**Influence of age of single eye bud settling and nutrient management on cane yield and nutrient acquisition of sugarcane (*Saccharum hy. sp.*) under south Gujarat condition**

**ABSTRACT**

An experiment was conducted for two consecutive years at Main Sugarcane Research Station, Navsari Agricultural University, Navsari, Gujarat, India during 2021-22 and 2022-23 to study the effect of age of single eye bud settling and nutrient management influence on cane yield and nutrient acquisition of sugarcane (*Saccharum hy*. *sp*.) under south Gujarat condition. The experiment comprised of twelve treatments which was laid out in factorial randomized block design with three replications. Significantly higher cane yield (86.44, 89.79 and 88.11 t/ha) was recorded with treatment of 30 days old settling. Nutrient management practices have marked effect on cane yield and treatment recommended dose and schedule of nutrient applications recorded significantly highest cane yield (85.17, 84.38 and 84.78 t/ha) during both the years and in pooled analysis, respectively. It was remained at par with treatments RDN + RDK in four splits and RDN + RDK in three splits in both years and in case of pooled analysis only treatment RDN + RDK in four splits remained on par. Maximum K balance was recorded in case of treatment combinations 20 Days old settling+ Recommended dose and schedule of nutrient applications which was followed by 30 Days old settling+ Recommended dose and schedule of nutrient applications (+213.99) and (+209.26) kg/ha, where nitrogen and phosphorus balance was found negative under all treatment combinations.

**Keywords**: Age of settlings, nutrient management, Available nutrient, uptake and nutrient balance.

**INTRODUCTION**

 Sugarcane is one of the most important cash crops in India and plays pivotal role in both agricultural and industrial economy of our country. Sugarcane is an exhaustive crop, it produces heavy tonnage and depletes more nutrients from soil. It is high-nutrient demanding crop removing nearly 208 kg N, 53 kg P, 280 kg K, 6.3 kg Fe 1.2 kg Mn and 0.6 kg Zn from the soil by an average crop producing 100 t/ha of sugarcane (Malavolta, 1994). With the intensive cultivation, soils are getting depleted in the availability of nutrients hence becoming less fertile; the low fertility of soil is one of the important limiting factors in sugarcane productivity. In India, sugarcane-growers apply N and P only and generally do not apply K, secondary nutrients and micronutrients. Consequently, they face huge economic loss and sugar industries observe less sugar recovery per unit of sugarcane which is serious emerging issue in front of sugar industries since they are always unaware that the sugarcane they are procuring is properly fed with nutrients or not which is directly related to the sugar production in the industry (Lamba *et al*., 2016).

 Insufficient or ill-timed supply of N-fertilizer applied to sugarcane would result in poor growth, such as narrow leaves, thin stems, short internodes and yield (Bell *et al*., 2014). However, potassium requirement by the crop in general is greater than nitrogen or phosphorus. It is required for maintaining cell turgidity, photosynthesis, root development *etc*. It has a balancing effect on both nitrogen and phosphorus (Lakshmi *et al*., 2020). Phosphorus requirement is relatively less than N and K. Phosphorus is necessary for the synthesis of phosphorylated compounds and a lack of this nutrient immediately disturbs plant metabolism and development (Santos *et al*., 2014).

 Sugarcane is a clonally propagated crop with the planting of sugarcane setts. Cane cutting with one, two and three buds, known as setts, are used as seed (Jain *et al.,* 2010). In conventional method, there is high requirement of seed cane, low germination rate, difficulty in seed cane transportation, seed quality, *etc*. are affecting the cost of cultivation and sugarcane production. Single Bud Planting (SBP) seedling system is one of new technique of sugarcane seedling. The nursery is raised in protrays using single eye bud setts and 25-35 days old settlings are transplanted in field either manually or planters. Transplanting sugarcane single-bud/bud-chip settlings can save seed cane requirement up to 80 % besides providing healthy plants and good field establishment Singh *et al*., 2014. The proper seed age during the panting in the field is one of the important things to improve the plant productivity.

