STUDY ON ROW DISTANCE AND PLANTING METHOD OF SUGARCANE CULTIVATION IN HAU GIANG PROVINCE

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ABSTRACT

Planting sugarcane in high density is a traditional culture method, which possibly reduces yield and quality of sugarcane in Hau Giang province. This is one of factors that increases the input costs and makes unstable economic efficiency. The experiment on row distance and planting method of sugarcane was conducted in Hau Giang province. QD 13 variety was used in the study. This experiment was set into two row distance (1m and 1.2m), and three planting methods including separating 20 centimeters, queue up and quincunx to find out row distance and economic planting method. The results showed that sugarcane planted with 1.2 m for row distance and quincunx style had higher yield than other treatments.

Keywords: *sugarcane, QD13, row distance, planting method, density, height, Birx.*

INTRODUCTION

Sugarcane, *Saccharum officinarum* L. (Monocotyledonae: Poaceae) occupies an area of 20.42 million hectares worldwide. These varieties become the earliest production industries, which have high sucrose content (Bakker 1999). Their production is about 1.333 million tons and suporting more than 50% demand of sugar over the world (Monique Hunziker *et al.*, 2009).

In Vietnam, sugarcane has been growing for a long time throughout the country from Lang Son to Ca Mau. However, there are many reasons such as cultivation techniques, varieties, planning, investment... that make yield and income of the sugarcane are unstable in recent years. Not only the impact of supply and demand, but also limited techniques of the majority of farmers. High investment costs, productivity, inadequate quality make the cost of sugarcane production higher, therefore, it is hard to compete with other countries in the regional area and in the world. The cultivated area and production of sugarcane in Hau Giang province are the highest in the Mekong Delta, and it is the main income of thousands of farmers in this province. They have experience about sugarcane planting for 40-50 years. However, the traditional methods of producing, scattered acreage, yield and quality of sugarcane are not yet improved, therefore, economic efficiency is not really stable.

During the World Trade Organization system, the competition of agricultural products increases fiercely. Therefore, application of scientific techniques is a requirement for the farmers to improve productivity, quality and to reduce production costs in order to achieve the highest economic efficiency (Le Van Tam, 2006). Currently, there are no more researches in pest management and cultivation have been studied intensively in Mekong Delta region, particular in Hau Giang province.

The aim of this experimental research is to make the increasing productivity and quality of sugarcane, as well as improve economic efficiency for producers and contribute to sustainable development of raw sugarcane area of Hau Giang province in particular and Mekong Delta in general. In addition, the pupose of this study was determination of the row distance and planting method suitable for sugarcane in Phung Hiep - Hau Giang.

MATERIALS AND METHODS

The experiment was started from January 2011 to November 2011 in Hiep Hung

commune, Phung Hiep district, Hau Giang province. The sugarcane variety was QD 13 (*Saccharum officinarum* L.). This variety of the same age (6-9 months old) was clean of pests, and not bruised, and stalks are then cut into short segments (within three eyes germ) were used as planting materials

The experiment was laid out in split plots design with two experimental factors and three replications. The two levels of row space factor as K1: distance between rows was 1m and K2: distance between rows was 1.2 meters were randomly assigned to whole plots (main plots) and three levels of planting method factor as C1: distance 20 cm, C2: queue up and C3: quincunx were randomly assigned to split plots (sub plots) within each whole plot. Each split plot size was 60 m^2.

Table 1. The treatments of the experiment

No	Treatments	Row distance	Planting method
1	K1C1	1 m	20cm
2	K1C2	1 m	Queue up
3	K1C3	1 m	Quincunx
4	K2C1	1.2 m	20cm
5	K2C2	1.2 m	Queue up
6	K2C3	1.2 m	Quincunx

Fingure 1. Three planting methods

The recorded data included plant height, trunk diameter, number of plantss/m^2, Brix degrees and raw yield. These data were recorded periodically for every 30 days after one month planting.

• In each plot, we selected 10 random points among two diagonal corners. Each random point of chosen plants, we marked and used of measuring instruments to record the indicators on plant height, trunk diameter, and measure the Brix.

• In each plot, we chose randomly three rows to count the number of sugarcane in m^2 by followed formula: Number of sugarcanes/m^2 = number of plantss on the row/row area (1)

• The yield per hectare of sugarcane was converted from the weight in each plot of the experimental treatments.

The data were analysed by IRRI's standard method.

