International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 1430-1434

Received: 03-09-2019
Accepted: 07-10-2019

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Performance evaluation of battery operated seed drill

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Abstract
Chickpea has occupied unique place in cropping system of the Indian farmers due to its winter growing ability and high nutritional values in diet. During the study, the required physical properties of chickpea seed was determined. The developed seed drill was tested for laboratory and field test. The overall size of developed seed drill was 2030×1150×1050 mm. It was operated by 24V, 28Ah battery. A DC motor of 400 watt 24V was used as power source. Ground wheels have 14 lugs. It sowed seeds in two rows at a time. The overall weight of developed seed drill was 54 kg. In the field, draft of implement 37.19 kgf, missing index 2.46%, depth of seed placement 6.10 cm, germination per cent 84.49%, and cost of operation of the developed seed drill were ₹ 350.22/ha. The field efficiency of the developed seed drill was found as 83%.

Keywords: DC motor, battery, seed drill, chickpea crop

Introduction
Sowing of seed is considered as one of the most important operation that involves factors like correct seed rate, appropriate depth of seed placement and required seed spacing. Several studies related to the crops which need a fixed distance between plant to plant, show that use of country seed drills needs a skilled person to meter the seed accurately if at all skilled person is not available then there are chances that plant population may not be up to level and this lead to 10 to 20% higher seed rate and thinning is required to get desired plant population (Kalkat *et al*., 1997) [2].

Pulses is one of the important crops. The food value of pulses is essential due to its high protein content. The pulses crop is mainly grown for its grains which are consumed either whole or in split form (*dal*). Properly and timely sowing has a dominant effect on germination of seed, plant growth, plant population in the field and ultimately on the total production. In general, pulses is sown by animal/tractor drawn seed drill or manually. Tractor drawn seed drills are suitable for medium or big farms with high seed rate. Draft animals are not only becoming costly but they are diminishing also. More than 75% of Indian farmers belong to small and marginal category and doing all operations manually. Manual sowing is a highly labour intensive, tedious, time consuming and not technically suitable. Therefore, a double row battery operated seed drill for pulses seed was developed and tested.

Materials and Methods
The major components of the machine include the metering unit (cell, metering shaft), Ground wheel, shovel, battery, DC motor, chain and sprocket, seed hopper, covering and the frame. Leafy crop stem was cut by the cutter bar blade which was powered by engine. The Ground wheel was power by DC motor and they transmit to the metering mechanism with help of chain and sprocket (Seed spider company). The details of machine are given below Figure 1.

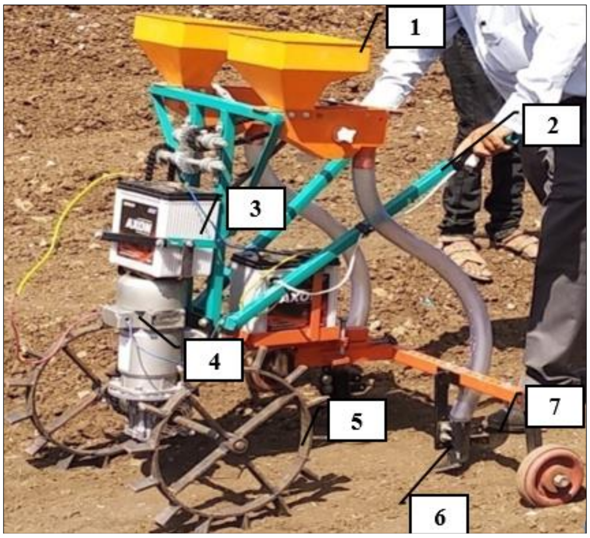

Fig 1: 1. Seed hopper 2. Handle 3. Battery 4. DC motor 5. Ground wheel 6. Shovel 7. Supporting wheel

Location of experiment

In order to evaluate the performance of battery operated seed drill, experiment was carried out at Department of Farm Machinery and Power Engineering, Collage of Agricultural Engineering and Technology, JAU, Junagadh (Gujarat) during the year 2019.

