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PERFORMANCE EVALUATION OF ROTAVATOR BASED ON DIFFERENT SOIL MOISTURE CONTENT

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ABSTRACT

Rotary tillage implements are now being projected as important equipment that results in production of fine tilth soil. Preparation of an optimum seedbed condition by minimizing the time, cost and energy requirements has assumed considerable significance for the paddy-wheat farming system widely practiced in northern part of India. In order to study the effect of various parameters on the performance under actual field conditions, a rotary tiller was selected. Moisture content (11.27%, 17.04 % and 22.87%) was recorded in the different field conditions. The rear shield position was adjusted at full down, full up and middle positions and three different Forward speeds of the tractor 2.5 km/hr, 3.0 km/hr and 3.5 km/hr and three types depth of cut 5cm, 8cm and 12cm. were used for the study. The study was undertaken to examine the influence of Forward speed, depth of cut at different moisture content fields with dependent parameters such as draft, fuel consumption, power consumption, field efficiency, and residue incorporation by rotavator. In this paper the results indicated that as the forward speed, shield position full down and depth of cut increases, the value of draft, fuel consumption, power consumption also increases

KEYWORDS: Forward speed, Rotavator, Shield position and Moisture content.

INTRODUCTION

Rotavator is a tillage machine which is used in soil bed preparation and weed control in arable field and fruit gardening agriculture. It has a huge capacity for cutting mixing to top soil preparing the seed bed directly and also it has more mixing capacity seven times than a plough. Its components work under miscellany our forces because of power vibration pointless impact effect of soil parts as after reaching to higher etc. The rotator tillage is a tillage machine designed for preparing land suitable for sowing seed for eradicating weeds mixing for seed and fertilizer in to soil to up and renovate pastures for crushing clods etc.

The rotator will produce a perfect seedbed in fewer passes. It is the ideal implement for cash crop farmers who need to bury and in corporate crop residues quickly between crope. Tillage tools direct energy into the soil to cause some desired effect such as cutting breaking. A gardening rotator is a compact machine which can be used on any land size but is more appropride for gardening. The rotator can be easily adjusted for various working depts. for soil bed preparation.

Approximately 20 percent of energy for production agriculture is used for field operations, with a majority of this energy applied toward tillage operations (Stout *et al.,* 1984). All most all the conventional tillage implements are passive tillage implements for soil- implement interface. The power for these implements is supplied by the tractor through soil-type interface. Only about 40-56 percent of net engine power is available at the drawbar of a tractor when transmitting power through the soil-type interface, whereas it is about 80-85 percent for PTO driven active tillage tools (Taylor and Burt, 1975). Poor transmission efficiency, mainly due to high wheel slippage at the soil-tyre interface, reduces the tillage efficiency of the implements. Conventional tillage is an energy intensive method and there is a need for implements, which should ensure timeliness of field operations, besides being cost and energy effective. Transmission of power to the soil engaging tools through PTO of tractor reduces inefficiency of soil-tyre interface. The PTO driven tools transmit power directly to the soil rather than being pulled through it. These implements are more effective in soil pulverization, cutting ability and require less draft. The soils with moderate hardness can be prepared more rapidly by rotary powered implements. These implements can play an important role in multiple cropping systems where time is the main constraint for land preparation. Rotavator tools obtain their energy in more than one manner, reduce the draft requirement and have greater versatility in manipulating the soil to obtain the desired result. Thus, rotavator also reduces the time required to get an optimum seedbed by combining the primary and secondary tillage operation.

MATERIAL AND METHODS

The study was under taken to evaluate the performance of rotavator and to optimize the forward and rotational speed of rotavator in three different fields of Agronomy Research Center IFTM University Moradabad. A Sonalika make rotavator was evaluated for its performance in Deferent fields. And different parameters like fuel consumption, draft measurement, power consumption, field capacity, residues incorporation, clod weight mean diameter, were measured to assess the suitability of rotavator in India.

Fuel Consumption

The tank was filled to full capacity before and after the test. A mount of refueling after the test was the fuel consumption for the test. While filling up the tank, careful attention should be paid to keep the tank horizontal and not to leave empty space in the tank. The fuel consumption will give an idea of energy requirement by the implement for the operation.

