**Impact of Seed Rate on Yield Performance and Quality Traits of Sugarcane (*Saccharum officinarum* L.) Varieties**

.ABSTRACT

|  |
| --- |
| Seeding rate is a critical factor in sugarcane production as it influences stand density and, consequently, cane yield and quality. An appropriate seeding rate can help maximize both cane and sugar yields. Field experiments were conducted at the Sugarcane Research Section, Pyinmana, and Nyaungpintha Research Farms from December 2023 to December 2024 to evaluate the effect of different seed rates on the yield and quality of sugarcane varieties and to determine the optimal seed rate for maximizing both these parameters. A split-plot design with four replications was used, with three sugarcane varieties (K95/84, KK-3, and K2000/89) assigned to the main plots and three seeding rates (40,000, 50,000, and 60,000 three-budded setts ha⁻¹) to the subplots. Results indicated that the variety KK-3 produced the highest number of millable canes (68,068) and cane yield (99.03 t ha⁻¹) in Pyinmana, and (68,964) and (110.54 t ha⁻¹) in Nyaungpintha. In contrast, K95/84 showed superior performance in stalk diameter, single cane weight, and quality traits including brix %, pol %, purity %, commercial cane sugar (CCS %), and sugar yield (12.32 t ha⁻¹ in Pyinmana and 13.68 t ha⁻¹ in Nyaungpintha). The highest seeding rate, 60,000 three-budded setts ha⁻¹, consistently resulted in the greatest values for millable cane, single cane weight, cane yield (100.27 t ha⁻¹ in Pyinmana and 111.82 t ha⁻¹ in Nyaungpintha), stalk height, quality parameters, and sugar yield (12.11 t ha⁻¹ in Pyinmana and 13.66 t ha⁻¹ in Nyaungpintha), except for stalk diameter. Based on these findings, a seeding rate of 60,000 three-budded setts ha⁻¹ is recommended to achieve higher cane and sugar yields in both study locations. |

***Keywords: seed rate, cane yield, quality, sugarcane varieties***

1. INTRODUCTION

Sugarcane is one of the most important industrial crops in tropical and subtropical countries, serving as a primary source of raw material for the production of sugar and bioenergy (Manimekalai et al., 2022 & Gravina et al., 2021). In Myanmar, sugarcane cultivation plays a significant role in the agricultural economy, contributing to both domestic consumption and industrial demand. To meet the growing need for sugar and bioenergy, increasing the productivity of sugarcane is essential. This requires optimizing agronomic practices, particularly those related to planting density and crop establishment (Shalaby, Osman, Ranya, and Abdel Aziz, 2011). In Myanmar, the total area of sugarcane was 165000 ha, the average cane yield was 65.83 t ha⁻¹, and domestic sugar production was 10.9 million tons in 2023 (MOALI, 2023).

The reasons for low yield of sugarcane include improper land preparation, traditional planting methods, use of less than the recommended seed rate, heavy weed infestation, shortage of irrigation water, imbalanced fertilizer application, low support price, lack of coordination between growers and mill owners, natural disasters, delayed harvesting, pest and disease incidence, and poor management of the ratoon crop. Many investigators have shown that cane yield increases when seeding rate is increased to the optimal level (Abo El-hamd et al., 2019). The cost of sugarcane production is becoming high due to an increase in labor cost and inputs, including seed. Seed is the costlier input in sugarcane cultivation and accounts for nearly 25% of the total operational cost in sugarcane (Jain, Solomon, Shrivastava & Chandra, 2010).

In sugarcane production, seeding rate is crucial, as it determines stand density. There is a positive relationship between seeding rate and the final number of millable canes. A suitable seeding rate may ensure maximum cane and sugar yields, which are the key factors for farmers’ high income (Ahamed, El-Laboudy & Maracy, 2020). The factors that affect cane yield include late planting, uneven use of seed rate without keeping in view the cane genotype/varieties, complex weed communities, and low population density (Khaliq et al., 2020).

Sugarcane varieties differ genetically in their yield potential due to variation in their vegetative growth and qualitative traits. As a result, the optimum seed rate can vary significantly between varieties. Genotypes of sugarcane have a highly significant effect on vegetative characters such as stalk height and diameter as well as millable cane and recoverable sugar yields. Also, sugarcane genotypes have a highly significant effect on all quality traits, i.e., brix %, sucrose %, pol %, purity %, and sugar recovery % (Mohamed & El-Taib, 2007). With the recent development and introduction of high-yielding sugarcane varieties, it is necessary to reassess standard cultivation practices. Despite the introduction of improved sugarcane varieties, limited information is available on their response to different seed rates under local agro-climatic conditions in Myanmar. Therefore, studying how seed rate affects yield and quality in various sugarcane varieties is essential to understanding this key aspect of sugarcane cultivation. However, limited research has been conducted to evaluate the effect of seed rate and variety performance under different sugarcane growing areas such as Pyinmana and Nyaungpintha. Given this background, this study was undertaken with the following objectives:

1. To evaluate the effect of different seed rates on yield and quality of sugarcane varieties

2. To determine the optimum seed rate for maximizing yield and quality in sugarcane varieties

2. materials and methods

The experiments were conducted from December 2023 to December 2024 at two locations: the Sugarcane Research and Development Farms in Pyinmana, Nay Pyi Taw, and Nyaungpinthar in Phyu Township. The Pyinmana site is located at 19°43ʹ59.99'' N latitude and 96°11ʹ60.00'' E longitude, at an elevation of 152.36 meters above sea level, within Pyinmana Township, Dekkhina District, Nay Pyi Taw Union Territory. The Nyaungpinthar site is situated at 18°28ʹ59.99'' N latitude and 96°25ʹ59.99'' E longitude, 175 meters above sea level, in Phyu Township, Taungoo District, Bago Region.

The experiment followed a split-plot design with four replications. Three sugarcane varieties (12 months in plant growth duration) were assigned as main plot treatments: V1 = K - 95/84**,** V2 = KK - 3 andV3 = K - 2000/89 and three seeding rates: S1=40000 three-budded setts ha-1, S2 = 50000 three-budded setts ha-1 and S3 = 60000 three-budded setts ha-1 were assigned to the subplots. In total, the experiment consisted of 36 experimental units. Each plot measured 10 × 5.33 m², consisting of four rows 10 meters long, with a row spacing of 1.33 meters.

Prior to the experiment, soil samples were collected to analyze key physicochemical properties, and the results are shown in Table 1. The initial soil at both study sites was found to be moderately to strongly acidic, with pH values ranging from 5.1 to 5.7. The initial soil analysis showed medium levels of available nitrogen (61-64 mg kg⁻¹), low to medium levels of available phosphorus (6-13 mg kg⁻¹), low levels of available potassium (58-68 mg kg⁻¹), and low levels of organic matter (1.18-1.48%). These results indicate that the soils in both study sites are of low fertility. Therefore, the fertilizers were applied at the recommended rate by the Department of Agriculture (DOA). Nitrogen fertilizer was applied as urea at the rate of 247 kg N ha⁻¹, which was split into three doses (basal, 95, and 120 days after planting (DAP)). Phosphorus fertilizer was applied as triple super phosphate at the rate of 123 kg P₂O₅ ha⁻¹ at basal. Potassium fertilizer was applied as potash at the rate of 123 kg K₂O ha⁻¹, which was a split application of two equal doses (95 and 120 DAP). Sugarcane was planted in the first week of December 2023 and harvested at the age of 12 months in both locations. The agricultural practices were done as recommended by DOA. Weather parameters, including temperature and precipitation, for both study locations were also recorded during experimental period (Fig. 1 and 2).

**Table 1. Physicochemical properties of experimental soil at Pyinmana and Nyaungpintha Research Farms**

|  |  |  |
| --- | --- | --- |
| Properties | Pyinmana | Nyaungpintha |
| pH | 5.70 (Moderately acid) | 5.10 (Strongly acid) |
| Available N (mgkg-1) | 64.00 (Medium) | 61.00 (Medium) |
| Available P (mgkg-1) | 6.00 (Low) | 13.00 (Medium) |
| Available K (mgkg-1) | 68.00 (Low) | 58.00 (Low) |
| Organic matter (%) | 1.18 (Low) | 1.48 (Low) |

**Fig. 1. Rainfall, minimum and maximum temperature during experimental period (2023 December – 2024 December) in Pyinmana Research Farm**

**Fig. 2. Rainfall, minimum and maximum temperature during experimental period (2023 December – 2024 December) in Nyaungpintha Research Farm**

**2.1 Data Collection**

**2.1.1 Millable stalk height**

The stalk height was measured from fixed ground level to the top visible dewlap (TVD) of the cane plant. The five random plants were selected and measured at 360 days after planting (DAP).

**2.1.2 Millable stalk diameter**

The stalk diameter was measured by selecting five sample plants at 360 DAP with a Vernier caliper. The fixed plants were measured at the mid-point of their internodes and these measurement points are positioned one-third of the way up from the ground level.

**2.1.3 Number of millable cane**

From each plot, the number of millable cane was counted at 360 days after planting. These counted millable canes were used to determine cane yield.