 South Gujarat has good potential of expanding area under sugarcane by adopting alternative planting method like sugarcane settling. Progressive farmers are adopting settling planting material for sugarcane planting. However, no adequate information is so far available on effect of age of single eye bud settling and nutrient management on sugarcane in Gujarat. Keeping the above facts in view, the present study was therefore undertaken to evaluate the effect of age of single eye bud settling and nutrient management on nutrient contain and uptake of sugarcane (*Saccharum hy. sp.*) under south Gujarat condition.

**MATERIALS AND METHODS**

 A field experiment was conducted during 2021-22 and 2022-23 at Main Sugarcane Research Station, Navsari Agricultural University, Navsari, Gujarat, India. The soil of the experimental sites is classified under the order "Inceptisols" according to the 7th Approximation, which includes members of the fine, montmorillonitic, isohyperthermic great soil group of Vertic Ustrochrepts and soil series Jalalpur by the soil survey officer, Navsari, Department of Agriculture, Gujarat state (Desai and Patel 1970), having poor drainage capacity and good water holding capacity.

 It comprised total twelve treatments of combination of factors Age of settling and Nutrient management *viz*., S1: 20 days, S2: 30 days and S3: 40 days and N1: RDN + RDK in two splits (Basal 25 % remaining at 60 and 120 DAP in equal splits), N2: RDN + RDK in three splits (Basal 25 % remaining at 60, 120 and 150 DAP in equal splits), N3: RDN + RDK in four splits (Basal 25 % remaining at 45, 60, 120 and 150 DAP in equal splits) and N4: Recommended dose and schedule of nutrient applications (250-125-125 N-P2O5-K2O kg/ha) (P2O5 & K2O 100 % at Basal and N in four splits 15 % Basal, 30 % at 75 DAP, 20 % at 100 DAP and 35 % at 150 DAP) were evaluated in factorial randomized block design with three replications. The weather parameters were taken during the year of experimentation (as depicted in fig. 1 and fig. 2).

**Preparation of Single Eye Bud Settlings**

 Single eye bud of sugarcane variety CoN 13072 were carefully cut from healthy canes manually and used for raising nursery. Plastic protrays were used for preparing sugarcane single eye bud settling. Single eye bud settling of sugarcane was prepared in nursery for 20, 30 and 40 days old settlings. Different aged (20, 30 and 40 days old settling) prepared in nursery were transplanted in field on same day 20th December, 2021 and 9th December, 2022 and harvested in the first week of March, 2023 and January, 2024 in both season of experiments, respectively. Other cultural operations and plant health care were same as followed for commercial planting. Data obtained from the experiment was statistically analyzed by standard statistical methods.

**Analysis of Soil and Plant Samples**

 A composite soil sample was collected from 0-15 cm depth of the experimental field before commencement of the experiment for analysis. Following the crop harvest, soil samples were

**Fig. 1: Meteorological parameters during the cropping season 2021-22.**

**Fig. 2: Meteorological parameters during the cropping season 2022-23**

collected from each plot in order to study chemical

changes brought about after experiment. The soil samples collected was then air dried, grounded and sieved through 2 mm sieve, labelled and stored for further analysis. Soil of experimental plot was clayey in texture and low in available nitrogen (206.98 and 225.79 kg/ha), available phosphorus was medium (53.53 and 57.92 kg/ha) and high in available potash (467.27 and 549.55 kg/ha). The soil was found slightly alkaline (7.86 and 7.85) with normal electrical conductivity (0.72 and 0.67 dS/m) during the year 2021-22 and 2022-23, respectively.

**RESULTS AND DISCUSSION**

**Cane Yield**

 A close surveillance of data presented in Table 1 showed that cane yield was influenced significantly with the age of different settling levels. Significantly higher cane yield (86.44, 89.79 and 88.11 t/ha) was noted under the treatment with 30 days age of setting (S2) during both the years as well as in pooled analysis, respectively. However, treatment S3 was recorded significantly lowest cane yield (75.65, 65.68 and 70.66 t/ha) during both

years and also in pooled analysis, respectively.

