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Effect of Intra row sett spacing on Growth and Yield of Early Maturing Sugarcane Varieties (Cuba Origin -2003 Entry) as Influenced by Ethephon at Metahara Sugar Estate, Ethiopia

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Abstract

A field experiment was conducted in 2016/17 cropping season on plant cane crops at Metahara sugar state to determine optimum population density under different intra row spacing and to observe ethephon effect on growth parameters. Factorial combination of five varieties and three intra row sett spacing were laid out in RCBD with three replications. Equal amount of ethephon was applied for treated plots during planting similarly untreated plot also planted and replicated three times. The growth parameters yield and yield components of sugarcane were significantly affected by the varieties except sprout percent and sugar yield. Except tiller count and number of millable stalk all the parameters considered did not show significant variation under different intra-row set spacing. Ethephon application at planting does not increase sprout percent, tiller count and stalk heights. Sett spacing influenced neither cane yield nor sugar yield. Based on the partial budget analysis it can be recommended that since no statistical difference was observed for sugar yield among the tested varieties and intra row set spacing the relative profitability were selected based on comparing the variable costs. Therefore, end to end planting, the one with the minimum variable cost, is recommended for the test varieties in the study area.

Keywords: Set spacing, Ethephon, variable cost

1. Introduction

The increase in sugar production has largely come about as a result of introduction or adaptation for higher cane yield, sugar content and disease resistance varieties. At Metahara condition, due to the decrease in age of harvest for the late maturing commercial varieties, the factory starts to face yield reduction as well as risk of cropping cycle for the future harvest campaign. For this matter, the expansion of these early maturing, high sucrose content varieties are imperative not only for increasing productivity per hectare per month due to time value but also vital strategy for maintaining cropping cycle. At the present time, Metahara Sugar Factory, Agricultural operation expanding of these early maturing Cuba varieties but some problems have been observed in some of the varieties when planted at large scale. Some of these problems are relatively low number of millable stalk at harvest and difficulties in mechanical operation especially during moulding (personal communication and observation)

Improper intra- row spacing, set position and seeding density are the most critical factors reducing sugarcane yield (Bashir *et al.*, 2000; Muhammad, U.C., 2007).

Both sub-optimal seeding density and improper intra-row spacing result in low plant population density and hence less number of millable canes per unit area which is the key component of cane yields (Bashir *et al.,* 2000; Mahmood *et al.,* 2005). Seeding density directly affects the number of stalks, stalk length and stalk diameter which are positively associated with cane yield per unit area (Nazir *et al.,* 1999). Optimum planting density is importance to obtain optimum sprouts for an adequate initial stand establishment consequently for higher yield of sugarcane.

Of the many variables involved in the production of sugar and the yield from cane plant, probably the most significantly related factor is the number of millable canes (stalks) per unit area of land at harvest (Rahaja 1954). Although, length and girth (thickness) of canes also influenced yield but with a lesser degree (Yadav and Sharma, 1978). Among these three attributes; the number of millable stalks and cane length could be altered by modifying the micro-environment and providing optimum conditions to plant for growth. The girth, being genetically controlled. Many agronomical studies, therefore, have aimed to increase the number of millable stalks at harvest than to alter girth and length of canes. It holds true that, because as per present indications one of the limiting factors for the newly introduced sugar cane varieties yield is the number of millable stalks per hectare. If these could be increased by certain suitable agro-techniques, the potential yield of this sugar cane varieties could be easily be achieved. Nestanet *et al*, 2014 recommended that the intra-row spacing of 10 cm between setts for the late maturing varieties B52298, Nco334 and N14 should be used instead of the conventional ear-to-ear (5 cm overlapping) setts intra-row spacing. But it does not hold true for some of the early maturing sugar cane varieties (Cuba Origin) due to the nature of the varieties to compensate the wider spacing, consequently, affects the number of millable stalks at Metahara condition (personal communication and observation).

