Progress. Agric. 23(1 & 2): 75 – 80, 2012 ISSN 1017-8139

BATTERY OPERATED *USG* APPLICATOR

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ABSTRACT

Nowadays *USG* application in paddy field is an innovative technology to reduce the nitrogen fertilizer losses in the field. Manual application of *USG* in the field by hand between four seedlings is very much time consuming, costly and back breaking task. As a result different models of *USG* applicator were developed in home and abroad. Most of the applicators are manually pushed or pull type. An applicator was designed and developed to operate by a DC electric motor. In this machine 12 Volt 9 AH rechargeable battery was used. Power was transmitted by pulley and v-belt from the motor to the driven wheel. The average missing rate was found 4.84% and the average applicator capacity was found 19.37 kg/hr and the average field capacity was found 0.0924 ha/hr. When the machine operated in the unpuddled land, distance between two dropped *guti* was found averagely 38.76 cm. By selecting more powerful motor, the machine performance can be improved.

Key Words: *USG*, Fertilizer, Motor, Battery, V-belt

INTRODUCTION

Urea, a highly nitrogen rich chemical fertilizer has a great contribution in rice production. About 29 lakh ton of urea is used annually for rice production in Bangladesh. Statistics indicates that about 80% of urea is used for rice production (BRRI, 2009). Only 15 to 35% of the total urea applied is utilized by the rice plant. Urea fertilizer is one of the most essential chemical fertilizers for growing crops all over the world. Use of urea had been started in Bangladesh since 1951 with the introduction of high yielding variety (HYV) of rice. Since then, the application of urea is increasing year after year. Presently 247 kg of urea is applied per hectare of rice field (BRRI, 2009). About 29 lakh ton of urea is used for rice production in Bangladesh. Nitrogen loss caused due to ammonia volatilization, de-nitrification, run-off, seepage and leaching. Deep placement of urea fertilizer in the form of *guti* into the anaerobic soil zone is an effective method to reduce volatilization loss. Today *USG*, made by compressing granular urea into briquette of 1.8 grams and 2.7 grams size is available. It is also known as Urea Super Granule (USG). Each briquette has to be placed about 3 inches beneath the soil surface but at the center of four plants maintaining a distance of 40 cm x 40 cm between *USG* briquettes, after 5-7 days of rice plantation. The

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application of *USG* requires 25-35% less urea and one round application per crop than the traditional hand broadcasting method. On the other hand, yield of rice increased by 15-20 % (BRRI, 2009).

Deep placement of *USG* by hand requires more labor and cost. To solve the problem of *USG* placement by hand, a manually operated push type fertilizer applicator for puddle rice field has been developed by BRRI (Amit, *et al.*, 2011), BARI (Wohab, *et al.*, 2011), BEVCO and other private organizations in the country. Bangladesh Machine Tools Factory, Mahabub Engineering Workshop and BEVCO have started manufacturing *USG* applicator. DAE and IFDC in collaboration BARI have been demonstrating this technology in 68 Upazilas (The daily Star, 27 June 2011). The farmers opined that an electronic remote controlled version of the machine (no walking by the operator through the muddy field) may be widely accepted as it will be more comfortable, low cost and precision of placement. It is also very laborious to operate a manually operated *USG* applicator. So by developing a motor operated *USG* applicator is essential to reduce the exertion.

It will also help laborer to work long period in the field. The main objectives of the research were as follows:

1. To design a motor operated *USG* applicator;
2. To fabricate the applicator;
3. To evaluate the performance of the motor operated USG applicator in the field.

MATERIALS AND METHODS

All the materials used in the machine were locally found and most of the parts were fabricated in the workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. The photographic and isometric view of the motor operated USG applicator is mentioned in Fig. 1 and 2, respectively.

The major components of the improved applicator were frame with handle made of M.S. (Mild Steel) flat bar, Drive wheel, 12 Volt, 9 AH DC motor (40 rpm), 12 Volt, 9 AH Battery, Float with leveler, Pulley, V-belt (Size- A 23).

