AATCC Review

28 February 2024: Received
06 April 2024: Revised
30 April 2024: Accepted
15 June 2024: Available Online

www.aatcc.peerjournals.net

Research Article

Open Access

Studies on Energetics of Drum Seed Rabi Rice in Relation to Weed Management Practices and Nitrogen Levels

K. Preethika Reddy[*1], K. P. Vani[2], M. Madhavi[3], G. Jayasree[3] and D. Saida Naik[5]

[1]Telangana Social Welfare Residential Agricultural College, Jagtial, Telangana, India-505326
[2]Agricultural College, Professor Jayashanker Telangana State Agricultural University, Sircilla, Telangana, India-505405
[3]College of Agriculture, Professor Jayashanker Telangana State Agricultural University, Hyderabad, Telangana, India-500030
[5]Agricultural College, Professor Jayashanker Telangana State Agricultural University, Jagtial, Telangana, India-505529

ABSTRACT

With the increasing cost of labor and water shortage, the farmers are forced to look for substitute to present existing transplanting system of cultivation to drum seeded rice, where labor need is reduced by more than 20% but, weed infestation and low nitrogen use efficiency are the major problems. Because of the above problems a field experiment was conducted at the College of Agriculture, Rajendranagar, Hyderabad, during Rabi 2020-21 and 2021-22 to study the effect of nitrogen levels and weed management practices on drum-seeded rice. The field trial consisted of 16 treatments with four weed management practices and four nitrogen levels laid out in a factorial randomized block design. During both years, out of all weed practices, energy indices were found to be higher with Pretilachlor 6% + Pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} as pre-emergence followed by mechanical weeding at 25 and 50 DAS (W_4) at par with Pretilachlor 6% + Pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} as pre-emergence followed by penoxsulam 1.02% + cyhalofop butyl 5.1% OD 120 g ha^{-1} as post-emergence (W_2). Among nitrogen levels, 125% RDN (N_4) which was statistically comparable with 100% RDN (N_3) registered higher.

Keywords: *cost of cultivation, drum-seeded rice, energy equivalent, energy use efficiency, energy productivity, grain yield, pre-emergence (PE), post-emergence (POE)*

INTRODUCTION

Rice is an important source of food for more than 60% of the world's population, and it plays an important role in food security and livelihood for almost every household. Rice is grown on 161 million hectares in over 100 countries worldwide, with Asia producing and consuming 90% of the world's rice **[1].** India has the largest paddy cultivating area (43.7 million ha) and is the second largest producer (118.9 million tons) with a productivity of 2722 kg ha^{-1} **[2]**. For millennia, rice has been grown under puddled transplanted conditions, which requires huge water (1000-2000 mm) for puddling and continuous flooding, high energy (5630-8448 MJ ha^{-1}) and 15-20% more labor, making it unaffordable for small and marginal farmers **[3].** In recent years, due to the untimely availability of water, coupled with the scarcity of labor during peak periods, growers in many Asian countries having shifted from TPR to drum-seeded rice to combat these problems as it is less labor-intensive which requires only 4-5 labor ha^{-1} and eliminates nursery raising and transplanting operations **[4].** Crop matures in 7 to 10 days earlier, saves water of 11-18% and 20% of total labor requirement, reducing production costs by 40%, and increasing productivity and profits by 8 and 56% compared to transplanted rice **[5].** But the major constraints for drum-seeded rice are severe weed competition and low nitrogen use efficiency.

