Effect of Method Seed Preparation on Seedling Establishment and Growth of Sugarcane

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Abstract: - Sugarcane is an important commercial crop cultivated in the command area. Once the crop occupies the field stays for a very long period unlike other field crops. The number of ratoon crops taken up depends on the kind of management of the plant crop. To reap more no. of ratoon crops with sustainable yields, all the management practices play a pivotal role. Among the many practices, selection of seed material and method of seedling establishment is of paramount importance as good seed result in good plant crop and subsequent ratoon crops. Hence, Seed material forms important input in production system**.** Sugarcane crop requires bulk seed material and method which facilitates reduction in quantum of seed helps in saving of cost and labour. As a prelude to this an experiment conducted at ZARS, V.C. Farm, Mandya, Karnataka, India on nine methods of seed preparation and planting indicated that seedlings raised in nursery beds have resulted in seedlings with similar vigour, plant height, leaf area, leaf area index, number of tillers, shoot to root ratio and survival of seedlings compared with poly bag raised seedlings.

Key-Words: - *M*ethods of Sugarcane seed preparation, nursery seedlings and seedling vigour

1 Introduction

Sugarcane (*Saccharum officinarum* L.) is an important commercial crop that provides sugar, bio-fuel and manure besides many by-products. Sugarcane in India is grown in two distinct agro-climatic regions – the Tropical (largely comprising Maharashtra, Karnataka, Gujarat and Tamil Nadu) and the Sub-tropical (Uttar Pradesh, Punjab, Haryana and Bihar).In the world there are 115 countries cultivating sugarcane with a sugar production of 1331.2 m. t. which is three fourth of the total sugar production of the world and remaining sugar is derived from sugar beet (21.5 %). Globally, sugarcane is cultivated in an area of about 24.5 m ha with an annual production of 1850 m t and an average productivity of 75.5 t ha^{-1}. India is the world's second largest producer of sugarcane in terms of area (5.3 m ha) and production (365 m t) with a productivity of 70 t ha^{-1}contributing 19.98 per cent of world's total (27.1 m t) sugar production. In Karnataka, it is cultivated in an area of about 0.50 m ha with a production of 47 mt and an average productivity of 94.0 t ha^{-1}(Soloman, 2016) [10].

Commercially sugarcane is propagated vegetatively. The planting materials used are the stem cuttings known as "sett", each having one or several eyes/buds (Sundara, 2000) [11]. Age of the seed cane, portion of the stalk, number of buds per sett, material status of seed cane, duration between cutting and planting are known to have considerable effect on sprouting and subsequent growth of sugarcane (Barnes, 1974) [1]. The size of cane portion used for planting differs from place to place. According to Sundara (2000) [11], in India, three eye bud setts are the most common planting material. In Tamil Nadu two eye budded setts are recommended. On the other hand, whole stalks or longer stalk pieces are planted in countries where sugarcane planting is done through machineries.

Sugarcane crop requires large quantities of seed cane (7-8 t/ha) with conventional three budded setts planting under sub-tropical conditions which accounts for nearly twenty-five per cent of the total operational costs in sugarcane. This works out to 10 per2 cent of the cane produced. Translated in to practice, this means that about 1.2 million tonnes of sugar are being buried in the soil annually in India (Shukla and Menhilal, 2003) [9]. This large mass of planting material poses a great hassel in transport, handling and storage of seed cane and undergoes rapid deterioration thereby reducing the viability of buds and subsequently their sprouting. The primary components of cane yield are stalk population and weight of individual cane. Stalk population per unit

area is directly affected by planting density which changes rapidly with the closer spacing or with the increase in seed rate. Thus, yield level can be increased substantially by manipulating certain cultural practices like spacing, seed rate, planting material etc.

