Original Research Article

Performance evaluation of remote controlled paddy weeder in different soils

ABSTRACT:

Key words: Remote operated paddy weeder, fuel consumption, field capacity,field efficiency missing space after comma

1. INTRODUCTION:

Rice (*Oryza sativa* L.) is India's prominent crop, and is the staple food for most of the Indians. India has the world's largest area under rice cultivation and is one of the largest producers of white rice, accounting for 20 per cent of global production. Even though many improved technologies have been introduced in paddy cultivation, still management of weed is a major concern in paddy cultivation which competes for sunlight, space and nutrients with the main crop and directly responsible for reduction in crop yields due to 10 to 25% weeds and 35 to 45% in direct sowing paddy (Yaduraju 2012). The common type of weeds which affects yield is *Cyperus difformis*, *Marselia quadrifoli, Echinochloa crusgalli etc.,* (Yaduraju,2012). Different manufactures, industries and scientists have developed different types of weeders for both dry and wet land paddy conditions using improved equipment like hand hoe, finger & cono weeders, animal, power tiller and self-propelled weeders for weeding in paddy fields. Major constraints in using above weeders are Chocking of mud, High risk of manoeuvrability, high cost of operation and tedious operation.To overcome above problems and identified research gap, an remote controlled paddy weeder was developed at Dr NTR College of Agricultural Engineering, Bapatla using differential chassis, triangular track wheels, drive system and operating system.The prototype was assembled after fabrication of Axle system, Chassis, weeding system, Driving system and Operating system. The weeding rotors were mounted to chassis frame mounted on the axle of paddy weeder. Triangular track wheels were attached to both side of axle and make them as integrated system. Engine, main gearbox and weeder gearbox was connected and fixed to chassis of weeder. The electronic control system along with linear actuators were connected to mechanical levers which were controlling the brakes, clutches and lifting frames. After connection all electronic systems, it was connected to developed mobile app through Bluetooth module for controlling operation of paddy weeder. The developed remote controlled paddy weeder is as shown in Plate 1 with the following specifications given in Table 1.

Table 1 Specifications of remote-controlled paddy weeder

Particulars	Specifications
Power source	8 HP petrol engine
Number of rows covered	2 No.
Width of each row covered (Adjustable)	225-300 mm
Weight of equipment	250 kg
Operating system	Bluetooth operated Mobile app
Controlling system	Linear actuators
Transmission system	Gear boxes with chain &sprockets
Weeding system	Rotary weeding wheels
Axle system	Differential with triangular track wheels
Cost of fabrication	Rs.1,50,000/-

Plate 1: Front view of developed remote operated paddy weeder

2. MATERIALS & METHODS:

The performance evaluation of weeder was conducted at rotary weeder rotational speed of 160rpm and weeding depth of 50mm in terms of the observations on fuel consumption, field capacity and field efficiency. Weeding operation was carried on 20th day and 40th day after transplanting. Each field test was conducted over a run length of 50m at constant speed and depth in different soils were recorded for all the parameters and each test was replicated thrice to eliminate experimental bias. The data pertaining to different parameters were recorded and performance values were calculated from the field data.

2.1. Speed of operation

The remote-controlled intercultural equipment was operated at a constant forward speed of 0.6 ms^{-1}, since a 150-200mm width working tool in between the rice crop rows (30 cm row spacing) gave minimum crop damage (Qi *et al.*, 2017).

2.2. Fuel consumption

It is measured by top fill method; the fuel tank was filled to full capacity before the testing at levelled surface. After completion of test operation, amount of fuel required to top fill again was the fuel consumption and is expressed in litre per hour.

2.3 Theoretical field capacity

It is calculated from the rated field coverage that would be obtained if the equipment was performing its function at 100 per cent of the time in forward speed and covered 100 per cent of its rated width (Kepner *et al.,* 1978). missing comma

$$F_{CT} = \frac{W_t \times S}{10}$$

Where, F_{CT} =Theoretical field capacity, ha h^{-1}
W_t = Working width, m
S = Forward speed, km h^{-1}

2.4 Effective field capacity

The operational efficiency of the machine, in practical field conditions, is quantified through the concept of "field capacity." This metric encapsulates the actual area covered by the machine, taking into account both the total time consumed and the effective working width. As elucidated by Guru et al. in 2018, field capacity was expressed as the area covered per unit time of operation. In essence, it provides a measure of the machine's real-world performance, considering both time and spatial factors, and serves as a valuable indicator for assessing the productivity and effectiveness of the machine under field conditions. It can be calculated by formula missing comma

$$F_{CE} = \frac{A}{T \times 10000}$$

Where, F_{CE} =Effective field capacity, ha h^{-1}
A = Area covered by weeder, m^2
T = Total time taken, h

2.5 Field efficiency

The Field efficiency is the ratio between the actual or effective field capacity and the theoretical field capacity, as articulated by Sahay in 2017. This ratio was a pivotal metric that quantifies the real world operational efficiency in relation to the maximum potential capacity. Expressed as the actual to theoretical field capacity ratio, it provides insights into the practical utilization and effectiveness of a system in comparison to its idealized capacity. Sahay's delineation of this ratio contributes to a comprehensive understanding of the operational dynamics and efficiency benchmarks in various fields, offering a valuable tool for assessing and optimizing operational performance. It can be calculated by formula,

$$F_E = \frac{F_{CE}}{F_{CT}} \times 100$$

Where, F_E =Field efficiency, %

F_{CE} = Effective field capacity, ha h^{-1}

F_{CT} = Theoretical field capacity, ha h^{-1}

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3. RESULTS AND DISCUSSIONS:

The Remote controlled paddy intercultural equipment was evaluated under sandy, sandy loam and loamy soils in terms of fuel consumption (l/h), field capacity (ha/h) and field efficiency (%).