Corresponding Author: **K. Preethika Reddy*

DOI: https://doi.org/10.58321/AATCCReview.2024.12.02.103

Studies on drum-seeded rice indicated that any delay in weeding leads to uncontrolled weeds, reducing yield by 50-60% **[6].** Manual weeding is very common in India, which is an environmemt-friendly and effective method of weed control, but because of its unavailability and high price of labor, this method will become expensive in the near future. Therefore, the use of herbicides controls weeds from the beginning, giving good crop growth and competitive superiority over weeds **[7].** But continuous use of the same herbicides makes weed flora persistent perennials and builds up herbicide resistance and herbicide residues in soil and consumable products. It was also found that, even after the application of pre and post-emergence herbicides, it was not enough to achieve adequate weed control **[8].** Therefore, an integrated weed management approach is needed. One of the components of an integrated weed management approach is to increase the competitive ability of crops with weeds by using optimal fertilizer management **[9].**
Nitrogen is the kingpin in any fertilizer management program for rice, and it is the most widely used nutrient. It was observed that nitrogen fertilizer has a profound effect on growth and 70-80% increase in yield **[10].** Insufficient and inappropriate fertilizer nitrogen management in wet drum-seeded rice may account for one-half to two-thirds of the gap between actual and potential yields **[11].** Nitrogen plays a significant role in the competitive balance between weeds and crops and favors their total biomass production **[12].** Nitrogen increases the competitive ability of some weed species, which are more N-responsive than crops; therefore, the addition of nitrogen fertilizer can sometimes reduce crop yield **[13].** However, studies also reported that nitrogen fertilizer application favored crops more than weeds. Therefore, it is not always true that, in the presence of weeds, a higher nitrogen rate will be more

beneficial for crops or weeds, and the response depends on several factors such as population density and the crop and weed species. Hence, it is essential to identify an effective method of controlling weeds with an appropriate level of nitrogen fertilizer, especially for the drum seeding method. Very limited work has been conducted on weed and nitrogen management in direct wet seeded rice through drum seeder. Keeping this in mind the present study is planned.

MATERIAL AND METHODS

A field experiment was conducted during the *rabi* seasons of 2020-21 and 2021-22 at College Farm, College of Agriculture, Rajendranagar. The soil of the experimental field was loamy sand in texture with a pH of 8.17, low in organic matter (0.37%) and available nitrogen (236 kg ha^{-1}), medium in available phosphorous (31.3 kg ha^{-1}), and high in available potassium (419.6 kg ha^{-1}). The experiment comprised of 16 treatments which was laid out in factorial randomized block design having four weed management practices *viz.,* W_1: Unweeded (control), W_2: Pretilachlor 6% + pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} as PE fb penoxsulam 1.02% + cyhalofop butyl 5.1% OD 120 g ha^{-1} as POE, W_3: Pyrazosulfuron-ethyl 70% WDG 21 g ha^{-1} as PE fb penoxsulam 1.02% + cyhalofop butyl 5.1 % OD 120 g ha^{-1} as POE, W_4: Pretilachlor 6% + pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} as PE fb mechanical weeding at 25 and 50 DAS and four nitrogen levels as Factor II (F2) viz., N_1-No nitrogen (control), N_2-75 % RDN (112.5 kg N ha^{-1}), N_3-100 % RDN (150 kg N ha^{-1}), N_4-125 % RDN (187.5 kg N ha^{-1}) replicated thrice. The rice variety JGL 24423 was sown with the help of a drum seeder spacing of 20 cm and a seed rate of 35 kg ha^{-1}. The recommended fertilizer dose of 60 kg P_2O_5 was applied to all the plots as a basal dose in the form of single superphosphate and 40 kg ha^{-1} K_2O in two equal splits, *viz.,* as basal at sowing and panicle initiation stage in the form of muriate of potash. Nitrogen was applied in the form of urea as per treatments in three equal splits, *viz.,* as basal dose, tillering, and panicle initiation stage. Pre-emergence herbicides, *viz.,* pretilachlor 6% + pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} (ready mix) and pyrazosulfuron-ethyl 70% WDG 21 g ha^{-1} were applied by mixing with sand at 3 DAS in the respective treatments. Post-emergence herbicide, *i.e.,* penoxsulum 1.02% + cyhalofop butyl 5.1% OD 120 g ha^{-1} (ready mix) was sprayed at 2-3 leaf stage of weeds. Two mechanical weedings were done at 25 and 50 days after sowing (DAS) with the help of a conoweeder with a spacing of 20 cm.