The variations in cane yield per hectare due to nutrient management were significant during both the years and in pooled analysis. Significantly higher cane yield (85.17, 84.38 and 84.78 t/ha) was recorded with treatment of recommended dose and schedule of nutrient applications (250-125-125 N-P2O5-K2O kg/ha) during both the years and in pooled analysis, respectively. It was remained at par with treatment N3 and N2 in both year and in case of pooled analysis treatment N4 was at par with only treatment N3 only.

**Effect on Available NPK Status**

 A perusal of data indicated that different age of settlings and nutrient management treatments did not show their significant effect on soil available nitrogen, phosphorus and potassium after harvest of sugarcane (Table 2).

**Effect on Uptake of Nutrients**

The differences in nitrogen, phosphorus and potash uptake by canes due to different age of settling treatments was found non-significant during both individual years of study except pooled analysis of nitrogen uptake (Table 3). Significantly higher nitrogen uptake (140.85 kg/ha) removal by canes under 30 days old settling treatment during pooled analysis. Numerically, higher P uptake and K uptake by cane (70.89, 69.21 and 70.05 kg/ha) and (210.78, 210.45 and 210.61 kg/ha) was recoded with treatment of S2 (Table 3). This might be due to the fact that the better development of sugarcane crops due to adequate light, space, moisture and nutrients availability and increase in the uptake of nutrients.

 In case of nutrient managementstreatment N4 removed significantly more nitrogen (145.34 and 144.46 kg/ha) than remaining treatments and it remained at par with treatment N3 (138.66 and 136.29 kg/ha) during first year and in pooled analysis, respectively, but during second year nutrient management treatments did not differ significantly for nitrogen uptake. The significantly higher total phosphorus uptake (74.09 and 73.02 kg/ha) recorded under treatment of recommended dose and schedule of nutrient applications (N4) during second year and in pooled analysis, respectively. Total K uptake not affected significantly due to

**Table 1: Effect of age of settling and nutrient management on cane yield**

|  |  |
| --- | --- |
| **Treatments** | **Cane yield (t/ha)** |
|  | **2021-22** | **2022-23** | **Pooled** |
| **Age of Settlings (S)** |
| **S1**: 20 days | 76.42 | 76.10 | 76.26 |
| **S2**: 30 days | 86.44 | 89.79 | 88.11 |
| **S3**: 40 days | 75.65 | 65.68 | 70.66 |
| SEm± | 2.93 | 3.30 | 2.21 |
| CD (P=0.05) | 8.60 | 9.67 | 6.29 |
| **Nutrient Management (N)** |
| **N1**: RDN + RDK in two splits  | 72.91 | 67.65 | 70.28 |
| **N2**: RDN + RDK in three splits  | 75.93 | 76.93 | 76.43 |
| **N3**: RDN + RDK in four splits | 84.00 | 79.79 | 81.89 |
| **N4**: Recommended dose and schedule of nutrient applications. (250-125-125 N-P2O5-K2O kg/ha)  | 85.17 | 84.38 | 84.78 |
| SEm± | 3.39 | 3.81 | 2.55 |
| CD (P=0.05) | 9.93 | 11.17 | 7.26 |
| **Interaction (S x N)** |
| SEm± | 5.86 | 6.60 | 4.41 |
| CD (P=0.05) | 17.20 | 19.34 | 12.58 |
| **Year** | - | - | NS |
| **Significant interactions with Y** | - | - | NS |
| CV (%) | 12.77 | 14.80 | 13.80 |

different nutrient management treatments during both years. Recommended dose and schedule of nutrient applications (N4) treatment recorded significantly the highest (217.12 kg/ha) uptake of potassium by sugarcane during pooled analysis. The result thus indicated that integration of nutrients had beneficial impact on availability of N, P and K in soil and fast conversion of soil nutrients in to available form to the plant. All these factors collectively might have resulted in higher total uptakes. Similar finding was reported by Virdia and Patel (2010), Dev *et al*. (2011), Meena and kumar (2015), Zinzala(2019), Lakshmi *et al.* (2021) and Patel(2023).

