Indian Journal of Weed Science **48**(1): 25–28, 2016
DOI: 10.5958/0974-8164.2016.00005.8

Development and testing of self-propelled cono-weeder for mechanized rice cultivation

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Received: 21 January 2016; Revised: 9 March 2016

ABSTRACT

Manual cono weeding in rice is a tedious job requiring more labour and energy. An effort was made to develop prototype of a self propelled cono-weeder under the AICRP on Weed Management at the College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur with an objective to reduce drudgery involved in manual cono-weeding in rice. Main components of the newly developed self propelled cono-weeder are the main frame, a prime mover, front and rear floats and a rotor. Field experiment was conducted at Pattambi in Palakkad district to study the performance of the prototype in comparison with manual cono weeding and conventional weeding methods in rice. The weed density, weed dry weight and the grain and straw yields of rice at various treatments were observed. It was found that self propelled cono-weeder had a field capacity of 0.1 ha/h at an operating speed of 2.0-3.0 km/h. The weeding efficiency of the unit in rice was at par with that of the manual cono-weeder operated twice at 15 and 30 days after transplanting.

Key words: Cono-weeder, Manual weeding, Mechanical weeding, Rice, Self-propelled weeder

Drum seeders, self-propelled rice transplanters and the system of rice intensification (SRI) technique are being increasingly adopted by the rice farmers of our country. When the adoption of these technologies increased, the area under line sown low land rice crop became popular but it had the problem of heavy weed growth and the related labour cost. Farmers were looking for an efficient and cost-effective machinery for weed control. Years ago, a mechanical hand weeder was developed in Japan to facilitate weeding between rows. It had various names and undergone modifications, but was widely known as rotating hoe or rotary hoe. Mechanical weeding using inter row cultivators or rotory weeders needed about 50 to 60 human hours to weed one hectare of rice field (Parthasarathy and Negi 1977).

Engineers at the International Rice Research Institute (IRRI), Philippines subsequently developed a cono-weeder (conical weeder), which work better in various soils, especially heavy clay soils. An improved and modified IRRI cono-weeder was developed for wet field conditions and it was compared with the conventional weeding practices. The field capacity of the weeder was 0.02 ha/h and a weeding efficiency of 80% during the first weeding. The cost of weeding with this weeder amounted to $ 10 per hectare, while manual weeding did cost $ 24 per hectare. Sixty per cent of time was saved in comparison to manual weeding (Parida 2002). This modified IRRI cono-weeder was further modified and used for efficient weeding in rows. The implement reduced drudgery due to less time taken from 50 to 55% and its use resulted in saving cost of operation by 45% compared to hand weeding. The weeding efficiency varied between 75 and 100% in clayey soil. This manual cono-weeder could operate an area of one acre in a day of 8 h (Sarma *et.al.* 2006).

The presently available cono-weeder has two rotating cone shaped drums with width adjustability. It has better soil working efficiency and operational simplicity. One of the major constraints in using these hand operated weeders is the physical effort that is needed to push the weeder in the wet and highly resistant clay soil. It was found that the push type cono-weeders are difficult to use as they have to be moved back and forth and do not work well under conditions of highly dried soil, high inundation of flood water and at the existence of bigger sized weeds (Moody 1991). Reports from China by JiaGuo *et al.* (2004) also indicated the complex and laborious nature of management measures for weeding under SRI. In the operation of cono-weeder soil gets tilled deeply and the weeds are uprooted thoroughly, but the farmers find it very hard to operate as it pains the chest and hands (Kumar *et al.* 2006).

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Operational difficulties with the cono-weeder were identified as constraints in SRI practice and the farmers demanded to develop a cost effective motor operated cono-weeder (Manimekalai *et al.* 2006). Labour intensity involved in SRI as well as non-availability of various models of weeders suited to different agro-situations have been identified as the constraints in SRI by Rao and Goud (2007). For scaling up of SRI technique, they suggested to redesign existing models of weeders to suit to the site specific situations. After studying the constraints faced by the farmers of Palakkad district of Kerala, India in the adoption of SRI, Shanmugasundaram *et al.* (2008) also suggested to redesign the cono-weeder so as to ease the weeding operation. In this context of various positive aspects of cono weeding in SRI, it is essential to make available cono-weeders that make the operation untiring and drudgery free.