Draft Measured

Draft can be measured by two tractors and a dynamometer. An implement was mounted on a tractor (A) and this tractor was towed by another tractor (B) through a dynamometer as shown in fig. measure the draft when the tractor a was in neutral gear condition but implement in operating condition and again which the implement was in lifted position. The difference between two readings gives the draft requirement of implement.
Draft of implement = pull required at load condition – pull required at no load condition

Power Consumption

Draft power requirement for the operation of implement can be calculated by the following Formula for calculation:

$$PS = \frac{2\pi NT}{4500}$$

Where,
PS = Pto horse Power
T = Torque (Kgf.m)
N = Revolution (rev/min)

Residue Incorporation

The residue incorporation is the process through which furrow slice is inverted. The residues incorporation characteristics can be measured by weed count method. In this method the number of weed, stubble present were counted before and after operation with the help of placing a square ring of 30 x 30cm or 50 x 50 cm at random in the field and the maximum five location. The residue incorporation is expressed on percentage basis.

$$\text{Residue incorporation (\%)} = \frac{WB - WA}{WB} \times 100$$

Where,
WB = Number of weed present per unit area before the operation.
WA = Number of weed present per unit area after the operation.

Effective field capacity

The actual output in terms of area covered per hour is expressed as the effective field capacity. In calculating the effective field capacity. The time consumed for real work and that lost for other activities such as turning. Adjustment etc. should be taken. Time for refueling should be deleted because usually filling up before starting the test can make refueling unnecessary except for especially large field. It can be calculated as:

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$$E_e = \frac{A}{T_p + T_n}$$

Where
E_e = Effective field capacity (ha/h)
A = Area covered (ha)
T_p = Productive time (h)
T_n =non productive time (h)
(Non productive time is the time lost for turning and adjustment etc. excluding refueling and machine trouble)

RESULT AND DISCUSSION

The field experiment was carried out in the sandy clay loam soil at. IFTM University, Lodhipur, Rajput, Moradabad U.P. during the year 2015- 2016. The study was undertaken to examine the influence of Moisture content, forward speed of the tractor, Shield position of rotavator and depth of cut on different parameters of rotavator. During the experiment the performance of rotavator at the three Moisture content fields (1.2, 1 ha) and (1.3 ha) respectively were selected. The results obtained during the course of study were analyzed statistically by using the three factorial designs (RBD). The statically analysis (ANOVA) is given different tables indicated that different field, Forward Speed of Tractor and depth of cut have significant effect on the draft, fuel consumption, power consumption, mean mass diameter, field capacity, field efficiency, and residue incorporation at 5% level of significance

Table 1- Effect of forward speed, shield position and depth of cut on different parameters of rotavator.
Effect of Forward speed, shield position and depth of cut on the draft requirement by rotavator Table 1 presents the draft required at different Forward speed and depth of cut. The effect of Forward speed and depth of cut on draft is shown in 4.1.The maximum draft in Moisture content (11.27) was found to be 169.9 kgf at a forward speed 2.5 Km/hr, depth of cut 12cm, Shield position is down and the minimum draft in Moisture content (11.27) was found to be 140 kgf at forward speed of 2.5 km/hr, depth of cut 5 cm. and Shield position is up. The maximum draft for rotavator in Moisture content (17.04) was found to be 165 kgf at the respective forward speed, depth of cut and Shield position 3.0km/hr, 12cm and Shield position is down position. The minimum draft of 150 kgf was attained at a forward speed of 2.5 km/hr, depth of cut of 5cm and Shield position is up .The maximum draft Moisture content (22.87) was found to be175 kgf at a Forward speed of 3.5km, depth of cut 12 cm. and Shield position is down. The minimum draft in Moisture content (22.87) was found to be 163 kgf at forward speed of 3.5km/hr, depth of cut 5 cm and Shield position down

Table 1- Effect of Forward speed, shield position and depth of cut on the draft under different moisture content.

Experiment no.	Forward Speed (km/hr)	Shield position	Depth of cut (cm)	Moisture content (%)	Average value of Draft (kgf)
1	F_1	S_1	D_1	11.27	140
2	F_1	S_1	D_2		144
3	F_1	S_1	D_3		153
4	F_1	S_1	D_1		145
5	F_1	S_1	D_2		147
6	F_1	S_1	D_3		154
7	F_1	S_1	D_1		156
8	F_1	S_1	D_2		161
9	F_1	S_1	D_3		169
10	F_2	S_2	D_1	17.04	150
11	F_2	S_2	D_2		153
12	F_2	S_2	D_3		156
13	F_2	S_2	D_1		155
14	F_2	S_2	D_2		159
15	F_2	S_2	D_3		160
16	F_2	S_2	D_1		157
17	F_2	S_2	D_2		159
18	F_2	S_2	D_3		165
19	F_3	S_3	D_1	22.87	165
20	F_3	S_3	D_2		169
21	F_3	S_3	D_3		173
22	F_3	S_3	D_1		166
23	F_3	S_3	D_2		169
24	F_3	S_3	D_3		**174**
25	F_3	S_3	D_1		163
26	F_3	S_3	D_2		166
27	F_3	S_3	D_3		175