3.1 Fuel consumption:

The fuel consumption of remote operated paddy weeder operation with optimized values was determined. The fuel consumption observations recorded at 20th and 40th day after transplanting in different soils during weeding operation variations were shown in Fig. 1.

The highest fuel consumption was observed as 2.2l/h when weeder was operated in loamy soil at 40 days after transplanting due to high resistance of soil compared with sandy and sandy loam soils. The lowest fuel consumption was observed as 1.2 l/h when the weeder was operated in sandy soils at 20 days after transplanting in sandy soils due to less resistance from soil.

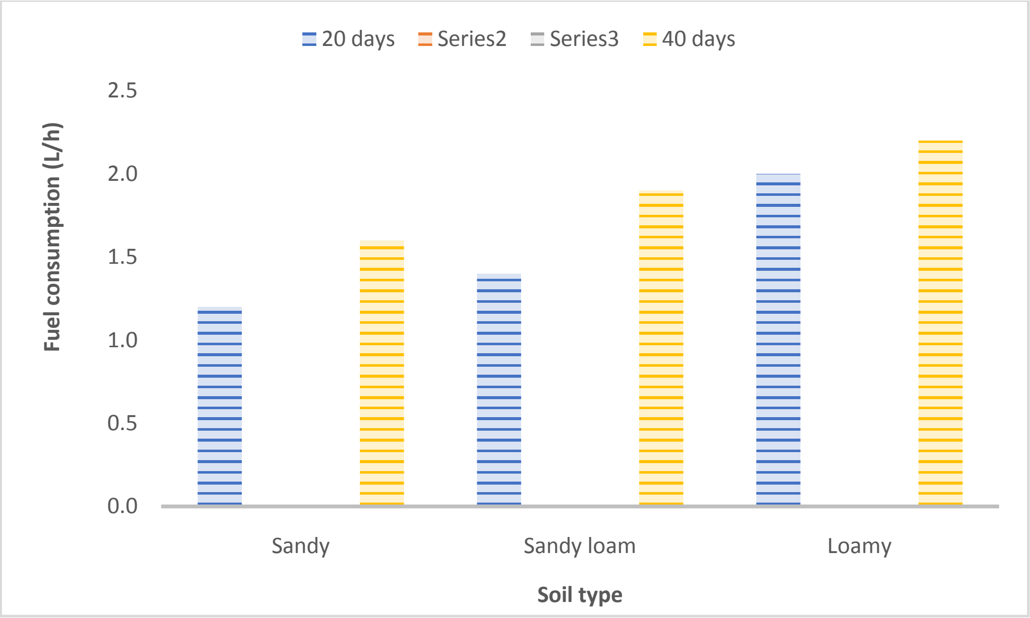

Fig.1 Variation of fuel consumption in different soils for paddy weeder operation

The fuel consumption was increased when operated the paddy weeder from sandy soil to loamy soil due to more resistance to movement and weeding due to high bulk density in sandy loam and loamy soils. It was also observed that fuel consumption was more when the weeder operated at 40 days after transplanting than the weeder operated at 20 days after transplanting in all soils mainly due to more time of operation in increased vegetative growth.

3.2 Field capacity

The field capacity of remote operated paddy weeder operation with optimized values was determined. The field capacity observations recorded at 20th and 40th day after transplanting in different soils during weeding operation variations were shown in Fig. 2.

The highest field capacity was observed as 0.098ha/h when weeder was operated in sandy soil at 20 days after transplanting due to faster operation when compared with sandy loam and loamy soils. The lowest field capacity was observed as 0.076ha/h when the weeder was operated in loamy soils at 40 days after transplanting in loamy soils due to more operation time.

