

Original Research Article

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Performance Evaluation of Tractor Operated Fertilizer Broadcaster

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ABSTRACT

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The performance of tractor operated fertilizer broadcaster was evaluated at RDS farm, CCS Haryana Agricultural University, Hisar, Haryana in Rabi, 2014. Fertilizers are applied in the soil to provide essential nutrients required by the plant for growth. Generally fertilizer application is done manually which is time consuming and also results in non-uniform application in the field. Thus performance of the fertilizer broadcaster was evaluated in the field to check its applicability to overcome above mentioned problem of non-uniform application. The comparative analysis of the performance of conical fertilizer broadcaster and square fertilizer was also performed. The actual field capacity was observed as 4.16 and 3.27ha h⁻¹ for conical and square fertilizer broadcaster, respectively. The field efficiency calculated was 60.1 and 79.0% for conical and square fertilizer broadcaster respectively when tested in levelled field.

Introduction

The northern part of India has high cropping intensity, states like Punjab and Haryana have cropping intensity of 194.3% and 169.0%. Thus, the number of crops grown on the same fields leads to nutrient deficiency in the soil. As nutrients available in the soil plays significant role in the growth of plant and affect the crop yield. To provide the nutrients in the soil generally fertilizers are applied to soil. In the large part of the country farmers generally apply the fertilizer manually which lead to non-uniform application of the fertilizer and the process is laborious. Thus, to make fertilizer application more uniform and

efficient fertilizer broadcasters can be used. Fertilizer broadcaster is an equipment which is designed particularly to spread fertilizer with great ease and efficiency. As mentioned earlier manual broadcasting of fertilizer is more laborious, time consuming and health hazardous. This machine is comfortable to use, less time consuming and does not cause any health hazard to the farmers. It can spread fertilizer over 12 to 14 m width in the field. Its unique distributing mechanism ensures uniform spreading of fertilizer over a large area. There is provision in the machine to adjust the quantity of the fertilizer to be broadcasted as per the requirement by adjusting the levers provided.

Different types of fertilizer broadcaster are available for the use, but they differ in the type of hopper and distributor used for spreading the fertilizer.

Materials and Methods

Fertilizer broadcaster is an equipment with three point linkage operated with tractor Power Take Off (PTO) shaft. Tests were performed on the machines to evaluate their performance. Two types of fertilizer broadcasters i.e. conical type and square type were evaluated for their performance. Conical type fertilizer broadcaster have its hopper in the shape of cone. The calibration was performed in the laboratory of Department of Farm Machinery and Power Engineering, CCS Haryana Agricultural University, Hisar. The dimensions and other details of conical fertilizer broadcaster are shown in Table 1. Apertures are provided at the bottom of the hopper with the sliding shutter. The sliding shutter is adjusted with a lever which is mounted on an indexing plate which have holes provided for adjustment.

The dimensions and other details of square fertilizer broadcaster are shown in Table 2. Its capacity is less than conical type. It has more number of aperture compared to the conical fertilizer broadcaster.

Field test

To evaluate the performance of fertilizer broadcaster, tests were conducted at RDS Farm, CCSHAU, Hisar, Haryana. Test was performed for 20 hours in number of trials. Fertilizer used for the test was DAP. Tractor operator is the only labour required to operate the machine. During each trail, the data related to performance of the machines was collected that includes total fertilizer spread, fertilizer application rate by changing the operating parameters such as speed of the tractor, PTO

RPM, aperture opening and angle of blade of distributor. The effect of operating parameter was analyzed and performance of machine was determined in terms of uniformity coefficient, actual field capacity, field efficiency and fuel consumption.

Comparative analysis

The performance of the conical and square fertilizer was compared at the same operating condition. The effect of the change of angle of blade on the spreading width was analyzed. A comparative analysis was performed for the two machine on the parameters such as field capacity, field efficiency and fuel consumption.

Results and Discussion

Conical fertilizer broadcaster

The effect of operational parameters on the performance was analyzed and observed that with the change in the forward speed from 4.23 to 4.76 kmph the uniformity coefficient which shows the evenness of spreading of fertilizer varied from 53.8 to 56.7. The maximum uniformity coefficient was observed at the speed of 4.25 kmph, and with further increase in speed it decreased. The fertilizer application rate was in the range of 114 to 125 kg/ha and corresponding fuel consumption varied from 3.22 l/h to 3.75 l/h. The results obtained from the different trials are shown in the Table 3.

Square fertilize broadcaster

The effect of operational parameters on the performance was analyzed and observed that with the change in the forward speed from 3.03 to 3.12 kmph the uniformity coefficient varied from 54.6 to 59.2. The maximum uniformity coefficient was observed at the speed of 3.05 kmph.