The cost of cultivation was calculated by considering the prevailing charges of agricultural operations and the market price of the inputs involved. The energy input was calculated by the summation of the energy requirements for labor, farm machinery, seed, fertilizers, and irrigation used in the system and expressed in MJ ha^{-1}. The addition of energy equivalents for all inputs used in the system is represented in Table 1. The gross output energy was calculated by multiplying the energy equivalents with their respective grain and straw yields. Energy intensity in economic terms was calculated by considering the cost of cultivation, as presented in Table 2. The analysis procedure as suggested by Gomez and Gomez, 1984 **[14]** was followed. Statistical significance was tested by computing the F value at the 5% level of probability, and the critical difference was calculated for the comparison of the treatment means.

The energy indices were determined by using the following formula.

Total net energy (NEt) = Energy output – Energy input

$$\text{Energy use efficiency (\%)} = \frac{\text{Total Energy Output (MJ/ha)}}{\text{Total Energy Input (MJ/ha)}}$$

$$\text{Energy productivity (EPt)} = \frac{\text{Grain + Straw yield (kg /ha)}}{\text{Total Energy Input (MJ/ha)}}$$

$$\text{Energy intensity in economic terms (EI)} = \frac{\text{Gross energy output (MJ /ha)}}{\text{Cost of cultivation (Rs./ha)}}$$

RESULTS AND DISCUSSION

All the energy parameters were significantly influenced by weed management practices and nitrogen levels, but their interaction was found to be non-significant in both the years represented in Table 3. Total energy input was found to be highest with pretilachlor 6% + pyrazo sulfuron-ethyl 0.15% GR 615 g ha^{-1} as PE fb mechanical weeding at 25 and 50 DAS (W_4), then in pretilachlor 6% + pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} as PE fb penoxsulam 1.02% + cyhalofop butyl 5.1% OD 120 g ha^{-1} as POE (W_2) and pyrazosulfuron-ethyl 70% WDG 21 g ha^{-1} PE fb penoxsulam 1.02% + cyhalofop butyl 5.1% OD 120 g ha^{-1} POE (W_3). The lowest energy input was with unweeded (W_1). The high energy input in W_4 might be due to the consumption of more labor for manual weeding. The lowest energy input recorded in unweeded plot was due to no use of herbicides and labor for weed management. Among nitrogen levels, 125% RDN (N_4) registered higher energy input, followed by 100% RDN (N_3) and 75% RDN (N_2), and the lowest energy input was found in $N_{1.}$ Input energy increased with an increase in N levels because of an increase in nitrogen dose.

Among weed practices, W_4 registered higher total energy output and total net energy, which were on par with W_2. W_3 is the next best treatment that generated a higher value, while the lowest was W_1. The higher total energy output and net energy in W_4 and W_2 compared to W_3 and W_1 may be because of better weed control, higher grain and straw yields. Similar results were stated by **[15].** Among nitrogen levels, N_4 exhibited the maximum total energy output and net energy and was comparable with N_3. N_2 was the next best treatment that registered the highest, which was significantly superior to control. The higher total output energy in N_4 and N_3 compared to N_2 and no nitrogen in N_1 was due to maximum grain and straw yield. **[16], [17], [18]** had also found similar results.

The highest total energy use efficiency and energy productivity were registered with W_4 which was on par with W_2 followed by W_3 which was significantly lower than the above treatments. Unweeded has recorded the lowest. The higher yields with low energy input might have resulted in higher energy use efficiency and energy productivity in these treatments, which were also reported by **[19]** and **[20].** Within nitrogen levels N_1 had shown the highest total energy use efficiency and energy productivity, which was significantly higher than the rest of the levels, and the lowest was recorded with N_4 due to less energy input in no nitrogen treatment.

