PERFORMANCE EVALUATION OF TRACTOR OPERATED TWO ROW SUGARCANE CUTTER PLANTER

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ABSTRACT

To assess the performance of a two row tractor operated sugarcane cutter planter and to find most economical mode of operation of the planter, a performance evaluation test was performed. Planter was operated by a 55 hp tractor at different operational speed of 1, 1.5, 2 and 2.5 km/h in the field and its performance was evaluated under 9 different operational speeds namely average sugarcane sett length, uniformity in sett length, number of sets, number of buds, percentage bud damage, overlapping of sets, percentage missing area, ground wheel skid, and tractor wheel slip for 5 m of planting distance. 1.5 km/h operational speed of planter was found best suited speed for the planting of sugarcane because at this speed we got best uniformity in sett length of sugarcane, maximum number of sett, maximum number of buds, minimum bud damage, minimum percentage missing area and desired overlapping in sett in 5m planting distance.

Key words : Tractor, sugarcane cutter planter, speed, buds, planting distance

Planting of sugarcane basically involves two operations-first cutting canes into pieces, called sets and secondly, opening of furrow, laying the sets in the furrows and covering these with a blanket of soil. These operations are sometimes modified to suit the varying agro-climatic conditions in different part of the country and are performed either manually with spades or furrows are opened with the help of animal drawn or tractor drawn ridger and sugarcane sets in the furrows are placed manually. The covering of sugarcane sets is done by covering mechanism while furrows are opened with the help of tractor drawn ridger. Simultaneously tamping roller is used to smoothen the field. The whole process of sugarcane planting is very tiresome and requires a lot of labour and time. The sugarcane planting is considered as one of the most important operations which involves factors like correct seed rate, appropriate depth of seed placement and uniformity in seed dropping with required overlapping. Uniform placement of the sugarcane sets is a key indicator of the quality of the planting operation. The uniformity in sugarcane sets distribution during planting is essential for uniform crop stand and higher production (1).

It has been noticed that only few sugarcane planters have been developed in the country having a metering mechanism. However performance was not found satisfactory because of the non-uniform placement of sets with desired overlapping. One of the common problem observed in the present sugarcane planters is improper metering device leading to non-uniform placement of sugarcane sets with desired overlapping. Planting of sugarcane, therefore, needs an equipment for accurate placement of sets in the furrows. Hence, there is a need to evaluate the performance of sugarcane planter. Keeping above facts in view, the present study was taken to evaluate the performance of two row tractor operated sugarcane cutter planter with following major objectives:

- To evaluate the performance of Sugarcane cutter planter on different parameter.
- To suggest the modifications in the design of planter, if required.

MATERIALS AND METHODS

The detailed description of the materials used and method followed while conducting the experiment for the analysis of performance of sugarcane planter are discussed here.

Parameters of evaluation of performance

Percentage overlapping : Percentage overlapping was determined by first calculating the total sett length in the planted distance. The total sett length was the summation of the individual sett length in the planted distance. The percentage overlapping of the sets was then calculated by the following relationship :

\[
\% \text{ overlapping} = \frac{L_s - L_p}{L_p} \times 100
\]

Where,

- \( L_s \) is total sett length in planted distance in (m)
- \( L_p \) is planted distance in (m)

Percentage unplanted / missing area : Missing area was the area where no sett was found. This was determined by calculating the total unplanted distance in 5 m which was the summation of all unplanted distances in 5 m. The percentage unplanted/missing area was determined by the following relationship:

\[
\% \text{ Missing} = \frac{(\text{Unplanted distance 5 m})}{5 \text{ m}} \times 100
\]
Seed rate, Kg/ha: The weight of sets dropped in 5m distance is taken by physical balance at the time of planting. Area was calculated by the multiplication of planted distance and the furrow width. The seed rate in Kg/ha is calculated as stated below.

\[
\text{Seed rate (kg/ha)} = \frac{\text{Quantity of seed dropped in } 5 \text{m} \times 100 \times 100}{5 \times 0.90 \times 100} = \frac{\text{Quantity of seed in } 5\text{m}, \text{gm} \times 2.667}{5 \times 0.90 \times 100}
\]

Bud damage, %: The number of buds damaged in 5m length were counted at the time of planting. The percentage bud damage was determined by the following relationship:

\[
\text{Bud damage (\%)} = \frac{B_1}{B_2} \times 100
\]

Where,

- \(B_1\) is Number of bud damage in 5m distance,
- \(B_2\) is Number of bud in 5m distance

Depth of planting: The depth of planting was measured with the help of a meter scale after digging the covered furrow. The readings were taken randomly at three places in each replication. Average depth of operation was calculated by taking the mean of all readings.