Where:

F_1 = 2.5 km/hr	S_1 = Shield position up	D_1 = 5cm
F_2 = 3.0 km/hr	S_2 = Shield position middle	D_2 = 8cm
F_3 = 3.5 km/hr	S_3 = Shield position down	D_3 = 12cm

Table 2- Effect of Forward speed, shield position and depth of cut on the fuel consumption by rotavator

Table 2 presents the fuel consumption at different Forward speed and depth of cut. The effect of Forward speed and depth of cut on fuel consumption is shown in 4.2. The maximum fuel consumption in Moisture content (11.27) was found to be 5.8 l/h. at a forward speed 2.5 Km/hr, depth of cut 12cm, Shield position is up and the minimum fuel consumption in Moisture content (11.27) was found to be 5.0 l/h at forward speed of 2.5 km/hr, depth of cut 12cm. and Shield position is up. The maximum fuel consumption for rotavator in Moisture content (17.04) was found to be 6.9 l/h at the respective forward speed, depth of cut and Shield position 3.0km/hr, 12cm and Shield position is down position. The minimum fuel consumption of 6.2l/h. was attained at a forward speed of 3.0 km/hr, depth of cut of 5cm and Shield position is up .The maximum fuel consumption Moisture content (22.87) was found to be 7.1 l/h at a Forward speed of 3.5km, depth of cut 12 cm. and Shield position is down. The minimum fuel consumption Moisture content (22.87) was found to be 6.6 l/h at forward speed of 3.5km/hr, depth of cut 5 cm and Shield position down

Figure1: The Measurement of Actual Working Width of Rotavator

Table 2- Effect of Forward speed, shield position and depth of cut on the fuel consumption by rotavator

Experiment no.	Forward Speed (km/hr)	Shield position	Depth of cut (cm)	Moisture content (%)	Average value of Fuel Consumption(l/h)
1	F_1	S_1	D_1	11.27	5.5
2	F_1	S_1	D_2		5.7
3	F_1	S_1	D_3		5.8
4	F_1	S_1	D_1		5.4
5	F_1	S_1	D_2		5.5
6	F_1	S_1	D_3		5.7
7	F_1	S_1	D_1		5.3
8	F_1	S_1	D_2		5.2
9	F_1	S_1	D_3		5.0
10	F_2	S_2	D_1	17.04	6.2
11	F_2	S_2	D_2		6.6
12	F_2	S_2	D_3		6.8
13	F_2	S_2	D_1		6.3
14	F_2	S_2	D_2		6.4
15	F_2	S_2	D_3		6.6
16	F_2	S_2	D_1		6.6
17	F_2	S_2	D_2		6.8
18	F_2	S_2	D_3		6.9
19	F_3	S_3	D_1	22.87	6.9
20	F_3	S_3	D_2		7.1
21	F_3	S_3	D_3		7.2
22	F_3	S_3	D_1		6.7
23	F_3	S_3	D_2		6.9
24	F_3	S_3	D_3		7.0
25	F_3	S_3	D_1		6.6
26	F_3	S_3	D_2		6.8
27	F_3	S_3	D_3		7.1

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Where:

F_1 = 2.5 km/hr	S_1 = Shield position up	D_1 = 5cm
F_2 = 3.0 km/hr	S_2 = Shield position middle	D_2 = 8cm
F_3 = 3.5 km/hr	S_3 = Shield position down	D_3 = 12cm

Table 3 Effect of Forward speed, shield position and depth of cut on mean mass diameter, (mm) under different moisture content.

Table 4.3 presents the mean mass diameter at different Forward speed and depth of cut. The effect of Forward speed and depth of cut on mean mass diameter is shown in 4.3. The maximum mean mass diameter in Moisture content (11.27) was found to be 2.5 mm. at a forward speed 2.5 Km/hr, depth of cut 5cm, Shield position is up and the minimum mean mass diameter in Moisture content (11.27) was found to be 1.6 mm at forward speed of 2.5 km/hr, depth of cut 12cm. and Shield position is down. The maximum mean mass diameter for rotavator in Moisture content (17.04) was found to be 2.5 mm at the respective forward speed, depth of cut and Shield position 3.0km/hr, 5cm and Shield position is up position. The minimum mean mass diameter of 1.2 mm. was attained at a forward speed of 3.0 km/hr, depth of cut of 12cm and Shield position is middle. The maximum mean mass diameter (mm) Moisture content (22.87) was found to be 2.7mm at a Forward speed of 3.5km, depth of cut 5 cm. and Shield position is up. The minimum mean mass diameter (mm) Moisture content (22.87) was found to be 1.3 mm at forward speed of 3.5km/hr, depth of cut 12 cm and Shield position down as shown in 4.3. The statically analysis (ANOVA) is given Table A3 indicated that Moisture content (11.27, 17.04 and 22.87), forward speed, depth of cut and Shield position have significant effect on the mean mass diameter at 6% level of significance. In general it was found as the forward speed increases mean mass diameter decreases. The increases in depth of cut were also found to cause in decreases the mean mass diameter requirement by the rotavator.

