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Design of Wheel Hoe Weeder for Wide-Row Crops

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Abstract - wheel hoe weeders have been developed for manual weeding in about 20 cm row spaced crops.These weeders are unable to provide uniform depth of cut and lateral stability. Keeping these facts in view, a weeder, employing two innovative techniques such as application of 'wheels hoe weeder' and 'Long handle' was developed for wide row spaced crops. The slicing/cutting the weeds with best possible depth control were the main considerations for its design.

A push-type operated wheel weeder with an long handle, was designed, constructed and tested.showed that it could weed satisfactorily, and eliminate the drudgeries associated with the use of the short handle hoe such as backache, pains at the spine and lower waist region. Field capacity and efficiency of 0.050ha/hr and 87.5% were obtained respectively.Furthermore, the average weeding index and performance index obtained were 86.5% and 1108.48, respectively. At a speed of 0.04m/s, a high efficiency of 91.7% at 0.4m depth of cut was obtained. The developed wheeled long- handle weeder was found efficient.

Key Words: Push-type, long handle weeder, Gender-friendly equipment, Manual-operated, Push-pull,

1. INTRODUCTION

The weeder was designed based on the principle of weed stem failure due to soil shearing, impact and abrasion. The material selection was considered in terms of cost, availability, durability, overall weight and affordability. The design parameters considered were the ease of operation, average walking speed of the operator (0.8m/s), energy requirement of the weeder, and types of weeds to be operated upon. The material used for the shaft was mild steel. The shaft was designed based on strength, rigidity and stiffness. The shear stress, bending moment and deflections were also considered.The push-type long handle weeder is shown in isometric view, plan view as in Figures 1, 2 respectively.

1.1 Design of Wheel Hoe weeder Components

Let's take a look at the different parts which make the Wheel Hoe Weeder components. The entire Wheel Hoe Weeder can be divided into the following main parts:

- **Handle**
- **Weeding blade**
- **Wheel**
- **U-channel**
- **Blade connecting bar**
- **Wheel connecting bar**
- **Blade headpiece**

Handle -

This was constructed with two galvanized pipes of lengths 900mm and 471mm respectively, making a total length of 1371mm. The galvanized pipes were welded across the mainframe handle to form the hand grip which has a length of 140mm. The handle enables the operator to push or pull and direct the machine during operation within the crop rows. It also enables the operator to raise the cutting blade a little bit high, should stone and stumps be encountered during operation. The handle is made adjustable to create comfort to the operator irrespective of the operator's height. The essence of the long handle is to enable an upright posture while on weeding operation.

Weeding blade -

The weeding blade was made from 51mm × 210mm mild steel having a thickness of14mm. The blade at the lower end was sharpened and slanted to an angle of 15° to the horizontal. It is attached to a headpiece by means of bolt for easy replacement due to wear and tear. The blade has a maximum cutting depth of 0.6m with design width of cut of 0.2m.

Ground wheel -

The ground wheel has a diameter of 300mm and a hub of 25mm made from mild steel. The hub was attached to the centre of the wheel with the aid of spokes. The essence of the wheel is to enable easy movement while the implement is in use.

U-channel -

The U-channel is made of a steel plate of 1.5mm thick with dimension 124mm × 120mm × 51mm. The U-channel creates a fulcrum base for the ground wheel, blade, handle and the connecting flat bar linking the hub to the U-channel.

Blade connecting bar -

This is made of steel flat bar 250mm×51mm. It acts as linkage from the blade head piece to the U-channel with the aid of bolt and nut.

Ground wheel connecting bar -

This is made of a flat bar 295mm × 24mm. It connects the ground wheel from the hub to the U-channel. The ground wheel connecting bar is a two-piece flat bar.

Blade headpiece -

This unit consists of mild steel with dimensions 170mm x 125mm. The blade is connected to the blade headpiece by means of bolt and nut. It is curved to almost a semi U-shape.

