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Comparison of dimensions of commercially available tractor drawn rigid cultivator tines

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■ **ABSTRACT :** Commercially available agricultural machines are not matching with standards which affect the performances. Many times, commercially available rigid cultivator tines used in tractor drawn cultivator do not match in dimensions as given in respective BIS code. A study conducted in Udaipur, Rajasthan revealed that out of four such tines only one tine T_1 fulfilled the requirement of BIS code 7565:1975 whereas maximum deviation was observed for tine T_2.

■ **KEY WORDS :** Rigid cultivator, Tines, Hole diameter, Hole center to center distance

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Farm machinery is the key driver of farm productivity. Indian agriculture witnessed unprecedented growth in farm mechanization. The farm power availability on Indian farms has grown from 1.47 kW/ha in 2005-06 to 2.24 kW/ha in 2016-17 (Mehta *et al.*, 2019). Farm mechanization in India stands at about 40-45 per cent. In the trend of growth of power operated machinery, cultivators and seed drill were mostly used by farmers. Cultivator is one of the most important tillage tools used by Indian farmer (Jangid *et al.*, 2010). Reversible shovel, sweep, half sweeps, furrower etc. are primarily used for loosening and stirring the soil. The farmer uses reversible shovel in cultivator because of simplicity in attachment, cheaper cost and ease in repairs. They do not usually have an inverting effect and penetrate more easily in hard grounds because of less upward soil reaction. Most of farmers were either having seed drill or cultivator (Singh, 2005). The farmer having cultivator may not have seed drill or *vice versa*, due to its higher price. Farmers either hire the cultivator or seed drill tocomplete the operation within time. There is a need of such versatile machine which overcome the economic constraints of farmer and can perform operation.

We know that, the agricultural Mechanization necessitates application of quality farm machine for more profitable crop production. The manufacturers of agricultural machines especially in small scale sector generally face problem due to non-availability of quality materials and inadequate manufacturing process because of which the quality of machine is not up to that standard. Also, design is carried out on trial and error basis without bringing the concept of optimization resulting in over design, excessive manufacturing cost time. Presently, many commercially available rigid cultivator's tines of various sizes are available in the market. Normally it has been observed that the dimensions of most of the commercially available rigid cultivator tines do not follow BIS standard in many aspects. They differ in geometry like length, width etc. The BIS code IS: 7565-1975 for cultivator characterizes rigid cultivator tines for tractor operated cultivator for parameters like width and length etc. These parameters are given in a range so as to meet the requirements of various soil types and soil conditions. Mismatch with the standards in terms of geometry may affect the quality of work of cultivator and finally may affect the profitability in farming (Yadav *et al.*, 2018). Optimizing the tillage tool geometry and working conditions also minimizes the number of subsequent tillage operations required. So, the total energy input for a given tillage system decreases. For reducing the tillage operations and energy requirement, it is important to know the draft requirements for different tillage tool geometry (Marakoglu and Carman, 2009). Since, soil tool interaction is complex one; there is a need to study the performance of commercially available rigid cultivator tines used in tractor operated cultivator (Darmora and Pandey, 2006).

■ METHODOLOGY

A survey was conducted to identify the commercially available rigid cultivator tines used for tractor drawn cultivator in Udaipur region of Rajasthan. Out of various parameters given in BIS code IS: 7565-1975, dimensions considered in the study are presented in (Fig. A) and their value as per BIS code IS: 7565-1975 is given in Table A.

Four rigid cultivator tines were identified during the survey. The various dimensions were measured by using digital Vernier caliper, measuring tape. The method used for measuring various dimensions is presented in (Fig. B to Fig. C) gives the dimensional details of the rigid cultivator tines selected for the study.

Similarly, for measurement and calculation of radius

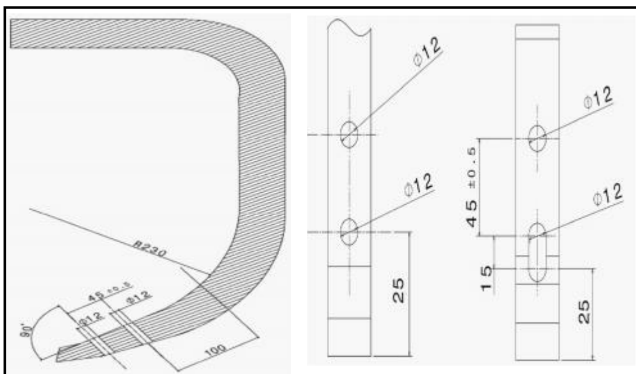

Fig. A : BIS standard-7565 rigid tractor drawn cultivator tine (All dimensions in mm)

Table A : Specification for tractor drawn rigid cultivator tine BIS code 7565-1975

Particulars	Dimensions (mm)
Hole diameter	12
Hole center to center distance	45±0.5
Hole center to edge distance	25
Radius of curvature	230
Length	600
Width	60
Thickness	25