Slippage, %: The percentage slippage of the tractor is determined by measuring the distance traveled in 5 revolutions of tractor rear wheel at the time of actual operation of the equipment in the field and idle running of the tractor on the concrete surface under no load condition. The slippage is calculated by using the following relationship:

\[
\text{Slippage, \%} = \frac{X_1 - X}{X_1} \times 100
\]

Where,

- \(X\) is distance covered at load condition, m in 5 revolutions,
- \(X_1\) is distance covered at no load condition, m in 5 revolutions

Ground Wheel Skid, %: The revolutions of ground wheel are counted at the time of planting and distance is measured for 5 revolutions. The revolutions of ground wheel are also counted on the concrete surface and distance covered in 5 revolutions is measured.

\[
\text{Wheel skid} = \frac{D_d - D_{th}}{D_{th}} \times 100
\]

Where,

- \(D_d\) is actual distance covered in 5 revolutions of ground wheel in (m),
- \(D_{th}\) is theoretical distance to be covered in 5 revolutions of ground wheel in (m)

Effective field capacity: To determine the effective field capacity of machine, the time taken by the tractor to complete the operation including turning losses in plot is noted with the help of stop watch. The effective field capacity “E.F.C.” of the machine is calculated by using the relationship given below:

\[
\text{Effective field capacity, ha/h} = \frac{\text{Area covered ha}}{\text{time taken, h}}
\]

Field efficiency: In order to calculate the field efficiency of the machine, forward speed of travel is determined. The time taken for a marked length of plot is determined at three different places. By taking average value of time, the speed of travel in km/h is calculated. The field capacity and field efficiency are determined in following manner.

The theoretical field capacity (T.F.C.) is first calculated as follows:

\[
\text{T.F.C. (ha/h)} = \frac{\text{Speed of travel (km/h)} \times \text{Width of coverage (m)}}{10}
\]

Therefore, the field efficiency is determined by the following relationship.

\[
F_{\text{eff}}(\%) = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 10
\]

Description of tractor mounted two row sugarcane cutter planter: Tractor operated sugarcane cutter planter was developed by IISR Lucknow for the efficient planting of sugarcane. The planter cut the sugarcane sett, makes the furrow and cover the soil over the sett and compact it simultaneously in a single operation. It was operated by John deere 5310 tractor of 55 HP. Different component of planters are shown in fig.-1.

Power Transmission System of planter: Power transmission system consisted of four shafts namely a ground wheel shafts, two sugarcane sett cutting shafts and a fertilizer metering mechanism shaft. It has 8 bearings, two bevel gears, two bevel pinions, one chain and two sprockets as shown in power transmission diagram figure-2. The cutting unit and fertilizer metering mechanism takes power from ground wheel of the planter, as ground wheel consists of lugs, it experiences a resistance from the soil during the motion of planter and it starts rotating. The ground wheel is attached with the main shaft also start revolving with ground wheel. Two bevel gears are mounted on the main shaft 45 cm from the centre of shaft. It consists of 18 teeth, transfer the power at right angle to the bevel pinion having 10 teeth. Bevel pinion is attached with sett cuttings shaft with help of two bearing. At the end of shaft, there is a disc of dia 16
was allowed to run at engine speed of 1 km/h for planting the sett metering units. The tractor attached with planter sugarcane in the hoppers and for feeding the canes into low gear. Two persons were employed for filling the km/h respectively in 1

2000 engine rpm which gave operating speeds of 1, 1.5, 2, and 2.5 km/h. Physical dimensions of the sugarcane such as length and diameter were taken. Observations of number of setts/5m, number of buds/setts, depth of operation, weight of setts/5m, gap between two setts and overlapping were measured. Also soil samples were collected for determining soil moisture content and bulk density.

RESULTS AND DISCUSSION

Effects of operating speed on different parameter like sett length, frequency distribution of sett, number of sett, number of buds, percentage bud damage, overlapping of setts, percentage missing area, tractor wheel slippage, and ground wheel skid of planter is mentioned and best suited operating condition is analysed.

Effect of speed on sugarcane sett length: Effect of speed on sugarcane sett length was determined for four different speeds of operation and three replication for each speed. The result has been presented in Table-1. The average sett length in at 1, 1.5, 2 and 2.5 Km/h forward speed was 38.66, 36.83, 38.33 and 33.66 cm respectively. At speed of 1 km/h, maximum sett length were obtained and by increasing the speed from 1 to 1.5 km/h the sett length decreased up to 36.83 cm. From fig.-3 we observed the variation of sett length with increase in operational speed of planter. Minimum sett length was found at 2.5 km/h of operational speed.

