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**OriginalArticle**

# Effect of Harvesting Age on Yield of Exotic Sugarcane Varieties at Metahara Sugar Estate

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**ABSTRACT**

Viability of a given sugar sector depends on the yield of sugar and age of harvesting affects sugar yield the return the most. Therefore, an experiment was conducted at Metahara Sugar Estate plantation to determine the effect of different harvesting ages (12, 14 and 16 months after planting) on 12 sugarcane varieties (C86-12, C90-501, C86-165, C132-81, C120-78, C1051-73, B78-505, B80-250, SP70-1284, C86-56, NCo334 and B52-334) on plant cane crop using a factorial RCBD design with three replications. Analysis of variance indicated that none of the interactions were found to be significant; however, the main effects age of harvesting and variety were significant ($p<0.01$). Harvesting cane at the age of 14 months gave a significantly ($p<0.01$) higher sucrose percent cane than 12 and 16 months of age harvesting which were in statistical parity. However, 14 and 16 months of age harvesting were not significantly differed each other; however, they were superior to 12 months of age harvesting. Therefore, it can be concluded that the harvesting age should range from 14 to 16 months for maximum economic advantage for the varieties considered.

**Keywords:** sugarcane, variety, age, harvesting, Cuba.



## INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is an industrial crop of the World cultivated for its diverse uses among which sugar is the important one. To enhance productivity per unit area conducting appropriate investigation on the agronomic management of cane (Ayele *et al*., 2014) through extensive studies is vital to be competitive in the World market.

Cane sugar yield is determined by the age of harvesting at which the cane matures (Sundara, 2000; Verma, 2004). Basically, sugarcane varieties differ inherently in their time of maturity. In Iran for instance, the optimum age to harvest for certain cane varieties depends on whether the cane is early maturing (10-12 months), medium maturing (12 months) or late maturing (14-16 months) (Calderon *et al*., 1996).

Some sugarcane varieties have relatively high sucrose content in early season and are defined as early maturing while it is the reverse in others which are known as late maturing

(Calderon *et al*., 1996).The crop season is also variable in different countries being 20 - 24 months in Hawaii, 13-19 months in Jamaica, 12-18 months in India, 16 months in Mauritius and 15 months in Queensland (Australia) (Salisbury and Ross, 1991). The climate elements, temperature, solar radiation, relative humidity and total rainfall variables that account for a major variation in harvest age among sugarcane growing countries (Jorge *et al.*, 2010).

Some cane is harvested before achieving maximum sucrose levels due to an increase of cane supply in early-season milling operations. Mauritius has used information on sucrose content at the time of harvest to develop maturity status for individual varieties (Mamet and Galwey, 1999). The effect of variety on sugarcane sucrose accumulation rates has been well-established but maturity status (level) for Canal Point (CP) sugarcane varieties have not been reported since 1977 (Miller and James, 1977). Consequently, lack of maturity status makes it difficult to make informed harvest scheduling decisions and the time of ripening depends on characteristics which are closely related to the length of growing period (Gilbert *etal*., 2004).

In Ethiopian Sugar Estates cane maturity is customarily determined by taking the crop age and appearance as criteria for several years. In addition, the Ethiopian Sugar Estates have been using a wide range of harvest period which extends from 18 to 24 months after planting on plant cane for all varieties. From Scientific point of view chronological age of sugarcane is not a reliable guide to determine cane maturity alone (UF, 2003). Therefore, other factors such as varieties, weather conditions, and soil type may have more direct bearing on the real maturity of canes than the crop age.

Therefore, the percentage of sucrose content (or quality of cane juice) mainly depends on various factors such as the sugarcane variety, the maturity of the sugarcane (the age of the sugarcane from the date of planting) in the case of plant cane, weather and harvesting conditions (Liu and Bull, 2001).

Harvesting of sugarcane at a proper time, *i.e.*, peak maturity, by adopting the right techniques is necessary to realize maximum weight of the millable canes produced with the least possible field losses under the given growing environment (Muchow *et al.*, 1998). On the other hand, harvesting either under-aged or over-aged cane with improper time of harvest leads to loss in cane yield, sugar recovery, poor juice quality and problems in milling (Khandagave and patil, 2007).