Performance evaluation of the battery operated seed drill

Experiments were conducted by varying forward speed (2.15, 2.87 and 3.58 km/hr) and hopper filling (full, ¾, 1/2) in different combinations. Two factorial completely randomized design was adapted for the experiment by taking three replications (Panse and Sukhatme, 1985) [1]. The results were analysed statistically. The performance of the device was evaluated by determining draft, field efficiency, missing index and multiple index. The cost of seed drill was also calculated. The depreciation was calculated by straight line method (Witney, 1988) [4]. The seed drill was able to sawing double rows at a spacing of 45 cm row to row spacing. Row to row spacing is adjustable.

a. Draft of implement

The horizontal component of pull, in the line of motion is considered as draft. Draft can be calculated as:

$$\text{Draft (kg)} = P\cos\theta$$

Where

P = pull

θ = angle of inclination

b. Number of missing

The seed drill was operated in the field and the distance between two consecutive seeds was measured for the length of about 10 m in each row. If the distance between two consecutive seed exceed 1.5 times of the theoretical spacing, then this was considered as missing. Following this procedure, number of missing was determined for all condition.

Fig 2: Spacing between Plant

c. Number of multiples

If two seeds were found per hill or at same spot in row at the time of measuring the distance between two consecutive seeds, then this was considered as number of multiples. Even if a cluster or four seeds was found it was taken as multiples.

d. Field efficiency

The rate of coverage of the machine based on 100% of time at rated speed and covering 100% of its rated width is known as theoretical field capacity.

$$\text{Theoretical field capacity (ha/h)} = \frac{\text{Width of coverage(m)} \times \text{Speed(km/h)}}{10}$$

And

$$\text{Actual or Effective field capacity (ha/h)} = \frac{\text{Area of plot (ha)}}{\text{Time taken (h)}}$$

Now, the field efficiency was calculated as follows:

$$\text{Field efficiency (\%)} = \frac{\text{Actual or Effective field capacity (ha/h)}}{\text{Theoretical field capacity (ha/h)}}$$

Results and Discussion

I. Combined effect of hopper filling and forward speed on draft

Table 1 shows the combined effect of hopper filling and forward speed and their interaction on the change in draft. The interaction between hopper filling and Forward speed was found non-significant at 5 per cent level of significance. The highest value of draft in full hopper and 3.58 km/hr forward speed.

Table 1: Effect of interaction of hopper filling and Forward speed on draft

Forward speed, km/h	Draft, Kgf		
	Hopper filling		
	Full	3/4	½
2.15	37.19	36.28	36.12
2.87	38.20	37.79	37.18
3.58	40.85	38.34	38.04

SEM 0.48 $CD_{0.05}$ NS

Draft for different Forward speed against hopper filling (Fig 3). This is evident from the observation that for all different Forward speed the full hopper filling achieved the highest draft, followed by the 3/4 hopper filling and 1/2 hopper filling. The draft was increase with increase in quantity of hopper filling due to increase in mass of seed.

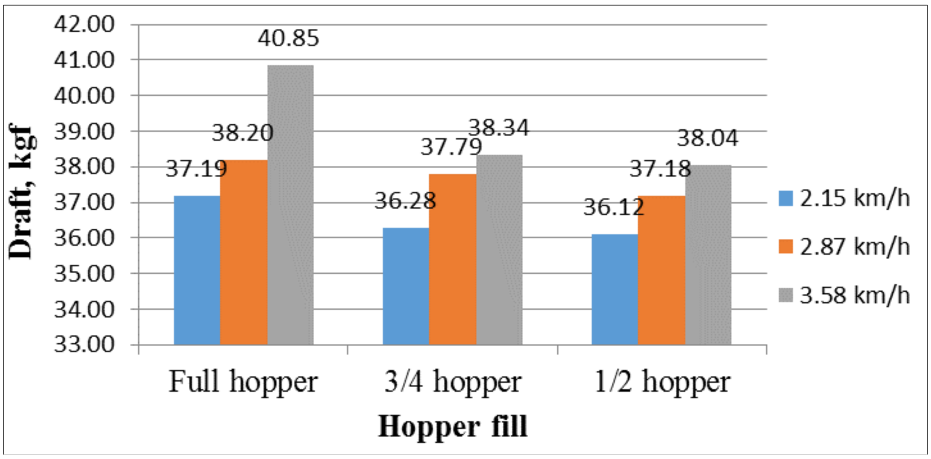

Fig 3: Combined effect of hopper filling and forward speed on draft

II. Combined effect of hopper filling and forward speed on missing index

Table 2 shows the combined effect of hopper filling and forward speed and their interaction on the change in missing index. The interaction between hopper filling and forward speed was found non-significant at 5 per cent level of significance. The highest value of missing index in full hopper and 3.58 km/hr forward speed.

