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Performance evaluation of bullock drawn cotton planter

■ **S.H. THAKARE, D.M. KADAM AND V.V. SARAF**

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See end of the Paper for authors' affiliation

Correspondence to :

V.V. SARAF
Department of Farm Power and Machinery, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA
Email : vinusaraf17@gmail.com

■ **ABSTRACT :** A 3-row bullock drawn cotton planter was evaluated on field of the Department of Farm Power and Machinery, Dr. PDKV, Akola using NHH-44 variety of cotton. The average moisture content of soil was 33 per cent. The field performance tests conducted over an 0.182 ha area revealed that the average horse power for the planter was 0.467 for an average draft of 48.53 kgf and average speed of 2.6 km/hr. The theoretical field capacity, effective field capacity, field efficiency obtained for continuous operations of planter were 0.47 ha/day, 0.34 ha/day and 72.51 per cent, respectively. In view of the above performance it can be concluded that newly developed bullock drawn cotton planter is suitable for cotton planting.

■ **KEY WORDS :** Spacing adjustment, Gear ratio, Hopper, Seed plate, Ground wheel

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Cotton, the 'white gold' is India's principle commercial crop play a key role in national economy in terms of both employment generation and farming exchange. The area under cotton cultivation in India is 121.78 lakh hectares and production is 353.00 lakh bales with productivity of 493 kg lint/ha where as area under cotton in Maharashtra is 41.25 lakh ha with average productivity of 305 kg lint/ha. In Vidharbha area under cotton cultivation is 1.70 million ha with production of 1.73 millions tones (Anantacher, 2001). Sowing of cotton is labour intensive, ultimately resulting in higher cost of cultivation. The labour requirement for planting cotton seed is high (15%) which is next to harvesting operation (44%)Vaiyapuri (2004). Thus, it results in higher cost of cultivation.

The sowing of the crop is the placement of seed in the soil at the proper depth with proper moisture and soil temperature. At present the cotton is sown either by drilling or dibbing. The Desi cotton is generally drilled by using locally available wooden seed drill drawn by pair of bullock. Another method is dibbling by manually labour which is generally adopted for hybrid varieties. Metering in drilling method is not perfect, the seed rate per hecter may be high or low, whereas manually dibbling method is labour intensive, time consuming and expensive. Hence, there is need to develop a precision equipment which can meter cotton seed, plant them at predetermined depth with uniform seed to seed and row to row spacing and essentially saves labour, time of operation, cost of operation and costly cotton seeds. Sharma *et al.* (1983) developed a bullock drawn single row seed cum fertilizer drill with combined furrow opener for seed cum fertilizer drill placement and suitable for wheat, cotton and gram crops. Kathirvel *et al.* (2001) evaluated that the till planter machine for cotton has forward speed of operation was optimized as 1.4m/s. The average draft and fuel consumption unit as 2300 N and 3.82 x 10^{-3} m^3 / hr, respectively. The field capacity of the unit was 0.81 ha / hr. with field efficiency of 71.43 per cent. The till planter resulted in 23.65, 90.09 and 18.25 per cent saving in cost, time and energy, respectively when compare to conventional method. Taking in view the above aspects, an attempt was made to develop a suitable bullock drawn cotton planter which fulfills all the requirements.

■ METHODOLOGY

Features of bullock drawn cotton planter :

A machine essentially consists of major components like M.S. main frame with adjustable (beam) hitching unit, M.S. beam, ground drive cum transport wheel of 44 cm diameter, ground wheel shaft of 25.4 mm diameter with clutch assembly, counter shaft with set of sprocket (gear box), chain and sprocket type transmission system with adjustable speed ratio 1:0.875 to 1:2.187, handle, furrow openers and three separate seed hoppers with vertical plate type seed metering mechanism.

During operation of planter, vertically mounted seed metering plate rotate in same direction, as that of the rotation of ground wheel, after receiving power from counter shaft

through chain drive. Seed flows by gravity from small rubber seed tube provided at bottom of seed hopper, into cell or cavity spaced along the periphery of vertical plate at specified intervals. The continuous motion of metering plate accommodates seed in the plate's cell and drops them into funnel and then to seed tube attached to furrow openers, where they are dispensed into the soil in row with predetermined spacing and depths. The clutch plate was attached to metering mechanism to stop it during the turns.

Performance evaluation of bullock drawn cotton planter :

The performance of modified bullock drawn cotton planter was evaluated as per RNAM test code by taking laboratory test. The field trial of BD cotton planter was conducted in the field of Dr. PDKV, Akola. The size of plot selected for trial was 200 m× 50 m (10000 m^2 or 1 ha) the row to row spacing was kept 60 cm. The variety of cotton NHH-44 was used for field trial. The performance of bullock drawn cotton planter was evaluated in term of following :

Moisture content :

It was determined by oven drying method. Five samples were collected randomly at 15 cm depth from test plot and then kept in oven for 24 hr at the temperature of 105° C. Moisture content was calculated by weighing the sample before and after drying :

$$\text{Moisture content (d.b)\%} = \frac{W_1 - W_2}{W_2}$$

where,

W_1 = Initial weight of sample, g

W_2 = Oven dry weight, g.