Planting material and plant geometry plays a crucial role in establishment of sugarcane crop which occupies the field for 3-4 years in a plant-ratoon cropping system. Proper planting material and the right geometry of planting harness optimum space and light to manifest the resources for the best output. Perhaps this one aspect of non-adequate spacing is responsible for lower productivity in sugarcane. Under irrigated conditions, generally 40,000 three budded setts from healthy matured cane is recommended for sugarcane. Saving of seed material by changing the type of seed material (sett size) and seed rate without any deleterious effect on plant stand may help in getting higher cane yield with lower cost of production. Sugarcane has got plasticity with respect to spacing & crop geometry. The present system of planting three eye budded setts requires a huge quantity of seed material (3 tonnes /ha). However, still there will be gaps in the field as the average germination observed is 60-65 per cent. Alternatively, raising the seedlings either in poly bags, nursery by taking eye bud or node it is possible to raise the seedlings and plot there in the field so that 3-4 weeks time is saved in preparation of main field and saving of water till then is envisaged. Sugarcane seedling germination and vigour depends on the initial environ in which it is in. Stored food material is another dimension that added to the well being of the seedlings. Different materials/ environment like portrays, raised beds polybags. Direct planting in the mainfield with different food reserves in bud chip, node single eye bud, two eye bud and three eye budded setts are expected to yield seedlings of different vigour and strength. Hence the present investigation was carried out to reduce the cost of production through technology that economises seed cane. In the context of these issues, an experiment entitled "Evaluation of methods of seed preparation on growth and yield of sugarcane" was laid out during 2015-2016 at Zonal Agriculture Research Station, V. C. Farm, Mandya under the aegis of UAS, Bengaluru.

2 Material and Method

The field experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, which falls under Southern Dry Zone of Karnataka (Zone-VI). The station is situated between 12º45' N latitude, 76º 45' E longitude and at an altitude of 695meters above Mean Sea Level (MSL). The soil was neutral in pH (7.42) and organic carbon content was 1.14 per cent with electrical conductivity of 0.28 dSm^{-1}. The soil had medium available nitrogen (310 kg ha^{-1}), medium phosphorus (33 kg ha^{-1}) and medium in available potassium (178 kg ha^{-1}).

The experiment was laid out in a Randomised complete block design comprising nine treatments replicated thrice. The treatments are as follows.

T1: Planting single eye budded setts raised in poly bag.
T2: Planting single eye budded setts raised in bed.
T3: Planting single eye budded setts raised in pro trays.
T4: Planting bud chips raised in poly bag.
T5: Planting bud chips raised in bed.
T6: Planting bud chips raised in pro trays.
T7: Planting single eye budded setts directly in main field.
T8: Planting two eye budded setts directly in main field.
T9: Planting three eye budded setts directly in main field.

Healthy cane from nine months old plant crop was selected with good inter nodal length and girth which were free from pest and diseases. The bud chipper was used to remove bud chips from the selected canes. Single bud setts were prepared by cutting just above growth ring and leaving 8-10 cm of the inter node below the bud and then used for planting in the pro trays, poly bags and raised beds.

3 Results and Discussion

The results of seedling establishment on sugarcane growth are discussed in this section.

3.1 Germination and Seedling Vigour

It was observed that at 30 days after planting (DAP) (Table -1), planting of single eye budded setts raised in poly bag (T1) recorded significantly higher germination per cent (73.38 %) which was on par with planting single eye budded setts raised in bed (70.96 %), planting bud chips raised in poly bag(70.42 %), planting bud chips

raised in bed (71.35 %), planting two eye budded setts directly in main field (68.53 %) and planting three eye budded setts directly in main field (72.11 %). The lower germination per cent was recorded in planting single eye budded setts raised in pro trays (57.83 %), planting bud chips raised in pro trays (40.30 %) and planting single eye budded setts directly in main field (60.30 %).These findings are in conformity with the results of Saxena *et al*. (2012) [8] , Chitkaladevi *et al* (2011) [2] and Meharchand *et al* (2011) [6] who have noticed maximum (90.41%) germination was under poly bag method over single, two and three eye budded sett planting.

