RESEARCH PAPER International Journal of Agricultural Engineering | Volume 10 | Issue 2 | October, 2017 | 590-594
e ISSN–0976–7223 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/10.2/590-594**

Performance analysis of rotavator and other tillage implement driven by the tractor

■ **RAHUL KUMAR YADAV, PRASHANT SINGH AND SAURABH KUMAR SINGH**

Received : 07.08.2017; **Revised :** 05.09.2017; **Accepted :** 20.09.2017

See end of the Paper for authors' affiliation

Correspondence to :

RAHUL KUMAR YADAV
Department of Farm Machinery and Power Engineering, Vaugh School of Agricultural Engineering and Technology, Sam Higginbottom Institute of Agriculture, Technology and Science, ALLAHABAD (U.P.) INDIA
Email : rahul.yadav893@gmail.com

■ **ABSTRACT :** Performance analysis of rotavater and other tillage implements in the field during the year 2014-15 is calculated in this research paper performance analysis of rotavator and other tillage system is calculated the field capacity, Fuel consumption, actual, theoretical speed performance index and energy requirement for preparation of seed bed with the performance of rotavator is calculated in plot with area of 60 x 20 m^2 the combination of ploughing ploughing + cultivating, ploughing + disc harrowing, ploughing + Rotavating, Single operation of rotavator and double operation of rotavator with speed of 5.21 km/h gave the highest performance index 83.34% and energy consumption was 586.73 MJ/h in this field area rotavator performance index is 25.75 and energy consumption 761.6 MJ/ha, respectively

■ **KEY WORDS :** Mean weight diameter, Fuel consumption, Energy requirement

■ **HOW TO CITE THIS PAPER :** Yadav, Rahul Kumar, Singh, Prashant and Singh, Saurabh Kumar (2017). Performance analysis of rotavator and other tillage implement driven by the tractor. *Internat. J. Agric. Engg.*, **10**(2) : 590-594, **DOI: 10.15740/HAS/IJAE/10.2/590-594.**

The Indian farmers are using tractor drawn improved Agricultural implements and machinery for different operations in the field. Use Primary tillage operations implements MB plough is used whereas for the secondary tillage operations implements, disc harrow, cultivators and rotavator were used. In recent years rotavator is becoming popular among the farmers for land preparation of seed bed where two or more crops are taken in a year. Rotavator can plough an important role in double or multiple cropping systems where the time for land preparation is very less or limited. Whereas in MB plough cultivator disc harrow and rotavator during tillage operations energy consumption is comparatively more. Tillage is the most important unit operation in agricultural it is done mainly to loosen the upper layer of soil to maximum the soil with fertilizer and to remove weeds as a result of this procession the water air thermal and nutrient regimes of the soil are improved in the interest of the growth and development of crop.

The most widespread method of tillage land is plugging with mould board in the process of plugging. The soil layer is subjected to various deformations and turned to the bottom of the groove. However by the use of mould board plough the upper layer of the soil is not always loose had to the different layers achieved. Hence additional operations such as disking. Cultivation and harrow in it are carried out to improve on the plugging.

The maximum field efficiency was obtained with cultivator attachment when it was compared with the field performance of other attachment of multipurpose tool bar such as plough riger and bund formers. Cost of operation of cultivator attachment observed was Rs. 175/ ha which was less than that of cost of operation of other attachments. When the cultivator was operated sandy loam soil at 20 per cent moisture content with operating speed 5 km/ha field efficiency observed was 79.43% which was more than other attachments (Job *et al*., 1984).

METHODOLOGY

A field experiment was conducted at Vaugh School of Agricultural Engineering and Technology, SHIATS Allahabad during the year 2014-2015 to study. The performance analysis of Rotavator and other tillage implement driven by the tractor different combinations of tillage implements for tillage operations were selected as ploughing with mould board plough (S1) Mould board plough + cultivator (S2) cultivator + Disc horrow (S3) Disc harrow + Rotavator (S4) Single operation of rotavator (S5) and Double operation of rotavator (S6). Three replications of each combination were taken in the field for more accuracy of results.

