**Effect of in situ mulching of sugarcane trash in ratoon sugarcane on soil fertility and productivity of Sugarcane**

**Abstract**

Sugarcane is the promising sugar crop cultivated in our study areas as cash crop. The main problem associated with cultivation is poor management practices. Especially insitu stubble burning and indiscriminate use of chemical fertilizers vulnerably affects the crop yield. The present study explores the effective recycling of sugarcane trash in ratoon sugarcane with integrated nutrient management practice on soil fertility and productivity of sugarcane. On-farm trails were conducted in five farmers’ field with three treatments under randomized block design. Three treatments namely, farmers practice (FP) - Application of Di Ammonium Phosphate & Muriate of Potash each @ 250 kg/ha as basal dose, urea as top dressing @ 250 kg/ha & removal of residues and burning and no intercropping (Check), Recommended practice (RP) - 100% Recommended Dose of Fertilizers NPK @ 375:100:200 kg/ha, insitu mulching of trashes with application of NCOF waste decomposer, application of bio fertilizers @ 2 kg/ha, application of enriched sugarcane micro nutrient mixture @ 50 kg/ha and foliar spraying of sugarcane booster @ 4.5 kg/ha @ 45,60 & 75 days after planting and Alternate Practice (AP) - 100% Recommended Dose of Fertilizers NPK @ 375:100:200 kg/ha, insitu mulching of trashes with application of urea @ 50 kg/ha + *Trichoderma viride* @ 10 kg/ha and cowdung @ 100 kg/ha, application of bio fertilizers @ 2 kg/ha and micro nutrients i.e. iron sulphate @ 20 kg/ha, zinc sulpahte @ 10 kg/ha, borax @ 5kg/ha and sulphate @ 10 kg/ha. Soil samples were collected periodically at the time of ratoon establishment, 3-4 months after incorporation of trash and post-harvest stage of cane and analyzed its major properties. Yield data was collected and presented in t/ha. Insitu mulching with INM practice accelerated the favorable environment in the rhizosphere region. Especially conserved the soil moisture, controlled weed emergence and increased the availability of nutrients and favored the environment for earthworm population. It can be suggested that farmers cultivating ratoon sugarcane for more than a years, are advised to adopt trash mulching instead of burning in the same field. This package of practices enhances the soil health and productivity of cane significantly.

**Key words**: Sugarcane, insitu mulching, nutrient management, yield and economics

**Introduction**

Burning of residue causing pollution to the atmosphere and creating many health problems for soil and living life. Indian farmers in sub tropical region are taking only one to two ratoon crops. The continuous plant - ratoon system increased soil compaction, reduced soil fertility and cane yield. Several researchers have emphasized the benefits of predominantly agricultural techniques such as mulching of crop residue, green manuring, and agroforestry efficiently and having positive influence on crop productivity and in the maintenance of farming system sustainable under tropical and sub-tropical climatic conditions (Bairwa et al., 2022). Sugarcane is the major sugar crop being cultivated in Namakkal district in an area of 10071 ha. Annually, it produces 1,25,885 tonnes of sugarcane trash waste in Namakkal district. Sugarcane cultivation generates significant residual biomass, known as sugarcane trash, which remains in the field post-harvest. Improper management of this residue poses challenges such as soil degradation, increased pest incidence and environmental pollution. Sustainable alternatives, including microbial-assisted decomposition, are gaining attention as eco-friendly solutions for efficient sugarcane trash management (Sugumaran et al., 2025). Recently, after the harvest of the economic part, management of stubbles in the field to cultivate the succeeding crop is a big challenge faced by the farmers due to non-availability agricultural labours. Hence, farmers' chosen burning of stubble is best option to carry out the field work for next crop cultivation. Burning causes environmental pollution, resulting in soil fertility deterioration due to nutrient volatilization and the death of beneficial organisms. Especially stubbles burning is common everywhere in sugarcane and maize growing areas in the five blocks of Namakkal. 529 tonnes of Nitrogen, 189 tonnes of Phosphorus and 629 tonnes of Potassium are being wasted due to sugarcane trash burning operations.Besides the loss of organic matter and plant nutrients, burning of crop residues results in increase of atmospheric pollution due to the emission of toxic gases like methane and carbon dioxide. Surface organic mulch such as sugarcane trash is used to conserve soil moisture, moderating soil temperature extremes, checking weed growth and adding organic matter to soils (Nagaswathi and Reddy, 2022). To nullify the ill effects of burning, Society has to be sensitized with novel technology like composting methods. Also, indiscriminate use of chemical fertilizers without inclusion of adequate quantity of biofertilizers and organic manures has deteriorated the soil fertility drastically over the periods after the introduction of the green revolution. The cumulative effect of above said process made the plants week during the critical growth stages and more susceptible to pest and disease attack and thus finally leads to tremendous yield loss. In general, farmers got nearly 250 tonnes of cane yield / ha during 2000 decades and recently they recorded an average yield of 140 t / ha during 2024 decades. The yield gap between the years was 110 t/ha. Rs.2,75,000/- ha lost by farmers due to various reasons especially non-adoption of scientific package of practices in sugarcane cultivation. Keeping these points in view, this on-farm trial was conducted with all scientific management practices, especially nutrient management and in situ composting techniques. The main objective of this experiment was to study the effective recycling of sugarcane trash in ratoon sugarcane with integrated nutrient management practice on soil fertility and productivity of sugarcane.

