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community of the Indo-Gangrtic Plains of the Eastern India.

ɔ and Mandava weeder

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Short communicat

Comparative performance of manual weeders under system of rice intensification in Indo-Gangetic plains

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ce (Oryza sativa L.) is grown under diverse es ranging from irrigated to rainfed upland, d and deep water. Traditional crop shment, i.e. puddling and transplanting, s large amount of water, energy and labour, are becoming scarce and expensive (Mishra gh 2012). Weeds are considered to be one of jor biotic constraints in achieving the higher oductivity as they cause a reduction of 10- rain yield in rice field (Kumar et al. 2016). of Rice Intensification (SRI) is a modern and ive method of rice cultivation for reduced use , water and labour and to increase the crop ivity. But this system is much infested with because growing under the limited water ment. Echinochloa spp., Cynodon dactylon, ca quadrifida and Cyperus spp. are the major associated with SRI. Herbicides were proved e but the continuous and indiscriminate use of les for a longer period may result in buildup of natic weeds and development of herbicide ce. Adoption of rotary or cono-weeder use in ys a significant role in improving the growth, d economics of rice. Weed management with ed tools not only uproot the weeds between ws but also ensuring the better soil aeration. nt type of weeders are available for weeding these designs are location specific and d to meet the requirement of soil type, crop cropping pattern and availability of the local es (Goel et al. 2008). Hence, performance of ing manual weeders was evaluated in SRI he middle Indo-Gangetic plains.

field experiment was conducted at ICAR h Complex for Eastern Region, Patna (25°35' de and 85° 04' E longitude) during the Kharif experimental site was sub-tropical in nature exhib high humidity and medium rainfall. The rice cv. ' 1509' (120 days duration) was used as test mate The monthly mean maximum and minin temperature during the crop growing period ra from 29.2 - 35.4°C and 12.2 - 23.2°C, respecti The rice seedlings were transplanted at 25×25 apart. The specification of the experimental wee is mentioned in **Table 1**.

Table 1. Specification of cono and Mandava weeder

Cono weeder	Mandava weeder
Length : 2040 mm	Length: 1500 mm
Nominal width:194 mm	Width (handle): 460 mm
Working width: 125 mm	Nominal width: 150 mm
Height: 1120 mm	Working width: 120 mm
Width (handle): 500 mm	Height: 1000 mm
Type of handle: T-Type	Type of handle: T-Type
Number of rotors: 02	Number of rotors: 01
Weight: 6.1 kg	Weight: 5.1 kg
Unit Cost: ` 1200/-(approx.)	Unit Cost: ` 1000/- (appr

Different test parameters were evaluated with form given as below:

Theoretical field capacity Theoretical field capa was calculated with standard formula as sugge by Mehta et al. (2005).

$$\text{Theoretical field capacity} = \frac{\text{Working width} \times \text{Speed}}{10} \quad \ldots\ldots\ldots$$

Where, working width in m and speed in km/h

Effective field capacity: Effective field capacity i average output of the weeder per hour and calcu from total area weeded in ha and the total work (Mehta et al. 2005).

$$\text{Effective field capacvity} = \frac{\text{Area covered by weeder}}{\text{Total time taken} \times 10000} \quad \ldots\ldots$$

Where, Area covered in m^2 and total time in hr

Field efficiency: It is the ratio of the effective

) study the performance of weeders i.e. cono
ndava weeder under the irrigated ecosystem.
the experimental plot was clay loam (sand:
, silt: 39.64% and clay: 37%). The climate of

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capacity to theoretical field capacity and express
percent (%) and it was calculated by using
formula as suggested by Mehta et al. (2005).

$$\text{Field efficiency (\%)} = \frac{\text{Effective field capacity}}{\text{Theoritical field capacity}} \times 100 ......$$

$$\text{Field capacity} = \frac{W \times S}{10} \times \frac{E}{10} ....(4)$$

here, W= theoretical width of cut in m, S =
f travel in km/h, E= field efficiency (%)

ng efficiency: Square loop (0.25 m^2) was
ly thrown to field and number of weeds
ng in loop was counted before and after
g (Rangasamy et al. 1993). Three sets of
tions were taken and weeding efficiency was
ted as below.

$$\text{Weeding efficiency (\%)} = \frac{W_1 - W_2}{W_1} \times 100 ....(5)$$

here, W_1= number of weeds before weeding,
mber of weeds after weeding

lamage: It was calculated by counting the
of injured plants and total number of plants in
plot and expressed in per cent (%) (Biswas
lav 2004).

$$P_d = \frac{A}{B} \times 100 ....(6)$$

here, Pd = Plant damage (%), A=Injured plant
= Total no. of plant in sample plot

e human energy co-efficient 1.96 MJ was
red as suggested by De et al. (2001)

force measurement: The force requirement
ation was determined in field using spring
and three persons involved in test (**Figure 1).**
balance was fixed between pulling wire and
rson pulled weeder, while another person
d data of spring balance and third person just
ndle of weeder along with line of action.

broad-leaved weeds (BLW) Trianthe
portulacastrun L., Euphorbia hirta L.; sedges
Cyperus rotundus L. and Cyperus iria L.
important weed flora during the experimentation.
relative dominance of BLWs, grasses and sedges
recorded as 84, 11 and 5%, respectively.