**Balance Sheet of Nutrients**

 There was a net loss of available nitrogen and phosphorus in all of the treatment combination (Table 4 and 5). The highest loss of available nitrogen and phosphorus amounting to 117.60 and 85.92 kg/ha was recorded with treatment combinations S1N1 (20 days old settling + RDN + RDK in two splits). Besides the lowest decline was recorded in case of nitrogen with treatment combinations S1N4 (20 days old settling + Recommended dose and schedule of nutrient applications) and phosphorus with treatment combinations S3N4 (40 days old settling + Recommended dose and schedule of nutrient applications). There was a net gain of available potassium in all treatment combinations of the sugarcane (Table 6). The maximum gain of 213.99 kg/ha was recorded under S1N4, which might be due to during crop growth soil potassium is released from minerals and organic matter that enhanced available K pool in soil.

**CONCLUSION**

##  It can be concluded from the results that nutrient uptake by plant and higher productivity of sugarcane achieved through the single eye bud settling transplant with 30 days old settlings and fertilized with recommended dose and schedule of nutrient applications (250-125-125 N-P2O5-K2O kg/ha) (S2N4).

## Table 2: Effect of age of settling and nutrient management on soil available nitrogen, phosphorus and potassium status after harvest of sugarcane

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Available N (kg/ha)** | **Available P2O5 (kg/ha)** | **Available K2O** **(kg/ha)** |
| **Treatments** |
|   | **2021-22** | **2022-23** | **2021-22** | **2022-23** | **2021-22** | **2022-23** |
| **Age of Settlings (S)** |
| **S1**: 20 days | 246.31 | 267.64 | 31.90 | 36.47 | 547.02 | 576.44 |
| **S2**: 30 days | 248.13 | 277.54 | 34.02 | 36.61 | 570.06 | 592.07 |
| **S3**: 40 days | 231.14 | 253.07 | 31.39 | 35.85 | 545.50 | 573.18 |
| SEm± | 6.66 | 9.12 | 0.93 | 1.15 | 16.10 | 17.80 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS |
| **Nutrient Management (N)** |
| **N1**: RDN + RDK in two splits  | 225.61 | 244.37 | 30.70 | 33.35 | 527.47 | 562.66 |
| **N2**: RDN + RDK in three splits  | 240.75 | 269.67 | 32.18 | 36.37 | 560.64 | 574.76 |
| **N3**: RDN + RDK in four splits | 247.81 | 273.74 | 32.54 | 37.10 | 562.56 | 581.40 |
| **N4**: Recommended dose and schedule of nutrient applications. (250-125-125 N-P2O5-K2O kg/ha)  | 253.27 | 276.56 | 34.32 | 38.44 | 566.10 | 603.43 |
| SEm± | 7.69 | 10.54 | 1.08 | 1.32 | 18.59 | 20.56 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS |
| **Interaction (S x N)** |
| SEm± | 13.32 | 18.25 | 1.86 | 2.29 | 32.20 | 35.60 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS |
| CV (%) | 9.54 | 11.88 | 9.96 | 10.93 | 10.06 | 10.62 |
| **Initial value** | 206.98 | 225.79 | 53.53 | 57.92 | 467.27 | 549.55 |

