

Research Paper :

Development and performance evaluation of manually pull type two row rice seeder for wet seedbed condition in India

R.S. DEVNANI, N.H. TAYADE, S.K. THAKARE AND J.S. NIKHADE

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ABSTRACT

Two row rice seeder of manually pull type with operator walking backwards was developed and evaluated at the Agricultural Mechanization Division, Central Institute of Agricultural Engineering, Bhopal for sowing of pregerminated seed in wet rice field. The seeder consists of the seed drum, seeder handle, furrow markers, seeder skids, wheels and front end support. The weight of the machine is about 11 kg. Seeder requires only one operator to do the seeding of pregerminated seeds. The work capacity of the seeder varied from 198 m²/h to 353 m²/h. Crop established with a drum seeder resulted in grain yield level from 3.07 t/ha to 4.33 t/ha. The average pull required for operating the machine was 8 kgf. The physiological load on the operator while operating the seeder increased the heart rate from 100 to 135 beats/min for the above field capacity. The seeder is quite simple in design and cost of Rs. 750/- (\$17). The small two row rice seeder is within the physiological load for the operator.

See end of the article for authors' affiliations

Correspondence to:

N.H. TAYADE

Department of Farm Power and Machinery, College of Agriculture Engineering and Technology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

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Rice (*Oryza sativa*) is major crop that is grown in more than 110 countries. The total area planted to rice in India is 42-20 million hectares, which is largest in the world against a total area of 148.40 million hectares. The total rice production of the world was 527 million tones out of which 84.74 million tones were produced in India, second after china's 187 million in an area of 31 million hectares (Survey of Indian Agriculture, 1999). Though India has largest area planted to rice, it is still among the countries with low yield of only 1.9 t/ha in comparison of Egypt (8.3 t/ha) and China's (6.1 t/ha). The yield level of rice has to increase by 25 to 30 per cent from the present level of 1.9 t/ha if the country is to remain self-sufficient by 2010 (Survey of Indian Agriculture, 1999 and 2000). The labour involved in cultivation of rice raising, uprooting, cleaning, transport and transplanting of seedlings is 100-110 man-days/ha. This labour requirement is very intense at the time of transplanting season. Wet paddy seeding can reduce the labour requirement during transplanting season. The direct wet paddy seeding also reduces the water requirements of crop and it saves at least 10 days in the crop growth period. Therefore, direct wet seeding of pre-germinated seed would be very useful for the small rice farmers in eastern and southern India especially in areas of rainfed rice ecosystem.

The wet seeding technology is very simple and can be adopted by the farmers easily. The pre-germinated

seeds are prepared by soaking the paddy seeds for 24 hours in water and after soaking they are incubated for 12 hours till 1 to 2 mm size sprouts are visible. The wet seedbed is prepared by shallow puddling with tractor cage wheel in fully saturated soil and allowed 12 hours with a thin layer of water is good for sowing the pre-germinated rice seed preferably under anaerobic conditions.

Shrivastava and Pawar (1985) and Devnani (2002) reported the use of seeder as superior to broad casting method of raising the rice crop. As rice is mostly raised in the high rainfall areas, the weeds are the main problem that affects the establishment of plants. Thus control of weeds by appropriate chemical means is must and to make use of mechanical weeders, the line sowing of rice seeds will be most desirable compared to broad casting of seeds. Thus, the present day recommendation for the rice farmers is to go for wet seeding of rice as an alternative to the transplanting operation because of reduction in labour requirements, saving of water application and cost of operation etc. even on a small scale of farming. Hence, the study on the design of manually operated rice seeder for wet seeding of pre-germinated seeds, which should be within the physiological work capacity of the farm operator was taken up.

METHODOLOGY

Description of two row rice seeder:

It is a manually pull type two-row rice seeder for

sowing pre-germinated seeds in a puddle, leveled and settled field with a thin layer of water, with operator movement in backward direction. The seeder consisted of the following parts (i) seed drum (ii) seeder handle (iii) furrow markers (iv) seeder skids (v) wheels (vi) front end support is shown in Fig.1. The seed drum was made from aluminum container of 21.5cm diameter with 25 cm length with a seed capacity of 3 kg. A square slot was made at the centre for filling the seeds in the drum. The drum was provided with horizontal slots (10 x 20 mm) at 4.0 cm centre to centre. Thus 17 slots were made for each row. The row distance was 20 cm. The seeder drum was mounted on a 19 mm diameter pipe which acts as axle for the wheels. The seed drum was mounted on the angle iron frame of 30x30x3 mm size angle. Two 50 cm diameter wheels with 25 mm x 40 mm lugs were fitted at the two ends of the drum. The wheels were made 7 cm dia. iron rod and fitted with bushes at the centre and supported with eight spokes.

