
ORIGINAL ARTICLE

Comparative Performance Evaluation of Urea Briquette
Applicator in Transplanted Rice

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ABSTRACT

Urea briquette applicator attachment for self-propelled rice transplanter was developed at ICAR-National Rice Research Institute, Cuttack. The performance of the developed applicator was compared with manual deep placement method and point type manual applicator. The effective field capacity of developed urea briquette applicator was 0.191 ha h⁻¹. The developed urea briquette applicator was saved cost of operation by 81.38% and 83.68% compared with point type manual applicator and manual deep placement method respectively. The developed urea briquette applicator was saved time of operation by 88.49% and 90.06% compared with point type manual applicator and manual deep placement method respectively.

Keywords: Urea briquette applicator, cost of operation and man power requirement

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INTRODUCTION

Nitrogen (N) is one of the most limiting nutrients for lowland rice production (1). Nitrogen fertilizer is usually broadcast as prills in paddy fields prior to transplanting, followed by one or more top dressing in the flood water within the period from transplanting to flowering. Farmers' practices for nitrogen fertilizer application generally include basal broadcasting without incorporation before transplanting and/or one or two top dressings in the floodwater immediately after transplanting up to flowering (reproductive stage). But such practices are inefficient because only about one third of the fertilizer nitrogen is used by plants. The remainder is lost through gaseous losses, runoff, and leaching or is immobilized in the soil. In wetland paddy cultivation, only 30-40% of nitrogen applied is successfully utilized [2-3]. There is a need to improve nitrogen use efficiency of paddy crop to decrease the manufacture of chemical nitrogen and also minimize nitrogen emission to atmosphere due inefficient use nitrogen. Deep placement of nitrogenous fertilizer is one of the alternatives for increasing the nitrogen use efficiency in rice crop. Urea briquette fertilizer is a simple physical modification of ordinary urea fertilizer. It consists of large discrete particles of urea containing 46% nitrogen. The nitrogen fertilizer production is 13.41 Mt and consumption is about 17.37 Mt during 2015-16 [4].

To compare the performance of developed urea briquette applicator with point type manual applicator and manual deep placement method.

MATERIAL AND METHODS

Urea briquette applicator was fabricated at ICAR-NRRI, Cuttack which is attached to the existing self-propelled rice transplanter. The developed urea briquette applicator performance was compared with

Manual deep placement of urea briquette and Point type Manual Applicator in terms of distance between dropped urea briquettes, depth of placement of urea briquette, speed of operation, effective field capacity, missing rate %, multiple dropping % and labour requirement.

The urea briquette applicator attachment was developed based on the following consideration.

- A. The transplanter is adjustable to different spacing, but urea briquette applicator is mostly considering row to row and plant to plant spacing 20×15 cm.
- B. The depth of placement of urea briquette may be 4-5 cm in puddled soil.
- C. Only one urea briquette is supplied every four hills.
- D. The briquette placement should be at alternate rows at centre of four hills, so spacing between urea briquettes 30cm.

Developed urea briquette applicator

The developed urea briquette applicator consists of hopper, metering mechanism, delivery tube, furrow openers and ground wheel. The components were designed, developed and fabricated. The overall dimensions of frame of urea briquette applicator were 1150 × 1700 × 1200 mm as length, breadth and height respectively and constructed using mild steel. The developed urea briquette applicator attachment weight was 40 kg. Metering mechanism was driven by ground wheel. The ground wheel was connected to frame by using chain-sprocket and gears. The developed applicator attached to rear side of self-propelled rice transplanter. The urea briquette applicator was developed for alternative rows of self-propelled rice transplanter.

Manual deep placement of urea briquette

In manual deep placement method one person is required for deep placement of the urea briquettes. The person carry the briquette bag in one hand and place the briquettes deeply in field with other hand. In this method person continuously works in bending posture. The one briquette was applied for every four hills. The urea briquettes were applied in alternative rows.