Speed of operation and turning time :

The forward speed of the machine and turning time required were determined by obtaining distance and time required for turning (in seconds) with the help of stop watch:

$$\text{Speed (km/hr)} = \frac{\text{Distance covered (65m)}}{\text{Time required to cover above distance (sec.)}} \times 3.6$$

The draft and horse power required :

To measure the depth of the planter, a spring was attached between the yoke and the frame of the implement. The readings were recorded at different places in the field and inclination of beam was determined by measuring the vertical and horizontal distance.

$$D = P \cos \theta$$

$$\theta = \tan^{-1}\left(\frac{y_2 - y_1}{x}\right)$$

where,

D = Draft in kgf

θ = Angle between line of pull and horizontal in degrees

$y_2 - y_1$ = Difference in elevation

x = horizontal distance

P = Pull (dynamometer reading) in kg.

Horse power required was calculated from average draft and average speed of planter :

$$HP = \frac{\text{Draft (kgf)} \times \text{Speed (km/hr)}}{270}$$

Ground wheel slip :

It was calculated by recording actual number of revolutions of ground wheel for given distance :

$$\text{Ground wheel slip (\%)} = \frac{N_t - N_a}{N_t} \times 100$$

$$N_t = \frac{L}{\pi D} = \frac{\text{Distance to be traved}}{\text{Circumference of wheel}}$$

where,

N_t = Theoretical number of revolutions made by ground wheel for given distance.

N_a = Actual number of revolutions made by ground wheel for given distance.

Field capacities and field efficiency :

Theoretical field capacity, effective field capacity and field efficiency were calculated by using formulae :

$$\text{Theoretical field capacity (ha/hr)} = \frac{\text{Avg. speed of planter (km/hr)} \times \text{Width of planter (m)}}{10}$$

$$\text{Effective field capacity (ha/hr)} = \frac{\text{Actual area covered during test, ha}}{\text{Actual time required to cover the area, hr}}$$

$$\text{Field efficiency (FE)} = \frac{\text{EFC (ha/hr)}}{\text{TFC (ha/hr)}} \times 100$$

Depth of seed placement and average number of seed per hill:

Total 20 observations were taken from entire field to measure average depth of seed placement. Also average number of plant per hill was calculated by counting number of plants on hill at randomly selected 50 hills.

Hill to hill spacing and row to row spacing :

The distance between hills in a row and between rows were measured with the help of steel tape, 10 days after sowing at randomly selected 50 hill pairs and 100 places, respectively.

Number of plants per meter, per hector and seed rate :

Number of plants per meter and plants population per hectare were calculated from values of average hill to hill spacing and average row to row spacing observed. Seed rate was calculated by recording actual quantity of seed required

(kg) to plant one hectare field with cotton :

$$\text{No. of} = \frac{100}{\text{Avg. plant spacing observed} \times \text{plant/m}}$$

$$\text{No. of} = \frac{10^8}{\text{Avg. plant spacing observed} \times \text{Avg. row spacing observed} \times \text{plants/ha}}$$

Missing hills, dropped on hill :

To find out per cent no seed, one seed, two seed, and three seed on hill, the observation of number of plants per hill were taken in randomly selected 15 rows in field :

$$\text{Missing hills (\%)} = \frac{\text{Missing hills}}{\text{Theoretical no. of hills}} \times 100$$

$$= \frac{\text{Theoretical no. of hills} - \text{Actual no. of hills}}{\text{Theoretical no. of hills}} \times 100$$

$$\text{Single seed (\%)} = \frac{\text{Avg. no. of single dropped}}{\text{total no. of hills}} \times 100$$

$$\text{Two seed (\%)} = \frac{\text{Avg. no. of two dropped}}{\text{Total no. of hills}} \times 100$$

$$\text{Three seed (\%)} = \frac{\text{Avg. no. of three dropped}}{\text{Total no. of hills}} \times 100$$

RESULTS AND DISCUSSION

Following results were obtained after conducting field test of cotton planter as per standard procedure.

Moisture content of soil varied from 28 per cent to 37 per cent and average moisture content was found to be 33 per cent which was sufficient for satisfactory work of planter in field. The average speed of planter was found 2.6 km/hr and average time lost turning was found to be 0.231 min. The average draft required was observed 48.53 kgf and average power required to pull was computed to be 0.46 hp. The average ground wheel slip occurred during operation was found 7.38 per cent. Theoretical field capacity, effective field capacity and filed efficiency of 3-row planter were found to be 0.47 ha/hr, 0.34 ha/hr and 72.51 per cent, respectively. Depth of seed placement varied from 3 to 6.2 cm and average depth was 4.9 cm as against expected depth 5 cm. The average hill to hill spacing, row to row spacing and number of plants per hill found were 43.84 cm, 59.78 cm and 2.04, respectively as expected values 45 cm, 60 cm and 2, respectively. Thus, deviation of observed hill spacing and expected hill spacing (45 cm) found was slightly more in Fig. 1 and 2. The number of plants per metre length and average seed rate were found 2.28 and 4.6 kg/ha, respectively as against recommended 2.22 and 4.7 kg/ha for NHH – 44 variety of cotton.