**2.1.4 Cane yield**

At harvesting, ten stalks were randomly selected and hand-harvested from the middle row of each individual plot. These ten sampled stalks were then weighed using a hanging scale to determine the average single stalk weight. The cane yield was calculated by using the following formula:

**2.1.5 Analysis of percentage of brix, pol, purity, fibre content, commercial cane**

**sugar (CCS) and sugar yield**

Cane juice was extracted by a three-roller sugar mill, and brix % was determined by the use of a Brix hydrometer. Cane juice was clarified with lead acetate, and pol reading was recorded using the polarimeter. Purity percent was computed from brix and pol using the following equation:

(Meade and Chen, 1977)

Fibre content was determined from the cross-section of the stalk from the base, middle, and top portions of each sample cane stalk. It was extracted from cane stalks by using a cane shredder, followed by the application of a standard washing method. Commercial cane sugar (CCS %) and sugar yield were computed using the following formulae:

Where, P = Pol% in cane juice

B = Brix% in cane juice

F = Fibre% in cane

**2.1.6 Statistical Analysis**

The data were subjected to analysis of variance using Statistix (8.0 version) software. The treatment means were compared using the Least Significant Difference (LSD) test at a 5% level of significance.

3. results and discussion

**3.1 Millable stalk height**

In both Pyinmana and Nyaungpintha research farms, millable stalk height varied significantly with different varieties and seed rates (Fig. 3). Among the varieties, the KK-3 variety recorded the highest millable stalk heights with 307.25 cm in Pyinmana and 312.92 cm in Nyaungpintha. These differences are likely attributed to genetic variability among the varieties. Similar findings were reported by Mohamed and El-Taib (2007) and Abd El-Azez (2008), who also observed significant varietal differences in stalk height of sugarcan varieties. With a seed rate of S3 (60000 three-budded setts ha⁻¹), the highest millable stalk heights of 292.00 cm and 306.25 cm were attained in Pyinmana and Nyaungpintha, respectively. The increase in stalk height with higher seed density may be due to intensified competition for growth resources such as light, nutrients, and space, promoting vertical elongation. These observations are consistent with the findings of EL-Geddawy et al. (2005), who reported increased stalk height with higher planting densities. There were no significant interaction effects on millable stalk height between varieties and seed rates in both locations (Fig. 3). This suggested that varietal differences did not modify the response of stalk height to seed rate.

**3.2 Millable stalk diameter**

At both sites, millable stalk diameter varied significantly with different varieties while no significant difference was observed among the seed rates (Fig. 4). The highest millable stalk diameter was recorded by the K95/84 variety with 29.69 mm in Pyinmana and 30.50 mm in Nyaungpintha. Stalk diameter of K 95/84 variety exceeded the other two varieties while the KK-3 variety recorded the lowest value. These results are indeed a reflection of the different genetic structures among varieties. These findings are in line with reported by Abd El-Azez (2008); who found that sugarcane varieties differed significantly in stalk thickness. Regarding seed rates, the highest stalk diameter was recorded from S2 (50000 three-budded setts ha⁻¹), and the lowest stalk diameter was obtained from S3 (60000 three-budded setts ha⁻¹). The increase in stalk diameter when using a medium seed rate S2 (50000 three-budded setts ha⁻¹) may be attributed to decrease inter-plant competition for light, water and nutrients, as well as less mutual shading. Conversely, the decrease in stalk diameter was observed at the higher seed rate S3 (60000 three-budded setts ha⁻¹), likely due to the higher plant population, resulting in thinner stalk diameter. These findings are consistent with those reported by Shalaby, Osman, Ranya, and Abdel Aziz (2011) and Makhlouf et al. (2016) and who reported that a dense plant population compete more intensely for resources leading to thinner stalk diameter. There were no significant interaction effects between varieties and seed rates on stalk diameter in both locations (Fig. 4). This suggests that the effect of seed rate on stalk diameter was independent of the sugarcane variety used.

**3.3 Single cane weight**

In Pyinmana and Nyaungpintha sites, single cane weight varied significantly with different varieties and seed rates (Table 4). When using K95/84, the maximum cane weights were 1.73 kg and 1.79 kg in the Pyinmana and Nyaungpintha sites, respectively.Single cane weight of K.95/84 was greater than that of the other varieties in both sites. The superiority of K.95/84 over the other varieties in this parameter might be due to its greater stalk diameter (Fig. 4). Similar results were found by Muhammad et al. (2002), who noted that the weight per stalk for different sugarcane genotypes varied significantly. The highest single cane weights of 1.55 kg and 1.70 kg were attained at a seeding rate of S3 (60000 three-budded setts ha⁻¹), in the Pyinmana and Nyaungpintha sites, respectively. This indicated that the seed rate S3 might be high enough to ensure a heavier single cane weight for both study locations**.** The increase in single cane weight by increasing seeding rates is due to the increase in millable cane height (Fig. 3). The results of this study are consistent with those of Bora et al. (2014), who reported a highly significant and positive correlation between millable cane height and single cane weight. There were no significant interaction effects on single cane weight between varieties and seeding rates in both locations (Table 4). This indicated that the influence of seeding rate on single cane weight was consistent across the different sugarcane varieties.

