**Impact on soil fertility by resource based organic farming in sugarcane under south Gujarat condition**

**ABSTRACT**

The investigation was conducted during the *rabi* seasons of the years 2019–20 and 2020–21 at Organic Farm, Aspee College of Horticulture, Navsari Agricultural University, Navsari (Gujarat). The soil of the experimental field was clayey in texture, with electrical conductivity within the safe limit (0.46 and 0.47 dS/m). The soil was medium in organic carbon (0.67 and 0.74 %) and slightly alkaline in reaction (pH 7.70 and 7.65). Medium in available nitrogen (248.30 kg/ha and 226.40 kg/ha) and P2O5 (45.20 and 35.70 kg/ha), high in available K2O (416.40 and 429.10 kg/ha), DTPA-extractable Fe (17.00 and 18.20 mg/kg), Mn (15.20 and 16.80 mg/kg), Cu (2.62 and 2.67 mg/kg), and DTPA-extractable Zn (1.60 and 1.48 mg/kg) during both years, respectively.

The treatments, *viz*.,(Factor A Spacing, S1: 90 cm; S2: 120 cm x 60 cm paired row with green manuring). (Factor B Manure levels, M1: NADEP @ 100 % RDN; M2: NADEP @ 75 % RDN; M3: NADEP @ 50 % RDN; and M4: NADEP @ 25 % RDN + Sugarcane trash @10 t/ha + jeevamrut @ 2000 l/ha., were applied to the sugarcane crop in the *rabi* season and replicated three times in factorial randomised block design.

The soil physico-chemical properties enumerated with treatment M1: NADEP @ 100 % RDN its enhanced soil fertility, increasing organic carbon significantly during both the experimental years and nitrogen during second year of experiment. Organic farming positively impacts soil health. The Soil Properties reported enhanced soil fertility with organic treatments and reduced depletion of nutrients.

**INTRODUCTION**

Sugarcane (*Saccharum* Hy.sp.) is one of the most important industrial cash crops in both tropical and subtropical region of the world and a major export product of many developing countries. Sugarcane cultivation in India dates back to the Vedic period. The earliest mention of sugarcane cultivation is found in Indian writings of the period 1400 to 1000 B.C. It is a principal raw material for sugar industry as world’s 75% sugar comes from sugarcane (Anon., 2013). It is the main source of sugar, jaggery (gur) and brown sugar (khandsari). Crushed by-products of sugarcane industry like bagasse and molasses also have important uses. Molasses is used in distilleries for the manufacturing of citric acid, ethyl, alcohol *etc.* Press mud is generally used for soil amendment. The upper green part of sugarcane is also used as a fodder for cattle feeding. Owing to its versatile utility and vast capability to meet the demands of human population, it is rightly called as ‘Wonder cane’.

Sugarcane (*Saccharum* Hy.sp.) belongs to the family *poaceae* (Gramineae) and tropical sugarcane originated from Oceania (New Guinea) while Indian cane (*Saccharum spontaneum* L.) originated from North Eastern India. The word *Saccharum* is derived from the Sanskrit word “sharkara” and it indicates its Indian origin. Brazil led the world in sugarcane production. India is the second largest producer of sugar in the world with over 5 mha of sugarcane growing area. In India, sugarcane is grown in 50.98 lakh hectare with total production 430.50 Milliontones with the productivity of 84.44tons per hectare and the average sugar recovery of 10.23%. Considering area, Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Bihar, Andhra Pradesh and Gujarat are the major sugarcane growing states. Gujarat produces only 3.72 per cent sugarcane from 4.65 per cent area of India. Sugarcane area, production, productivity and sugar recovery, in Gujarat was 2.23 lakh hectare, 17.44 million tones, 78.31 t/ha and 11.09 %, respectively (Anon., 2023). Surat, Navsari, Valsad, Bharuch, Tapi, Narmada, Bhavnagar, Rajkot, Junagadh and Jamnagar are the important sugarcane producing districts.

**MATERIALS AND METHODS**

**Experimental Site**

The experiment was conducted at Organic Farm, Navsari Agricultural University, Navsari, Gujarat. The farm was converted in to organic during 2005, since then organic management practices were adopted to raise the crops. This place is situated at 20°57’ N latitude, 72°54’ E longitude and has an altitude of about 10 m above the mean sea level and is located 12 km away in the east from the great historical place ‘Dandi’ on the Arabian seashore.

