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Evaluation of seed sett ages and stem segment position on sugarcane yield and yield related traits

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Abstract: Sugarcane (*Saccharum officinarum* L.) plays a vital role in tropical and sub-tropical economies due to its high sucrose content, bioenergy potential, and drought resistance. This study aimed to comprehensively investigate the effects of different seed sett (seed material) ages and variations in stem position of the seed setts on both yield and yield related traits of sugarcane cv. Khon Kaen3 (KK3). The experiment was laid out by 3×3 factorial in randomized complete block design (RCBD) with three replications. Factor A represented sugarcane seed sett ages (8, 9 and 10 months old), factor B represented different stem positions where seed setts segments were sectioned out (basal, mid and top part) and-used as planting material (clones). Agronomic management was administered at recommended rates and the growth, development and yield traits were observed. The results showed that seed sett ages influenced the number of tillers at specific growth stages, while different segments affected leaf area (LA) and stalk fresh weight. Seed sett age and position showed significant interactions for some traits. Notably, juice yield was significantly affected by both seed sett ages and segments, with the combination of 10-month-old seed setts and the middle segment yielding the highest juice. Brix value, a crucial trait for sugar production, remained unaffected by these factors. Dry matter accumulation was inconsistent, with seed sett ages impacting stalk dry weight. In conclusion, the results showed that most growth and development traits were not influenced by seed sett ages and stem position segments, but most importantly juice yield at maturity was influenced by seed sett age and position of stem segments. These findings enhance our understanding of sugarcane cultivation practices, offering valuable insights for optimizing planting strategies in the sugarcane industry.

Keywords: seed cane ages, cutting/segment positions, commercial cane sugar, yield performance, brix value.
Abbreviations: RCBD_randomized complete block design; LA_leaf area; CCS_commercial cane sugar; MAP_month after planting; LAI_leaf area index; SCMR_spad chlorophyll meter reading; EC_electrical conductivity; OM_organic matter.

Introduction

Sugarcane (*Saccharum officinarum* L.), is one important crop as it plays a pivotal role in the economies of tropical and sub-tropical regions due to its high sucrose content, bioenergy potential (Getaneh et al., 2016) and remarkable drought resistance, making it a cornerstone for sugar production. The crop is of global importance as it accounts for about 85% of global sugar output, particularly from equatorial territories like Brazil and various parts of the Asia-Pacific (Krungsri Research, 2021). This intricate web of production additionally yields value-added byproducts during the sugar extraction process, like molasses, filter cake, bagasse, vinasses and bio-fertilizers, among others. In Thailand, sugarcane assumes a pivotal role as an economic cash crop, its cultivation extending across diverse regions from North, Northeast, East, to Central areas. Notably, in the year 2022, Thailand's aggregate production area surpassed 1.76 million hectares, yielding a staggering 105.94

million tons of cane, with an average yield reaching 60.37 tons ha^{-1}, and an average commercial cane sugar (CCS) of 12.71 (Office of the Cane and Sugar Board; OSCB, 2022). Sugarcane cultivation in Thailand predominantly follows a rain-fed production system, with planting occurring during the late rainy season, particularly in the Northeastern region of the country. Moisture content in the soil stands as a pivotal determinant of successful seed sett (planting material) germination and subsequent establishment of the crop. In certain production areas, challenges emerge in the form of reduced germination percentages and availability of high-quality seed setts. Seed sett is a section of the sugarcane stem that is used for planting, it is a vegetative planting material that consists of a portion of the cane stem with one or more nodes, the nodes are the points on the sugarcane stem from which shoots and roots develop. These setts are planted in the soil to grow into new sugarcane plants.

Suggested seed sett ages typically range from 8 to 10 months old, with the middle segment of the stem emerging as the primary choice as a planting material cane in the sugarcane cultivation. Consequently, the remaining sections of the stem often go unused. However, there is limited conclusive evidence to support these recommendations. Previous studies have explored the impact of seed sett ages on the yield and yield components of sugarcane. For instance, Ayele et al. (2014) suggested that seed cane ages of 6-8 months yield good performance in sugarcane cultivation. In contrast, Neto et al. (2017) used sugarcane that was eleven months old for their study, focusing on the number of buds and bud positions. Many previous studies have emphasized the number of buds on seed setts or seed cane rather than the positions of buds on the stem (Patel and Patel, 2014; Neto et al., 2017; Tesfa and Ayele, 2018; Khaing, 2018). Thus, it becomes important to evaluate other factors like seed sett ages and bud positions so as to come up with an informed advisory position for the farmers on which seed setts to use to achieve better yields and also reduce on cost related to seed material.

Despite the economic significance of the sugarcane industry in Thailand and globally, there remains a gap in our understanding of how variations among seed sett ages and different stem segments (positions) impact sugarcane germination, development and yield. Therefore, this study aims to comprehensively address this gap by investigating the effects of different seed sett ages and different in stem segments on growth, development and yield of sugarcane cv. KK3. This variety, renowned in Thailand, serves as a representative example to provide insights into sugarcane cultivation practices with potential implications for global sugarcane production.

Results and discussion

Agronomic performances

Days to buds emergence: there were no significant differences observed for this trait both in seed setts ages and stem segment position of the seed setts. Furthermore, no significant interaction was observed between seed sett ages and segments position. The average days to buds emergence ranged from 21.3 to 27.0 days after planting (data not shown). Previous studies did not observe days to buds emergence but focused on the percent of sprouting and observed that seed sett ages and cultivars had significant different percentage bud sprouting (Ayele et al., 2014), buds germination (Shukla and Lal, 2003; Parnidi and Hamida, 2021; Neto et al., 2017; Patel and Patel, 2014).