## Table 3: Effect of age of settling and nutrient management on total nutrient uptake of sugarcane at harvest

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments**   | **Total N uptake (kg/ha)** |  **Total P uptake (kg/ha)** | **Total K uptake (kg/ha)** |
| **2021** | **2022** | **Pooled** | **2021** | **2022** | **Pooled** | **2021** | **2022** | **Pooled** |
| **Age of Settlings (S)** |
| **S1**: 20 days | 132.66 | 128.95 | 130.80 | 68.94 | 67.34 | 68.14 | 201.19 | 199.34 | 200.27 |
| **S2**: 30 days | 142.97 | 138.73 | 140.85 | 70.89 | 69.21 | 70.05 | 210.78 | 210.45 | 210.61 |
| **S3**: 40 days | 132.61 | 135.39 | 134.00 | 68.22 | 69.15 | 68.68 | 196.54 | 199.65 | 198.10 |
| SEm± | 3.71 | 3.67 | 2.61 | 1.81 | 1.51 | 1.18 | 5.24 | 5.59 | 3.83 |
| CD (P=0.05) | NS | NS | 7.44 | NS | NS | NS | NS | NS | NS |
| **Nutrient Management (N)** |
| **N1**: RDN + RDK in two splits  | 128.45 | 129.29 | 128.87 | 65.23 | 65.85 | 65.54 | 194.59 | 191.57 | 193.08 |
| **N2**: RDN + RDK in three splits  | 131.87 | 130.65 | 131.26 | 70.90 | 67.88 | 69.39 | 197.20 | 201.93 | 199.56 |
| **N3**: RDN + RDK in four splits | 138.66 | 133.91 | 136.29 | 69.33 | 66.44 | 67.89 | 202.38 | 202.03 | 202.20 |
| **N4**: Recommended dose and schedule of nutrient applications. (250-125-125 N-P2O5-K2O kg/ha)  | 145.34 | 143.58 | 144.46 | 71.96 | 74.09 | 73.02 | 217.17 | 217.08 | 217.12 |
| SEm± | 4.28 | 4.24 | 3.01 | 2.09 | 1.74 | 1.36 | 6.05 | 6.45 | 4.42 |
| CD (P=0.05) | 12.56 | NS | 8.59 | NS | 5.11 | 3.88 | NS | NS | 12.61 |
| **Interaction (S x N)** |
| SEm± | 7.42 | 7.34 | 5.22 | 3.62 | 3.02 | 2.36 | 10.49 | 11.18 | 7.66 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Year** | - | - | NS | - | - | NS | - | - | NS |
| **Significant interactions with Y** | - | - | NS | - | - | NS | - | - | NS |
| CV (%) | 9.44 | 9.47 | 9.46 | 9.04 | 7.63 | 8.37 | 8.95 | 9.53 | 9.25 |

## Table 4: Balance sheet of available nitrogen in soil

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** **combination** | **Initial available N** | **Addition of N in cane cultivation** | **Total available N**  | **Removal of N by crops (cane+ trash)**  | **Expected balance of available N**  | **Actual balance of available N**  | **Net gain/loss**  |
| **S1N1** | 216.39 | 249.55 | 465.94 | 123.91 | 342.03 | 224.44 | -117.60 |
| **S1N2** | 216.39 | 249.55 | 465.94 | 125.96 | 339.98 | 247.08 | -92.91 |
| **S1N3** | 216.39 | 249.55 | 465.94 | 139.57 | 326.37 | 268.02 | -58.36 |
| **S1N4** | 216.39 | 249.55 | 465.94 | 133.78 | 332.16 | 288.38 | -43.78 |
| **S2N1** | 216.39 | 249.55 | 465.94 | 139.59 | 326.35 | 248.58 | -77.77 |
| **S2N2** | 216.39 | 249.55 | 465.94 | 137.50 | 328.44 | 270.46 | -57.98 |
| **S2N3** | 216.39 | 249.55 | 465.94 | 141.81 | 324.13 | 260.88 | -63.25 |
| **S2N4** | 216.39 | 249.55 | 465.94 | 144.51 | 321.43 | 271.41 | -50.02 |
| **S3N1** | 216.39 | 249.55 | 465.94 | 123.11 | 342.83 | 231.95 | -110.88 |
| **S3N2** | 216.39 | 249.55 | 465.94 | 130.32 | 335.62 | 248.08 | -87.54 |
| **S3N3** | 216.39 | 249.55 | 465.94 | 127.48 | 338.46 | 253.43 | -85.03 |
| **S3N4** | 216.39 | 249.55 | 465.94 | 155.08 | 310.86 | 234.96 | -75.90 |

