J. King Saud Univ., Vol. **3**, *Agric. Sci.* (1), pp. 5-14 (1411/1991)

Performance Evaluation of a Sugar Cane Planter

Abdelaziz Mohd. Dafa'alla and **Mustafa A. Hummeida**
Department of Agricultural Engineering, Agricultural Division, Guneid Sugar Company, Sudan, and Department of Agricultural Engineering, University of Khartoum, Sudan

Abstract. Two levels of seed rates and three forward speeds were applied in a randomized complete block design experiment using a mechanical sugar cane planter. The effects of three speeds and two seed rates on the eye damage percent, stalk cutting percent and uniformity of set placement were studied. Manually cultivated plots were used as control plots. Results showed that increasing forward speed up to 6 km/h gave a significant increase in the eye damage percent and stalk cutting percent for both seed rates used. The various speeds used were found to influence the number of stalks dropped per row and consequently the cane yield. Mechanically planted cane was found to produce more tillers per stool than hand planting due to the higher application rates. No significant differences in yield were found between machine and hand planting when a seed rate of 2.0 m cane/m land was used.

Introduction

Sugar cane *Saccharum officinarum* L. is a perennial plant, usually cultivated as poly-annual and rarely as an annual crop. It is cultivated in tropical and subtropical regions of the world between latitudes 35°N and 35°S [1].

Approximately 165.000 fed. (about 69, 298 ha) of sugar cane are planted each year in Sudan, mainly in Kenana, Girba, Guneid, Sinnar and Assalaya schemes.

Sugar cane is manually cultivated in all those sugar cane plantations. The total number of feddans planted at Guneid sugar farm is dependent upon the availability of irrigation water, rotation requirements and the availability of labourers. It was found that 7- man- days were required to plant a feddan of (0.42 ha) sugar cane. The problem of labourers shortage and their arising wages so often forced sugar cane producers out of the season.

Delayed sowing dates of sugar cane resulted in poor crop stands, reduction in yield and hence low sugar recovery. Because of this, it is conceived that mechanical planting can partially solve the problem. Recently, single-row sugar cane planters have been introduced in Guneid sugar farm targeting mechanical planting. However, technical and economical evaluation of the performance of the planter is vital for adoption of mechanical planting.

The objective of this study was to evaluate the performance of one of the available makes of sugar cane planters. However the specific objectives were to:-

1- Study the effect of forward speeds on machine planting.
2- Study the effect of various seed rates on crop parameters and machine performance.

Materials and Methods

An experiment was conducted in Guneid sugar farm in a field area of about 1.26-2.1 ha. Two trials were laid down using a mechanical planter and conventional hand planting. A randomized complete block design (RCBD), including eight treatments and four replications was adopted. The treatments were combinations of: Two planting rates (1.08 and 2.0 m cane/m land for end-to-end and double set positions respectively), three mechanical speeds, 2,4 and 6 km/h, and manual. The experimental area was divided into two halves, each of which consisted of thirty two experimental plots. The net area of each plot was 15 × 9 m composed of six rows 15 m long and spaced 1.5 m apart. Blocks were separated by a distance of one meter from each other. Plots in the same block were separated by a distance of three meters. The two experiments were separated by a distance of four meters from each other, and a distance of ten meters was left at each boundary as border distance separating the two experiments from the adjacent fields.

Two crops were planted to be harvested in two seasons. One half of the area was planted in autumn while the second was planted in winter. Mechanical and manual planting were the two methods used for planting.

Machine planting was carried out by a chopper type single-row planter, which placed three to four-eyed sets using the whole stalks; with the top leaves and the accompanying parts of the stalk chopped off. The dropped sets were placed in a furrow ditch about 0.20-0.25 m in depth- and were covered immediately. In hand planting, the normal practice of three-eyed seed pieces was adopted.

Data on machine and crop parameters was collected. The effect of the forward speeds on stalk eye damage percent, stalk cutting percent and uniformity of set placement was investigated.

The eye damage percent was computed by taking the number of damaged eyes along a distance of 30 m as a percentage from the total number of eyes actually dropped.

The stalk cutting percent was obtained by the number of uncut stalks as a percentage from the total number of stalks fed along a thirty-meter distance.