**3.4 Number of Millable Cane**

At both locations, there were significant variations in millable cane in different varieties and seed rates (Table 4). At Pyinmana and Nyaungpintha Research Farms, the KK-3 variety produced the highest number of millable cane, 68068 ha-1 and 68964 ha-1, respectively. In comparison to the other varieties, KK-3 has a higher number of millable cane, which may be genetically controlled and reflects its ability to produce more tillers and increase their survival till harvest. This finding is in agreement with those obtained by Ahamed, El-Laboudy, and Al-Maracy(2020); Getaneh, Ayele and Negi (2016); and Ahmed and Awadalla (2016), who observed significant variation among the cane varieties in the number of millable canes m-2. At the seed rate of S3 (60000 three-budded setts ha⁻¹), the greatest millable cane number of 65303 ha-1 at Pyinmana and 66125 ha-1 at Nyaungpintha Research Farms were recorded. The results of this study are consistent with those of Bashir et al. (2000), who found a positive correlation between sugarcane plant population and seeding density. There were no significant interaction effects on millable cane per hectare between varieties and seed rates in both locations (Table 4). This indicated that effect of seed rate on millable cane per hectare was not influenced by variations in varieties.

**3.5 Cane yield**

Both variety and seed rate had a significant effect on cane yield at the Pyinmana and Nyaungpintha sites (Table 4). At Pyinmana, the highest cane yield was recorded for variety KK-3 (99.03 t ha⁻¹), followed by K95/84 (90.36 t ha-1) and K2000/89 (88.42 t ha-1). Similarly, significant differences in cane yield were observed at the Nyaungpintha site, where KK-3 produced the highest yield (110.54 t ha⁻¹), followed by K95/84 (99.22 t ha-1) and K2000/89 (96.82 t ha-1). These findings are consistent with those of Abazied (2018) and Abd El-Azez et al. (2018), who also reported significant yield differences among sugarcane varieties. The highest cane yields, 100.27 t ha⁻¹ at Pyinmana and 111.82 t ha⁻¹ at Nyaungpintha, were recorded at the highest seed rate, S3 (60,000 three-budded setts ha⁻¹). These results suggest that increasing the seed rate can enhance cane yield, likely due to a greater plant population and increased intra-specific competition, which may promote more efficient resource utilization. This trend is consistent with the findings of Bull and Bull (2000) and Omoto, Auma, and Muasya (2014), who reported that higher planting densities led to increased sugarcane yields. At either site, the interaction effects of seed rate and variety on cane yield were not statistically significant (Tabel 2). This indicates that the response of cane yield to seed rate was consistent across varieties, suggesting independent effects of these factors on cane yield performance.

**3.6 Brix percentage (Brix %)**

Significant differences in brix % among sugarcane varieties were observed at both sites (Table 3). The highest brix % was recorded by the K95/84 variety with 20.09% in Pyinmana and 20.29% in Nyaungpintha. One possible explanation for this variation is the genetic background of the varieties. The significant influence of variety on brix % has also been reported by Ahamed, El-Laboudy, and Al-Maracy (2020); Ahmed and Awadalla (2016); and Abd El-Azez *et al.* (2018).According to their findings, the sugarcane varieties exhibited significant differences in total soluble solids (TSS %) content. In terms of seed rates, the highest brix % was observed at the seed rate of S3 (60000 three-budded setts ha⁻¹) while the lowest was found at the seed rate of S1 (40000 three-budded setts ha⁻¹). These results are consistent with the finding of Makhlouf et al. (2016), who reported that higher plant densities result in a greater number of thinner plants, which tend to have lower moisture content and therefore higher total soluble solids. There were no significant interaction effects on brix percentage between varieties and seeding rates in both locations (Table 3). This indicated that the effect of seed rate on the brix percentage of sugarcane was not influenced by variations in varieties.

**3.7 Commercial cane sugar (CCS %)**

While significant differences in CCS % were found among sugarcane varieties, no significant differences were observed among seed rates at both sites (Table 3). The highest CCS % was recorded by the K95/84 variety with 13.58 % in Pyinmana and 13.76 % in Nyaungpintha. Genetic characteristics, environmental factors, and management techniques have an impact on sugarcane CCS %, which varies greatly among varieties. This result is consistent with the findings of Abazied (2018), Abd El-Azez et al. (2018), and El-Shafai and Ismaail (2006). They observed that cane varietals had significant effects on the percentage of sugar recovery. With a seed rate of S3 (60000 three-budded setts ha⁻¹), the highest CCS % of 12.06 and 12.23 were attained in Pyinmana and Nyaungpintha, respectively. This indicates that the seed rate S3 might be high enough to attain a higher CCS % for both study locations**.** This trend is consistent with the findings of Sharar, Ayub, Choudhry, Amin, and Khalid (2000), who reported that a greater seeding density of 100,000 setts ha⁻¹ improved CCS% in comparison to a density of 75,000 setts ha⁻¹. In both locations, there was no interaction of CCS % between the varieties and seed rates (Table 3). This indicates that changes in CCS % due to varieties were not related to changes due to seeding rates.

