Comparative performance evaluation of various intercultural implements for their adoptability and suitability to farmers

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ABSTRACT: The operations performed in the field after sowing but before harvesting of crop are termed as intercultural operations. Interculture is described as breaking the upper surface of soil, uprooting the weeds (unwanted plants), aerating the soil, thereby promoting the activities of microorganism and making good mulch, so that moisture inside the field is properly retained from evaporation. These operations are accomplished by means of many tools and implements, such as hoes, rotary offset tillers, offset harrows, cultivators, rotary hoes etc**.** Performances evaluation of different intercultural implements is essential to assess their adoptability and suitability to farmers for better production and profit. Therefore, numbers of research papers were reviewed to assess their suitability for adoption by farmers. The study concluded that rotary offset tiller was found to be the most suitable intercultural implement because of efficient performance due to less draft requirement (1086 N), less fuel consumption (3.5 l/h), high degree of pulverization (45 mm), high residue incorporation (92.27 %), lower field capacity (0.43 ha/h) and higher field performance index (80 %) as compared to others.

Key words: Intercultural implement, tillage, performances

The lighter and finer operations carried out on the soil, between sowing and harvesting are termed as intercultural operations. They include weeding, fertilizer application, mulching, etc. The implements like rotary offset tiller, offset harrow and cultivators used for this purpose are called as intercultural implements. Rotavator (derived from rotary cultivator) is a tractor mounted active tillage implement comprising of blades mounted on flanges affixed to a shaft that is driven by the tractor (PTO). Rotavator performs (one plowing and two harrowing) operation in a single pass therefore, rotavator is accepted by the majority of farmers in India, as a time-saving equipment under low and high land conditions. It produced better quality of work (25–30%) than the cultivator (Sahay *et al.,* 2009). The degree of soil pulverization attained by the rotavator is more as compared to harrow and cultivator. The energy required per unit volume of soil for rotavator is about 39.2 to 47.0 MJ/m^3 while, 70.7 to 116.3 MJ/m^3, 62.2 to 103 MJ/m^3 and 53.3 to 110.2 MJ/m^3 for mould board plough, desi plough and cultivator respectively (Filipovic *et al.,* 2004). Rotary tillage implements are also now projected as important versatile tillage machinery for better seedbed preparation; however the ordinary rotavator being in line with the tractor centre line at the rear cannot be used in orchards due to hindrance posed because of narrow space between the plants. Therefore, the concept of a rotary offset tiller was proposed, which could perform intercultural operation between the plants (Namdev *et al.,* 2017). It has been observed that rotary tiller is one of the most cost intensive implements and cannot be afforded by ordinary farmers due to low land holding and economic status. Most farmers also perform traditional farming because of lack of mechanization, which results in decreased production (Narkhede *et al.,* 2002). There are various types of implements that are available for intercultural operations but the main constraint is their adoptability and suitability to farmers for better production and profit. The performance of intercultural implements also influences quality of operation (Cakmak *et al.,* 2010). Thus, comparative study of performances of various intercultural implements becomes essential to assess their adoptability and suitability to farmers for better production and profit. In this study, it was attempted to find out the most efficient intercultural implement by reviewing their comparative performances.

MATERIALS AND METHODS

The research work on rotary offset tiller was carried out by Namdev (2015), in which, rotary offset tiller was designed and developed by CSIR-Center of Excellence for Farm Machinery, Central Mechanical Engineering Research Institute, Ludhiana (Punjab) and performance was evaluated by Department of Farm Machinery and Power Engineering, College of Technology, G. B. Pant

University of Agriculture and Technology, Pantnagar (Uttarakhand). The intercultural implements namely rotary offset tiller, offset harrow and tyne cultivator were selected for comparative study, where rotary offset tiller has rotating tines mounted on a horizontal shaft and can be attached to the three point linkage of 50-65 hp tractors. It is provided with adjustable mechanical sensing unit which has side shift of 300 mm. It has seven flanges spaced 220 mm apart and each flange carried six blades (Namdev *et al.,* 2018). The offset harrow was tractor mounted type 16 disc at a distance of 228 mm each and contained notched disc in front gang, plain disc in rear gang with overall width of 1852 mm. The cultivator was a tractor mounted type spring loaded 11 tines of cultivator with overall width of 2300 mm (Okoko *et al.,* 2018). The view of rotary offset tiller, offset harrow and cultivator is presented in Figures 1, 2, 3 respectively.

