Biological Forum – An International Journal **15(8): 582-585(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

System Productivity and Profitability of Rice Greengram System under Different Irrigation and Nutrition Following Rice Establishment Method

Rasmirekha Pattnaik[1*], Sabyasachi Biswal[2], Tarini Prasad Das[1], Sunita Dandasena[3] and Krishnamayee Sethi[4]

[1]Research Scholar, Department of Agronomy,
College of Agriculture, OUAT, Bhubaneswar (Odisha), India.
[2]Professor, Department of Agronomy,
College of Agriculture, OUAT, Bhubaneswar (Odisha), India.
[3]Scientist, Agronomy, Krishi Vigyan Kendra, Koraput, Odisha (Odisha), India.
[4]Farm Manager, Krishi Vigyan Kendra, Koraput, Odisha (Odisha), India.

(Corresponding author: Rasmirekha Pattnaik)*
(Received: 09 June 2023; Revised: 30 June 2023; Accepted: 29 July 2023; Published: 15 August 2023)
(Published by Research Trend)

ABSTRACT: A field experiment was conducted in the Instructional Farm, Department of Agronomy, OUAT, Bhubaneswar in 2019-20 and 2020-21. In the *kharif* season, rice was grown in Randomized Block Design with three different establishment methods namely, Direct sowing, Non Puddled Transplanting and Puddled Transplanting. In the *Rabi* season greengram was taken in those plots where the residual effect of rice establishment methods was taken as main plots, two irrigation schedules *i.e.*, one irrigation at the pre-flowering stage & No irrigation was taken in sub plots. In sub-sub plots nutrient management schedules were taken *i.e.,* no fertilizer, 2% spray of NPK 19-19-19 at pre-flowering and flowering stage & 100 kg soil application of DAP. DSR-based system was found to be economically profitable even though PTR-based system has produced higher system yield. Crop grown with irrigation performed better over no irrigated plots. Similarly, soil application of fertilizers has shown higher system productivity and profitability over foliar application followed by no fertilizer.

Keywords: Establishment method, Irrigation, Soil application, Foliar application, Rice-greengram.

INTRODUCTION

Rice, being the predominant crop in South Asia is mostly cultivated in a single season of a year but the same area often remains unutilized during the successive cropping seasons which are termed as rice fallows (Mutert and Fairhurst 2002). In India, the rice fallow area covers about 19.6 million ha (Gumma *et al.,* 2016). In eastern India, rice is typically cultivated in the *kharif* season; however, large areas remain fallow during the subsequent *rabi* season. Around 80% of India's rice fallow is from the eastern Indian states of Odisha, West Bengal, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, and Assam (Ali *et al.,* 2014; Singh *et al.,* 2016; Kumar *et al.,* 2016). The farmers in eastern India are unable to utilize the rice fallows productively due to various environmental and socioeconomic factors (Kumar *et al.,* 2019). Lack of irrigation facilities is one of those factors, as the rapid depletion of residual soil moisture makes it difficult for farmers to go for a second crop in the *rabi* season followed by rice (Ghosh *et al.,* 2016 ; Kar *et al.,* 2009). Considering the better utilization of these areas pulse crops should be grown as they have several benefits. Further, the cultural practices that are followed in rice have a greater impact on the succeeding crop. In the conventional puddled transplanting system (PTR), a large quantity of irrigation water is used for puddling which destroys soil aggregates and results in the formation of a hardpan, creating problems for the establishment and growth of succeeding crops.

Among the various agronomic practices required to enhance the productivity of succeeding pulse crops nutrients play a pivotal role in increasing seed yield (Chandrasekhar and Bangarusamy 2003). Soil application of fertilizers at land preparation is an age-old practice but nowadays foliar application is also gaining popularity because of higher utilization efficiency as there is less loss. Foliar application is a simple and effective method of providing nutrients to the crops directly without spending energy for their transport and any losses in transit which often brings about an immediate improvement in the crop growth than soil application (Alexander and Schroeder 2012). However foliar application cannot be considered as a suitable substitute for soil application concerning macronutrients as the amount that is applied is very less in foliar application. Pulse crops grown in the *rabi* season suffer due to moisture stress because of low winter rainfall. Hence providing irrigation at the most critical stage can enhance productivity.

This paper aims to evaluate the system productivity and profitability of the rice-greengram cropping system under different irrigation and nutrition schedules

following distinct rice establishment methods. By analyzing these factors, we seek to provide insights into the most effective strategies for maximizing crop yield and economic returns while promoting sustainable agricultural practices.