Plant height: similarly to days to emergence, there were no significant differences observed in plant height at all stages (data not shown) and a recent study results are similar to Sime (2013), but in contrast to the results reported by Neto et al. (2017), where they observed that different position of seed setts resulted in plant height variations, with apical and central positions recording a greater height compared to the basal position when using 11 months old seed setts. The choice of seed sett age may significantly impact plant height, as younger seed setts may exhibit different growth patterns compared to older ones (Meiriani and Siahaan, 2019). This variability in growth dynamics could explain the lack of significant differences in plant height observed in a current study. However, Parnidi and Hamida (2021) reported that bud sett age did not have any effect on plant height of sugarcane.

Stem diameter: the results of this trait showed that there were no significant differences between treatments. Additionally, no significant interaction effects were observed between seed sett ages and different segments positions (data not showed), this finding is consistent with Sime (2013) who concluded that various stalk portions of the seed sett had no impact on stem diameter. In contrast Neto et al. (2017) reported greater stem diameter in plants grown from central and apical segments when using seed setts with two buds and an age of 11 months.

Spad chlorophyll meter reading (SCMR): the result of SCMR showed no significant differences among seed sett ages and different positions of seed setts at all growth stages of sugarcane (data not shown).

The number of tillers per plant: the number of tillers per plants were recorded at 4, 5, and 6 months after planting (MAP). The results showed that seed sett ages had significant impact on the number of tillers at 4 and 5 MAP, but there was no significant difference at 6 MAP (Figure 1a). Furthermore, the seed setts position did not have any significance influence in the number of tillers, except at 5 MAP, where the seed setts from apical part recorded significantly higher tiller numbers than other seed setts from other positions (Figure 1b), similarly Neto et al. (2017) reported that apical and central part recorded higher number of tillers than the base part. In a current study, an interaction between seed sett ages and different seed sett position was observed at 4 and 5 MAP (Table 1), but none at 6 MAP (data not shown). While Ayele et al. (2014) reported that sugarcane planted with seed setts aged 6 to 8 months had a higher number of tillers compared to those planted from 9 to 10 months old setts, in contrast a recent study found that seed setts aged 10 months resulted in a higher number of tillers at 4 and 5 MAP. However, at 6 MAP, there were no significant differences in the number of tillers in this study. Moreover, Parnidi and Hamida (2021) found that there was no significant difference on number of tillers at 3 and 6 MAP.

The number of stalks per plant: was collected at 8, 10, and 12 MAP. The results revealed that neither seed sett age nor different positions of seed setts had significant impact on the number of stalks per plant. The stalk count ranged from 3.8 to 4.2, 2.1 to 2.5, and 2.3 to 2.5 per plant stand stalks at 8, 10, and 12 MAP, respectively. Additionally, no interaction was observed between seed sett ages and different positions of seed setts on this trait (data not shown). These results contradict the findings of Ayele et al. (2014), who reported a significant effect of seed cane age on the number of millable canes with seed cane ages of 6, 7 and 8 months recording significantly higher number of millable canes compared to seed cane ages of 9 and 10 months. Current results are agreement with that of Sime (2013) who also recorded no significant difference on number of millable cane planted from different seed setts harvested

Table 1. Interaction between seed sett age and segment on number of tillers per plant at 4 and 5 MAP.

seed sett age	base part	segment middle part	top part	base part	segment middle part	top part
		4 MAP			5 MAP	
8 months	13.3c	14.9bc	13.5c	9.2bc	9.8bc	9.5bc
9 months	16.2ab	14.4bc	13.4c	9.5bc	9.3bc	9.8bc
10 months	18.5a	14.2bc	19.2a	10.9b	8.8b	14.6a
F-test		*			*	

*; significantly different at p≤0.05, compare mean by LSD method.

Table 2. Interaction between seed sett age and segment on leaf area at 9 and 12 MAP.

seed sett age	segment base part	middle part	top part	segment base part	middle part	top part
		9 MAP (cm^2 $plant^{-1}$)			12 MAP (cm^2 $plant^{-1}$)	
8 months	3389.0bc	5461.2abc	6524.2a	10582.0a	2975.0bc	2297.0bc
9 months	5497.6ab	3527.4c	2999.5c	3982.0bc	1697.0c	3335.0bc
10 months	4674.1abc	4340.5bc	5316.0abc	4805.0b	2616.0bc	3709.0bc
F-test		*			**	

* and **; significantly different at p≤0.05 and p≤0.01 respectively, compare mean by LSD method.

Table 3. Interaction between seed sett age and segment on stalk fresh weight at 12 MAP.

seed sett age	segment base part	middle part	top part
		(g $plant^{-1}$)	
8 months	1117.5a	247.3c	170.9c
9 months	365.3c	145.3c	1069.1a
10 months	373.9c	742.5b	339.5c
F-test		**	

**; significantly different at p≤0.01, compare mean by LSD method.

from different positions of the mother stalk. The differences in current results could be influenced by many things like environmental conditions, variety and management as they all have been shown to influence development of sugarcane (Jones et al., 2021; Seife and Tena, 2020; Zhou and Shoko, 2011).

Number of leaves per plant: was recorded at 9 and 12 MAP. The result indicated that the number of leaves was not significantly influenced by either factor A or B and no interaction effect between factor A and factor B was observed at both 9 and 12 MAP (data not shown). Similar to Parnidi and Hamida (2021) and da Silva et al. (2017) who reported that the number of leaves was not affected by bud sett and bud chip, similar to da Silva et al. (2017) who reported that number of green leaves was not affected by different of cultivars.

Number of internodes per plant: this trait was also considered at 9 and 12 MAP. The result showed that the number of internodes was not significantly influenced by either seed sett ages or different segments and no interaction effect was found at both 9 and 12 MAP (data not shown). Sime (2013) also investigated this trait and their results align with those of the current study, indicating that different stalk portions of the seed sett had no significant effect on the number of internodes in sugarcane.

