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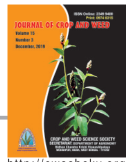

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Integrated implication of biofertilizers, trash mulching and chemical fertilizers on quality of sugarcane seed crop

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ABSTRACT

The experiment was conducted at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh on the sugarcane seed crop for two consecutive years during 2019-20 and 2020-21. The experiment was designed in a split-plot layout, with the treatments, i.e, control, biofertilizer mixture, trash mulching with bio-decomposers and application of different rates and timings of nitrogen and potassium were allotted to sub plot treatments and were replicated thrice. In both the years of experimentation, quality parameters of seedcane were not influenced by organic sources, however the sub plot treatments showed significant influence only on moisture percent, reducing sugars percent, germinability and seedling vigour index (SVI). The seedcane grown with the application of 125% STBNK alone at 45 days interval recorded significantly higher moisture percentage, reducing sugars percentage, germinability and SVI over 75 % STBNK (S_1 and S_2), it was statistically comparable with 125% STBNK applied at 30 days interval + additional dose of 25% recommended K at one month before harvesting, 100% STBNK alone applied at 45 days interval and 100% STBNK applied at 30 days interval + additional dose of 25% recommended K at one month before harvesting.

***Keywords*:** Germinability, moisture percentage, reducing sugars, seedling vigour index and sugarcane seed crop

In many sugar cane plantations, seedcane cultivation is given less attention than commercial crop plants, despite the fact that seedcane is an essential component of sugar production (Koeheler, 1984). Because sugarcane is propagated vegetatively by stem cuttings, the intrinsic stalk properties influence sprouting and tillering, and the stage of growth is mostly determined by the reserve food in the sett (Singh and Ali, 1973). Seedcanes that have been well-treated and nourished are planted on a foundation to provide a good germination capability and vigour for a healthy crop (Bikila *et al.,* 2014). A well-nourished short crop may help in realizing higher yields from the succeeding commercial crop (Lakshmi *et al*., 2006). The moisture, nitrogen, and glucose content in bud tissue appear to be positively connected with bud sprouting ability (Dellewijin. 1952). As a result, it is critical that seedcane plants receive special cultural treatments including fertilisation, irrigation, crop protection, and so on. Fertilization is an important input for seedcane production, in addition to other cultural techniques (Bikila *et al.,* 2014).

In the sugarcane plant-ratoon system, integrated application of FYM, biofertilizers, and trash absorption with inorganic fertilisers resulted in enhanced economic output, improved soil health, and increased microbial activity (Tyagi *et al*., 2011). Sugarcane trash is one of the most common farm wastes in sugarcane growing areas, and it is crucial for preserving soil fertility and promoting longer-term crop growth.

Increasing and extending the role of microorganisms by way of inoculation or application of biofertilizers may reduce the need for chemical fertilizers and thereby decrease adverse environmental effects (Govindarajan *et al*., 2008). Nutrients in appropriate and balanced amounts are required for optimal plant growth, yet only a tiny part of nutrients are released from the soil each year through biological and chemical processes. Fertilizers are therefore used to augment the nutrients already present in the soil (Chen, 2006). Nitrogen and potassium, among the primary nutritional components, have an essential role in increasing sugarcane crop productivity. At present farmers apply potassium only as basal dose, where some quantity may be fixed by clay colloid and some may be lost leading to insufficient availability during later crop growth stages. So, it is necessary to recommend optimum rate and time of N and K application for improving the quality of seedcane setts.

Actually, seedcane plants should be fertilised similarly to commercial cane fields. Furthermore, data on the optimal level and timing of fertiliser treatment on

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sugarcane seedcrops, as well as its impact on sett quality, is lacking. As a matter of fact, this investigation was performed to ascertain the integrated implication of biofertilizers, trash mulching and chemical fertilizers on quality of sugarcane seed crop.