**Experimental Details**

The experiment was carried out in a factorial randomized block design comprising of 8 treatments, combinations with thrice in replication (Table 1). Sugarcane variety used for experiments was CoN:7072 sown with two different spacing treatments like S1: 90 cm and S2: 120 cm x 60 cm paired row (with green manuring) and four different manuring levels treatments like M1:NADEP @ 100 % RDN, M2:NADEP @ 75 % RDN, M3:NADEP @ 50 % RDN and M4:NADEP @ 25 % RDN+ Sugarcane trash @10 t/ha + jeevamrut @ 2000 l/ha. The NADEP compost is used as a organic manures equivalent to nitrogen requirement of sugarcane (RDN). Sugarcane trash and jeevamrut (500 lit/ha) at first four irrigation as per treatment. The physico-chemical properties of soil recorded before (initial) and after harvest of sugarcane during both the years for each plot. Soil samples will be collected before and after experiment. About 1.5 kg of representative soil sample will be collected from each plot at 0–22.5 cm depth. The soil samples will be air dried in shade. After air drying, the soil will be ground with wooden mortar and pestle and passed through 2.0 mm sieve. These processed soil samples will be stored in cloth bags for detailed analysis. The soil samples will be analyzed for different parameters by adopting standard procedures (Table 2).

**Table 1.Treatments details**

|  |
| --- |
| **Treatments** |
| **Factor I: Spacing** |
| S1: 90 cm |
| S2: 120 cm x 60 cm paired row (with green manuring) |
| **Factor II: Manure levels** |
| M1:NADEP @ 100 % RDN |
| M2:NADEP @ 75 % RDN |
| M3:NADEP @ 50 % RDN |
| M4:NADEP @ 25 % RDN+ Sugarcane trash @10 t/ha + jeevamrut @ 2000 l/ha. |

**Table 2.** Soil and water analysis methods

|  |  |  |
| --- | --- | --- |
| **Properties** | **Methods** | **References** |
| Bulk density | Core | Black (1965) |
| Organic carbon | Walkley and Black titration | Jackson(1973) |
| Available N | Alkaline potassium permanganate | Subbiah and Asia (1956) |
| Available P2O5 | Olsen (Extraction with 0.5M NaHCO3at pH 8.5) | Jackson(1973) |
| Available K2O | Flamephotometric (Extraction with 1  N NH4OAcat pH 7.0) | Jackson(1973) |

**RESULTS AND DISCUSSIONS**

**Bulk density of soil**

The result regarding soil bulk density (g/cc) at harvest of sugarcane as affected by different treatments is presented in Table 3. The result revealed that soil bulk density (g/cc) at harvest of sugarcane was not affected significantly by the treatments of spacing, compost as well as year and their interactions.

**Soil Organic Carbon (%)**

Result regarding treatment effect on soil organic C is presented in Table 4. The result revealed spacing treatment did not affect soil organic C significantly during both the individual years. However, numerically higher soil organic C content after harvest of sugarcane (0.73 and 0.79 %) was found with treatment S2 (120 cm x 60 cm paired row with green manuring) during the year 2019-20 and 2020-21, respectively. Effect of compost treatment on soil organic C content after harvest of sugarcane was significant. Treatment M1 (NADEP compost @ 100 % RDN) recorded significantly higher soil organic C content after harvest of sugarcane during the year 2019-20 (0.75 %) and 2020-21(0.82 %). Minimum soil organic C content after harvest of sugarcane was recorded in treatment M3. Interaction effect of SxM on soil organic C content after harvest of sugarcane was non-significant during the year 2019-20 and 2020-21.

**Available N (kg/ha)**

The result pertaining to soil available N (kg/ha) status after harvest of sugarcane is presented in Table 5. The result revealed that the content of available N in soil in the year 2019-20 was not differed significantly but it was differed significantly in the year 2020-21 due to spacing treatments. In the year 2020-21, spacing treatment S2 (120 cm x 60 cm paired row with green manuring) recorded significantly higher available N content in soil (251.2 kg/ha) as compared to treatment S1 (90 cm), recorded available N content 241.6 kg/ha in soil after harvest of sugarcane. Similarly, the content of available N in soil in the year 2019-20 was not differed significantly but it was differed significantly in the year 2020-21 due to compost treatments. In the year 2020-21, treatment M1 (NADEP compost @ 100% RDN) recorded significantly higher content of available N (266.9 kg/ha) after harvest of sugarcane. However, this treatment was remained at par with treatment M2 (application of NADEP compost @ 75 % RDN). Comparatively lowest content of available N in soil was recorded in treatment M4 (application of NADEP compost @ 25 % RDN+ Sugarcane trash @ 10 t/ha + jeevamrut @ 2000 l/ha). During both the years, interaction effect of SxM on available N content in soil after harvest of sugarcane was non-significant.