Leaf area (LA): this trait was also measured at 9 and 12 MAP. The results indicated that at 9 MAP, seed sett ages and different segments had no significant effect on LA (Figure 2a, 2b), however, an interaction effect was observed. The combination of seed sett age at 8 months with the top part resulted in significantly higher LA than other combinations (6524.2 cm^2 $plant^{-1}$). However, this combination did not differ significantly from several other combinations (Table 2). In contrast, at 12 MAP, both seed sett ages and different segments had significant effect on LA and an interaction effect was observed. The seed sett age of 8 months resulted in higher LA, although it was not significantly different from seed sett age at 10 months (5284.6 and 3709.8 cm^2, respectively) (Figure 2a). Regarding different seed setts position, the base segment exhibited the highest LA (6456.3 cm^2) compared to the middle and top segments (2429.3 and 3113.4 cm^2, respectively) (Figure 2b). An interaction effect was also observed where a combination of seed sett age at 8 months and base segment had a significantly higher LA (10582.0 cm^2), as compared to other combinations (Table 2). Leaf area is a crucial physiological trait that is closely related to the rate of photosynthesis in plants. Leme et al. (1984) reported that the leaf area index (LAI) is an effective measure for assessing final yield in sugarcane, as they observed higher LAI values throughout the development cycle of the cane and associated with higher yield recorded. da Silva et al. (2017) found that leaf area (LA) and leaf area index (LAI) of plant cane, first ratoon and second ratoon cane were not affected by various sugarcane cultivars, this is in line with the results of the current study, which showed that LA exhibited no significant differences in response to seed sett ages and various segments at 9 MAP. However, significant differences were observed at 12 MAP, where both seed sett ages and different segments had an effect on leaf area (Figure 2a and 2b).

Yield performances

Stalk fresh weight: the results showed that there no significant differences in stalk fresh weight at 9 MAP, neither seed sett ages nor different positions of seed setts had any effect on this trait (Figure 3a). The combination of these factors also showed no influence on stalk fresh weight (data not shown). However,

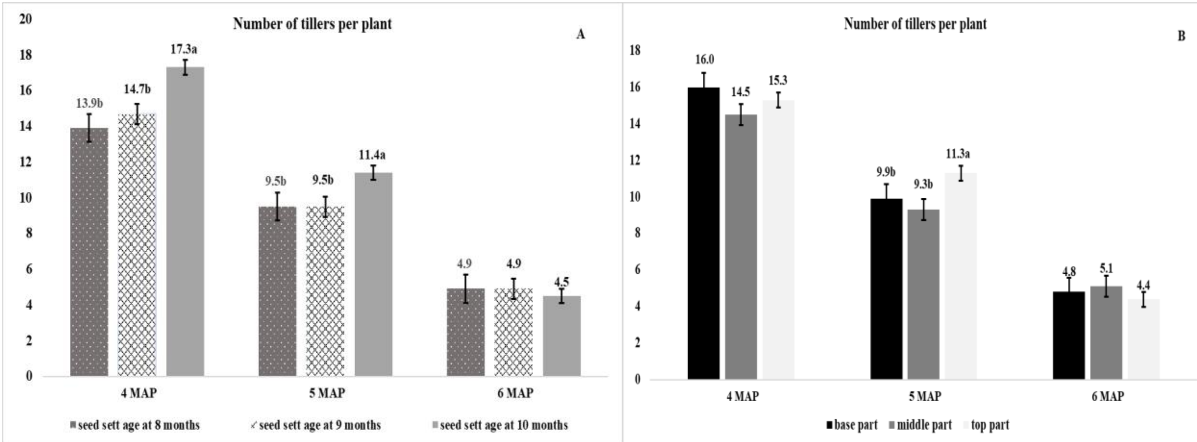

Figure 1. Number of tillers per plant at 4, 5 and 6 MAP on different seed sett ages (a) and segments (b).

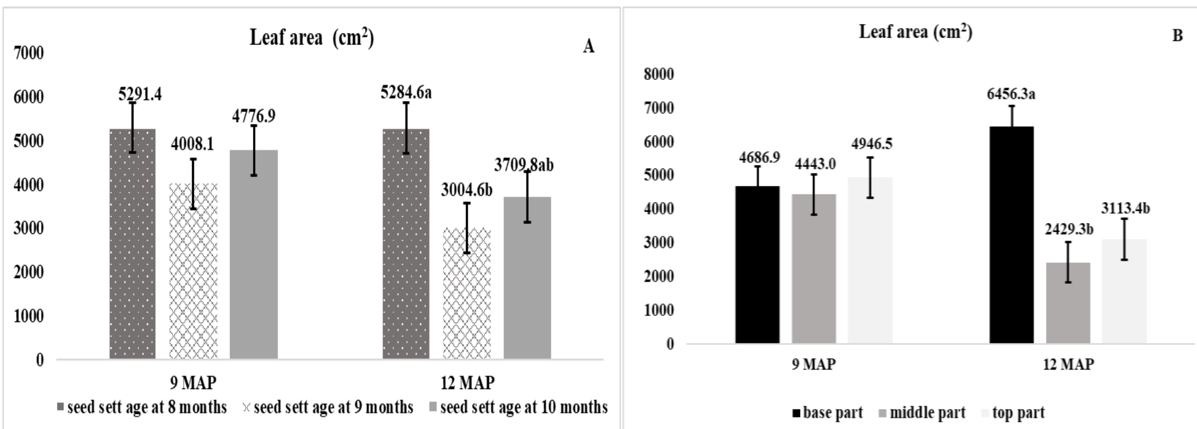

Figure 2. Leaf area at 9 and 12 MAP on different seed sett ages (a) and segments (b).

