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Effect of Different Nitrogen Levels and Herbicides on Growth Indices of Transplanted Rice (*Oryza sativa* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Kharif* season 2022 and 2023 at Agronomy research farm, Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya Uttar Pradesh, (India). The experiment was laid out in split plot design with thrice replications. Taking three nitrogen levels 80 Kg/ha, 120 Kg/ha and 160 Kg/ha in main plot and five weed management practices Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT, Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT, Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT, Weed free and Weedy check in subplot.

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Results revealed that significantly higher crop growth rate, relative growth rate, and net assimilation rate and grain yield was recorded in 160 Kg N ha^{-1} and Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT which was comparable to weed free during both the years of investigation on transplanting rice.

Keywords: CGR; RGR; NAR; nitrogen levels; herbicides and transplanted rice.

1. INTRODUCTION

"Rice (*Oryza sativa* L.) is one of the most major cereal food grain crops of the *kharif* season and is a member of the Poaceae family. Rice is the most important staple food in Asia, providing on an average 32 % of total calorie uptake" [1] "Because of growing population, the demand for rice is expected to increase in the coming decades" (Pingali *et al*., 1997). "However, to meet this demand the crop should perform to its full potential. Certain factors tend to restrict the crop's potential performance. Rice is the principal food for more than 50 % people and contributes about one-fifth to the total calories consumption of the world" [2] **"**Transplanting in puddled soil is the most dominant and traditional method of rice establishment in irrigated low land ecosystem. Puddling reduce water infiltration and to maintain the standing water in the field, which also helps in reducing weed density, preventing leaching losses of plant nutrients, increases water retention capacity and facilitates easier transplanting" [3] "Weeds are responsible for heavy rice yield losses under extreme conditions. Uncontrolled weeds reduced the rice yield by 62.6 % under transplanted conditions. Nitrogen plays an important role in realizing higher rice yield and maintaining the photosynthetic activity during grain filling stage of the crop. It is important to increase nitrogen utilization efficiency in rice production system through scheduling of nitrogen application as per the demand of crop plants" [4,5].

"Weed infestation and competition are severe in puddled drum seeded rice as compared to transplanted rice because of the simultaneous growth of both crops and weeds. Reduction in yield to the tune of 34 per cent in transplanted rice, 45 % in direct seeded low land rice and 67 per cent in upland rice due to weeds" were reported by Muthukrishnan et al. [6]. "Weed competition is one of the major factors responsible for low yield of rice. Competition offered by weeds is most important and it reduces the grain yield up to the extent of 32**%"** [7].

2. MATERIALS AND METHODS

The experiment was conducted during two consecutive seasons of *Kharif* 2022 and 2023 at the Agronomy Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.). The experimental site falls under sub-tropical conditions with remarkable humidity and lies between 24.4^0 North latitude and 82.12^0 East longitudes with an altitude113 meters above mean sea level. The experimental site falls under sub humid subtropical zone in Indo-Gangetic plains receives a mean annual rainfall of about 1013 mm, out of which about 90 percent is receive from mid-June to end of September. However, occasional showers are also common during winter.The experiment was layout in split plot design (SPD) with three replications taking three nitrogen levels 80 Kg/ha, 120 Kg/ha and 160 Kg/ha in main plot and five weed management practices Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT, Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT, Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT, Weed free and Weedy check in subplot. Soil was sampled before sowing and after harvest of the crop to know the fertility status of the experiment field. The growth analysis was done as per standard procedures.

2.1 Crop Growth Rate

It represents the dry weight gained by a unit area of crop in unit time. The crop growth rate (CGR) was estimated by using the formula suggested by Buttery [8] and expressed in g m^{-2} day^{-1}.

$$CGR = \frac{1}{A} \times \frac{W_2 - W_1}{T_2 - T_1}$$

Where,

A is area, W_1 and W_2 Whole plant dry weight at T_1 and T_2 time, respectively.

2.2 Relative Growth Rate

It is an index of the amount of growing material per unit dry weight of plant present per unit time. The relative growth rate (RGR) was estimated by using the formula suggested by Blackman [9] and expressed as g g^{-1} day^{-1}.

$$RGR = \frac{Log_e W_2 - Log_e W_1}{T_2 - T_1}$$

Where,

W_1 and W_2Whole plant dry weight at T_1 and T_2 time, respectively. While Log e is the Neparian log value.