**Available phosphorus (kg/ha)**

Result regarding effect of spacing on soil available P2O5 status after harvest of sugarcane is given in Table 6. Result indicated that the content available P2O5 in soil after harvest of sugarcane was not affected significantly by spacing treatments during both the individual years. The content available P2O5 in soil after harvest of sugarcane was affected significantly by compost treatments during the year 2020-21. In the year 2020-21, treatment M1 (NADEP compost @ 100 % RDN) recorded significantly the highest content of available P2O5 (47.5 kg/ha) after harvest of sugarcane. Significantly the lowest content of available P2O5 (39.0 kg/ha) after harvest of sugarcane was recorded in treatment M4. However, this treatment was remained at par with the treatment M3 during the year 2020-21. During both the years, interaction effect of SxM on available P2O5 content in soil after harvest of sugarcane was non-significant.

**Available K2O (kg/ha)**

The result regarding available K2O content in soil after harvest of sugarcane is presented in Table 7. The result showed that effect of different treatments *i.e.* spacing, compost and their interactions on available K2O content in soil after harvest of sugarcane were not significant during both the individual years. Application of NADEP compost @ 100 % RDN (M1) found numerically higher soil available potassium (436.4 and 443.3 kg/ha respectively) status after harvest of sugarcane while lower soil available potassium (414.3 and 419.1 kg/ha respectively) status was noted with application of NADEP compost @ 25 % RDN+ Sugarcane trash @ 10 t/ha + jeevamrut @ 2000 l/ha (M4) during the year 2019-20, 2020-21. A perusal of data revealed that the interaction effects of different treatments on soil available potassium (kg/ha) status after harvest of sugarcane were found to be non-significant during both the individual as displayed in Table 7.

**Table 3. Effect of different treatments on bulk density of soil after harvest of sugarcane**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Bulk density (g/cc)** | |
| **2019-20** | **2020-21** |
| **Factor I: Spacing** |  | |
| S1 -90 cm | 1.38 | 1.36 |
| S2 -120 cm x 60 cm with GM | 1.37 | 1.36 |
| S Em± | 0.01 | 0.01 |
| CD at 5% | NS | NS |
| **Factor II: Compost levels** |  | |
| M1 -Com. @ 100 % RDN | 1.36 | 1.34 |
| M2 -Com. @ 75 % RDN | 1.37 | 1.35 |
| M3 -Com. @ 50 % RDN | 1.39 | 1.38 |
| M4 -Com. @ 25 % RDN+ ST @ 10t/ha + JM @ 2000 l/ha) | 1.37 | 1.37 |
| S Em± | 0.01 | 0.01 |
| CD at 5% | NS | NS |
| CV (%) | 2.47 | 2.49 |
| **SXM** |  |  |
| S Em± | 0.02 | 0.02 |
| CD at 5% | NS | NS |
| Initial | 1.41 | |

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

**Table 4. Effect of different treatments on soil organic C content after harvest of sugarcane**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Soil organic C (%)** | |
| **2019-20** | **2020-21** |
| **Factor I: Spacing** |  | |
| S1 -90 cm | 0.71 | 0.77 |
| S2 -120 cm x 60 cm with GM | 0.73 | 0.79 |
| S Em± | 0.01 | 0.01 |
| CD at 5% | NS | NS |
| **Factor II: Compost levels** |  | |
| M1 -Com. @ 100 % RDN | 0.75 | 0.82 |
| M2 -Com. @ 75 % RDN | 0.71 | 0.78 |
| M3 -Com. @ 50 % RDN | 0.70 | 0.75 |
| M4 -Com. @ 25 % RDN+ ST @ 10t/ha + JM @ 2000 l/ha) | 0.70 | 0.77 |
| S Em± | 0.01 | 0.01 |
| CD at 5% | 0.03 | 0.03 |
| CV (%) | 3.69 | 3.59 |
| **SXM** |  |  |
| S Em± | 0.02 | 0.02 |
| CD at 5% | NS | NS |
| Initial | 0.67 | |

