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RESEARCH ARTICLE

Evaluation of physiological, agronomical and technological traits of various sugarcane varieties at different ages

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Abstract

A field experiment was conducted at the Shandaweel Agricultural Research Station in Sohag Governorate, Egypt, during the 2021/22 and 2022/23 growing seasons. This study aimed to evaluate the physiological, agronomical and technological traits of four sugarcane varieties: Cuba 57-14, Giza 2003-47, Giza 84-47, and the commercial check variety G.T. 54-9, at various ages: 240, 270, 300, 330, and 360 days after planting using a Randomized Complete Block Design in split plot distribution with three replications. The results revealed that the tested varieties markedly varied in cane and sugar yields, stalk height, diameter, and number of tillers/m^2. G.T.54-9 variety recorded considerably higher sugar yield compared to other examined varieties. G.84-47 variety surpassed the other three tested varieties in stalk height. However, the C.57-14 variety was the highest in stalk diameter; mean leaf area, and specific leaf weight. Meanwhile, G.84-47 variety recorded a higher number of tillers/m^2 and leaf area index (LAI) with an insignificant difference from G.T.54-9 variety**.** Increasing plant age caused a gradual marked enhancement in stalk height and diameter in plant cane 1 and 2; however, it reduced the number of tillers/m^2 in both seasons. Sugarcane plants at 360 days' age recorded the highest brix, sucrose, purity, and sugar recovery percentages, stalk height, and diameter traits, while it scored the lowest number of tillers/m^2 in plant cane 1 and 2 seasons. G.T.54-9 and G.2003-47 varieties demonstrated superior performance at 360 days across multiple metrics, suggesting these varieties should be prioritized for cultivation to enhance productivity.

Keywords: Physiological; Agronomical; Technological; Sugarcane Varieties; Different ages.

1. Introduction

Sugarcane (*Saccharum* ssp.) Cultivation in Egypt is primarily centered around sugar refineries in Upper Egypt, which account for 77% of the country's cane area. Middle Egypt has an extra 15% of the sugarcane area, while the Delta region has 8%. Post estimates for the harvested area in the 2023/24 marketing year are unchanged from the 2022/23 year, remaining at 136,000 hectares (Omar and Morgan, 2023).

Sugarcane is typically grown as a perennial crop and is harvested multiple times before replanting. The initial harvest is referred to as the plant crop, while subsequent harvests are known as ratoons. Although sugarcane can be grown from true seeds, commercial plantings are always made using stem cuttings, or setts, often referred to as seed (Cock, 2001).

Varietal differences in sugarcane play a crucial role in production. These varieties can vary significantly in performance, quality, and yields, mainly due to differences in their genetic structures. Moreover, physiological, agronomical, technological, and yield traits are

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notably influenced by the age of the plants. Numerous researchers have highlighted the importance of sugarcane varieties. For instance, Abd El-Azez (2008) evaluated several sugarcane varieties, including G.84-47, G.99-103, G.98-28, G.98-88, Phil.8013, and the commercial variety G.T.54-9 and revealed that these varieties differed significantly in stalk height, stalk diameter, millable cane, and recoverable sugar yields. Additionally, the varieties exhibited differences in quality parameters such as total soluble solids (TSS %), purity %, and sugar recovery %. The Phil.8013 and G.99-103 varieties recorded the highest values for millable cane and recoverable sugar yields. In a related study, Galal and Yousef (2019) found that the commercial sugarcane variety G.T.54-9 performed better than the other varieties in terms of both sugar and cane yields, cane weight, and the number of millable canes per hectare. Nonetheless, the G.T.54-9 and G.84-47 types' variations in these examined features were largely negligible. Furthermore, Yousif *et al.* (2023) reported that the G.2004-27 variety achieved the highest millable cane length and cane yield, while the G.2005-47 variety produced the best results for millable cane diameter, weight, and sugar yield. On the other hand, the G.2003-47 variety recorded the highest sucrose levels, purity and sugar recovery rates.