Table 2: Effect of interaction of hopper filling and forward speed on missing index

Forward speed, km/h	Missing index, %		
	Hopper filling		
	Full	¾	½
2.15	3.63	2.40	1.35
2.87	1.42	1.39	1.00
3.58	4.02	3.22	1.42

SEM 0.040
$CD_{0.05}$ 0.120

Missing index for different forward speed against hopper filling (Fig 4). This is evident from the observation that for all different Forward speed the full hopper filling achieved the highest missing index, followed by the 3/4 hopper filling and 1/2 hopper filling.

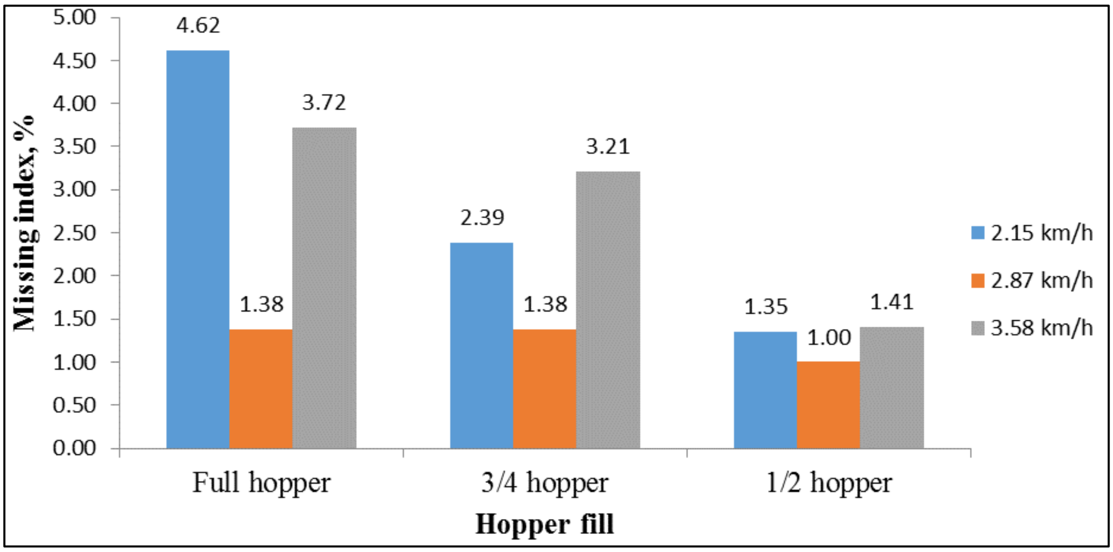

Fig 4: Effect of hopper filling on missing index at different level of forward speed

III. Combined effect of hopper filling and forward speed on number of multiples

Table 3 shows the combined effect of hopper filling and forward speed and their interaction on the change in number of multiples. The mean values of the number of multiples and their non-significance are shown in Table 3.

Table 3: Effect of interaction of hopper filling and forward speed on number of multiples

Forward speed, km/h	Number of multiples, %		
	Hopper filling		
	Full	3/4	½
2.15	12.35	11.32	12.06
2.87	11.40	10.05	10.05
3.58	16	14	11.67

SEM 0.19
$CD_{0.05}$ 0.56

Number of multiples for different forward speed against hopper filling (Fig 5). This is evident from the observation that for all different forward speed the full hopper filling achieved the highest number of multiples, followed by the 3/4 and 1/2 hopper filling due to normal weight increase with increase in hopper filling.