Energy intensity in economic terms was registered at its maximum in W_2 at par with W_4. This is due to higher grain and straw yields and a low cost of cultivation in W_2 compared to W_4, cost of cultivation increased with the involvement of labor for manual weeding in W_4 and the lowest was with W_1 due to lesser yield. Out of four nitrogen levels, N_4 showed higher energy intensity in economic terms comparable with N_3 but significantly superior to N_2 and the lowest by N_1 could be due to higher total energy output obtained through maximum yields. The results are in agreement with the findings of **[21]** and **[22].**

CONCLUSION

In this study, it can be concluded that among weed practices, pretilachlor 6% + pyrazo sulfuron-ethyl 0.15% GR 615 g ha^{-1} as PE followed by mechanical weeding at 25 and 50 DAS (W_4) being at par with pretilachlor 6% + pyrazosulfuron-ethyl 0.15% GR 615 g ha^{-1} as PE fb penoxsulam 1.02% + cyhalofop butyl 5.1% OD 120 g ha^{-1} as POE (W_2) and within nitrogen levels, 125% RDN (N_4) comparable with 100% RDN (N_3) obtained more yield with less cost of cultivation, energy expenditure under drum seeded rice.

Future scope of study: Studies on integrated nutrient management, greenhouse gas emissions, soil enzymatic activity, microbial activity, and herbicide persistence in the soil of drum-seeded rice in comparison to other rice establishment methods can be experimented with.

Conflict of interest: The authors have declared that no conflict of interest exists.

Acknowledgements: K. Preethika Reddy is thankful to PJTSAU for aiding financial assistance and to the chairperson and members for their constant support and guidance during the course of the study.

Table 1. Energy equivalent values of agricultural input and output.

Energy source	Energy equivalent	Unit	Source
Input energy			
Tractor	64.8	MJ hr^{-1}	Devasenapathy *et al.* (2009)
Cultivator	3.135	MJ hr^{-1}	Nassiri and Singh (2009)
Rotavator	10.283	MJ hr^{-1}	Nassiri and Singh (2009)
Leveller	4.703	MJ hr^{-1}	Nassiri and Singh (2009)
Diesel	56.31	MJ lt^{-1}	Devasenapathy *et al.* (2009)
Water	1.02	MJ m^{-3}	Singh *et al*. (2008)
Paddy Seed	14.7	MJ kg^{-1}	Tuti *et al*. (2012)
Adult Man	1.96	MJ hr^{-1}	Mittal and Dhawan (1988)
Adult Woman	1.57	MJ hr^{-1}	Mittal and Dhawan (1988)
Chemicals			
N	60.6	MJ kg^{-1}	Devasenapathy *et al.* (2009)
P_2O_5	11.1	MJ kg^{-1}	Devasenapathy *et al.* (2009)
K_2O	6.7	MJ kg^{-1}	Devasenapathy *et al.* (2009)
Herbicide	278	MJ kg^{-1} a.i	Tzilivakis *et al.* (2005)
Insecticide	237	MJ kg^{-1}	Tzilivakis *et al.* (2005)
Knapsack Sprayer	0.502	MJ hr^{-1}	Nassiri and Singh (2009)
Output Energy			
Grain	14.7	MJ kg^{-1}	Tuti *et al.* (2012)
Straw	12.5	MJ kg^{-1}	Tuti *et al.* (2012)

Table 2. Grain, straw yield (t ha^{-1}) and Cost of cultivation (Rs ha^{-1}) of drum seeded rabi rice influenced by weed management practices and nitrogen levels

