

Tractor operated different depth fertilizer applicator for wheat crop

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The high fertilizer rate and labour requirement are common problems in traditional application of fertilizer. Fertilizer applicator was tested and evaluated for wheat crop (Triticum aestivum L.) planted on bed cultivation system. For efficient metering of fertilizer by the machine, physical properties of granular urea fertilizer have been studied such as size, shape, sphericity, moisture content, bulk density and hundred particles weight. The machine was calibrated in the laboratory for different rates of fertilizer application and determination of coefficient of variation. The field tests of machine were conducted on the wheat crop planted on bed in 5 rows. The tractor operated different depth fertilizer applicator resulted in 3% and 6.5% increase in yield as compared to broadcast and foliar application. Fertilizer application using tractor operated fertilizer applicator reduces the cost of operation and saves a lot of fertilizer as compared to broadcast and foliar application methods.

Keywords: Broadcast, Fertilizer applicator, Foliar and fertilizer application, Wheat crop

TRACTOR operated different depth fertilizer applicator for application of granular urea at the root zone of wheat plants was introduced in the country to meet the growing needs of the farmers with high level of production and productivity and to increase the use efficiency of urea. Top dressing of nitrogen to the wheat crops results in emission of nitrogen gas to the atmosphere. To reduce the loss of nitrogen (N) in atmosphere and to increase the utilization efficiency, research work is needed for the placement of nitrogen in the root zone of plants. For maximum efficiency of applied fertilizer, it is essential to deliver nutrients to the root zone of plants at a rate which is sufficient for maximum uptake while avoiding fixation with clay particles. The attention should, therefore, be given towards addition of fertilizers in subsoil to increase its nutritive status. In situations where deep loosening is required, the incorporation of fertilizer has been found to be beneficial as compared

to spreading of nitrogenous fertilizer in the field that leads to loss of about 30% N to the atmosphere.

Fertilizer applicator

The fertilizer applicator machine has been used for testing and performance evaluation of application of fertilizer (urea) on bed planted wheat crop. It also includes suitable measurement techniques for recording various parameters related to performance evaluation of machine under the laboratory and field condition. The properties of fertilizer (granular urea) used in the experiment were determined for efficient metering of the application rate of fertilizer. Machine was calibrated in the laboratory for different rates of fertilizer application and determination of coefficient of variation. The field tests of machine were conducted on the wheat crop planted on beds and its performance parameters were recorded. For efficient metering of fertilizer by the machine, physical properties such as shape, size, sphericity, and weight

of granular urea were determined in the laboratory

The machine parameter of the frame and row to row spacing between lines were considered according to wheat crop and fertilizer application between rows. For the line and furrow opener, soil type, soil resistance, working soil moisture and bulk density of black soil were considered as main factors. The sectional strength of these components such as their ability to work at soil depth varying from 50–300 mm was selected. Machine components included main frame, fertilizer box, fertilizer metering system, shank furrow openers and ground drive wheel (Table 1 and 2)

Laboratory testing of machine

The following steps were followed for calibration of fertilizer applicator:

- Diameter of the ground drive wheel was measured to calculate circumference of wheel.
- Area covered in one revolution of the drive wheel was calculated.

Table 1. Machine components and materials

Machine part	Material
Frame	Mild steel
Hitching system	MS flat
Fertilizer box	Angle iron, MS sheet
Fertilizer adjustment lever	Mild steel
Fertilizer metering system	Die casted aluminium (BIS:6816 part 1973)
Fertilizer metering drive mechanism	Mild steel, Chain, Gear
Fertilizer tube	Transparent plastic pipe
Furrow opener	Mild steel, MS pipe, MS plate, MS sheet
Ground wheel	Mild steel, MS flats, MS rod

Table 2. Machine specifications

Particulars	Dimension
Machine dimension (L × W × H) (mm)	1850 × 1645 × 1258
Weight of machine (kg)	126
Capacity (ha/h)	0.65
Speed (km/h)	3.7
Power requirement (tractor) (hp)	35
Depth of application of fertilizer (mm)	100–150
Row spacing of crop (mm)	225



Calibration for fertilizer applicator

- The calibration was done for 20 revolution of the drive wheel; therefore, the area delivered in 20 revolution of the wheel was calculated from the area covered by 20 revolution of drive wheel.
 - The rate control adjustment for the fertilizer was set for maximum dropping.
 - The fertilizer dropped in polythene bags attached with each furrow opener was weighed separately and total weight of fertilizer was calculated.
- The fertilizer applicator was calibrated for application of granular urea at the rate of 130.4 kg/ha in the laboratory to provide 60 kg N/ha in 20 revolutions of ground drive wheel. The fertilizer delivered in each tube of furrow opener was collected and weighed for three

replications. The minimum and maximum quantities of fertilizer discharge from 20 revolution of ground drive wheel were 0.350 kg and 0.745 kg.

