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Research Article

PERFORMANCE STUDY OF A LOW COST MANUALLY OPERATED SEED DRILL FOR SOWING OF JUTE

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Abstract- A low cost manually operated seed drill for jute and other similar small seeds has been developed and evaluated in the laboratory and field condition to study its seed pattern characteristics and economic viability for small and marginal farmers in the jute growing areas of Indo Gangetic Plain. The machine was evaluated with Jute variety JRO-204 (Suren) in ICAR-CRIJAF Farm. From the experiments, it was found that the seed requirement for developed seed drill was 3-4 kg/ha against 6-7 kg/ha in broadcast sowing. The effective field capacity at mean speed of 1.6-2.0 km/h was 0.17 ha/h *i.e.*, 6 man-hours per hectare with field efficiency of 89.5 per cent. The draft requirement for its operation was 75.6 N which is within the capacity of an average man/woman. The sowing of jute with seed drill followed by mechanical weed control using jute weeder/nail weeder showed reduction in manual labour (about 87) requirement for weeding and thinning as compared to about 135 man-days/ha required in broadcast field and there was net saving of Rs. 15000-17000/- per hectare with increase in fibre yield of 20-22 per cent.

Keywords- Jute, Fibre, Seed drill.

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Introduction

Jute (*Corchorus olitorius* and *Corchorus capsularies*) is an important environment friendly fibre producing plant and its fibre is the second most important vegetable fibre next to cotton [1]. It provides direct or indirect employment to 40 million farm families. India and Bangladesh are two major jute producing countries in the world and accounting about 80% of total export to worldwide. The total area under jute cultivation in India is about 0.8 million ha and it is mainly grown by small and marginal farmers as a rain-fed crop followed by paddy. Sowing of jute is the most important farm operation for getting healthy and dieses less crop for higher fibre production. The crop yield is affected by plant population, row spacing, plant to plant spacing, type and variety of seed and their emergence [2]. Traditionally jute farmers follow broadcast method of sowing to utilize the limited soil moisture on receipt of pre-monsoon showers. It is difficult to maintain the recommended seed rate due to small size seeds and low rate in broadcast method of sowing. In practice farmers use a higher seed rate of 7-8 kg/ha. To maintain optimum plant population of 5-6 lakh/ha in the field, excess 75-80% of the emergent seedlings are removed during weeding and thinning operation at 21-45 DAE. The weeding and plant protection measures are major problem due to scattered and higher plant density [3]. About 15 % of total energy of 10904.1 MJ/ha and about 30% of total cost of production is consumed in the weeding and thinning operation and requires about 30 % extra labour (90-160 labourers/ha) and time. Mechanical weeding is not possible in broadcasted field, which increases production cost with decrease in yield and quality. Further, due to uneven plant population and higher plant density, the overall fibre yield reduces about 10-15 per cent. On the other hand, line sowing of small seeds using seed drill saves precious seed, ensures depth of placement, germination and reduced cost of sowing and weeding [4]. A few seed drills available commercially for small seeds, use sophisticated pneumatic metering mechanism and are costly [5]. The socio-economic conditions of the jute farmers do not permit them to have seed drills. They are therefore bound to follow the traditional practice of broadcast sowing and face difficulty in intercultural operations and overall management of their crop. As the yield rate is low, farmers derive marginal benefit out of their produce. Considering the above aspects, the present study was undertaken to evaluate the seed pattern characteristics of seed rate deviation, seed distribution and economics of developed manual seed drill.

Materials and Methods

The spatial dimensions of the jute seed of the promising variety, JRO-204 (Suren) were measured in the laboratory [Table-1] and accordingly the dimensions of the seed box and seed dispensing holes were optimized [6]. Using those spatial dimensions and other agronomic information, shape and capacity of seed hopper, number of seed dispensing holes for seed metering and distance between them were determined. The bulk density of the seed determined the wall thickness of seed hopper. The shape and size of seed dispensing hole were determined by trial and error method taking the seed rate into account.

Table-1 *Spatial/ physical parameters of jute, JRO-204 (Suren)*

Seed	Size, mm			Test weight (g)	Bulk density (g/cc)	Angle of repose (deg)
	Length mm	Breadth mm	Thickness mm			
Jute: JRO-204 (Suren)	2.11	1.27	1.15	1.925	0.739	25.32
	2.08	1.25	1.12	1.922	0.745	26.23
	2.05	1.18	1.09	1.930	0.741	28.34
	2.03	1.17	1.06	1.921	0.738	27.95
	2.09	1.14	1.10	1.917	0.740	28.41
Average	**2.07**	**1.20**	**1.10**	**1.923**	**0.740**	**27.25**

