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Research Paper :

Performance evaluation of tractor operated manure spreader

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ABSTRACT

Organic manure is considered as the eco-friendly bio-fertilizer for the highly polluted modern era. Proper application of manure to the land is essential to prevent pollution of land, ground and surface water and to prevent loosing of ammonia and other nutrients from the manure. Timely application of manure in accordance with the nutrient requirements of the crops will result in improved crop production. A manure spreader was attached to the 45 HP tractors through the hitch point and test was conducted. The 540 ±rpm PTO speed was used to operate the rotary blades of manure spreader. The distribution pattern of farm yard manure was uniformly spread over the area and little variation was found. This was due to clods in to manure. It showed that there was saving of 94 per cent in time as compared to traditional method. The field capacity of the manure spreader was also worked out in terms of area coverage per hour. The actual average swath width of manure spreader was found 7.6 m but the effective swath was taken as 7.4 m by considering the overlap uniformity of application and spread pattern. The manure spreader was operated in two different fields. The theoretical field capacity of a tractor operated manure spreader was found to be 1.950 and 2.06 and average actual field capacity of the tractor operated manure spreader was found to be 1.395 and 1.473 at forward speed of 2.438 km/h. The average field efficiency of the tractor operated manure spreader was found to be 71.55 per cent. The field application rate of farm yard manure was observed to be 5.435 and 5.89 t per ha. The cost economics of the manure was analyzed. The cost of spreading with the tractor operated manure spreader was Rs. 247 per ha. The saving in cost and time were 72 and 94 per cent, respectively as compared to conventional method of manual broadcasting.

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Organic manure is considered as the eco-friendly bio-fertilizer for the highly polluted modern era. Proper application of manure to the land is essential to prevent pollution of land, ground and surface water and to prevent loss of ammonia and other nutrients from the manure. Timely application of manure in accordance with the nutrient requirements of the crops resulted in improved crop production. The important parameters to be considered while spreading the manure on the field are:

Restrict manure spreading on the land to the growing season of the crop, do not apply manure on the land when there is no crop.

Balance the quantity of manure with the nutrient requirements of the crop. The quantity of manure which is to be applied per ha depends on the soil type and should be limited not to manure but it should be equivalent of 150 kg N per hectare.

Evaporation of ammonia and greenhouse gases should be reduced when manure is not or only for a short time exposed to fresh air. The manure should be covered with soil (e.g. harrowing) immediately after spreading or should be injected into the soil directly.

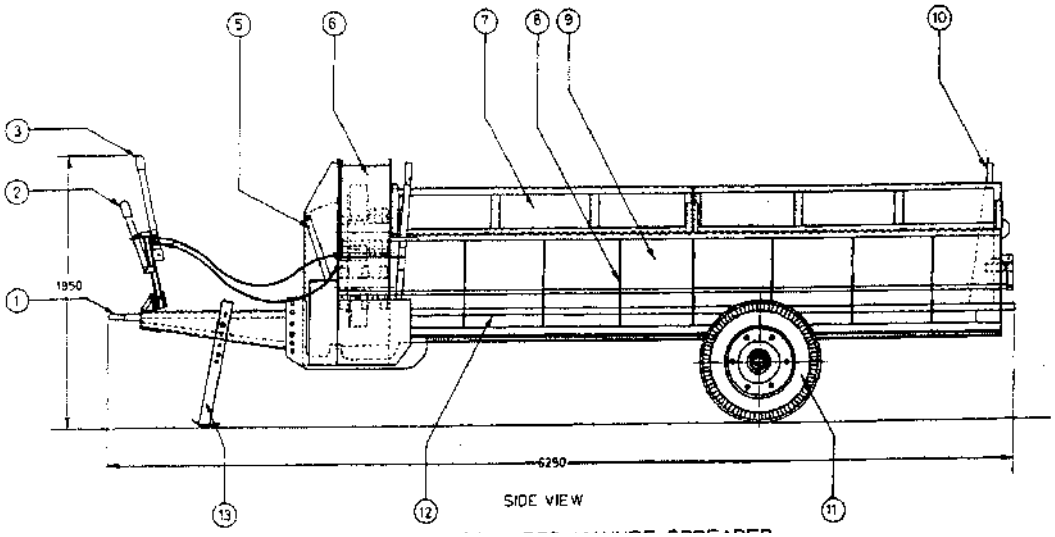
Millions of tones of organic solid waste are produced every year in India and the land application of these solid waste has become a popular method of disposing them in an environmentally safe manner. Spread the manure manually in the field, which is laborious tedious, unfortunately there is no mechanical device commercially available in India to spread the solid organic manure uniformly in the field (Dhaliwal and Vinay, 2004).