In the above context, an attempt was made to modify the existing manually operated cono-weeder to a self propelled version so as to reduce drudgery in its operation for weeding in low land rice.

MATERIALS AND METHODS

The presently available cono-weeder with two rotating cone shaped drums was used as the base material for development of prototype of a self propelled cono-weeder. The work was undertaken at the engineering workshop of the Regional Agricultural Research Station, Pattambi, Palakkad district, Kerala during 2008. To start with the study, the existing cono-weeder was given additional fittings and accessories so as to make it self-propelled. The new machine was field tested and noted the limitations for its smooth running. It was then undergone many modifications/refinements and brought to the prototype of a self propelled cono-weeder as a single row machine for weeding in low land rice.

The prototype was field tested in a mechanically transplanted rice field to study its effectiveness on weed control in comparison with other weed control practices. The field study was conducted at the Regional Agricultural Research Station, Pattambi, Palakkad district, Kerala using four treatments. The treatments were arranged in randomized block design (RBD) with three replications each with a gross plot size of 10 x 2 m. The four treatments were:

1. Manual cono weeding twice at 15 and 30 days after transplanting (DAT)
2. Self propelled cono weeding twice at 15 and 30 DAT
3. Manual cono weeding four times at 10, 20, 30 and 40 DAT
4. Hand weeding twice at 20 and 40 DAT.

Observations on weed density (number/m^2), weed dry weight (grams/m^2), rice grain yield (kg/ha) and straw yield (kg/ha) were recorded at 30 and 60 DAT and analysed statistically (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Major components of the newly developed self propelled cono weeder were the main frame, prime mover, floats and a rotor (Fig. 1).

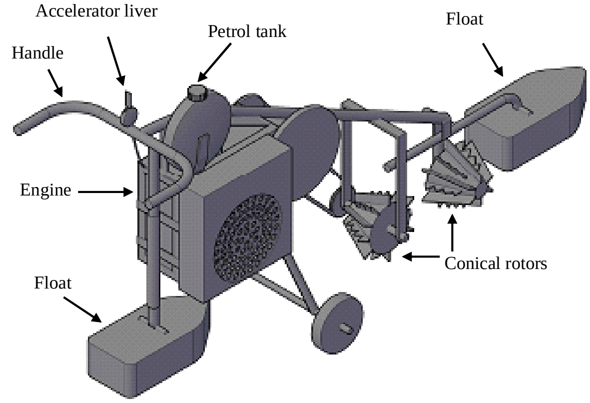

Fig. 1. Components of the self propelled cono-weeder

Main frame: The main frame mounts the engine, control units, float and the rotors. It was fabricated with 25 mm square MS steel pipe. A handle made of mild steel pipe of 25 mm diameter is attached to the frame.

Prime mover: An air cooled 2-stroke petrol engine was used as a prime mover. It had a rated power of 0.9 kW at 5500 RPM with specific fuel consumption of 650 g/kW/h. A cooling fan was provided to cool the engine. Engine power was taken through belt drive to the rotors through a larger pulley and a chain sprocket system. An accelerator was provided in the handle to control the speed of the engine. A clutch engage and disengaged the belt drive which transmits power from engine to the rotor.

Floats: Two floats made of mild steel sheets and shaped into a hollow top covered boat were provided each at the front and rear ends. The front end float was provided with a small swinging action to ensure flexibility. The rear end float with telescopic shaft was provided to prevent the weeder from sinking, especially in deeper clayey soils and to control the depth of operation.

Rotors: The rotors were detachable cone shaped frustums with smooth, serrated metal stripes welded along their periphery. The cono-weeder has two conical rotors mounted in tandem with opposite orientation. As the rotor receives forward motion, the smooth and serrated blades mounted alternately on the rotor uproot and bury the weeds into the soil. It facilitated a satisfactory weeding by the self propelled cono-weeder in a single forward pass without a push pull movement.