RESULTS AND DISCUSSION

Observed factors included indicators of growth such as density, height, trunk diameter, stalk density and internodes, in which height was the key factor to decide the sugarcane yield. Moreover, the target Brix level and sugarcane yield were also monitored to examine the influence of these factors on raw yield.

Height of sugarcane

The target height was continuously measured periodically every month after planting 30 days. The results showed that there were not significant differences in the height of sugarcane of treatments at 1, 3, 4 and 10 months after planting. The results in table 2 indicate that row distance (K1 and K2) did not affect on the height of sugarcane in one month after planting. In contrast, planting method showed significantly affected the height of sugarcane. The stalk height in type C1 and C2 had average height of 14.9 cm and 14.6 cm, respectively and considerably lower than the C3 type (18.7 cm). However, the interaction between row distance and planting method did not affect the height of sugarcane.

Table 2. Effect of row distance and planting method on the height of sugarcane at the first month after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	**Height (cm)**		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	15.2	14.5	**14.9 b**
C2 (queue)	15.6	13.5	**14.6 b**
C3 (quincunx)	19.8	17.5	**18.7 a**
Average – K	**16.9**	**15.2**	
F (K)	*ns*	*CV (a) =12.0*	
F (C)	*	*CV (b) = 14.9*	
F (K x C)	*ns*		

*ns: non-significant; *: difference at 5%. K: row distance, C: planting method*

The data in table 3 show that the row distance (K1 and K2) had non-significant effect on the height of sugarcane at 3 months after planting. The planting method significantly influence on the height of sugarcane, in which C3 type of planting with the height around 87.5 cm, significantly higher than C2 (80.6 cm); but non-significant compared with the C1 (82.3 cm). The interaction between planting method and row distance had non-significant effect on the height of sugarcane.

Table 3. Effects of row distance and planting method on height of sugarcane at 3 months after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	**Height (cm)**		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	81.4 b	83.2 a	**82.3 ab**
C2 (Queue)	80.5 b	80.6 a	**80.6 b**
C3 (quincunx)	91.3 a	83.7 a	**87.5 a**
Average – K	**84.4 a**	**82.5 a**	
F (K)	*ns*	*CV (a) = 4.7*	
F (C)	*	*CV (b) = 5.2*	
F (K x C)	*ns*		

*ns: non-significant; *: difference at 5%. K: row distance, C: planting method*

The sugarcane height was not affected by different row distance (1m and 1.2m), while significantly affected by planting method at 10 months after planting (table 4). The C3 of planting method had average height about 286.4 cm significantly higher than C1 and C2 methods (274.9 and 272.9 cm, respectively). However, the interaction between planting method and row distance did not extensively affect the height of sugarcane.

This results show the height of sugarcane in planting quincunx was significantly higher than queue at 1, 3, 4 and 10 months after planting and higher than planting distance 20 cm at 1 and 10 months after planting.

Table 4. Effects of row distance and planting method on height of sugarcane at 10 months after planting (Hiep Hung - Phung Hiep, 2011)

Treatment	Height (cm)		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	275.2 b	274.7 ab	**274.9 b**
C2 (Queue)	285.0 ab	260.8 b	**272.9 b**
C3 (quincunx)	296.0 a	276.8 a	**286.4 a**
Average – K	**285.4 a**	**270.7 a**	
F (K)	*ns*	*CV (a) = 8.5*	
F (C)	*	*CV (b) = 2.8*	
F (K x C)	*ns*		

*ns: non-significant; *: difference at 5%. K: row distance, C: planting method*

Density

The density of sugarcane was recorded every month after one month planting. However, differences only occurred between treatments at one month and two months after planting and no different after three months of planting. The row distance (K1 and K2) and planting methods (C1, C2 and C3) affected density of sugarcane in one month after planting (table 5). The row distance of 1.2 m (K2) had average density about 10.5 plants per m^2 significantly lower than row distance of 1 m (K1). In planting method, the planting quincunx (C3) had the highest density of sugarcane (13.1 plants/m^2) compared with others. This result is the same finding of Irvine and Benda (1980). However, the interaction between planting method and row distance did not significantly affect the density of sugarcane.

