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Comparative Performance of Different Power Weeders in Rainfed Sweet sorghum crop

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ABSTRACT: Three commercially available power weeders were evaluated for weeding and inter-cultivation in the sweet sorghum crop in Andhra Pradesh. The weeding efficiency of 'L' shape blade power weeder was found to be 91%, whereas 'C' type and Sweep type blade power weeders recorded 87 % and 84 % respectively. The performance index of 'L' shape, Sweep shape and 'C' type blade weeder were observed to be 169.84, 153.23 and 114.30 respectively. Field capacity of Sweep type weeder was 0.12 ha/hr which is more than 'C' and 'L' type blade weeder and plant damage observed minimum as compared to other two. The cost of operation for Sweep type power weeder was Rs.550 against Rs. 580 and Rs.429 per hectare for 'C' and 'L' shape blade power weeder. It is economical and more effective to use L-shape weeder as it saved 10.88 per cent weeding cost; reduces plant damage and achieved weeding efficiency 84 per cent.

Keywords: Power weeder, field capacity, weeding efficiency, performance index

Indian agriculture is of the subsistence type and therefore not much scope for increasing cultivable area. Hence, it is imperative to improve the yield by intensive agriculture, which necessitates better use of through best management practices. Weeding and interculture is one of the critical management practice which has proportionate effect on soil moisture conservation, nutrients loss in rainfed areas and finally affects the crop yield significantly.

In India Rs.4200 million is being loss in the form of nutrients loss annually due to weeds. When weeds are allowed to compete with crop, it results in yield loss to the extent of 20 percent (Natarajan, 1987). On average one third of the cost of cultivation Rs. 945 per ha, being incurred on weeding (Rangasamy *et al.*, 1993) out of the total cost of cultivation of Rs.3000.00 per ha for agricultural crops (Tajuddin *et al.*, 1991). Though manual and bullock drawn weeding methods are existing, the availability, efficiency and prevailing operational charges discourages the farmers to take up these methods. In addition to these the availability of optimum moisture content in the soil is highly essential for effective weeding operation. In rainfed areas the availability of enough labour and the bullock power for weeding operations does not synchronize with the ideal rainy days. Hence, majority of the farmers could not complete the weeding operations in time. Due to all these reasons, the other sources of weeding methods like mechanical and chemical ways need to be exploited. However, mechanical weeding is preferred to chemical because weedicide application is generally expensive, hazardous and selective. On the other hand mechanical weeding methods keeps the soil surface loose by producing soil mulch, which results in better aeration and runoff water conservation (Duraisamy and Tajuddin, 1999).

Tractor operated weeding implements can save about 75 percent time and 20 percent cost as compared to bullock drawn methods. But there is uncovered headland and tractor hiring charges will be a crucial input cost which may vary according to the season. Compaction of the soil by the tractor tires may also pose a problem in heavy soils and affects the subsequent crops if the weeding is done very frequently using the tractor drawn equipments (Mayande et al, 2004).

One approach for row crops is to uproot the weed population between the rows mechanically, leaving only a small fraction in the row require hand weeding. However, acceptance of existing inter-row weeders is limited because of concern about the level of weed control and the low work rates achieved. The cost of operation by engine-operated weeder comes to only one-third of the cost by manual labour (Tajuddin, 2006). Row crop weeders are simple, economically viable and useful for small to medium scale farm holders. It is also a positive step towards reduction of drudgery involved in row crop weeding (Olawale and Oguntunde, 2006). In recent past, many such self propelled weeders have come into the markets which are simple in operation with easy driving compatibility. The paper reviews the relative merits and ability of different weeding mechanisms in rainfed sweet sorghum crop which is grown to produce Bio-ethanol .