METHODOLOGY

The manure spreader evaluated under present study is a tractor operated trailed implement (Fig.1)

Power transmission system of the machine:

The power for the manure spreader was transmitted form the tractor PTO. The drive from the PTO was transmitted to the jack shaft of the manure spreader. The main drive shaft transmits power to all other mechanisms. The power was transmitted to the main drive shaft through a chain drive. From the compound sprocket, drive was transmitted to both the upper and lower spreader drums and also to the beater through chain drive. The drive from the main drive shaft was transmitted to the tail gate drive mechanism through chain drives. For tail gate the drive



REF.	NAME	REF.	NAME	REF.	NAME
1	HITCH FRAME	6	DISINTEGRATOR HOUSING	11	PNEUMATIC TYRE (750x60)
2	TAIL GATE SPEED LEVER	7	SIDE EXTENSION PLATE	12	MAIN FRAME
3	SWATH WIDTH LEVER	8	SUPPORTING RIBS	13	PARKING STAND
		9	MANURE TUB		
5	TAIL GATE REVERSE LEVER	10	TAIL GATE		

Fig. 1 : Side view of tractor operated maure spreader

was transmitted to a bevel gear arrangement through chain and sprockets to turn the direction of rotation through 90^0. The bevel gear shaft was fixed to the main frame and carried an eccentric cam and a sprocket with reversing arrangement. The cam on this shaft imparts intermittent drive to the pawl and ratchet mechanism. The ratchet was mounted on the tail gate drive shaft. The number of teeth advanced by the pawl governs the distance of advancement of the tail gate for every stroke of the cam. The feed rate can be set by the feed adjustment lever with five positions. The feed adjustment lever actuates the pawl and ratchet mechanism through a cable. A clutch plate was provided to engage or disengage the pawl from the sprocket to reverse the tail gate. The direction of rotation of the tailgate drive shaft was reversed by the bevel gear reversing arrangement.

Field performance of tractor operated manure spreader:

The performance of tractor drawn manure spreader was evaluated for its feasibility. The field performance tests were conducted on Oil Seed Research Unit (CRS) and Animal husbandry and Dairy field in Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola. Manure spreader was available in the Department of Farm Power and Machinery, College of Agriculture and Engineering and Technology, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola. The manure spreader was tested as per testing code provided by TNAU. The field performance tests were carried out to obtain actual data on overall machine performance including actual operating time, time loss in turning, speed of operation, fuel consumption, field capacity and cost of operation etc.

The manure spreader has a single point hitch at the front for hitching to the drawbar of the tractor. An endless conveyor was provided at the bottom of the trailer for conveying the manure towards the rear end. For shearing off the manure and it's distribution, swinging hammer type beaters were provided at rear end. The power to the conveyor and the beater was provided to rotate the shaft having beaters. The conveyor has four moving speeds which are adjusted with help of ratched lever while the beater rotates at one speed. During field test of tractor operated manure spreader, the trailer was filled with manure with help of labors a tractor of 45 hp Massey Ferguson was used for the test. Power transmitted to the manure spreader through PTO. The tractor was run in second low speed to get better spreader effect.

The observations which was made during the evaluation of manure spreader is as follows:

– Conveyor speed
– Forward speed

– Application rate

For measuring the conveyor speed and forward speed, measuring tape and stop watch was used. Weight of manure per trailer was measured at weighting balance. For measuring application rate, metal trays were used. A set of two trays were placed at three different location of the track and manure was collected in those trays which was weighed afterwards. The manure spreader was evaluated at one conveyor speed *i.e.* 2.45 m/min.

RESULTS AND DISCUSSION

The tractor operated manure spreader was tested at Oil Seed Research Unit (CRS) of Dr. PDKV, Akola. The manure spreader was operated in the field to spread the farmyard manure (FYM) and its performance was evaluated by using the test procedure described in TNAU test code (Anonymous, 2004). The field performance of manure spreader was evaluated in terms of spreading uniformity, application rate, swath width and field capacity. The field performance of manure spreader are discussed and presented in comparison with conventional method of broadcasting.