The two furrow markers of inverted shoe type were mounted at the bottom frame angle at the front. The three

pieces of plastic skids of 5,10,5 cm width were fitted at the base of frame to support weight of seeder. A float type front end piece of 35 cm width was provided to prevent soil build up while pulling the unit. The seeder was provided with a 1.5 m long handle which was pivoted and fitted at the base strip of seeder for easy pulling of the unit and easy turning at the corners of field or sides. The handle can be moved upto bring the unit close to bund or levee. The weight of two row unit was 11 kg. For adjusting the required seed rate the slot opening can be adjusted by the two 20 mm wide steel strips mounted on the cover along the periphery of the seed drum. The slot opening can be set to sow the seeds from 50 to 200 kg/ha. The estimated cost of unit was Rs.750/-. It was fabricated in CIAE Workshop during May 2003. The field performance of model was evaluated in the field at Bhopal during July 2003. The specifications of unit are given in the Table 1.

Calibration of two row rice seeder:

Two row rice seeder was made to drop the seeds

Table 1 : Specification of developed two row rice seeder

Type	Manually pull type (backward movement)	
Make	CIAE Make	
Model	Experimental Model	
Manufacturer's name	Design not released	
Price	Rs.750	
Dimension		
	Length (mm)	1780
	Width(mm)	480
	Height (mm)	840 handle in upright position 1530
	Weight of seeder (kg)	11
Features		
	Drum size (mm)	250 (Aluminium)
	Pre-germinated seed capacity (kg)	2
	Diameter (mm)	215
	No. of rows (mm)	2
	No. of slots per row (mm)	17
	Size of slot (mm)	10x20 horizontal
	Filling seed in drum	Square port with cover provided
	Length of handle (mm)	1500
	Type	Hinged at the base
	Width of handle (mm)	480
Material of construction		
	Drum	Aluminum
	Float	MS sheet and made from plastic chopping board
	Handle	Conduit pipe
	Frame, mm	Angle iron 30x30x3
	Ground wheel	500 mm dia, 7 mm dia rod with 25x40 mm lugs (16 Nos.), 8 spokes.
	No. of operator required	One worker
	Speed of operation (m/min)	20/25 in puddle field

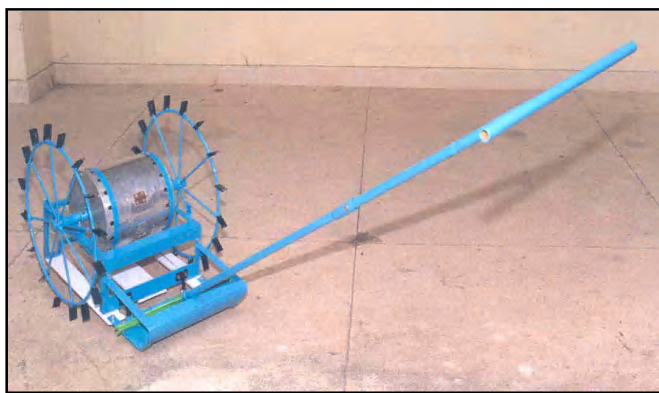


Fig. 1 : Two row rice seeder

along the row. It was noted that even though rice seeder was close to ground still while moving the unit there was dispersal of seeds along the ground. In the model, 17 slots of 10 x 20 mm size at 4.0 cm centre to centre were made for each row. The slot opening was adjustable for which a metal band was wrapped around the drum. The fall of seeds along the rows was checked on the dry pulverized seeds bed and the seed fallen along the rows are shown in the 1 m² frame (Fig.2).

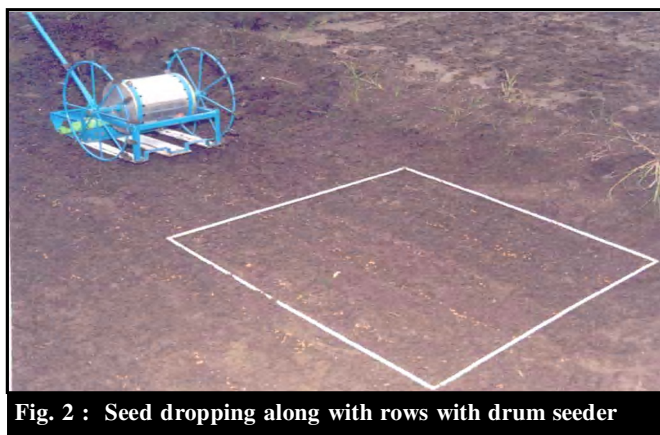


Fig. 2 : Seed dropping along with rows with drum seeder

The wet fields were to be prepared by puddling with tractor with cage wheels or a bullock drawn puddlers but the fields were to be puddled and leveled thoroughly to a shallow depth of 15 cm. The plots were drained of excess water before the sowing operation. The operation of seeder indicated that even though the operator was sinking in the field up to ankle depth put the skids provided on the seeder limited the sinkage of the unit to 2 cm only. The excess soil build up in front of seeder was avoided by slight lift of the front end of unit by the handle. It was also easy to take turns at the corner of fields.

