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Development of a Device for Broadcasting Tiny Agricultural Seeds

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Abstract

A manually operated device for broadcasting tiny agricultural seeds was developed in the Department of Farm Power and Machinery of Bangladesh Agricultural University, Mymensingh. The principles of dynamics and projectile of a particle has been used in designing the device. It was a light weight portable device, could be carried on the chest, having a weight of 2.0 kg when empty and the fabrication cost was Tk. 1500.00 only (2012). The overall length and diameter of the device are 555 mm and 200 mm, respectively. It was tested in the laboratory with mustard and jute seeds only. The average field capacity ranges between 0.77 to 1.21 ha/hr and seed application rate ranges between 1.3 to 3.7 kg/ha depending on the adjustment of metering unit. The uniformity index was found over 95%. The device performed excellent having nearly 100% uniformity of application at 20 mm opening of the metering unit, both for mustard and jute seeds. Cultivation of crops using the device and comparison of yield data is needed for further validation of the device. It is recommended that the device must be tested in the farmer's field before its commercial manufacture. It is expected that if the device be validated through field trial, it will help reduce drudgery of the farmers/laborers, and overall cost of the operation.

Key words: Tiny seeds, Portable device, Broadcasting, Field capacity

1. Introduction

A significant change in Bangladesh agriculture has been observed, especially in the area of mechanization. Migration of labour force from rural areas to urban areas for better livelihood has been creating some problem in city areas. However, it is making favourable environment for further agricultural mechanization. Very recently Bangladesh Agricultural Research Council (BARC) and Krishi Gobeshona Foundation (KGF) have jointly initiated to review and update research priority areas/topics in twelve sub-sectors of Bangladesh Agriculture through four regional workshops held during December 2009 to February 2010 in a comprehensive way. It reveals that farmers demand seed sowing machines. Very similar findings were also reported in a publication (Alam *et al.*, 2008). In the recent past, PRA surveys conducted by various institutes in Faridpur, Bogra, Pabna and Rangpur indicated that the farmers demand portable seed sowing device for very small agricultural seeds like jute, mustard, onion etc. They are very keen to use a seed broadcaster if an effective, cheap and portable machine is available in the market. Even the poor farmers have expressed their willingness to use the machine on rental basis.

Literature search reveals that many seed sowing machines have been developed in the past, powered by man, bullock and engines. These are mainly designed for medium to large agricultural seeds. Ziauddin (2002) has developed a manually operated BAUZIA seed-cum-fertilizer distributor suitable for medium and large agricultural seeds and granular fertilizers. It is a highly successful device for sowing medium and large spherical seeds. However, limited performance of the machine has been observed in case of sowing tiny agricultural seeds like onion, jute and mustard, specially under windy environment. Therefore, an efficient and handy device is needed for tiny agricultural seeds.

Roy (1992) developed and tested a low cost Seed-cum-fertilizer distributor for broadcasting seeds and fertilizer in the field. The materials to be distributed fell down by the gravity from a tank on a fixed metallic platform. A hand-operated rotor distributed the materials uniformly. This simple mechanical device was designed to carry on the shoulder of an operator during operation. The Uniformity Coefficient of Distribution (UCD) of traditional broadcasting system is about 30% to 43% depending up on the labor skills. But the average UCD of this device is about 82.32%, 80.43% and 85.66% for the fine urea, granular urea and wheat

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respectively. The performance test indicated that the developed seed-cum-fertilizer could be used in the field with high satisfaction (Roy and Ziauddin, 1995).

Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur has developed an onion seeder using the principle of drum seeder (Hassan, 2011). The seeder is suitable for small farmers who practice direct seeding of onion under dry land cultivation. However, their study was limited to onion seed only. It cannot sow other tiny agricultural seeds. Agricultural equipment should be designed for multi-purpose use.

Farmers normally use hand-broadcasting method for broadcasting seeds. In this method, seeds cannot be uniformly broadcasted in the field. It is especially true for tiny agricultural seeds such as jute, mustard and onion. Highly experienced labourer is needed to sow these kinds of seeds. Mustard and onion are very smooth and slippery and is not easy to sow by hand. As a result, low efficiency and high cost are incurred. The main disadvantage of traditional hand broadcasting method is the non-uniform distribution of seeds and thus non-optimal use of resources. With a view to minimize these problems, an attempt has been made to develop a hand carried portable device for efficient broadcasting of tiny agricultural seeds with the following objectives:

1) To design a multi-purpose low cost broadcasting device suitable for sowing jute, mustard and onion seeds
2) To construct the hand-carried portable broadcasting machine
3) To evaluate the performance of the machine in the laboratory/test bed