2.3 Net Assimilation Rate

It is increase in dry matter per unit of leaf area per unit time. NAR is calculated by using the formula as suggested by Gregory [10] and expressed as mass unit^{-1} leaf area present per unit time (g cm^{-2} day^{-1}).

$$NAR = \frac{W_2 - W_1}{T_2 - T_1} \times \frac{Log_e A_2 - Log_e A_1}{A_2 - A_1}$$

Where,
W_2-W_1/T_2-T_1 is the CGR, A_2 & A_1 is the leaf area at times T_2 and T_1 respectively and log e is the Neparian log value.

3. RESULTS AND DISCUSSION

3.1 Crop Growth Rate

Data given Table 1 and depicted in Fig. 1a and 1b clearly indicated that nitrogen and weed management practices had significant effect on crop growth rate (CGR) at all stages of crop growth during both the year of experimentation.

At 30-60, 60-90, 90 DAT-at harvest, crop growth rate significantly influenced by nitrogen and weed management practices during both years. Data further revealed that maximum crop growth rate 15.62 and 16.02, 11.91 and 12.20, 6.23 and 6.28 recorded at 160 Kg N/ha, which was statistically at par with 120 Kg N/ha at 30-60, 60-90, 90 DAT-at harvest during 2022 and 2023, while significantly higher than 80 Kg N/ha. This might be due to continues and optimum nitrogen available for plant growth at all stages in such treatment. All most similar results were reported by Tiwari et al. [11].

Among weed management practices weed free recorded maximum crop growth rate 16.14 and 16.61, 13.73 and 13.67, 7.37 and 7.72, during 2022 and 2023 respectively which was statistically at par with application of Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT, While, significantly higher than rest of the weed management practices during both years. This might be due to effective control of weeds, reduce the crop weed competition, increase maximum availability of moisture, nutrient, space and light to the plant resulted in higher crop growth rate and dry matter production. Similar results have been reported by Yadav et al. [12].

3.2 Relative Growth Rate

Data given Table 2 and depicted in Fig 2a and 2b clearly indicate that nitrogen did not influence significantly relative growth rate at all stages of crop growth except 30-60 DAT and weed management practices had significant effect on relative growth rate at all stages of crop growth during both the year of experimentation.

Data further revealed that maximum relative growth rate 38.54 and 38.72, recorded with 160 Kg N/ha at 30-60 DAT during 2022 and 2023, respectively which was statistically at par with 120 Kg N/ha. This might be due to continuous supply of optimum nitrogen which Improve the availability of nutrient to plant increasing of plant growth. These results are supported by the findings Laxminarayana [13].

Among weed management practices, weed free recorded significantly maximum relative growth rate 39.37 and 39.64, 15.45 and 15.09, 5.80 and 5.97 at 30-60, 60-90, 90 DAT-at harvest during 2022 and 2023 respectively, which was at par with application of Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT. While significantly higher than rest of the weed management practices during both years. It might be because of the facts that rate of dry matter accumulation per unit time was direct linked with crop weed competition, happened during the course of crop growth period. The results are in close conformity with Mukherjee and Singh [14].