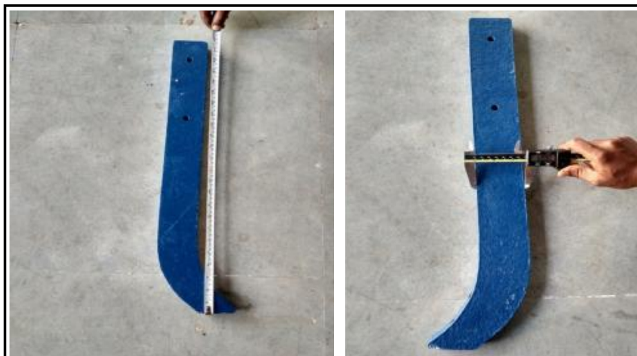

Fig. B&C: Measuring length and width of rigid tine using measuring tape and varnier caliper, respectively

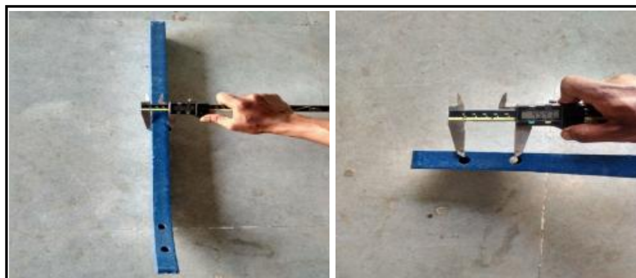

Fig. D&E: Measuring thickness and center to center distance of rigid tine using varnier caliper

Fig. F&G: Measuring hole center to edge and diameter of the hole of rigid tine using varnier caliper

Table 1 : Dimensions of selected tractor drawn rigid cultivator tines

Tine	Hole diameter, mm	Hole center to center distance, mm	Hole center to edge distance, mm	Radius of curvature, mm	Length, mm	Width, mm	Thickness, mm
T_1(BIS)	12.04	45.34	24.92	228.5	605	60.46	25.23
T_2	10.85	46.62	42.34	184.7	435	68.50	24.35
T_3	11.20	40.31	40.39	220	590	75.39	23.40
T_4	11.21	46.93	23.37	170.1	440	57.19	32.16

of curvature following formula was used (Anonymous, 2020).

$$\text{Radius, } r = \frac{h}{2} + \frac{w^2}{8h}$$

where, r- radius of curve;
h- Height;
w- Width

RESULTS AND DISCUSSION

The various dimensions of the four rigid cultivator tines considered in the study are in Table 1. The study showed that the dimensions of tine T_1 matched with BIS standard cultivator tine.

Comparison of dimensions of commercially available rigid cultivator tinesas per BIS standard:

Hole diameter:

Rigid tine T_2 had smallest holes diameter (9.88 % smaller) followed by rigid tine T_3(6.97 % smaller) and rigid tine T_4(6.89 % smaller) as compared to BIS rigid tine T_1.

Hole center to center distance:

Rigid tine T_3 had smallest hole center to center distance (11.09 % smaller) whereas rigid tine T_4had a highest hole center to center distance (3.5 % higher) followed by rigid tine T_2 (2.8 % higher) as compared to BIS rigid tine T_1.

Hole center to edge distance:

Rigid tine T_4 had smallest hole center to edge distance (6.21 % smaller) whereas rigid tine T_2 had a highest hole center to edge distance (69.90 % higher) followed by rigid tine T_3 (62.07 % higher) as compared to BIS rigid tine T_1.

Radius of curvature:

Rigid tine T_4 had smallest radius of curvature (25.55 % smaller) followed by rigid tine T_2 (19.16 % smaller) and rigid tine T_3 (3.71 % smaller) as compared to BIS rigid tine T_1.

Length:

Rigid tine T_2 had smallest tine length (28.01 % smaller) followed by rigid tine T_4 (27.27 % smaller) and rigid tine T_3 (2.47 % smaller) as compared to BIS rigid tine T_1.

Width:

Rigid tine T_4had smallest tine width (5.40 % smaller) whereas rigid tine T_3had a highest tine width (24.69 % higher) followed by rigid tine T_2 (13.29 % higher) as compared to BIS rigid tine T_1.

Thickness:

Rigid tine T_3 had smallest tine thickness (7.25 % smaller) followed by rigid tine T_2(3.4 % smaller) whereas rigid tine T_4had a highest tine thickness (27.46 % higher) as compared to BIS rigid tine T_1.

Conclusion:

Rigid cultivator tine T_1 fulfilled the requirement of BIS code whereas all other tines varied from the standards. Tine T_2 showed highest variability in terms of holediameter and hole center to edge distance to BIS standards. Tine T_3 showed the highest variability in terms ofhole center to center distance and T_4 showed the highest variability in terms of radius of curvature, respectively.

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