**Materials and methods**

KVK, Namakkal has conducted the survey among the farmers about ill effects of burning, followed by conducting on campus, off campus training, method demonstration, and awareness programmme. Then interested 5 farmer’s field selected and conducted on farm trail with integrated crop management practice especially insitu mulching techniques cum integrated nutrient management practices. The trial was conducted at DFI village Ganapathipalayam, during the year 2020 - 2021. Randomized block design was adopted. Sugarcane was the test crop. Three treatments namely, farmers practice - Application of Di Ammonium Phosphate & Muriate of Potash each @ 250 kg/ha as basal dose, urea as top dressing @ 250 kg/ha & removal of residues and burning and no intercropping (Check), Recommended practice-100% Recommended Dose of Fertilizers NPK @ 375:100:200 kg/ha, insitu mulching of trashes with application of NCOF waste decomposer, application of bio fertilizers @ 2 kg/ha, application of enriched sugarcane micro nutrient mixture @ 50 kg/ha and foliar spraying of sugarcane booster @ 4.5 kg/ha @ 45,60 & 75 days after planting and alternate practice - 100% Recommended Dose of Fertilizers NPK @ 375:100:200 kg/ha, insitu mulching of trashes with application of urea @ 50 kg/ha + trichoderma viride @ 10 kg/ha and cowdung @ 100 kg/ha, application of bio fertilizers @ 2 kg/ha and micro nutrients i.e. iron sulphate @ 20 kg/ha, zinc sulpahte @ 10 kg/ha, borax @ 5kg/ha and sulphate @ 10 kg/ha. Soil samples were collected periodically at the time of ratoon establishment, 3-4 months after incorporation of trash and post post-harvest stage of cane and analysed its major properties. Yield data was collected and presented in t/ha. The average value of treatment effects in five replicates is presented hereunder.

Collected soil samples were studied for its soil properties as per standard procedures. pH and EC were determined in Soil: Water (1:2.5 ratio) extract by potentiometric and conductometric methods, respectively (Jackson, 1973). Organic carbon was estimated by the chromic acid wet digestion method (Walkley and Black, 1934). Available N in soil was estimated by alkaline permanganate method (Subbiah and Asija, 1956), available P by Colorimetry method (Olsen *et al*., 1954), available K by Neutral Normal Ammonium Acetate method (Stanford and English, 1949) and available S by Turbidimetric method (Williams and Steinbergs, 1959). Growth and yield attributes were recorded as per the standard format. Then Gross cost (Rs./ha), Gross income (Rs./ha), Net income (Rs./ha) and Benefit Cost Ratio worked out accordingly. Gross cost is worked out by using the total expenses incurred in crop cultivation. Gross income is worked out by using the income generated from the total cultivable area in ha. Net income and BC ratio were worked out by using the formula.