**3.8 Sucrose (Pol %)**

Significant differences in pol % were observed among sugarcane varieties, whereas seed rate had no significant effect at either site (Table 4). The highest pol % was recorded by the K95/84 variety with 17.83 % in Pyinmana and 18.07 % in Nyaungpintha. The differences between tested varieties with respect to pol % may be mainly due to gene makeup, in addition to the surrounding environmental conditions prevailing during the formation period of soluble solids. Perhaps this is due to the fact that the percentage of sucrose in cane is affected by a number of factors, such as variety (Yousaf et al., 2002). Regarding the seed rates, the highest Pol % was recorded from the seed rate of S3 (60000 three-budded setts ha⁻¹). The result is consistent with the finding of Bhati et al. (2014) and Maqsood et al. (2005), who reported that greater sucrose content was associated with increased plant density in sugarcane crops. Varieties and seed rates did not interact with pol (sucrose) percentage in any location (Table 4). This indicates that changes in pol % due to varieties were not related to changes due to seeding rates.

**3.9 Purity %**

While significant differences in purity % were found among sugarcane varieties, no significant differences were observed among seed rates at both sites (Table 4). The highest values of 88.73% and 89.04% were recorded from K95/84 at Pyinmana and Nyaungpintha, respectively. Similar findings were reported by Abazied (2018) and Abd El-Azez et al. (2018), who found that sugarcane varieties were discovered to have a considerable impact on the percentage of juice purity. When compared to the low seed rates of S1 and S2 (40000 three-budded setts ha⁻¹ and 50000 three-budded setts ha⁻¹), S3 (60000 three-budded setts ha⁻¹) showed the highest values, 85.15 % and 85.80%. According to the finding of Bhati et al. (2014), a higher purity could result from an increase in plant density. On the other hand, excessive lodging brought on by high-density planting may degrade the sugarcane quality, Bull & Bull (2000). In both locations, there was no interaction effect on purity % between the varieties and seed rates (Table 4). This suggested that the effect of seed rate on the purity % of sugarcane was not influenced by variations in varieties.

**3.10 Sugar yield**

Significant differences in sugar yield were observed among varieties and seed rates at both locations (Table 6). The highest sugar yield among the varieties was recorded for K 95/84, with 12.32 t ha-1 at Pyinmana and 13.68 t ha⁻¹ at Nyaungpintha. The superior performance of K 95/84 in sugar yield is primarily attributed to its higher CCS% and pol % (Tables 5 and 6). Regarding seed rates, the maximum sugar yield of 12.11 t ha-1 at Pyinmana and 13.66 t ha-1 at Nyaungpintha was achieved with the seed rate S3 (60000 three-budded setts ha-1). The increase in sugar yield at higher seed rates was mainly due to improved cane yield and higher seed rates (Table 4), which contributed directly to the final sugar output. Similar findings were reported by Abo El-hamd et al. (2019) and Shalaby et al. (2011), who observed the highest sugar yield at a high seed rate of 50400 buds per feddan. There were no significant interaction effects on sugar yield between varieties and seed rates in both locations (Table 6). This study indicated that the effect of seed rate on sugar yield of sugarcane was not influenced by variations in variety.

(A)

(B)

**Fig. 3. Mean values of stalk height (cm) as affected by (A) sugarcane varieties and (B) seed rates in Pyinmana and Nyaungpintha research farms**

Table 2: Mean values of stalk height in Pyinmana Farm and Nyaungpintha Farm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Pyinmana Farm | | Nyaungpintha Farm | |
| Varieties (V) | Seed rates (S) | Varieties (V) | Seed rates (S) |
| Pr > F | 0.001 | 0.001 | 0.001 | 0.003 |
| LSD 0.05 | 6.759 | 9.331 | 9.282 | 7.620 |
| V x S | 0.220 | | 0.316 | |

S1= 40000 three-budded setts ha-1, S2= 50000 three-budded setts ha-1, S3= 60000 three-budded setts ha-1

(A)

(B)

**Fig. 4. Mean values of stalk diameter (mm) as affected by (A) sugarcane varieties and (B) seed rates in Pyinmana and Nyaungpintha research farms**

Table 3: Mean values of stalk diameter in Pyinmana Farm and Nyaungpintha Farm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Pyinmana Farm | | Nyaungpintha Farm | |
| Varieties (V) | Seed rates (S) | Varieties (V) | Seed rates (S) |
| Pr > F | 0.016 | 0.552 | 0.001 | 0.569 |
| LSD 0.05 | 2.798 | 1.005 | 1.395 | 1.749 |
| V x S | 0.775 | | 0.396 | |

S1= 40000 three-budded setts ha-1, S2= 50000 three-budded setts ha-1, S3= 60000 three-budded setts ha-1