The parameters obtained from the laboratory studies were utilized for the testing of machine in the field. Physical properties of fertilizer (granular urea) related to fertilizer applicators that have been studied included size, shape, sphericity and moisture content of granular urea. It indicated that the urea used in the experiment was almost round in shape. The hundred particles weight of urea was 0.8 ± 0.6 at 18.7% moisture content of urea fertilizer mass (weight) of hundred particles.

Machine performance

The developed machine was tested with a 35 hp tractor for application of fertilizer at the depth of 150 mm on wheat crop sown on beds in 5 rows. During the field trials of machine moisture content, bulk density and cone index of experimental field were 26.47%, 1.32 g/cc and 0.79 kg/cm² at the depth of 0–100 mm, respectively. During field testing the operational speed and wheel slippage of machine were 3.7 km/h and 4.69%, respectively. The average field capacity and field efficiency of machine was 0.65 ha/h and 80.10% respectively. Average plant damage was 4.33% in the field during the application of fertilizer at the depth of 150 mm in wheat crop sown on beds.

Grain and straw yield

Yield of wheat crop under different methods of application of granular urea was 5.72/ha, 5.38/ha and 6.1/ha for fertilizer application through broadcast, foliar application and developed tractor operated fertilizer applicator, respectively. The tractor operated fertilizer applicator resulted in 3% and 6.5% increase in yield as compared to broadcast and foliar application as ammonia did not evaporate to the atmosphere due to placing of fertilizer at a depth of 150 mm below the soil surface.

Straw yield of wheat crop under



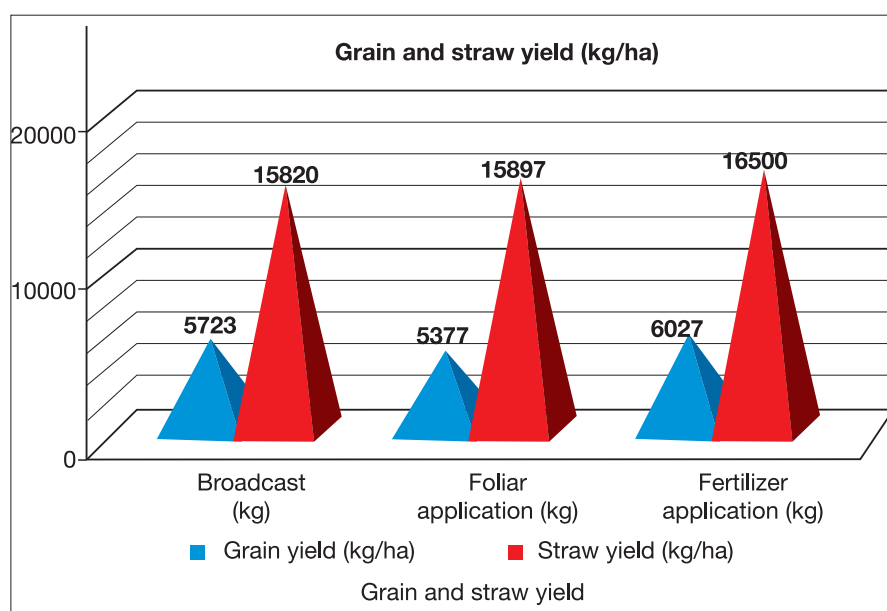
Field testing of fertilizer applicator on wheat crop

different methods of application of granular urea were 15820 kg/ha, 15896.67 kg/ha and 16500 kg/ha for fertilizer application through broadcast, foliar application and developed fertilizer applicator, respectively.

SUMMARY

The developed machine with a 35 hp tractor performed efficiently for the placement of urea at the depth of 150 mm below the soil surface. It saved the fertilizer, fuel, and time resulting in increased yield, use efficiency of nitrogen saving fertilizer by placing near the root zone of wheat plant below the soil. It prevented the loss of nitrogen to atmosphere. The speed of operation and slippage of developed machine in the field were 3.70 km/h and 4.69% during the field operation. The field capacity and field efficiency of machine were 0.65 ha/h and 80.10% during the fertilizer application on 5 rows bed planted wheat crop. The tractor operated fertilizer applicator resulted in 3% and 6.5% increase in yield as compared to broadcast and foliar application methods. The machine also resulted in saving cost of operation ₹341/ha and ₹611/ha as compared to broadcast and foliar application methods including cost of fertilizer.

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Tractor operated pigeon pea transplanter

A tractor operated pigeon pea transplanter was developed by the Indian Council of Agricultural Research, as a new tool for increasing productivity. The row-to-row spacing can be set either 90 cm or 105 cm and plant spacing can be changed by adjusting metering mechanism. The unit weighs 170 kg, and it can be operated by 35 hp tractor under the ploughed soil condition. Its field capacity is 0.13 ha/h with field efficiency of 75.78% and wheel slip of 8.2%. The cost of operation is ₹8,000/ha. The break-even point and payback period are 118 h/year and 0.8 year, respectively. It is recommended for medium and small farmers of pigeon pea cultivation in the country.

