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PERFORMANCE OF NO-TILL DRILL FOR ESTABLISHMENT OF RICE AND ITS COMPARISON WITH DRUM SEEDER AND CONVENTIONAL METHOD

T.P. Singh

Department of Farm Machinery and Power Engineering
College of Technology
G.B. Pant University of Agriculture & Technology
Pantnagar – 263 145, U S Nagar, Uttarakhand, INDIA

K e y w o r d s: rice seeding methods, rice production economic analysis, no-till drill.

A b s t r a c t

In Tarai region of state of Uttaranchal, mainly contractual laborers are engaged for accomplishing rice transplanting, which is very tedious and labor intensive operation. Also they do not maintain required plant population resulting in poor yield. Shortage of agricultural laborers during the peak transplanting season is often faced by the farmers due to which timely transplanting is jeopardized again contributing to lower field. Direct seeding of dry or pre-germinated rice through suitable machineries could be a solution to this problem. This will not only reduce labor and production cost but also increases turn-a-round time for the subsequent crop. Considering the above facts, an experiment was laid down during 2001 and 2002 to evaluate the performance of Pantangar zero-till ferti-seed drill (T_1) for establishment of rice and the result was compared with manually operated rice seeder (T_2) and conventional method of transplanting (T_3). The experimental results indicate higher plant population with no-till drill as compared to rice seeder and transplanting method. The grain yield was recorded maximum for T_1 followed by T_2 and T_3. The economic analysis shows lower cost of production and higher benefit-cost ratio in order. Based on the result, no-till drilling and drum seeding could be recommended to the farmers in labor scarcity area for establishment of rice.

WYDAJNOŚĆ SIEWU BEZPOŚREDNIEGO RYŻU W PORÓWNANIU Z SIEWEM METODĄ KONWENCJONALNĄ I SIEWNIKIEM BĘBNOWYM

T.P. Singh

Katedra Maszyn Rolniczych i Energetyki Przemysłowej
Wydział Technologii
Uniwersytet Rolniczo-Technologiczny G. B. Pant
Pantnagar – 263 145, U S Nagar, Uttarakhand, INDIE

S ł o w a k l u c z o w e: metody siewu ryżu, ekonomiczna analiza produkcji ryżu, siew bezpośredni.

Abstrakt

W regionie Tarai stanu Uttaranchal pracownicy kontraktowi są zatrudniani głównie do przesadzania ryżu, operacji bardzo żmudnej i pracochłonnej. Liczba pracowników nie jest wystarczająca do utrzymywania odpowiedniej wielkości zasiewów, powoduje to niezachowanie właściwych terminów przesadzania i niski plon. Siew bezpośredni suchego lub kiełkowego ryżu przeznaczonymi do tego maszynami może być rozwiązaniem tego problemu. Stosowanie go zmniejsza zapotrzebowanie na pracowników i koszt produkcji, daje więcej czasu na kolejną uprawę. Biorąc to pod uwagę, w latach 2001 i 2002 przeprowadzono eksperyment, by sprawdzić wydajność siewnika bezpośredniego „Pantangar" (T_1) w uprawie ryżu i porównać rezultaty z wynikami siewu siewnikiem ręcznie sterowanym (T_2) i konwencjonalną metodą przesadzania (T_3). Wyniki wskazują na to, że wyższy plon jest osiągany po siewie siewnikiem bezpośrednim niż dwoma pozostałymi metodami. Maksimum plonu osiągnięto dla T_1, a potem kolejno dla T_2 i T_3. Analiza ekonomiczna wykazuje niższy koszt produkcji oraz lepszy bilans zysków i kosztów. Na tej podstawie można powiedzieć, że dla rolników borykających się z brakiem rąk do pracy w uprawie ryżu jest zalecany siew bezpośredni lub siewnikami bębnowymi.

Introduction

Rice is the staple food of more than 70 percent of the world's population. The rice belt is distributed geographically over a wide range of conditions between 45°N to 40°S latitudes. However 90 percent of total area under rice is situated in the wet tropical South and South East Asia. China is believed to be the origin of rice. Among the rice growing countries, India has the largest area under rice in the world, accounting for about 31 percent of the total area under rice cultivation producing about 80 million tons of rice annually.

Broadly there are three methods of growing rice. Firstly, direct seeding either manually or with traditional drills in well-prepared seedbed. A smooth, level seedbed is necessary to ensure that seeds are not planted at depths greater than 10 to 15 mm. Sowing is considered at the correct depth when five to ten percent of the seed is visible on the surface after sowing. The benefit of drilling the seed is that fertilizer can be applied at the same time as the seed. Also manual weeding is much easier in machine-drilled crops than in broadcasted crops.