The application of ethephon is a technology used throughout the sugarcane growing world to regulate growth in many ways: flowering, tillering, germination, and stalk maturation (Solomon et. al, 2003; Li, Yang Rui and S. Solomon, 2003). *Ethephon* @ 500 ml/ha showed improved germination of sugarcane setts with relatively better tillering potential. Lewis, 2006 indicated that the characteristics of ethephon that can have significant impact on sugarcane relate to its ability to improve germination rate and tillering.. In India, the application of ethephon was found to promote seed cane sprouting (13-17%), and improved tillering and millable cane formation (12-16%). Some studies also indicated that ethephon treated sugarcane plants were efficient to hold up growth process regarding height of plants, but had no effect on diameter of stalks and did not affect the number of plants per meter at harvest and did not cause quantitative alterations in the mass of stalks per hectare. Application of ethephon in the furrow on seed pieces before covering tends to be the most effective in increasing shoot counts and heights (Wiedenfeld, 2003).

At Metahara Sugar Estate a major factor that drive sugarcane productivity for the early maturing sugarcane varieties (Cuba origin) is unpleasant germination of cane setts or sprouting and consequently low plant population densities in the semi-commercial fields. Above information suggests that maintenance of optimum plant population density can substantially increase cane yield per hectare, nevertheless the information on optimum plant population is lacking for the newly introduced early maturing Cuba varieties in the literature. Therefore, this Advisory proposal is initiated to determine optimum population density under different intra row spacing and to observe the effect of ethephon on growth parameters for the newly introduced sugar cane varieties (Cuba –origin 2003 entry) under Metahara condition.

2. Materials and Methods

2.1 Description of the Study Area

Metahara is located at the central part of East African Rift Valley at about 200 Km South East of Addis Ababa. The Estate is situated at $8^0$51' N and $39^0$12' to $39^0$52' E with an altitude of 950 meters above sea level. It has long term mean annual rain fall of 554 mm and mean annual maximum and minimum temperatures of 32.6 ^{O}C and 17.5 ^{O}C, respectively.

2.2 Treatments and Experimental Design

Factorial combination of five Cuba varieties; SP70-1284, C86-165, C86-56, C132-81 and C90-501 and three intra row sett spacing; 10 cm between setts, setts placed end to end and setts placed ear-to ear (5 cm overlapping) were laid out in Randomized Complete Block Design with three replications.

A field experiment was conducted in 2016/17 cropping season on plant cane crops at Metahara sugar state plantation field. Planting was carried out on light to medium textured soils. The plot size was 5 m length and 8.7 m width having an area of 43.5 m^2 for a single plot (six furrows of 5 m length and 1.45 m width). The net plot area used for data collection was 29 m^2 (four furrows of 5 m length and 1.45 m width). The distance between adjacent plots and replications were 1.5 and 2.9 meters, respectively. For each variety healthy stalks of 8-9 months of age was used as seed cane source and three budded setts were prepared from the same portion of seed cane, i.e., the middle of the stalk for planting.

For treated plot equal amount of ethephon was applied in each plot for the tested five varieties using end to end planting for observation during planting and replicated three times. Untreated plot also planted in end to end planting pattern replicated with three times. Ethephon was applied with a 15 liter Solo knapsack sprayer fitted with a Teejet TF-VP5 (flood jet) nozzle in the furrow on seed pieces before covering; recommended rate of 119gm ha^{-1} was used. In one liter ethephon 480gm a..i is obtained, for the experiment 23.3gm needed which is 50 ml. for each plot **1.1ml** of ethephon was applied. Pre and post planting management practices was carried out based on the standard of the estate except sett spacing.

2.3. Data Collection and Analysis

Number of set per plot was counted during planting before soil covering and sprout percentage also calculated based on bud count (sett) during planting at 45 days after planting. Tiller count was recorded at 3 and 5 month after planting and population count data were recorded starting from the 4th month of planting until the plant age of 9 months. Plant height was measured from ten randomly selected stalks from the middle three rows by measuring the length from the soil surface to the top visible part after harvest. Stalk girth (diameter) was determined during harvest time from three cane positions (top, middle and bottom internodes) from 10 millable stalks on each plot using a caliper and the average result was taken for analysis. Then diameter will be converted to cane girth by using the following formula (Mali et al., 1982). Cane girth (cm) = diameter (cm) x 22/7.

The total number of millable stalks from a net plot of 34 m^2 (four furrows of 6 m length and 1.45 m width) was counted during harvest at the age of 10 months. An average cane weight of 20 stalks was taken per plot at harvest. Cane yield was estimated by multiplying the total number of millable canes from a net plot of 34 m^2 (four furrows of 6 m length and 1.45 m width) with average weight of a single stalk taken from 20 sample millable stalks using weighing balance. Then, commercial sugar yield per hectare was estimated as the product of cane yield per hectare and estimated recoverable sugar.