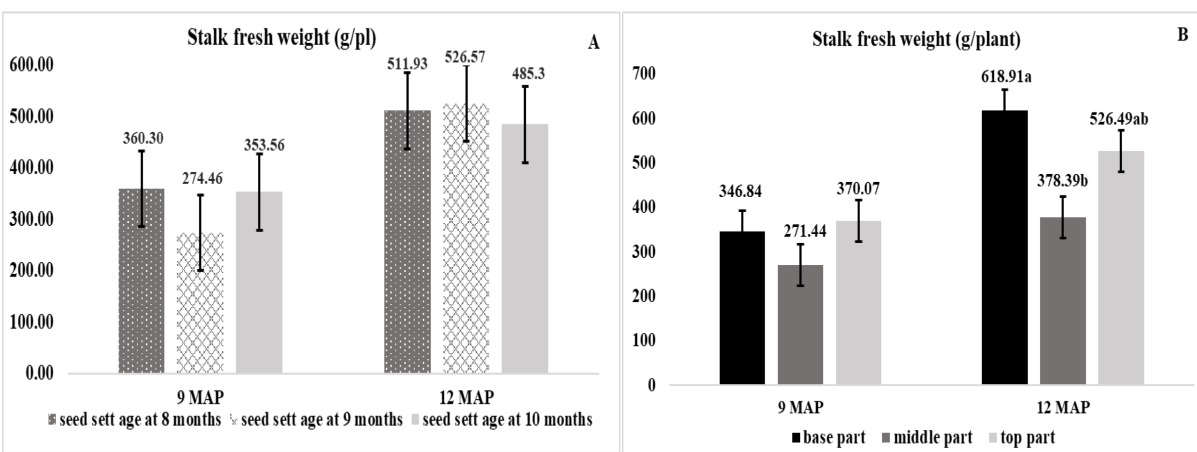

Figure 3. Stalk fresh weight at 9 and 12 MAP on different seed sett ages (a) and segments (b).

significant differences in stalk fresh weight were observed at 12 MAP. The different position of seed setts did have an impact on stalk fresh weight. The base segment recorded a higher stalk fresh weight (618.91 g), which was not significantly different from the top segment's weight (526.49 g). In contrast, the middle segment yielded a lower stalk fresh weight (378.39 g) compared to the base segment, but there was no significant difference compared to the top segment (Figure 3b), whereas Neto et al. (2017) reported that apical and central part had higher cane yield than base part, however, a recent study revealed that base part and top part showed higher stalk weight. In a current study, we observed that seed sett ages did not have a significant effect on stalk yield. However, Ayele et al. (2014) found a significant difference in cane yield, with seed sett ages of 6, 7, and 8 months resulting in higher cane yields

Table 4. Interaction between seed sett age and segment on leaf fresh weight at 9 and 12 MAP.

seed sett age	segment base part	segment middle part	segment top part	segment base part	segment middle part	segment top part
	9 MAP (g plant^{-1})			12 MAP (g plant^{-1})		
8 months	123.20bcd	136.73abc	157.70ab	178.51b	72.22d	62.39d
9 months	174.80a	79.10d	93.20cd	122.98c	54.48d	305.29a
10 months	120.90bcd	120.53bcd	153.74ab	134.24bc	267.81a	89.27cd
F-test		**			**	

**; significantly different at p≤0.01, compare mean by LSD method.

Table 5. Interaction between seed sett age and segment on juice yield at 12 MAP.

seed sett age	segment base part	segment middle part	segment top part
		(ml plant^{-1})	
8 months	38.81c	63.46c	55.26c
9 months	121.4b	35.97c	40.1c
10 months	139.9b	411.1a	114.1b
F-test		**	

**; significantly different at p≤0.01, compare mean by LSD method.

Table 6. Interaction between seed sett age and segment on stalk dry weight at 9 and 12 MAP.

seed sett age	segment base part	segment middle part	segment top part	segment base part	segment middle part	segment top part
	at 9 MAP (g plant^{-1})			12 MAP (g plant^{-1})		
8 months	67.70b	98.30ab	115.17a	257.23a	66.16b	42.74b
9 months	117.90a	63.45b	59.63b	77.41b	39.81b	62.03b
10 months	85.81ab	66.40b	84.55ab	76.55b	186.69a	64.96b
F-test		*			**	

* and **; significantly different at p≤0.05 and p≤0.01 respectively, compare mean by LSD method.

Table 7. Interaction between seed sett age and segment on leaf dry weight at 12 MAP.

seed sett age	segment base part	segment middle part	segment top part
		(ml plant^{-1})	
8 months	87.54a	33.71bc	24.15bc
9 months	37.99bc	19.47c	107.53a
10 months	41.98b	29.88bc	41.25bc
F-test		**	

**; significantly different at p≤0.01, compare mean by LSD method.

compared to 9- and 10-months old seed sett canes. In this study, an interaction between these two factors was found where, seed sett age of 8 months with the base segment yielded the highest stalk fresh weight (1117.5 g plant^{-1}) among all combinations even though it did not significantly differ from seed sett age of 9 months with top segment (1069.1 g plant^{-1}) (Table 3). However, Ayele et al. (2014) did not find any interaction effect when studying the interaction between sugarcane cultivar and seed sett age, while a current study observed an interaction between seed sett age and stem position.

