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TECHNOLOGY

Evaluation of Sugarcane Cutter Planter

A. Patil[1], A.K. Dave[2] and R.N.S. Yadav[3]

[1,3]Senior Research Fellow and Principal Scientist, Central Institute of Agricultural Engineering, Nabi Bagh, Berasia Road, Bhopal - 468 032, India

[2]Assistant Professor. Faculty of Agricultural Engineering, IGAU, Raipur, India

Sugarcane planting is very labour intensive job and involves considerable human drudgery. Planting creates the foundation for a crop and plays an important role in its growth and yield. Study was undertaken to evaluate the performance of two different models of sugarcane planters namely, Khalsa PE-630 type cutter planter and ITI make cutter planter. The field capacity of Khalsa make planter was 0.20 ha/hr with the field efficiency of 87.50% at effective working width of 1.34 m and forward speed of 2.5 km/hr at 2nd low gear. A set length of 32.96 cm with an average overlap of 6.14 cm was observed at the same speed and the required seed rate was 9.0 tonnes per hectare on the other hand field capacity of ITI make planter was observed as 0.21 ha/hr with field efficiency of 76.92% at effective working width of 1.50 m and forward speed of 1.8 km/hr at 1st low gear. A set length of 26.96 cm and an average overlap of 3.68 cm were observed at the same speed. Seed rate required was 9.23 tonnes per hectare.

KEYWORDS : Sugarcane, sugarcane planter, field efficiency

Sugarcane (*Saccharum* hybrids L.) is the important crop of India and holds the prominent position as a cash crop. It is main source of sugar, gur and khandsari in the country. It is cultivated in an area of about 4 million ha with an average production of 75 tonnes/ha. Total production of sugarcane has been increasing steadily from 230 million tonnes in 1993-94 to 295 million tonnes in 1998-99. Traditionally sugarcane has always planted manually. However to reduce the cost of planting, drudgery and proper placement of fertilizer, machinery for sugarcane planting has been developed in India. These machines are basically of two types, widely known as drop planters and cutter planters. In drop planters, pre cut sugarcane setts of desired length are fed in to the machine. The setts may be cut manually or mechanically. These planters consist of two vertical rotating drums with 12 circular vertical seed compartments in each drum. The rotating drum is powered by ground wheel through central shaft. In the cutter planter, whole cane is fed. It is provided with the cutting unit, which cuts the fed cane to a pre-determined length and carries it to the furrow. Presently most common design of planter is the cutter planter which performs the job of sett cutting, furrow opening, fungicidal and anti termite treatment of setts, placement of the fertilizer in bands or either side of setts, covering and pressing the setts. Whole cane is fed through the chute manually from the sugarcane through. Designs of two and three row cutter planters are commercially available. There are about 10 to 15 manufacturers of sugarcane planters in the country who manufacture different models. These models are tested and evaluated at different research stations in the country. Still there are some parameters, which needs to be improved. Considering the present trends and problems, the laboratory testing and field evaluation of these planters were under taken at CIAE Bhopal.

Author for Correspondence : Amol Patil
e-mail : amolpatil22@rediffmail.com; **Fax** : 0755-2734016

REVIEW OF LITERATURE

Qaisrani (1992) reported that a three-row tractor rear-mounted sugarcane planter able to plant 53,000 to 87,000 setts of cane per hectare was developed. It saved approx. 80 man-hours per hectare, which would be required for sett cutting and manual planting. Best planting was achieved when the planter was operated in the 1st gear at an engine speed of 1200 rev/min or in 2nd gear at 1200 to 1400 rev/min.

Singh *et al.* (1994) reported, the optimum working speed of FMI and AMRI sugarcane planters were found to be 1.2 and 2.65 km/h respectively. Average effective capacities were found to be 1.04 and 1.68 ha/day respectively. Corresponding average field efficiencies were 64.5 and 34.8 respectively.

Srivastava (1995) reported that, due to inclusion of sett cutting unit, the cutter planter energy and cost requirements were about 40 per cent less compared with traditional method of planting sugarcane. He has also reported that bud emergence was quicker when the setts were planted with the cutter planter and there was significant increase in the yield per unit area.