Plant genetics and the growing environment, or the combination of both, affect cane and sugar yields as well as physiological, agronomical, and technological characteristics. (Gomathi *et al.*, 2013). The productivity and sucrose content of sugarcane are determined in large part by this interplay. (Rehman *et al.*, 2014). Plant age has a major impact on physiological, technical, and productive features, and the impacts of environmental conditions on sugarcane growth have been well-documented. Abu-Ellail *et al.* (2020) reported a significant increase in leaf area index, with increasing harvest age. To understand how plant age impacts growth and physiological development in sugarcane, it is essential to quantify how different ages and growth processes contribute to variations in cane productivity. This requires studying physiological parameters for sugarcane to establish growth analysis benchmarks, typically through daily sampling over the entire growing season (Robertson *et al.*, 1996; Nava *et al.*, 2016).

The objective of this study was to evaluate the physiological, agronomical and technological traits of various sugarcane cultivars at different ages under the conditions of Sohag Governorate conditions.

2. Materials and methods

A field experiment was carried out at Shandaweel Agricultural Research Station (latitude of 26´ 33° N and longitude of 31´ 41° E), Sohag Governorate, Egypt on a plant cane 1 and 2 grown in 2021/22 and 2022/23 seasons to evaluate physiological, agronomical and technological traits of four sugarcane varieties namely: Cuba 57-14, Giza 2003-47, Giza 84-47 and the commercial variety G.T.54-9 as a check variety at different ages: 240, 270, 300, 330 and 360 days after planting. A randomized complete block design in a split-plot arrangement was used with three replications. Sugarcane varieties occupied the main plots, while, examined ages were distributed randomly in the subplots. Each subplot area was 35 m^2 with 5 rows of 7 meters long and 1.0 meter apart. Sugarcane was planted in the last week of February in both seasons. Phosphorus fertilizer as calcium super phosphate (15% P_2O_5) was added once during seed bed preparation at the rate of 30 kg P_2O_5/fed. Nitrogen fertilizer as urea (46% N) was applied to the plant cane 1 and 2 at 210 kg N/fed, which was divided into three doses: after the 1^{st}, 2^{nd} hoeing and 30 days later i.e., 45, 75 and 105 days after transplanting. Potassium fertilizer was added once as potassium sulfate (48% K_2O) with the 2^{nd} dose of N fertilizer at the rate of 48 kg K_2O/fed. The other agronomic practices were done as recommended by the Sugar Crops Research Institute.

Mechanical and chemical properties of the upper 30 cm of the experimental soil showed that the soil texture was clay loam, which contained 21.5 % sand, 29.3 % silt, 49.2 % clay; 94 mg/kg soil N, 18 mg/kg soil P_2O_5 and 917 ppm K_2O with pH of 7.55, which were calculated using the approach of A.O.A.C. (1990).

2.1. Agronomic characters

The following data were recorded at different studied ages from 20 random tiller canes for each subplot:

1. Stalk height (cm) was measured from the soil surface to the top visible dewlap.
2. Stalk diameter (cm) was measured at the middle part of the stalks.
3. Number of tillers/m^2.

2.2. Physiological characters

The Physiological growth analysis used in this trial was calculated according to the following equations:

1. Mean leaf area was determined according to the method described by Muller (1991):

The mean leaf area (cm^2) = (leaf length x maximum width x 0.75).

2. Number of leaves/tiller.
3. Leaf area index (LAI) was calculated according to Watson (1952) as follow:

Leaf area index (LAI) = Plant leaf area (cm^2) / land area per plant (cm^2).