## Table 5: Balance sheet of available phosphorus in soil

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments****combination** | **Initial available P2O5** | **Addition of P2O5 in cane cultivation** | **Total available P2O5** | **Removal of P2O5 by crops (cane+ trash)** | **Expected balance of available P2O5** | **Actual balance of available P2O5** | **Net gain/loss** |
| **S1N1** | 55.73 | 125 | 180.73 | 65.99 | 114.74 | 28.82 | -85.92 |
| **S1N2** | 55.73 | 125 | 180.73 | 71.15 | 109.58 | 36.02 | -73.56 |
| **S1N3** | 55.73 | 125 | 180.73 | 65.41 | 115.32 | 33.75 | -81.56 |
| **S1N4** | 55.73 | 125 | 180.73 | 70.01 | 110.72 | 38.15 | -72.56 |
| **S2N1** | 55.73 | 125 | 180.73 | 67.02 | 113.71 | 34.01 | -79.70 |
| **S2N2** | 55.73 | 125 | 180.73 | 68.07 | 112.66 | 35.08 | -77.59 |
| **S2N3** | 55.73 | 125 | 180.73 | 71.66 | 109.07 | 36.15 | -72.92 |
| **S2N4** | 55.73 | 125 | 180.73 | 73.47 | 107.26 | 36.03 | -71.23 |
| **S3N1** | 55.73 | 125 | 180.73 | 63.61 | 117.12 | 33.25 | -83.87 |
| **S3N2** | 55.73 | 125 | 180.73 | 68.95 | 111.78 | 31.73 | -80.05 |
| **S3N3** | 55.73 | 125 | 180.73 | 66.59 | 114.14 | 34.56 | -79.59 |
| **S3N4** | 55.73 | 125 | 180.73 | 75.59 | 105.14 | 34.96 | -70.19 |

## Table 6: Balance sheet of available potassium in soil

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments****combination** | **Initial available K2O** | **Addition of K2O in cane cultivation** | **Total available K2O** | **Removal of K2O by crops (cane+ trash)** | **Expected balance of available K2O** | **Actual balance of available K2O** | **Net gain/loss** |
| **S1N1** | 508.41 | 125.25 | 633.66 | 194.05 | 439.61 | 517.14 | 77.53 |
| **S1N2** | 508.41 | 125.25 | 633.66 | 190.79 | 442.87 | 549.92 | 107.06 |
| **S1N3** | 508.41 | 125.25 | 633.66 | 203.76 | 429.90 | 544.68 | 114.77 |
| **S1N4** | 508.41 | 125.25 | 633.66 | 212.47 | 421.19 | 635.18 | 213.99 |
| **S2N1** | 508.41 | 125.25 | 633.66 | 189.50 | 444.16 | 541.83 | 97.67 |
| **S2N2** | 508.41 | 125.25 | 633.66 | 213.69 | 419.97 | 571.57 | 151.60 |
| **S2N3** | 508.41 | 125.25 | 633.66 | 212.65 | 421.01 | 594.54 | 173.53 |
| **S2N4** | 508.41 | 125.25 | 633.66 | 226.62 | 407.04 | 616.31 | 209.26 |
| **S3N1** | 508.41 | 125.25 | 633.66 | 195.69 | 437.97 | 576.22 | 138.26 |
| **S3N2** | 508.41 | 125.25 | 633.66 | 194.21 | 439.45 | 581.61 | 142.16 |
| **S3N3** | 508.41 | 125.25 | 633.66 | 190.20 | 443.46 | 576.72 | 133.26 |
| **S3N4** | 508.41 | 125.25 | 633.66 | 212.29 | 421.37 | 502.80 | 81.43 |

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

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

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