Table 1: Germination per cent and Seedling vigour at 30 and 45 DAP as influenced by methods of sugarcane seed preparation

Treatment	**Germination (%)**		**Seedling vigour index**	
	30DAP	**45 DAP**	**30DAP**	**45 DAP**
T1: Planting single eye budded setts raised in poly bag	73.38	75.33	1205.9	1831.4
T2: Planting single eye budded setts raised in bed	70.96	72.89	1102.2	1903.1
T3: Planting single eye budded setts raised in pro trays	57.83	60.83	766.5	1053
T4: Planting bud chips raised in poly bag	70.42	70.28	1016.5	1460.4
T5: Planting bud chips raised in bed	71.35	69.69	984.9	1516.1
T6: Planting bud chips raised in pro trays	40.30	41.93	500.2	642.5
T7: Planting single eye budded setts directly to main field	60.30	62.13	972	1805.9
T8: Planting two eye budded setts directly to main field	68.53	70.10	1149.6	1692.4
T9: Planting three eye budded setts directly to main field	72.11	74.87	1099.2	1783.1
S.Em. ±	2.70	2.73	83.4	127.8
CD @ 5%	8.08	8.18	250.1	383

At 45 DAP, the same trend was noticed with higher per cent of germination in planting of single eye budded setts raised in poly bag (75.33 %) followed by planting single eye budded setts raised in bed (72.89 %), planting bud chips raised in poly bag (70.28 %), planting bud chips raised in bed (69.69 %), planting two eye budded setts directly in main field (70.10 %) and planting three eye budded setts directly in main field (74.87 %) which were on par with each other. The lower germination per cent was recorded in planting single eye budded setts raised in pro trays (60.83 %), planting single eye budded setts directly in main field (62.13 %) and planting bud chips raised in pro trays (41.93 %).

It was observed that at 30 DAP, higher seedling vigour index (1205.880) was recorded in planting of single eye budded sett raised in polybag (T1). However, it was on par with planting single eye budded setts raised in bed (1102.23), planting bud chips raised in poly bag (1016.52), planting bud chips raised in bed (984.78), planting single eye budded setts directly in main field (971.97), planting two eye budded setts directly in main field (1149.25) and planting three eye budded setts directly in main field (1099.25) and the lowest index was observed in planting of single eye budded sett (T3) and bud chip (T6) raised in pro tray.

At 45 DAP, the higher seedling vigour index (1903.14) was recorded in planting of single eye budded setts raised in bed (T2), and it was on par with planting single eye budded setts raised in poly bag (1831.47), planting bud chips raised in poly bag (1460.98), planting bud chips raised in bed (1516.07), planting single eye budded setts directly in main field (1805.92), planting two eye budded setts directly in main field (1692.41) and planting three eye budded setts directly in main field (1783.02). However, it was significant over planting single eye budded setts raised in pro trays (1052.98) and planting bud chips raised in pro trays (642.47).

3.2 Plant height, Leaf Area and LAI

The data on plant height, leaf area and leaf area index (LAI) are presented in table 2.

3.2.1 Plant Height

At 90, 120 and 150 DAP, an evidenced by the observation that among different methods of seed preparation direct planting of three eye budded setts in main field (T9) recorded higher plant height (53.30, 89.61 and 144.52 cm, respectively) and it was on par with planting single eye budded setts raised in poly bag (48.89, 76.98 and 133.55 cm, respectively), planting single eye budded setts directly in main field (52.65, 88.08 and137.33 cm, respectively) and planting two eye budded setts directly in main field (51.30,82.67 and 136.33 cm, respectively). The lower plant height was recorded with planting single eye budded setts raised in bed (32.75, 66.21 and 114.03 cm, respectively), planting single eye budded setts raised in pro trays (22.33, 41.25 and 99.80 cm, respectively), planting bud chips raised in poly bag (31.40, 65.74 and 119.64 cm, respectively), planting bud chips raised in bed (28.07, 55.44 and110.70 cm, respectively) and planting bud chips raised in pro trays (19.47, 38.85 and 78.23 cm, respectively).