The peak sucrose content of sugarcane at harvest time is affected by different growing and plant physiological conditions during the maturation period (Cox *et al.*, 1998; O'Leary, 2000). Furthermore, the variation among soil on cane fields causes considerable differences in soil moisture holding capacity, degree of drying, and, consequently, the rate at which cane fields ripen (Muchow *et al.*, 1993; Scarpari and Beauclair, 2004). Moreover, harvesting of cane without considering peak sucrose content is one of a major problem to yield loss. Thus, inappropriate drying (wet or excessive drying) of cane management practices is practically observed in Ethiopia Sugar Estates. In Ethiopian Sugar Estates, there is lack of maturity status for individual varieties and time of ripening on length of growing period.

Thus, Pre-harvest cane quality testing is a best tool to monitor the dynamic change on the standing crop with respect to cane maturity. Therefore, monitoring the maturity of the standing crops periodically by taking some representative fields using as samples is vital to fix harvest time (Sundara, 2000).

The goal of this quality testing method is to provide productivity evaluation before harvesting so as to increase the efficiency of strategic and administrative decisions (Bakker, 1999). Accordingly, there is no proper time of harvest during dry period on Cuba's cane varieties under different growing conditions will be one of the possible major constraints of cane production in Ethiopia. In addition, lack of information on proportion of early, mid-late and late maturing varieties results in improper supply of quality cane in some crushing periods in all Ethiopian Sugar Estates. Various studies were conducted to enhance productivity in the sugar industry (Netsanet *et al.*, 2014a; Netsanet *et al*., 2014b); however, in relation to cane maturity the research and development is infant.

Therefore, this proposal was initiated with the objective to determine the optimum harvest age of 10 varieties imported from Cuba at Metahara Sugar Estate.

## MATERIALS AND METHODS

### Site Description

Metahara sugar estate is located in the Rift Valley region of Ethiopia at a latitude and longitude of 8º51'N and 39º52'E, respectively with elevation of 950 m.a.s.l. The area has a mean maximum and minimum temperature of $32.6^0$C and $17.5^0$C, respectively, and mean annual total rainfall of 554 mm.

### Treatments and Design

The experiment was conducted from on the cane plantation fields of Metahara Sugar Estate. The treatments were four different times of age of harvesting (12, 14 and 16 months after planting) and 12 sugarcane varieties (C86-12, C90-501, C86-165, C132-81, C120-78, C1051-73, B78-505, B80-250, SP70-1284, C86-56, NCo334 and B52-334. The study was carried out on Class IV (heavy) soil in a randomized complete block design.

To avoid the interference of rain, the experiment was implemented in such a way that the dry-off periods rest in the dry period of the crushing season. For all the treatments the 20 days dry-off period was used prior to harvesting. All other cultural practices were made as per the plantation except the treatments.

The experimental design was laid out in randomized complete block design in three replications.Area of each experimental plot was 62.25 $m^2$ (three furrows of 15m length and 1.45m width) and the central row was used for data collected.The distance between adjacent plots and replications were 1.50 and 2.90 meters, respectively. Hand weeding was conducted manually as required until full canopy coverage attained. Irrigation was provided as per the norm of the estate. Every other management was as per the estate except the time of nitrogen fertilizer application.

### Data Collection

***Single cane weight per stalk***: was determined by taking 30 samples randomly from the plot and by measuring the weight of each sample using a spring balance during harvesting. Then the average weight per stalk was taken.

***Millable stalk:*** Number of millable canes in each plot was counted at harvest.

***Juice quality analysis****:* juice was extracted from 20 stalk samples using Jeffco and Brix, Pol and Purity were analyzed at Metahara Research laboratory. Percent recoverable sucrose (*rendiment*) was calculated using Winter Carp indirect method of cane juice analysis (Kassa, 2010).