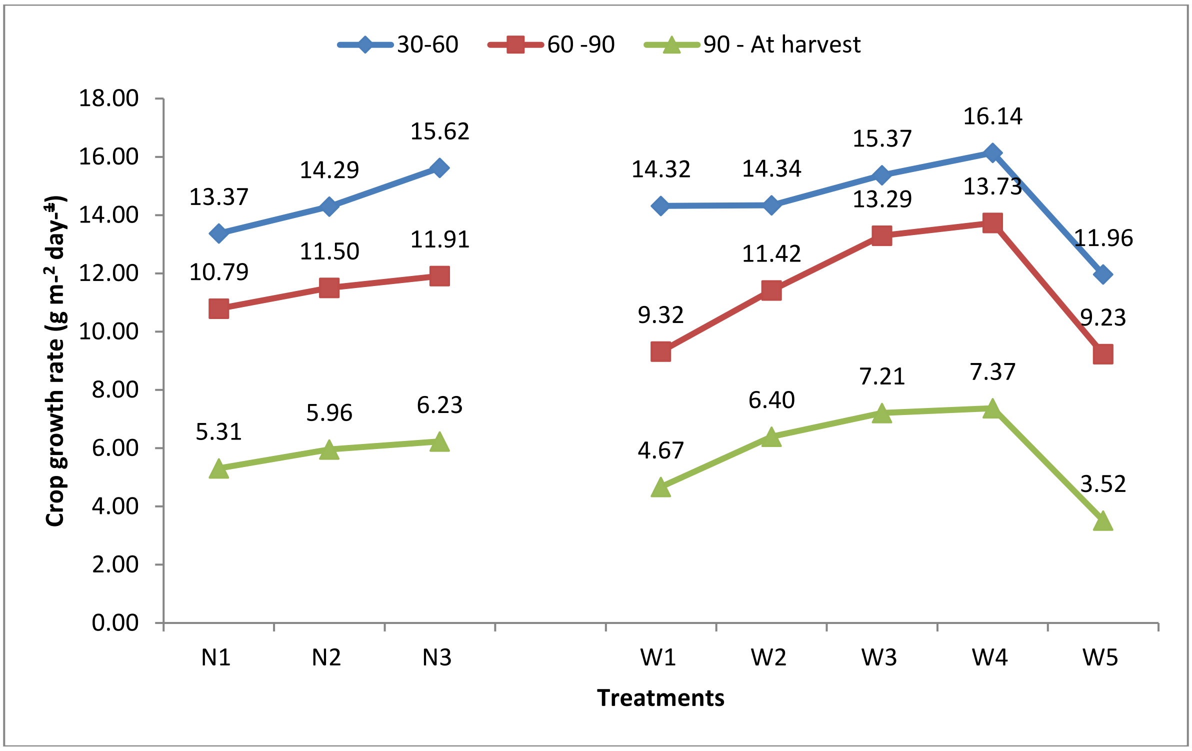

Fig. 1a. Effect of different nitrogen levels and weed management practices on crop growth rate (g $m^{-2}day^{-1}$) of rice during 2022

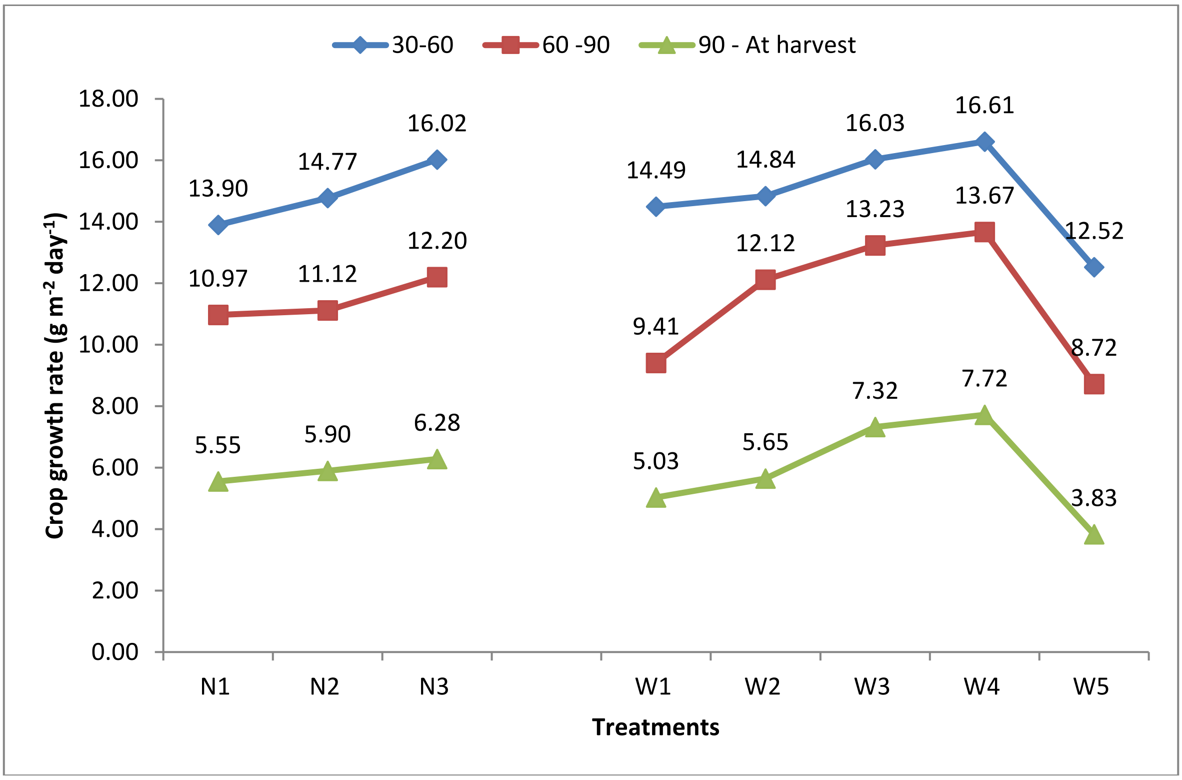

Fig. 1b. Effect of different nitrogen levels and weed management practices on crop growth rate (g $m^{-2}day^{-1}$) of rice during 2023