1.2 View of Wheel Hoe weeder-

1 Handle

2 Weeding blade

3 Blade connecting bar

4 U- channel

5 Ground wheel

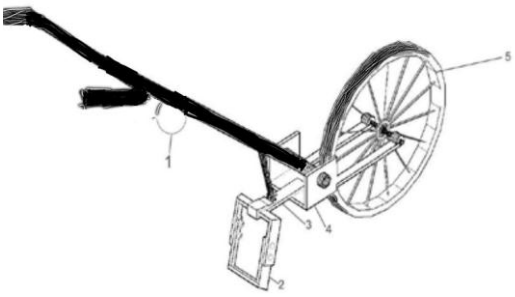

Fig 1- ISOMETRIC VIEW

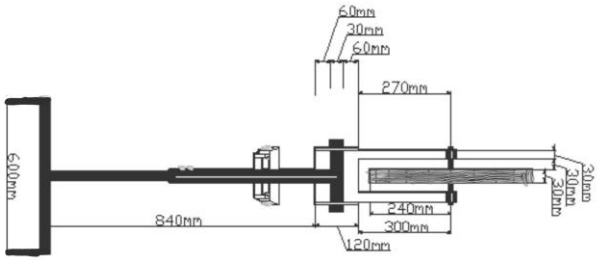

Fig 2- PLAN VIEW

2. CALCULATIONS -

Weeding Index -

Weeding index can be calculated using the following equation 1

Weeding index (%) = $W_1 - W_2$ x 100 _ _ _ _ _ 1

W_1

where

W_1= number of weeds per area before weeding

W_2= number of weeds per area after weeding

Performance Index -

The weeder performance was accessed through performance index (PI) by using equation 2 (Yadav and Pund, 2007)

PI= aqe 2
F

where

a = field capacity of weeder (ha/hr)

q = plant damage (%)

e = weeding index (%)

F = required draught force

3. RESULT -

Table -1: The performance parameters of the wheeled long- handle hoe

Sr no	Description	Parameters
1	Depth of Cut	0.4 m
2	Weeding Index	86.5%
3	Field Capacity	0.050 ha/hr
4	Weeding Efficiency	91.7%
5	Weight	5.3 kg
6	Performance Index	1108.48

The performance data of the weeder is presented in Table 1

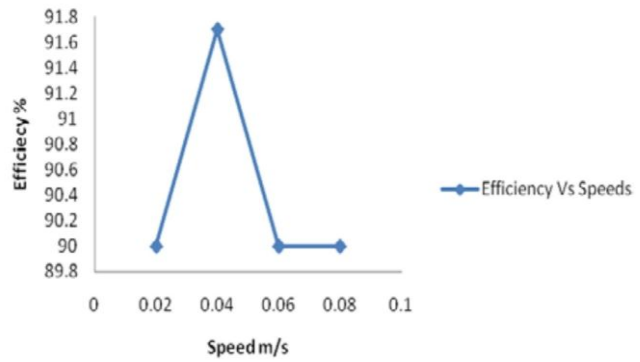

Chart -1: -Effect of speed on efficiency

The effect of speed on efficiency of the weeder is shown in Figure 6. The weeding efficiency linearly increased from 90% to 91.7% within the speeds of 0.02m/s to 0.04m/s. The weeding speed of 0.04m/s recorded the maximum efficiency of 91.7% which sharply dropped to efficiency of 90% at 0.06m/s. It then remained constant from 0.06m/s to 0.8m/s at weeding efficiency of 90%. This indicates that the best weeding speed for push-type wheeled long-handle weeder is 0.04m/s.

4. CONCLUSION-

It is a better option because of the standing position of the operator which eliminates backache, pains at the spine and lower waist region of the operator, reduction in time spent in operation and the energy/force applied. This wheel-long handle hoe consists of a wheel, a weeding blade, U-channel and an long handle to enable the operator to use it it is a better option because of the standing position of the operator which eliminates backache, pains at the spine and lower waist region of even at an erect/standing posit

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