



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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ijpss/2025/v37i45396>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://pr.sdiarticle5.com/review-history/134305>

Original Research Article

Received: 07/02/2025

Accepted: 09/04/2025

Published: 12/04/2025

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

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Cite as: Chaudhari, D.M., H. M. Viridia, Sonal Tripathi, Narendra Singh, J. Kokani, and K. N. Rana. 2025. "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". *International Journal of Plant & Soil Science* 37 (4):149-59. <https://doi.org/10.9734/ijpss/2025/v37i45396>.

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; cane yield; uptake and nutrient balance; splits.

1. 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.

2. 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).

2.1 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.

2.2 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 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

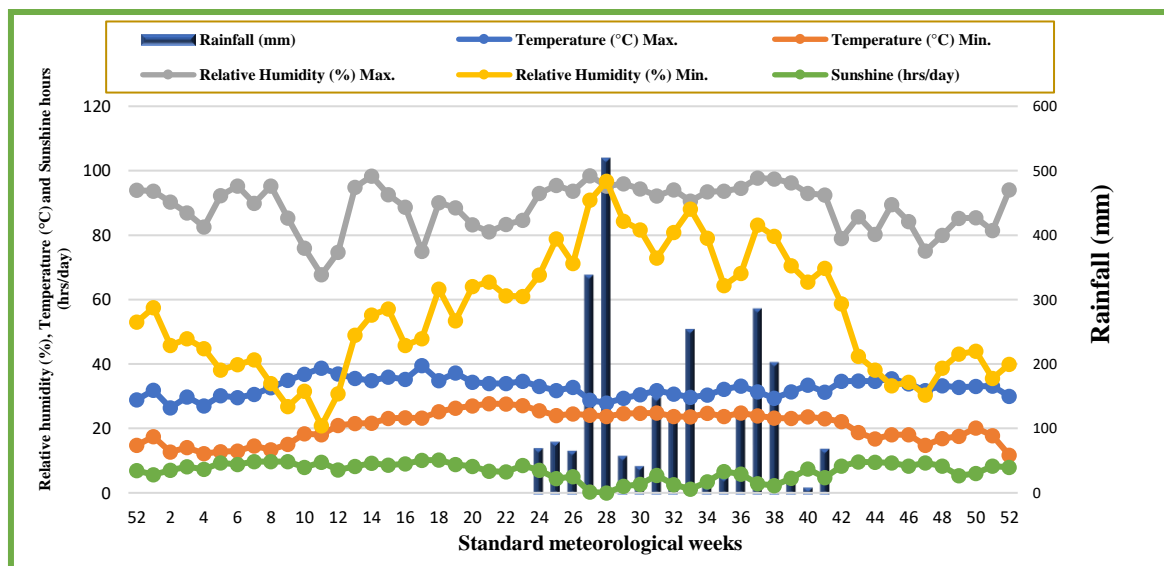


Fig. 1. Meteorological parameters during the cropping season 2021-22

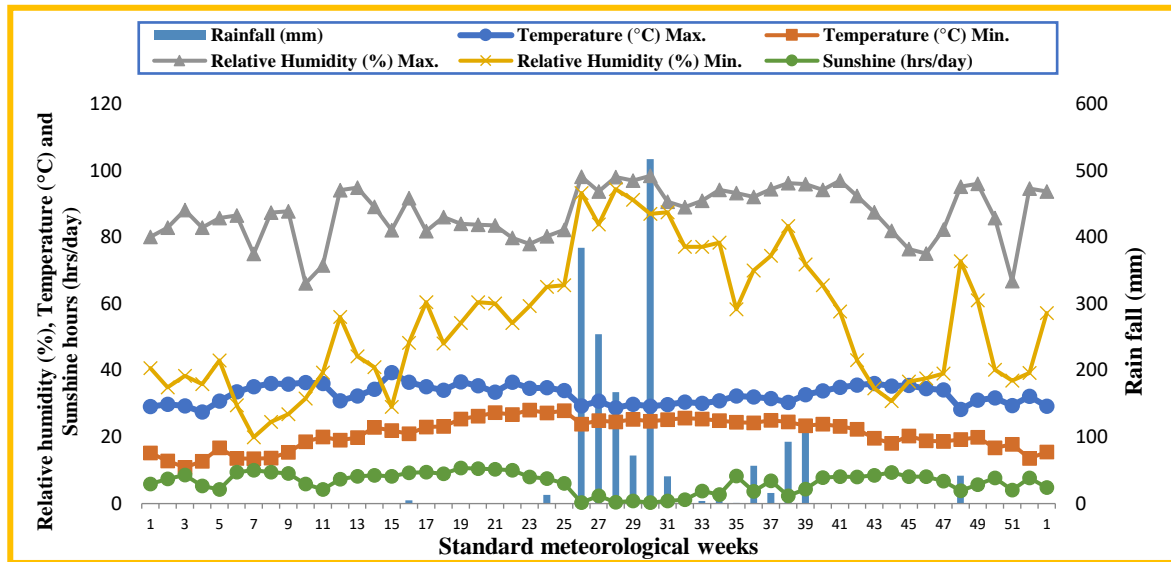


Fig. 2. Meteorological parameters during the cropping season 2022-23

(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.

3. RESULTS AND DISCUSSION

3.1 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 (S_2) during both the years as well as in pooled analysis, respectively. However, treatment S_3 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 N_3 and N_2 in both year and in case of pooled analysis treatment N_4 was at par with only treatment N_3 only.

3.2 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).

3.3 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 S_2 (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 managements treatment N_4 removed significantly more nitrogen (145.34 and 144.46 kg/ha) than remaining treatments and it remained at par with treatment N_3 (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

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)			
S ₁ : 20 days	76.42	76.10	76.26
S ₂ : 30 days	86.44	89.79	88.11
S ₃ : 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)			
N ₁ : RDN + RDK in two splits	72.91	67.65	70.28
N ₂ : RDN + RDK in three splits	75.93	76.93	76.43
N ₃ : RDN + RDK in four splits	84.00	79.79	81.89
N ₄ : Recommended dose and schedule of nutrient applications. (250-125-125 N-P ₂ O ₅ -K ₂ O 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