Description of the seed drill

Main parts of the seed drill are seed hopper or seed box, ground-cum-transportation wheels, frame, furrow openers and covering device [Fig-1]. Conical

frustum shaped seed hoppers or boxes having average diameter of 9.7 cm and length 9.3 cm were used in the seed drill with a capacity of 0.699 litres made of tin sheet. During operation, seed falls directly from the seed boxes through seed dispensing holes to the furrow and no seed tube is used. The seed dispensing holes 14 nos. of 2.36 mm diameter are made on the periphery of the larger diameter of conical frustum shaped seed boxes at equal interval of 2.74 cm to achieve plant to plant distance 5-7cm in the field [7]. Shovel type furrow openers of length 22 cm are fitted just ahead of the seed boxes and furrow covering device as chains made up of mild steel are attached besides the seed boxes. The spacing between furrow openers is 25 cm as per recommended spacing for *Olitorious*/tossa jute [8]. Two 25 x 3 mm mild steel ground wheels of 22 cm diameter facilitate movement of machine. To prevent wheels from slippage in the field, 8 nos. 4 cm long spikes welded at equal interval on periphery of each wheel. The technical specifications of the seed drill have been presented in [Table-2].

Fig-1 Field evaluation of manually operated seed drill

Laboratory test

The seed drill was calibrated in the laboratory as per BIS test code at full, three fourth and one-half filled of the seed box. Seeding uniformity test was carried on a bed of 5 m x 1 m size prepared in the field with a white cloth lying on the top. A thin layer of grease was applied on the cloth to prevent displacement of seeds from line while falling from seed box. The seed drill was operated on the prepared seed bed using plain ground wheels of same dimensions at walking speed of 1.2-1.8 km/h. Number of seeds per meter of bed was counted and uniformity of seed distribution along the line was calculated using the following equation.

$$S_e = 100 \left(1 - {}^{Y}/_{D}\right) \quad \text{..... [1]}$$

Where,

S_e = Seed distribution efficiency of seed drill;

Y= Average numerical deviation of number of seeds per meter from average number of seeds per meter length;

D= Average number of seeds per meter length.

As seed dropping is gravitational from seed box, the mechanical damage was negligible.

Field test

The field experiment for line sowing of jute was conducted in the ICAR-CRIJAF Farm as per BIS test code. The soil in the experiment site was sandy loam having sand, silt and clay in the ratio of 74.8, 13.2 and 11.8 per cent, respectively. The tests were replicated thrice in plot size of 20 m x 10 m. The field observation like speed of operation, depth of seed placement, effective field capacity and draft were recorded and mean observations were taken. A direct reading type spring dynamometer was used to measure the pull of seed drill. Draft of the seed drill was calculated using the following formula.

$$\text{Horse power (hp)} = \frac{D \times S}{75} \quad \text{..... [2]}$$

Where, D = Draft of the implement, kg;

S = Speed of operation, m/s.

Labour requirement, field efficiency and cost economics of the seed drill was calculated for its feasibility for the small and marginal farmers. The seed pattern characteristics were observed after germination of the seed under field condition and compared with broadcast sowing. The plant physical parameters and fibre yield was compared with broadcast sowing.

Table-2 *Technical specifications of manually operated seed drill*

Parameter	Values
Overall dimensions	
Length	1040 mm
Width	1530 mm
Height	350 mm
Weight	16 kg
Ground drive details	
No. of wheels	Two
Effective diameter	220 mm
Lug height	40 mm
Seed metering	Gravity fall
Hopper capacity	Volume 0.000699 m^3
Row spacing	25cm for Jute
No. of rows	4
Suitability of crop	Jute, mustard and sesame
Seed covering mechanism	Chain type

Results and Discussion

Laboratory calibration of the seed drill was carried out for jute and the results are shown in the [Table-3].

Table-3 *Laboratory calibration of seed drill*

Seed box condition	Amount of seed (g)	Wt. of seed dropped in 50 revolution (g)				Average seed dropped (g)	Seed rate (kg/ha)
		Box 1	Box 2	Box 3	Box 4		
Full filled	400	5.2	4.3	3.5	3.0	16.06	4.08
		3.7	3.0	4.2	4.5		
		4.0	4.2	3.6	5.0		
¾ filled	300	2.5	3.0	2.6	3.2	11.60	
		3.7	3.0	2.8	2.9		
		2.7	2.8	2.9	2.7		
½ filled	200	5.5	4.0	6.5	7.0	22.40	
		5.0	5.2	4.0	5.5		
		6.0	7.0	5.2	6.3		

There was variation in seed rate at different seed box condition and may be due to unequal size of seeds. The minimum seed rate of 2.84 kg/ha was observed with 3/4th filled seed box. The observed mean seed rate of 4.08 kg/ha was significantly lower than the seed rate of 6-7 kg/ha for broadcast sowing. Thus, around 50 per cent reduced seed rate may help in reducing the cost of cultivation in terms reduction in labour cost for weeding and thinning operations.