Fig. 1. Photographic view of the motor operated USG applicator

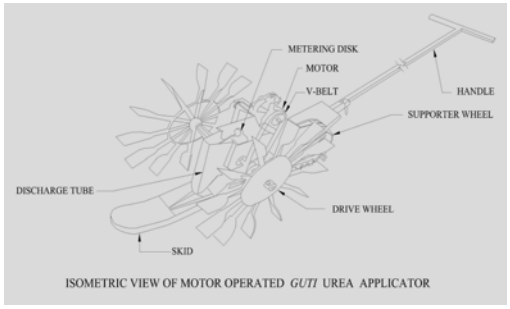

Fig. 2. Isometric view of the motor operated USG applicator

The major components of the improved USG applicator are described below:

Supporter wheel: The diameter of the supporter wheel was 230 mm and it was 950 mm width. It was a plastic made wheel. It carried the weight of the battery and gave support the machine to keep it stable. It also worked as a power transmission device to put the dropped *guti* into the soil.

Metering disk: The metering disk of 145 mm diameter made of plastic with four cups at 60° angle was connected with drive wheel and fixed inside the hopper with a hollow metal tube. The external and internal diameter of the USG picking cup was 22 and 20 mm, respectively. The seat for a *guti* was 6.5 mm in diameter that can accommodate *guti* of 2.7 and 1.8 gm.

Drive wheel with shaft: The external diameter of the drive wheel was 500 mm. Two drive wheels were used where each of them contain 12 fins for making traction with mud in the rice field. The length of the shaft of the drive wheel was 440 mm.

Hopper: The hopper (capacity around 900 gm) and discharge tube were made of plastic and fixed with the applicator frame, metering disk and cage wheel. Length, width and depth of hopper were 160, 90 and 120 mm, respectively with rounded tapering at bottom.

Frame and handle: Frames for holding the different components of the applicators were made by metal including U shape components of 20 mm flat bar. The height, length, and width of the frame were 360, 450, and 110 mm, respectively. Other part of frame was made of 550 mm flat bar. The handle was made of square bar of 1250 mm length, attached with a 480 mm U shape components of 20 mm flat bar to keep the applicator stable in forward movement.

Discharge tube: Discharge tube and small metal guide strip were used to reduce missing rate and was fixed with hopper using a small nut. Height of the discharge tube was 385 mm with 80 mm width.

Motor and battery: 12 Volt 9 Ah DC motor was used to operate the machine. RPM of the motor was used 40. Total watt of the motor was 108. 12 volt 9 Ah maintenance free rechargeable battery was used to supply sufficient electricity to the motor.

Skid with leveler: A skid having 630 mm length and 105 mm width was used. It was made of plastic. After 445 mm length the skid became 30^{o} angle in 185 mm length. There was a leveler under the skid made of M.S sheet. The length and width of the leveler were 150 mm and 100 mm, respectively.

Pulley and V-belt: The diameter of the both pulley attached with the motor and drive shaft were 55 mm. A V-belt of A23 size was used for power transmission.

The following parameters were calculated to judge the performance of the improved USG applicators-

Missing rate: Missing rate was determined using the following equation.

$$\% \text{ missing } \frac{N_1}{N_2} \times 100$$

N_1 = Number of *guti* missed to pickup by metering disk into discharge tube.
N_2 = Number of *guti* required to pick up theoretically by the metering disk.

Applicator capacity: Applicator capacity is defined as the rate of urea application by the applicator. The operation time is calculated by a stop watch. The applicator capacity is determined by the following equation:

$$\text{Applicator capacity } \frac{\text{Total weight of the } guti \text{ dropped in Kg}}{\text{Time taken to operate the applicator in hr.}} \times 100$$

Field capacity: Field capacity is defined as the rate of field coverage by the applicator. Effective field capacity of the applicator was determined by the following equation.

Where, S = Forward speed, km/hr; w = Width of coverage, m

$$\text{b) Effective field capacity } \left(\frac{\text{ha}}{\text{hr}}\right) = \frac{\text{Field coverage in ha}}{\text{Actual time of operation in hr}}$$

Distance between two dropped *Guti:* Distance between two dropped *guti*, maintained by the applicator was measured very carefully. After the observation, the average distance of dropped *guti* was calculated.

Depth of dropped *Guti*: During operation operator and one observer measured the depth of *guti* dropped into the soil. After the observation, the average depth of dropped *guti* was calculated.

Power requirement: The power requirement of operation was determined by calculating the battery power and the motor required power.

RESULTS AND DISCUSSION

The performance of the motor operated *USG* applicator was evaluated on weight of applicator, missing rate, and applicator capacity. The self weight of the motor operated applicator was found 11.16 kg.