**Table 4.** **Single cane wt. (kg), number of millable cane ha-1 and cane yield (t ha-1) of sugarcane varieties as affected by seed rates**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Pyinmana Farm** | | |  | **Nyaungpintha Farm** | | |
| **Single cane wt. (kg)** | **No. of millable cane ha-1** | **Cane yield ( t ha-1)** |  | **Single cane wt. (kg)** | **No. of millable cane ha-1** | **Cane yield ( t ha-1)** |
| **Variety (V)** |  |  |  |  |  |  |  |
| K 95/84 | 1.73 a | 52452 b | 90.36 b |  | 1.79 a | 55366 b | 99.22 b |
| KK-3 | 1.46 b | 68068 a | 99.03 a |  | 1.60 b | 68964 a | 110.54 a |
| K 2000/89 | 1.38 b | 64257 a | 88.42 b |  | 1.50 c | 64481 a | 96.82 b |
| LSD 0.05 | 0.09 | 4054 | 7.29 |  | 0.07 | 5093 | 6.50 |
| **Seed rate (S)** |  |  |  |  |  |  |  |
| S1 | 1.48 b | 60372 b | 88.51 b |  | 1.58 b | 60521 b | 95.00 b |
| S2 | 1.53 a | 59102 b | 89.03 b |  | 1.62 b | 62165 ab | 99.76 b |
| S3 | 1.55 a | 65303 a | 100.27 a |  | 1.70 a | 66125 a | 111.82 a |
| LSD 0.05 | 0.04 | 4896 | 7.02 |  | 0.07 | 4476 | 9.16 |
| **Pr > F** |  |  |  |  |  |  |  |
| Variety (V) | \*\* | \*\* | \* |  | \*\* | \*\* | \*\* |
| Seed rate (S) | \*\* | \* | \*\* |  | \*\* | \* | \*\* |
| V x S | ns | ns | ns |  | ns | ns | ns |
| CV % (a) | 5.66 | 6.59 | 7.88 |  | 4.21 | 8.10 | 6.36 |
| CV % (b) | 3.04 | 9.27 | 8.84 |  | 5.04 | 8.29 | 10.45 |

\*\*= significant at 1 % level, \*= significant at 5 % level, ns = non-significant

S1= 40000 three-budded setts ha-1, S2= 50000 three-budded setts ha-1, S3= 60000 three-budded setts ha-1

**Table 5. Brix % and CCS % of sugarcane varieties as affected by seed rates**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Pyinmana Farm** | |  | **Nyaungpintha Farm** | |
| **Brix %** | **CCS %** |  | **Brix %** | **CCS %** |
| **Variety (V)** |  |  |  |  |  |
| K 95/84 | 20.09 a | 13.58 a |  | 20.29 a | 13.76 a |
| KK-3 | 18.28 b | 10.83 b |  | 18.69 b | 11.76 b |
| K 2000/89 | 18.33 b | 9.98 b |  | 18.66 b | 10.25 c |
| LSD 0.05 | 0.96 | 1.10 |  | 0.70 | 1.07 |
| **Seed rate (S)** |  |  |  |  |  |
| S1 | 18.53 | 11.10 |  | 18.96 | 11.87 |
| S2 | 18.69 | 11.24 |  | 19.08 | 11.67 |
| S3 | 19.48 | 12.06 |  | 19.60 | 12.23 |
| LSD 0.05 | 0.98 | 0.98 |  | 0.89 | 0.92 |
| **Pr > F** |  |  |  |  |  |
| Variety (V) | \*\* | \*\* |  | \*\* | \*\* |
| Seeding rate (S) | ns | ns |  | ns | ns |
| V x S | ns | ns |  | ns | ns |
| CV % (a) | 5.08 | 9.62 |  | 3.60 | 8.96 |
| CV % (b) | 6.03 | 9.94 |  | 5.42 | 9.00 |

**Table 6. Pol % and Purity % and Sugar yield (t ha-1) of sugarcane varieties as affected by seeding rates**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Pyinmana Farm** | | |  | **Nyaungpintha Farm** | | |
| **Pol %** | **Purity %** | **Sugar yield ( t ha-1)** |  | **Pol %** | **Purity %** | **Sugar yield ( t ha-1)** |
| **Variety (V)** |  |  |  |  |  |  |  |
| K 95/84 | 17.83 a | 88.73 a | 12.32 a |  | 18.07 a | 89.04 a | 13.68 a |
| KK-3 | 15.35 b | 83.81 b | 10.78 b |  | 16.23 b | 86.77 a | 13.07 a |
| K 2000/89 | 14.53 b | 79.12 c | 8.84 c |  | 14.89 c | 79.79 b | 9.91 b |
| LSD 0.05 | 1.23 | 2.71 | 1.15 |  | 1.25 | 3.91 | 1.24 |
| **Seed rate (S)** |  |  |  |  |  |  |  |
| S1 | 15.43 | 83.05 | 9.85 b |  | 16.22 | 85.54 | 11.30 b |
| S2 | 15.67 | 83.45 | 9.97 b |  | 16.13 | 84.25 | 11.70 b |
| S3 | 16.62 | 85.15 | 12.11 a |  | 16.84 | 85.80 | 13.66 a |
| LSD 0.05 | 1.16 | 2.51 | 1.44 |  | 1.02 | 2.77 | 1.60 |
| **Pr > F** |  |  |  |  |  |  |  |
| Variety (V) | \*\* | \*\* | \*\* |  | \*\* | \*\* | \*\* |
| Seeding rate (S) | ns | ns | \*\* |  | ns | ns | \*\* |
| V x S | ns | ns | ns |  | ns | ns | ns |
| CV % (a) | 7.75 | 3.23 | 10.79 |  | 7.60 | 4.59 | 10.12 |
| CV % (b) | 8.52 | 3.49 | 15.79 |  | 7.26 | 3.79 | 15.29 |