Figure 1: Rotary offset tiller

Figure 2: Offset Harrow

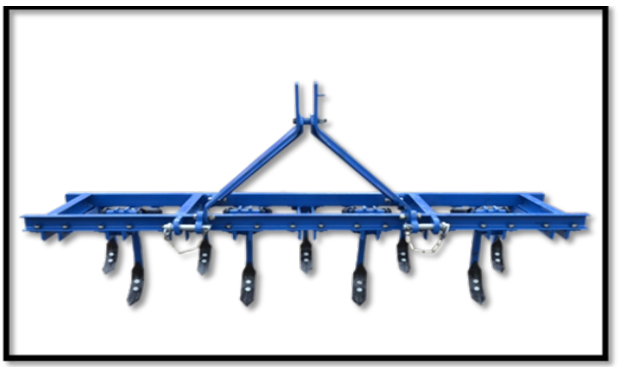

Figure 3: Cultivator

Brief specification of a rotary offset tiller

S.L. No.	Specification	Units
1.	Power requirement	50 hp
2.	Number of flanges	7
3.	Type of blades	L- Shape
4.	Number of blades	42
5.	Flange plate diameter	400 mm
6.	Rotor shaft diameter	280 mm
7.	Spacing between flange plates	235 mm
9.	The overall height of offset rotavator	1120 mm
10.	The overall width of offset rotavator	2000 mm
11.	The overall length of offset rotavator	400 mm
12.	Rated width of cut	1800 mm
13.	Hydraulic sift	370 mm
14.	Standard position offset	500 mm
15.	Right side maximum offset	650 mm
16.	Left side minimum offset	300 mm

Table 1: Comparative performance parameters of various intercultural implements (Namdev, 2015 and Extension Bulletin No. CIAE/FIM/2002/26)

Parameters	Intercultural Implements		
	Rotary Offset Tiller	Offset Harrow	Cultivator
Draft Requirement, N	1086.8	1250.5	1375.2
Fuel Consumption, l/h	3.5	5.0	4.7
Clod Size after Operation, mm	45	72	103
Residue Incorporation, %	92.27	85.2	80.48
Field Capacity, ha/h	0.43	0.54	0.62
Field Performance Index, %	80	72	75
Total Saving		23 % fuel saving over harrow 35 % fuel saving over cultivator 19 % time saving over harrow 45 % time saving over cultivator	