For cane quality analysis, juice was extracted from 10 stalk samples using a sample mill. Percent soluble solids (brix %), Percent pol (pol %), Juice purity and Percent recoverable sucrose were calculated using ICUMSA (1994) method the Winter Carp indirect method of cane juice analysis (Kassa, 2010): For economic analysis of the main effects, simple partial budget analyses approach (CIMMYT, 1988) was employed to observe the economic feasibility of varieties and intra row set spacing.

The collected data were subjected to analysis of variance using SAS software (SAS Institute, 2002). The treatment means that were significantly different were separated using the Least significant difference (LSD) at 5% levels of significance. For ethephon observation Data were subjected to analyze by using GenStat 17th edition student's t test procedure for unpaired mean that is two sample t-test on treated vs. untreated samples.

3. Results and Discussion

3.1 Effect of intra- row set spacing on yield and yield component of early maturing cuba varieties

The results obtained for Yield and yield components of sugarcane under different intra-row set spacing treatments are shown in table 1and 2. Tiller count before moulding, stalk diameter, number of millable stalk, single stalk weight and cane yield (Q/ha) was significantly ($P< 0.001$) affected by the main effect of varieties but sprout percent and sugar yield (Q/ha) did not show significant variation. Similarly, except tiller count and number of millable stalk all the parameters considered were not show significant variation on the main effect of intra- row set spacing. The interaction effect of varieties and intra –row set spacing also did not show significant variation for all the parameters measured (Table 1 and 2).

The maximum mean value of tiller count before moulding was recorded from the variety C131/81 followed by C86/56 and C86/165 where as the least number of tiller count was obtained from the variety C90/501 followed by SP70/1284. This variation might be due to the genetic variability of the varieties to generate tillers. On the other hand, the highest mean value of tiller count was obtained from 5 cm overlapping followed by end to end planting pattern while the least mean value was recorded from 10 cm spacing. This variation might be due to high density planting favors for more number of tillers. The present study also in agreed with Bashir et al. (2000) there is a positive relationship between seeding density and tiller number of sugarcane. Similarly, Raskar and Bhoi, (2003) reported that high density planting might have enhanced proliferation of more tillers. On the contrary, Verma, 2004 indicated that high density planting reduces the number of tillers produced per each planting material due to mutual shading and competition for light, nutrients, and water. From the present study it can be observed that the population dynamics was showed a sharp declining trend after moulding. From the present investigation it could be found that around 40 % the tiller were damaged during moulding due to heavy earthing up actually buried small tillers and test out further formation of new tillers to be millable stalks. Netsanet et al (2014) noted that after earthing-up, the population remained more or less stable indicating minimum rates of stalk mortality. In agreement with this result, Sundara (2000) also stated that earthing-up checks further tillering.

Table 1.Mean Comparison of, sprout percent, tiller count and girth of early maturing cuba varieties as influenced by intra-row set spacing on medium textured soil at MSE in 2016/17 cropping season

Treatments	Sprout percent	Tiller count before moulding (‘000)	Stalk diameter(cm)
Varieties			
SP70/1284	66.7	130.6^{b}	3.15^{ab}
C86/56	68.5	182.4^{a}	3.01^{c}
C132/81	73.6	185.9^{a}	3.25^{a}
C90/501	70.7	126.2^{b}	3.09^{bc}
C86/165	72.6	179.8^{a}	3.23^{a}
LSD (5%)	**ns**	**17.87**	**0.116**
Set Spacing			
5 cm overlapping	68.8	172.3^{a}	3.14
End to end	72.1	163.7^{a}	3.12
10 cm between sets	70.4	147.1^{b}	3.18
LSD (5%)	**ns**	**13.8**	**ns**
CV (%)	14.3	11.49	3.82

Means with the same letter within a column are not significantly different from each other by LSD (P< 0.05).

