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Research Paper :

Development of tractor drawn inter-row rotary weeder

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ABSTRACT

The tractor drawn inter-row rotary weeder was developed with an objective of mechanical means of weeding and keeping in view the crop, soil and machine parameters. Weeding is an important practice to be carried out during the initial stages of crop growth especially for controlling the weeds competing with the crop, stirring the soil for aerating the crop root zones and for burying the weeds into the soil. The weeder is suitable for crops having maximum row spacing. The width of inter-row rotary weeder could be change according to the crop row spacing. The developed weeder was evaluated at different test fields for different crops from the field tests it is seen that weeding efficiency 92.23 per cent field efficiency 86.34 per cent and field capacity was 1.43 ha/ day.

Key words : Power weeder, Tractor operated weeder, Inter row rotary weeder, Weeding parameters

Weed control in Indian Farm is a serious concern weeds pose major problem during warm and humid climate especially affecting *Kharif* crops. The problem of weed control is more acute in black soil during *Kharif* season. Weed control is one of the most expensive operations in crop growth. The high cost of weeding can be understood from a comparative study of the losses in the farm due to various causes. Infection of weeds is more in *Kharif* than in *Rabi* season often weeding is incomplete or delayed as a result there is significant loss of 20% or more. Weeds increase cost of production and lower the quantity as well as the quality of the crop. Depending on the weed density 20-30% loss in grain yield is the quite usual which may increase to 50%, when crop management practices are not properly followed. In production technology plant protection is a key in increasing the productivity of crop. Under plant protection, weed control plays an important role for increasing the yield. Weed alone was found to be reducing the yield of the extent of 58-85%.The yield losses in cotton due to weeds alone was assessed as 13.60 per cent than that of insects and diseases which is about 35.80 per cent, while the losses due to weeds alone was assessed was 33.80 per. This shows the necessity of effective weeding operation. Usually tractor mounted cultivators are used for weeding and inter-culturing operations in farm. The rotary type weeder stirs the soil more accurately, disturb the weed root and remove them from the soil. In addition this helps in keeping the soil in loose condition for proper aeration. Especially for the wide row spaced crops like cotton, maize where the tractor can be run in the rows. Looking the above facts tractor drawn Inter-row rotary weeder was developed for widely spaced row crops.

METHODOLOGY

Design considerations:

A due attention was provided on the following design aspects while designing and fabrication tractor drawn inter-row rotary weeder: A machine was designed by keeping in mind the various agronomical requirement of crop, spacing of crop about 45- 90 cm. Height of the crop about 15 -45 cm from the ground level. Machine should be simple in design and it should easy to operate, Cost of the machine should be low, It should be easily repairable by farmer or village artisan, crop variety is an important parameter, which influence the mechanical weeding operation since the growth factor and foliage varies for each variety, normally the recommended row spacing for cotton ranges between 450 mm to 900 mm depending upon the crop variety. While in operation the tractor tire may cause damage to the crop, so the tread width of the tractor wheel should be reversed to allow the tire to run in between the rows, machine movement in the field mainly depends on height of the crop. Since the tractor ground clearance is 450 mm, to achieve efficient weeding with minimum crop damage, the crop height should be less than 550 mm , the weeding has to be done before the specified days at which the crop is achieving the restricted height. Moreover the weeds will compete only at the early stages of crop growth. Weeds take about 8 weeks to reach maximum canopy cover due to its quick growth while cotton takes at least 16 weeks to cover 90 per cent space. Weeds are getting matured within a period of 30 to 45 days, the weeding has to be

done before the critical period for efficient control. At this stage the crop is not exceeding 350 mm height (at 50 days), which is less than ground clearance of the tractor. The soil parameters influencing mechanical weeding of different crops were identified and measured. The soil properties relevant to the design of tool for weeding were identified as soil type, moisture, bulk density and cone index. The type of soil affects on the implements and draft required to it, soils having more moisture content give more slip and hence increase the draft.

The theoretical width of operation can be calculated as follows:

Width of each rotary unit, mm	= 400
Number of rotary weeding units	= 3
Spacing between the consequent Rotary weeding unit, mm	= 200
Theoretical width of operation, mm	= 1600

The depth of operation was considered to be for design 5 to 6 cm . The developed inter row rotary weeder was tested in the field as per RNAM test codes

RESULTS AND DISCUSSION

The inter row rotary weeder was fabricated which consists mainly five units: 1) Main frame, 2) Support frame, 3] Gearbox and gearbox housing frame, 4) Power transmission, 5) Rotary weeding assembly.

Mainframe:

A 2180 x 55 x 55 mm square frame was made from M.S. angles; holes of 10 mm are drilled to the whole frame. The position of the rotary units can be adjust as per the crop spacing by just changing the position of support frame with respect to the holes on the main frame.