The uniformity of set placing was computed from the following relation:-

$$\text{Uniformity} = 1 - \sqrt{\frac{\sum (Si - \bar{S})^2}{N-1}}$$

Where:

S = distance of skip (m)
$\sum (Si-\bar{S})^2$ = sum of the deviations square
N = number of skips.

The crop parameters included two seed rates which were expected to affect height of cane plant, number of tillers per stool, yield of cane and number of stalks dropped per row [2].

Data on plant height (m) and number of tillers per stool was taken monthly starting four months after planting.

Yield of cane (kg/m^2) was obtained by weighing a representative sample in an area of 18 m^2 for each experimental plot. The yield results were then converted to a per hectare basis (tons/ha).

The number of stalks dropped per row was obtained by counting the total number of stalks actually dropped along a 30 m distance.

Data on time study for hand labour was obtained by taking the total time required for dropping and covering operations; hence the actual field capacity of man-hour/day was calculated.

Machine Description

The sugar cane planter is a fully mounted, one row machine which can be easily operated by a wheel tractor of about 60 kw.

The major parts of the machine include two carrying wheels which drive the

whole planting mechanisms, two carrying baskets, and a seat for two operators. Additionally it includes a double gear box which has two sets of chains and sprockets with different sizes and lengths, and two pairs of rotating cutting knives which cut the cane stalks into suitable planting sets. The feeding mechanism consists of too sets of feed rollers each comprises three tyres adjustable in relation to the size of cane plant. The furrow opener consists of a share bottom ridger which ditches a furrow upto 0.30 m deep. Those openers are followed by coverers to cover the sugar sets dropped in the furrow. A fertilizer hopper and an insecticide tank were also attached. The overall arrangements of the parts on the planter are shown in Fig 1. The machine specifictions are shown in Table 1.

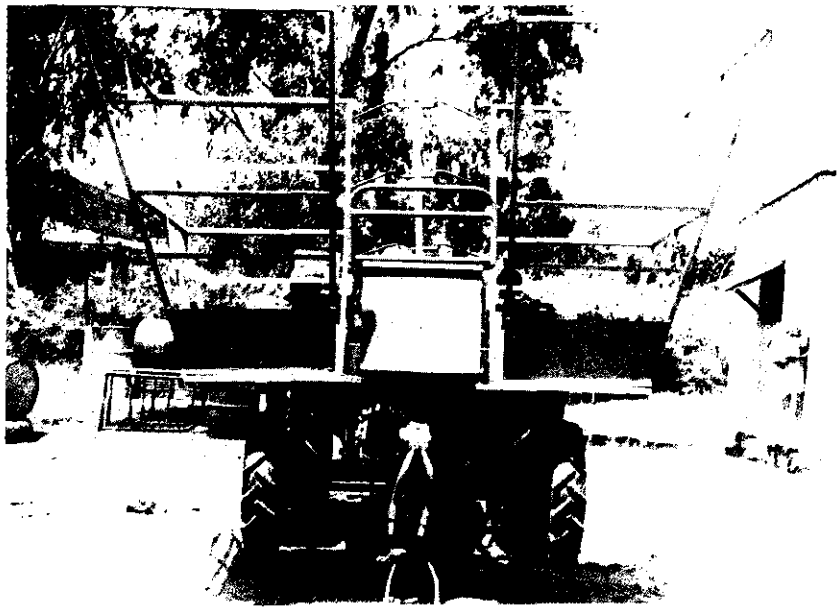

Fig. 1. Sugar cane planter (rear view)

Table 1. Machine specifications

Overall length	3.0 m
Overall width	2.0 m
Overall height	2.5 m
Weight	650-740 kg
Baskets capacity	600 kg
Fertilizer hopper capacity	100 kg
Insecticide tank capacity	50 l.
Number of rows	1
Row-to-row spacing	1.5 m
Depth of planting	0.2-0.25m

Seed and soil description

Variety Co 527 of sugar cane was used in the experiment. The variety grows stalks up to 2.0 m in length with an average number of joints of 15 per stalk. The stalk diameter was about 85 mm. The seed material was manually cut from the best looking fields of cane when the plant age was about 10-12 months.