Effect of speed on frequency distribution of sett: The frequency distribution of sett as experimentally determined for different engine speed and data related to the same has been presented in table-2. When the planter was operated at any particular speed, the different range of sett length was obtained and it lied from 5 cm to 45 cm.

Time taken in 5 revolutions of tractor wheel was also measured by stop watch to determine the forward speed of the tractor. Test was replicated three times by operating the machine at each speed. The same procedure was followed to operate the machine in other speeds of 1.5, 2, and 2.5 km/h. In this way power finally reaches from the ground wheel to the cutting unit. To operate the fertilizer metering mechanism, fertilizer box shaft takes power from ground wheel shaft and through chain sprocket system. On the main ground wheel shaft, a sprocket of 25 cm diameter having 40 teeth is mounted on the centre of shaft. It deliver the power through the chain to fertilizer box shaft having a sprocket of 10 cm dia consisting of 16 teeth as shown in power transmission system diagram, with help of this power a fluted roller type metering mechanism is operated for fertilizer metering purpose.

Test procedure: To evaluate the performance of sugarcane planter, an experiment was conducted in a completely randomized design in a field in the Crop Research Centre, Pantnagar having silty clay loam type soil. Sugarcane variety CO 3684 was used in the field test. An area of 0.135 ha was taken to conduct the experiment with field size of 45m length and 30m width. The sugarcane seed was placed at both ends and middle of the experimental plot to ensure regular and smooth seed availability for the planter. The Equipment was operated with John deere 5310 tractor of 55HP at 1000, 1500 and 2000 engine rpm which gave operating speeds of 1, 1.5, 2 km/h respectively in 1st low gear and 2.5 km/h in the 2nd low gear. Two persons were employed for filling the sugarcane in the hoppers and for feeding the canes into the sett metering units. The tractor attached with planter was allowed to run at engine speed of 1 km/h for planting sugarcanes. The distance travelled in 5 revolutions of tractor and ground wheel were measured separately to determine the wheel slippage and skid percentage of sugarcane planter drive wheel respectively.

It is clear from the table that at 1 km/h speed, 5.7% setts falls in length from 0-10 cm, 5.7% from 20-25 cm, 8.6% from 25-30 cm, 11.4% from 30-35 cm, 62.9% from 35-40 cm, and remaining 5.8% sett varies in length above 40 cm. At 1.5 km/h speed, 4.5% setts varied in length from 10-15 cm, 2.3% from 15-20 cm, 2.3% from 20-25 cm, 2.3% from 25-30 cm, 2.3% from 30-35 cm, and 86.4% from 35-40 cm. At 2 km/h speed, 2.5% setts varied in length from 0-10 cm, 2.5% from 15-20 cm, 2.5% from 20-25 cm, 2.3% from 25-30 cm, 2.3% from 30-35 cm, and 72.5% from 35-40 cm, and remaining 12.5% sett varies in length above 40 cm. At 2.5 km/h speed, 3% setts varied in length from 0-10 cm, 6% from 10-15 cm.
Effect of speed on sett length: Table-1 shows the average sett length at different engine speed in 5 m planting distance.

<table>
<thead>
<tr>
<th>Replication</th>
<th>Sett length (cm)</th>
<th>1 km/h</th>
<th>1.5 km/h</th>
<th>2 km/h</th>
<th>2.5 km/h</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>40</td>
<td>36</td>
<td>38</td>
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</tr>
<tr>
<td>2</td>
<td></td>
<td>38</td>
<td>38</td>
<td>38</td>
<td>39</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>38</td>
<td>36.5</td>
<td>39</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>116</td>
<td>110.5</td>
<td>115</td>
<td>101</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>38.66</td>
<td>36.83</td>
<td>38.33</td>
<td>33.66</td>
</tr>
</tbody>
</table>

Effect of speed on number of setts: Table-2 shows the number of setts in 5 m planted length at different forward speeds.

<table>
<thead>
<tr>
<th>Replication</th>
<th>Number of setts</th>
<th>1 km/h</th>
<th>1.5 km/h</th>
<th>2 km/h</th>
<th>2.5 km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>15</td>
<td>16</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>10</td>
<td>18</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>39</td>
<td>49</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>13</td>
<td>16</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

3% from 15-20 cm, 6% from 20-25 cm, 12% from 30-35 cm, and 69.6% from 35-40 cm. From above observation it is clear that we found maximum uniformity in sett length of sugarcane at 1.5 km/h and minimum uniformity at 1 km/h. The major sett length was ranging between 35-40 cm.

Effect of speed on the number of setts: Effect of speed on number of sugarcane sett was determined for four different speeds of operation and three replication for each speed. The result has been presented in table-1. Number of sets in 5 m planting distance were obtained at different operational speed. At 1, 1.5, 2 and 2.5 Km/h speeds, number of setts were 13, 16, 13 and 12, respectively Initially the number of sett was increasing from 13 to 16 and after that it decreased with increase in the operational speed from 1 to 2.5 km/h. From fig 3.1 we observed the variation of number of setts with increase in operational speed of planter.