El-sahrigi (1998) evaluated the performance of four billet planters tested in Egypt and found that the best forward speed to operate the planter was 2.2 km/hr the optimum adjustments and operating condition for planters were also described.

Srivastava (2000) concluded that, with the inclusion of furrow guider and ground wheel to the sugarcane planter, it helped aligning setts in the furrow before pushing the loose soil to cover them. As direct planting device it yielded a saving of about 32 per sent in total cost as well as total energy required to raise sugarcane crop.

Bahl *et al.* (2001) reported that sugarcane cutter planter have an effective field capacity of 0.15 hectare per hour. There was substantial reduction of labour requirement from 130-150 man-hours per hectare by conventional method to 35-40 man-hours per hectare by machine planting.

Garg (2001) concluded that the machine has the capacity of 0.15 hectare per hour at 1.40 km per hour and five persons were required to operate the machine.

Yadav *et al.* (2001) reported that overall requirement of labour for sugarcane cultivation is 3300.0 man-hours. Labour requirement for preparatory tillage, manuring, planting, irrigation, intercultural and other operations, harvesting and stripping are 331.5, 238.0, 337.5, 392.0, 816.0 and 11923.0 respectively. He emphasized on the need to develop and popularize sugarcane machinery system based on regional situation.

MATERIALS AND METHODS

Study was undertaken to evaluate the performance of two different models of sugarcane cutter planter. One model was Khalsa PE-630 type cutter planter manufactured by M/s Punjab Engineers, Meerut. Another model was ITI make cutter planter, designed by Indian Institute of Sugarcane Research, Lucknow and manufactured by Indian Telephone Industries, Rai Bareli.

Lab testing of the planters

Testing work related to calibration, bud damage determination, quality of cut, length of sett and fertilizer drop was done as per the procedure given under this section.

Calibration

Calibration was done by mounting the planter on tractor by three-point linkage system and the planter was powered by tractor PTO. Tractor was operated in second low gear at 1600 engine rpm. Total number of setts cut per minute were collected and counted. This procedure was repeated for three times and average was calculated. Seed rate required per hectare was calculated.

Bud damage determination

In order to determine bud damage 100 setts were selected randomly and number of buds damaged were observed and recorded. Three replications were made and average was calculated.

Quality of cut

In order to examine the quality of cut 100 setts were selected at random and nature of cut was observed and noted for both the planters. This was carried for three times and average was calculated.

Fig. 1 : Field trials of Khalsa make sugarcane cutter planter

Fig. 2 : ITI make sugarcane cutter planter in operation

Length of setts

To determine average length of sett 100 sample of setts were selected and length of each sett was measured and average was calculated.

Fertilizer drop

Fertilizer box was filled to 3/4th of its capacity. Tractor was operated in second low gear for 30 seconds. Fertilizer dropped during this time was collected and weighed in the physical balance. Fertilizer required per hectare was calculated. Test of fertilizer drop was carried for Urea, DAP and Single Super phosphate.

FIELD TEST

Depth of placement

Planter was operated in the field without covering device. Depth of placement of setts in the furrows was evaluated. Depth was measured at five different places and average was calculated. Depth of placement of setts was controlled by the hydraulic system of the tractor.

Overlap/gap

Planter was run in the field for 30 meters length. All setts dropped were collected and number of setts and length of each sett was measured.

The machine was operated in the speed range of 1.74 to 6.03 km/hr at different gear ratios.

Average overlap =

$$\frac{\text{Total length of setts - Distance (30 m.)}}{\text{Total no. of setts}}$$

Average gap =

$$\frac{\text{Distance (30 m.) - Total length of setts}}{\text{Total no. of setts}}$$

Speed of operation

To know the speed of operation a fixed distance of 90 meter was measured in the field and planter was run from one end to other end of this distance, time required to cover this distance was noted. Simultaneously time required for turning the planter was also noted. As such five observations were taken to get the accuracy.

Theoretical field capacity

Theoretical field capacity of planter was calculated from speed of operation and theoretical width of the planter.