The tractor drawn implements produce best performance only in rectangular field therefore rectangular plots of 60 m x 20 m were marked for each trial. Performance of tractor drawn MB plough, disc harrow, Cultivator, and rotavator varies considerably according to the type of Soil, moisture content of soil, weeds, crop residues and traveling speed. Therefore the conditions of the test have to be clearly stated and before starting the test at various field conditions moisture content on dry basis was determined and all tests were conducted as per the RNAM test code. During field trials for each operation speed of operation in km/h, depth of penetration in cm, area covered in unit time (ha/hr), moisture content of the soil to the operational depth in per cent, sieve analysis for clod size after operation in mm and draft required for pulling implement (kg) were recorded. These observations were used to calculate the fuel consumption, combination of implement, depth of cut, field performance index, cost of operation and energy requirement.

Pulverization test was carried out in the field aggregates was considered as pulverization index and it was expressed in mm. It also includes the experimental procedure to measure these data during field operation of tillage implement. All these aspects are described in details under following headings :

Techniques for determining the variable :

Fuel consumption :

The fuel consumption was measured by toping method, in this method tractor was place in horizontal position was tank field completely before use in the field for testing of tillage implement after the test place the tractor on the same level horizontal position and field the tank on the same level with the help of measuring cylinder. The added amount of fuel is consumption of fuel.

Energy requirement :

The energy requirement from mechanical source such as tractor was computed from the quantity of fuel consumed for a particular operation and the energy co-efficient of the fuel used. The fuel consumption for a particular field operation was estimated from the following equation :

FC = LCF x RHP x SFC/1000

where

FC = Fuel consumption l/h

LCF = Load co-efficient factor for field operation

RHP = Rated horse power of the power source

SFC = Specific fuel consumption ml/hp/h

Energy of farm machinery :

The indirect input from the use of the machine in the field was computed with the help of the following equation :

IE = C x WM x HUM/OA

where

IE=Indirect energy input machinery MJ

C = Energy co-efficient, MJ/kg

WM=Weight of machinery, kg

HUM = Hours of use of Machinery, H

Used :

Human Energy = No. of labour x Energy Equivalent (MJ/man-h) x Time (h)

Rotavator, cultivator, mould board plough and disc plough (machinery energy = [wt. (kg) x Energy Equivalent (MJ/kg-yr) x time (hr.) ÷ [life (yrs.) x annual use (hr.)

Diesel = Fuel consumption (lit/hr.) x Energy Equivalent (MJ/lit.) x time (hr.)

Mean weight diameter :

For each experiment after completion of the tillage operation approximately 500 g soil sample was collected and dry the mean weight diameter of the clay was found out by using sieve analysis with different size of sieve 15, 11.2, 8, 5.6, 4, 2.8 and 2.

Mean weight diameter can be calculated from the equation as follow :

MWD = Σ Xi Wi

where

Xi = Mean weight diameter of the soil fraction *i.e.* the average diameter of the sieve on which soil aggregates

Wi=The proportion by weight of the given size fraction of aggregates.

Moisture content :

The sample where collected weight and dry temperature 105^{0}C for 24 hour then try weight was taken and moisture content was calculated

$$MC\ Z\ \frac{W_1 - W_2}{W_2} x\,100$$

where

W_1=Total weight of soil, kg

W_2=Dry great of soil, kg

Experiment procedure :

For conducting the experiment, the size of each plot was 60 x 20 m^2. The moisture content was determined on dry weight basis. Three different tillage implements were taken as combination, there implement were M.B. plough, cultivator, Disc harrow, and Rotavator. There implement were used field moisture content measured after the operation. The soil mean weight diameter of sandy loam was determined by sieve analysis. A standard mean weight diameter was taken as 10 mm and experiment were conducted to find which implement reached the closet value of standard value of sand with minimum number of operations. The speed of operation was taken and width of implement also with total time of operation to find out the field efficiency. After each moisture content we can obtain on relation between the weight and depth after operation. The total time used also to found the tractor it is recorded, fuel consumption used to found the energy requirement and cost of operation.

RESULTS AND DISCUSSION

The result of field experiment on different combination of primary tillage and secondary tillage implement at sandy loam soil are presented and discussed in this chapter. The indices for evaluation the performance of implement. The indices for evaluating the performance of implement combination at sandy loam soil are-mean weight diameter, field performance index, moisture content, fuel consumption, cost of operation, and energy requirement. To study the variation for each combination of independent variable were computed.