Material and Methods

To assess and quantify the relative effectiveness of different weeding machinery, a field experiment was conducted at Hayatnagar Farm of Central Research Institute for Dryland Agriculture. The soils are of Alfisol type with shallow depth. The average annual rainfall of the area varies around 650-750mm. As a part of the Bio-ethanol value chain project, Sweet sorghum was sown as test crop with 60 cm row spacing and 20 cm plant to plant spacing with a tractor drawn planter. Three power weeders as described below were selected for the experiment.

Power weeders used in the experiment

C-shaped rotary blades power weeder

A 5.0 hp, air-cooled diesel engine was mounted on a front side of the square frame. Two pneumatic wheels powered through 'V' pulley, belts and gears are attached to the frame (Fig 1). A handle is provided with clutch and accelerator to control motion of the weeder. A separate lever is fixed on handle for forward and reverse movement. The power from the engine to the central shaft is given through 'V' belt and pulley. Pneumatic wheel shaft was synchronized with central shaft by a separate gear box mounted on it. Central shaft was extended to weeding blade assembly with bevel gears. 'C' shaped weeding blades were fixed on assembly shaft with nut & bolts. The projected length of the blade is around 150 mm with 135^0 curvature at the central shaft end as shown in Fig.1 (a). Rotational speed of blade can be controlled by internally expanding type pulley tensioner clutch. The width of cut can be adjusted from 300 mm to 750 mm and the depth of cut can be controlled by depth wheel fixed behind.

Fig. 1 : 'C' shape blade power weeder

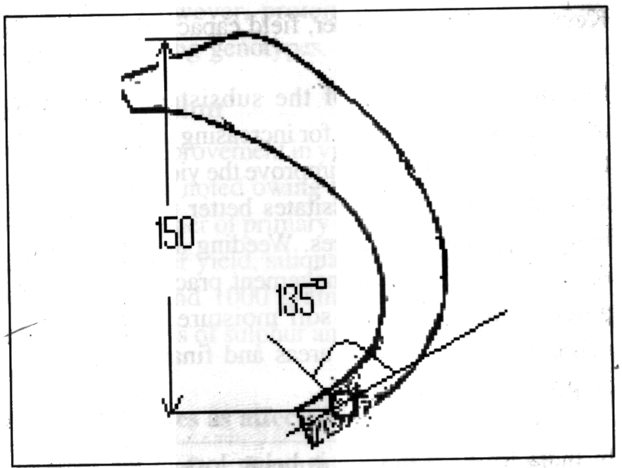

Fig. 1(a) : 'C' type blade

L-shaped blade rotary tiller

This is a Self-propelled power unit run buy a 3 hp, air cooled petrol start/ kerosene run engine. The drive was taken from engine to gear box through 'V' belt and pulley arrangement (Fig 2). From gear box, the power is further transmitted to rotary blades by heavy duty chain and sprocket assembly. Rotary blade assembly consists of four rows of square discs (140 x 140 mm) mounted with four numbers of 'L' type curved blades on each disc. Total length of 'C' shaped blade is around 160 mm and it is bent with 45^0 curvature angle at a distance 100 mm from central shaft (Fig. 2(a)). These

Fig. 2 : 'L' shape blade power weeder

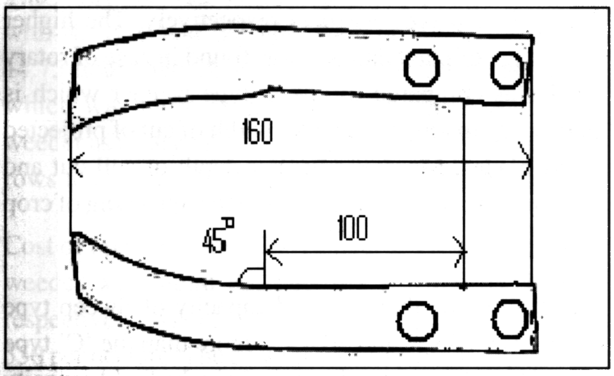

Fig. 2(a): 'L' type blade

blades when rotate enable cutting and mulching the soil. The width of coverage of the rotary tiller ranges from 300 to 600 mm and the depth of operation can be adjusted to uproot the weed and mulch the soil by depth control bar.