Result of missing rate: Missing rate of motor operated *USG* applicator is presented in Fig. 3. The average missing rate was found 4.84%.

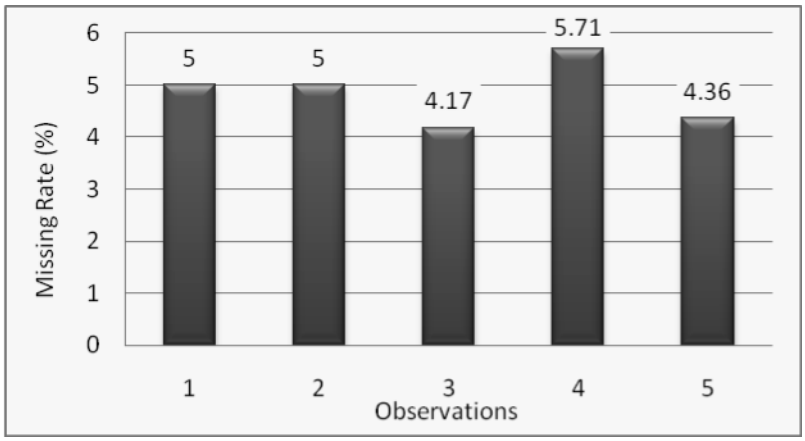

Fig. 3. Graphical representation of missing rate

Determination of the capacity of the applicator: Applicator capacity of the motor operated USG applicator is presented in Table 1. The average applicator capacity was found 19.37 kg/hr and the average field capacity was found 0.0924 ha/hr.

Table 1. Applicator capacity and field capacity

Obs No.	No. of RPM of the wheel	Time taken to operate the wheel (sec) (t)	No. of *guti* in hopper before operation (a)	No. of *guti* in hopper after operation (b)	No. of *guti* dropped (a-b)	Weight of *guti* dropped (gm) (a-b)×2.7 (gm)	Applicator Capacity (kg/hr)	Field Capacity ha/hr
1	20	37.67	180	104	76	205.2	19.61	0.0937
2	25	47.32	200	105	95	256.5	19.51	0.0932
3	30	57.20	275	160	115	310.5	19.54	0.0925
4	35	67.79	275	143	132	356.4	18.93	0.091
5	40	77.2	275	122	153	413.1	19.26	0.0914

Test result of distance between two dropped *Guti*: Distance of dropped *Guti* of motor operated USG applicator was presented in Fig. 4 in graphical representation.

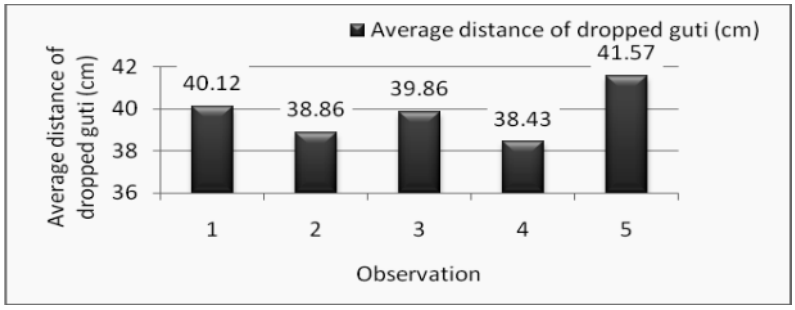

Fig. 4. Graphical representation of average distance of dropped *guti*

Power requirement of the motor operated USG applicator

When the machine was operated then 12 volt, 9 AH battery was used that created 108 watt. The capacity of the motor used in the machine was .15 hp.

CONCLUSIONS AND RECOMMENDATIONS

From the above test result of motor operated USG applicator the operating principle of the applicator was very scientific and the overall performance of the motor operated USG applicator was effective for the application of USG although it has some problem. The motor used in the machine was not capable to run the machine in the heavy muddy land. More power is required to operate the machine in the field. The self weight of the applicator was comparatively higher. Field test of the machine can be done after the improvement of some parts of the machine. Following are the recommendations for proper functioning of motor operated USG applicator.

1. Self weight should be reduced;
2. A motor must be selected that would be able to provide sufficient power to the machine;
3. Instead of pulley and v-belt, gear transmission system can be used to increase the efficiency of transmission of power;
4. Steel rod can be used as drive shaft so that it can provide sufficient strength to the machine.

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