4. Specific leaf weight (SLW) (mg/cm^2) = Leaf dry weight/ Leaf area this formula was described by Landsberg (1990).

2.3. Quality characters

At the different studied ages, a sample of 20 tillers from each subplot was collected at random, cleaned and crushed to extract the juice, which was analyzed to determine the following quality traits:

1. Brix % (TSS: total soluble solids of juice), which was determined using a "Brix Hydrometer" according to A.O.A.C. (2005).
2. Sucrose % was determined using a “Saccharimeter” according to A.O.A.C. (2005).
3. Juice purity% was calculated using the following equation:

Purity %= (Sucrose %/brix %) x 100

4. Sugar recovery% was calculated according to Yadav and Sharma (1980) as follows:

Sugar recovery % = sucrose% - 0.4(brix % - sucrose %) × 0.73

2.4. Yields characters

1. Cane yield/fed (ton), which was estimated at harvested sugarcanes of the inner three rows of each sub plot were cut, topped, cleaned up from trash, weighed (kg) and then converted into (ton/fed).

2. Sugar yield/fed (ton), which was estimated according to the following equation:

Sugar yield/fed (ton) = cane yield/fed (ton) x sugar recovery %/100.

2.5. Statistical analysis

The collected data were statistically analyzed according to Gomez and Gomez (1984) using the computer "MSTAT-c" statistical analysis package described by Freed *et al*. (1989). The least significant differences (LSD) at 0.05 level of probability were calculated to compare the differences among means of treatments according to Snedecor and Cochran (1980).

3. Results and discussion

3.1. Agronomic traits

Data in Table 1 show significant variances among the tested sugarcane varieties regarding stalk length, diameter, and the number of tillers/m^2 in both seasons. The G.84-47 variety recorded the highest stalk height with insignificant difference from the G.T.54-9 variety in both seasons. Concerning stalk diameter, the C.57-14 variety exhibited the highest mean values compared to the other three varieties in both seasons. Additionally, the G.T.54-9 and G.84-47 varieties produced the highest number of tillers/m^2, with insignificant variance between them in either season. Conversely, C.57-14 variety recorded the lowest stalk height in both seasons, with insignificant variance from G.2003-47 in the second season. Furthermore, G.84-47 had the lowest stalk diameter in both seasons, while C.57-14 produced the lowest number of tillers/m^2 with insignificant variance from G.2003-47 in the second season. Many researchers have noted the influence of sugarcane varieties on yield components (Abu-Ellail *et al*., 2020; Yousif *et al*., 2023), stating that the differences observed among sugarcane varieties can be attributed to their genetic structures, which affect stalk height, diameter, and the number of millable tillers/fed.

Moreover, data in the same table also illustrate that as plant age increased, there were gradual marked increases in both stalk height and diameter in both seasons. However, this growth was accompanied by a decrease in the number of tillers/m^2 in both seasons. This reduction in tillers may be linked to a die-off that occurs during the stem elongation and maturation stages, as noted by Cock (2001), who mentioned that the number of stalks typically remains constant during the elongation and maturation period. Reports from Australia indicate that considerable stalk death can occur during this phase (Muchow *et al.*, 1995). Nevertheless, other studies in Australia have not consistently validated the phenomenon of stalk death, though there is a noted association between stalk death and lodging (Singh *et al.*, 2000). Sugarcane plants that were 360 days old exhibited the highest stalk height and diameter, while they had the lowest number of tillers/m^2 in both seasons. In contrast, canes that were 240 days of age showed the lowest stalk height and diameter but had the highest values for tiller number/m^2 in both seasons. These contrasting results may be due to genetic differences among the varieties regarding their ability to grow internodes and decide the stalk diameter. (Ahmed *et al.*, 2016). These findings align with those reported by Yousif *et al.* (2023), which indicated that the length and diameter of millable cane increased steadily with delayed harvesting age.

Table 1. Effect of variety and plant age on stalk length (cm), stalk diameter and number of tillers/m^2 of sugarcane in plant cane 1 and 2 seasons.