The second method is to sow pre-soaked sprouted seed (soaked for twenty four hours and incubated for forty-eight hours), at 80 to 100 kg/ha, with the help of rice seeder in puddle soil. It has been reported that this method reduces labor hours by 69 percent (183 to 57 h/ha) and production cost by 59 percent that is mainly due to reduced labor requirement in seedling raising and seeding operations. However, weeding and water management efforts in the paddy field increases. The advantage is that direct-seeded crop matures seven to ten days earlier than the transplanted rice as the seedlings are not subjected to stress such as being pulled from the soil and reestablishing fine rootlets. This provides more turn-a-round time available for the next crop. However, it has

disadvantages also like the seeds are exposed to birds, rats, and snails. There is greater crop-weed competition being of similar age and plants tend to lodge more because of less root anchorage.

The third and most widely adopted method of growing rice is transplanting method. It is preferred over other two methods with the reason that this method gives better yield and there is less weed infestation. In the Tarai region of Uttaranchal, hired/contractual labourers mainly accomplish transplanting of rice. This method is very tedious and labour intensive operation. Approximately, more than 25 percent of the total working hours for rice production are spent for the process of transplanting and raising nursery (KHAN et at. 1989). The average plant population of manually transplanted rice has been reported much less than the required one (KHAN et al. 1979).

Often the farmers face the problem of shortage of labours during the peak transplanting season due to which timely rice transplanting is jeopardized. It has been reported that delay in transplanting by one and two months has a yield reduction of about 25 to 70 percent, respectively (RAO, PRADHAN 1973). Due to late transplanting the turn-around time available for the next crop is very small which again affects the yield of the subsequent crop.

Considering the above facts and advantages of direct sowing an experiment was conducted to evaluate the performance of Pantnagar zero-till ferti-seed drill and drum seeder for establishment of direct seeded rice (dry and pre-germinated) and its comparison with traditional method of transplanting as well as economics.

Materials and Method

Pantnagar no-till ferti-seed drill

Pantnagar no-till Ferti-Seed Drill with inverted-T type furrow opener, generally used for direct seeding of wheat in no-till condition, was used for sowing dry rice seed in well prepared seedbed. This ferti-seed drill can be used in well prepared soil as well without any modification. Precaution should be taken to adjust the seeding depth while sowing in friable soil. The position of leaf provided in seed metering device should be adjusted to lower most position for seeding rice.

Rice seeder

A manually operated 8-row rice seeder was used for sowing the pre-germinated rice seed in puddled bed. The machine has four cylindrical hollow

drums with peripheral opening at both the ends to give eight rows with a line spacing of 200 mm. Two lug wheels are fitted to support the weight of the seeder as well as to rotate the circular drum. A handle is provided to drag the machine in the field. A furrow opener under each perforated line of the drum is provided to open a shallow furrow for placement of seed into the puddle soil. The total weight of the machine is about 15 kg. The technical detail of the rice seeder is given in Table 1.

Table 1

Technical specifications of manually operated rice drum seeder

Particulars	Dimensions
Number of drum	4
Length of drum, mm	275
Diameter of drum, mm	145
Diameter of hole, mm	8.6
Number of holes	36
Number of rows	8
Row spacing, mm	200
Size of opening in drum, mm	115 x 85
Shape of the opening	rectangular
Length of handle, mm	900
Material of handle	GI Pipe
Diameter of pipe for handle, mm	21
Diameter of drive wheel, mm	390

Calibration of drill and rice seeder

Before actual sowing operation, the Pantnagar zero-till ferti-seed drill was calibrated for correct seed rate by keeping the leaf position in the seed metering device at the lower most position to facilitate the free flow of rice seed without breakage. The calibration of the drill was done as per the standard test procedure. However, there was no provision to adjust the seed rate in case of rice drum seeder. The seed rate was kept at 60 kg/ha for dry and pre-germinated rice seeding whereas it was 40 kg/ha for transplanting.

Experimental field

The field investigation was carried out for growing rice, by all the three methods, at Crop Research Center of the university continuously in the same filed for two years. The texture of the soil is silty – clay ~ loam (sand 8.8%, silt

61.4% and clay 29.7%). The average bulk density of the soil is 1.44 g/cc with organic matter content as 3.4%. The hydraulic conductivity of soil is 0.648 mm/h. The previous crop sown was wheat.