Stalk diameter was significantly affected by the main effects of variety but not spacing and their interaction (Table 1). The maximum mean value of stalk diameter (3.25cm) was recorded from the variety C132/81 followed by C86/165 (3.23cm) and the minimum stalk diameter value (3.01cm) was obtained from the variety C86/56 followed by C90/501(3.09 cm). In consistence with this study Yadav and Sharma, (1978) reported that girth (thickness) of canes influenced yield with a lesser degree since it is being genetically controlled. In agreement with this study Hunsigni (1993) as cited by Netsanet et al (2014) noted that a varietal difference in stalk girth is observed. On the other hand, from the present study significant variation was not observed from different intra row set spacing on stalk girth but Hunsigni (1993) who stated that higher stalk girth is observed under wider spacing than narrow spacing. According to Rao (1990), as cited by Netsanet et al (2014) tillering per clump is more and canes are thicker under wider spacing while in closer spacing, tillering per clump is less and canes were thinner under narrow spacing. Similarly, however, the non significant variation among intra row set spacing on girth of the newly introduced early maturing Cuba varieties might be attributed to the less contribution of modifying the micro-environment and providing optimum conditions like intra-row spacing to plant for growth to increase thickness of the plant since girth is being genetically controlled trait.

Number of millable stalk was significantly affected by the main effect of varieties and intra row set spacing but not their interaction (Table 2). The maximum mean value of millable stalks /ha was recorded from the variety C86/56 (112,000) followed by C132/81(93,900) and C86/165 (91,600) where as the minimum value was obtained from SP70/1284 (84,600). The variations among the varieties on millable stalk attributed to the genetic potential of the varieties to generate more tillers and consciously increased number of millable stalks. Similarly, Feyissa et al. (2008) also observe differences in stalk population among sugarcane varieties.

The result revealed that end to end planting recorded the highest millable stalk (95,100) followed by 5 cm overlapping (94,700) where as the least millable stalk (89,500) was obtained from 10 cm set spacing. The low number of millable stalk from 10 cm spacing for early maturing Cuba varieties might be attributed to improper intra- row spacing which result in low population density and hence less number of millable canes per unit area which is the key component of cane yields. In addition, it might be the suboptimal density planting results in a loss of yield due to inefficient use of the land space. In agreement with this study, Nazir *et al.*, 1999 reported that plant density directly affects the number of millable stalks, stalk length and stalk diameter which are positively associated with cane yield per unit area. Similarly, Netsanet et al (2014) reported that intra-row spacing influences number of millable canes in which high density planting rates result in higher number of millable canes than low density plantings. Preecha (2006) also found that numbers of millable canes per unit area is influenced by plant spacing.

Table 2.Mean Comparison of yield and yield component of early maturing cuba varieties as influenced by intra-row set spacing on medium textured soil at MSE in 2016/17 cropping season

Treatments	**Number of millable stalk/ha (‘000)**	**Single stalk weight (kg)**	**Cane yield(Q/ha)**	**Sugar yield (Q/ha)**
Varieties				
SP70/1284	84.6[c]	1.89[a]	1589.3[b]	190.4
C86/56	112[a]	1.72[b]	1929.9[a]	197.1
C132/81	93.9[b]	2.03[a]	1914.4[a]	193.4
C90/501	83.3[c]	1.94[a]	1618.6[b]	189.9
C86/165	91.6[b]	1.91[a]	1755.1[ab]	186.4
LSD (5%)	57.5	0.17	206.56	ns
Set Spacing				
5 cm overlapping	94.7a	1.92	1815.7	198.5
End to end	95.1a	1.85	1755.4	191.7
10 cm between sets	89.5b	1.93	1713.3	184.2
LSD (5%)	4.4	ns	ns	ns
CV (%)	6.39	9.33	12.14	13.03

Means with the same letter within a column are not significantly different from each other by LSD (P< 0.05).

Single stalk weight was significantly ($P \leq 0.05$) affected by the main effect of varieties. However, set spacing and their interaction effect were not significant (Table 2). The maximum mean value of single stalk weight (2.03kg) was recorded from the variety C132/81 but significant variation was not observed from SP70/184, C86/165 and C90/501. C86/56 recorded the minimum value of single stalk weight (1.72kg). Netsanet and Samuel (2014) reported that the highest mean weight per stalk is obtained in 20 cm intra-row spacing followed by the 10 cm intra-row spacing and end-to-end spacing which were not differed significantly. Similarly, the present study showed that end to end and 10 cm spacing did not show significant variation on single stalk weight.

Cane yield Q/ha was significantly (P<0.01) affected by the main effect of varieties but intra row set spacing and their interaction effect did not show significant variation (Table 2). Variety C86/56 recorded the highest cane yield (1929.9Q/ha) followed by C132/81 (1914.4Q/ha). Variety SP70/1284 recorded the minimum cane yield (1589.3Q/ha) which was not significantly variable with the variety C86/165 and C90/501. According to Somro et al. 2006, as cited by Abiy Getaneh 2016, the presence of variation of cane yield among varieties indicated the difference in their inherent yielding ability.