MATERIALS AND METHODS

Field experiment was conducted at the Regional Agricultural Research Station, Anakapalle, Andhra Pradesh during 2019-20 and 2020-21. The experimental soil had a sandy clay texture, was neutral in reaction, and had a medium level of organic carbon, a low level of available nitrogen, a high level of available phosphorus, and a medium level of available potassium. The experiment was designed in a split-plot layout, with three main treatments, *i.e*,M_1-control, M_2-biofertilizer mixture (*Azospirillum*, Phosphorus Solubilizing Bacteria, Potassium Releasing Bacteria each @ 1250 ml ha^{-1} and VAM @ 12.5 kg ha^{-1}) and M_3-trash mulching with bio-decomposers and six sub treatments *viz.,* S_1-75% STBNK at planting, 30, 60, 90, 120 DAP + additional dose of 25% recommended K at one month before harvesting, S_2-75% STBNK at planting, 45, 90, 135 and 180 DAP, S_3-100% STBNK at planting, 30, 60, 90, 120 DAP + additional dose of 25% recommended K at one month before harvesting, S_4-100% STBNK at planting, 45, 90, 135 and 180 DAP, S_5-125% STBNK at planting, 30, 60, 90, 120 DAP + additional dose of 25% recommended K at one month before harvesting, S_6-125% STBNK at planting, 45, 90, 135 and 180 DAP, in three replications. Nitrogen, phosphorus and potassium were applied in the form of neem coated urea, SSP and MOP, respectively. Furrows were made at spacing of 80 cm and three budded setts of sugarcane variety 87A 298 from short crop seed material (40,000 three budded setts ha^{-1}) were planted in deep furrows. Irrigations were provided as and when required. All other agronomic practices like hand weeding, earthing up, trash twist propping *etc*. were carried out as per recommendations. Observations on both seed crops were recorded.

Moisture Percentage in Sett

Moisture content of seedcane stalk for each treatment was determined by samples taken randomly and fresh weight was recorded. Then those were shade dried followed by oven drying and dry weight was recorded. The moisture percent was calculated with the formula.

$$\text{Moisture }\% = \frac{\text{weight of fresh sample - weight of dry sample}}{\text{weight of dry sample}}$$

Reducing sugars percentage

The reducing sugars were estimated by Lane and Eynon's volumetric method. Five ml of each Fehlings A and Fehlings B solution was taken and boiled until clear bubbles appeared then added three to four drops of methylene blue were added and then it was titrated against filtered cane juice till solution turned to brick red colour and volume of juice consumed was recorded and it was expressed in per cent. The reducing sugars per cent was calculated by using the formula (Brown and Zerban, 1941).

$$\text{Reducing sugars }\% = \frac{5}{\text{Title value}}$$

Brix and sucrose percentage

A tiny amount (3-5 g) of dry lead acetate was added to the extracted juice sample and filtered through conventional filter paper to clarify it. Sucrolyzer was used to determine the brix and sucrose % at harvest. The percentage of sucrose in juice was calculated using a pol reading and brix percent values were calculated using table values (Brown and Zerban, 1941).

Purity percentage

The purity of juice was calculated as the ratio of sucrose percent to corrected brix, which reflects the proportion of sucrose in total solids present in the juice. It was calculated with the use of a formula (Brown and Zerban, 1941).

$$\text{Purity }\% = \frac{\text{Sucrose}}{\text{Corrected brix}} \times 100$$

Germinability of seed produced

Healthy canes from a seven-month-old plant crop that were free of pests and illnesses were chosen at random. Single bud setts were created by cutting just above the growth ring and leaving 8-10 cm of the inter node below the bud, using a bud chipper to remove bud chips from the selected canes. After harvesting the seed crop, a hundred single bud setts were randomly selected from each plot and planted in portrays. Germination percentage was calculated at 30 DAP. It was computed as the number of plants established to the total number of buds originally planted.

$$\text{Germination }\% = \frac{\text{Number of buds germinated}}{\text{Total number of buds kept for germination}} \times 100$$

Seedling vigour index

Ten seedlings from the germination test were randomly selected for measurement of seedling length. The seedling length was measured from base of the plant to the tip of the leaf and expressed in centimeters. It was computed by using below formula (Abdul-Baki and Anderson, 1973).