Theoretical Field capacity =

$$\frac{\text{Theoretical width (m)} \times \text{Speed of operation (km/hr)}}{10}$$

Actual field capacity

The plot of 0.12-hectare having length 60 m and width of 20 m was selected and time taken to cover this area was noted. Time taken for turning, hopper filling and other operational obstructions was also noted.

Field efficiency

Field efficiency was calculated using following formula,

$$\text{Field efficiency} = \frac{\text{Actual field capacity}}{\text{Theoretical field capacity}} \times 100$$

RESULTS AND DISCUSSIONS

Tractor operated sugarcane cutter planter was tested in laboratory as well in the field to study the performance in respect of performance of sett cutting unit, performance of fertilizer metering unit and field performance of sugarcane cutter planter. The planter was fitted with appropriate transmission system, sett cutting unit and all other moving parts as per specifications and it was found that they were working as per standards.

A. Performance of sett cutting unit

Metering (seed rate)

Average number of setts dropped in 60 seconds was 131 and 126 in Khalsa and ITI make sugar cane cutter planters respectively. Average weight of single sett was 159 gm and 135 gm for Khalsa and ITI make planters respectively. Seed rate required was 9 t/ha and 8.4 t/ha for Khalsa and ITI make planters.

Bud damage

Out of 386, 14 buds were observed as damaged buds (4.14%) in Khalsa make planter where as in ITI make planter out of 335, 12 buds were observed as damaged (3.58%).

Buds per sett

Distribution of buds on the setts among the selected setts are shown in figure 3 and 4 for Khalsa and ITI make planters, respectively.

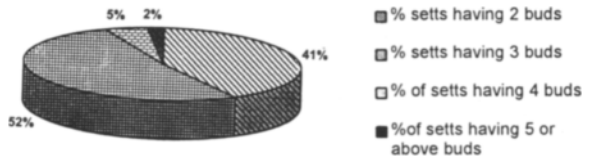

Fig. 3 : Sugarcane sett cutting pattern in Khalsa make sugarcane cutter planter

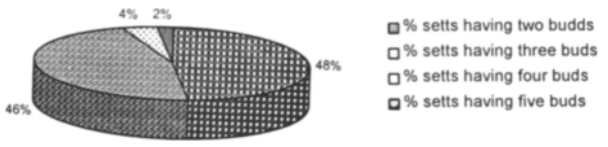

Fig. 4 : Sugarcane sett cutting pattern in ITI make sugarcane cutter planter

It was found that under Khalsa planter that the three buds per sett recorded highest percentage distribution (52%), where as lowest was for five buds per sett, in ITI make planter percentage distribution was highest (48%) where the two bud per sett was observed, whereas lowest was for five buds per sett.

Quality of cut

Quality of cut was found to be better in ITI make planter than Khalsa make planter. A clean cut was observed irrespective of the diameter of the cane using in ITI make planter, however in Khalsa make planter little rupture was observed for cane having diameter more than 35 mm. This may be noted that variety known as Co-419 had only one per cent of the canes having diameter more than 35 mm. So either of the planters can be utilized when the cane is having the diameter less than 35 mm, otherwise ITI planter should be preferred.

Length of the sett

Average length of setts was observed to be 32.96 cm with standard deviation of 4.33 cm in Khalsa make sugarcane planter where as in ITI make planter average length of setts were 26.90 with standard deviation of 11.13 cm.

Average overlap/gap

Planter was run in the field at various speeds and overlap or gap observed was recorded. In ITI make planter overlap was observed at 1st low gear only. While as in Khalsa make planter at two gear ratios overlap was observed i.e. 1st and 2nd low and for all other speeds gap was observed. Observed gap/ overlap for ITI and Khalsa make planters are given in table 1 and 2.