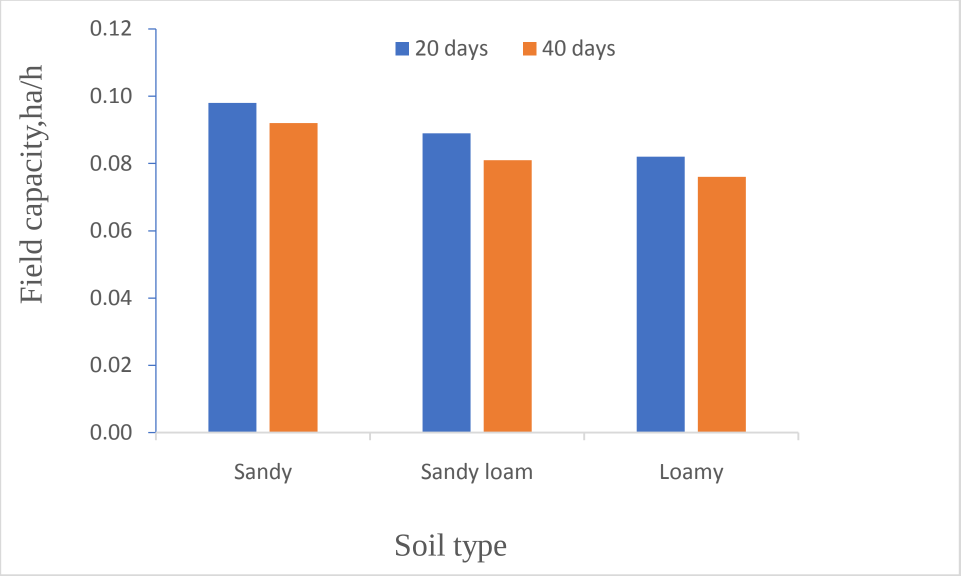

Fig.2 Variation of field capacity in different soils for paddy weeder operation

The field capacity was decreased from sandy soil to loam soil due to more time of operation in loamy soil followed by sandy loam and sandy soils respectively. It was also observed that field capacity was more when the weeder operated at 20 days after transplanting than the weeder operated at 40 days after transplanting in all soils mainly due to less vegetation and faster operation.

3.3 Field efficiency

The field efficiency of remote operated paddy weeder operation with optimized values was determined. The field efficiency observations recorded at 20th and 40th day after transplanting in different soils during weeding operation variations were shown in Fig. 3.

The highest field efficiency was observed as 81.66% when weeder was operated in sandy soil at 20 days after transplanting due to faster operation when compared with sandy loam and loamy soils. The lowest field efficiency was observed as 63.33% when the weeder was operated in loamy soils at 40 days after transplanting in loamy soils due to more operation time.

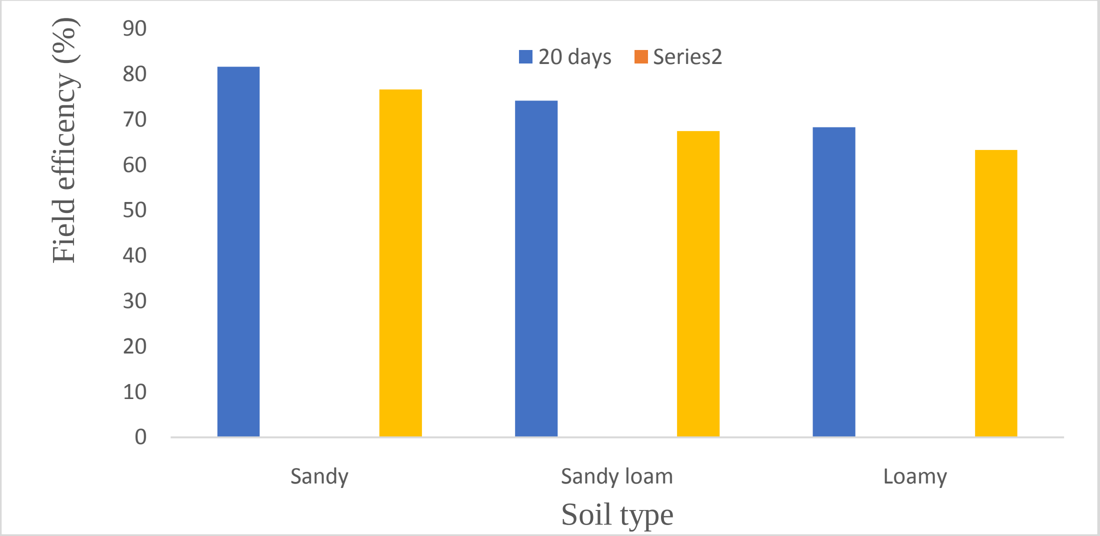

Fig.3 Variation of field efficiency in different soils for paddy weeder operation

The field efficiency was decreased from sandy soil to loamy soil due to more time of operation in loamy soil followed by sandy loam and sandy soils respectively. It was also observed that field efficiency was more when the weeder operated at 20 days after transplanting than the weeder operated at 40 days after transplanting in all soils mainly due to less vegetation and faster operation.

4. CONCLUSIONS:

The highest fuel consumption was observed as 2.2l/h when weeder was operated in loamy soil at 40 days after transplanting and lowest was 1.2 l/h when the weeder was operated in sandy soils at 20 days after transplanting. The highest field capacity was observed as 0.098ha/h when weeder was operated in sandy soil at 20 days after transplanting and lowest as 0.076ha/h when the weeder was operated in loamy soils at 40 days after transplanting. The highest field efficiency was observed as 81.66% when weeder was operated in sandy soil at 20 days after transplanting and the lowest as 63.33% when the weeder was operated in loamy soils at 40 days after transplanting missing period

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