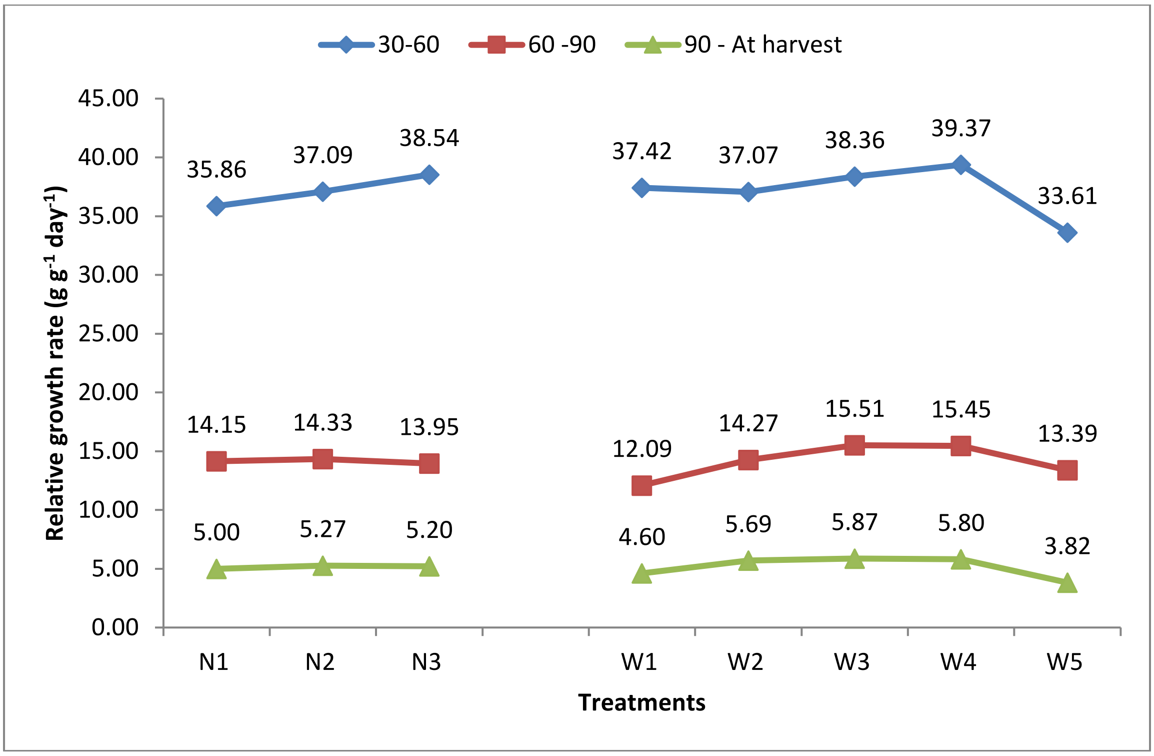

Fig. 2a. Effect of different nitrogen levels and weed management practices on relative growth rate (g g^{-1} day^{-1}) of rice during 2022