Table - 1 : Observed overlap/gap for ITI make sugarcane cutter planter

Gear ratio	Speed 'km/hr'	Average Overlap 'cm'	Average Gap 'cm'
1st Low	1.8	3.77	_
2nd Low	2.4	_	6.74
3rd Low	3.45	_	14.77
1st High	3.05	_	9.98
2nd High	4.58	_	46.35
3rd High	5.76	_	99.66

B. Performance of fertilizer metering unit

Tractor was operated in 2nd low gear at 1600 rpm and fertilizer dropped in 30 seconds was collected for all 15 adjustments of Khalsa make planter and three grove settings of ITI make planter. Fertilizer required per hectare was calculated. Test for fertilizer drop was carried for different fertilizers viz. Urea, DAP and SSP. Fertilizer distribution per hectare for different fertilizers is given in table 3 and 4 for Khalsa and ITI make planters respectively.

Table - 2 : Observed overlap/gap in Khalsa Make sugarcane cutter planter

Gear ratio	Speed 'km/hr'	Average overlap 'cm'	Average gap 'cm'
1st Low	1.74	9.53	-
2nd Low	1.85	8.6	-
3rd Low	3.22	-	9.93
1st High	3.05	-	5.04
2nd High	4.01	-	46.18
3rd High	6.03	-	134.17

C. Field performance

Actual field capacity

A plot of 0.12 ha having length 60 m and width 20 m was selected and time taken to cove this area was observed. It was found to be 36 and 34 minutes including time taken for turning hopper filling and other operational obstructions for Khalsa and ITI make Sugarcane cutter planters respectively. The actual field capacity was found to be 0.20 and 0.21 ha/hr for Khalsa and ITI Make planters respectively. One filling of seed cane and fertilizer was able to cover 0.12 ha where as 10 to 12 fillings for seed and 2 to 3 filling for fertilizer were required per hectare.

Theoretical field capacity

Theoretical field capacity of Khalsa make PE-630 planter was recorded as 0.24 ha/hr at 1.85 km/hr

Table - 3 : Fertilizer distribution for Khalsa make sugarcane cutter planter

Grove Setting	DAP 'kg/ha'	Urea 'kg/ha'
1	89.93	86.34
3	193.83	237.90
5	309.93	355.78
7	432.81	447.5
9	575.47	618.05
11	733.42	817.26
13	871.73	994.26
15	1009.67	1135.43

Table - 4 : Fertilizer distribution for ITI make sugarcane cutter planter

Grove Setting	DAP 'kg/ha'	Urea 'kg/ha'
1	-	127.00
2	325.36	328.35
3	487.07	467.15

speed of operation where as for ITI make planter it was 0.23 ha/h at the speed of 1.74 km/h.

Field efficiency

The field efficiency of Khalsa make sugarcane cutter planter was calculated as 83.33 percent whereas this was 73.65 percent for ITI make sugarcane cutter planter.

CONCLUSION

Khalsa make planter

The field capacity of the machine was 0.20 ha/hr with the field efficiency of 85.97 percent at effective working width 1.34 m (row to row spacing of 0.67m) and forward speed of 2.5 km/hr at 2nd low gear. At cutting speed of 1600 rpm (engine), a sett length of 32.96 cm at forward speed 2.5 km/hr (2nd low gear) with an overlap of 6.14 cm was observed. The seed requirement was observed 9.0 tonnes per hectare at the forward speed of 2.5 km/h at 2nd low gear. The fertilizer metering mechanism was force-feed type with different groove setting with fluted rollers. It worked satisfactory for granular fertilizers such as DAP and Urea. Fertilizer drop was excess than the recommended. Fertilizer metering mechanism could not meter the powdery fertilizer such as Single Super Phosphate.

ITI make planter

The field capacity of the machine was 0.21 ha/h with the field efficiency of 73.96 percent at effective working width 1.50 m (row to row spacing of 0.75 m) and forward speed of 1.85 km/hr at 1st low gear. At cutting speed of 1600 rpm (engine) a set length of 26.96 cm at forward speed of 1.8 km/hr (1st low gear) an overlap of 3.68 cm was observed. The seed requirement was observed 9.23 tonnes per hectare at the forward speed of 1,8 km/hr at 1st low gear. The fertilizer-metering unit was force feed type with three different groove settings. It functioned well for DAP and Urea but it could not meter Single Super Phosphate. Performance of the fertilizer metering mechanism of both the planters was satisfactory. It could not meter the powdery fertilizer and granular fertilizer was dropped excessively.

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