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Influence of variable irrigation schedules and nitrogen levels on PAR (%) of rice (*Oryza sativa* L.) in temperate ecology of Kashmir

Mohd Salim Mir[1]*, Waseem Raja[1], M.A. Bhat[2], Eajaz A. Dar[3], Raihana H. Kanth[1], Amal Saxena[1], Aamir Hassan Mir[4], Fehim Jeelani Wani[5], Zahoor Ahmad Shah[3] and Zakir Amin[6]

[1]*Division of Agronomy, Faculty of Agriculture, Wadura, Sopore, SKUAST-K, J&K, India*
[2]*Directorate of Education, SKUAST-K, Shalimar, J&K, India*
[3]*Krishi Vigyan Kendra, Ganderbal, SKUAST-K, J&K, India*
[4]*Dryland Agriculture Research Station, Rangreth, Srinagar, SKUAST-K, J&K, India*
[5]*Division of Agri-economics & Statistics, Faculty of Agriculture, SKUAST-K, J&K, India*
[6]*Division of Plant Pathology, Faculty of Agriculture, Wadura, SKUAST-K, J&K, India*

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ABSTRACT

A field experiment was conducted at Faculty of Agriculture, Wadura, Sopore, SKUAST-Kashmir during *Kharif* 2021 and 2022 on silty clay loam soil. The soil of the experimental field was neutral in reaction, medium in available N, P and K and organic carbon. The experiment comprised of four irrigation schedules: I_1: Recommended Irrigation Scheduling, I_2:At field capacity (20 L m^{-2}), I_3:10 % depletion from field capacity (20 L m^{-2}) and I_4: 20 % depletion from field capacity (20 L m^{-2}), assigned to main plots and four nitrogen levels including N_0: Control, N_1: 75 % RDN (Recommended dose of nitrogen), N_2: 100 % RDN and N_3: 125 % RDN assigned to sub-plots, replicated thrice. The test variety evaluated was Shalimar Rice-4 (SKUA-408) and the experiment was laid out in split plot design. The data revealed that recommended irrigation scheduling though at par with application of irrigation water at field capacity recorded significant increase in intercepted PAR (photosynthetically active radiation) (%) as compared to other irrigation schedules during both the years of experimentation. Among the different nitrogen levels, 125 % RDN treatment recorded significantly higher values of intercepted PAR (%)but was at par with 100 % RDN treatment during 2021 and 2022. Significantly lowest values of intercepted PAR (%) were observed when the irrigation water was applied at 20 % depletion from field capacity among irrigation schedules and control treatment among nitrogen levels during both the years of experimentation.

Key words : *Depletion, Field capacity, Intercepted PAR, Irrigation scheduling*

Introduction

Rice is considered as main staple food for almost half of the global population (Zhao *et al*., 2023) and is a semi-aquatic crop requiring continuous supply of irrigation water in order to avoid yield loss (Upadhyay, 2016). Within the country, rice occupies one-quarter of the total cropped area i.e., 44.5 million hectares, contributes about 40 to 43 percent, i.e., 116.42 million tonnes of total food grain production and continues to play a vital role in the national food and livelihood security system (FAO, 2020). Rice consumes about 3000-5000 litres of water to produce 1 kg grain, depending on the different rice cultivation methods (Geethalakshmi *et al.,* 2011) and irrigated rice consumed about 40 per cent of the world's irrigation water (Dawe, 2005). Thus it consumes approximately 80 per cent of the total irrigated fresh water resources in Asia (Bouman and Toung, 2001). By 2025, 15-20 million hectares of rice lands will suffer from some degree of water scarcity (Tuong and Bouman, 2003). Deficit irrigation (DI) has been widely investigated as a valuable strategy (Pereira *et al.,* 2002) where water is the limiting factor for rice crop cultivation. Towards the end of the year 2050, demand in rice is prognosticated to 800 metric tons (Rana *et al*., 2020).

Water and fertilizer are two coupling factors that influence and constrain each other during growth and development and yield formation processes in rice (Wang *et al.,* 2016). Water management and nitrogen application techniques are also important components of super-high-yielding cultivation techniques for rice (Pan *et al.,* 2017). Hence, efficient use and management of nitrogen in crop production is critical for obtaining optimum crop productivity, quality, environmental safety and economic returns. Irrigation also plays a pivotal role in increasing the productivity of rice. The nitrogen use efficiency of applied nitrogen fertilizers in rice is quite low i.e., 30-40 per cent (Pathak *et al.,* 2003) due to different losses of nitrogen, like ammonia volatilization, denitrification, leaching and erosion. Among these losses of nitrogen, the nitrogen losses can be minimized by reducing the irrigation water. Hence, there is a great need to identify optimum irrigation schedule and nitrogen level for obtaining higher water productivity and nitrogen use efficiency in rice. So, in order to investigate the effect of variable irrigation schedules and nitrogen levels on rice productivity in Kashmir valley, current study was undertaken with the objective to investigate the influence of variable irrigation schedules and nitrogen levels on intercepted PAR (photosynthetically active radiation) percentage of rice.