Seedling Vigour Index = G(%) × SL (cm)

RESULTS AND DISCUSSION

Moisture percentage in seedcane setts

The data pertaining to moisture percent in cane setts was recorded at harvest of seed crop is presented in Table 1. Perusal of data shows that different organic sources, interaction between organic sources and different time, dose of N and K application did not differ the moisture percent significantly in cane setts while, the application of nitrogen and potassium in different doses and timings had exerted significant influence during 2019-10, 2020-21 and in pooled data.

Significantly higher moisture per cent in cane setts (73.6%) was documented with 125% STBNK alone applied at 45 days interval when compared to other treatments however maintained parity with 125% STBNK applied at 30 days interval + additional dose of 25% recommended K at one month before harvesting (72.8%), 100% STBNK alone applied at 45 days interval (72.7%) and 100% STBNK applied at 30 days interval + extra 25% recommended dose of K at one month before harvesting (71.4%). The 75% STBNK applied at planting, 30, 60, 90, 120 DAP + additional 25% recommended dose of K at one month before harvesting recorded lower moisture per cent in cane setts and it was closely followed by S_2 treatment during the first year of experimentation. Similar trend was observed in the second year and in pooled data also. The present findings were also supported by earlier reports of Alexander *et al*. (2002) and Patel *et al*. (2011).

Additional fertilizers given to seedcane crop or pre fertilizing the nursery crop at 6 to 8 weeks prior to harvest for planting helps to obtain healthy setts with more moisture, reducing sugars and high nitrogen content as well (Sundara, 2000).

Reducing sugars percentage

Reducing sugars percentage in seedcane sett was not influenced by different organic source treatments tried in this study during both the years of experimentation and in pooled data (Table 1).

During both the years of experimentation and in pooled data, reducing sugars per cent in cane setts was altered by time and dose of N and K application. Among the different treatments, higher reducing sugars (2.04, 1.91 and 1.98%) was recorded with application of 125% STBNK alone at 45 days interval (S_6)and differed significantly over rest of the treatments. However, addition of 125% STBNK at planting, 30, 60, 90, 120 DAP + additional dose of 25% recommended K atone month before harvesting, 100% STBNK at 30 days interval + additional 25% recommended dose of K at one month before harvesting and 100% STBNK alone applied at 45 days interval treatments were statistically on par with S_6. Lower reducing sugars per cent (1.79, 1.69 and 1.74% during 2019-20, 2020-21 and in pooled data, respectively) was registered with application of 75% STBNK at 30 days interval + additional 25% RDK at one month before harvesting might be due to less nitrogen supply. The current findings are in line with the earlier findings of Alexander *et al*. (2002), Bikila *et al*. (2014) and Patel *et al*. (2011).The high amount of reducing sugar content was observed with young and immature canes (Richard and Irvine, 1993).

The interaction between organic sources and application of nitrogen and potassium in different timings and levels did not alter the reducing sugars significantly during both the years and in pooled data.

Brix and sucrose percentage

Sucrose and brix percentage in cane juice are considered as an important qualitative parameters used for judging maturity in sugarcane. Perusal of data revealed that both organic sources as well as time and dose of nitrogen and potassium application and their interaction failed to hold significant effect on brix percentage (Table 1) and sucrose percentage (Table 2) during both the years of experimentation and in pooled data. The current findings are in agreement with earlier results of Bikila *et al*. (2014) and Mohanty *et al*. (2013), who reported non-significant influence of nutrient management practices on brix and sucrose percentage.

Late nitrogen treatment, according to Wiedenfeld (1997), results in poor juice quality (low brix and pol value) in matured cane, but it is a favourable quality for seedcane plants in retaining a food store for the sprouting buds (Singh and Kanwar, 1986).The lowering value of sucrose per cent in seedcane has an adverse association with the growing rate of late fertiliser application (Mohammed, 1989).Lower sucrose content of immature seedcane may be due to a slower rate of reversion of glucose and fructose to sucrose during the plant's intense growth phase (Bakker, 1999).