MATERIALS AND METHODS

The field experiment was conducted at the Instructional Farm of Department of Agronomy, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar (20°15' N, 85°52' E, 25.9 m above mean sea level and about 64 km away from the Bay of Bengal), Odisha during the Year 2019-20 and 2020-21. The station lies within the East and South Eastern Coastal Plain Agro-climatic Zone of Odisha. The soil of the experimental site was sandy loam in texture having pH 5.43, organic carbon 0.37%, available N 183 kg/ha, available P 14.13 kg/ha, and available K 297.2 kg /ha. In *kharif* season rice variety (Swarna sub-1) was grown with three different establishment methods namely Direct sowing, Pudlled transplanting, and non-puddled transplanting which was taken as the main plot. Land preparation for the plots was done as per the requirement of treatments. In *Rabi* Greengram variety IPM 2-14 was grown with two irrigation treatments *i.e.,* with & without irrigation taken as sub plot. Irrigation was given to the assigned plots at pre flowering stage *i.e.,* at 26 DAS. Three nutrient management schedules *i.e.,* no fertilizer, 2% foliar application of NPK 19-19-19, and soil application of 100 kg DAP were taken in sub-sub plots. Soil application was done at the time of sowing and foliar application was done two times one at pre flowering stage and flowering stage. The residual effects of kharif treatments as well as the direct effect of irrigation and nutrient schedules on greengram were evaluated in a split-split plot design. Data related to system yield were collected. Production economics of rice- greengram system was computed to find out the suitable combination of treatments for productivity and profitability of the system.

RESULT AND DISCUSSION

System yield and production efficiency of the rice-greengram system was significantly influenced by the residual effect of the rice establishment method and different irrigation and nutrition schedules in both the years under the study (Table 1).

Table 1: System yield and Production Efficiency of rice- greengram system under different irrigation and nutrition schedules following rice establishment methods.

Treatment	System yield (Kg/ha)			Production efficiency(kg REY/ha/day)		
Main plot : *Establishment method*	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
DSR	7112	7257	7185	19.49	19.88	19.69
NPTR	7212	7355	7284	19.75	20.15	19.96
PTR	7256	7389	7323	19.88	20.24	20.06
SEm(±)	23.138	24.580	20.526	0.065	0.067	0.056
CD (0.05)	90.83	96.50	80.58	0.25	0.26	0.22
Sub plot : Irrigation						
without irrigation	6697	6827	6762	18.41	18.70	16.53
With irrigation	7690	7840	7765	21.00	21.48	21.28
SEm(±)	13.176	12.161	5.341	0.033	0.033	0.015
CD (0.05)	45.58	42.07	18.48	0.11	0.11	0.05
Sub sub plot: Nutrition						
No fertiliser	6683	6854	6768	18.78	18.78	16.55
Foliar application	7349	7449	7399	20.41	20.41	20.27
Soil application	7549	7698	7624	21.09	21.09	20.89
SEm(±)	16.952	19.386	12.999	0.046	0.053	0.036
CD (0.05)	49.47	56.57	37.94	0.14	0.15	0.10

Maximum system yield and production efficiency were found in the PTR-based system (7323 kg/ha, 20.06 kg/ha/day) which was at par with the NPTR-based system (7284kg/ha, 19.96 kg/ha/day) followed by DSR-based system. This might be ascribed to the higher grain yield of rice under Puddled transplanted conditions.

Similarly, irrigation had a significant effect on system yield and production efficiency. Maximum system yield and production efficiency were observed, when grown with one irrigation at the pre-flowering stage (7765 kg/ha, 21.28 kg/ha/day) was significantly higher than one grown without irrigation. This might be due to better translocation of photosynthates towards grain due to water availability at the root zone at the critical stage whereas, plots having no water supply produced lesser system yield because of less availability of nutrients from soil solution. Similar results were obtained by Amede *et al.* (2014), who reported that On an average, crop yield under irrigation was at least 35% higher compared to non-irrigated farms. A significant difference in system yield and production efficiency was observed with the difference in methods of fertilizer application. Pooled data reveals that the highest system yield and production efficiency (7624 kg/ha, 20.89 kg/ha/day) was obtained with soil application of 100 kg DAP followed by foliar application of 2% NPK (19-19-19) (7399 kg/ha, 20.27 kg/ha/day) and no fertilizer.

Table 2: Nutrient Uptake of rice- greengram system under different irrigation and nutrition schedules following rice establishment methods (kg/ha).