Table 5. Effect of row distance and planting method on density of the sugarcane in one month after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	Density (plants/m^2)		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	13.6 b	10.3 ab	**11.9 b**
C2 (Queue)	13.1 b	9.9 b	**11.5 b**
C3 (Quincunx)	15.0 a	11.2 a	**13.1 a**
Average– K	**13.9 a**	**10,5 b**	
F (K)	*	*CV (a) = 10.0*	
F (C)	**	*CV (b) = 4.6*	
F (K x C)	*Ns*		

*Ns: non-significant; *: difference at 5%. **: difference at 1%. K: row distance, C:* ***planting method***

In the period of 2 months after planting, the row distance (K1 and K2) did not influence on the sugarcane density (table 6). The quincunx planting method had the highest density (20.6 plants/m^2) and significantly higher in comparison with the planting of type queue (18.8 plants/m^2) and type 20 cm (17.3 plants/m^2). The interaction between planting method and row distance did not affect the density of sugarcane.

Table 6. Effect of row distance and planting method on density of the sugarcane in two months after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	Density (plants/m^2)		
	K1 (1 m)	**K2 (1.2 m)**	**Average - C**
C1 (20 cm)	17.5 b	17.1 b	**17.3 b**
C2 (Queue)	19.1 ab	18.5 ab	**18.8 b**
C3 (Quincunx)	21.3 a	19.9 a	**20.6 a**
Average – K	**19.3 a**	**18.5 a**	
F (K)	*Ns*	*CV (a) = 3.1*	
F (C)	**	*CV (b) = 6.6*	
F (K x C)	*Ns*		

*ns: non-significant; **: difference at 1%. K: row distance, C: planting method*

The row distance and planting method were not significant between treatments at the time of 3 months after planting. The interaction between planting method and row distance did not affect the density of sugarcane (see in table 7).

Table 7. Effect of row distance and planting method on density of sugarcane at 3 months after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	Density (plants/m^2)		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	19.5 b	19.3 a	**19.4 a**
C2 (Queue)	22.6 a	17.9 a	**20.3 a**
C3 (Quincunx)	20.1 ab	18.4 a	**19.3 a**
Average – K	**20.7 a**	**18.5 a**	
F (K)	*Ns*	*CV (a) = 6.5*	
F (C)	*Ns*	*CV (b) = 7.6*	
F (K x C)	*Ns*		

ns: non-significant; K: row distance, C: planting method

The results observed at 10 months after planting (before harvest) showed the density of sugarcane decreased when compared to sugarcane tillering at 3 months after planting because of the damaged side shoots, malnourished or diseased shoots. The results in table 8 did not show any differences of sugarcane density at 10 months after planting with a space of 1 and 1.2 m (corresponding to 11.5 and 10.9 plants/m^2). Sugarcane density did not differ significantly among treatments plantation style C1, C2 and C3 (corresponding to 11.4; 10.9 and 11.4 plants/m^2). The interaction between planting method and row distance was not effect the sugarcane density at 10 months after planting.

In summary, planting sugarcane at the row distance of 1 m increased the density plants/m^2 at one month after planting compared with 1.2 m row distance. In addition, planting quincunx had a higher density of sugarcane than others did at 1 and 2 months after planting. However, at 10 months

after planting, there was not difference about density of sugarcane between planting method and row distance.

Table 8. Effect of row distance and planting method on density of sugarcane at 10 months after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	Density (plants/m^2)		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	11.5	11.3	**11.4**
C2 (Queue)	11.1	10.7	**10.9**
C3 (Quincunx)	12.0	10.8	**11.4**
Average – K	**11.5**	**10.9**	
F (K)	*ns*	*CV (a) = 4.1*	
F (C)	*ns*	*CV (b) = 5.1*	
F (K x C)	*ns*		

Ns: non-significant; K: row distance, C: planting method

Sugarcane diameter

Variation of sugarcane diameter was monitored monthly. However, the trunk diameter in the last month before harvest (10 months after planting) was the most important because it affected the sugarcane yield. The data in table 9 show the row distance and planting method did not influence on sugarcane diameter at 10 months after planting. The average of sugarcane diameter was 2.81; 2.75 and 2.77 cm corresponding to C1, C2 and C3 plant methods and did not differ significantly among the treatments. The interaction between planting method and row distance did not affect trunk diameter at 10 months after planting.