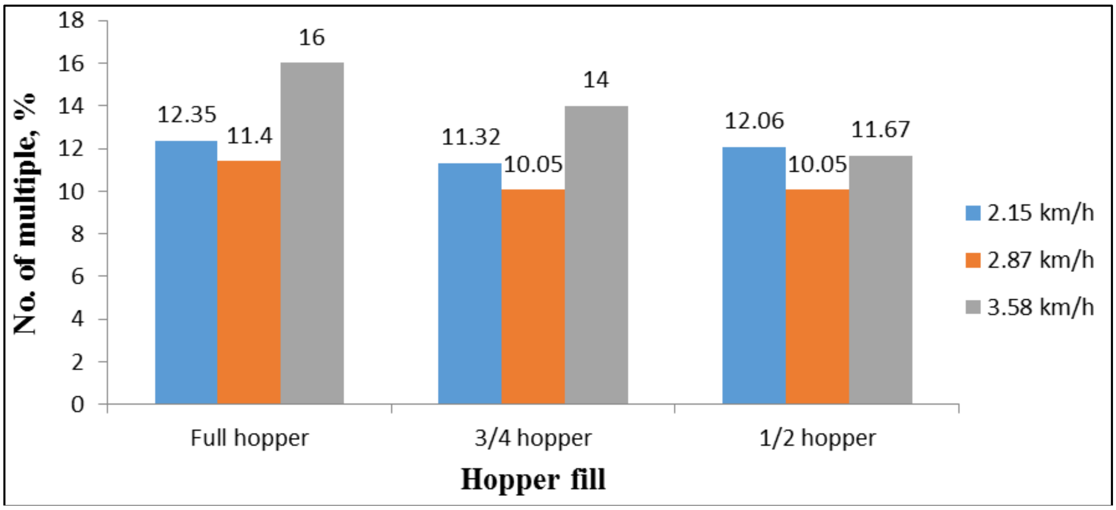

Fig 5: Effect of hopper filling on number of multiples at different level of forward speed

IV. Combined effect of hopper filling and forward speed on field efficiency

Table 4 shows the combined effect of hopper filling and forward speed and their interaction on the change in field efficiency. The mean values of the field efficiency and their non-significance are shown in Table 4.

Table 4: Effect of interaction of hopper filling and Forward speed on field efficiency

Forward speed, km/h	Field efficiency, %		
	Hopper filling		
	Full	¾	½
2.15	81.78	82.25	81.00
2.87	79.97	79.04	77.05
3.58	70.08	69.25	70.83

SEM 0.01
$CD_{0.05}$ NS

Field efficiency for different forward speed against hopper filling (Fig 6). This is evident from the observation that at same forward speed and different hopper filling, the negligible difference found for mean field efficiency.

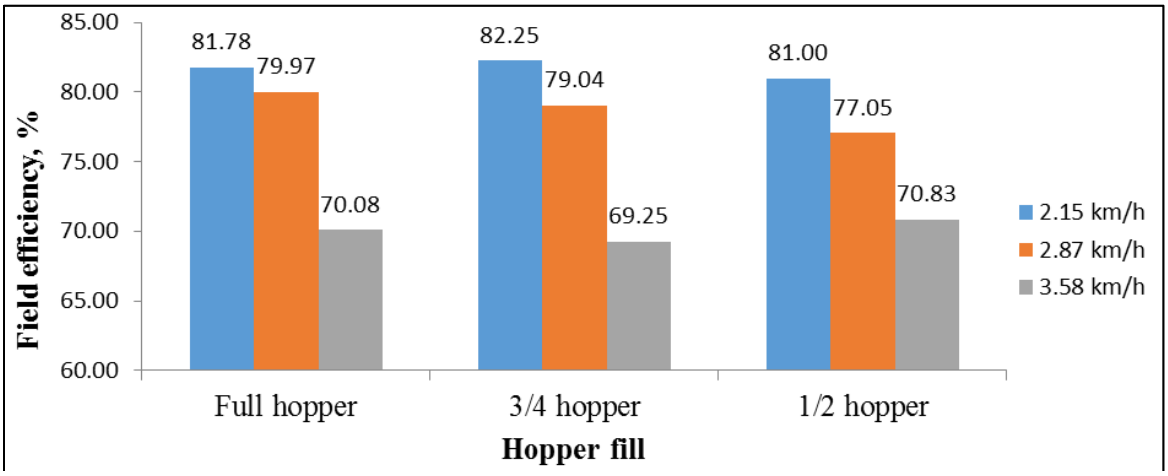

Fig 6: Effect of hopper filling on field efficiency at different level forward speed

Conclusion

The chickpea sowing by battery operated seed drill, sufficient seed rate was found as 63.20 kg/ha, mechanical damage 1.20%, required draft of implement 37.19kgf, missing index 3.63%, number of multiples 12.35%, and 81.78% field efficiency at 2.15 km/h on full hopper filling. The performance of the developed seed drill found better at 3/4hopper filling as compared to full and 1/2 hopper filling at 2.87 km/hr forward speed.

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