Working of the self-propelled cono-weeder

The engine rotates a small pulley of diameter 50 mm which is connected to the crankshaft. This pulley is further connected to a larger pulley of diameter 260 mm by means of a V-belt. This in turn is connected to the rotor (cone frustums) through a chain and sprocket arrangement. A 32-toothed chain with 18 toothed sprocket was used for further speed reduction and to operate the weeder under field condition. This helped to cover an area of 0.1 ha/h with normal working speed of 2.0 - 3.0 km/h. The total weight of the unit is 36 kg. Thus the forward motions of the weeder help in entangling the weeds within the rotors and get uprooted. Further movement enables the weeds to get buried into the soil. As reported by Datta (1981) and Moody (1991), push type cono-weeders were difficult to use as they have to be moved back and forth and do not work well under conditions of highly dry soil, high inundation of flood water, existence of bigger sized weeds etc. The working speed of the unit may be related to its higher self weight of 36 kg and the sticky nature of the rice soil. The heavy weight of the existing power weeder caused it to sink deeper into the wet soil and impeded its forward motion (Singh *et al.* 2006). The orthographic views of the self propelled cono-weeder are shown (Fig. 2).

Density of all types of weeds was the minimum with hand weeding at both the stages of observation. Use of self propelled cono-weeder as well as manual cono-weeder at 15 and 30 DAT responded almost uniformly in reducing the weed density, especially at 30 days after planting (Table 1).

Hand weeding at 20 and 40 DAT recorded the lowest weed dry weight at 30 and 60 DAT and it differed significantly from all the cono-weeder treatments (Table 2). Use of self propelled cono-weeder at 15 and 30 DAT recorded the second lowest weed dry weight at 30 DAT, while at 60 DAT it was by manual cono weeding four times. Grain yield was the maximum in the hand weeded plot, while straw yield was higher with the use of self propelled cono-weeder at 15 and 30 DAT as well as manual cono weeding four times (Table 2). Thus the newly