	Stalk height (cm)		Stalk diameter (cm)		Number of tillers/m^2	
Treatments	1st season	2nd season	1st season	2nd season	1st season	2nd season
Varieties						
G.T. 54-9	293.2	281.1	2.44	2.50	15.7	16.8
C. 57-14	264.4	271.3	2.67	2.69	13.7	14.9
G.2003-47	276.0	272.7	2.33	2.41	14.8	15.8
G.84-47	294.8	283.7	2.22	2.34	15.2	17.4
LSD at 0.5	3.90	4.30	0.10	0.06	0.6	1.4
Plant age (days)						
240	249.3	235.7	2.29	2.39	17.8	19.4
270	269.2	269.7	2.41	2.45	15.7	17.4
300	285.7	282.9	2.45	2.49	14.5	16.6
330	298.1	293.5	2.41	2.52	13.2	13.9
360	308.3	304.1	2.52	2.55	12.2	13.8
LSD at 0.5	2.6	2.4	0.09	0.01	0.5	1.5

Data in Table 2 indicate significant interaction effects between sugarcane varieties and plant age on stalk height and diameter in the second plant cane and the number of tillers/m^2 in the first season. Specifically, increasing the plant age from 330 to 360 days for the G.T.54-9 and G.84-

47 varieties resulted in improvements in stalk height of 11.8 cm and 12.3 cm in the second one. Similarly, this increase in plant age also led to enhancements in stalk diameter, with increases of 0.02 cm and 0.03 cm observed in the 2nd season. Conversely, this same increase in plant age resulted in a decrease in the number of tillers/m^2 in the first season, showing reductions of 1.5 for G.T.54-9 and 0.8 for G.84-47. The interaction between variety and plant age significantly affects stalk diameter and height in sugarcane, revealing notable differences while showing no consistent patterns in tiller production. Varieties such as G.T.54-9 demonstrate strong growth, especially in height, while C.57-14 is recognized for its diameter. Overall, these trends suggest that older plants tend to prioritize vertical growth over the production of tillers.

Table 2. Significant interaction between variety × plant age effects on stalk length, stalk diameter and number of tillers/m^2 of sugarcane in plant cane 1 and 2 seasons.

Treatments		Stalk height (cm)	Stalk diameter (cm)	No. tillers/m^2
Variety	Plant age (days)	2nd season	2nd season	1st season
	240	238.4	2.43	14.4
	270	276.3	2.46	16.9
G.T. 54-9	300	285.1	2.49	15.9
	330	296.9	2.54	14.2
	360	308.7	2.56	12.7
	240	229.3	2.61	15.8
	270	264.1	2.67	13.9
C. 57-14	300	277.7	2.69	12.8
	330	288.3	2.72	11.9
	360	297.2	2.74	11.1
	240	234.6	2.34	17.9
	270	259.4	2.38	15.8
G.2003-47	300	280.6	2.41	14.3
	330	289.6	2.45	13.2
	360	299.0	2.48	12.5
	240	240.7	2.19	19.1
	270	278.7	2.31	16.1
G.84-47	300	288.1	2.37	15.0
	330	299.2	2.41	13.4
	360	311.5	2.44	12.6
LSD at 5%		4.7	0.02	0.8

3.2. Physiological traits

Data in Table 3 reveal significant variations among the tested varieties in terms of mean single leaf area, the number of leaves/tiller and specific leaf weight in both seasons, as well as the leaf area index in the second season. The C.57-14 variety exhibited the highest mean leaf area and specific leaf weight compared to the other three varieties in both seasons. In contrast, G.T.54-9 and G.84-47 varieties produced a higher number of leaves/tiller than the other two varieties, with insignificant difference between them in either season. Notably, the G.T.54-9 variety significantly outperformed the other three varieties in terms of LAI in second season. The observed reductions in mean single leaf area, number of leaves per tiller, specific leaf weight, and LAI may be attributed to the advancing age of the plants, which leads to the transition to storage and maturity stages. Variations between cane varieties in physiological properties were also documented by Abu-Ella *et al.* (2020).