Purity percentage

Data related to purity percentage as influenced by organic sources and time and dose of nitrogen and potassium application were computed and embodied in Table 2 revealed that purity percentage of seedcane did not differ significantly due to various organic sources and time and dose of nitrogen and potassium application besides their interaction as well during 2019-20, 2020-21 and in pooled data also. These results were in agreement with other findings of Mohanty *et al*. (2013) and Shukla and Singh (2011).

Table 1 : Moisture, Reducing sugars and Brix percentage of sugarcane seed crop as influenced by biological nutrient management during 2019-20, 2020-21 and pooled data

Treatments	Moisture percentage			Reducing sugars percentage			Brix percentage		
	2019-20	2020-21	Pooled data	2019-20	2020-21	Pooled data	2019-20	2020-21	Pooled data
Organic sources									
M_1	68.7	66.7	67.7	1.87	1.76	1.81	18.2	18.3	18.3
M_2	72.6	69.3	71.0	1.98	1.84	1.91	17.8	18.0	17.9
M_3	72.3	69.3	70.8	1.91	1.82	1.87	18.1	18.1	18.1
SEm(±)	1.67	1.52	1.40	0.052	0.046	0.049	0.40	0.51	0.45
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	10.0	9.4	8.5	11.6	10.9	11.1	9.5	11.9	10.6
Time and dose of N & K application									
S_1	68.2	64.2	66.2	1.79	1.69	1.74	18.2	18.2	18.2
S_2	68.5	65.0	66.7	1.84	1.69	1.77	18.3	18.4	18.4
S_3	71.4	69.3	70.4	1.89	1.81	1.85	18.0	18.1	18.1
S_4	72.7	69.9	71.3	1. 98	1.86	1.92	17.9	18.0	18.0
S_5	72.8	70.9	71.9	1.98	1.87	1.93	17.9	18.1	18.0
S_6	73.6	71.3	72.4	2.04	1.91	1.98	17.9	18.0	17.9
SEm(±)	1.42	1.92	1.63	0.058	0.049	0.058	0.47	0.63	0.63
CD (0.05)	4.1	5.5	4.7	0.17	0.14	0.17	NS	NS	NS
CV (%)	6.0	8.4	7.0	9.1	8.1	9.3	7.9	10.4	10.4
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

Germinability of setts produced from seedcane after harvest

Germinability of setts produced from seedcane after harvest (Table 2) was differed significantly with application of nitrogen and potassium in different timings and rate. While, the effect of organic sources and the interaction among these two could not reach the level of significance with pooled data.

Higher germinability of setts (88.7, 85.6 and 87.2% during 2019-20, 2020-21 and in pooled data, respectively) was recorded with application of 125% STBNK at planting, 45, 90, 135 and 180 DAP which might be due to high nutritional status of cane setts over rest of the treatments. However, it was comparable with the application of 125% STBNK at planting, 30, 60, 90, 120 DAP + additional 25% RDK at one month before harvesting, 100% STBNK applied at planting, 45, 90, 135 and 180 DAP and 100% STBNK applied at planting, 30, 60, 90, 120 DAP + additional 25% recommended dose of K at one month before harvesting. The distinctly lower sprouting was noticed with lower fertilizer dose *i.e.*, 75% STBNK (S_1 with 81.2, 77.1 and 79.1% and S_2 with 82.0, 77.9 and 80.0% during 2019-20, 2020-21 and in pooled data, respectively). These findings are consistent with Patel *et al.* (2011) and Wubale and Girma (2018)'s conclusions.

Plants with a high nitrogen content germinate better than setts from a crop that has been under-fertilized (King, 1965). The moisture, nitrogen, and glucose content in bud tissue appear to be positively connected with bud sprouting ability (Dellewijin, 1952). Cornelison and Cooper (1994) reported that late application of nitrogen at higher dose gave more sprouting compared to others which might be due to storage of nitrogen temporarily in the nodes just below the buds under application. Therefore, the sprouting buds might have easily utilized this nitrogen for emergence and successive growth.