Effect of speed on number of buds: The total number of buds in 5 m of planting distance were determined separately for all four operational speeds with three replication of each observation, and result has been presented in table-3. It was observed from the table that the number of buds in 5 m planting distance at 1, 1.5, 2, and 2.5 Km/h speed found to be 42, 43, 33 and 27 respectively. From fig.-3 it is clear that the maximum number of buds appeared at speed of 1.5 km/h and number of buds were minimum at speed of 2.5 km/h. From 1 to 1.5 km/h number of buds remained almost constant and after that it decreased from 43 to 27 with increase in speed from 1.5 to 2.5 km/h.

Bud damage: Effect of speed on bud damage was determined for four different speeds of operation and three replication were taken for each speed. The result has been presented in table-4. During the planting of sugarcane the bud may damage due to the impact of cutting blades and since bud is responsible for germination, so bud damage is an important aspect to study. The percentage bud damage at 1, 1.5, 2 and 2.5 km/h speeds were found to be 7.14, 6.18, 9 and 11.11%, respectively. The maximum bud damage was found at 2.5 km/h and minimum bud damage appeared at speed of 1.5 km/h. From fig.-3 it is clear that initially the percentage bud damage decreased from 7.14 to 6.18% with increase in speed and after that it increased from 6.18% to 11% with increase in operational speed from 1.5 to 2.5 km/h. Once again 1.5 km/h appeared to be the best suited speed as the percentage bud damage is minimum in this case.

Overlapping of setts: When two, or more than two setts coincides partly with each other, it is called as overlapping of the setts. Small percentage of Overlapping of setts is necessary, for uniform germination of plants. The overlapping between the setts in 5 m of planting distance was determined separately for all four operational speeds with three replication of each observation, and result has been presented in table 4.8. As we can see that at 1, 2 and 2.5 km/h there is no any overlapping between the setts. We found an overlapping of 3.5% only in case of 1.5 km/h of speed.

Percentage unplanted/missing area: Unplanted or missing area refers to the section of furrow where no sett was found. In that areas plant will be missing after the germination, by mean of which uniformity and production will affected. The table 4.9 shows the percentage unplanted/missing area at different engine speeds. The unplanted/missing area at 1, 1.5, 2 and 2.5 km/h speeds of operation were 24.87, 22.6, 24.73 and 24.87% respectively. From table it is clear that unplanted/missing area was almost constant at different operational speed of planter. Percentage missing area was minimum at 1.5 km/h.

Effect of speed on tractor wheel slippage: The tractor wheel slippage was determined separately for all four operational speeds with three replication of each observation, and result has been presented in table 4.10. The average tractor wheel slippage at 1, 1.5, 2 and 2.5 km/h forward speeds was observed to be 2.9, 5.08, 5.43 and 6.3%, respectively. The maximum slippage was found at 2.5 km/h as 6.3% and minimum slippage of 2.9% was obtained at the minimum speed of operation i.e at 1 km/h. From Fig.-3 it is clear that tractor wheel slippage continuously increased from 2.9 to 6.3% with increase in operational speed from 1 to 2.5 km/h.
Effect of speed on ground wheel skid of planter:
Sugarcane cutter planter takes the power for cutting of sett and for fertilizer metering mechanism from the ground wheel, so ground wheel skid will directly affect the parameters. Effect of speed on ground wheel skid was determined for four different speeds of operation and three replication were taken for each speed. The result has been presented in table-6. The average ground wheel skid at 1, 1.5, 2 and 2.5 km/h forward speeds was observed to be 11.9, 14.04, 14.04 and 13.47% respectively. The minimum ground wheel skid was observed at 1 km/h and with increase in speed of operation, it increased slightly. After further increase in speed from 1.5 to 2.5 km/h ground wheel skid remained almost constant.

CONCLUSION

After analysing the data carefully, it was observed that 1.5 km/h is most suitable speed for the operation of planter. Following are the reason behind this.
- At this speed we found best uniformity in sett, as 86.4% of setts were in the same range of sett length.
- At above mentioned speed we obtained maximum number of setts (16) in 5m of planting distance.
- The maximum number of buds (43) were observed at speed of 1.5 km/h.
- Percentage bud damage was minimum at this speed as (6.18%).
- This was the only speed of operation at which we got an overlapping of 3.5%. A t other operational speed there was not any overlapping.
- Percentage missing area was minimum (22.6%) at this speed.

Therefore operating this machinery at this speed will be most economical and beneficial.

REFERENCES