Field preparation

The field was prepared using two operations of rotavator for direct seeding of rice. The depth of operation was kept shallow (about 10 cm). The seeding operation was performed with the help of Pantnagar no-till ferti-seed drill.

For seeding pre-germinated rice, the field was prepared again by using two operations of rotavator and then it was flooded with irrigation water. The shallow, weed free and leveled puddled bed was created by using peg type puddler. After puddling operation, the sprouted seed was sown with the help of drum seeder after allowing 24 hours sedimentation period.

In conventional method of transplanting, the puddled bed was prepared in similar way as it was done for pre-germinated rice. The transplanting was performed by manual labour on contract basis.

After sowing/transplanting operation, all the cultural practices in respect of weeding, chemical application, fertilizer application and plant protection etc was done similar in all the plots as per the agronomical requirement.

Treatments

The treatments for this experiment were as under:

T_1 – Direct seeding of dry rice – By zero-till ferti-seed drill

T_2 – Direct sowing of sprouted rice – By manually operated rice seeder, and

T_3 – Rice transplanting – By conventional method – control

The number of replication was kept three with total nine experiments. The plot size was kept 30 x 6 m.

Results and Discussion

The various machine and crop parameters noted during the experimentation period have been discussed as under:

Calibration result of seed drill

The calibration test was performed in the laboratory for Pantnagar zero-till ferti-seed drill for sowing dry rice at a seed rate of 60 kg/ha and the results have been presented in Table 2. It is clear from the table that the drill could deliver 61.30 kg/ha of seed at an exposure length of 7.64 mm. The seed rate was kept slightly higher (about 2 percent) than the desired rate of 60 kg/ha to accommodate positive slip. The visible grain damage was also determined and the same was found as 3.16 percent which was well within the acceptable range. The co-efficient of variation was found as 8.40.

Table 2

Calibration result of Pantnagar no-till ferti-seed drill for rice

Replication	Exposure length (mm)	Weight of seed dropped (g)	Seed rate (kg/ha)	Visible gram damage (%)	Coefficient of variation
1.	7.64	272	63.29	2.38	9.30
2.	7.64	263	61.20	3.80	9.79
3.	7.64	264	61.21	3.80	7.41
4.	7.64	258	60.27	2.71	7.99
5	7.64	260	60.51	3.11	7.51
Average	7.64	263.4	61.30	3.16	8.40

Performance of Pantnagar zero-till drill and drum seeder

The performance of Pantnagar zero-till ferti-seed drill and rice drum seeder was determined in actual field condition and the results so obtained have been presented in Table 3. The actual speed of operation was found about

Table 3

Performance results of Pantnagar no-till ferti-seed drill and manually operated rice drum seeder

Parameter	Pantnagar no-till ferti-seed- drill	Manually operated rice drum seeder
Crop	rice	rice
Soil condition	friable	puddled
Speed of operation, km/h	5.18	1.50
Field capacity, ha/h	0.50	0.13
Field efficiency, %	80	62
Cost of machine, Rs	12600 (USD 280)	2500 (USD 55.56)
Cost of operation, Rs/ha	500 (USD11.11)	300 (USD 6.67)
Labor requirement, man- h/ha	4-6	15-20

5.18 km/h for Pantnagar no-till ferti-seed drill where as it was 1.50 m/h for manually operated rice drum seeder. The data indicates that an area of about 0.50 and 0.13 ha/h could be covered with the no-till ferti-seed drill and drum seeder with observed field efficiency of 80 and 62 percent, respectively. The cost of operation was found higher, Rs 500/- per ha, for seed drill compared to Rs 300/- per ha for rice drum seeder. However, no difficulty was encountered in sowing dry and pre-germinated rice with both the equipment. The Pantnagar zero-till ferti-seed drill required no modification for sowing dry rice.

Crop yield and its attributing parameters

Number of tillers per meter

The number of tillers per meter length was recorded at the time of maturity of the crop and the pooled data for both (First and second) years have been presented in Table 4. The data shows higher number of tillers (340) per square meter for treatment T_1 where as it was only 318 and 279 for drum seeded and transplanted rice. The higher number of tillers in case of drilled rice (T_1) may be due to the reason that in case of drilling continuous dropping of grain takes place instead of hill sowing. Incase of drum seeding (T_2) the seeds do not drop individually in line but the grain drops in hills at uneven spacing. The reason for lowest number of tillers in case of manual transplanting (T_3) may be due to the fact that the contractual labour does not plant the nursery at required spacing and they want to cover more area within the available time. This indicates that the higher plant population could be maintained with no-till drill as compared to rice sown by drum seeder and transplanting method.