Sweep blade type mini tiller

It is a multipurpose machine with 6.5 hp petrol, air cooled engine, made of square bar frame. The drive was taken from engine shaft through V-belt and given to flywheel. The flywheel shaft has chain and sprocket assembly through which the drive is given to ground wheels. A handle with disc brake lever is provided to control and balance the machine (Fig 3). A self-depth control assembly is mounted on a bar frame which is bolted to prime mover. The full sweep of 300 mm width (Fig.3 (a)) and half sweep, 180 mm width (Fig.3 (b))

Fig. 3: Sweep blade type power tiller

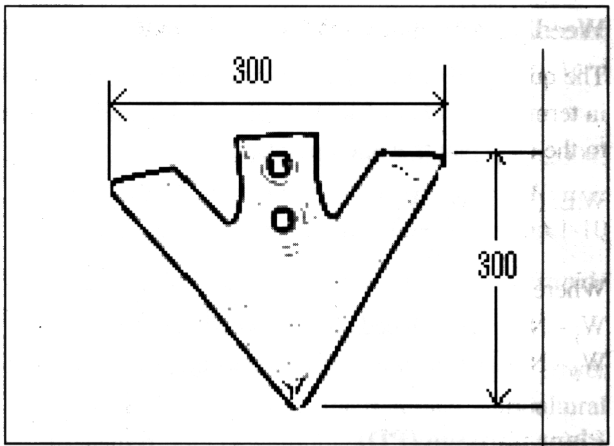

Fig. 3(a): Sweep type blade

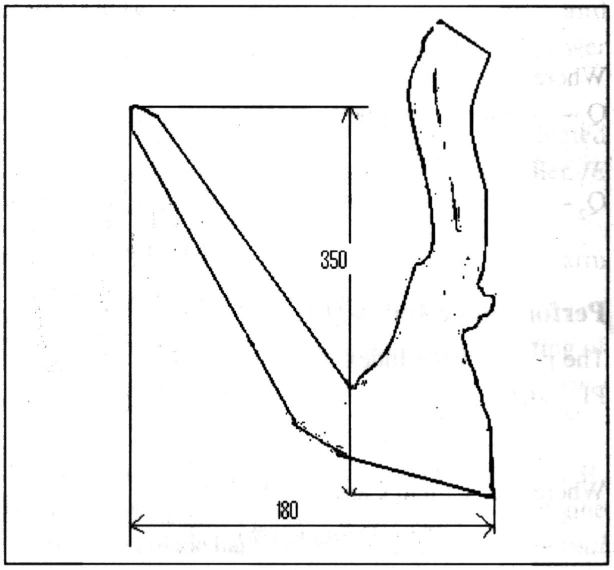

Fig. 3(b): Half sweep type blade

are attached to depth control assembly frame. Separate depth control wheels are also provided in front of the sweeps.

The selected weeders were tested in 300 x 100 m size plots with three replications and uniform depth of cut, 40 mm is maintained through out operations as a recommended practice.

Performance evaluation of weeders

To compare the field performance of weeders different parameters time taken for operation, plant damage and weed count, weeding efficiency, field capacity and performance index were calculated as per the procedure were measured and described by Singhal (2001).

Weeding efficiency (WE)

The quality of work carried by a machine is measured in terms of number of weeds cut uprooted and damage to the crop plants while operation .

$$W.E.\ (\%) = \frac{W_1 - W_2}{W_1}$$

Where,

W_1 - Number of weeds before weeding

W_2 - Number of weeds after weeding

Plant damage (PD)

$$\text{Plant damage } (\%) = \frac{Q_2}{Q_1} \times 100$$

Where,

Q_1 – Number of plants in 10 m row length before weeding

Q_2 - Number of plants damaged along 10 m row length after weeding.

