The Journal of Agriculture and Natural Resources Sciences

Journal homepage: http://www.journals.wsrpublishing.com/index.php/tjanrs

ISSN:2383-238X

Original Article

Agronomic Performance Evaluation of Ten Sugarcane Varieties under Wonji-Shoa Agro-Climatic Conditions

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ARTICLE INFO

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How to Cite this Article:
Getaneh, A., F. Tadesse and N. Ayele1. 2015. Agronomic Performance Evaluation of Ten Sugarcane Varieties under Wonji-Shoa Agro-Climatic Conditions. *The Journal of Agriculture and Natural Resources Sciences.* 2(1): 260-266.

Article History:
Received: 17 December 2014
Accepted: 17 January 2015

ABSTRACT

Field experiment was conducted at Wonji/Shoa Sugar Estate during 2007 to 2012 cropping season, to evaluate and select sugarcane varieties with better agronomic performances under Wonji/Shoa agro-ecological condition. Ten sugarcane varieties: namely DB 228/57, B 60267, CO 622, CO 678, B 4906, B 5736, CP 36/111, CP 69/1059, B 59250, and E188/56 were compared with the check variety B52 298. They were evaluated in completely randomized block design with three replications. Result indicated that none of the varieties in both light and heavy clay soil of the trials could outshine the check variety B52 298 in terms of average cane and sugar yield. However, the varieties CO 622 and E 188/56 produced higher mean cane and sugar yields (ton ha-1 month-1) than the rest variety in both light and heavy clay soil fields of Wonji/Shoa, which was at par with the check variety B52 298. Besides variety DB 228/57, B 60267 and B 4906 responded well in sugar yield for light clay soil unlike CO 678 and CP 69/1059 which was better in heavy clay soil. Therefore, the sugarcane varieties CO 622 and E188/56 in both soil; whereas DB 228/57, B 60267 and B 4906 in light soil; CO 678 and CP69-1059 in heavy soil should be verified further on large commercial fields under agro-climatic conditions of Wonji/Shoa.

Keywords: agro-ecology, Clay soil, Sugarcane, Variety, Wonji.

INTRODUCTION

In commercial cane sugar production varieties play a vital role, and other inputs, though are very essential to obtain high and improve quality, cannot bring better outputs beyond the potential limit of a variety. Obviously using superior cane cultivars is a primary requirement for maximum profitability, and in many countries substantial yield increases due to variety improvement had been achieved. According to Sundara (2000), in order to enhance productivity and profitability of commercial scale sugarcane cultivation, adoption of high yielding varieties and improved production packages are highly demanding.

There are number of reasons for lower cane yield and one of those is the planting of low yielding varieties. Therefore, it is need of the time to introduce new high yielding varieties with good ratoon ability in the country (Chattha and Ehsanullah, 2003). Variety plays a key role in both increasing and decreasing per unit area sugar yield, while use of unapproved, inferior quality cane varieties affect sugarcane production negatively as situation prevails to day (Mian, 2006). The solution of low cane yield and sugar recovery problem lies in the planting of improved cane varieties (Chattha *et al*., 2006). Efforts are being made to increase cane production by introducing high yielding varieties and adoption of improved crop production techniques (Gill, 1995).

Success of variety depends upon its adaptability to agro-climatic conditions of the area. Selection of a proper variety to be sown in a particular agro-ecological zone is a primary requisite to explore its yield and sugar recovery potential. Ratoons are important for overall profitability of sugarcane cultivation as they save about 30% in the operational cost, mainly that of seed and reduced expenses for soil management (Sundara *et al*., 1992). The inherent potential of a variety to give better yields in plant and ratoon crops is of paramount importance for sustaining high productivity.

Acceptance of a variety by the farmers now depends very much on its ratooning potential. Thus, sugarcane varieties, which show good performance in plant and ratoon crops, should be promoted for commercial cultivation.

In Ethiopia, even if the country has a fertile soil and favorable environmental condition for sugarcane production its average cane yield is limited to about 104 ton/ha/year (Sugar Corporation, 2011) this could be attributed by many factors, of which lack of improved varieties play central role. Therefore, the government has developed a strategy to import divers improved sugarcane varieties from around similar ecological locations of the glob to secure the upcoming huge development and expansion in sugar industry.

Accordingly, from the introduced materials, 10 promising sugarcane entries were promoted and tested under two soil types of Wonji/Shoa agro-ecological condition to identify elite candidate for pre-commercial release. Therefore, the present study was conducted to identify better performer variety/varieties in yield and yield components under Wonji/ Shoa agro-ecological condition.

MATERIALS AND METHODS

Site Description

The study was conducted at Wonji Sugar Estate during 2007 to 2012 cropping season, which is situated at 8°31’ N & 39°20’ E with an elevation of 1540 m.a.s.l. in the Rift Valley Region of Ethiopia about 100 km South East of Addis Ababa. It receives an annual rainfall of 831 mm, with a mean maximum and minimum temperature of 26.9 and 15.3°C, respectively.