The farm soil as described by Ali [3], was a dark brown non-saline, alkaline, cracking clay within the top 0.90 m; gypsum below 90 cm or absent. The soil pH was more than 8.5 within the 0.90 m depth.

Results and Discussion

The analysis of variance of the effect of the forward speeds and the seed rates on the crop and the machine parameters under investigation showed a highly significant effect of the forward speeds and seed rates on the eye damage percent at 0.5% level. Increasing the speed up to 6 km/h resulted in increasing the eye damage percent for both seed rates. However, the lower seed rate of 1.08 m cane/m land showed more eye damage percent than the high seed rate of 2.0 m cane/m land as shown in Fig 2. The eye damage percent varied within a range of 4.6 to 10.5% as shown in Table 2.

Table 2. Total number of eyes, number of damaged eyes and damage percent for three forward speeds and two seed rates.

Operating speed km/h	Avrg. number of stalks dropped per 30 m.	Total number of eyes	Number of eyes damaged	Damaged %
		Seed rate 1.08 m cane/m land		
2	13	166	12	7.23
4	14	166	15	9.03
6	13	152	16	10.5
		Seed-rate 2.0 m cane/m land		
2	17	235	11	4.68
4	17	215	12	5.58
6	15	184	15	6.15

The results showed that the speed and seed rate had a significant (1%) effect on the stalk cutting percent. As the speed of operation increased the percentage of stalk cutting for the three speeds and the two seed rates also increased. However, it varied within a range of 54.5 to 69.2% as shown in Table 3. The stalk cutting percent was greater for a seed rate of 2.0 m cane/m land than the seed rates of 1.08 m cane/m land (Fig 3).

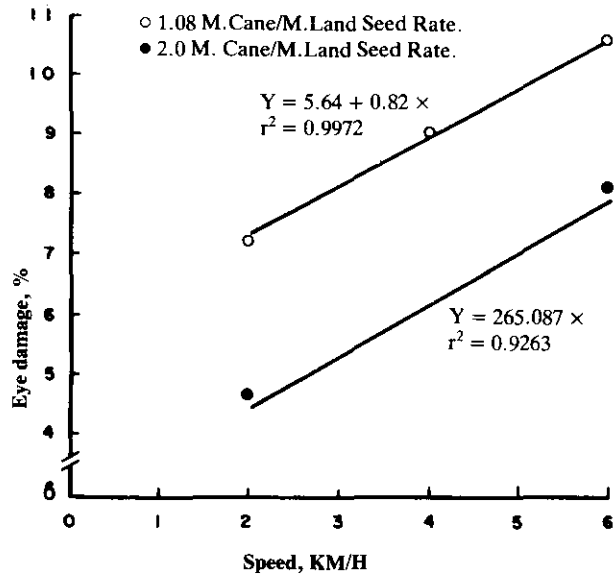

Fig.2. Effect of machine speed on eye damage percent under different seed rates.

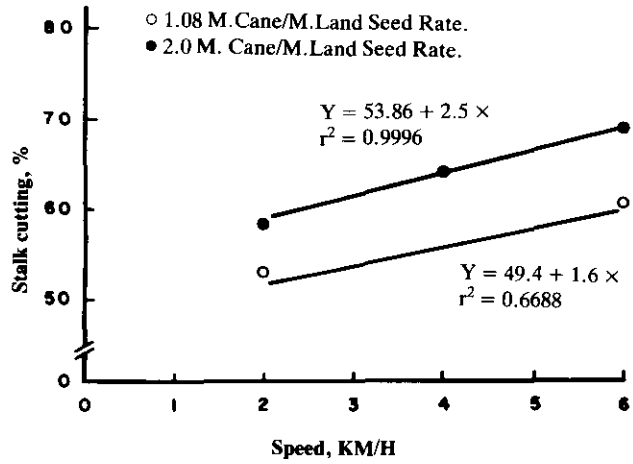

Fig. 3.Effect of machine speed on stalk cutting percent under different seed rates.

Table 3. Average number of fed stalks, number of uncut stalks and cutting percent for three speeds and two seed rates.