Treatment	N			P			K		
Main plot : *Establishment method*	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**
DSR	135.56	139.86	137.71	23.95	25.27	24.61	132.23	136.24	134.24
NPTR	137.87	142.08	139.97	25.67	26.91	26.29	135.82	139.05	137.44
PTR	138.67	142.44	140.56	26.28	27.64	26.96	135.74	139.52	137.63
SEm(±)	0.234	0.204	0.189	0.027	0.024	0.023	0.168	0.114	0.137
CD (0.05)	0.920	0.802	0.743	0.106	0.094	0.090	0.659	0.449	0.537
Sub plot : Irrigation									
without irrigation	131.47	135.47	133.47	24.84	26.15	25.50	131.84	135.54	133.69
With irrigation	143.93	148.12	146.03	25.76	27.06	26.41	137.35	141.00	139.18
SEm(±)	0.217	0.093	0.124	0.017	0.010	0.010	0.125	0.079	0.096
CD (0.05)	0.751	0.322	0.428	0.060	0.035	0.035	0.431	0.274	0.332
Sub sub plot: Nutrition									
No fertiliser	131.31	135.66	133.49	24.91	26.21	25.56	131.82	135.60	133.71
Foliar application	139.79	143.70	141.75	25.46	26.74	26.10	135.52	139.22	137.37
Soil application	142.00	146.03	144.01	25.54	26.87	26.21	136.45	139.99	138.22
SEm(±)	0.170	0.186	0.141	0.015	0.019	0.013	0.111	0.097	0.094
CD (0.05)	0.496	0.544	0.410	0.043	0.054	0.037	0.324	0.284	0.274

Table 3: Economics of rice- green gram system under different irrigation and nutrition schedules following rice establishment methods.

Treatment	GROSS RETURN (Rs/ha)			NET RETURN (Rs/ha)			B/C Ratio			System Profitability (Rs/ha/day)		
Main plot : Establishment method	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**
DSR	137458	144202	140830	57877	63581	60729	1.72	1.79	1.76	158.6	174.2	166.4
NPTR	139605	146345	142975	57758	63419	60589	1.70	1.76	1.73	158.2	173.7	166.0
PTR	140480	147066	143772	55529	61051	58290	1.65	1.71	1.68	152.1	167.3	159.7
SEm(±)	419.94	544.92	421.34	419.94	544.92	421.34	0.005	0.007	0.005	0.61	0.45	0.40
CD (0.05)	1648.6	2139.3	1654.1	1648.6	2139.3	1654.1	0.021	0.026	0.020	2.4	1.8	1.6
Sub plot : Irrigation												
without irrigation	130166	136393	133279	49036	54218	51627	1.60	1.66	1.63	134.3	148.5	141.4
With irrigation	148196	155348	151772	65073	71149	68111	1.78	1.84	1.81	178.3	194.9	186.6
SEm(±)	239.14	223.36	98.21	239.14	223.36	98.21	0.003	0.003	0.001	0.65	0.61	0.27
CD (0.05)	827.4	772.8	339.8	827.4	772.8	339.8	0.010	0.009	0.004	2.3	2.2	0.9
Sub plot: Nutrition												
No fertiliser	129917	136897	133407	49660	55596	52628	1.62	1.68	1.65	152.3	152.3	144.2
Foliar application	141996	148023	145009	59127	64077	61602	1.71	1.76	1.74	175.5	175.5	168.7
Soil application	145631	152692	149161	62377	68379	65378	1.75	1.81	1.78	187.3	187.3	179.1
SEm(±)	307.67	362.38	239.81	307.67	362.38	239.81	0.004	0.004	0.003	0.84	0.99	0.65
CD (0.05)	897.9	1057.5	699.8	897.9	1057.5	699.8	0.011	0.013	0.009	2.5	2.9	1.9

Maximum N uptake (140.56 kg/ha), P uptake (26.96 kg/ha), and K uptake (137.63 kg/ha) were observed under the PTR-based system followed by NPTR and DSR-based system (Table 2). This might be due to the maximum system yield under PTR-based system that directly resulted in the maximum value of nutrient uptake. Among irrigation schedules higher value of N uptake (146.03 kg/ha), P uptake (26.41 kg/ha), and K uptake (139.18 kg/ha) was found under one irrigation at pre flowering stage followed by no irrigation. Similarly, the maximum value of N uptake (144.01 kg/ha), P uptake (26.21 kg/ha), and K uptake (138.22 kg/ha) was recorded under soil application of 100 kg DAP followed by foliar application and no fertilizer.

Economics of rice- greengram system as influenced by different nutrition and irrigation schedules followed by rice establishment methods (Table 3) revealed that the maximum Gross return was found for PTR-based system (143772 Rs/ha) followed by NPTR and DSR-based system. This might be due to the higher system yield of PTR-based system that resulted in the higher Gross return of the system. However, a higher value of Net Return (60729 Rs/ha), B-C ratio (1.76), and system profitability (166.4 Rs/ha/day) was observed for DSR-based system followed by NPTR and PTR based system. Lesser production cost involved in a DSR-based system is the probable reason for this maximum value. The value of all economic parameters followed a similar trend as that of system yield for irrigation schedules. Maximum Net Return (68111 Rs/ha) and B-C ratio (1.81)were observed with one irrigation at pre sowing stage. This is because irrigation enhances the crop performance under moisture stress conditions in *rabi* season reflected in higher crop yield as well as higher value of economic parameters.