Point type Manual Applicator

Manual applicator is a simple device carry in hands to place the urea briquette deep in the soil. Operator has to put urea briquette in the funnel and push the handle to place the briquette 5-6 cm deep in the soil. After every push, operator has to pull applicator from mud and move forward. Handle, funnel, delivery tube and plunger assembly is made by using PVC pipes and depth control ring is made by MS flat. It is light in weight and easy to carry. Overall dimensions of this device (L×W×H) were 1200×150×1200 mm. The length of handle was 100 mm and weight of device without load was 1.66 kg.



Fig1: Urea briquette applicator with self-propelled rice transplanter



Fig2: Manual deep placement of urea briquette



Fig3: Point type Manual Applicator

Depth of placements of urea briquette

Depth of placements of urea briquette was determined using scale. Ten randomly selected observations were taken and the mean was determined to represent the depth of placements of urea briquette.

Missing percentage and multiple dropping percentage

The hoppers of the applicator were filled with urea briquettes and the metering shaft was rotating by ground wheel. The metering shaft was rotated for ten revolutions the dropped urea briquettes from all the boots of applicator was counted and recorded. Then the missing and multiple dropping percentage of urea briquette applicator was calculated using following formula:

$$\text{Missing and multiple dropping percentage} = \frac{(N \times Y) - NG}{(N \times Y)} \times 100 \quad (5)$$

Where,

N = Number of turn of drive wheel,

Y = Number of cups on metering plate,

NG = Total number of urea briquette

If value is negative, it is multiple dropping

Distance between urea briquettes

The measurement of distance between two consecutive briquettes was measured using scale. Ten randomly selected observations were taken and the mean was determined to represent distance between urea briquettes.

Speed of operation

For determination of speed of operation, 20 m distance was marked and time noted to cover the 20 m distance. The speed of operation was expressed in km h⁻¹.

Effective field capacity

It is the actual rate of coverage of area by a machine. Effective field capacity was determined using the following relationship:

$$\text{Effective field capacity, } \frac{\text{ha}}{\text{h}} = \frac{\text{Total area covered, ha}}{\text{Total time taken, h}} \times 100(5)$$

RESULTS AND DISCUSSION

Comparative evaluation of developed urea briquette applicator with manual applicator and manual deep placement method

The developed urea briquette applicator was compared with manual deep placement of urea briquettes and point type injector applicator. The comparison was in terms of distance between dropped urea briquettes, depth of placement of urea briquette, speed of operation, effective field capacity, missing rate %, multiple dropping % and labour requirement.