Net income (Rs./ha) = Gross cost (Rs./ha) - Gross Income (Rs./ha)

BC ratio = Gross cost (Rs./ha) / Gross Income (Rs./ha)

**Results and discussion**

**Effect of treatments on Soil properties**

Sugarcane is an annual crop and hence all management practices quite varied from all seasonal crops. In situ incorporation of residues and nutrient management practices played a vital role in the improvement of soil fertility and yield (Table 1). Soil reaction ranges from 7.18 to 7.59, Electrical conductivity recorded in non-saline range (0.039-0.057). Due to its buffering capacity of soil, management practices do not alter the above-mentioned parameters drastically. Meanwhile, soil pH in the farmers practice tends towards alkaline range from its initial value due to the burning process and indiscriminate use of chemical fertilizers. Release of organic acids during the composting of in situ incorporated sugarcane trashes, solubilizing the salts and making them available for plant uptake. Also it assists in regulating the soil pH and maintaining at neutral level. According to the observation of Rajinder Pal *et al*., (2021), treatments had no significant influence on soil pH and EC. Also they highlighted that treatments that received application of FYM/any source of organic manures showed a marginal reduction in pH than farmers practice. This might be due to the production of organic acids from organic residues upon microbial decomposition in the soil.

With regards to organic carbon content and available nitrogen, were recorded low (0.46% & 245 kg/ha respectively) to medium category (0.72 % & 321 kg/ha respectively). Improvement in organic carbon from 0.51% to 0.72 % (0.21 %) and available nitrogen from 277 kg/ ha to 321 kg/ha (44 kg/ha) was noticed in 4 months after incorporation of trash. Then it was declined at the harvest stage and even then slight improvement was observed when compared to its initial soil test values. Prakash Gowda *et al*., (2022) observed from the experiment, appreciable changes in organic carbon content were observed in soil might be associated with poor agronomic practices like trash burning, reduction in use of organic manure and other sources of organic manure.

Irrespective of treatments, available phosphorus was recorded high category (29.15 – 35.64 kg/ha), potassium was recorded medium category (186 - 243 kg/ha) and sulphur was recorded medium to high category (14.97 – 20.45 mg/kg), respectively. Proper nutrient supplementation along with insitu mulching, released nutrients to the solution and thereby increased the availability and root uptake in the rhizosphere region. As per the statement of Abhishek Ranjan *et al*.,(2020), balanced use of organic and inorganic form of nutrients along with addition of biofertilizers act as an evidenced tool for sustaining the cane productivity as well as increasing soil fertility in sugarcane and sugarcane-based cropping systems.

**Table : 1. Effect of treatments on Soil nutrient status in initial and post harvest analysis**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **Initial soil test value** | **Nutrient status**  **(3-4 months after incorporation)** | **Post harvest soil test values** | | |
| **Farmers practice** | **TNAU**  **Practice** | **SBI**  **practice** |
| Soil reaction | 7.18 | 7.32 | 7.59 | 7.23 | 7.35 |
| Electrical Conductivity (dS m-1) | 0.057 | 0.039 | 0.053 | 0.054 | 0.055 |
| Organic carbon (%) | 0.51 | 0.72 | 0.46 | 0.67 | 0.63 |
| Available nitrogen (kg ha-1) | 277 | 321 | 245 | 298 | 279 |
| Available phosphorus (kg ha-1) | 29.15 | 35.64 | 25.32 | 31.23 | 31.09 |
| Available potassium (kg kg-1) | 186 | 243 | 189 | 220 | 267 |
| Available sulphur (mg kg-1) | 14.97 | 20.45 | 15.32 | 18.06 | 19.09 |

**Effect of treatments on yield attributes and economics of sugarcane**

Cane height ranged from 197 cm to 248 cm, cane girth from 19.6 cm to 27.8 mm, no. of millable canes from 94 to 144.6X103/ha and cane yield from 115.33 to 166.7 t/ha (Table 2 & Fig.1). Mulching with organic residues conserved soil moisture at all critical growth which inturn reflected in good germination percentage and tillering ability of cane even under unfertilized condition (De Silva *et al*., 2012). Begum *et al*., (2023) reported that integrated nutrient management practice significantly resulted in yield attributing characters and yield of cane.