RESULTS AND DISCUSSION

The field trials on the two row rice seeder were

conducted to evaluate its field performance by sowing four varieties of paddy viz., IR-36, Vandana, Krishna Hamsa and Kalinga-III. The field performance of the unit was measured in terms of the ability of the seeder to sow the pregerminated seeds in the field at different seed rates, the area covered by the seeder in unit time. The pull required to operate the machine and the physiological load on the operator.

The two row rice seeder evaluated during 2003 was used to sow the pregerminated seeds of four varieties with seed rate varying from 130 to 217 kg/ha of wet pregerminate seeds and field capacity varied from 198 to 353 sqm/h (Table 2). Also the plant emergence varied from 48 per meter row length to 105 plants per meter indicating the excellent performance of sowing the seeder in wet field. (Table 3)

The crop stand of the four varieties sown at Bhopal after 52 to 56 days of sowing was excellent. All the four varieties sown were raised nicely and well (Fig. 3). The performance of seeder was very good from the point of crop stand, field coverage, ease of operation, ease of setting or adjusting the seed rate etc. The sinkage of seeder was within 2 cm of soil depth. There was no problem of soil accumulation etc., in field plots.

From Table 4 it is noted that yield of paddy from the plots sown with two row manually pull type developed seeder for IR-36 and Kalinga-III were close to the range of 4 tons/ha. The yield of variety Krishna Hamsa achieved was 3.072 to 3.770 tons/ha and for the Vandana yield level was 2.57 tons/ha. The crop condition of Vandana at the time of harvest was affected due to lodging effect. This was due to good and well distributed rainfall received during the season. On the whole it was concluded that the performance of the developed two row rice seeder was excellent based upon the yield of crop obtained in the field. The rice seeder with pregerminated seed when operated by the worker in the field by walking in backward direction resulted in the speed of 1.2 to 1.3 km/h (Table 5).

Table 6 shows the force required to pull the unit was 6 to 10 kgf. It was easy to take turn at the end of fields corners due to provision of pivoted handle. The heart beat rate of the operator was measured to assess the physiological load on the operator. The heart beat rate was measured before the seeding operation and after the plot was completed. The observations were taken on one operator and heart beat rate data expressed as beats per minute are shown in Table 7. The heart beat rate was minimum of 100 beats/min to maximum of 135 beats/min while working with seeder and covering the area 198 m² to 353 m² in one hour duration. Thus the value of heart

Table 2 : Plot wise performance data of drum seeder trails

Plot I		Plot II	
Date of sowing	July 8, 2003	Date of sowing	July 8, 2003
Variety	IR-36	Variety	IR-36
Area (m ²)	190.12	Area (m ²)	184.24
Slot opening (mm)	12	Slot opening (mm)	12
Seed sown (kg)	4	Seed sown (kg)	4
Seed rate (kg/ha)	210	Seed rate (kg/ha)	217
Time taken for sowing (min)	46	Time taken for sowing (min)	52
Soil moisture, % (wb)	37	Soil moisture, % (wb)	35
Field capacity (m ² /h)	248	Field capacity (m ² /h)	212
Plot III		Plot IV	
Date of sowing	July 2, 2003	Date of sowing	July 2, 2003
Variety	Vandana	Variety	Vandana
Area (m ²)	185	Area (m ²)	175.6
Slot opening (mm)	11	Slot opening (mm)	11
Seed sown (kg)	2.4	Seed sown (kg)	2.3
Seed rate (kg/ha)	131	Seed rate (kg/ha)	131
Time taken for sowing (min)	50	Time taken for sowing (min)	50
Soil moisture, % (wb)	38	Soil moisture, % (wb)	36
Field capacity (m ² /h)	221	Field capacity (m ² /h)	211
Plot V		Plot VI	
Date of sowing	July 4, 2003	Date of sowing	July 4, 2003
Variety	Krishna Hamsa	Variety	Krishna Hamsa
Area (m ²)	188	Area (m ²)	176.5
Slot opening (mm)	11	Slot opening (mm)	11
Seed sown (kg)	2.4	Seed sown (kg)	2.3
Seed rate (kg/ha)	127.5	Seed rate (kg/ha)	130.28
Time taken for sowing (min)	50	Time taken for sowing (min)	30
Soil moisture, % (wb)	NA	Soil moisture, % (wb)	NA
Field capacity (m ² /h)	225	Field capacity (m ² /h)	353
Plot VII		Plot VIII	
Date of sowing	July 10, 2003	Date of sowing	July 11, 2003
Variety	Kalinga-III	Variety	Kalinga-III
Area (m ²)	198.85	Area (m ²)	196.8
Slot opening (mm)	11	Slot opening (mm)	12
Seed sown (kg)	2.5	Seed sown (kg)	3.1*
Seed rate (kg/ha)	125.7	Seed rate (kg/ha)	157.5
Time taken for sowing (min)	60	Time taken for sowing (min)	50
Soil moisture, % (wb)	40	Soil moisture, % (wb)	38
Field capacity (m ² /h)	198.8	Field capacity (m ² /h)	236
Weight of 100 seeds (g) (pre-germinated)	3.5	*Sown after storing for 24 h in refrigerator	