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

**Table 5. Effect of different treatments on available N content in soil after harvest of sugarcane**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Available N (kg/ha)** | |
| **2019-20** | **2020-21** |
| **Factor I: Spacing** |  | |
| S1 -90 cm | 223.6 | 241.6 |
| S2 -120 cm x 60 cm with GM | 224.4 | 251.2 |
| S Em± | 2.3 | 3.1 |
| CD at 5% | NS | 9.4 |
| **Factor II: Compost levels** |  | |
| M1 -Com. @ 100 % RDN | 230.2 | 266.9 |
| M2 -Com. @ 75 % RDN | 224.5 | 255.4 |
| M3 -Com. @ 50 % RDN | 221.6 | 232.7 |
| M4 -Com. @ 25 % RDN+ ST @ 10t/ha + JM @ 2000 l/ha) | 219.8 | 230.6 |
| S Em± | 3.2 | 4.4 |
| CD at 5% | NS | 13.3 |
| CV (%) | 3.5 | 4.4 |
| **SXM** |  |  |
| S Em± | 4.6 | 6.2 |
| CD at 5% | NS | NS |
| Initial | 248 | |

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

**Table 6. Effect of different treatments on available P2O5 content in soil after harvest of sugarcane**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Available P2O5 (kg/ha)** | |
| **2019-20** | **2020-21** |
| **Factor I: Spacing** |  | |
| S1 -90 cm | 34.5 | 41.5 |
| S2 -120 cm x 60 cm with GM | 34.7 | 43.4 |
| S Em± | 0.7 | 0.6 |
| CD at 5% | NS | NS |
| **Factor II: Compost levels** |  | |
| M1 -Com. @ 100 % RDN | 36.8 | 47.5 |
| M2 -Com. @ 75 % RDN | 35.3 | 42.8 |
| M3 -Com. @ 50 % RDN | 33.9 | 40.4 |
| M4 -Com. @ 25 % RDN+ ST @ 10t/ha + JM @ 2000 l/ha) | 32.4 | 39.0 |
| S Em± | 1.0 | 0.9 |
| CD at 5% | NS | 2.7 |
| CV (%) | 7.3 | 5.2 |
| **SXM** |  |  |
| S Em± | 1.5 | 1.3 |
| CD at 5% | NS | NS |
| Initial | 45 | |

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

**Table 7. Effect of different treatments on available K2O content in soil after harvest of sugarcane**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Available K2O (kg/ha)** | |
| **2019-20** | **2020-21** |
| **Factor I: Spacing** |  | |
| S1 -90 cm | 422.9 | 431.7 |
| S2 -120 cm x 60 cm with GM | 426.5 | 431.0 |
| S Em± | 6.9 | 4.3 |
| CD at 5% | NS | NS |
| **Factor II: Compost levels** |  | |
| M1 -Com. @ 100 % RDN | 436.4 | 443.3 |
| M2 -Com. @ 75 % RDN | 430.2 | 433.5 |
| M3 -Com. @ 50 % RDN | 417.8 | 429.5 |
| M4 -Com. @ 25 % RDN+ ST @ 10t/ha + JM @ 2000 l/ha) | 414.3 | 419.1 |
| S Em± | 9.8 | 6.1 |
| CD at 5% | NS | NS |
| CV (%) | 5.7 | 3.5 |
| **SXM** |  |  |
| S Em± | 13.9 | 8.6 |
| CD at 5% | NS | NS |
| Initial | 416 | |

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

**Conclusion:**

It can be concluded that the soil physico-chemical properties enumerated with treatment M1: NADEP @ 100 % RDN its enhanced soil fertility, increasing organic carbon significantly during both the experimental years and nitrogen during second year of experiment. Organic farming positively impacts soil health. The Soil Properties reported enhanced soil fertility with organic treatments and reduced depletion of nutrients. Soil organic carbon improvement might be helpful for nutrient availability as well as biological properties of soil and improvement microbial activity. The sustainable agriculture productivity as well as maintenance of soil fertility available organic resource based treatment positive impact was noticeable.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE):**

Author(s) hereby declares that no generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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