Statistically no significant variation was observed among different intra-row spacing on cane yield; the mean value of cane yield /ha was higher in 5 cm overlapping followed by end to end planting for the newly introduced early maturing Cuba varieties. Furthermore, the current result indicated that planting at a high density may not necessarily result in a correspondingly significant high yield under the normal growth and management conditions. On the other hand, suboptimal density planting results in a loss of yield due to inefficient use of the land space (Azhar et al., 2007). Moreover, the presence of variation on the different early growth parameters like tiller count and millable stalk did not affect the final major yield component cane yield. Similarly, the differences in the number of millable canes due to the treatments in the plant cane were not reflected in the cane yield. This indicates that naturally sugarcane has a high compensating ability to maintain potential yield under different cases of spacing and population density (Netsanet et al. 2014). Moreover, previous studies conducted on at the Wonji-Shoa and Finchaa Sugar Estates in Ethiopia revealed a similar result (Tsehay, 1993; Worku, 2001; Netsanet et al, 2012). This means a widely-spaced planting compensate for the low stalk population. The presence of adequate incident sunlight might have resulted in high photo assimilate production and partitioning of dry matter in the wider spaced planting, thereby avoiding diversion of carbohydrate away from the stalks. This may be attributed to the phenomenon that where sunlight quality and intensity are limiting, cane yield reductions arise due to the diversion of photosynthate away from the primary stalks (Amolo and Abayo, ND; Nayamuth and Koonjah, 2003). In addition, Netsanet et al, 2012 recommended that intra-row spacing of 10 cm between setts for late maturing varieties (Nco334, B52/298 and Mex.245) ensures economy of planting material without sacrificing both cane and sugar yields. On the contrary the present study observed that for early maturing Cuba varieties using intra row set planting of 10 cm economically not assured.

3.2 Effect of intra- row set spacing on quality parameters of early maturing cuba varieties

The analysis of variance indicated that all the quality parameters; ERS, Pol % ^{o}Brix and purity were significantly (P<0.001) affected by the main effect of varieties. However, the main effect of spacing and its interaction with variety did not have a significant influence on all quality parameters considered (Tables 3).

The highest recoverable sucrose percent value (11.96) was recorded from the variety SP70/1284 followed by C90/501 (11.74) where as C132/81 recorded the lowest value (10.11) and not significant variation from C86/56. In agreement with current finding Feyisa et al (2014) reported that there is a difference among the early maturing Cuba varieties in all the quality parameters. Similarly, Tsehay (1993) also found difference among varieties in percent recoverable sucrose.

On the other hand, the highest Pol % (19.36) and Brix (19.36) was recorded from the variety C90/501 followed by SP70/1284 (17.33) and (19.38) respectively where as the minimum value of Pol % (14.08) and Brix (15.69) recorded from C86/56 and C132/81 respectively. In general, variety C90/501 and SP70/1284 superior in all the quality parameters considered except purity where as C86/56 recorded significantly highest millable stalk but sugar yield was no significant among the early maturing varieties this might be attributed to variety that have more number of millable cane recorded relatively low recoverable sucrose percent resulted in comparable sugar yield for each varieties.

All the quality parameters considered in this study did not show significant variation among different intra row set spacing. This result substantiates that of Sundara (2003) who reported that sett spacing did not affect sucrose content. Similarly, previous experiments conducted at the Wonji-Shoa Sugar Estate also indicated that can sucrose percent was not affected by sett spacing (Tsehay, 1993).

Table 3.Mean Comparison of sprout count, sprout percent and tiller count of early maturing cuba varieties as influenced by intra-row set spacing on medium textured soil at MSE in 2016/17 cropping season

Treatments	ERS (%)	Pol (%)	^{0} Brix	Purity (%)
Varieties				
SP70/1284	11.96^{a}	17.33^{a}	19.38^{a}	89.18^{ab}
C86/56	10.19^{bc}	14.08^{c}	15.69^{c}	88.02^{c}
C132/81	10.11^{c}	14.63^{bc}	16.42^{bc}	89.39^{ab}
C90/501	11.74^{a}	17.25^{a}	19.36^{a}	88.84^{bc}
C86/165	10.65^{b}	15.24^{b}	16.89^{b}	90.18^{a}
LSD (5%)	0.52	0.72	0.76	1.13
Set Spacing				
5 cm overlapping	10.96	15.79	17.69	89.4
End to end	11.01	15.75	17.54	88.83
10 cm between sets	10.81	15.58	17.42	89.15
LSD (5%)	ns	ns	ns	ns
CV (%)	4.88	4.73	4.47	1.32

