RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 12 | Issue 2 | October, 2019 | 251-255
ISSN–0974–2662 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/12.2/251-255**

Comprehensive study on execution of three tyn wheel hoe at farmers field

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Received : 13.07.2019; **Revised :** 28.08.2019; **Accepted :** 15.09.2019

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■ **ABSTRACT :** In agriculture weeding has been established as one of the major drudgery prone occupation of unorganized sector due to lack of awareness and access to improved agricultural technologies. The women traditionally carried out weeding operation by using tools e.g. hand hoes in bending position which decreases the work efficiency. In order to overcome this problem, KVK, Vonipenta has organized front line demonstration entitled with work and field efficacy performance of wheel hoe in weeding activity. With this objective to reduce the drudgery with muscular stress and fatigue and work efficiency of the farmers. The demonstration component included use of weeding implement (Three tyn wheel hoe) developed by CRIDA, skill training and exposing advantages. In the recommended weeding practice, shown that the same amount of work could be done in almost half of the time and work efficiency was increased. Farmers were adopted the improved technique as it had increased the efficiency of work, reduced the drudgery and helped in avoiding bending posture. The weeding efficiency of the three tyn wheel hoe weeder was easy to operate and weeder could work upto 60 mm depth with field capacity of 0.048 ha/hr and higher weeding efficiency was obtained upto 96.8 per cent. During weeding operation, the peak heart rate of the subjects was found to range from 142 to 150 beats per min. In case of heavy work and dense grass infested field, the rest pause of 15 minutes was required by the subjects to come to the normal heart rate. The overall performance of the three tyn wheel hoe weeder was satisfactory.

■ **KEY WORDS :** Drudgery index, Weeding efficiency, Economic efficiency

■ **HOW TO CITE THIS PAPER :** Runjala, Suneetha, Nagarjuna, V. and Ravigoud, E. (2019). Comprehensive study on execution of three tyn wheel hoe at farmers field. *Internat. J. Agric. Engg.*, **12**(2) : 251-255, **DOI: 10.15740/HAS/IJAE/12.2/251-255.**

Weeding is an important activity in crop production but equally labour intensive. Weeding accounts for about 25 per cent of the total labour requirement (900–1200 man-hours/ hectare) during a cultivation season (Nag and Dutta, 1979). Delay and negligence in weeding operation affect the crop yield upto 30 to 60 per cent (Singh, 1988). In India about 4.2 billion rupees are spent every year for controlling of weed in the production of major crops, at least 40 million tons of major food grains are lost every year due to weeds alone (De Dutta, 1981). As well as aaccidents and injuries are natural hazards to everyone working in the farm environment and these happening as a culmination of multiple factors. The hand tools vary widely in different regions owing to agro-ecological factors. The high rate of work, awkward work posture and design deficiencies of the hand tools result in cumulative musculo-skeletal strain and injuries in farm

activities e.g., cuts on the hands, feet and shins. Weeding, soil loosening and earthening up are doing by women with hand tools like spade and khurpi. In order to perform this operation, farm women sit in squatting position which increases drudgery leading to back pain and fatigue and injuries in palm Nag and Nag (2004).

Timely weeding is very much essential for good yield and this can only be achieved by using improved manual weeders (manual three tyn wheel hoe) which perform simultaneous job of weeding and hoeing and can reduce the time spent on weeding (man hours), cost of weeding and drudgery involved in improved manual weeding. The main aim of this study was to reduce drudgery, increase the work efficiency of farmers and also reduce the cost of weeding operation to farmers by introducing three tyne wheel hoe.The subjects' responses were also studied while operating the weeder in the farmer's field. The results indicated that the push pull actuation of manual weeders contributed the maximum continuous load application of 30 N with least fatigue. The simulation studies on actuary motion were able to assess the man machine interaction accurately.

METHODOLOGY

Three tyne wheel hoe:

Three tyne wheel hoe is manually operated equipment for weeding. It consists of wheel frame and the wheel hoes were widely accepted as weeding tool for weeding and inter culture in row crops. It is a long handled tools operated by push and pull action.