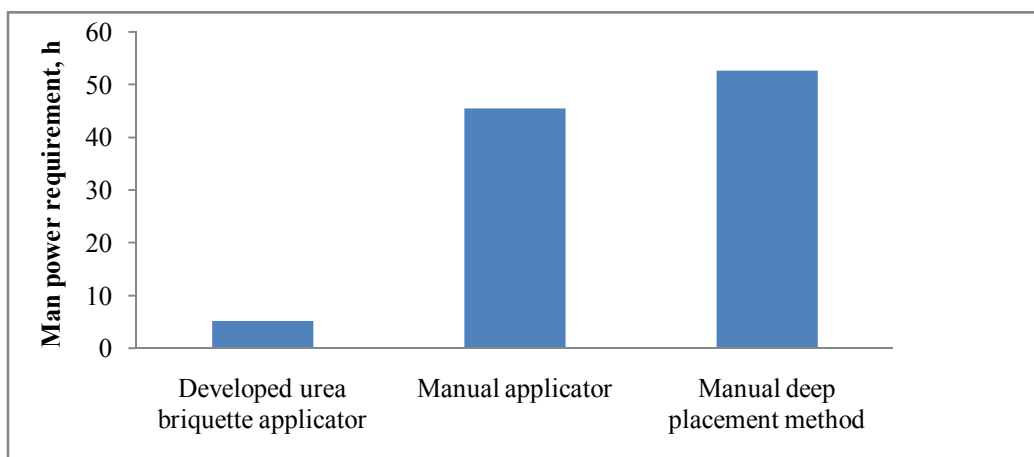
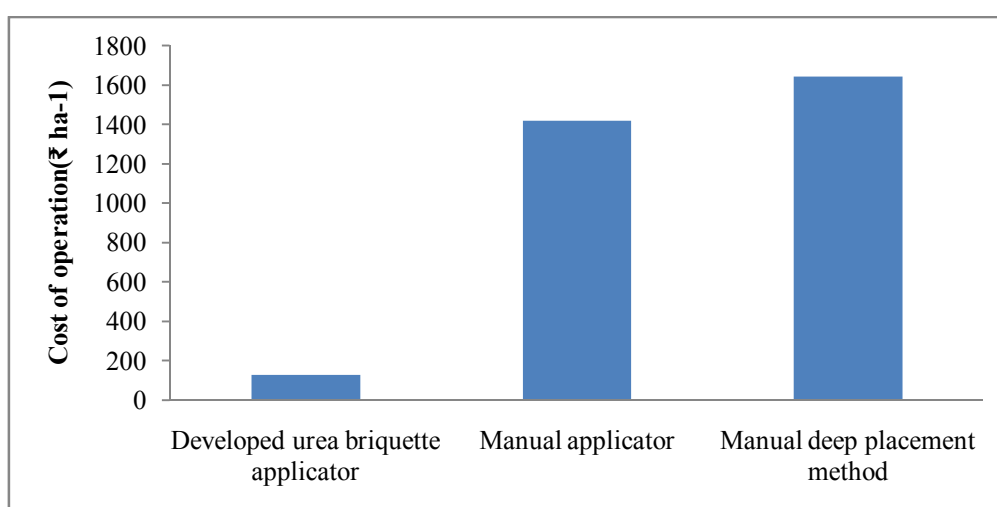
The mean distance between placement of briquettes in developed urea briquette applicator was constant, because of fixed gear ratio, but the distance between remaining two methods is adjustable. There was no missing rate observed in all three methods of briquette application. Maximum (2.07%) multiple dropping rate observed in developed urea briquette applicator and there is no multiple dropping rate observed in rest of methods. The speed of operation was maximum in urea briquette applicator and minimum in Point type Manual Applicator. The highest field capacity was observed in the urea briquette applicator and lowest field capacity observed in manual deep placement method. The man hours required to complete 1ha The cost of operation of urea briquette applicator, manual applicator and manual deep placement method were ₹ 126 ha⁻¹, ₹ 1420 ha⁻¹ and ₹ 1644 ha⁻¹ respectively.

The results were tabulated in table 1.

Table1: Comparative evaluation of urea briquette applicators

S. No.	Particular	Developed urea briquette applicator	Manual applicator	Manual deep placement method
1	Distance between briquettes, cm	32	Adjustable	Adjustable
2	Depth of operation, cm	4-6	6	6
3	Speed of operation, km h ⁻¹	1.66	0.57	0.78
4	Effective field capacity, ha h ⁻¹	0.191	0.022	0.019
5	Missing rate, %	Nil	Nil	Nil
6	Multiple dropping rate, %	2.07	Nil	Nil
7	Man power requirement, man-h/ha	5.23	45.45	52.63
8	Cost of operation, ₹ ha ⁻¹	126	1420	1644

*cost of operation only includes labor charges for application. It does not include cost of urea.

Fig4: Labour requirement (man-h ha⁻¹)Fig 5: Cost of operation (₹ ha⁻¹)

CONCLUSION

The cost of operation of urea briquette applicator attachment, manual applicator and manual deep placement method were ₹ 126 ha⁻¹, ₹ 1420 ha⁻¹ and ₹ 1644 ha⁻¹ respectively. Additional cost of ₹. 170 per hour was realized for preparation of urea briquettes by using prilled urea. As the urea briquette was used to compare all three methods of application so cost of urea was similar. The urea briquette applicator attachment was saved cost of operation by 81.38% and 83.68% compared with manual applicator and manual deep placement method respectively. The urea briquette applicator attachment was saved time of operation by 88.49% and 90.06% compared with manual applicator and manual deep placement method respectively.

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