\*\*= significant at 1 % level, ns = non-significant

S1= 40000 three-budded setts ha-1, S2= 50000 three-budded setts ha-1, S3= 60000 three-budded setts ha-1

4. Conclusion

The study demonstrated that seed rate has a major impact on sugarcane growth and juice quality. Except for a slight reduction in stalk diameter, cane growth and yield parameters such as millable stalk height, single cane weight, number of millable cane, cane yield, and cane quality parameters, including brix %, pol %, purity %, commercial cane sugar (CCS%), and sugar yield, increased with higher seed rate. Among the treatments, the S3 seed rate (60000 three-budded setts ha-1) consistently optimized the number of millable cane, single cane weight, cane yield, sugar yield, and quality parameters at both sites. The variety K 95/84 responded positively to increasing seed rates, showing improvement in stalk diameter, single cane weight, brix %, pol %, purity %, CCS %, and sugar yield at both Pyinmana and Nyaungpintha sites. Similarly, the KK-3 showed a favorable response, particularly in terms of cane yield, number of millable canes, and stalk height. Based on these findings, the optimal seed rate for improving both yield and quality in all tested sugarcane varieties under study conditions is 60,000 three-budded setts ha⁻¹.The results of this study can help farmers and agronomists to choose the right seed rates for specific varieties, which can lead to better economic returns and improved crop quality.

**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.

**ACKNOWLEDGEMENTS**

I want to express deep appreciation to my mentors and seniors for their invaluable guidance, support, and encouragement throughout this research. I am also most grateful to my colleagues who are involved in research fieldwork experiment. I am very thanks to the department of Agronomy for all the necessary facilities to complete the experiment. Lastly, I would like to thank my family and friends for their unwavering encouragement and motivation.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

References

Abazied, S. (2018). Influence of delivery delay on quality of some promising sugar cane varieties under Aswan condition. *Egyptian Journal of Agronomy*, The15th International Conference on Crop Science, *40*(4)21-29.

Abd El-Azez, Y. M. (2008). Evaluation of some new sugar cane varieties as affected by harvesting dates under middle and upper Egypt conditions. Doctoral dissertation, Department of Agronomy, Faculty of Agriculture, Minia University, Egypt.

Abd El-Azez, Y. M., Nagib, S. R., & Elwan, A. M. (2018). Yield and yield components of some sugar cane varieties (*Saccharum officinarum* L.) as affected by different nitrogen fertilization levels. *Journal of Plant Production*, *9*(6), 553-557.

Abo El-Hamd, A. S., Ibrahim, M. M., Ahamed, A. Z., & Kamel, A. E. (2019). Evaluation of some promising sugar cane varieties under different planting dates and seeding rates in upper Egypt. *Journal of Biological Chemistry and Environmental Sciences*, *14*(4), 137-154.

Ahamed, A. Z., El-Laboudy, E. H. S., & Al-Maracy, S. H. (2020). Productivity and quality of some sugar cane varieties as influenced by seeding rate. *Journal of Biological Chemistry and Environmental Sciences*, *15*(2), 31-47.

Ahmed, A. Z., & Awadalla, A. O. (2016). Effect of Harvesting Age on Yield, Yield Components and Quality of Some Promising Sugarcane Varieties. *Journal of Plant Production*, *7*(12), 1501-1507.

Bashir, S., Saeed, M., Ghaffar, A., Ali, Z., & Khan, R. M. Z. (2000). Analysis of economic aspects of raising autumn sugarcane at different planting patterns and seeding densities. *International Journal of Agriculture and Biology*, *2*(1), 322-325.

Bhati, A. S., Yadav, B. S., Bhunia, S. R., & Chauhan, R. P. S. (2014). Effect of levels of irrigation and crop geometry on quality of sugarcane under drip irrigation. *The Journal of Rural and Agricultural Research*, *14*(2), 5-8.

Bora, G. C., Goswami, P. K., & Bordoloi, B. C. (2014). Studies on variability and character association in sugarcane (*Saccharum* spp) under rainfed condition of North Eastern India. *Direct Research Journal of Agriculture and Food Science*, *2*(5), 55-59.