Field capacity of Mandava weeder was hi
(0.0168 ha/hr) than cono-weeder (0.0149 ha/hr).
lower value of effective field capacity for c
weeder was also reported by Shakya et al. (20
The wide difference in the values of field capaci
both the weeders may be due to difference in wid
cutting parts (blades) as well as forward sp
Mandava weeder facilitates worker by providing
push and pull action to the implement as compar
cono-weeder. Field efficiency was higher
Mandava weeder (89%) as compared to c
weeder (87%). Higher field efficiency of weeder
because of minimum time loss in turning and d
operation (Shakya et al.2016). Weed density o
and 96/m^2 was recorded before weeding wit
cono-weeder and Mandava weeder, respecti
(**Table 2**). The maximum weeding efficiency
found with Mandava weeder (88%) as compare
cono-weeder (71%) which might be due to gre
soil contact and soil inversion capacity of the we
The wide difference in the values of wee
efficiency in both weeders may be due to differ
in shape of blades and depth of operation.
average value of plant damage factor for cono
Mandava weeder were obtained 7.58 and 6.
respectively, which was 30% lower in devel
cono-weeder reported by Shakya et al. (20
Involvement of man power was examined
respect to weeder used in controlling weeds of

l. Pushing force measurement

lora

ajor weed associated with crop was grasses, eaved weeds and sedges. Among grasses, chloa crus-galli (L.), Echinochloa colona (L.) Eleusine india (L.) Gaertn., Leptocholoa sis (L.) Nees, Cynodon dactylon (L.) Pers.;

under SRI and it was noted that Mandava we consumed the minimum man-days/ha (7.44).

Human energy: The highest human energy consumed by cono-weeder (131.39 MJ/ha compared to Mandava weeder (116.65 MJ/ha). cono-weeder required the highest energy, it was found to be economical in terms of eco-energ (**Table 3**). But Mandava weeder was not only pr efficient in terms of eco-energetics but also usef completing weeding in lesser time.

Pushing force measurement: Result showed forces of 98°74' N and 68°64'N are required fo

Weed density (no./m^2) and weed control efficiency (WCE) as affected by two weeders

	Grasses (no no./m^2)	Broad-leaved weeds (no./m^2)	Sedges (no./m^2)	Weed count (no./m^2) before weeding	Weed count (no./m^2) after weeding	Weeding efficien (WCE %)
eeder	71.0	9.24	4.20	84	24	71
a weeder	80.64	10.56	4.80	96	12	88

mm water depth, respectively in cono-weeder, n mandava-weeder; they were 89.38 N and I, respectively (**Table 4**).

omics Evaluation: Ergonomic study was out with 5 male workers for weeding in SRI. ometric rod and weighing balance were used sure the physical characteristics and stop for recording time. Polar Heart Rate Monitor 0, Finland) was used for recording heart rate ject. To evaluate the weeding through nic point of view, 5 workers in age group of 6 yrs were selected and average age as 33.8 dy height of 167.8 cm and weight 66.60 kg, ively (**Table 5**).

ysiological stress of weeding was determined basis of parameters i.e. heart rate during work t, energy expenditure and cardiac cost of hile performing activity (**Table 6**).

here was 10.4% increase in working cy with usage of the mandava weeder. The

Human energy requirement for weeders in SRI

output recorded by Mandava weeder was 168 r as compared to cono-weeder (149 m^2/hr). Du weeding with cono and Mandava weeder, ÄHR 27.6 and 24.4 beats/min, respectively. En expenditure was 8.57 kJ/s and cardiac cost 1 beats/m^2 for cono-weeder. However, in cas Mandava weeder it was found 7.68 kJ/s and beats/m^2 of energy expenditure and cardiac c respectively. Manduva weeder saved 21.88% ca cost and increases efficiencd 10.38%.

SUMMARY

Two weeding tools were evaluated in S Maximum weeding efficiency was recorded mandava weeder as compared to cono-wee Mandava weeder consumed minimum man-day Therefore, mandava weeder may be promote farmer's fields in wider scale as it reduces energy of small and marginal farming community of Indo-Gangrtic Plains of the Eastern India.

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rice field

	Human (Man-hr/ha)	Energy requirement (MJ/ha)
'eeder	67.04	131.39
ı weeder	59.52	116.65

. Pushing force vs. water levels in rice field

levels	Pushing force (N)	
	Cono-weeder	Mandava weeder
	196.2	188.58
	98.74	89.38
	68.64	61.14

Physical characteristics of selected male farmers (N=5)

l characteristic	Mean±SD
s)	33.80±9.18
cm)	167.80±3.96
(kg)	66.60±4.28

. Performance of male farmers during field operation (N=5)

	Cono-weeder	Mandava weeder
working heart rate min)	108.8±10.47	103.2±10.64
heart rate during rest min)	81.2±5.59	78.8±7.39
eats/min)	27.6	24.4
n^2/hr)	149	168
xpenditure (kJ/s)	8.57	7.68
ost (beats/m^2 area covered)	11.15	8.71
ı in drudgery (%)	-	10.38
n efficiency (%)	-	21.88

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