Materials and Methods

The experiment was laid out at research farm of Division of Agronomy, Faculty of Agriculture, Wadura, SKUAST-Kashmir in *Kharif* 2021 and 2022. The field is situated between $34^{O}21'$ N latitude and $74^{O}23'$ E longitude and at an altitude of 1590 meters amsl. A temperate climate prevails in the area, with freezing temperatures in the winter and hot weather in the summer. The soil of the experimental field was silty-clay loam in texture, medium in organic carbon, medium in available nitrogen, phosphorus and potassium with neutral pH. The experiment was laid out in split plot design with four main plot treatments viz. I_1: Recommended Irrigation Scheduling, I_2: At field capacity (20 L m^{-2}), I_3:10 % depletion from field capacity (20 L m^{-2}) and I_4: 20 % depletion from field capacity (20 L m^{-2}) and four sub plot treatments viz. N_0: Control, N_1: 75 % RDN (Recommended dose of nitrogen), N_2: 100 % RDN and N_3: 125 % RDN. The size of each experimental plot was 5.0 m x 3 m and the variety tested was Shalimar Rice-4 (SKUA-408). The Cochran and Cox technique (1936) was used to statistically analyse the data obtained for a number of observations and the treatment differences were assessed using the F test of significance.

Results and Discussion

PAR (%): Intercepted PAR percentage was significantly influenced by variable irrigation schedules and nitrogen levels during 2021 and 2022 (Table 1). Intercepted PAR (%) increased with the advancement of crop growth up to 75 DAT(days after transplanting) and thereafter gradually decreased during both the years of experimentation. Among variable irrigation schedules, recommended irrigation scheduling though at par with application of irrigation water at field capacity recorded significantly highest values of PAR percentage (86.24 and 83.17) at 75 DAT as compared to other irrigation schedules during both the years of experimentation. Significantly lowest values of PAR percentage were recorded in the application of irrigation water at 20 % depletion from field capacity during both the years. This might be due to higher leaf area index, healthier and green biomass and higher chlorophyll index in recommended irrigation scheduling and field capacity treatmentsdue to availability of adequate moisture to cropas also reported by Vijayshekar *et al.,* 2021 and Dar *et al.,* 2019. Among different nitrogen levels, 125 % RDN treatment though at par with 100 % RDN treatment recorded significantly higher values of PAR percentage (85.26 and 82.70) at 75 DAT during both the years of experimentation. Significantly lowest values of PAR percentage were observed in control treatment throughout the crop growth season of 2021 and 2022. This might be due to higher biomass production, higher leaf area and canopy

Table 1. Intercepted PAR (%) of rice as influenced by variable irrigation schedules and nitrogen levels in 2021 and 2022

Treatments	15 DAT		30 DAT		45 DAT		60 DAT		75 DAT		90 DAT	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Irrigation Schedules												
I_1	38.52	33.41	47.64	43.58	65.96	62.77	82.65	78.42	86.24	83.17	84.42	81.37
I_2	38.44	33.25	47.59	43.55	65.83	62.61	82.40	78.11	86.14	83.04	84.18	81.10
I_3	33.64	31.52	44.18	41.89	64.19	61.90	78.37	75.98	83.26	80.87	80.95	78.81
I_4	31.52	30.35	42.17	41.04	62.62	61.19	77.27	75.48	81.29	79.61	79.42	77.91
SE(m)±	0.04	0.05	0.01	0.02	0.06	0.05	0.08	0.09	0.06	0.04	0.07	0.09
CD (P≤0.05)	0.16	0.19	0.06	0.09	0.23	0.20	0.31	0.32	0.22	0.15	0.24	0.36
Nitrogen Levels												
N_0	33.58	30.19	43.66	40.78	63.19	60.66	78.48	75.30	82.62	80.06	80.57	78.13
N_1	35.45	32.05	45.50	42.62	64.68	62.15	80.25	77.07	84.17	81.61	82.26	79.81
N_2	36.19	32.79	45.87	42.99	65.22	62.68	80.82	77.64	84.88	82.32	82.81	80.37
N_3	36.89	33.50	46.54	43.66	65.53	63.00	81.15	77.98	85.26	82.70	83.33	80.89
SE(m)±	0.28	0.29	0.22	0.19	0.11	0.11	0.09	0.11	0.18	0.10	0.18	0.16
C.D. (p≤0.05)	0.75	0.79	0.68	0.67	0.34	0.34	0.36	0.34	0.42	0.39	0.55	0.58

{where I_1: recommended irrigation scheduling, I_2: at field capacity, I_3: 10% depletion from field capacity, I_4: 20% depletion from field capacity and N_0: control, N_1: 75% RDN (recommended dose of nitrogen), N_2: 100% RDN, N_3: 125% RDN}

spread in 125% RDN treatment due to higher availability of nitrogen fertilizer to crop. These results are in close conformity with the findings of Nazir*et al.*, 2022.

Conclusion

Suitable irrigation scheduling coupled with optimum nitrogen application in rice is important as it could be the promising alternative in current scenario of global water scarcity. From the present study it was concluded that application of irrigation water at field capacity proved to be more feasible and promising in terms of intercepted PAR percentage in rice. Furthermore, among different nitrogen levels, 100% recommended dose of nitrogen observed higher intercepted PAR percentage. Therefore, it can be concluded that application of irrigation water at field capacity with the application of 100% RDN (120 kgha^{-1}) can be sustainable in temperate ecology of Kashmir.

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