RESULTS AND DISCUSSION

Performances of various intercultural implements

Figure 4: Working of rotary offset tiller in orchards

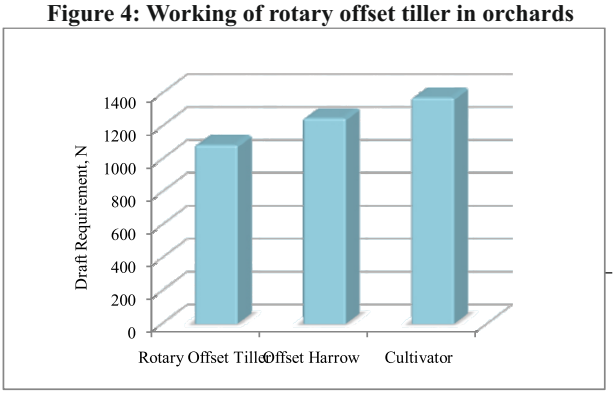

Figure 5: Variation in draft requirement of different intercultural implements

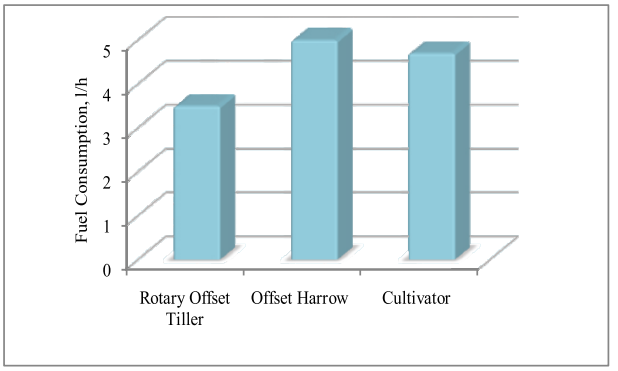

Figure 6: Variation in fuel consumption of different intercultural implements

The comparative performance of various intercultural implements are given in Table 2 and variations in different performance parameters are shown in Figures 5 to Figure 10. The results show that the draft requirement for rotary tiller, offset harrow, cultivator are found 1086.8, 1250.5, 1375.2, N and fuel consumption 3.5, 5.0, 4.7, l/h respectively. The clod size and residue incorporation are 45, 72, 103, mm and 92.27, 85.20, 80.48, % while field

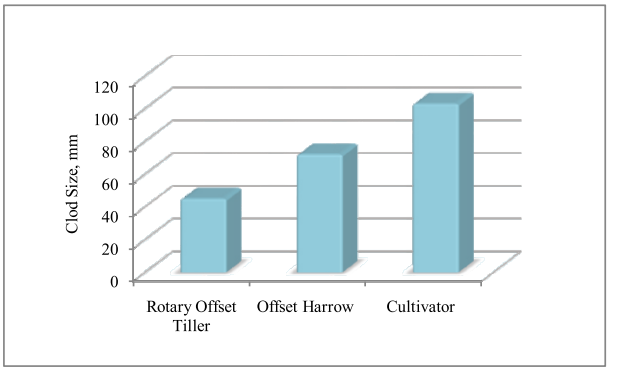

Figure 7: Variation in clod size of different intercultural implements

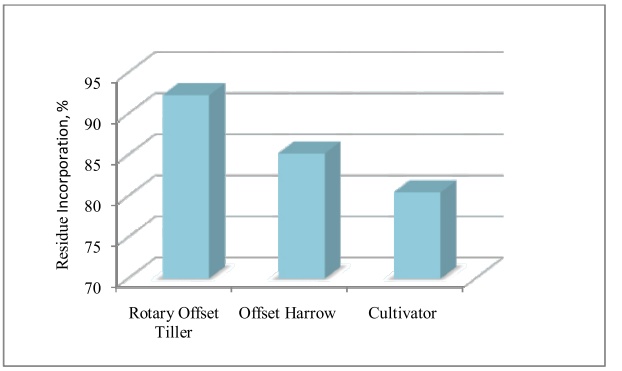

Figure 8: Variation in residue incorporation of different intercultural implements