The effect of implement combination on the performance indices at sandy loam soil were tested by

Table 1 : Field performance index and energy requirement for different combination of implement

Sr. No.	Items	S1	S2	S3	S4	S5	S6
1.	Length of plot covered (m)	60	60	60	60	60	60
2.	Width of plot covered (m)	20	20	20	20	20	20
3.	Area of plot covered (ha)	0.12	0.12	0.12	0.12	0.12	0.12
4.	Moisture content during test	4.23	4.23	4.23	4.23	4.23	4.23
5.	Time required to cover the plot (hr)	1.46	0.46	0.86	0.54	0.83	0.67
6.	Duration of test (ha/hr)	0.08	0.26	0.13	0.22	0.14	0.17
7.	Depth of cut (cm)	12	11	15	14	13	15
8.	Width of cut (cm)	60	210	115	145	145	145
9.	Average speed of implement (km/hr)	1.64	5.21	2.69	4.45	3.25	4.60
10.	Actual field capacity (ha/hr)	0.082	0.26	0.13	0.22	0.14	0.17
11.	Theoretical field capacity (ha/hr)	0.098	1.09	0.30	0.64	0.54	0.66
12.	Field performance index (x)	83.34	23.76	43.30	34.37	28.60	25.75
13.	Fuel consumption (l/hr)	7.14	5.74	3.29	4.32	4.31	3.45
14.	Fuel consumption (l/ha)	52.08	22.32	24.45	19.39	23.27	18.10
15.	Fuel consumption for 0.012 ha	6.24	2.67	2.93	2.32	2.79	2.17
16.	Energy requirement (MJ/ha)	586.73	733.90	783.65	678.72	770.6	716.6

analysis of variance. Before conducting the trials, soil moisture was measured for each plot. Moisture content measured to depth of 3 to 5 cm was 3.6% on day basis Moisture content to depth of 15 cm was found to be 4.6% on dry basis and to a depth of 30 cm it was 5.26% on dry basis. The plot size selected was 60 m in length and 20 m in width comprising total area of 0.012 ha for all trials.

The fuel consumption during operation was found to be 42.08 l/ha with implement S1 (mould board plough) the fuel consumption during operation was found to be 19.39 l/ha with implement combination S2 (ploughing+ cultivator) the fuel consumption during operation was found to be 24.45 l/ha with implement combination S3 (ploughing + Disc harrow).

The fuel consumption during operation was found to be 22.32 l/ha with implement S4 (ploughing + rotavator) the fuel consumption during operation was found to be 37.27 l/ha with implement S5 (rotavator single pass) and the fuel consumption during operation was found to be 18.10 l/ha with implement S6 (rotavator double pass) in mean weight diameter. The comparative of all implement at mean weight diameter.

Maximum fuel consumption during operation was mould board plough implement at mean weight diameter and minimum fuel consumption during operation was ploughing + cultivator implement.

Maximum fuel consumption for sandy loam of soul that's because high draft offered by implement and high resistance from the soil Minimum fuel consumption this was mainly due to low draft of the implement. This result in low load on the tractor, ultimately reducing its fuel consumption. The energy requirement was 586.73 MJ/ ha with implement SI (mould board plough). Energy requirement was 733.90 MJ/ha with implement combination S2 (ploughing + cultivator). Energy requirement was 786.65 MJ/ha with implement combination S3 (ploughing + Disc harrow). Energy requirement was 678.72 MJ/ha with implement combination S4 (ploughing + rotavator). Energy requirement was 183.93 MJ/ha with implement combination S5 (rotavator single pass). Energy requirement was 358.8 MJ/ha with implement combination S6 (rotavator double pass) in mean weight diameter.

Maximum energy requirement was 783.63 MJ/ha with implement combination S3 (ploughing + Disc harrow) and minimum energy requirement was 183.93 MJ/ha with implement combination S5 (rotavator single pass). The comparative of all implement at mean weight diameter is presented.

The energy requirement is also affected by fuel consumption and different properties for each implement.

Mean weight diameter after the operation was found to be 4.7 mm with implement S6 (rotavator double pass) mean weight diameter was found to be 4.9 mm with implement S5 (Rotavator sing pass) in sandy loam soil. Mean weight diameter was found 4.5 mm with implement combination S4 (ploughing + rotavator) mean weigh diameter was found 10.25 mm with implement combination S3 (ploughing + disc harrow) mean weight diameter was found 11.23 mm with implement combination S2 (ploughing + cultivator) and mean weight diameter 14.54 mm with implement S1 (mould board plough). The performance analysis of all combination with sandy loam soil is presented.