Results in the same table indicated that plant age significantly influenced mean single leaf area, number of leaves/tiller and specific leaf weight, while LAI was only insignificantly affected by plant age in both plant cane seasons. As plant age increased from 240 days, there was a marked gradual increase in mean single leaf area, peaking at 330 days, which recorded the highest leaf area in both plant cane seasons. Conversely, the number of leaves per tiller gradually decreased as cane age increased from 240 days to 360 days in both seasons, though there was insignificant difference between the number of leaves/tiller at ages 330 and 360 days in the second season. Additionally, the highest specific leaf weight was observed in cane plants at 270 days of age. These findings align with those reported by Wood *et al.* (1997), which noted that the reduction in leaf appearance rate and changes in leaf size are associated with the partitioning of assimilates and the deposition of sucrose, primarily occurring in the lower nodes.

Table 3. Effect of variety and plant age on mean leaf area, number of leaves/tiller, specific leaf weight (SLW) (mg/cm^2) and leaf area index (LAI) of sugarcane in plant cane 1 and 2 seasons.

Treatments	Mean leaf area (cm^2)		Number of leaves/tiller		SLW (mg/cm^2)		LAI	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Varieties								
G.T. 54-9	283.4	303.5	10.4	11.2	10.58	10.79	4.35	5.63
C. 57-14	337.5	348.8	8.7	9.9	19.07	18.06	4.45	5.22
G.2003-47	239.9	258.4	9.8	10.5	16.29	13.47	4.39	4.42
G.84-47	219.1	233.1	10.2	11.6	13.07	10.91	3.13	3.95
LSD at 5%	8.4	7.1	0.18	0.93	1.12	2.02	NS	0.31
Plant age (days)								
240 days	237.5	253.6	11.9	12.9	14.69	14.00	5.29	4.86
270 days	261.8	277.2	10.4	11.6	16.19	14.87	3.95	5.04
300 days	282.9	300.9	9.6	11.0	14.55	13.04	3.86	5.14
330 days	302.6	327.0	8.8	9.3	14.07	11.78	3.91	5.13
360 days	256.0	270.9	8.2	9.2	14.27	12.86	3.38	3.84
LSD at 5%	9.3	8.0	0.27	0.69	0.68	0.85	NS	NS

Data in Table 4 donate that the considerable interaction influence between varieties and plant age regarding mean leaf area in both seasons. It also shows effects on the number of leaves/tiller and specific leaf weight in the first season, as well as the leaf area index in the second one. The data indicates that increasing the plant age from 330 to 360 days for the C.57-14 and G.84-47 varieties resulted in a reduction of mean leaf area, with decreases of 62.2 and 82.7 cm^2 in the first season and 25.2 and 15.1 cm^2 in the second one, respectively. Nevertheless, the same increase in plant age led to a reduction in the number of leaves/tiller for the G.T.54-9 variety, whereas it had an insignificant effect on G.2003-47 and G.84-47 in the first season. Furthermore, the increase in plant age for G.T.54-9 significantly decreased the LAI, while it had no significant effect on G.84-47 in the second season. Otherwise, increasing the plant age from 240 to 300 days for G.T.54-9 had insignificant effect on specific leaf weight, while this same increase in plant age for C.57-14 led to a considerable enhancement of SLW weight in the first season.

3.3. Quality traits

Data in Table 5 illustrate significant variances among the tested varieties in terms of brix, sucrose, purity and sugar recovery percentages in both seasons. The results indicated that the variety G.84-47 outperformed the other three varieties in brix, sucrose, purity and sugar recovery percentages in both seasons. However, it was found insignificant differences in purity and sugar recovery percentages when compared to G.2003-47 in the two seasons. In contrast, the variety C.57-14 recorded the lowest values for brix, sucrose, purity, and sugar recovery percentages in both seasons. These variances among sugarcane varieties were previously reported by Abu-Ellail *et al.*, (2020), Ali *et al.*, (2022), and Yousif *et al.*, (2023).

Table 4. Significant interaction between variety and plant age effect on mean leaf area (cm^2), number of leaves/tiller, specific leaf weight (mg/cm^2) and LAI of sugarcane in plant cane 1 and 2 seasons.