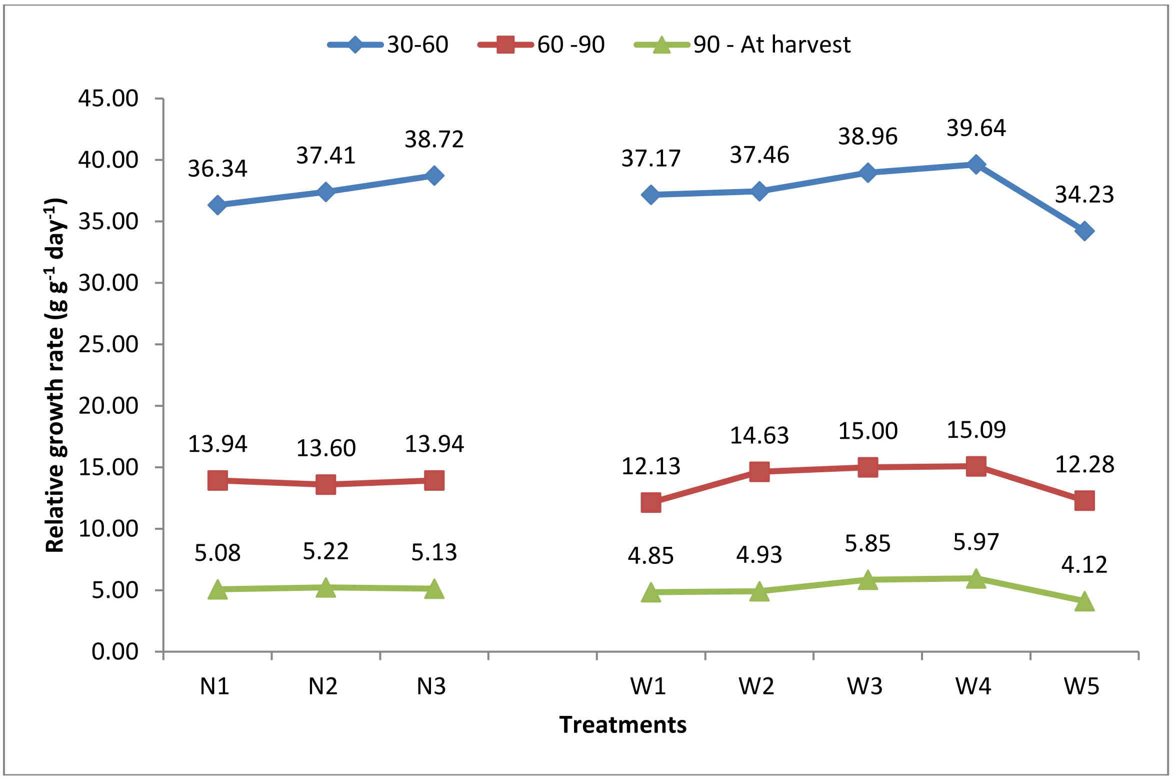

Fig. 2b. Effect of different nitrogen levels and weed management practices on relative growth rate (g g^{-1} day^{-1}) of rice during 2023