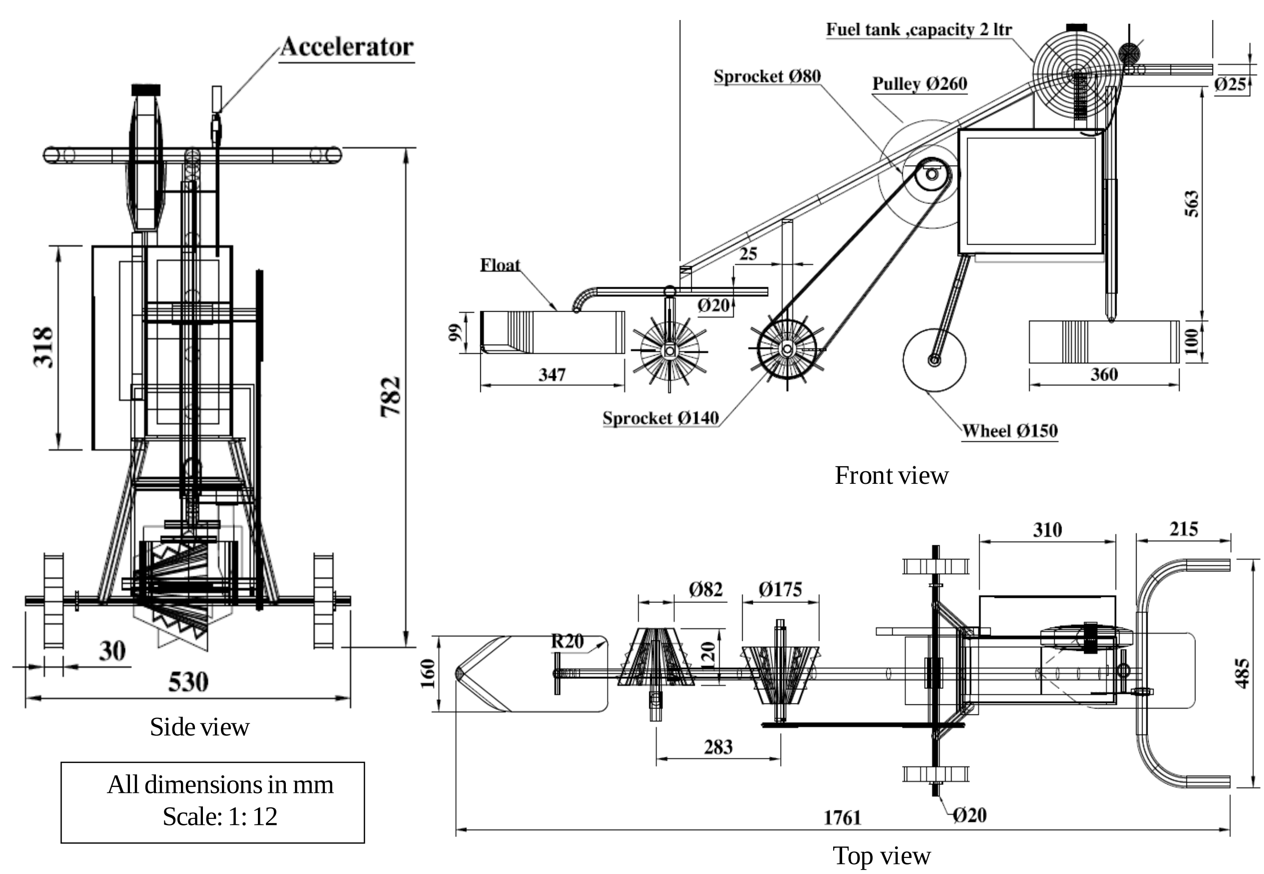

Fig. 2. Orthographic views of the self propelled cono-weeder

Table 1. Weed density (no./m^2) in rice at 30 and 60 DAT as influenced by the different treatments

Treatment	30 DAT				60 DAT			
	Grasses	Sedges	Broad-leaved weeds	Total weeds	Grasses	Sedges	Broad-leaved weeds	Total weeds
Manual cono weding at 15 and 30 DAT	2.72 (7.0)	11.63 (137.2)	7.74 (60.2)	14.2 (204.3)	1.43 (1.8)	8.86 (79.0)	5.51 (30.3)	10.51 (111.2)
Self propelled cono weeding at 15 and 30 DAT	2.32 (5.0)	10.17 (103.7)	9.93 (98.3)	14.39 (207.0)	1.51 (2.2)	10.38 (107.7)	6.55 (42.7)	12.35 (152.5)
Manual cono weeding at 10, 20, 30 and 40 DAT	1.51 (2.0)	6.40 (41.3)	6.82 (46.3)	9.44 (89.7)	1.35 (1.8)	8.89 (79.0)	5.97 (35.7)	10.78 (116.5)
Hand weeding at 20 and 40 DAT	1.08 (0.8)	1.58 (2.8)	2.23 (4.7)	2.87 (8.3)	1.35 (1.8)	2.90 (8.2)	4.11 (16.5)	5.17 (26.5)
LSD (P=0.05)	0.33	0.78	0.54	0.82	NS	0.58	0.49	0.66

(Values are $\sqrt{x+0.5}$ transformed, Original values in parentheses), DAT – days after transplanting

Table 2. Weed dry weight at 30 and 60 DAT, and grain and straw yield in rice as influenced by the different treatments

Treatment	Weed dry weight (g/m^2)		Yield (t/ha)	
	30 DAT	60 DAT	Grain	Straw
Manual cono weding at 15 and 30 DAT	5.59 (30.9)	10.69 (114.9)	2.16	2.19
Self propelled cono weeding at 15 and 30 DAT	4.30 (18.1)	11.7 (136.1)	2.26	2.45
Manual cono weeding at 10, 20, 30 and 40 DAT	4.70 (21.8)	8.69 (75.5)	2.19	2.43
Hand weeding at 20 and 40 DAT	1.05 (0.7)	3.07 (9.1)	2.28	2.10
LSD (P=0.05)	0.270	0.651	0.11	0.13

(Values are $\sqrt{x+0.5}$ transformed, original values in parentheses), DAT – days after transplanting

developed self propelled cono-weeder was successfully operated in the rice field and showed effective weed control. This self-propelled cono-weeder has many desirable qualities of a good weeder as listed out by WASSAN (2006), *viz.* simplicity in design as it was manufactured locally, the rugged and sturdy composite of units suitably attached each other, the easiness in operation and the effectiveness in weed control.

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