No mechanical damage of seed was observed due to absence of mechanical metering mechanism and gravity flow of seeds from seed box. Minimum and maximum number of seeds dropped per meter was 55 and 73. The seed distribution efficiency of drill varied from 85.47 to 88.87 per cent and found decreased with increase in speed of operation, due to scattering of seeds during centrifugal discharge.

The field performance of the seed drill was observed at the ICAR-CRIJAF Farm, Barrackpore and results are presented in [Table-4]. During the field test mean actual seed rate was found to be 3.45 kg/ha. The lower seed rate obtained may be due to skidding of ground wheel during operating in the field. The depth of seed placement was varied from 1.65 cm to 2.43 cm. The speed of operation in the field varied from 1.6 -2.0 km/h. Effective field capacity (EFC) of seed drill was varied

from 0.166 to 0.176 ha/h and thus, one hectare could be sown in 5.88 hours only. The labour requirement was found to be 6 man-h/ha and average field efficiency of seed drill was found to be 89.50 per cent. Draft of the machine was calculated taking height of the handle from ground during the operation. The angle of pull was found to be 39.62^0. The draft was varied from 71.31 N to 78.32 N with an average of 75.60 N. The power requirement was varied from 41.62 W to 42.65 W with an average of 42.35 W, which could be easily pulled by a man for 2-3 hours continuously. The overall performance of the manually operated seed drill was found satisfactory.

Table-4 *Field performance of manually operated seed drill*

Particulars	Observed values
Crop	Jute
Variety	JRO-204 (Suren)
Date of sowing	24.04.2014
Type of soil	Sandy loam
Size of plot	20 m x 10 m
Soil moisture, % (db)	22.55
Mean weight diameter of clods, mm	0.35
Average speed, km/h	1.90
Coverage width, m	1.0
Depth of seed placement, cm	1.95
Actual seed rate observed, kg/ha	3.45
Draft, N	75.60
Effective field capacity, ha/h	0.170
Field efficiency, %	89.50
Seed distribution efficiency, %	89.05
Average number of plants/hill	1.58
Seed pattern observed	Drilling
Fibre yield, kg/ha	28.60

The seed pattern characteristics were observed after germination of seeds under field condition. The average number of plants per hill was found to be 1.58. The plant growth characters like plant height and basal diameter were compared with broadcast method of sowing and depicted in [Fig-2]. The jute plants were harvested at 120 DAS and retted in water for fibre extraction. The fibre yield of about 28.6 q/ha was obtained in line sowing against yield of 22.3 q/ha in broadcast method of sowing.

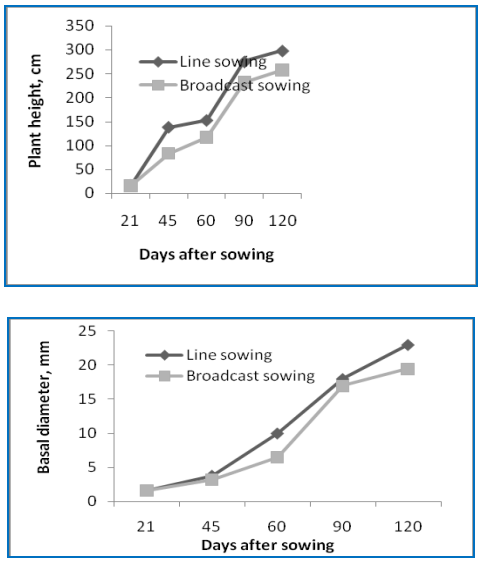

Fig-2 Comparison between line sowing and broadcast sowing

The cost of manually operated seed drill was Rs. 3650.00 with an operating cost of Rs. 29.00 per hour. The cost required for traditional broadcast sowing is less but the labour requirement for weeding and thinning operation is about 137 man-days/ha. Whereas, only 87 man-days/ha is required in line sowing crop. Hence, there is a saving of Rs. 15000.00-17000.00 per hectare in line sowing method comparison to broadcast method of sowing.

Conclusion

Sowing of small seeds like jute in line is very much desirable to save seed, to reduce the cost of sowing and weeding. The developed manual seed drill for jute distributed seeds uniformly along the rows. Mechanical intercultural operations in line sown crop reduce labour and cost for weeding and thinning by more than 50%. Due to evenly plant population, the overall fibre yield increases about 10-15 per cent than broadcast method.

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Author Contributions

All the authors are equally contributed throughout this study.

Abbreviations

cm-Centimeter, g- Gram, ha- Hectare, kg- Kilogram, km- Kilometer, m- Meter

Ethical Approval

This article does not contain any studies with human participants or animals performed by any authors.

Conflict of Interest: None declared

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