Treatments and Design

Study was conducted at Wonji/Shoa Sugar Estate during 2006/7 cropping season. In the trial performance of 10 sugarcane varieties; namely DB 228/57, B 60/267, CO 622, CO 678, B 4906, B 5736, CP 36/111, CP 69/1059, B 59250, and E 188/56 were compared with the standard variety B52 298. The candidate sugarcane varieties are originated from Barbados, Coimbator, Canal point and the like. The experiments were laid out following randomized complete block design with four replications in heavy and light clay soil type. Each experimental plot composed 6 rows of 1.45m width and 6m length.

The central four rows of each plot were used for data collection. The spacing was 1.5m between adjacent plots, 2m between replications, and 3 meters from the border crop. Equal number of two budded setts of each variety was planted.

Data Collection and Analysis

All agronomic, insect pest and disease control measures were adopted uniformly throughout the growing season. The data for different parameters such as sprout percent, tiller number, millable canes and stalk weight were recorded and cane yield were taken at harvest on plot basis and then converted into hectares. Ten canes were randomly selected from the bulk produced in each plot for juice analysis. Finally, the collected data were subjected to General Linear Models Procedure (GLM) using SAS software statistical package (SAS, 1989) following a procedure appropriate to the design of the experiment (Gomez and Gomez, 1984). The treatment means that were significantly different were separated using the Duncan Multiple Rang Test (DMRT) at 5% levels of significance.

RESULTS AND DISCUSSION

Sprouting, Tillers, Millable Canes and Stalk Weight

Combined analysis of the data on plant cane and ratoons revealed no interaction between varieties and soil types on percent sprouting, while interaction exists in number of tillers, stalk weight and number of millable canes (Appendix table 1). Whereas, sugarcane varieties were significantly different from each other on percent sprouting, number of tillers and number of millable canes in both soil types (Table 1 and 2).

Table 1: The effect of variety on sprout, tiller, stalk weight, millable cane, cane yield, sucrose content and sugar yield over three cuttings at Wonji/Shoa on light clay soil

Varieties	Sprout (%)	No of Tillers (‘000’ ha^{-1})	Stalk weight (kg)	No of Millable canes (‘000’ ha^{-1})	Cane Yield (ton/ha/month)	ERS (%)	Sugar Yield (ton/ha/month)
B52 298	70.3^{bc}	404.42^{cd}	0.98^{ab}	122.55^{cd}	12.00^{a}	13.35^{bc}	1.596^{a}
DB 228/57	68.8^{bc}	393.42^{cd}	0.83^{c}	125.06^{cd}	11.76^{ab}	12.68^{d}	1.471^{abc}
B 60267	69.0^{bc}	336.33^{ef}	1.08^{a}	94.14^{fg}	11.79^{ab}	13.49^{bc}	1.582^{ab}
CO 622	67.3^{bc}	401.08^{cd}	0.76^{cd}	135.94^{bc}	12.00^{a}	12.70^{d}	1.504^{abc}
CO 678	69.5^{bc}	402.58^{cd}	1.02^{a}	112.87^{de}	11.21^{abc}	12.59^{de}	1.401^{bc}
B 4906	83.5^{a}	474.75^{a}	0.67^{de}	145.32^{b}	10.51^{bcd}	13.75^{b}	1.435^{abc}
B 5736	71.8^{b}	304.00^{f}	0.74^{cd}	104.73^{ef}	9.36^{de}	14.48^{a}	1.341^{c}
CP 36/111	60.3^{cd}	374.50^{de}	0.85^{bc}	128.91^{c}	11.79^{ab}	12.07^{e}	1.398^{bc}
CP 69/1059	70.5^{bc}	327.17^{f}	0.86^{bc}	87.26^{g}	8.57^{e}	13.04^{cd}	1.123^{d}
B 59 250	55.3^{d}	450.42^{ab}	0.58^{e}	168.77^{a}	10.21^{cd}	9.20^{f}	0.948^{d}
E 188/56	73.5^{a}	416.92^{bc}	0.73^{cd}	145.46^{b}	11.25^{abc}	13.36^{bc}	1.486^{abc}
CV	9	13	12	21	14	5	15

Table 2: The effect of variety on sprout, tiller, stalk weight, millable cane, cane yield, sucrose content and sugar yield over two cuttings at Wonji/Shoa on heavy clay soil