2. Materials and Methods

A seed sowing device has been designed, constructed, modified and tested in the well-equipped engineering workshop of the Department of Farm Power and Machinery of Bangladesh Agricultural University, Mymensingh. This has been designed using the principles of dynamics and projectile of a particle (Ziauddin, 2002). A high speed rotating horizontal plastic plate received seeds by gravity through a tube and a metering device. The seed flows down vertically through the tube via a metering device from a seed hopper (Fig. 1 & Fig. 2). The high speed rotating disk spreads out the seed uniformly in the field while the device is carried by a person on his chest across the field. It is powered by hand using a small gear-pinion mechanism. The overall length and diameter of the device are 555mm and 200 mm, respectively. It is a light weight portable device having a weight of 2.0 kg when empty and the fabrication cost is Tk. 1500.00 only. The applicator was tested in the workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. The effective rate of seed application, effective field capacity and uniformity of application of mustard and jute seeds were determined. The uniformity index, effective field capacity and the rate of application of the device were calculated using the following equations.

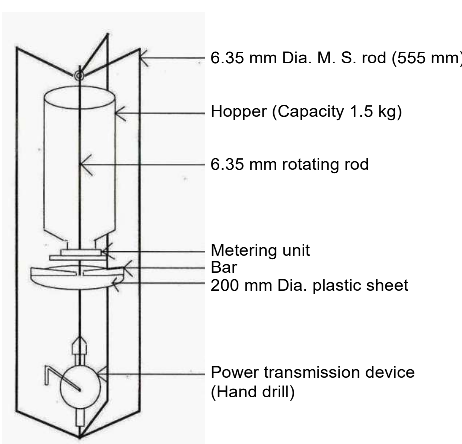

Fig. 1. Different parts of the applicatoe

Fig. 2. Pictorial view of the applicator

Uniformity index: The Uniformity Co-efficient of Distribution (UCD) is the key parameter of the applicator and it was determined using the following formula (Tajuddin, 1989).

$$UCD = 1 - \frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n\overline{x}} \quad (1)$$

Where, $\overline{x}$ = average weight of materials of all boxes.
x_i = weight of materials in each box; and
n = number of boxes kept for the test.

Effective field capacity: The effective field capacity is

$$F = \frac{S \times W}{10} \text{ ha/hr} \quad (2)$$

Where,
S = Actual average walking speed of the operator, km/hr
W = Actual width of material spreaded in the field, meter

Application Rate: Application rate of the materials depends on the discharge rate of material and the actual field coverage by the distributor. The application rates of the material (kg/ha) for different hopper opening were calculated using the following relationships.

$$\text{Application rate, A} = \frac{D}{F} \text{ kg/ha} \quad (3)$$

Where,
D = Actual discharge rate of materials, kg/hr
F = Effective field capacity of the broadcasting machine, ha/hr.

3. Results and Discussions

The device has been tested in the workshop of the Department of Farm Power & Machinery of Bangladesh Agricultural University, Mymensingh with two crops, mustard and jute. Fig. 3 shows the experimentation with the applicator. An area of 10 m x 5 m was identified. In which a 24 paper boxes (150 mm x 150 mm x 70 mm were placed at uniform distances throughout the experimental area. The loaded device with mustard seeds was broadcasted over the testing area as shown in Fig. 3. The weight of the seed dropped into each paper box was recorded. The application time, uniformity of application, rate of seed applied and the effective field capacity of the device were calculated. The experimental results are tabulated in the following six tables, Table 1 to Table 6. The device performed very well having 100% uniformity at 20 mm opening of the metering unit, both for mustard and jute seeds (Table 3 and Table 6).

Table 1. Performance of the broadcaster for Mustard seed with 17 mm. opening of the metering unit

Replication No.	Length of the experimental plot d (m)	Width coverage, w (m)	Area covered, A = d × w (m^2)	Time, t(sec.)	Seed dropped (gm)	Effective Field capacity, (ha/hr)	Discharge rate, (kg/ha)	Average uniformity index (%)
01		6.3	31.5	11.1	10.0	1.02	3.17	
02		6.5	32.5	10.5	9.8	1.11	3.01	
03	5	6.9	34.5	11.3	11.4	1.09	3.30	98.80
04		7.0	35	11.0	10.6	1.14	3.02	
05		6.5	32.5	10.9	9.7	1.07	2.98	

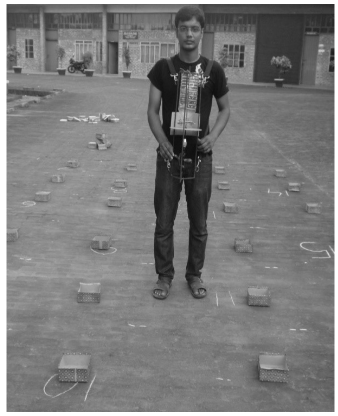

Fig. 3. Pictorial view of testing the applicator

Table 2. Performance of the broadcaster for Mustard seed with 18mm. opening of the metering unit