Table 1 : The specifications of tractor operated manure spreader

Sr. No.	Particulars	Dimensions
1.	Overall dimensions (Lx B x H), mm	6000 x 1950 x 1700
2.	Wheel base, R, mm	1500
3.	Overall dimensions of the tub (l x h), mm	4200 x 550
4.	Capacity of the tubV,m^3	3.50
5.	Bottom width of the tub, b mm	750
6.	Height of the tub, mm	550
7.	Container height from the ground, mm	1230 + 310
8.	Recommended PTO. rpm	540
9.	No. of disintegrator blades	5
10.	Speed of disintegrator disc, rpm	120
11.	No. of shredder blades	3
12.	Speed of shredder blades, rpm	660
13.	No of spreader drums	2
14.	Speed of spreader drums, rpm	1080
15.	No. of guide vanes on spreader drum	21
16.	Speed of beater, rpm	1080
17.	Forward speed of tail gate, m/sec	
	At gear position 1	0.0039
	At gear position 2	0.0067
	At gear position3	0.012
	At gear position 4	0.021
	At gear position 5	0.029
18.	Effective width of spread	
	Swath width door up position, m	5-8
	Swath width door down m position	9-12
19.	Tyre	7.50 x 16.0 – 16 PR
20.	Overall weight, Kg.	950

Uniformity of manure spreader:

The manure spreader was operated in the field to spread farm yard manure. The manure spreader was attached to the 45 hp tractor through the hitch point and tests were conducted. The 540 $\pm$ 10 rpm PTO speed was used to operate the rotary blades of manure spreader. The manure spreader was operated in the field to spread farm yard manure. For uniformity of the manure, the weight of manure per tray was noted. At 2.4 Km per h (40 m per min) forward speed, the weight of manure per tray is given in Table 2. It shows that at 2.45 m per min conveyor speed, the weight of manure varied from 288 gm to 300 gm per tray. This variation was due to the clods in the manure. The result obtained are shown in Table 2.

Table 2 : Uniformity of the weight of manure

Conveyor speed	Weight of manure per tray (gm)		
2.45	Tray 1	Tray 2	Tray 3
	288	288	300
	285	270	296
Average	286.5	279	298

The distribution pattern of farm yard manure was uniformly spread over the area and little bit variation was found. This was due to clods in to manure

Field capacity of manure spreader:

The field capacity of the manure spreader was also worked out in terms of area coverage per hour. The actual average swath width of manure spreader was found 7.6 m but the effective swath was taken as 7.4 m by considering the overlap uniformity of application and spread pattern. The mean values of the results obtained from the field testing of the manure spreader are presented in Table 3.

The theoretical field capacity of a tractor operated manure spreader was found to be1.950 and 2.06 and average actual field capacity of the tractor operated

Table 3 : Field performance evaluation of manure spreader

Sr. No.	Particulars	Field test in CRS	Field test in Dairy
1.	Area covered (ha)	0.2646	0.2494
2.	Actual speed (km/h)	2.438	2.438
3.	Field capacity		
	Theoretical field capacity (ha/h)	1.950	2.06
	Actual field capacity (ha/h)	1.395	1.473
4.	Field efficiency (%)	71.53	71.57
5.	Effective swath width (m)	7.6	7.4
6.	Fuel consumption (lit/h)	3.0	2.75
7.	Application rate (t/ha)	5.435	5.89

manure spreader was found to be 1.395 and 1.473 at the forward speed of 2.438 km/h. The average field efficiency of the tractor operated manure spreader was found to be 71.55 per cent. The field application rate of farm yard manure was observed to be 5.435 and 5.89 t per ha.

Conclusion:

The manure requirement by the convectional method was found to be 7.4 t/ha, which was very less than recommended application rate of manure. The performance of tractor operated manure spreader depends upon the uniformity of spreading. The spreading pattern of tractor operated manure spreader was accepted. The field performance of tractor operated manure spreader was calculated, the average theoretical field capacity was 2.05 ha/hr, average actual field capacity was 1.44 ha/hr and average field efficiency was 71.55 per cent. The effective swath width of tractor operated manure spreader was observed 7.5m.

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