Leaf fresh weight per plant: at 9 MAP, there was no significant differences in leaf fresh weight, but an interaction between seed sett ages and different stem seed sett position was observed (Table 4). However, at 12 MAP, seed sett ages had a significant effect on leaf fresh weight with seed sett ages from 10- and 9-months old cane recording a higher leaf fresh weight compared to seed sett ages of 8 months old cane (163.78 g and 160.92 g, respectively, compared to 104.37 g) (Figure 4), and an interaction effect was also observed for this trait. Specifically, seed sett age of 9 months in combination with the top part, and seed sett age of 10 months with the middle part, exhibited higher leaf fresh weights than other combinations (305.29 g and 267.81 g, respectively) (Table 4).

Juice yield: juice yield as a crucial trait in sugar production was also evaluated in this study, with the observations done at 12 MAP or at the harvest day. The results demonstrated that seed sett ages and different stem seed sett position had significant impact on juice yield in sugarcane. Furthermore, an interaction between seed sett ages and different seed sett position was noted. Juice yield from seed sett ages of 10 months exhibited a significantly higher juice yield per plant (221.7 ml) compared to seed sett ages from 9- and 8-months old cane (65.8 and 52.5 ml, respectively) (Figure 5a). Additionally, the cane planted from the middle segment yielded significantly higher juice than the cane planted from base segment, and the cane planted from base segment produced more juice than the cane planted from top segment (170.2 ml > 100.0 ml > 69.8 ml plant^{-1}, respectively) (Figure 5b). The combination of seed sett age of 10 months with the middle segment gave the highest juice yield among all combinations (411.1 ml), this was followed by seed sett age of 10 months with the base segment (139.9 ml), seed sett age of 9 months with the base segment (121.4 ml), and seed sett age of 10 months with the top segment (114.1 ml) (Table 5).

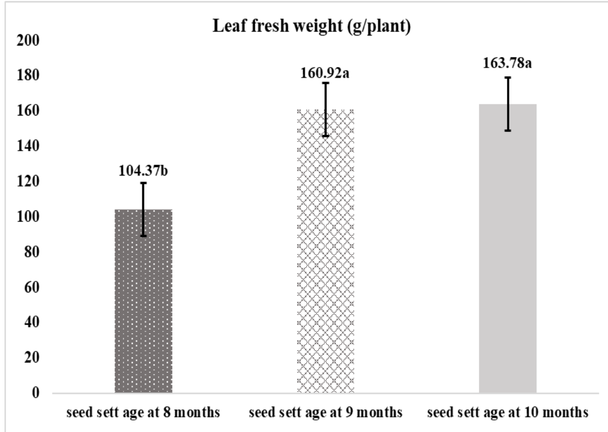

Figure 4. Leaf fresh weight 12 MAP on different seed sett ages.`

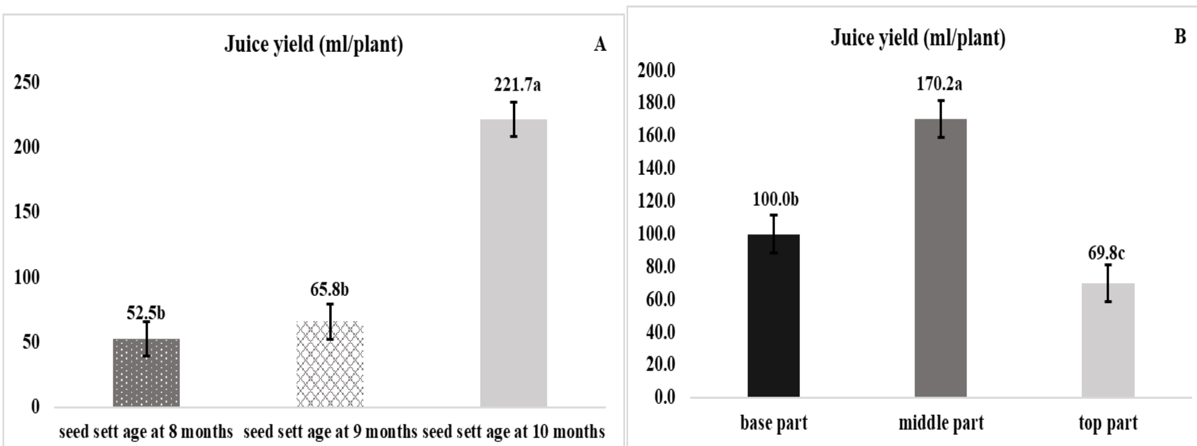

Figure 5. Juice yield at 12 MAP on different seed sett ages (a) and segments (b).

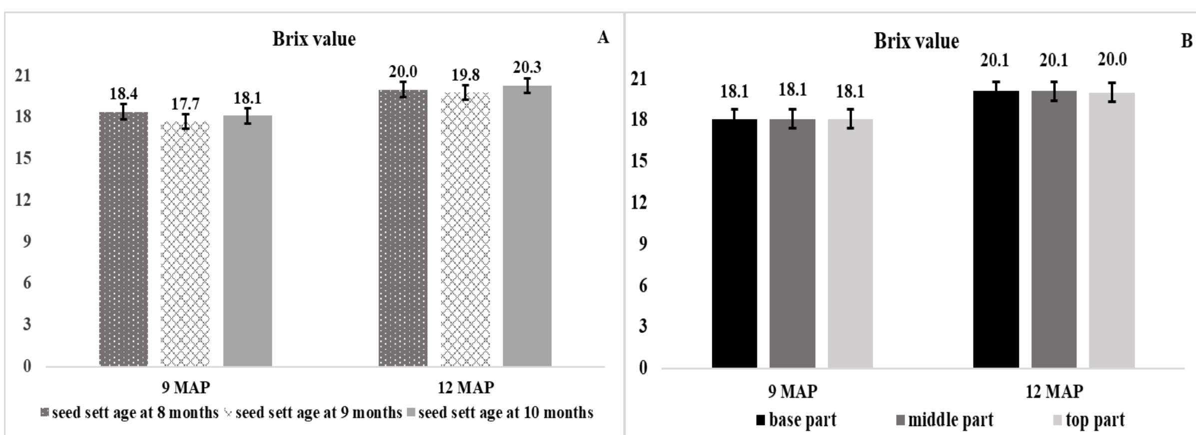

Figure 6. Brix value at 9 and 12 MAP on different seed sett ages (a) and segments (b).