The maximum mean weight diameter was found 14.54 mm implement S1 (mould board plough) and minimum mean weight diameter was found 4.5 mm with implement S2 (Ploughing+Rotavator) effected by the quality of the moisture content and sand loan soil. In sandy loam of soil the moisture content high and the nature of this sandy loam soil make the maximum and minimum mean weight diameter is kind of big which

Table 2 : Energy requirements for different combination with tractor with tractor drawn implement

Name of trail	Name of implement	Energy for machinery (MJ/ha)	Energy for diesel (MJ/ha)	Energy for human (MJ/ha)	Energy for implement (MJ/ha)	Energy for trail (MJ/ha)
Ploughing	M.B. Plough	82.73	495.28	5.72	586.73	586.73
Plouhging + cultivator	Cultivator	19.16	126.21	1.80	147.17	733.90
Ploughing + Disc harrow	Disc harrow	69.22	124.22	3.48	196.92	783.65
Ploughing+Rotavator	Rotavator	30	59.88	2.11	91.99	678.72
Rotavator+single pass	Rotavator	37.22	144.11	2.62	183.93	770.68
Rotavator+double pass	Rotavator	11.52	160.10	3.25	174.87	761.6

hundred proper penetration of the implement that's mean increase the number of moving of the same implement to obtain good seed bed.

The percentage of field performance index was found to be 67.26 with implement S1 (mould board plough) percentage of field performance index was found to be 79.43 with implement S2 (ploughing + cultivator) in mean weight diameter, the percentage field performance index 47.30 with implement combination S3 (ploughing + Disc harrow) the percentage field performance index 83.34 with implement S4 (ploughing + rotavator). The percentage of field performance index 56.97 with S5 (rotavator single pass) and the percentage of field performance index 78.75 with S6 (rotavator double pass) in mean weight diameter. The maximum percentage of field performance index was S4 (ploughing + rotavator) and minimum field performance index was S3 (ploughing + Disc harrow).

Field performance index is percentage of actual field capacity upon theoretical field capacity. The maximum field performance index in each soil for different implement show that the good performance of the implement S4 (Poloughing+rotavator) in sandy loam soil

The speed of operation with respect to different combination of implement was kept same.

Conclusion :

This study was undertaken in investigate the effect of different combination of primary and secondary tillage implement. At sandy loam soil on mean weight diameter, field efficiency, fuel consumption, cost of operation and energy requirement.

The experiment was conducted with sandy loam soil with fore combination implement. During the experiment observation were made and computed. Or heads, are organizational devices that guide the reader through your paper. There are two types : component heads and text heads. This study was undertaken to investigate the effect of different combination of primary and secondary tillage implement at sandy loam soil on mean weight diameter, field efficiency, fuel consumption, cost of operation and energy requirement.

The experiment was conducted with sandy loam soil with fore combination implement. During the experiment observation were made and computed.

Authors' affiliations:
PRASHANT SINGH AND SAURABH KUMAR SINGH, Department of Farm Machinery and Power Engineering, Vaugh School of Agricultural Engineeirng and Technology, Sam Higginbottom Institute of Agriculture, Technology and Science, ALLAHABAD (U.P.) INDIA

■ REFERENCES

Adewoyin, A.O. and Ajav, E.A. (2013). Fuel consumption of some tractor models for ploughing operation in the sandy-loam soil of Nigeria at various speeds and ploughing depth. *Agari. Engg. Internat. CIGR J.*, **3** : 67-74.

A.H. Clark, R.L. (1981). Tractive and energy performance of a small four-wheel drive tractor. ASAE Paper No. 81-1042, ASAF, St. Joseph, MI 49085

Arvindsson, J., Keller, T. and Gustafsson, K. (2004). Specific draft for mouldboard plough, chisel plough and disk harrow at different water contents. *Soil & Tillage Res.*, **79** : 221-223.

Bukhari, Sh. B. and Baloch, J.M. (1982). Fuel consumption of tillage implements, *AMA*, **13** : 20-22.

Guruswami, T. (1986). Cultivator an efficient implement in dry land agriculture. *Agric. Engg. Today*, **10** (4) : 15-17.

Triag, O. Osman and Moayad, B. (2014). Zaied and Ahmed M.E., Field performance of modified chisel plough. *Internat. J. Natural Sci. Res.*, **6** : 85-96.

10th Year
★★★★★ of Excellence ★★★★★