Treatments		Mean leaf area (cm^2)		Number of leaves/tiller	SLW (mg/cm^2)	LAI
Variety	Plant age (days)	1st Season	2nd season	1st season	1st season	2nd season
G.T. 54-9	240	248.5	253.7	12.3	11.49	5.71
	270	259.4	281.2	11.2	10.44	5.40
	300	274.5	301.7	10.6	11.53	5.58
	330	324.3	383.8	9.4	10.16	6.66
	360	310.2	297.3	8.4	9.27	4.78
C. 57-14	240	307.8	322.1	10.5	16.22	6.04
	270	334.9	343.8	9.2	20.41	5.63
	300	375.4	384.7	8.5	19.02	5.78
	330	360.9	388.0	7.9	19.03	5.10
	360	298.7	305.3	7.4	20.68	3.57
G.2003-47	240	201.7	221.9	11.9	19.80	4.52
	270	241.1	258.7	10.6	19.75	4.65
	300	254.6	280.3	9.5	14.63	4.78
	330	270.4	285.5	8.8	13.01	4.49
	360	231.7	275.7	8.3	14.28	3.64
G.84-47	240	191.9	216.8	12.7	11.23	3.17
	270	212.0	225.3	10.7	14.17	4.48
	300	227.2	236.9	9.6	13.01	4.44
	330	244.8	250.7	8.9	14.09	4.28
	360	219.6	235.6	8.4	12.86	3.39
LSD at 5%		18.6	16.0	0.52	1.36	0.60

Data in the same table focus that rising the age of sugarcane plants had a significant positive impact on brix, sucrose, purity, and sugar recovery percentages when compared to other ages studied during the 1st and 2nd seasons. Sugarcane plants that were 360 days old exhibited the highest values of brix, sucrose, purity, and sugar recovery percentages in both seasons. In contrast, the lowest values for these metrics were found in plants that were 240 days age in both seasons. These findings are consistent with the results reported by Abu-Ellail *et al.*, (2020), Gamechis and Ebisa (2021) and Yousif *et al.*, (2023) who noted that increasing the harvest age from 11 to 12, 13, and 14 months led to a significant and gradual increase in brix, sucrose, purity, and sugar recovery percentages. They also observed that the increase in purity percentage could be attributed to the rise in sucrose percentage within the total soluble solids content as the age of the sugarcane at harvest increases.

Table 5. Effect of plant age on brix, sucrose, purity and sugar recovery percentages of four sugarcane varieties in plant cane 1 and 2 seasons.

Treatments	Brix %		Sucrose %		Purity %		Sugar recovery %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Varieties								
G.T. 54-9	19.79	19.96	15.99	16.09	80.26	80.79	9.69	9.80
C. 57-14	18.46	18.68	14.59	15.13	78.56	78.96	8.72	8.91
G.2003-47	20.92	21.16	17.16	17.42	81.78	81.91	10.56	10.71
G.84-47	21.49	21.70	17.62	17.90	81.71	82.21	10.79	11.03
LSD at 5%	0.03	0.08	0.13	0.57	0.56	1.36	0.16	0.41
Plant age (days)								
240	16.55	16.66	12.67	12.77	76.51	77.29	7.41	7.61
270	18.19	18.38	14.31	14.76	78.58	78.68	8.52	8.63
300	20.62	20.89	16.64	17.04	80.65	80.98	10.07	10.19
330	22.38	22.57	18.49	18.50	82.54	82.83	11.38	11.55
360	23.09	23.38	19.58	19.90	84.62	85.06	12.32	12.57
LSD at 5%	0.10	0.09	0.16	0.34	0.52	1.06	0.17	0.21

Data in Table 6 indicate significant interaction effects between sugarcane varieties and plant age on Brix, sucrose and sugar recovery percentages in both seasons and on purity percentage in the 1st one. The results show that increasing the plant age from 330 to 360 days for the varieties G.T.54-9 and G.84-47 improved Brix % by 0.54 and 0.66 in the 1st season and by 0.63 and 0.61 in the 2nd one, respectively. Similarly, the increase in plant age for these varieties enhanced sucrose % by 1.12 and 0.85 in the 1st season and by 0.90 and 1.22 in the 2nd one. Additionally, this increase in plant age resulted in a rise in sugar recovery percentage by 0.97 and 0.70 in the 1st season, and by 0.78 and 1.19 in the 2nd one, respectively. Moreover, the same increase in plant age for G.T.54-9 and G.84-47 enhanced the purity % by 2.49 and 1.58 in the 1st season.