Figure 2: A View of Tractor Operated Rotavator

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Table 3 Effect of Forward speed, shield position and depth of cut on mean mass diameter, (mm) under different moisture content.

Experiment no.	Forward Speed (km/hr)	Shield position	Depth of cut (cm)	Moisture content (%)	Average value of Mean Mass Diameter, (mm)
1	F_1	S_1	D_1	11.27	2.5
2	F_1	S_1	D_2		2.4
3	F_1	S_1	D_3		2.4
4	F_1	S_1	D_1		2.0
5	F_1	S_1	D_2		2.1
6	F_1	S_1	D_3		2.0
7	F_1	S_1	D_1		1.8
8	F_1	S_1	D_2		1.7
9	F_1	S_1	D_3		1.6
10	F_2	S_2	D_1	17.04	2.5
11	F_2	S_2	D_2		2.4
12	F_2	S_2	D_3		2.3
13	F_2	S_2	D_1		1.5
14	F_2	S_2	D_2		1.4
15	F_2	S_2	D_3		1.2
16	F_2	S_2	D_1		1.8
17	F_2	S_2	D_2		1.7
18	F_2	S_2	D_3		1.7
19	F_3	S_3	D_1	22.87	2.7
20	F_3	S_3	D_2		2.6
21	F_3	S_3	D_3		2.4
22	F_3	S_3	D_1		1.7
23	F_3	S_3	D_2		1.7
24	F_3	S_3	D_3		1.6
25	F_3	S_3	D_1		1.5
26	F_3	S_3	D_2		1.4
27	F_3	S_3	D_3		1.3

Where:

F_1 = 2.5 km/hr	S_1 = Shield position up	D_1 = 5cm
F_2 = 3.0 km/hr	S_2 = Shield position middle	D_2 = 8cm
F_3 = 3.5 km/hr	S_3 = Shield position down	D_3 = 12cm

SUMMARY AND CONCLUSION

1. It was found as the forward speed increases draft increases. The increase in depth of cut was also found to cause in increasing the draft. The maximum draft in Moisture content (22.87) was found 174 kgf at forward speed 3.5 km/h. of 3.5 and depth of cut 12 cm and the minimum draft in Moisture content (22.87) was found to be 163kgf at forward speed 3.5km/h. and depth of cut 5 cm. The maximum draft for rotavator in Moisture content (17.04) was found to be 165kgf at the respective forward speed 3.0 km/h, depth of cut 12 and shield position is down. The minimum draft of 140 kgf was attained at a forward speed 2.5km, depth of cut of 5cm and shield position is up. The maximum draft in Moisture content (22.87) was found to be 175 kgf at forward speed 3.5km/h. and depth of cut 12 cm. The minimum draft in Moisture content (11.27) was found to be 140 kgf at forward speed 2.5Km/h & depth of cut 5 cm.

2. It was observed that as depth increases the fuel consumption during operation was increases. The maximum fuel consumption for Moisture content (11.27), Moisture content (17.04) and Moisture content (22.87) field were found to be 5.80 l/h. at forward speed 2.5km/h, depth of cut 12 cm shield position up, 6.90 l/h. at forward speed 3.5km/h, depth of cut 12 cm shield position down. And 7.20 l/h. forward speed 3.5km/h, depth of cut 12 cm shield position down respectively. For the same deferent moisture content field the minimum fuel consumption was found to be 5.00 l/h at forward speed 2.5km/h, depth 12 cm and shield position is down, 6.3 l/h at forward speed 3.00km/h, depth 5 cm and shield position meddle. 6.60 l/h at forward speed 3.5 km/h, depth 5 cm and shield position down respectively.
3. The maximum mean weight diameter for Moisture content (11.27), Moisture content (17.04) and Moisture content (22.87) field were found to be 2.5 mm at forward speed 2.5km/h, depth of cut 8 cm and shield position is up. 2.5 mm at forward speed 2.5km/h, depth of cut 5cm and shield position is up respectively.
For the same Moisture content field orchards the minimum Mean Mass Diameter mm were found to be 1.6 mm at forward speed 2.5km/h, depth of cut 12cm and shield position is down respectively.

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