Table 2: Plant height (cm), Leaf area (cm^2/clump) and LAI as influenced by methods of sugarcane seed preparation

Treatments	Plant height (cm)			Leaf area (cm^2/clump			LAI		
	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP
T1: Planting single eye budded setts raised in poly bag	48.89	76.98	133.55	3306.1	8383.3	12610.7	0.55	1.31	2.01
T2: Planting single eye budded setts raised in bed	32.75	66.21	114.03	3112.0	8683.4	11495.9	0.49	1.41	1.80
T3: Planting single eye budded setts raised in pro trays	22.33	41.25	99.80	2135.3	5236.9	7696.3	0.36	0.84	1.42
T4: Planting bud chips raised in poly bag	31.40	65.74	119.64	2947.2	6870.7	9392.2	0.47	1.16	1.50
T5: Planting bud chips raised in bed	28.07	55.44	110.70	2667.6	5988.9	9255.6	0.42	0.96	1.42
T6: Planting bud chips raised in pro trays	19.47	38.85	78.23	2034.8	5013.7	7018.8	0.31	0.78	1.08
T7: Planting single eye budded setts directly to main field	52.65	88.08	137.33	2236.4	5563.9	8707.7	0.66	1.62	2.57
T8: Planting two eye budded setts directly to main field	51.30	82.67	136.33	3075.4	8487.4	13038.5	0.74	1.95	2.99
T9: Planting three eye budded setts directly to main field	53.30	89.61	144.52	3403.1	8923.4	13896.2	0.59	1.43	2.24
S.Em.±	1.72	2.90	4.97	98.7	254.6	457.1	0.04	0.06	0.08
CD @ 5%	5.16	8.69	14.90	295.9	763.4	1370.6	0.12	0.19	0.25

3.2.2 Leaf Area

Methods of seed preparation significantly influenced the leaf area as shown in Table 4. At 90 DAP planting of three eye budded setts directly to main field (T9) recorded higher leaf area (3403.11cm^2 $clump^{-1}$) and it was on par with planting of single eye budded setts raised in poly bag (3306.13 cm^2 $clump^{-1}$) and it was significantly different over rest of the treatments. At 120 and 150 DAP, similar trend was observed. Higher leaf area was recorded (8923.37 and 13896.23 cm^2 $clump^{-1}$ respectively) in planting of three eye budded setts directly in main field and it was on par with planting of two eye budded setts directly in main field (8487.40 and 13038.49 cm^2 $clump^{-1}$,

respectively) and planting of single eye budded setts raised in poly bag (8383.32 and 12610.74 cm^2 $clump^{-1}$, respectively).

3.2.3 Leaf Area Index

LAI was significantly influenced by methods of seed preparation and at 90 DAP, planting of two eye budded setts directly in main field (T8) recorded significantly higher LAI (0.74) followed by planting of single eye budded setts directly to main field (0.66)with which it was on par and these treatments have recorded higher LAI over rest of the treatments (Table 4). At 120 and 150 DAP, it was followed similar trend with planting of two eye budded setts directly to main field (T8), which recorded significantly higher LAI (1.95and 2.99, respectively) followed by planting of single eye budded setts directly in main field (1.62 and 2.57, respectively) and they were significantly superior over other treatments

3.3 Tillering and Millable Cane Production

The data on number of tillers, tillering capacity, tillering mortality and shoot tomillable cane ratio are furnished in Table 3.

Table 3: No. of tillers ('000 ha^{-1}), Tillering capacity, Tiller mortality and Shoot to millable cane ratio as influenced by methods of sugarcane seed preparation.

Treatment	**No. of tillers ('000 ha-1)**			**Tillering capacity**	**Tiller mortality (%)**	**Shoot to millable cane ratio**
	90 DAP	**120 DAP**	**150 DAP**			
T1: Planting single eye budded setts raised in poly bag	148.36	163.23	152.66	9.59	6.48	0.62
T2: Planting single eye budded setts raised in bed	130.15	160.01	148.75	9.47	7.04	0.64
T3: Planting single eye budded setts raised in pro trays	78.35	119.85	130.63	8.06	-8.99	0.58
T4: Planting bud chips raised in poly bag	80.23	126.10	142.11	8.87	-12.69	0.54
T5: Planting bud chips raised in bed	75.71	113.79	128.04	8.30	-12.52	0.63
T6: Planting bud chips raised in pro trays	54.58	117.68	129.52	8.48	-10.06	0.57
T7: Planting single eye budded setts directly to main field	162.27	135.52	127.84	3.01	5.70	0.55
T8: Planting two eye budded setts directly to main field	198.34	168.95	158.01	3.44	6.48	0.62
T9: Planting three eye budded setts directly to main field	199.49	170.42	159.82	3.30	6.21	0.64
S.Em. ±	7.33	6.08	5.44	0.30	0.74	0.02
CD @ 5%	21.99	18.22	16.31	0.90	2.24	0.07

