chloride and 2-chloro ethyl phosponic acid are superior in terms of improvement of survival percentage, seedling vigour index and all morphological characters. It was also observed that the initial growth of the crop established through three budded setts was found better compared to bud chip raised crop.

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