Table 4

Crop performance (average of two years pooled data)

Treatments	Number of tillers/sq (m)	Plant height (cm)	Panicle length (cm)	Grain yield t/ha (d.b.)	Straw-grain ratio
Drilling of dry rice (T_1)	340	108.10	29.40	7.82	1.78
Drum seeding of sprouted rice (T_2)	318	102.30	29.20	7.28	1.77
Manual transplanting (T_3) – Control	279	100.10	21.60	5.97	1.65
CD CV	3.799760 0.5389316	1.181826 0.5058353	0.06445955 0.1095463	0.1260482 0.6515567	0.03462295 0.8848665

Plant height

The plant height was also measured at the time of crop maturity and it was found higher in T_1 (108.10 cm) over T_2 (102.30 cm) and T_3 (100.10 cm) respectively. The reason of lower plant height in case pf treatment T_3 may be that plant takes more time to recover itself after being uprooted for transplanting.

Panicle length

The panicle length of the crop measured at the time of harvest has been presented in Table 4. It was found as 29.40 cm in T_1, 29.20 cm in T_2 and 21.60 cm in treatment T_3. This indicates that the panicle length do not vary much in case of treatment T_1 and T_2 however it was found less in transplanted rice which may be due to the reason explained earlier.

Grain yield and straw-grain ratio

The grain yield and straw-grain ratio was determined and has been presented in Table 4. The data shows maximum grain yield (7.82 t/ha) for the rice sown by zero-till drill (T_1) followed by 7.28 t/ha with drum seeder (T_2) and 5.97 t/ha in transplanted rice. The reason for higher yield incase of treatments T_1 and T_2 may be due to higher number of tillers, height of crop and panicle length as compared to transplanted rice (T_3). The straw-grain ratio was also found higher, 1.78 and 1.77, for treatments T_1 and T_2, respectively as compared to transplanted rice (T_3) as 1.65.

Economics of direct seeded rice

The economics of establishing rice crop by all the three methods as discussed earlier was determined and has been presented in Table 5. The cost of production was found lower in case of drilled rice (T_1) as Rs. 10020.00 (USD 222.67) per ha followed by Rs. 11424.50 (USD 253.88) in pre-germinated rice sown by drum seeder (T_2). The highest cost of production of Rs. 12587.50 (USD 279.72) per ha was found for transplanted rice. The specific cost of production also followed the similar trend. The benefit-cost ratio was found higher (3.99) for direct seeded rice (T_1) as compared to 3.07 for sprouted rice (T_2) and 2.00 for transplanted rice (T_3). This indicates that the direct seeded

rice is more beneficial to the farmers as compared to other two methods of establishing rice.

Table 5

Economics of direct seeded rice

Parameters	Rice establishing method		
	drilled rice by no-till drill	drum seeded rice	manually transplanted rice
Field condition	friable	puddled	puddled
Seed rate, kg/ha	60	60	40
Equipment used	no-till drill	manually operated drum seeder	manually
Grain yield, t/ha	7.82	7.28	5.97
Straw yield, t/ha	13.92	12.89	9.85
Total cost of production, Rs/ha	10020 (USD 222.67)	11424.50 (USD 253.88)	12587.50 (USD 279.72)
Total output, Rs/ha	49970 (USD 1110.44)	46485 (USD 1033)	37760 (USD 839.11)
Net saving, Rs/ha	39950 (USD 887.78)	35060.5 (USD 779.12)	25172.5 (USD 559.39)
Benefit-cost ratio	3.99	3.07	2.00
Specific cost of production, Rs/kg	1.28	1.57	2.11

Cost of grain = Rs 5.50 per kg and cost of straw = Rs 0.50 per kg was taken for determining the costs, 1 USD = 45 INR

Conclusions

Based on the experimental results following conclusions can be drawn.

The sowing of dry rice is feasible with Pantnagar no-till drill without any modification in its metering device. The visible mechanical grain damage was found only 3.16 percent.

The field capacity of the drill and manually operated drum seeder was found as 0.53 and 0.13 ha/h with an observed field efficiency of 80 and 62 percent respectively.

The plant population was found higher in dry seeded drilled rice followed by pre-germinated rice sown by drum seeder and transplanted rice. The yield was also found to follow the similar pattern.

The cultivation of direct and sprouted seeded rice was found to be economical over conventional method of transplanting rice.

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