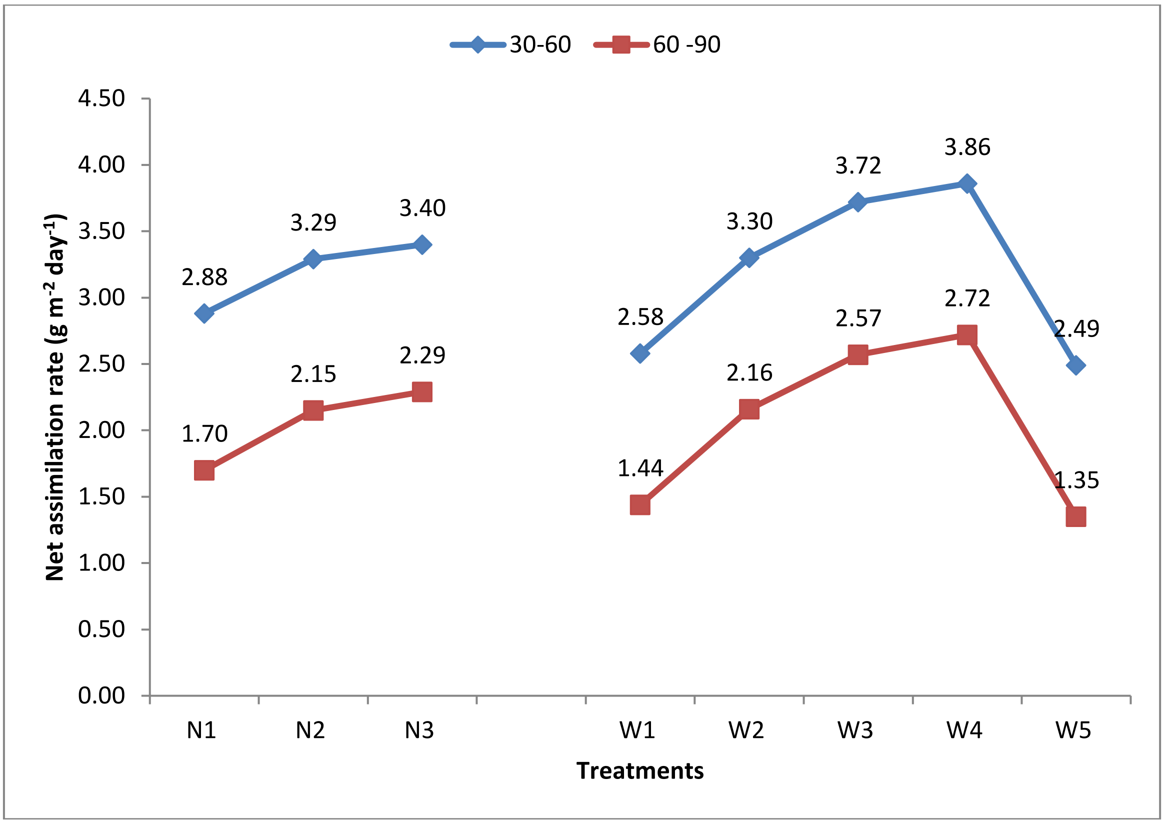

Fig. 3a. Effect of different nitrogen levels and weed management practices on net assimilation rate (g m^{-2} day^{-1}) of rice during 2022

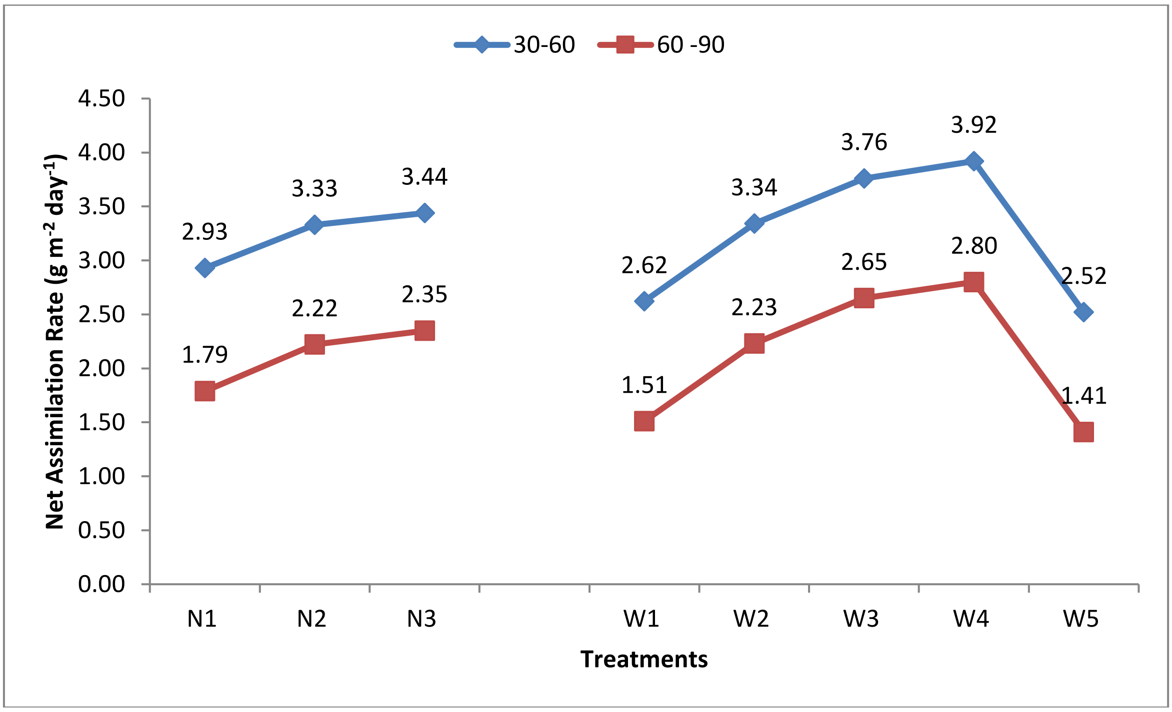

Fig. 3b. Effect of different nitrogen levels and weed management practices on net assimilation rate (g m^{-2} day^{-1}) of rice during 2023

Table 1. Crop growth rate (g m^{-2} day^{-1}) of rice as influenced by nitrogen levels and weed management practices