Recommended practice, soil test-based nutrient management practice along with insitu mulching of sugarcane trash recorded the highest yield of 166.7 t/ha with yield increase over farmers' practice was 44.54 %. It was recorded the highest net return of Rs.2,39,174/ha with BC ratio of 2.76. Shredded trash residues acted as a organic mulch over the surface, which hindered the weed establishment. Hence, one weeding cost Rs. 6,500/ha can be saved by adopting insitu mulching with sugarcane trash, especially during the initial growth period (Hoshino *et al*., 2017). Upon composting, it adds organic content to the soil system, hence farmers could save farm yard manure cost of Rs.25,000/ha by skipping its application to ratoon sugarcane. Additionally, trash mulch controls the moisture loss due to the evapotranspiration process from upper surface of the sugarcane field. According to the soil types it supported the farmers to schedule irrigation to the standing sugarcane crops.

**Table : 2. Effect of treatments on growth attributes, yield and Economics of Sugarcane**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Technology Options** | **Cane height (cm)** | **Cane girth (mm)** | **No. of millable cane (X103)** | **Yield (t/ha)** | **Cost of cultivation (Rs./ha)** | **Gross income (Rs./ha)** | **Net**  **Returns (Rs./ha)** | **B:C**  **ratio** |
| Recommended practice (Source: TNAU, Coimbatore, 2020) | 248 | 27.8 | 144.6 | 166.7 | 1,20,714 | 3,33,308 | 2,39,174 | 2.76 |
| Alternate practice  (Source: SBI, Coimbatore, 2020) | 232 | 24.9 | 104.6 | 161.64 | 1,18,491 | 3,23,100 | 2,30,589 | 2.73 |
| Farmers practice | 197 | 19.6 | 94.0 | 115.33 | 1,18,151 | 2,30,668 | 1,26,717 | 1.95 |
| CD (p=0.05) | 11.87 | 1.690 | 19.68 | 11.82 |  |  |  |  |

**Economics of sugarcane**

Cost of cultivation ranged from Rs.1,18,151/ha to Rs.1,20,714/ha, gross income ranged from Rs.2,30,668/ha to Rs.3,33,308/ha (Table 2 & Fig.2), Net income from Rs.1,26,717/ha to Rs.2,39,174/ha with BC ratio ranged from 1.95 to 2.76. The additional net income of Rs.1,12,457/ha was obtained in the plot that received trash mulching with INM practice. The yield increase was observed 44.54% than farmer’s practice. Timely application of all agricultural inputs improved the phenological and yield-bearing attributes which inturn increased the yield of cane. Generally, the average yield potential of cane decreased progressively due to poor management practices especially deterioration in soil health. The average productivity of cane was observed 225 t/ha in 2000 and recently recorded 125 t/ha in 2024. In situ mulching with INM practice accelerated the favorable environment in the rhizosphere region. Especially conserved the soil moisture, controlled weed emergence and increased the availability of nutrients and favored the environment for the earthworm population. These practices increased the no. millable cane, cane quality and yield of cane and finally resulted in better economics (Tayade *et al*., 2022)

**Conclusion**

Higher yield of sugarcane and soil available nutrients was achieved by adopting the integrated crop management practice, especially TNAU package of practices than other practices. From this study, it can be concluded that the scientific adoption of integrated nutrient management practice with in situ mulching process recorded noticeable improvement in soil fertility followed by an increase the no. of millable canes and yield of sugarcane. Farmer’s facing hurdles while doing shredding operation in the field during rainy season. Hence farmers are advised to go for mulching under dry climate for an effective shredding process. For effective composting of mulched trash at the field level introduction of any kind of biomineralizer is inevitable.

Hence, it can be suggested that farmers cultivating ratoon sugarcane for more than a years, are advised to adopt trash mulching instead of burning in the same field. This package of practices enhance the soil health and productivity of cane significantly.