Stripped Cane yield was taken from the middle two rows and converted to hectare basis. Then commercial cane sugar per hectare was calculated as follows:

$$ESY\ (t/ha) = CYH\ (t/ha) \times ERS\ (\%)$$

Where;

ESY = estimated sugar yield
ERS = estimated recoverable sucrose (%)
CYH = cane yield per hectare

Finally, the collected data were analyzed statistically using Fisher's analysis of variance technique with SAS software (SAS Institute, 2002). Comparisons among treatments with significant differences for the measured and counted parameters were based on Duncan Multiple Range Test.

## RESULTS AND DISCUSSIONS

Analysis of variance indicated that none of the interactions were found to be significant (Table 1); however, the main effects age of harvesting and variety were significant for all the parameters considered (Table 2). In terms of cane yield, 16 months age of harvesting gave a significantly ($p<0.01$) higher than 14 and 12 months ages of harvesting which are also significantly ($p<0.01$) different. In agreement with the current result Khandagave and patil (2007) reported the presence of difference in cane yield between ages of harvesting.

**Table 1: Main effects and interaction effects of sugarcane varieties and harvesting ages at Metahara Sugar Factory**

| Source of Variation | Cane yield(t $ha^{-1}m^{-1}$) | Sucrose(%) | ESY(t $ha^{-1}m^{-1}$) |
|---|---|---|---|
| Variety | ** | ** | ** |
| Age of harvesting | ** | ** | ** |
| Age*Variety | NS | NS | NS |
| **CV** | **9.44** | **7.4** | **11.78** |

** = significant at P < 0.01; Ns = non-significant; t = tone; ha = hectare; m = month.

A significantly ($p<0.01$) higher percent sucrose cane was observed on 14 months age of harvesting as compared to the 12 and 16 months of ages (Table 2). However, 12 and 16 months of ages of harvesting were in statistical parity (Table 2). According to Sundara (2000) and Verma (2004), age of cane determines the sucrose content of cane.

**Table 2: Mean values of Effect of harvest age on yield of twelve Cuba varieties grown on clay soil at Metahara sugar estate**

| Treatment | Cane yield(t $ha^{-1}m^{-1}$) | Sucrose(%) | ESY(t $ha^{-1}m^{-1}$) |
|---|---|---|---|
| **Age of harvesting** | | | |
| 12 MAH | 119c | 12.40b | 14.77b |
| 14 MAH | 131b | 13.41a | 17.54a |
| 16 MAH | 148a | 12.53b | 18.39a |
| LSD (5%) | 5.82 | 0.44 | 0.94 |
| **Variety** | | | |
| C86-12 | 111d | 12.69bc | 14.13f |
| C90-501 | 114d | 13.93a | 15.99def |
| C86-165 | 136c | 12.31bc | 16.61cde |
| C132-81 | 137c | 12.76bc | 17.52bcd |
| C120-78 | 93e | 12.73bc | 11.79g |
| C1051-73 | 120d | 12.76bc | 15.33ef |
| B78-505 | 144bc | 12.87b | 18.42bc |
| B80-250 | 146bc | 14.22a | 20.69a |
| Sp70-1284 | 153ab | 12.58bc | 19.18ab |
| C86-56 | 135c | 12.62bc | 16.85cde |
| NCO-334 | 141bc | 11.97c | 17.05cde |
| B52-298 | 160a | 11.96c | 19.25ab |
| LSD (5%) | 11.76 | 0.88 | 1.87 |
| **CV (%)** | **9.44** | **7.4** | **11.78** |

Means followed by the same letter in a column are not significantly different from each other; m = month; ESY= estimated sugar yield; t=ton; ha=hectare; LSD=least significant difference; MAH= months after harvesting.

In terms of estimated sugar yield, 14 and 16 months age of harvesting were found to be in statistical parity and were significantly ($p<0.01$) higher than 12 months of age harvesting (Table 2).

## CONCLUSION

Age of harvesting result influenced cane yield, sucrose percent cane and estimated sugar

yield. Therefore, from the result it can be concluded that the sugar cane varieties harvesting age should range from 14 to 16 months for maximum economic advantages.

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