Varieties	Sprout (%)	No of Tillers (‘000’ ha^{-1})	Stalk weight (kg)	No of Millable canes (‘000’ ha^{-1})	Cane Yield (ton/ha/month)	ERS (%)	Sugar Yield (ton/ha/month)
B52 298	43.0^{ab}	254.00^{b}	1.15^{a}	101.00^{bcd}	8.63^{a}	13.96^{d}	1.192^{a}
DB 228/57	43.5^{ab}	252.75^{b}	0.79^{cd}	98.85^{bcd}	6.09^{bc}	13.30^{e}	0.812^{bc}d
B 60267	34.8^{b}	192.88^{c}	1.03^{ab}	71.00^{de}	6.02^{bc}	13.81^{de}	0.819^{bcd}
CO 622	40.3^{ab}	254.88^{b}	0.73^{cde}	101.44^{bc}	5.96^{bc}	14.15^{bcd}	0.845^{abcd}
CO 678	43.8^{ab}	185.50^{c}	0.92^{bc}	104.36^{bc}	7.69^{ab}	14.19^{bcd}	1.087^{ab}
B 4906	62.5^{a}	261.50^{b}	0.61^{de}	109.71^{bc}	5.22^{bc}	14.59^{abc}	0.758^{bcd}
B 5736	58.0^{a}	164.63^{c}	0.73^{cde}	63.79^{e}	3.89^{c}	14.71^{ab}	0.555^{d}
CP 36/111	40.3^{ab}	192.75^{c}	0.79^{cd}	93.08^{cde}	5.56^{bc}	14.09^{cd}	0.778^{bcd}
CP 69/1059	53.0^{ab}	215.00^{bc}	0.82^{bcd}	97.11^{bcd}	6.29^{abc}	14.86^{a}	0.936^{abc}
B 59250	34.3^{b}	392.50^{a}	0.52^{e}	149.49^{a}	6.06^{bc}	11.64^{f}	0.713^{cd}
E 188/56	33.3^{b}	262.00^{b}	0.76^{cd}	126.18^{ab}	7.26^{ab}	13.33^{e}	0.962^{abc}
CV	9	13	12	21	14	5	15

Percent sprouting for eleven sugarcane varieties and the difference among them are presented in Table 1 and 2. Remarkably higher percent of sprouting for all varieties were obtained from light clay than the one obtained from heavy clay (Table 1 and 2), and this result agrees with previous result reported by Worku and Chinawong (2006). Greater percent of sprouting was obtained for varieties B 4906 on both light (83.5%) and heavy (62.5) clay soils. Like sprouting significantly higher number of tillers per hectare was recorded from variety B 4906 (474.75×103) in light clay soil and variety B 59250 (392.5×103) in heavy clay soil.

Even if it has low sprouting percentage the produced tillers reaching the status of millable cane was significantly higher in B 59250 in both soil types. The increment in numbers at the early stage of growth and the reduction of stalk population during the growth of sugarcane is a characteristic of several gramineous. This reduction of stalk population (mortality of cane) could be attributed to the factors which induce competition for light, moisture and nutrient; and the survival of the tillers after the competition is a character of a variety. Thus, in the present finding the variation in survival and mortality rate could be probably attributed to the differences in the genetic makeup of the varieties (Worku and Chinawong, 2006). Moreover, from the definition the variation observed among different genotypes grown in a similar environment is termed as true genetic difference (Stoskopf *et al*., 1999).

Maximum average cane weight was exhibited in variety B 60267 in both soil type (1.08 and 1.03 kg, in light and heavy soil respectively) and Co 678 (1.02 kg) in light soil; and it gives at par results of the check variety B52 298 (0.98 and 1.15 kg, in light and heavy soil respectively). In contrast the least stalk weight was attained by B 59250 (0.58). Though significantly higher number of millable canes per hectare was registered in B 59250 in both soil types the low value of its stalk weight contributed to minimal average cane yield (Table 1 and2). It is evident from the two soil type data that the varieties having heavy stalk weight (i.e the result of thicker plants and larger cane height) with sufficient millable canes produced higher yields during both soils of planting, while the varieties with lowest yield contributing traits resulted into reduced yield. Khan *et al*, (2003) reported that increase in cane yield might be due to maximum plant height, weight per stool and cane girth. Nazir *et al*., (1997) reported that higher cane yield is the function of high potential variety. Javed *et al*., (2001) reported that cane yield tonnes per hectare depend upon number of stalks per hectare and weight per stalk. Weight per stalk consequently depends upon stalk length and stalk girth. Sharma and Agarwal (1985) suggested that good germination and tillering with synchronized millable canes of average thickness are desired selection parameters to evaluate the agronomic performance of sugarcane varieties.

Cane Yield, Estimated Recoverable Sugar (ERS), and Sugar Yield

Combined analysis of the data on plant cane and ratoons revealed an interaction between varieties and soil types on cane yield, ERS and sugar yield (Appendix table 1). Whereas, sugarcane varieties were significantly different from each other on cane yield, ERS and sugar yield in both soil types (Table 1 and 2). In light clay soil, variety B 5736 was rich in ERS (14.48%) than other varieties, while in heavy clay soil variety CP 69/1059 (14.86%), B 5736 (14.71%) and B 4906 (14.59%) was significantly superior in ERS than the rest varieties but at par with the check variety B52 298.