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**References**

Abhishek Ranjan, C.K.Jha and Navnit Kumar. 2020. A Review of Effect of INM on sugarcane growth, yield and quality. Int. J.Curr.Microbiol.App.Sci., 9 (1): 2597 – 2605.

Begum, Mahima & Bordoloi, Bijnan & Ojha, Nayan & Kurmi, K. & Das, Ranjan & Singha, Dhiman & Pathak, Kalyan. (2023). Performance of Sugarcane Bud Chip Settlings Under Different Integrated Nutrient Management Practices. Sugar Tech. 26. 10.1007/s12355-023-01327-3.

De Silvaa A. L. C., B. D. S. K. Ariyawanshab, L. M. J. R. Wijayawardanaa, and W. R. G. Witharama. 2012. Effect of mulching on growth and yield in plant crop of sugarcane under rainfed conditions in Sevanagala, Srilanka. Paper Presented in Fourth Symposium on Plantation Crop Research - Technological Innovation for Sustainable Plantation Economy held at Tea Research Institute of Sri Lanka, St. Coombs, Talawakelle, 22100, Sri Lanka <https://www.researchgate.net/publication/344162746>.

Hoshino, A.T., F.T. Hata, G.S.d. Aquino, A.d.O.M. Junior, M.U. Ventura and C.d.C. Medina, 2017. Mulching with sugarcane straw reduces weed density in sugarcane field. Int. J. Agric. Biol., 19: 121‒124. <http://www.fspublishers.org>

Jackson M L (1973). Soil Chemical Analysis. Prentice Hall of India Ltd., New Delhi.

Olsen S R,. Cole C V, Watanabe P S and Dean L A (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S.D.A. Circ. 939.

Prakash Gowda, Vineet Singh, Naresh Deshmukh and Mahesh Girdhar. 2022. Role of enhanced efficiency fertilizers and balanced crop nutrition in increasing sugarcane production in India. Paper presented in International Conference on Sustainability of the Sugar and Integrated Industries issues and Initiatives held at Lucknow, India P.No.29-30. <https://www.researchgate.net/publication/364921401>.

Rajinder Pal, Onkar Singh, Gulzar S Sanghera and R. K. Gupta. 2021. Influence of INM on sugarcane productivity and soil fertility inder Indo-Gangetic Plain. Indian Journal of Agrl. Sci., 91 (5) : 703-707.

Stanford S and English L (1949). Use of Flame photometer in rapid soil test for K and Ca. Agron. J., 41: 446-447.

Subbiah B V and Asija G L (1956). A rapid procedure for estimation of available nitrogen in soils. Curr. Sci., 65:477-480.

Tayade,A.S., P. Geetha and S. Anusha.2022. Integrated Nutrient Management in Sugarcane. <https://www.researchgate.net/publication/366137204>.

Walkley A and Black C A (1934). An examination of Degitijareff method for determining the organic matter and proposed modification of the chromic acid titration method. Soil Sci., 37: 29-38.

Williams C H and Steinbergs A (1959). Soil sulphur fractions as chemical indices of available sulphur in some Australian soils. Aus. J. Agronomical Res., 10:   
340-352.

Bairwa, R., Jha, C. K., & Thakur, S. K. (2022). Effect of sugarcane trash management techniques on soil fertility, nutrient uptake and yield of sugarcane ratoon in calcareous soil. The Pharma Innovation, 11(5), 1538-1541.

Nagaswathi, S. R., & Reddy, R. (2022). Effect of trash management of sugarcane on soil organic carbon buildup and sustaining yields of successive ratoon crop in Khammam district of Telangana. Indian Journal of Ecology, 49(5) (SI): 1931-1934

Sugumaran MP, Gayathry G, Porkodi G, Kalaiselvi P, Kiruba M, Sassikumar D, et al. (2025). In-situ decomposition of sugarcane trash using microbial consortium and its impact on ratoon cane. Plant Sci. (Early access). https://horizonepublishing.com/journals/index.php/PST/article/view/6969