Among the nutrient management practices, the maximum value of Gross Return (149161 Rs/ha), Net Return (65378 Rs/ha), and B-C (1.78) ratio was observed with soil application of 100 kg DAP followed by foliar application and no fertilizer. Both the nutrient management practices performed well over no fertilizer. It is because of the better availability of

nutrients that is reflected in the overall performance of the crop. In between soil and foliar application, soil application performed well as the macronutrients are required for the plant in larger amounts that can be supplied through soil application.

CONCLUSIONS

From the above study, it can be concluded that even though for system productivity and production efficiency PTR-based system was higher still DSR system performed better concerning system profitability. As moisture during the *rabi* season is one of the critical factors, hence providing one irrigation at pre flowering stage will serve the purpose. Soil application of fertilizers performed better over foliar application as macronutrient needs are fulfilled better through soil application because of its requirement in higher quantities.

FUTURE SCOPE

The effect of other various rice establishment methods on the succeeding crops needs to be studied. Furthermore, research related to the comparison between soil and foliar application of macro and micronutrients is still less. More studies can be conducted on it.

Conflict of Interest. None.

REFERENCES

Amede, T, Marium, A. G. and Felloni, F. (2014). Small Scale Irrigation Interventions for System Productivity and Natural Resource Management in Ethiopian Highlands: Benefits and Best-bets.

Alexander, A. and Schroeder, M. (2012). Modern trends in foliar fertilization. *Journal of Plant Nutrition, 10*(9), 1391-1399.

Ali, M., Ghosh, P. and Hazra, K. (2014). Resource conservation technologies in rice fallow. In *Resource Conservation Technology in Pulses*, 1st ed.; Ghosh, P.K., Kumar, N., Venkatesh, M.S., Hazra, K.K., Nadarajan, N., Eds.; Scientific Publishers: Jodhpur, India, 2014; pp. 83–88.

Chandrasekhar, C. N., and Bangarusamy, U. (2003). Maxximizing the yield of mung bean by foliar application of growth regulating chemicals and nutrients. *Madras Agricultural Journal*, *90*(1-3), 142-145.

Ghosh, P. K., Hazra, K. K., Nath, C. P., Das, A., and Acharya, C. L. (2016). Scope, constraints and challenges of intensifying rice (*Oryza sativa*) fallows through pulses. *Indian Journal of Agronomy*, *61*(4), 122-128.

Gumma, M. K., Thenkabail, P. S., Teluguntla, P., Rao, M. N., Mohammed, I. A., and Whitbread, A. M. (2016). Mapping rice-fallow cropland areas for short-season grain legumes intensification in South Asia using MODIS 250 m time-series data. *International Journal of Digital Earth*, *9*(10), 981-1003.

Kumar, R., Mishra, J. S., Rao, K. K., Mondal, S., Hazra, K. K., Choudhary, J. S., and Bhatt, B. P. (2020). Crop rotation and tillage management options for sustainable intensification of rice-fallow agro-ecosystem in eastern India. *Scientific reports*, *10*(1), 11146.

Kar, G., and Kumar, A. (2009). Evaluation of post-rainy season crops with residual soil moisture and different tillage methods in rice fallow of eastern India. *Agricultural Water Management*, *96*(6), 931-938.

Kumar, R., Mishra, J. S., Upadhyay, P. K., and Hans, H. (2019). Rice fallows in the eastern India: Problems and prospects. *The Indian Journal of Agricultural Sciences*, *89*(4), 567-577.

Mutert, E., and Fairhurst, T. H. (2002). Developments in rice production in Southeast Asia. *Better Crops International*, *15*(Suppl), 12-17.

Singh, N. P., Praharaj, C. S., and Sandhu, J. S. (2016). Utilizing untapped potential of rice fallow of East and North-east India through pulse production. *Indian Journal of Genetics and Plant Breeding*, *76*(04), 388-398.

How to cite this article: Rasmirekha Pattnaik, Sabyasachi Biswal, Tarini Prasad Das, Sunita Dandasena and Krishnamayee Sethi (2023). System Productivity and Profitability of Rice Greengram System under Different Irrigation and Nutrition Following Rice Establishment Method. *Biological Forum – An International Journal, 15*(8): 582-585.