Table 1: Performance result of bullock drawn cotton planter

Sr. No.	Particulars	Performance values
1.	Moisture content, per cent	33
2.	Average forward speed, km/hr	2.6
3.	Average turning time, minutes	0.231
4.	Average draft required, kgf	48.53
5.	HP required	0.46
6.	Average ground wheel slip, per cent	7.38
7.	Theoretical field capacity, ha/hr	0.47
8.	Field efficiency, per cent	72.51
9.	Depth of seed placement, cm	4.9
10.	Average hill to hill spacing, cm	43.84
11.	Average row to row spacing, cm	59.78
12.	Number of plants / meter length	2.28
13.	Plant population, plant/ha	38.220
14.	Seed rate, kg/ha	4.6
15.	Number of plants per hill	2.04
16.	Missing hills, per cent	4.62
17.	Single seed per hill, per cent	3.48
18.	Two seed per hill, per cent	49.35
19.	Three seed per hill, per cent	42.55

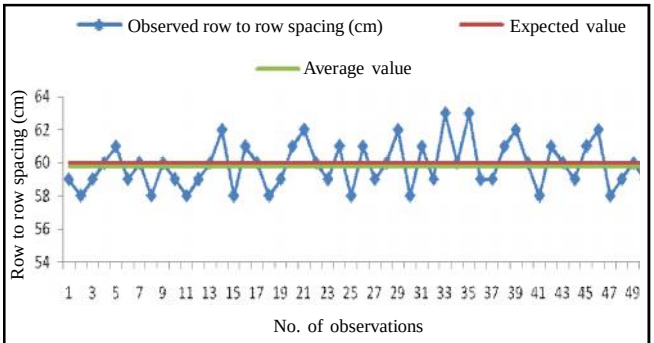

Fig. 1 : Deviation of row to row spacing from expected values and average values

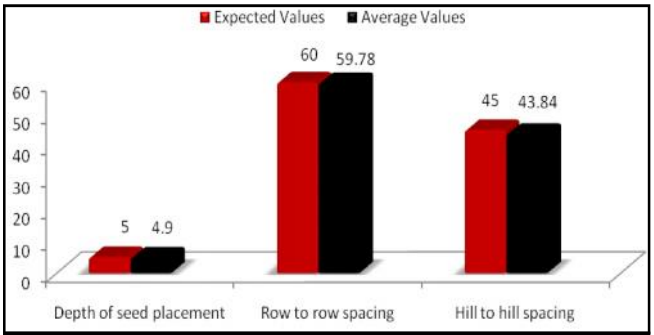

Fig. 2 : Expected and average value of depth of seed placement, row to row and hill to hill

The average plant population achieved by planter was observed 38,220 plants/ha which was found 3.19 per cent higher than recommended plant population (37,037) for given variety NHH – 44. The percentage of missing hills, one seed per hill (dropped), two seed per hill and three seed per hill found were 4.62, 3.48, 49.35 and 42.55 per cent, respectively (Table 1). Hence, percentage of two seed per hill was maximum and needs minimization of 3-seeds per hill (Fig.3).

Conclusion :

From the results obtained it was concluded that, the developed three row bullock drawn cotton planter is more suitable to farmers in terms of field capacity, field efficiency draft required and power consumption and is most suitable to hybrid varied of cotton crop and overall performance of machine was found satisfactory.

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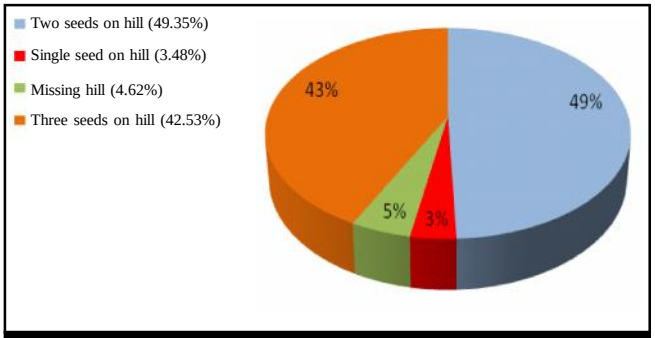

Fig. 3 : Performance of missing hills, single, two, and three seeds on hill observed in the randomly selected 15 rows in field

Authors' affiliations:

S.H. THAKARE, Department of Farm Power and Machinery, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

D.M. KADAM, Department of Farm Power and Machinery, Vasantrao Naik Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA

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