Performance Index (PI)

The performance Index was calculated as

$$PI = \frac{FC(ha/hr) \times ((100-PD(\%)) \times WE(\%)}{Power(hp)}$$

Where, FC = Field Capacity (ha/hr)

PD = Plant Damage (%)

WE = weeding Efficiency (%)

Cost Economics

The cost economics of the machine was calculated by accounting fuel consumption, area covered in unit time, labour requirement for operation, labour charges per day etc.

Results and Discussion

The table 1 gives various performance parameters for the weeding machines tested. Weeding efficiency were 87%, 91% and 84 % for 'C', 'L' and Sweep type power weeders respectively. The increased soil contact and soil inversion capacity of rotary weeder contributed to its higher weeding efficiency. The weeding efficiency was found less in sweep type might be due to sweep width as it covers only 50 cm width.

The plant damage was 3.4 %, 5.1% and 1.2% for 'C', 'L'and Sweep type weeders respectively. The higher percentage of plant damage was found in case of rotary weeder as compared to sweep type weeder which is mainly due to longer effective width of cut of projected rotary blades. Moreover greater depth of soil cut and inversion of rotary weeder caused the uprooting of crop plants.

It was observed that the field capacity of Sweep type weeder is 43.33 % and 50.83 % more than the 'C' type and 'L' type power weeders respectively. Field capacity of 'L' blade weeder was less as compare to 'C' blade type weeder due to L-shaped blades cut the soil slice off almost entirely along the cycloid and one of the lateral planes along the full depth of the blade. However, C-shaped blades partly cut and partly tore the soil slice along the cycloid; but the slice of the soil was cut off entirely along all its lateral planes but at varying depths so that power and time required is more and results in less field capacity (Sharda and Singh, 2004). Where as sweep type blade make an angle and continuous of cut beneath the soil. In addition to that, the sweep type weeder field capacity was more than other weeder since it covers two rows at a time.

Performance index of a weeding implement would be directly related to the field capacity, weeding efficiency and inversely related to power exerted. Performance index of 'C' type, 'L' type and sweep type weeder was found 114.30, 169.84 and 153.23 respectively. The

Table 1 : Performance characteristics of different weeders.

Characteristics	'C' type blade rotary weeder	'L' type blade rotary weeder	Sweep type weeder
Time required including turning, filling, etc (hr/ha)	16.96	14.75	8.67
Cost of operation (for fuel & labour charges (Rs/ha)	580	429	550
Weeding efficiency (%)	87	91	84
Plant Damage (%)	3.4	5.1	1.2
Actual Field capacity (ha/hr)	0.068	0.059	0.12
Performance Index	114.30	169.84	153.23

performance index of 'L' type weeder was higher than that of 'C' type and Sweep type power weeders, because of higher weeding efficiency and less power requirement.

The study showed that the time required for weeding with 'C' type and 'L' type blade power weeders were 14.75 hours and 16.96 hours per hectare respectively, which was more than the Sweep type blade power weeder as rotary tillers needed 2-3 passes between crop rows to completely cover the weed infected areas.

Cost of operation for 'C' type and 'L' type blade power weeder was found Rs. 580 and Rs. 429 per hectare respectively, whereas for sweep type weeder it is Rs. 550 per hectare. The cost for weeding by 'L' type power weeder was less as compared to 'C' type and Sweep type blade power weeder.

Conclusion

It can be concluded that L shaped rotary weeder can be recommended for inter row crops weeding and it churns the soil by uprooting weeds. This will be useful in the shallow depth soils. Sweep type blade are preferred for the soils where the depth of cut is preferred than inversion. All the three power weeders worked well in alfisols of Sweet sorghum crop with average weeding efficiency 87 %, 91 % and 84 % for 'C' type, 'L' type and Sweep type blade power weedes. The cost of operation for L shape power weeder was Rs.429/ha. only which is comparable to the conventional weeding operation.

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