Seedling vigour index of setts produced from seedcane after harvest

Data related to seedling vigour index displayed under Table 2 revealed that seedling vigour index significantly differed due to time and dose of nitrogen and potassium application. Organic sources and interaction between the main plots and sub plots, on the other hand, were

Table 2 : Sucrose percentage, purity percentage, germinability percentage and seedling vigour index of sugarcane seed crop as influenced by biological nutrient management during 2019-20, 2020-21 and pooled data

Treatments	Sucrose percentage			Purity percentage			Germinability of setts (%)			Seedling vigour index		
	2019-20	2020-21	Pooled data	2019-20	2020-21	Pooled data	2019-20	2020-21	Pooled data	2019-20	2020-21	Pooled data
Organic sources												
M_1	16.4	16.4	16.4	90.1	89.6	90.2	83.3	80.3	81.8	3352	3240	3296
M_2	16.2	16.2	16.2	91.0	90.0	91.1	86.4	83.7	85.1	3607	3496	3552
M_3	16.3	16.3	16.3	90.1	90.1	90.4	86.4	82.6	84.5	3533	3383	3458
SEm(±)	0.45	0.46	0.41	2.42	2.59	2.30	1.33	1.69	1.69	108.1	95.2	85.3
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	11.8	11.8	10.8	11.3	12.1	10.8	6.6	8.7	8.5	13.1	12.0	10.5
Time and dose of N & K application												
S_1	16.6	16.5	16.6	91.2	90.7	91.3	81.2	77.1	79.1	2953	2811	2882
S_2	16.5	16.3	16.4	90.2	88.6	90.9	82.0	77.9	80.0	3028	2906	2967
S_3	16.3	16.3	16.3	90.6	90.1	90.6	85.6	83.3	84.5	3686	3518	3602
S_4	16.2	16.3	16.3	90.5	90.6	90.6	87.2	84.5	85.8	3697	3631	3664
S_5	16.3	16.3	16.3	91.1	90.1	90.9	87.5	84.9	86.2	3809	3644	3726
S_6	16.0	16.3	16.1	89.4	90.6	90.3	88.7	85.6	87.2	3811	3728	3769
SEm(±)	0.41	0.62	0.53	3.33	3.54	3.04	1.88	2.26	2.06	118.2	121.2	103.1
CD (0.05)	NS	NS	NS	NS	NS	NS	5.4	6.5	6.0	341	350	298
CV (%)	7.5	11.4	9.8	11.0	11.7	10.0	6.6	8.3	7.4	10.1	10.8	9.0
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

determined to be non-significant in both the study years and the pooled data.

In the first year of study, among various sub plot treatments, application of 125% STBNK at 45 days interval recorded higher seedling vigour index (3811) and found significantly superior to application of 75% STBNK applied at 30 days interval + 25% RDK which displayed distinctly lower vigour (2953) and 75% STBNK alone at 45 days interval(3028). Application of 125% STBNK at 30 days interval + 25% recommended K at one month before harvesting, 100% STBNK applied at 30 days interval + 25% RDK at one month before harvesting and 100% STBNK alone applied at 45 days interval were found to be on par with S_6 treatment. Similar trend was observed during second year of study and also with pooled data.

Well-fertilized setts germinate quickly, producing vigorous seedlings with a high proportion of roots and shoots (Gururaj, 2001). Setts with a higher moisture content promote faster and more vigorous germination, and seedlings that emerge from such setts establish and grow quickly (Verma, 2004).

CONCLUSION

Based on the findings of this study, it is concluded that applying 125% STBNK alone at 45 days intervals improved seedcane quality by significantly increasing reducing sugars, moisture content, germinability, and seedling vigour index of seedcane setts over lower fertiliser applied plots, *i.e*., 75% STBNK, and was statistically comparable with 125% STBNK applied at 30 days interval + additional dose of 25% recommended K at one month before planting.

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