Operating speed km/h	Average number of fed stalks	Number of uncut stalks	Cutting %
	Seed rate 1.08 m cane/m land		
2	10	4.5	55
4	11	5	54.5
6	10	4	60
	Seed rate 2.0m cane/m land		
2	16	6.5	59.4
4	15	5.5	63.3
6	13	4	69.2

Statistically, no significant difference in the uniformity of set placing was observed for the three speeds and the two seed rates used. However, the average skip length observed ranged between 1.3 and 2.0 m as shown in Table 4. The results showed that it is possible to use any of the two seed rates with any of the three forward speeds without any significant difference in the placement of seed material.

No statistically significant effect of the speeds and the seed rates on the height of mechanically planted cane was observed. But there was a statistically significant effect on tillering ability of mechanically and manually planted cane at 5% level. The maximum average number of tillers per stool observed was 15.5 when the machine was driven at 4 km/h applying a seed rate of 2.0 m. cane/m land. It was noted that the two planting methods showed a similar trend of increasing in tiller population from the first to the 9th. month and gradual decline then after. Howerver, mechanically planted cane produced more tillers per stool than manually planted cane for both seed rates (Figs 4 and 5). This was attributed to the application of more seed material in mechanical planting than in hand planting. This agrees with what was reported by Eiland and Clayton [4]. The Regression analysis showed that the high seed rate of 2.0 m cane/m land produced more tillers per stool than the low seed rate of 1.08 m cane/m land.

The yield was found to be significantly (1%) affected by the speeds and the seed rates (5%). Using speeds of 2 and 4 km/h with seed rates 2.0 and 1.08 m cane/m land, respectively, were found to result in better yields than using a speed of 6 km/h. This may be due to the fact that at speeds of 2 and 4 km/h the labourers could feed the machine better than at the speed of 6 km/h. For manual planting no significant difference in yield was observed when using either 1.08 or 2.0 m cane/m land seed rate.

Comparing the yields obtained from the mechanically and manually planted fields, no significant difference was observed for the two seed rates used. Similar results were reported by Eiland and Clayton [5].

Test of significance showed a significant difference at 1% level in the number of stalks dropped per row when driving the machine at 2 and 4 km/h. Increasing the speed up to 6 km/h resulted in decreasing the number of stalks dropped. This may be due to the low skill of the labourers feeding the machine.

Table 4. Comparison of the mechanical planter skips at three forward speeds with two seed rates

Plot description	Avg. number of skips*	Total skip length (m)	Avg. skip length (m)	Percent skip
		Seed rate 1.08 m cane/m land		
MP@2km/h	5	6.55	1.31	21.82
MP@4km/h	4	5.47	1.37	18.22
MP@6km/h	5	6.59	1.32	21.97
		Seed rate 2.0m cane/m land		
MP@2km/h	3	6.03	2.01	20.1
MP@4km/h	4	7.61	1.9	2537
MP@6km/h	4	5.91	1.47	19.7

* Skips were considered as any distance without seed material.
MP - Mechanically planted.

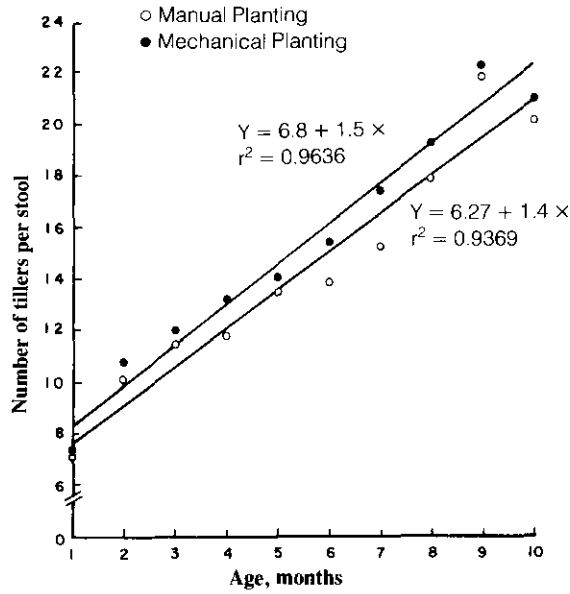

Fig. 4. Effect of mechanical and manual planting on tillering ability of cane plant at 1.08 m cane/m land see rate.