Table.1 Constructional details of conical fertilizer broadcaster

S. no	Particulars	Specification
1.	Hopper	
	Diameter of hopper at top, mm	1145
	Diameter of hopper at bottom, mm	146
	Height of hopper, mm	905
	Capacity	450 kg
2.	Metering mechanism	
	Feeder	Apertures are provided at the bottom
	Number of apertures	2
	Controller	Indexing lever with plate
	Number of holes on indexing plate	8
	Dimension of aperture, mm	117 × 72
3.	Fertilizer distributor	
	Number of disc	1
	Diameter of Disc, mm	450
	Number of distributor vane	4
	Length of blade, mm	180
	Height of blade, mm	50
	Angles of blades, degrees	0°,21°,47°,60°

Table.2 Constructional details of square fertilizer broadcaster

S. no	Particulars	Specification
1.	Hopper	
	Size of hopper at top, mm	1000 × 1000
	Size of hopper at bottom, mm	180 × 180
	Height of hopper, mm	860
	Capacity, kg	400
2.	Metering mechanism	
	Feeder	Apertures are provided at the bottom
	Number of apertures	3
	Controller	Indexing lever with plate
	Number of holes on indexing plate	8
	Dimension of aperture, mm	54× 48
3.	Fertilizer distributor	
	Number of disc	1
	Diameter of Disc, mm	432
	Number of distributor vane	4
	Length of blade, mm	190
	Height of blade, mm	30
	Angles of blades, degrees	0°,22°,33°,44°

Table.3 Effect of change in operational parameter on performance of conical type Fertilizer broadcaster

Test	Duration, h	Speed of tractor, Km/h	Angle of blades of distributor plate	Total fertilizer spreading width, m	Fertilizer application rate, kg/ha	Uniformity coefficient	Actual field capacity, ha/h	Field efficiency, %	Fuel consumption l/h
1	3.5	4.25	21°	13.2	125	56.7	3.68	65.6	3.75
2	4.5	4.68	21°	13.0	118	55.4	3.70	60.9	3.56
3	4.0	4.76	47°	16.8	114	53.8	4.62	57.8	3.22
4	3.5	4.23	47°	16.6	125	56.4	4.08	58.1	3.86
5	4.5	4.56	60°	17.8	120	55.6	4.72	58.2	3.76

Table.4 Effect of change in operational parameter on performance of square type Fertilizer broadcaster

Test	Duration, h	Speed of tractor, Km/h	Angle of blades of distributor plate	Total fertilizer spreading width, m	Fertilizer application rate, kg/ha	Uniformity coefficient	Actual field capacity, ha/h	Field efficiency, %	Fuel consumption l/h
1	4.0	3.05	22°	13.83	119	59.2	3.46	81.97	3.69
2	3.5	3.03	22°	13.80	114	58.5	3.21	78.20	3.64
3	4.5	3.09	22°	13.78	109	54.6	3.16	77.34	3.38
4	8.0	3.12	22°	13.91	120	58.4	3.28	78.52	3.17

Table.5 Comparative performance of fertilizer broadcasters

S. no	Parameters	Square type	Conical type
1.	Field condition	Levelled field	Levelled field
2.	Speed of operation, km/h	3.03 to 3.12	4.23 - 4.76
3.	Total fertilizer spreading width, m	13.78 to 13.91	13.0 - 17.8
4.	Fertilizer application rate, kg/ha	109 to 120	114 to 125
5.	Uniformity coefficient	54.6 to 59.2	53.8 to 56.7
6.	Actual field Capacity, ha/h	3.16 to 3.46	3.68 to 4.72
7.	Field efficiency, %	77.34 to 81.97	57.8 to 65.6
8.	Fuel consumption, l/h	3.17 to 3.69	3.56 to 3.88
9.	Fuel consumption, l/ha	0.97 to 1.13	0.80 to 1.02
10	PTO power requirement, hp	5.8 to 6.4	6.2 to 6.7

The fertilizer application rate was in the range of 109 to 120 kg/ha and corresponding fuel consumption varied from 3.17 l/h to 3.69 l/h. The results obtained from the different trials are shown in the Table 4.

Comparative analysis

The performance of conical and square fertilizer broadcaster was analyzed for various parameters. The results are shown in Table 5.

In this study the performance of two types of fertilizer broadcaster was analyzed. Based on the study it can be concluded that fertilizer broadcaster enhanced the fertilizer application as it is convenient to use and efficient. Both square type and conical type fertilizer broadcasters performed satisfactory in the levelled field. The field efficiency for square type fertilizer broadcaster was 81.97% which was higher compared to conical type 65.6%. The maximum field capacity was more for the conical type 4.72 ha/has compared to 3.46 ha/h of square type. Thus, these broadcasters can be used in the levelled field for fertilizer application.

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