The interaction between sugarcane varieties and plant age reveals that G.2003-47 consistently performs better in Brix, sucrose, purity, and sugar recovery percentages in both growing seasons. This variety seems optimal for maximizing sugar yield, whereas C.57-14 has potential issues concerning sugar quality parameters.

3.4. Yield traits

Data in Table 7 indicate significant differences among the examined sugarcane varieties on stalk weight, cane and sugar yields/fed in the first and second plant cane seasons. The C.57-14 variety outperformed the other three tested varieties in stalk weight and cane yield in both seasons. This advantage in cane yield for the C.57-14 variety may be attributed to its thickest stalk diameter (see Table 1) and heaviest stalk weight. Conversely, the check variety G.T.54-9 exhibited the highest sugar yield, with an insignificant difference compared with G.2003-47 in both seasons. These findings are consistent with those reported by Ahmed *et al.*, (2020), and Yousif *et al.*, (2023) who also noted significant differences in cane and sugar yields among the varieties examined. Data in the same table illustrated that increasing plant age led to a gradual and marked improvement in stalk weight, cane and sugar yields/fed in both seasons.

Table 6. Significant interaction between variety and plant age effects on brix, sucrose, purity and sugar recovery percentages of sugarcane in plant cane 1 and 2 seasons.

Treatments		Brix%		Sucrose%		Purity%	Sugar recovery%	
Variety	Plant age (Days)	1st season	2nd season	1st season	2nd season	1st Season	1st season	2nd season
G.T. 54-9	240	16.13	15.98	12.18	11.97	75.54	7.02	7.45
	270	17.94	18.10	14.10	14.22	78.58	8.39	8.46
	300	20.01	20.34	16.03	16.35	80.09	9.65	9.52
	330	22.17	22.37	18.25	18.52	82.31	11.21	11.43
	360	22.71	23.03	19.37	19.37	84.80	12.18	12.13
C. 57-14	240	14.60	14.80	10.73	10.90	73.46	6.04	6.15
	270	16.27	16.40	12.40	13.53	76.22	7.20	7.29
	300	19.53	19.71	15.43	16.13	79.03	9.19	9.42
	330	20.75	20.91	16.81	16.92	80.99	10.21	10.34
	360	21.16	21.62	17.59	18.11	83.12	10.95	11.34
G.2003-47	240	17.41	17.63	13.57	13.81	78.41	8.13	8.21
	270	19.08	19.34	15.18	15.76	79.56	9.11	9.24
	300	20.91	21.33	17.07	17.45	81.65	10.43	10.68
	330	22.97	23.13	19.21	19.39	83.58	11.94	12.09
	360	24.21	24.38	20.75	20.96	85.72	13.18	13.34
G.84-47	240	18.04	18.22	14.19	14.40	78.64	8.45	8.61
	270	19.47	19.70	15.57	15.81	79.97	9.38	9.53
	300	22.01	22.21	18.01	18.21	81.82	11.00	11.13
	330	23.65	23.87	19.70	19.93	83.28	12.18	12.34
	360	24.28	24.48	20.60	21.15	84.86	12.96	13.53
LSD at 5%		0.20	0.19	0.31	0.68	1.04	0.33	0.42

Table 7. Effect of plant age on stalk weight, cane and sugar yields fed-1(ton) of four sugarcane varieties in plant cane 1 and 2 seasons.