Quality performance

Brix value: as an important trait in sugar production, the brix value was also evaluated. The results showed that seed sett ages, different positions of seed setts and their combination had no effect on the brix value at both 9 and 12 MAP. The brix value ranged from 17.7-18.3 and 19.8-20.3 ° brix at 9 and 12 MAP, respectively (Figure 6a and 6b). Our findings align with previous researches, like Ayele et al. (2014) who reported that seed cane ages had no impact on sucrose content, echoing the similar brix values observed in this study. Similarly, Neto et al. (2017); Patel and Patel (2014) and Getaneh et al. (2016), investigated the influence of seed sett positions and the number of buds per seed sett on sucrose content and found out that these factors had no significant effect on the brix value. The uniformity of results across these studies suggests that factors such as seed sett age, bud position, and number of buds per seed sett may not be the primary determinants of sucrose content, as reflected by the brix value. Instead, other factors,

Table 8. Interaction between seed sett age and segment on root dry weight at 9 MAP and 12 MAP.

seed sett age	base part	segment middle part	top part	base part	segment middle part	top part
	9 MAP (g plant^{-1})			12 MAP (g plant^{-1})		
8 months	52.54bc	62.98bc	119.70a	163.75ab	70.95d	140.97abc
9 months	49.31bc	74.35b	36.43c	84.85cd	72.68d	183.03a
10 months	73.71b	71.71b	116.08a	157.65ab	62.41d	104.62bcd
F-test		**			*	

* and **; significantly different at p≤0.05 and p≤0.01 respectively, compare mean by LSD method.

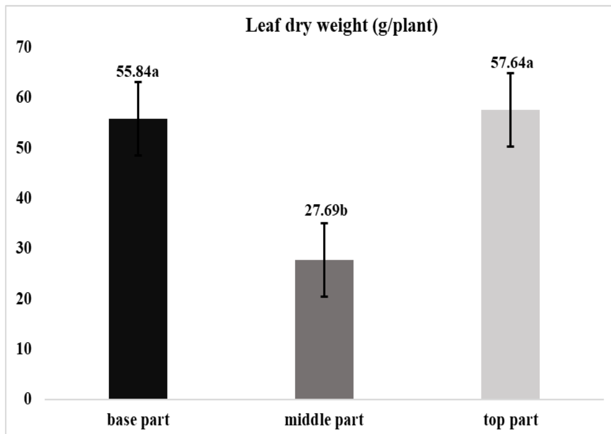

Figure 8. Leaf dry weight at 12 MAP on different segments.

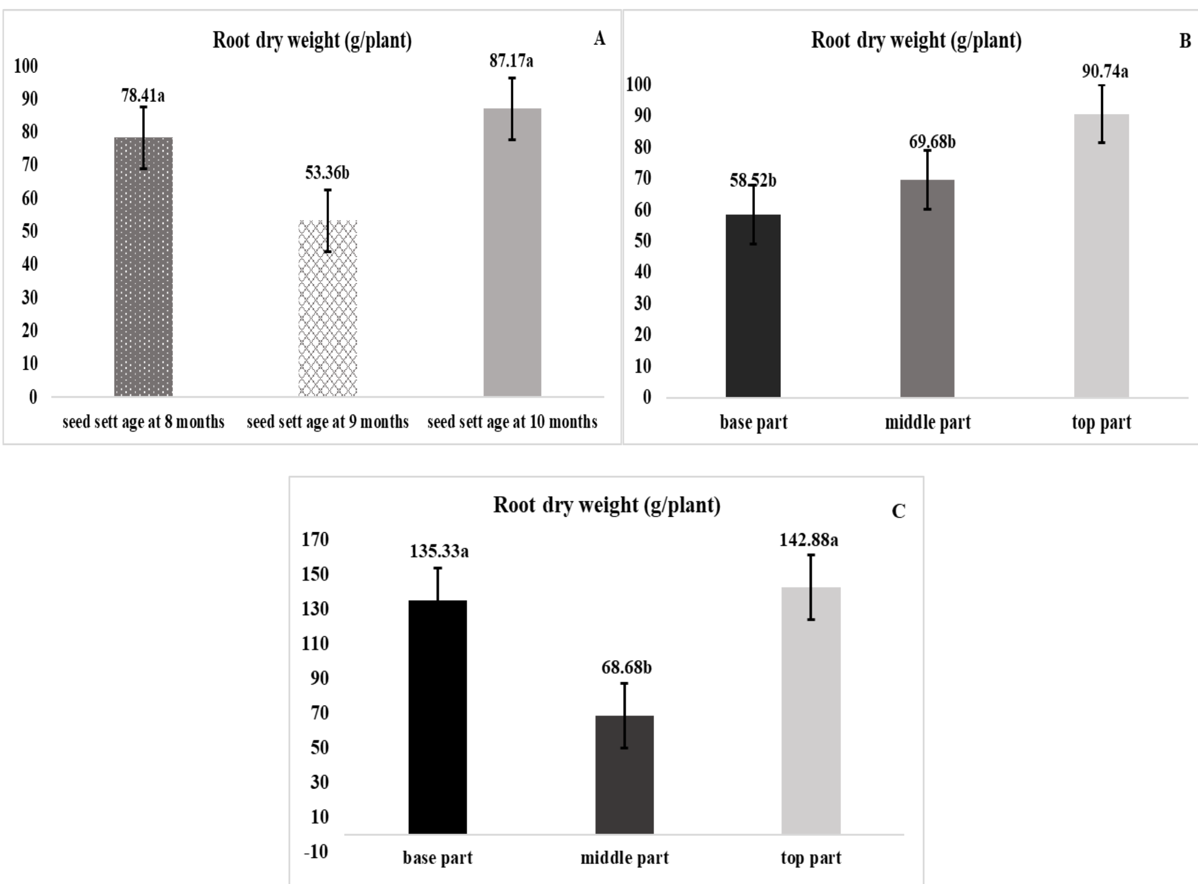

Figure 9. Root dry weight at 9 MAP on different seed sett ages (a) and segments (b), and root dry weight at 12 MAP on different segments (c).