Wheel hoe specifications:

Overall length (mm)	:	1400- 1500
Overall width (mm)	:	450- 500
Overall height (mm)	:	800- 1000
Number of tynes	:	2, 3, 5 Adjustable
Wheel diameter (mm)	:	200- 600
Working depth (mm)	:	Upto 60
Weight (kg)	:	8 kg

The performance of the developed three tyn wheel hoe weeder was evaluated in the field of chilly, tomato, green gram, cowpea and Bengal gram. The test was carried out in three series of short run tests. Selection of land was done according to RNAM (1983) test code. The test conditions such as soil moisture content, soil type, bulk density of soil, root zone depth of weed, density of weed, etc. were taken into consideration. Speed of travel in km/h was calculated as per RNAM (1983) test code by using a stop watch. The field capacity of the weeder (ha/h) was calculated by fixing the area of 300m^2 (150 x 2 m). The draft required by the weeder was calculated by using the equation.

RESULTS AND DISCUSSION

To evaluate the weeder through ergonomic point of view, 30 subjects in the age group of 25 to 45 years were selected. The basic anthropometric measurements were taken and calculated and given mean values. The

Table 1: Average body dimensions of weeder operator **(n=30)**

Sr. No.	Parameter	Range	Mean
1.	Age in years	25-37	34.7
2.	Weight in kgs	45-60	52.5
3.	Height in cm	145-160	154.2
4.	BMI	19.8 -25.6	22.8

Table 2 : Field capacity of weeder

Sr. No.	Crop	T_1 wheel hoe weeding	T_2 manual weeding
		m^2/hr	m^2/hr
1.	Chilly	133.3	78.7
2.	Tomato	128.4	71.3
3.	Green gram	129.3	69.2
4.	Cowpea	141.2	68.9
5.	Bengal gram	132	67

Field capacity of weeder: Field capacity of weeder is measured in terms of area/hour (E.g., hectares/hour).The subject operate the weeder for a fixed time and measure the area that was covered in the weeding activity

operators were acclimatized to report at the work site at 8:00 am and have rest for 30 minutes before starting the trial. After 30 minutes rest, the subject should be asked to perform the weeding for a duration of 30 minutes and took three trials, gave sufficient rest between each trial. Repeated the same procedure for all the subject.

Table 1 depicts the age, weight, hight and BMI of the sample group.

The weeding test was performed in chilly, tomato, green gram, cow pea and Bengal gram The test started at 35 days after plantation , row to row and plant to plant mean spacing of 50*45,The average plant population per square meter area range 20-40 and average height of plant was 30-40cm. Five readings of travel speed were taken and average travel speed was calculated and used in the study. The average travelling speed was found to be 5*5m/min. During testing it was observed that the travelling speed also depends on the parameters such as weight, height of the operator and physical condition of the operator. Therefore, to avoid the error in result analysis the subjects of more or less equal weight and anthropometry were selected for the study. The developed weeder was found easy to operate at the speed of 4 m/min.

Table 2 revealed that the performance of field capacity of the developed weeder was calculated by selecting the representative three sample plots of size 300m^2 (150 x 2 m) with five different farmers in different crops. The field capacity of the developed weeder was found out to be 133.3m^2/hr in chilly, 128.4 m^2/hr in tomato, 129.3 m^2/hr in line sown green gram, 141.2 m^2/hr in line sown cowpea and pea132 m^2/hr in line sown Bengal gram.

Table 3 depicts the per cent plant damage of the above crops are 1-4 per cent observed in wheel hoe weeder weeding plot and there is no plant damage in

Table : 3 per cent plant damage

Sr. No.	Crop	% of plant damage with wheel hoe	% plant damage with hand hoe
1.	Chilly	2	Nil
2.	Tomato	2	Nil
3.	Green gram	4	Nil
4.	Cowpea	2	Nil
5.	Bengal gram	1	Nil

Per cent plant damage = { 1 - (q / p)} x 100 where, q = Number of plants in a 10 m row length after weeding, p = Number of plants in a 10 m row length before weeding

Table 4 : Weeding index

Sr. No.	Crop	% of weeding efficacy with wheel hoe	% of weeding efficacy with hand hoe
1.	Chilly	96.8	95.9
2.	Tomato	92.3	94.7
3.	Green gram	88.5	89.2
4.	Cowpea	89.6	86.2
5.	Bengal gram	88.2	91.6

Weeding index per cent $e = [(W_1-W_2)/W_1] \times 100$., where, e = Weeding index, per cent ,W_1 = Number of weeds/m^2 before weeding, W_2 = Number of weeds/m^2 after weeding

Table 5 : Economic efficiency of wheel hoe

Sr. No.	Crop	% Economic efficiency with wheel hoe (Expenditure spent)	% Economic efficiency with hand hoe (Expenditure spent)
1.	Chilly	40	52
2.	Tomato	45	50
3.	Green gram	30	50
4.	Cowpea	35	55
5.	Bengal gram	30	57

hand hoe weeding.