Treatments	Stalk weight (kg/stalk)		Cane yield (ton/fed)		Sugar yield (ton/fed)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Varieties						
G.T. 54-9	1.024	0.959	47.898	47.807	4.750	4.780
C. 57-14	1.256	1.195	49.743	50.346	4.440	4.596
G.2003-47	0.965	0.938	44.028	43.587	4.742	4.765
G.84-47	0.881	0.849	40.831	41.482	4.487	4.658
LSD at 0.5	0.043	0.037	1.048	0.971	0.099	0.226
plant age (days)						
240	0.719	0.699	36.865	37.370	2.707	2.816
270	0.910	0.875	42.514	42.654	3.595	3.654
300	1.079	1.020	46.745	46.622	4.682	4.726
330	1.191	1.135	50.112	50.290	5.679	5.781
360	1.258	1.197	51.889	52.091	6.361	6.521
LSD at 0.5	0.027	0.026	0.686	0.619	0.086	0.109

Cane plants grown for 360 days recorded the highest values for stalk height, diameter (Table 1), and sugar recovery percentage (Table 5) in both seasons. The observed increases in these three measured traits can be attributed to the sufficient growth time that allowed for the maturation of the cane plants. These results align with the findings of Gamechis and Ebisa (2021) and Yousif *et al.,* (2023) who stated that increasing plant age significantly enhances cane and sugar yields.

Data in Table 8 show a significant interaction effect on stalk weight and sugar yield during the first and second plant cane seasons. The results indicated that increasing the plant age from 330 to 360 days enhanced the stalk weight of the C57-14 and G.84-47 varieties by 0.067 kg and 0.075 kg in the first season, and 0.065 kg and 0.055 kg in the second one, respectively. Additionally, the data revealed that for the G.T.54-9 and G.84-47 varieties, increasing plant age improved sugar yield by 0.689 tons and 0.593 tons in the first season, and 0.535 tons and 0.724 tons in the second one, respectively.

Table 8. Significant interaction between variety and plant age effect on stalk weight (kg) and sugar yield fed^{-1} (ton) of sugarcane in plant cane 1 and 2 seasons

Treatments		Stalk weight (kg)		Sugar yield fed^{-1} (ton)	
Variety	Plant age (Day)	1st season	2nd season	1st season	2nd season
G.T. 54-9	240	0.738	0.683	2.684	2.908
	270	0.898	0.850	3.746	3.758
	300	1.075	0.983	4.736	4.631
	330	1.172	1.112	5.948	6.005
	360	1.237	1.165	6.637	6.598
C. 57-14	240	0.853	0.842	2.436	2.540
	270	1.113	1.078	3.374	3.427
	300	1.337	1.242	4.669	4.799
	330	1.455	1.370	5.527	5.713
	360	1.522	1.445	6.193	6.500
G.2003-47	240	0.680	0.673	2.902	2.904
	270	0.863	0.837	3.721	3.737
	300	0.992	0.960	4.703	4.735
	330	1.110	1.077	5.773	5.796
	360	1.178	1.142	6.612	6.651
G.84-47	240	0.605	0.597	2.806	2.911
	270	0.765	0.735	3.540	3.694
	300	0.912	0.895	4.619	4.741
	330	1.028	0.982	5.468	5.610
	360	1.093	1.037	6.003	6.334
LSD at 5%		0.055	0.035	0.166	0.219

4. Conclusion

The varieties G.T. 54-9 and G.2003-47 have consistently shown superior performance in terms of cane and sugar yields, Brix %, and sucrose content at 360 days. Therefore, these varieties should be prioritized for cultivation. In terms of optimal harvest timing, it is recommended that sugarcane be harvested around 360 days to maximize sugar content and yield. This is particularly important for high-yielding varieties as the Brix and sucrose percentages t tends to increase in the later stages of growth. In variety selection, G.T. 54-9 stands out for its taller stalks and potential yield, while C.57-14 is preferable due to its thicker stalks. G.2003-47 proves to be a strong candidate for sugar accumulation and quality throughout the growth cycle. C.57-14 has a good stem weight but requires careful evaluation of sugar yield under the specific growing conditions. In summary, harvesting after about 360 days is critical to achieve maximum sugar content and utilization, especially with G.2003-47 variety.

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