Table 3 : Plant stand observed in test plot sown with seeder after 14 to 20 days of sowing

Plot I	Plot II
Paddy variety IR-36	Paddy variety IR-36
Average plant stand-105/m row length	Average plant stand-96/m row length
Plot III	Plot IV
Paddy variety Vandana	Paddy variety Vandana
Average plant stand-57/m row length	Average plant stand-61/m row length
Plot V	Plot VI
Paddy variety Krishna Hamsa	Paddy variety Krishna Hamsa
Average plant stand-48/m row length	Average plant stand-61/m row length
Plot VII	Plot VIII
Paddy variety Kalinga-III	Paddy variety Kalinga-III
Average plant stand-76/m row length	Average plant stand-84/m row length

Table 4 : Crop yield data obtained from the test plots 2003

Plot No.	Variety	Average yield/m ² , at moisture content		Yield calculated in kg/ha @ 10% m.c. (db)
		dry basis (%)		
Plot-I	IR-36	508	(29)	4330
Plot-II	IR-36	438	(26)	3823
Plot-III	Vandana	262	(12)	2573
Plot-IV	Vandana	324	(16)	3072
Plot-V	Krishna Hamsa	421	(25)	3700
Plot-VI	Krishna Hamsa	432	(26)	3770
Plot-VII	Kalinga-III	480	(28)	4125
Plot-VIII	Kalinga-III	444	(22)	4003

Table 5 : Measurement of the walking speed of the operator with rice seeder

Sr. No.	Distance traveled (m)	Time taken (min)		Walking Speed (m/min)	
1	11.40	0.66	0.58	19.65	19.65
2	11.40	0.50	0.50	22.80	22.80
3	11.40	0.58	0.46	19.65	24.78
4	11.40	0.50	0.53	22.80	21.50
5	11.40	0.55	0.52	20.72	21.92
Average	Speed			20.64 m/min	22.13 m/min
Average	Speed			1.24 km/h	1.32 km/h

Table 6 : Observation for measurement of pull for operating the two row rice seeder in test plots

Sr. No.	1	2	3	4	5	6	7	Average
Pull kg	10.0	7.5	6.5	9.0	6.0	7.5	8.5	8.0

Table 7 : Observation for measurement of heart beat rate of the operator after completing the plots

Sr. No.	1	2	3	4	5	6	7	8
Heart rate, beat/min	125	107	112	105	114	135	100	119
Capacity, m ²	248	212	221	211	225	353	198	236

beat varied from 100-135 beats/min was less than the 154 to 163 beats/min reported for seeding with manual seeder in wet land (Nag and Dutt, 1980). Thus, it can be

said that the developed seeder is within physiological load condition of the Indian operators.



Fig. 3 : The crop raised by two row rice seeder

Conclusion:

A light weight ,simple and easy to operate, low cost, two row rice seeder of manually pull type with operator walking backwards has been developed for sowing of the pregerminated seed in wet rice field conditions. The unit requires only one operator to do the seeding of pregerminated seeds. Operator was able to cover an area 198 m²/h to 353 m²/h. The plant establishment for the four different varieties was very good, varying from 250 to 505 per m² for seed rate 130 to 217 kg/ha. A uniformly prepared leveled and puddle seedbed with little of surface water is required for efficient operation. The physiological load on the operator while operating the two row seeder increased the heart beat rate from minimum of 100 beats/min to maximum of 135 beats/min. The unit is recommended for sowing of the pregerminated seeds in small plots along the rows as line sowing. The plant establishment with the seeder was very good in the test plots for the seed rate sown with seeder. It was concluded that for manually operated seeder the average walking

speed was 1.2 to 1.3 km/h and the average pull required for operating the machine was 8 kgf.

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Authors' affiliations:

R.S. DEVNANI, Central Institute of Agricultural Engineering, BHOPAL (M.P.) INDIA

S.K. THAKARE, Department of Farm Power and Machinery, College of Agricultural Engineering and Technology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, AKOLA (M.S.) INDIA

J.S. NIKHADE, Faculty of Agricultural Engineering, Indira Gandhi Agriculture University, RAIPUR (C.G.) INDIA

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