Replication No.	Length of the experimental plot d (m)	Width coverage w (m)	Area covered, A = d × w (m^2)	Time, t(sec.)	Seed dropped (gm.)	Effective Field capacity, (ha/hr)	Discharg e rate, (kg/ha)	Average uniformity index (%)
01.		6.6	33	11.0	8.3	1.08	2.51	
02.		7.0	35	11.3	11.1	1.11	3.17	
03.	5	7.0	35	11.5	12.0	1.09	3.42	95.08
04.		6.4	32	10.8	10.8	1.06	3.37	
05.		6.3	31.5	10.3	9.6	1.10	3.04	

Table 3. Performance of the broadcaster for Mustard seed with 20 mm. opening of the metering unit

Replication No.	Length of the experimental plot d (m)	Width coverage, w (m)	Area covered, A = d × w (m^2)	Time, t(sec.)	Seed dropped (gm.)	Effective Field capacity, (ha/hr)	Discharge rate, (kg/ha)	Average uniformity index (%)
01.		6.9	34.5	10.2	11.7	1.21	3.39	
02.		7.1	35.5	10.8	13.2	1.18	3.71	99.40
03.	5	6.8	34	10.3	12.6	1.18	3.70	
04.		6.7	33.5	11.1	10.3	1.08	3.07	
05.		7.0	35	11.3	10.4	1.11	2.97	

Table 4. Performance of the broadcaster for Jute seed with 17 mm. opening of the metering unit

Replication No.	Length of the experimental plot d (m)	Width coverage, w (m)	Area covered, A = d × w (m^2)	Time, t(sec.)	Seed dropped (gm.)	Effective Field capacity, (ha/hr)	Discharge rate, (kg/ha)	Average uniformity index (%)
01.		6.9	34.5	12.1	6.5	1.02	1.88	
02.		6.6	33	11.67	4.7	1.01	1.42	
03.	5	6.2	31	14.3	7.0	0.78	2.25	97.27
04.		6.1	30.5	9.8	6.7	1.12	2.19	
05.		6.5	32.5	10.1	3.3	1.15	1.01	

Table 5. Performance of the broadcaster for Jute seed with 18 mm. opening of the metering unit

Replication No.	Length of the experimental plot d (m)	Width coverage, w (m)	Area covered, A = d × w (m^2)	Time, t(sec.)	Seed dropped (gm.)	Effective Field capacity, (ha/hr)	Discharge rate, (kg/ha)	Average uniformity index (%)
01.		6.2	31	10.1	4.6	1.10	1.48	
02.	5	5.9	29.5	11.6	7.0	0.91	2.37	
03.		5.6	28	10.3	5.6	0.97	2.00	96.02
04.		6.6	33	10.0	4.3	1.18	1.30	
05.		6.2	31	11.4	5.9	0.97	1.90	

Table 6. Performance of the broadcaster for Jute seed with 20 mm. opening of the metering unit

Replication No.	Length of the experimental plot d (m)	Width coverage, w (m)	Area covered, A = d × w (m^2)	Time, t (sec.)	Seed dropped (gm)	Effective Field capacity (ha/hr)	Discharge rate, (kg/ha)	Average uniformity index (%)
01		5.8	29.0	11.1	4.2	0.94	1.44	
02		5.3	26.5	12.3	7.0	0.77	2.64	
03	5	5.6	28.0	9.8	4.8	1.02	1.71	99.60
04		6.1	30.5	10.5	4.5	1.04	1.47	
05		5.7	28.5	9.0	5.7	1.14	2.00	

4. Conclusion

The work has been successful in developing a device for application of tiny agricultural seeds. The field performance of the device was found satisfactory. The average field capacity ranges between 0.77 to 1.21 ha/hr, application rate ranges between 1.3 to 3.7 kg/ha depending on the adjustment of metering unit. The uniformity index was found over 95 %. The device performed very well having 100% uniformity at 20 mm opening of the metering unit, both for mustard and jute seeds. It is a light weight portable device having a weight of only 2.0 kg when empty and the fabrication cost was Tk. 1500.00 (in year 2012). It has been tested in the laboratory with mustard and jute seeds only. Cultivation of the crops using the device and comparison of yield data was needed for further validation of the device. This agronomic yield trial was not possible because of designing and fabrication of the device took longer time than expected and also for limitation of the budget. It is recommended that the device must be tested in the farmer’s field before its commercial manufacture. It is expected that if the device is validated through field trial it will help reduce drudgery of the farmers/labourers, overall cost of the operation, mitigate peak labour shortage, reduce turnaround time and could be a means of livelihood of skilled and unskilled rural youth.

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