Table 9. Effect of row distance and planting method on attrunk diameter of sugarcane at 10 months after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	Diameter of sugarcane (cm)		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	2.84 a	2.77 a	**2.81 a**
C2 (Queue)	2.73 b	2.77 a	**2.75 a**
C3 (Quincunx)	2.76 ab	2.79 a	**2.77 a**
Average – K	**2.78 a**	**2.77 a**	
F (K)	*ns*	*CV (a) = 8.2*	
F (C)	*ns*	*CV (b) = 1.6*	
F (K x C)	*ns*		

ns: non-significant; K: row distance, C: planting method

Sugarcane yield

The row distance factor in this study did not significantly affect yield of sugarcane (table 10). However, Bull (1975) found that the sugarcane yield is significantly increased when the row distance ranged from 140 to 150 cm. In our results, we found that the different method of planting had affected sugarcane yield, in which the quincunx type was higher yield than others style as C2 and C1 and sugarcane yield was not affected when row distance ranges from 1 m to 1.2. The interaction between planting method and row distance did not influence on sugarcane yield.

Table 10. Effect of row distance and planting method on sugarcane yield (Hiep Hung - Phung Hiep, **2011)**

Treatments	Sugarcane yield (ton/ha)		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	171.0 a	168.5 a	**169.8 ab**
C2 (Queue)	168.9 a	160.0 b	**164.5 b**
C3 (Quincunx)	173.5 a	168.0 a	**170.8 a**
Average – K	**171.2 a**	**165.5 a**	
F (K)	*ns*	*CV(a) = 3.5*	
F (C)	*	*CV(b) = 2.4*	
F (K x C)	*ns*		

*ns: non-significant; *: difference at 5%. K: row distance, C: planting method*

Brix level

The Brix of sugarcane was measured at three positions on the sugarcane: bottom, middle and top of stem. The averaged of Brix value was taken by calculating the average of Brix degrees of three positions of sugarcane. The results in table 11 show that the change of row distance and plant density did not affect the Brix of sugarcane and the interaction between planting method and row distance did not have any effect on the Brix level of sugarcane.

Table 11. Effect of row distance and planting method on Brix level of sugarcane at 10 months after planting (Hiep Hung - Phung Hiep, 2011)

Treatments	Sugarcane brix levels		
	K1 (1 m)	**K2 (1.2 m)**	**Average – C**
C1 (20 cm)	19.3	19.3	**19.3**
C2 (Queue)	19.8	19.1	**19.4**
C3 (Quincunx)	19.6	19.7	**19.5**
Average – K	**19.7**	**19.4**	
F (K)	*ns*	*CV (a)=0.7*	
F (C)	*ns*	*CV (a)=1.9*	
F (K x C)	*ns*		

ns: non-significant; K: row distance, C: planting method

Our results found that K1 and K2 row distance did not influence on the height of sugarcane but affected the density at 2 months after planting, and did not affect on trunk diameter, Brix level and yield of sugarcane at 10 months old. Planting method had a direct effect on the height of sugarcane, yield and Brix level but did not affect the density and trunk diameter of sugarcane at 10 months after planting. The height, density and productivity of sugarcane in the quincunx type were significant higher than queue treatment but did not differ significantly compared with planting method of the 20 cm distance.

CONCLUSIONS

The distance between two rows is 1 - 1.2 m and plant quincunx style had higher yield than other types. However, to save sugarcane materials, they should be planted between two rows about 1.2 m by quincunx style.

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NGHIÊN CỨU KHOẢNG CÁCH VÀ KIỂU TRỒNG MÍA Ở HẬU GIANG

Trồng mía với khoảng cách hàng dày (mật độ cao) là phương thức sản xuất mía truyền thống lạc hậu làm giảm năng suất và chất lượng mía đường của nông dân ở tỉnh Hậu Giang. Đây cũng là một trong những yếu tố làm tăng chi phí đầu vào dẫn đến hiệu quả kinh tế không ổn định. Thí nghiệm nghiên cứu kỹ thuật trồng mía bao gồm khoảng cách hàng và cách trồng được tiến hành vào vụ mía 2011 ở Hậu Giang trên giống mía QĐ 13 với hai khoảng cách hàng 1m và 1,2 m, và ba cách trồng: cách 20 cm, nối đuôi, nanh sấu nhằm tìm ra khoảng cách hàng và cách trồng phù hợp. Kết quả thí nghiệm cho thấy trồng với khoảng cách 1,2m với kiểu trồng nanh sấu đều cho năng suất cao hơn với khoảng cách hàng 1m và 2 cách trồng nối đuôi và cách 20 cm.