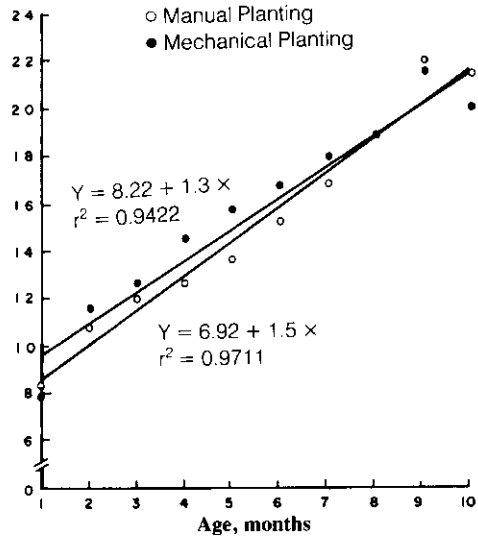

Fig. 5. Effect of mechanical and manual planting on tillering ability of cane plant at 2.0 m cane/m. land seed rates.

Conclusions

From the results of this experiment the following could be concluded:-

1- It is recommended that a speed of 4 km/h and seed rate of 1.08 m cane/m land be used. This would result in higher field machine capacity, and save a seed material without considerable loss in yield.

2- No- statistically significant difference in yield was observed between mechanical and manual planting. However, the costs of the various agricultural operations determine the type of method to be used in planting.

References

[1] Information pamphlet from Seifaferty, More Sugars from the Sugarcane Plantations Milano, Italy: 1967.

[2] Misra, Arvind and Naidu, K.M. "Effect of Seed Rates and Spacing on Growth, Juice Quality and Yield of Early Varieties of Sugarcane." *Indian J. of Agronomy*, **27** No. 4, (1982), 398.

[3] Ali, M.A. "Semi-Detaild Soil Survey of Annual Report of Guneid Sugar Cane Research Static." Guneid, Sudan. (1968).

[4] Eiland, B.R. and Clayton, J.E. "Development of a Singulation System for Planting of Sugar Cane in Florida." *ASAE paper, No.* **75**, (1975), 35-37.

[5] Eiland, B.R. and Clayton, J.E. "Sugar Cane Yields from Preliminary Mechanical Planting Studies in Florida." *ASSCT Journal.*, **2**, (1983).

تقويم أداء آلة زراعة قصب السكر

عبدالعزيز محمد دفع الله و مصطفى عبدالمجيد حميده

قسم الهندسة الزراعية شركة سكر كنانة و جامعة الخرطوم
الخرطـــوم، الســـــودان

ملخص البحث. في تجربة على طريقة القطاعات العشوائية التامة تم تقويم أداء آلة زراعة قصب السكر وذلك بدراسة أثر ثلاث سرعات أمامية للجرار ومعدلين من التقاوي على النسبة المئوية لتلف البراعم، والنسبة المئوية لقطع القصب وانتظام وضع العقل. وقد تمت زراعة قطاعات يدويا وذلك للمقارنة. أوضحت النتائج أن زيادة السرعة الأمامية للجرار إلى ٦ كيلومتر/ساعة نتج عنها ارتفاع في نسبة البراعم التالفة وأيضا ارتفاع في نسبة القطع وذلك بالنسبة للمعدلين من التقاوي.

وجد أن السرعات المختلفة تؤثر على عدد سيقان القصب التي يتم وضعها في الصف وبالتالي تؤثر على إنتاج القصب. ووجد أيضا أن القصب المزروع آليا ينتج عددا أكثر من الخلف بالمقارنة إلى المزروع يدويا. ويعزى ذلك إلى الكمية العالية من التقاوي التي يمكن وضعها في الأرض وذلك باستعمال الآلة. واتضح أيضا أن ليس هنالك فرقا معنويا بين الإنتاج المتحصل عليه من الزراعة آليا أو يدويا عندما تعادل كمية التقاوي ٢ متر قصب / متر أرض. وعلى ذلك فإن اختيار الزراعة بالآلة أو الزراعة اليدوية يتوقف على التكاليف المتعلقة بكل طريقة.