Support frame:

A triangular support frame comprises of M.S. angles and M.S. channels. Angles are fixed vertically to the main frame and channels are fixed to the main frame and inclined to the angle Fig.1.

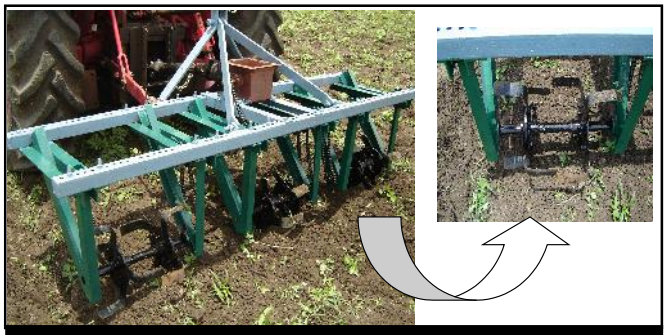

Fig. 1 : Tractor drawn inter-row rotary weeder

Gearbox and gearbox housing frame:

The gearbox is located at the top of the main frame. It has a pair of bevel gears having ratio of 1.6:1, which transmit the power to the transmission gears through drive shaft. The drive shaft provided with the sprocket of 13 teeth and power from which was transmitted to the main shaft by the chain and sprocket arrangement.

Power transmission:

The power from the tractor PTO was reduced from 540 rpm to 337 rpm with the help of a bevel gear arrangement, which is having a gear ratio of 1.6:1, which transmit power to the main shaft with ratio of 1.07:1. Again a power from main shaft reduced at a ratio of 1.21:1 and transmitted to rotary weeding assembly by chain and sprocket arrangement. The final speed of the blade was set to be 257 rpm.

Rotary weeding assembly:

The blade assembly consists of a on the periphery of the flange, steel blades of uniformly tapered edges were positioned such that it projects outwards with an inclination angle of 50^0 to horizontal. Similarly another shaft was fitted on antifriction bearings horizontally on a suitable framework. Another two sets of weeding units were fabricated within between 200 mm clearance. These three units were assembled in a specially constructed framework.

A triangular supporting frame supported the rotary weeding blade assembly. It consists of flanges, cutting blade and rotor shaft.

Rotor shaft:

The rotor shaft was used to mount the flanges with 'L' shaped blades. It receives power from main shaft by means of chain and sprocket arrangement. This shaft was supported on the journal bearing. The bearings were provided to the inner side of the channel. The solid Shaft of diameter 32 mm was used.

Flanges:

Flange or circular metal plates are used for structural component for the cutting blades. In order to mount the blades, flanges are used. Flanges are made of 10mm thick mild steel sheet and 180 mm diameter. The clearance between the two flanges or discs were 220 mm with a blade overlapping of 20 mm. The flange thickness was 10 mm.

Cutting blades:

L shaped rotary blades are selected and mounted on

flange. The cutting blades of spring steel material were used. There were 4 nos. of blades per flange with angle of orientation $50^{0.}$

The inter-row rotary weeder was taken to the field and trials were conducted in black soil, the parameters like soil type, moisture content, cone index, crop parameters are studied, the other factors are taken in to considerations are speed of operation, depth of operation, wheel slip, specific fuel consumption, draft. The field tests were conducted as per RNAM test code 1983.

Condition of field and soil:

Area and shape of the test field:

Three different test were conducted in the different fields of size 60 x 30 and shape of the field was rectangle, 2) Type of soil was black soil, 3) Soil moisture content observed 13 - 18.25% for different test conditions.

Condition of weeds:

Height of weeds was found to be 10 to 20 cm, 2) Type of weeds – Haryali, Lona, Shipi, vinchu, kolsi, Tandulja, Aagada, Doha.

Condition of crop:

Variety of crop – Cotton PH-348, Soybean M.A.U.S. -81, Sunflower S.C.H-35 , Planting method – dibbling and sowing, Age after seeding and crop height – 35-50 days after sowing, height 25-40 cm. and Row spacing – Field-I 60 cm, Field-II 45 cm, Field-III 60 cm

Condition of implement:

1) Type of soil working part: The 'L' type blade of spring steel material of length 250mm , 2) Width of cut for one run = 1200 mm, 3) Traveling speed – 1.1 -1.5 km/hr. 4) Type of power source – A tractor PTO is used as source of power.

As per the Table 1, following are the observations regarding the different performance parameters of the inter-row rotary weeder.

Row spacing:

The inter-row rotary weeder could be used in the crops of row spacing between 45 to 90 cm; with varying moisture contents it gives different depth of operation and weed of operation changes accordingly. The weeder is suitable for crops having maximum row spacing. The width of inter-row rotary weeder could be change according to the crop row spacing.