Number of tillers, tillering capacity, tillering mortality and shoot to millable cane ratio were significantly influenced by methods of seed preparation. At 90 DAP, planting of three eye budded setts directly in main field (T9) recoded highest number of tillers (199490 ha^{-1}) followed by planting two eye budded setts directly in main field 198380 ha^{-1}) with which it was on par and it was significantly superior over rest of the treatments.

At 120 and 150 DAP, planting of three eye budded setts directly to main field (T9) recorded highest number of tillers (170420 and 159820 ha^{-1}, respectively) except planting two eye budded setts directly in main field (168950 and 158010 ha^{-1}, respectively), planting single eye budded setts raised in poly bag (163230 and 152660 ha^{-1},

respectively) and planting single eye budded setts raised in bed (160010 and 148750 ha^{-1}, respectively) with which it was on par. Planting single eye budded setts in polybag (T1) recorded highest tillering capacity (9.49 germinated bud^{-1}) except planting single eye budded setts raised in bed (9.47 germinated bud^{-1}) and planting bud chips raised in poly bag (8.87 germinated bud^{-1}) with which it was on par and it was significantly superior over other treatments. Planting of single eye budded sett raised in bed (T2) recorded higher tiller mortality (7.04) followed by planting two eye budded setts directly in main field (6.48), planting of single eye budded sett raised in polybag (6.48) and planting of three eye budded sett directly in the main field (6.21) with which it was on par and it was significantly different over rest of the methods of seed preparation. Direct planting of three eye budded setts to main field (T9) and planting of single eye budded setts raised in bed (T2) recorded highest shoot to millable cane ratio (0.64) and they were on par with rest of the treatments except planting bud chips raised in poly bag (0.54) which has recorded lowest value. This is due to the fact that single eye bud planting either raised in polybag or nursery, has optimum space available as against the setts directly planted in field which face the competition for space, light and because of crowding effect. These findings are in line with the reports of Suryavamshi*et al*. (2010) [12]. Tillering though genetically controlled is also influenced by a number of environmental factors like space, temperature, moisture, nutrients etc., (Dillewijn, 1952) [3]. Tillering capacity depends upon the space available to the plants. These results are in line with the findings of Mohanty and Nayak (2011) [5] and Jayesh Singh *et al*. (2013) [4]. The tillers count was very low in treatments T1 – T6 at 90 DAP because of the transplanting shock as there is delay in tiller production.

Table 4: Survival per cent of seedlings as influenced by methods of sugarcane seed Preparation

Treatments	**Survival per cent at90 DAP**
T1: Planting single eye budded setts raised in poly bag	100.00
T2: Planting single eye budded setts raised in bed	89.62
T3: Planting single eye budded setts raised in pro trays	84.64
T4: Planting bud chips raised in poly bag	87.96
T5: Planting bud chips raised in bed	85.46
T6: Planting bud chips raised in pro trays	78.21

Survival per cent of seedlings at 90 DAP is furnished in Table 4. At 90 DAP, planting of single eye budded setts raised in poly bag (T1) recorded higher survival per cent (100 %) over other methods of seed preparation followed by planting single eye budded setts raised in bed (89.2 %) with which it was on par and they were significantly different over planting single eye budded setts raised in pro trays (84.64 %), planting bud chips raised in poly bag (87.96 %), planting bud chips raised in bed (85.46 %) and planting bud chips raised in pro trays (78.21 %). The poly bagSeedlings are transplanted without disturbing the root system along with moistened soil. This has helped in quick recovery of seedlings in the field where as the root system of setts planted from other methods was disturbed, damaged and thus has caused late establishment or mortality. Panje and Gill (1963) [7] have confirmed this point of view with higher survival rate in poly bag seedlings compared to normal planting method.