Table 4 revealed, the average weeding efficiency for the developed weeder it was found to be 96.8, depth of the soil 60 mm which shows that the weeder is efficient.

Table 5 shows the difference between the cost of wheel hoe weeding and hand hoe weeding expenditures. Two times weeding expenditure was reduced from the total cost of cultivation by using wheel hoe *i.e.*, 30-45 per cent in different crops based on density of weeds spread. Four times weeding expenditure spent *i.e.*,50-57 per cent from the total cost of cultivation by using hand hoe weeding by women.

Table 6 shows the performance of drudgery index of weeding with hand hoe and three tyne wheel hoe was determined by calculating the x = co-efficients pertaining to difficulty score, y = co-efficients pertaining to performance score. z= co-efficients pertaining to average. With wheel hoe moderate dgery index score 51.9-59.2 was recorded whereas in traditional practice (hand hoe) maximum drudgery score 78.1-89.3 was recorded.

Overall discomfort rating (ODR):

Table 7 shows the weeding in green gram, cowpea, is an activity where musculo-skeletal problems are more than in chilli tomato. The reason the activity is time taking and performed continuously for prolonged hours. The traditional method employs continuous sitting posture while weeding either with bare hands or using traditional hoe.

Musculo-skeletal problems:

The musculo-skeletal problems and posture were evaluated by asking the respondents as to where they felt pain in their body after weeding with traditional and improved technology. The data in (Table 7) depict that weeding with traditional tools in strenuous posture causes severe pain in shoulders, mid back, hands and knees. The women perceived the task as heavy. On the contrary, using improved weeding tool induced moderate to light discomfort/pain in shoulders, hands and arms. They were relieved from back pain and improved tool employed standing posture and eliminated continuous sitting posture as well as some movement is also employed while working on a three tyne wheel hoe. The rating of perceived exertion was also reported as moderate with use of three tyne wheel hoe.

Conclusion:

In agriculture, weeding is one of the important labour intensive activity and adoption shows increase not only in, efficiency but in terms of economy also by reducing labor engagement during weeding, productivity of worker is increased with the equipment than traditional method. It was found to be compatible, easy to handle and applicable in field situation as well as most efficient for weeding in horticultural and line sowed field crops. The body discomfort reduced with use of three tyn wheel hoe weeder because it involved standing posture

Table 6 : Drudgery index

Sr. No.	Crop	Drudgery index with wheel hoe	Drudgery index with hand hoe
1.	Chilly	53.6	78.1
2.	Tomato	58.9	87,9
3.	Green gram	59.2	82.2
4.	Cowpea	51.9	89.3
5.	Bengal gram	56.2	81.2

Drudgery index (DI) is calculated by using this formula DI= x +y +z/3 x100 where, DI Score between 70 and above = Maximum drudgery, DI score between 50 and 70 = Moderate drudgery , DI Score between 50 and below = Minimum drudgery

Table 7 : Mean value of ODR, MSP, RPE, score by respondents

Sr. No.	Parameter	Wheel hoe	Hand hoe
1.	Overall discomfort rating	5.4	8.9
2.	Musculo-skeletal problem	Moderate to light pain in shoulder, hands and arms	Severe pain in mid back, hands, shoulders, knees
3.	Rating of perceived	Moderate	Heavy

*ODR= Mean value of overall discomfort rating; *MSP=Musculo-skeletal problem; *RPE=Rating of perceived exertion

eliminating muscular fatigue and excessive loading of inter-vertebral discs of backbone. The chance of injuries also eliminated and provides safety to the worker. The three tyn wheel hoe weeder proved ergonomically sound, farmer friendly, drudgery reducing and improved worker's efficiency.

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