Depth of operation:

The depth obtained for field tests of inter-row rotary weeder was in the range of 42-55 mm. This was adequate for weeding operations. It was found that, as the speed of operation increases the depth of operation decreases accordingly and affecting the draft requirement of a weeder.

Speed of operation:

The different field tests were conducted for inter-row rotary weeder with different forward speeds *i.e.* 1.1, 1.2 and 1.5 km/hr. The draft requirement of a weeder decreases as speed of operation increases and effective field capacity increases.

Draft:

The draft requirement for an inter-row rotary weeder was in the range of 58-67 kgf and the average draft requirement was found to be 62.22 kgf for different field tests. The draft requirement for weeding operation was less as compared to power developed by the tractor. From Table 1 it is clear that draft required was increased as moisture content of the soil increased since it is concluded that draft requirement decrease with increased in speed of operation.

Effective field capacity:

The effective field capacity was found in the range of 1.17 to 1.58 ha/day and the mean effective field capacity was 1.43 ha/day. The speed of operation affects the effective field capacity. The effective field capacity was increased with increase in speed of operation and weeding efficiency decreased accordingly.

Field efficiency:

The field efficiency for different field test of inter-row rotary weeder were in the range of 92.09 to 93.19 per cent and average field efficiency was found to be 92.50 per cent. The field efficiency decreased with increase in speed of operation. The maximum field efficiency of 91.92 per cent was obtained at a speed of 1.1 km/hr for which weeding efficiency was found to be 94.44 per cent for field- III and the minimum field efficiency 81.51 per cent was found at a speed of 1.5 km/hr for field-I, for which the weeding efficiency was observed 92.23 per cent.

Fuel consumption:

In all the field tests the weeder was operated for speed of 1.1, 1.2 and 1.5 km/hr. The average operating speed of the weeder was 1.27 km/hr and fuel consumption was 2.7 lit/hr.

Table 1 : Results of field tests

Sr. No.	Particulars	Field-I	Field-II	Field-III	Mean
1.	Plot size	60x30	60x30	60x30	60x30
2.	Row spacing (cm)	60	45	60	55
3.	Crop height (cm)	32	25	29	29
4.	Working width (m)	1.8	1.35	1.8	1.65
5.	Speed of operation (km/hr)	1.27	1.27	1.27	1.27
6.	Depth of operation (cm)	50	45	49	48
7.	Soil moisture (%)	13.34	17.50	15.05	15.30
8.	Draft (kg)	60	63.67	61	63
9.	Time taken (min)	44.52	60.36	44.20	49.69
10.	Time lost in turning (min)	11.54	13.97	10.85	12.12
11.	Total time (min)	56.07	74.33	55.05	61.81
12.	Effective field capacity (ha/day)	1.55	1.17	1.58	1.43
13.	Theoretical field capacity (ha/day)	1.82	1.37	1.82	1.67
14.	Field efficiency (%)	85.65	86.17	87.21	86.34
15.	No. of weeds before operation in $1m^2$.	43	36	34	38
16.	No. of weeds after operation in $1m^2$.	3	4	3	3
17.	Weeding efficiency (%)	92.23	92.09	93.19	92.5

Power requirement:

The manual weeding requires nearly 144 man-hr/ha for weeding operation resulting in very high cost of operation *i.e.* Rs. 1080 per ha. The total man hour requirement was found to be 45 for weeding operation by inter-row rotary weeder. Thus it saved requirement of man hour per hectare for weeding operation as compared to conventional method of weeding.

Cost of operation :

Considering the material requirement and labour charges the cost of tractor drawn inter-row rotary weeder was calculated and found that 68.70 per cent saving in cost compared with conventional method of weeding. As far as the cost of operation is concerned the inter-row rotary weeder was always economical than conventional method of weeding. The total man-hour required was 45 man-hour for inter-row rotary weeder and 144 man hour by conventional method of weeding. The inter-row rotary weeder reduced the human labour considerably which is other wised a costliest source of power.

Conclusion:

The performance of the inter-row rotary weeder was evaluated in terms of field efficiency, weeding efficiency and cost economics. The experiments were conducted in three different crops with three forward speeds (1.1, 1.2 and 1.5 km/hr) at different moisture content. The field observations were analyzed which give the performance of inter-row rotary weeder. The type of soil was heavy soil where experiments were conducted.

The effective field capacity of inter-row rotary weeder was found to be 1.43 ha/day. The field efficiency and weeding efficiency was found to be 86.34 per cent and 92.23 per cent, respectively. The saving in cost and time were 68.70 per cent and 70 per cent, respectively as compare to conventional method of weeding. The developed tractor drawn inter-row rotary weeder relived the farmer from fatigues work of weeding.

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