Means with the same letter within a column are not significantly different from each other by LSD (P< 0.05). ERS: recoverable sugar

Table 4. T- test result for growth parameters of early maturing sugarcane varieties on light textured soil at MSE in 2016/17

Ethephon application at the rate of 119gm ha^{-1}									
Variety	**Variates**	**Treated plot**		**Untreated plot**					
		Mean	**SD**	**Mean**	**SD**	**95% CI for Mean Difference**	**t**	**df**	**p**
SP70/1284	Sprout percent	67	2.0	69	1.73	-6.241 to 2.241	1.31ns	4	0.261
	Tiller count(‘000)	130.6	11.78	131.1	7.76	-23.04 to 22.18	-0.05ns	4	0.960
	Stalk height (m)	2.29	0.045	2.28	0.06	-0.1180 to 0.1247	0.08ns	4	0.943
C86/56	Sprout percent	68.7	7.02	67	9.64	-17.46 to 20.79	0.24ns	4	0.821
	Tiller count(‘000)	182.5	13	180.7	9.08	-23.56 to 27.29	0.2ns	4	0.848
	Stalk height (m)	2.28	0.02	2.26	0.04	-0.06015 to 0.1001	0.69ns	4	0.527
C132/81	Sprout percent	73.7	6.66	72.7	6.66	-14.09 to 16.09	0.18ns	4	0.863
	Tiller count(‘000)	185.9	12.19	179.5	9.98	-18.79 to 31.72	0.71ns	4	0.516
	Stalk height (m)	2.28	0.07	2.31	0.01	-0.1374 to 0.09077	0.57ns	4	0.601
SP70/1284	Sprout percent	67.3	8.5	70.3	9.3	-23.19 to 17.19	-0.41ns	4	0.701
	Tiller count(‘000)	126.2	11.72	132	12.05	-32.7 to 21.17	-0.59	4	0.584
	Stalk height (m)	2.26	0.12	2.25	0.13	-0.2834 to 0.2967	0.06ns	4	0.952
C86/165	Sprout percent	72	7.55	75	14.8	-29.63 to 23.63	-0.31ns	4	0.77
	Tiller count(‘000)	179.8	6.59	178.2	9.1	-16.42 to 19.62	0.25ns	4	0.817
	Stalk height (m)	2.14	0.185	2.13	0.189	-0.4119 to 0.4386	0.09ns	4	0.935

ns = non-significant differences between the means

3.3 Response of ethephon on growth parameters of early maturing sugar cane varieties

Growth parameters like sprout percent, tiller count and stalk height as influenced by ethephon are presented in Tables 4 for early maturing sugarcane varieties studied on light textured soil. The results of the t test revealed that no significant variation was observed among the growth parameters considered on ethephon application. According to Wiedenfeld B. (2013), ethephon application in-furrow tended to be the most effective at increasing shoot counts and height. Eiland,B. (1985) also indicated that ethephon application to the seed pieces in-furrow at planting at the standard seed cane planting rate tended to increase shoot on some cultivars. Previous study also noted that ethephon application to seed cane in-furrow at planting is effective in increasing tillering, but natural declines in shoot population when stalk growth rates were highest eliminated any benefit except where very low seed cane planting rates were used.

Other studies on ethephon application showed that an experimental field treated with 500, 750, and 1000 ml/ha of ethephon showed a tendency to increase number of tiller/m, and at the same time reduce plant height. In some cases when number of tiller/m increases, tiller attrition rates also increase. In a sense, the increase in population achieved by early tillering is negated by competition at stalk formation. It may be concluded that ethephon treatment is only advantageous when plant population density is suboptimal. Moreover, the application of ethephon is found to promote seed cane sprouting (13-17%), and improved tillering and millable cane formation (12-16%). Similar observations in Jamaica indicate increased tillering in plots treated with 500, and 750 ml/ha (Lewis, 2006). In Hawaii, ethephon caused an increase in the number of tillers in the media containing 50 ppm and 100 ppm of the growth regulator (Moore et al, 1989).