Treatments	Grain yield		Straw yield		Cost of Cultivation	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Weed management practices						
W_1	2.18	2.33	4.22	4.43	42889	45376
W_2	5.61	5.77	7.58	7.82	48414	50901
W_3	4.92	5.11	6.93	7.26	47599	50086
W_4	5.83	6.02	7.81	8.10	52214	54701
SEm±	0.14	0.14	0.19	0.16	-	-
CD(P=0.05)	0.40	0.41	0.55	0.47	-	-
Nitrogen levels						
N_1	2.13	2.27	4.10	4.28	45768	48157
N_2	4.67	4.84	6.68	6.96	48043	50530
N_3	5.67	5.86	7.67	7.98	48448	50968
N_4	6.06	6.26	8.09	8.37	48856	51408
SEm±	0.14	0.14	0.19	0.16	-	-
CD(P=0.05)	0.40	0.41	0.55	0.47	-	-
Interaction						
SEm±	0.28	0.28	0.38	0.33	-	-
CD(P=0.05)	0.81	0.82	1.09	0.95	-	-

Table 3. Total energy input, energy output, net energy (MJ ha^{-1}), energy use efficiency, energy productivity (kg MJ^{-1}) and energy intensity in economic terms (MJ Rs^{-1}) of drum seeded rabi rice as influenced by weed management practices and nitrogen levels

Treatments	Total energy input		Total energy output		Total net energy		Total energy use efficiency		Total energy productivity		Energy intensity in economic terms	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Weed management practices												
W_1	12749	12908	84732	89520	71983	76612	7.00	7.21	0.53	0.55	1.96	1.96
W_2	13025	13184	177211	182833	164186	169649	13.97	14.22	1.04	1.06	3.64	3.57
W_3	12860	13019	159057	165768	146197	152750	12.82	13.17	0.96	0.98	3.32	3.29
W_4	13352	13510	183294	189770	169943	176260	13.98	14.42	1.04	1.08	3.40	3.45
SEm±	-	-	5851	5104	5661	5283	0.23	0.24	0.02	0.02	0.10	0.08
CD(P=0.05)	-	-	16898	14742	16349	15260	0.67	0.7	0.05	0.06	0.28	0.24
Nitrogen levels												
N_1	5987	6146	82509	86964	76522	80818	13.71	14.07	1.04	1.06	1.78	1.78
N_2	13060	13219	152259	158187	139199	144968	11.62	11.93	0.87	0.89	3.13	3.09
N_3	15333	15492	179201	185845	163868	170353	11.65	11.97	0.87	0.89	3.65	3.61
N_4	17605	17764	190325	196896	172719	179132	10.78	11.06	0.80	0.82	3.76	3.79
SEm±	-	-	5851	5104	5661	5283	0.23	0.24	0.02	0.02	0.1	0.08
CD(P=0.05)	-	-	16898	14742	16349	15260	0.67	0.7	0.05	0.06	0.28	0.24
Interaction												
SEm±	-	-	11702	10208	11322	10567	0.46	0.48	0.03	0.04	0.19	0.16
CD(P=0.05)	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

REFERENCES

1. Raviteja B (2020) Weed management in machine transplanted rice. *M.Sc. (Ag)Thesis*. Professor Jayashankar Telangana State Agriciultural University, Hyderabad, India.

2. Agriculture statistics at a glance (2021) Directorate of Economics and Statistics. Ministry of Agriculture. Government of India.

3. Shekhawat K, Rathore SS, Chauhan BS (2020) Weed Management in Dry Direct-Seeded Rice: A Review on Challenges and Opportunities for Sustainable Rice Production. Agronomy Journal10(9): 1264.

4. Raghavendra BM, Singh YV (2015) Direct wet drum seeded rice an emerging resource saving technology for rice crop establishment. Indian Farming65(1).

5. Gangaiah B, Swain S, Subramani T (2019) Direct wet seeding as an alternative to transplanted rice (Oryza sativa *L.*) cultivation in Andaman and Nicobar Islands. The Bioscan 14(1): 9-13.

6. Raghavendra BM, Susheela R, Madhavi M, Mahantheswara B (2015) Influence of weed management practices on nutrients uptake in wet seeded rice sown through drum seeder. Annals of Plant Protection Sciences23(1): 153-157.