such as soil quality, climate, and cultivation practices, may exert more influence on sucrose content in sugarcane. The highest brix value was 20.3% at 12 MAP and this was slightly lower than the brix reported by Ponragdee et al. (2011) who found that brix was 21.5% for the same sugarcane variety cv. KK3. The slight difference in brix is thought to have been influenced by either environmental or management factors as these factors have shown to influence the growth and development of sugarcane.

Dry matter accumulation

Stalk dry weight: this trait was evaluated at 9 and 12 MAP. The result showed that seed sett ages and different position of the seed setts had no significant effect on stalk dry weight (data not shown), however, an interaction effect between these factors was observed at 9 MAP. The combination of seed sett age of 9 months with base part and seed sett age of 8 months with top part recorded the highest stalk dry weight than other combinations (117.90 and 115.17 g plant^{-1}, respectively) and there were no significant differences in stalk dry weight among other combinations (Table 6). Whereas at 12 MAP, both seed sett ages and different positions of the seed sett had effect on stalk dry weight and an interaction was also observed. Specifically, seed sett ages of 8 and 10 months resulted in significantly higher stalk dry weights compared to 9 (122.04=109.40>59.75 g plant^{-1}, respectively) (Figure 7a). Additionally, the base segment recorded significantly higher stalk dry weight compared to the middle and top segments (137.06 > 97.55 > 56.58 g plant^{-1}, respectively) (Figure 7b). Notably, the combination of seed sett age of 8 months with the base segment and seed sett age of 10 months with the middle segment yielded the highest stalk dry weights among all combinations (257.23 g plant^{-1} and 186.69 g plant^{-1}, respectively) (Table 6). Many previous studies reported that, dry matter accumulation in sugarcane is affected by the size of the seed sett and number of buds per sett, with two and three budded setts showing significantly better dry matter accumulation compared to single budded setts (Jayesh et al., 2013; Singh et al., 2015; Jain et al., 2010).

Leaf dry weight: this trait was observed at 9 and 12 MAP, at 9 MAP, neither seed sett ages nor different positions of the seed sett had any effect on leaf dry weight, and no significant interaction between these factors was observed (data not shown). However, at 12 MAP, different positions of the seed setts had significant effect on leaf dry weight, whereas no significant effect was observed for seed sett ages. The top segment showed the highest leaf dry weight but was not significantly different from the base segment (57.64 and 55.84 g plant^{-1}, respectively) (Figure 8). An interaction was observed, where the combination of seed sett age of 9 months with the top segment and 8 months with the base segment resulted in the highest leaf dry weight (107.53 and 87.57 g plant^{-1}, respectively) compared to other combinations (Table 7).

Root dry weight: this trait was included in the study and assessed at 9 and 12 MAP. The results showed that root dry weight at 9 MAP recorded significant differences influenced by both seed sett ages and different positions of the seed sett, including interaction. The seed sett ages of 10 and 8 months showed significantly higher root dry weights than of 9 months (87.17 and 78.41 g plant^{-1}, respectively, compared to 53.36 g plant^{-1}) (Figure 9a). In terms of stem segments position, the top segment had significantly higher values compared to the middle and base segments (90.74 >69.68 = 58.52 g plant^{-1}, respectively) (Figure 9b). When considering the interaction effect, it was evident that combinations involving seed sett age of 8 months with the top part and 10 months with the top part produced the highest root dry weights (119.70 and 116.08 g plant^{-1}, respectively), surpassing other combinations (Table 8). However, at 12 MAP the results indicated that there was no significant effect on root dry weight due to seed sett ages (data not shown), while, significance was observed among different segments, and an interaction was also found. The top and base part of segment had higher root dry weight than middle part (142.88=135.33>68.68 g plant^{-1}, respectively) (Figure 9c). The seed sett age of 9 months in combination with the top segment exhibited the highest significance compared to other combinations (183.03 g plant^{-1}). However, it showed no significant difference when compared to seed sett age of 8 months with the base segment, seed sett age of 10 months with the base segment, and seed sett age of 8 months with the top segment (163.75, 157.65 and 140.97 g plant^{-1}, respectively) (Table 8).

Material and methods

Plant materials

The sugarcane variety Khon Kaen 3 (KK3), widely cultivated in Thailand, was the primary variety used in this study. This variety was obtained from farmer field in Maha Sarakham province, Thailand. Consideration were given to variations among seed sett ages and segment position used as propagating materials.

Soil properties analysis

The chemical content was analyzed in soil samples collected from the 0-20 cm layer of a field where the pot culture soil was obtained. The soil pH was 7.30, the electrical conductivity (EC) value was 0.5 ds m^{-1}. Organic matter (OM) was 10.06% (low), total nitrogen (N) was low (1.55 mg kg^{-1}), phosphorus (P) was low (1.42 mg kg^{-1}) and potassium (K) was low (3.8 mg kg^{-1}).