3.4 SPAD and Green Seeker Indicators

SPAD reading was not significantly influenced by methods of seed preparation and the data of SPAD readings are presented in Table 5.Green seeker reading recorded was found to be significantly different due to methods of seed preparation (Table 5).At 90 DAP, among methods of seed preparation, planting of single, two and three eye budded setts directly in main field recorded highest reading (0.58, 0.59 and 0.57,respectively) compared to other methods of seed preparation and they were on par with each other. The lowest was recorded in planting bud chips raised in pro trays (0.34). At 120 DAP, planting of single and two eye budded setts directly in main field (T7and T8) recorded highest green seeker reading (0.67) and they were on par with all other treatments except T6 (0.56) which recorded lowest reading.

Table 5: SPAD and Green seeker readings as influenced by methods of sugarcane seed Preparation

Treatment	**SPAD reading**			**Green seeker reading**		
	90 DAP	**120 DAP**	**150 DAP**	**90 DAP**	**120 DAP**	**150 DAP**
T1: Planting single eye budded setts raised in poly bag	41.76	48.86	42.99	0.46	0.64	0.48
T2: Planting single eye budded setts raised in bed	40.66	48.80	40.84	0.47	0.63	0.55
T3: Planting single eye budded setts raised in pro trays	45.14	46.97	41.31	0.36	0.60	0.60
T4: Planting bud chips raised in poly bag	41.26	45.30	42.37	0.46	0.66	0.60
T5: Planting bud chips raised in bed	42.71	47.19	43.63	0.46	0.62	0.51
T6: Planting bud chips raised in pro trays	43.35	48.66	41.60	0.34	0.56	0.57
T7: Planting single eye budded setts directly to main field	37.97	45.09	42.47	0.58	0.67	0.58
T8: Planting two eye budded setts directly to main field	40.84	45.51	41.79	0.59	0.67	0.63
T9: Planting three eye budded setts directly to main field	40.69	44.12	40.67	0.57	0.65	0.63
S.Em. ±	1.56	1.49	1.64	0.02	0.02	0.02
CD @ 5%	NS	NS	NS	0.06	0.07	0.07

At 150 DAP, among the methods of seed preparation, planting of two and three eye budded setts directly in main field recorded highest green seeker reading(0.63) and they were on par with planting single eye budded setts raised in pro trays (0.60), planting bud chips raised in poly bag (0.60), planting bud chips raised in pro trays (0.57) and planting single eye budded setts directly in main field (0.58) and the lowest green seeker reading was recorded in planting single eye budded setts raised in poly bag (0.48).

4 Conclusion

Initial vigour of sugarcane seedlings is a prerequisite for the good establishment of the crop. Seed material and method of its preparation plays an important role. Experiment conducted at ZARS, V.C. Farm, Mandya has revealed that poly bag raised seedlings have resulted in seedlings with similar vigour, plant height, leaf area, leaf area index, number of tillers, shoot to root ratio and survival of seedlings compared with seedlings raised in nursery beds. This implies that single node seedlings can be raised successfully in

nursery beds for planting in main fields which saves cost and time to the farmers to get the seedlings on time on their own fields. Sugarcane seedlings establishment paves way for a better healthy crop which furthers the no. of ratoon crops taken up with better establishment at the beginning of the crop. Sugarcane seedlings owing to apical dominance behave differently with different size and food reserves of seed material used. Seed cane with single eye bud planted directly in the field results in poor germination and establishment as the size of the setts decreases surface area increasesfor microbial attach. On the other hand, seedlings already raised in either poly bag or nursery bed given raise to vigorous healthy seedlings which ensures very high establishment role with minimum casualties. Intensive care can be taken up on seedlings raised in very small area for a period of seven weeks which makesthe seedlings to put forth more growth when out planted. Water, labour, over a large area of main fields thus is saved.

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