7. Saimaheswari K, Karuna Sagar G, Chandrika V, Sandhya Rani B (2024) Study of Real -time nitrogen management and sustainable weed management practices on maize productivity. Agriculture Association of Textile Chemical and Critical Reviews Journal 12(1): 71-81.

8. Chauhan BS, Ahmed Awan TH, Jabran K, Manalil S (2015) Integrated weed management approach to improve weed control efficiencies for sustainable rice production in dry-seeded systems. *Crop Protection* 71: 19-24.

9. Blackshaw RE, Anderson RL, Lemerle D (2007) Cultural weed management. Non-Chemical Weed Management: Principles, Concepts and Technology, Wallingford, UK:CAB International 35-48.

10. Salam MA, Ali F, Anwar MP, Bhuiya MSU (2004) Effect of level of nitrogen and date of transplanting on the yield and yield attributes of transplant aman rice under SRI method. Journal of the Bangladesh Agricultural University2(452-2018-3725): 31-36

11. Alagesan A, Babu CR (2011) Impact of different nitrogen levels and time of application on grain yield and yield attributes of wet seeded rice. International Journal of Food, Agriculture and Veterinary Sciences 1(1): 1-5.

12. Awan TH, Ali RI, Manzoor Z, Ahmad M, Akhta M(2011) Effect of different nitrogen levels and row spacing on the performance of newly evolved medium grain rice variety. *Journal of Animal and Plant Sciences* 21(2): 231-234.

13. Andreasen C, Litz AS, Streibig JC (2006) Growth response of six weed species and spring barley (*Hordeum vulgare*) to increasing levels of nitrogen and phosphorus. *Weed Research* 46: 503–512.

14. Gomez KA, Gomez AA (1984) Statistical Procedure for Agriculture Research. 2^{nd} Edition. John Willey and Sons, New York. 680.

15. Anusha S (2016) Weed control options for transplanted rice (*Oryza sativa* L.). *M.Sc. (Ag)Thesis*. Professor Jayashankar Telanagana State Agricultural University, Hyderabad, India.

16. Ravi S, Chandrasekaran B, Ramesh S (2007) Exploitation of hybrid vigour in rice hybrid (*Oryza sativa* L.) through green manure and leaf colour chart (LCC) based N application. Asian Journal of Plant Sciences 6(2): 282-287.

17. Alam MM, Rezaul K, Ladha JK (2013) Integrating best management practices for rice with farmers' crop management techniques: A potential option for minimizing rice yield gap. Field Crops Research 144: 62–68.

18. Vijayagouri K (2019) Productivity and profitability of rice as influenced by tillage and weed management in rice maize-green manure system under conservation agriculture. *M.Sc. (Ag) Thesis*. Professor Jayashankar Telangana State Agricultural University, Hyderabad, India.

19. Sreedevi B, Latha PC, Sandhyarani A, Sreenivas D, Mahender Kumar R (2015) Energy use and efficacy of weed management practices in aerobic rice. Proceedings of 25th Asian-Pacific Weed Science Society Conference on 'Weed Science for Sustainable Agriculture, Environment and Biodiversity, Hyderabad', India. 100.

20. Ravi kumar A (2017) Impact of different methods of rice establishment and weed management options on crop productivity, profitability and environment. *M.Sc. (Ag)Thesis*. Professor Jayashankar Telangana State Agriciultural University, Hyderabad, India.

21. Balakrishnan M, Ravisankar N, Swamam TP, Din M (2010) Influence of prickly sesban intercropping in wet-seeded rice (*Oryza sativa* L.) on productivity, profitability, energetic and nitrogen balance under island ecosystem. Indian Journal of Agricultural sciences 80: 21-23.

22. Thirupathi I (2017) Assessment of production potential and green house gas emissions from rice fields with irrigation regimes and nitrogen management practices under different establishment methods. *Ph.D. (Ag) Thesis.* Professor Jayashankar Telangana State Agricultural University, Hyderabad, India.