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

Treatments	Available N (kg/ha)		Available P ₂ O ₅ (kg/ha)		Available K ₂ O (kg/ha)	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Age of Settlings (S)						
S ₁ : 20 days	246.31	267.64	31.90	36.47	547.02	576.44
S ₂ : 30 days	248.13	277.54	34.02	36.61	570.06	592.07
S ₃ : 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)						
N ₁ : RDN + RDK in two splits	225.61	244.37	30.70	33.35	527.47	562.66
N ₂ : RDN + RDK in three splits	240.75	269.67	32.18	36.37	560.64	574.76
N ₃ : RDN + RDK in four splits	247.81	273.74	32.54	37.10	562.56	581.40
N ₄ : Recommended dose and schedule of nutrient applications. (250-125-125 N-P ₂ O ₅ -K ₂ O 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)									
S ₁ : 20 days	132.66	128.95	130.80	68.94	67.34	68.14	201.19	199.34	200.27
S ₂ : 30 days	142.97	138.73	140.85	70.89	69.21	70.05	210.78	210.45	210.61
S ₃ : 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)									
N ₁ : RDN + RDK in two splits	128.45	129.29	128.87	65.23	65.85	65.54	194.59	191.57	193.08
N ₂ : RDN + RDK in three splits	131.87	130.65	131.26	70.90	67.88	69.39	197.20	201.93	199.56
N ₃ : RDN + RDK in four splits	138.66	133.91	136.29	69.33	66.44	67.89	202.38	202.03	202.20
N ₄ : Recommended dose and schedule of nutrient applications. (250-125-125 N-P ₂ O ₅ -K ₂ O 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
S ₁ N ₁	216.39	249.55	465.94	123.91	342.03	224.44	-117.60
S ₁ N ₂	216.39	249.55	465.94	125.96	339.98	247.08	-92.91
S ₁ N ₃	216.39	249.55	465.94	139.57	326.37	268.02	-58.36
S ₁ N ₄	216.39	249.55	465.94	133.78	332.16	288.38	-43.78
S ₂ N ₁	216.39	249.55	465.94	139.59	326.35	248.58	-77.77
S ₂ N ₂	216.39	249.55	465.94	137.50	328.44	270.46	-57.98
S ₂ N ₃	216.39	249.55	465.94	141.81	324.13	260.88	-63.25
S ₂ N ₄	216.39	249.55	465.94	144.51	321.43	271.41	-50.02
S ₃ N ₁	216.39	249.55	465.94	123.11	342.83	231.95	-110.88
S ₃ N ₂	216.39	249.55	465.94	130.32	335.62	248.08	-87.54
S ₃ N ₃	216.39	249.55	465.94	127.48	338.46	253.43	-85.03
S ₃ N ₄	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 P ₂ O ₅	Addition of P ₂ O ₅ in cane cultivation	Total available P ₂ O ₅	Removal of P ₂ O ₅ by crops (cane+ trash)	Expected balance of available P ₂ O ₅	Actual balance of available P ₂ O ₅	Net gain/loss
S ₁ N ₁	55.73	125	180.73	65.99	114.74	28.82	-85.92
S ₁ N ₂	55.73	125	180.73	71.15	109.58	36.02	-73.56
S ₁ N ₃	55.73	125	180.73	65.41	115.32	33.75	-81.56
S ₁ N ₄	55.73	125	180.73	70.01	110.72	38.15	-72.56
S ₂ N ₁	55.73	125	180.73	67.02	113.71	34.01	-79.70
S ₂ N ₂	55.73	125	180.73	68.07	112.66	35.08	-77.59
S ₂ N ₃	55.73	125	180.73	71.66	109.07	36.15	-72.92
S ₂ N ₄	55.73	125	180.73	73.47	107.26	36.03	-71.23
S ₃ N ₁	55.73	125	180.73	63.61	117.12	33.25	-83.87
S ₃ N ₂	55.73	125	180.73	68.95	111.78	31.73	-80.05
S ₃ N ₃	55.73	125	180.73	66.59	114.14	34.56	-79.59
S ₃ N ₄	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 K ₂ O	Addition of K ₂ O in cane cultivation	Total available K ₂ O	Removal of K ₂ O by crops (cane+ trash)	Expected balance of available K ₂ O	Actual balance of available K ₂ O	Net gain/loss
S ₁ N ₁	508.41	125.25	633.66	194.05	439.61	517.14	77.53
S ₁ N ₂	508.41	125.25	633.66	190.79	442.87	549.92	107.06
S ₁ N ₃	508.41	125.25	633.66	203.76	429.90	544.68	114.77
S ₁ N ₄	508.41	125.25	633.66	212.47	421.19	635.18	213.99
S ₂ N ₁	508.41	125.25	633.66	189.50	444.16	541.83	97.67
S ₂ N ₂	508.41	125.25	633.66	213.69	419.97	571.57	151.60
S ₂ N ₃	508.41	125.25	633.66	212.65	421.01	594.54	173.53
S ₂ N ₄	508.41	125.25	633.66	226.62	407.04	616.31	209.26
S ₃ N ₁	508.41	125.25	633.66	195.69	437.97	576.22	138.26
S ₃ N ₂	508.41	125.25	633.66	194.21	439.45	581.61	142.16
S ₃ N ₃	508.41	125.25	633.66	190.20	443.46	576.72	133.26
S ₃ N ₄	508.41	125.25	633.66	212.29	421.37	502.80	81.43

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 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).

3.4 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.

4. 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 seedlings and fertilized with recommended dose and schedule of nutrient applications (250-125-125 N-P₂O₅-K₂O kg/ha) (S₂N₄).

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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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