Except lower values of B 4906, B 5736, CP 69/1059 and B 59250 for light clay soil, DB 228/57, B 60/267, CO 622, B 4906, B 5736, CP 36/111 and B 59250 for heavy clay soil, the total tonnage of the cane per hectare per month of sugarcane varieties were not significantly different from the check variety B52 298 (Table 1 and 2). Variety CO 678 and E 188/56 have got the highest ton per hectare per month cane yield consistently over the two soil type (Table 1 and 2). Except CO 678, B 5736, CP 36/111, CP 69/1059, and B 59250 for light clay soil, DB 228/57, B 60267, B 4906, B 5736, CP 36/111 and B 59250, the total tonnage of sugar yield per hectare per month of sugarcane varieties were not significantly different from the check variety B52 298 (Table 1 and 2). Variety B 59250 (0.948 ton/ha/m) in light and B 5736 (0.555 ton/ha/m) in heavy clay soil produced the least sugar yield (ton/ha/m) compared to any other variety (Table 1 and 2). While sugar yield is the product of cane yield and ERS, due to their marginally significant difference of some varieties the variation among them could eliminate in the final product i.e. sugar yield. That means, result of mean separation analysis for sugar yield, which is a product of cane yield and ERS, becomes marginally significant or the reverse when the significance level of the two or either of the two factor components was also marginal for significance or for the none significance. Generally, it was learnt that it goes so because of rounding effects which generally rounds numbers up or down to the nearest real digits.

The higher cane yield and sugar content in the varieties might be due to the heavy bearing tendency of these varieties and their adaptability to the climatic conditions of Wonji/Shoa. In addition to that, the inherent genetic makeup of a variety might have contributed towards higher and lower cane yield and sugar content in both soil types. Genetically improved varieties may bear ability to produce satisfactory results for per hectare yield and sugar percentage under given set of environmental conditions. EL-Geddway *et al*., (2002) stated that sugarcane varieties are greatly affected by genetic makeup. According to Keerio *et al.*, (2003) unless the genetic potentialities of a variety are high, mere provisions of growing conditions such as manuring, irrigation etc. will not lead to appreciable improvement in cane or sugar yield.

Generally, the mean values of sugar yield of the three cuttings (Table 1 and 2) indicated that, even if at par with the check variety B52 298; among the evaluated ten sugarcane varieties CO 622 and E188/56 were the best performing varieties in both soil types' viz. light and heavy clay. Besides, DB 228/57, B 60267 and B 4906 in light and CO 678 and CP 69/1059 in heavy soil were also outstanding sugarcane varieties in sugar yield. According to Worku and Chinawong (2006) different performances of the same variety on distinct two soil types might have been attributed to the differential response potential to the environment in which it was grown. In agreement with this result Dillewijn (1952) and Kakde (1985) reported that the differences in the ability of a variety to extract nutrients from different soil types affected its potential to grow under a given soil condition. Better performance of some varieties on both soil types could perhaps indicate their wide adaptation to different soil types.

Appendix Table 1: Analysis of variance for different parameters of 10 sugarcane varieties grown at 2 soil types

Source of variation	DF	No of tillers	Stalk weight	No of Millable Canes	Cane Yield	Sucrose % Cane	Sugar Yield
				Light soil			
Variety (V)	10	***	***	***	***	***	***
Cutting (C)	2	***	***	***	***	***	***
V * C	20	Ns	Ns	Ns	Ns	Ns	Ns
				Heavy soil			
Variety (V)	10	***	***	***	*	***	***
Cutting (C)	2	***	***	Ns	Ns	***	Ns
V * C	20	Ns	Ns	Ns	Ns	Ns	Ns
Variety * soil	20	***	***	***	***	***	***

CONCLUSION

It was observed that none of the varieties in both light and heavy clay soil of the trials could outshine the check variety B52 298 in terms of average cane and sugar yield. However, the varieties CO 622 and E118-56 produced higher mean cane and sugar yields (ton ha-1 month-1) than the rest variety in both light and heavy clay soil fields of Wonji/Shoa, which was at par with the check variety B52 298. Besides variety DB 228/57, B 60267 and B 4906 were found promising in light soil in sugar yield, while CO 678 and CP 69/1059 were better in heavy soil. Therefore, the sugarcane varieties CO 622 and E 188/56 in both soil; whereas DB 228/57, B 60267 and B 4906 in light CO 678 and CP 69/1059 in heavy soil need to be verified further on large commercial fields under agro-climatic conditions of Wonji/Shoa.

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