The present observation on ethephon application for the early maturing sugar cane varieties; SP70/1284, C86/56, C132/81, C90/501 and C86/165 were not showed significant variation on sprout percent, tiller count and stalk height. This might be attributed to the less response of the varieties to ethephon, rate of ethephon used and the ideal environment and management practice applied for sugarcane in the test area. Wiedenfeld B. (2013) noted that ethephon application in-furrow at planting had very little effect on shoot counts and stalk height for some cultivars which may have been less responsive to ethephon. Similarly, Zhang et al. (2001a) reported that the effect of ethephon on germination and plant growth might be variety-dependent.

3.4. The partial budget analysis for intra-row set spacing on early maturing sugarcane varieties

For economic analysis the only cost vary among the intra row set spacing was seed cane preparation cost, the remaining production cost is constant which is 660 birr and for gross benefit calculation 1400 birr was used. The result of partial budget analysis for intra row set spacing revealed that 10 cm set spacing was dominated (Table 5). Therefore, marginal rate of return of the two none dominated intra row set spacing (5 cm overlapping and end to end planting) were analyzed. Accordingly, the MRR attained for 5 cm overlapping and end to end planting were 104.2 and 103.5 % respectively (Table 5). This means that for every 1.00 Birr invested the state can expect to recover the 1.00 Birr, and obtain an additional 1.04 and 1.023 Birr respectively. Moreover, those two intra set spacing planting pattern gave the maximum mean value of sugar yield (Q/ha) (Table 2).

The marginal rate of return obtained for the variety C86/56 and C132/81with 5 cm overlap and end to end planting were above the CIMMYT's (1988) minimum acceptable rate of return of 100%. According to CIMMYT (1998) the treatment with the highest net benefit together with an acceptable MRR is being accepted as a recommendation. In view of the fact that, no statistical difference was observed for sugar yield among the tested varieties and intra row set spacing the relative profitability were selected based on comparing the variable costs. For that reason, end to end planting, the one with the minimum variable cost, is preferred (Table5).

Table: 5. Partial Budget analysis on sugar yield as influenced by early maturing sugar cane varieties and intra-row set spacing

Treatments	Adjusted Sugar yield (Q/ha)	Gross field benefit (Birr/ha)	Variable Cost (Birr/ha)	Net Benefit (Birr/ha)	Chang in Net benefit	MRR %
Variety						
C86/165	149.12	208768	98419.2	110348.8 D		
C90/501	151.92	212688	100267.2	112420.8		
SP70/1284	152.32	213248	100531.2	112716.8 D		
C132/81	154.72	216608	102115.2	114492.8	2072	112.1
C86/56	157.68	220752	104068.8	116683.2	2190.4	112.1
Set spacing						
10 cm between sets	147.36	206304	96957.6	109046.4 D		
End to end	153.36	214704	101217.6	113486.4	4440	104.2
5 cm overlapping	158.8	222320	105108	117512	4025.6	103.5

5. Conclusion and Recommendations

From the present investigation it can be observed that the growth parameters, yield and yield components of sugarcane were significantly affected by the tested varieties except sprout percent and sugar yield (Q/ha). Similarly, except tiller count and number of millable stalk all the parameters considered did not show significant variation under different intra- row set spacing. Variation of cane yield among the tested varieties observed due to the difference in their inherent yielding ability where as sugar yield didn't show a variation among the varieties

The results of the t test revealed that ethephon application in-furrow at planting on sugarcane does not increase sprout percent, tiller count and stalk heights on the tested varieties might be due to the less response of the varieties to ethephon, rate of ethephon used and the ideal environment and management practice applied for sugarcane in the test area. Application of ethephon indicates a distinct possibility that to improve field stand especially where germination is less than ideal, the evidence however, is not as pronounced as that reported from different literatures. Sett spacing influenced neither cane yield nor sugar yield. But increasing trend of numerical mean value of cane and sugar yield was observed in 5 cm overlapping followed by end to end planting. Based on the partial budget analysis it can be recommended that, since no statistical difference was observed for sugar yield among the tested varieties and intra row set spacing the relative profitability were selected based on comparing the variable costs. For that reason, end to end planting, the one with the minimum variable cost, is recommended for the test varieties for the study area under ideal condition.

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