Meteorological data

The average temperature, rainfall, cumulative rainfall, and relative humidity were monitored monthly. The average temperature during the crop cycle from January to December 2021 ranged between 22.4°C and 30.6°C. Monthly rainfall varied from 3.3 mm to 328.5 mm, with September recording the highest rainfall. The cumulative rainfall from January to December totaled 944.3 mm. Average relative humidity ranged between 66.9 to 82.4% (data not shown).

Layout

The experiment was laid out in a 3×3 factorial in randomized complete block design (RCBD) with three replications. Factor A was age of sugarcane plant were seed setts were sourced (8, 9, and 10 months after planting), while factor B was position on the stem were seeds setts were sectioned/cut (base, middle and top segments). The experiment was conducted in the Department of Agricultural Technology, Mahasarakham University, Kantarawichai district, Maha Sarakham province) in pot culture under rain-fed conditions. Soil was collected in field at 0-15 cm depth, thereafter mixed and air dried, then sieved through a 2 mm steel grating. About 8 kg of soil was placed in the planting pot of 20 × 28 cm (D × H). Sugarcane was planted on November 8, 2021, with each pot containing a single seed sett with 2-3 buds.

A chemical fertilizer (NPK) (15-15-15) was applied as basal fertilizer at a rate of 312.5 kg ha^{-1}. Sugarcane was top dressed at 120 after planting at the same rate as basal dressing. Weeding was performed manually, and irrigation was administered twice a week at field capacity during the initial growth stages of sugarcane to allow for seedling establishment.

Data collection

Days to bud emergence: time (days) from planting the seed setts to the point at which the new shoot becomes visibly noticeable above the soil surface.

Plant height: measurements were taken from 30 days after planting (DAP) and thereafter at monthly intervals. A tape measure was used to measure the height (cm) of sugarcane from the soil surface to the tip of the uppermost leaf. After a period of six months, this trait was reevaluated, with measurements from the soil surface to the leaf immediately above the leaf counted as +1.

Stalk diameter: This trait was recorded from 30 DAP and thereafter at monthly intervals, using a digital vernier caliper and measurements (mm) taken at the midpoint of the sugarcane stalk.

SPAD chlorophyll meter reading (SCMR): This trait was recorded using a SPAD-502 meter (Minolta, Tokyo, Japan). Measurements were taken at monthly intervals from the first month after planting until the day of harvest. The data points were collected from two leaves per pot, with three positions along the length of the leaf blade (excluding midribs) selected for each measurement. Subsequently, the data was averaged to a single value.

Number of tillers per plant: This trait was collected by counting number of tillers from the fourth to the sixth month. Subsequently, it transitioned to the number of stalks per plant from the seventh to the twelfth month (harvest day).

Stalk fresh weight: this trait was collected at 9 and 12 months after planting (MAP). Where sugarcane was cut just above the soil surface, and leaves removed then the stalks weighed using a digital balance, recorded in grams (g).

Leave fresh weight: this trait was recorded at 9 and 12 MAP, where leaves removed from sugarcane stem were weighed using a digital balance, recorded in grams (g).

Number of leaves plant^{-1}: the fully expanded leaves were counted and recorded at 9 and 12 MAP.

Number of internodes stem^{-1}: this trait was recorded at 9 and 12 MAP, where the leaves were removed from the stalk to expose the internodes to be counted.

Stalk dry weight: after recording fresh weight (at 9 MAP) and squeezing out the juice (at 12 MAP), the samples were oven dried at 70 °C for 72 h or until weight consistency was achieved. Stalk dry weight was then recorded in gram (g) by using a digital balance.

Leaves dry weight: after fresh weight was recorded (at 9 and 12 MAP), the leaf samples were then oven dried at 70 °C for 72 hr or until consistent weight was achieved. Leaf dry weight was then recorded in gram (g) by using a digital balance.

Root dry weight: this trait was collected at 9 and 12 MAP, after removing the upper portion, the roots were carefully removed from the pot. Subsequently, the roots were washed with tap water and placed in a bag and then oven dried at 70 °C for 72 h or until a constant dry weight. Root dry weight wad then recorded in gram (g) by using a digital balance.

Leaf area: this trait was evaluated at 9 and 12 MAP. After removing the leaves from the stem and weighing them, 10% of the leaf weight was sampled for leaf area measurement and recorded. Leaf area per plant was calculated based on these measurements.

Juice yield: this trait was recorded at 12 MAP, where juice from sugarcane was squeezed by small sugarcane extractor and then measured to determine the yield.

Brix value: this trait was assessed at 9 and 12 MAP, using a hand refractometer for measurement.

Statistical analyses

The gathered data was subjected to statistical analysis through Statistix 10. An analysis of variance (ANOVA) was employed to establish the overall significance of the data. To compare means at a 5% probability level ($p \leq 0.05$), the least significant difference (LSD) test, following the methodology outlined by Steel and Torrie (1960), was conducted.

Conclusion

In this current study, various growth, yield, and yield related traits in sugarcane cultivation were investigated. The findings indicated that several factors, including seed sett ages and stem segments positions, had a significant impact on certain traits. For example, seed sett ages influenced the number of tillers at specific growth stages, while different segments positions affected LA and stalk fresh weight. However, it's noteworthy that some traits, such as days to germination, plant height, stem diameter, and SCMR, remained consistent across varying conditions. These results provide valuable insights into the factors that affect sugarcane cultivation, aligning with previous research in traits while offering novel observations in others.

Overall, a current study revealed that while some growth and yield traits in sugarcane may be influenced by seed sett ages and stem segments, others remain remarkably stable. These findings contribute to our understanding of sugarcane cultivation and provide valuable information for optimizing planting practices. Future research should delve deeper into the mechanisms behind these observed effects, ultimately benefiting the sugarcane industry. However, this research was conducted only a year study, for more precise information and confirmation a recent study, a field research should be replicated and study over one-year study.

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