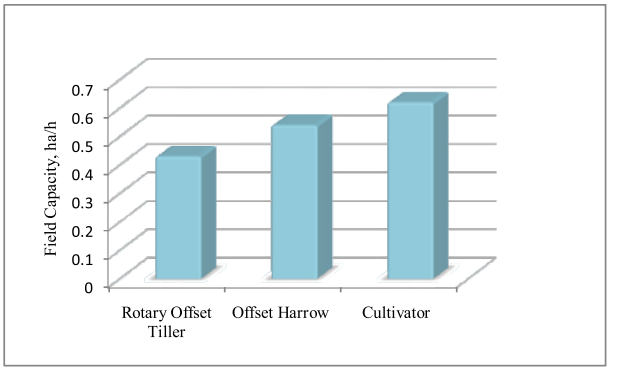

Figure 9: Variation in field capacity of different intercultural implements

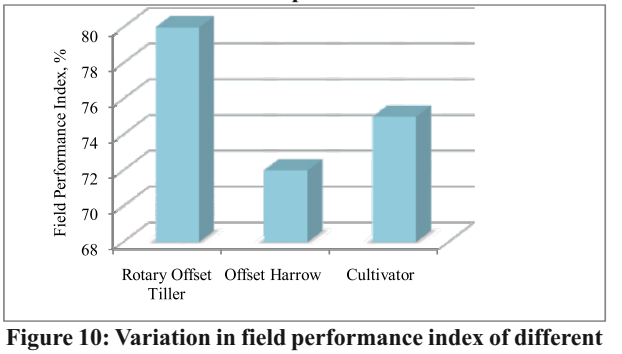

Figure 10: Variation in field performance index of different intercultural implements

capacity for rotary tiller, offset harrow, cultivator are found 0.43, 0.54, 0.62, ha/h and field efficiency 80, 72, 75, % respectively. It was also concluded that rotary offset tiller saves 23% fuel over harrow and 35% over cultivator and also saves 19% time over harrow and 45% over cultivator.

CONCLUSION

Comparative analyses of various intercultural implements are important to assess their adoptability and suitability for better production and profit. It was finally concluded that rotary offset tiller is a more suitable implement as compared to other intercultural implements because of better performance due to less draft requirement, less fuel consumption, high degree of pulverization, high residue incorporation, lower field capacity and higher field performance index. This study provides basis for conducting further comparative analyses on performances for various other intercultural implements.

STRENGTH

The side shift system of the machine can be adjusted and fixed at any position with the help of retaining screw so that it can be used both as normal rotavator as well as offset rotavator. Therefore, farmers need not purchase separate implement for intercultural operation.

The present study inferred that rotary offset tiller is the most efficient as compared to other intercultural implements hence tiller can be recommended to farmers.

Rotary offset tiller can perform function of both normal rotavator and offset rotavator, therefore, it is the most economical intercultural implement.

WEAKNESS

Plant parameters adversely affect the performance of rotary offset tiller in different orchards. Therefore there is need to improve the sensing mechanism for performing more fines intercultural operation.

Rotary offset tiller has higher initial cost as compared to other intercultural implements hence has problem in adoptability to farmers.

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REFERENCES

Cakmak, B., Aykas, E., Onal, I. and Cakir, E. (2010). The performance of developed rotary tiller fitted with pneumatic seeder. *Bulgarian Journal of Agricultural Science*, 16(6): 801- 810.

Filipovic, D., Kosutic, S., Gospodaric, Z. (2004). Energy efficiency in conventional tillage of clay. In: The Union of Scientists - Rousse: *Energy Efficiency and Agricultural Engineering*, 3-5 June 2004. Rousse. Bulgaria. 85-91

Namdev, S. K., Pateriya, R. N. (2017). Performance evaluation of modified offset rotavator in mango orchard. *Agricultural Engineering*, Year XLII, No. 2: 25-34.

Namdev, S. K., Pateriya, R. N., Modi, R. and Dash, B. S. (2018). Performance evaluation of modified offset rotavator in guava orchard. *International Journal of Agricultural Engineering*, 10(2): 44-51.

Namdev S. K, Pateriya R. N., Pandey, M. K. (2018). Effect of λ - ratio on work efficiency of rotary offset tiller in litchi orchard. *Agricultural Engineering Today,* Vol. 42(1): 58-67.

Narkhede, N. N., Deogirikar, A. A. and Pandey, M. M. (2002). Tractor mounted rotavator, *Agricultural Bulletin*, pg 1-11.

Okoko, P., Ajav, E. A. and Olosunde, W. A. (2018). Draft and power requirements for some tillage implements operating in clay loam soil. *CGIR Journal*, 20(1): 95-102.

Sahay, C.S., Thomas, E. V. and Satapathy, K. K. (2009). Performance evaluation of a novel power-tiller-operated oscillatory tillage implement for dry land tillage. *Bio Systems Engineering,* 102(42): 385-391.

Tillage Implements, *farmech* Available online at https://farmech.gov.in/FarmerGuide/UK/Tillage%20Implements.htm.

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