Bull, T. A., & Bull, J. K. (2000). High density planting as an economic production strategy:(a) overview and potential benefits. [Proceedings of the 2000 Conference of the Australian Society of Sugar Cane Technologists held at Bundaberg, Queensland, Australia,](https://www.cabidigitallibrary.org/action/doSearch?do=Proceedings+of+the+2000+Conference+of+the+Australian+Society+of+Sugar+Cane+Technologists+held+at+Bundaberg%2C+Queensland%2C+Australia%2C+2+May+to+5+May+2000.) 9-15.

EL-geddawy, I. H., Ahmed, A. Z., & Ahmed, A. L. M. (2005). Seeding rates and number of hoeings in relation to yield and quality of sugarcane variety. *Egyptian Journal of Agricultural Research*, *83*(3), 1225-1235.

El-Shafai, A. M. A., & Ismail, A. M. A. (2006). Effect of row spacing on yield and quality of some promising sugarcane varieties. *Egypt Journal of Applied Sciences*, *21*(11), 32-46.

Getaneh, A., Ayele, N., & Negi, T. (2016). Effect of sett type and intra-row sett spacing on yield of Sugarcane varieties at Metahara Sugar Estate. *International Journal of Advanced Research in Biological Sciences*, *3*(9), 108-113.

Gravina, O. S., Santos, G. G., Correchel, V., Silva, G. C. D., Medrado, L. D. C., Flores, R. A & Severiano, E. D. C. (2021). Physical attributes of ferralsol in fertigated sugarcane production environments for bioethanol in the midwest of Brazil. *Agronomy*, *11*(8), 1641.

Jain, R., Solomon, S., Shrivastava, A. K., & Chandra, A. (2010). Sugarcane bud chips: A promising seed material. *Sugar Tech*, *12,* 67-69.

Khaliq, A., Ahmad, H. B., Nadeem, M. A., Mehmood, A., Ahmad, N., & Yasin, M. (2020). Valuation of weed control methods by using inter row rotary weeder in sugarcane crop. *Indian Journal of Agricultural Research*, *54*(5), 666-670.

Makhlouf, B. S. I., El-Geddawy, D. I., & Mohamed, A. (2016). Performance Evaluation of Three Sugar Cane Varieties under Different Levels of Nitrogen Fertilization and Two Seeding Rates. *Assiut Journal of Agricultural Sciences*, *47*(5), 12-36.

Manimekalai, R., Suresh, G., & Singaravelu, B. (2022). Sugarcane transcriptomics in response to abiotic and biotic stresses: a review. *Sugar Tech*, *24*(5), 1295-1318.

Maqsood, M., Iqbal, M., & Tayyab, M. (2005). Comparative productivity performance of sugarcane (*Saccharum officinarum* L.) sown in different planting patterns at farmer’s field. *Pakistan Journal of Agricultural Sciences*, *42*(3), 25-28.

Meade, G. P., & Chen, J. C. (1977). *Cane sugar handbook* ,947.

Ministry of Agriculture, Livestock and Irrigation (MOALI). (2023). Myanmar Agriculture at a Brief, Naypyitaw, Myanmar.

Mohamed, B. D., & El-Taib, A. B. A. (2007). Evaluation of some spring planted sugar cane genotypes under different growing seasons: 2-Yield components, cane and sugar yield performance. Assiut Journal of Agricultural Sciences, *38*(1), 17-29.

Muhammad, Y., Amir, A., & Mahboob, A. (2002). Response of Two Genotypes of Sugarcane to Different Planting Patterns. Pakistan Agricultural Research Council (PARC). *Asian Journal of Plant Sciences*, *5*(1), 346-348.

Omoto, G., Auma, E. O., & Muasya, R. M. (2014). Effect of row spacing on seedcane yield and yield components in western Kenya. The [86th Annual Congress of the South African Sugar Technologists' Association (SASTA),](https://www.cabidigitallibrary.org/action/doSearch?do=86th+Annual+Congress+of+the+South+African+Sugar+Technologists%27+Association+%28SASTA+2013%29%2C+Durban%2C+South+Africa%2C+6-8+August+2013) 149-155.

Shalaby, N. M. E., Osman, A. M. H., & Abdel Aziz, R. M. (2011). Effect of seed rates and nitrogen fertilization levels on yield and quality of sugar cane. *Journal of plant production*, *2*(2), 279-287.

Sharar, M. S., Ayub, M., Choudhry, M. A., Amin, M. M. Z., & Khalid, M. M. (2000). Morpho-qualitative traits of sugarcane (*Saccharum officinarum* L.) varieties as influenced by seeding density. *Pakistan Journal of Biological Sciences*, *3*(7), 1156-1157.

Yousaf, M., Ahmed, A., & Akhtar, M. (2002). Response of two genotypes of sugarcane to different planting patterns. *Asian Journal of Plant Sciences*, *1*(4), 346-348.