Treatments	Crop growth rate (g m^{-2} day^{-1})					
	30-60		60 -90		90 - At harvest	
	2022	2023	2022	2023	2022	2023
(A) Nitrogen Levels						
N_1 : 80 Kg/ha	13.37	13.90	10.79	10.97	5.31	5.55
N_2 : 120 Kg/ha	14.29	14.77	11.50	11.12	5.96	5.90
N_3 : 160 Kg/ha	15.62	16.02	11.91	12.20	6.23	6.28
SEm±	0.19	0.20	0.21	0.22	0.11	0.11
CD at 5%	0.78	0.81	0.84	0.88	0.45	0.43
(B) Weed Management Practices						
W_1 : Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT	14.32	14.49	9.32	9.41	4.67	5.03
W_2 : Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT	14.34	14.84	11.42	12.12	6.40	5.65
W_3 : Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT	15.37	16.03	13.29	13.23	7.21	7.32
W_4 : Weed free	16.14	16.61	13.73	13.67	7.37	7.72
W_5 : Weedy check	11.96	12.52	9.23	8.72	3.52	3.83
SEm±	0.32	0.33	0.24	0.24	0.12	0.13
CD at 5%	0.92	0.95	0.71	0.69	0.36	0.37

Table 2. Relative growth rate (g g^{-1} day^{-1} x 10^{-3}) of rice as influenced by nitrogen levels and weed management practices

Treatments	Relative growth rate (g g^{-1} day^{-1} x 10^{-3})					
	30-60		**60 -90**		**90 - At harvest**	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**
(A) Nitrogen Levels						
N_1 : 80 Kg/ha	35.86	36.34	14.15	13.94	5.00	5.08
N_2 : 120 Kg/ha	37.09	37.41	14.33	13.60	5.27	5.22
N_3 : 160 Kg/ha	38.54	38.72	13.95	13.94	5.20	5.13
SEm±	0.50	0.42	0.26	0.27	0.09	0.08
CD at 5%	2.02	1.67	**NS**	**NS**	**NS**	**NS**
(B) Weed Management Practices						
W_1 : Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT	37.42	37.17	12.09	12.13	4.60	4.85
W_2 : Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT	37.07	37.46	14.27	14.63	5.69	4.93
W_3 : Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT	38.36	38.96	15.51	15.00	5.87	5.85
W_4 : Weed free	39.37	39.64	15.45	15.09	5.80	5.97
W_5 : Weedy check	33.61	34.23	13.39	12.28	3.82	4.12
SEm±	0.80	0.91	0.30	0.29	0.11	0.12
CD at 5%	2.33	2.66	0.88	0.85	0.32	0.34

Table 3. Net Assimilation Rate (g m^{-2} day^{-1}) of rice as influenced by nitrogen levels and weed management practices

Treatments	Net Assimilation Rate (g m^{-2} day^{-1})			
	30-60 DAT		60-90 DAT	
	2022	2023	2022	2023
(A) Nitrogen Levels				
N_1 : 80 Kg/ha	2.88	2.93	1.70	1.79
N_2 : 120 Kg/ha	3.29	3.33	2.15	2.22
N_3 : 160 Kg/ha	3.40	3.44	2.29	2.35
SEm±	0.08	0.06	0.07	0.04
CD at 5%	0.34	0.24	0.30	0.14
(B) Weed Management Practices				
W_1 : Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT	2.58	2.62	1.44	1.51
W_2 : Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT	3.30	3.34	2.16	2.23
W_3 : Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT	3.72	3.76	2.57	2.65
W_4 : Weed free	3.86	3.92	2.72	2.80
W_5 : Weedy check	2.49	2.52	1.35	1.41
SEm±	0.11	0.08	0.08	0.05
CD at 5%	0.33	0.23	0.23	0.15

3.3 Net Assimilation Rate

Data given Table 3 and depicted in Fig. 3a and 3b clearly indicated that nitrogen and weed management practices had significant effect on net assimilation rate (NAR) at both stages of crop growth during both the year of experimentation.

At 30-60 and 60-90 DAT, net assimilation rate significantly influenced by nitrogen and weed management practices during both years. Data further revealed that maximum net assimilation rate 3.40 and 3.44, 2.29 and 2.35 during 2022 and 2023 respectively, recorded under 160 Kg N/ha which was statistically at par with 120 Kg N/ha, while significantly higher than 80 Kg N/ha. This might be due to continues and optimum nitrogen available for plant growth at both stages in such treatment. All most similar results were reported by Tiwari et al. [11].

Among weed management practices weed free recorded maximum net assimilation rate 3.86 and 3.92, 2.72 and 2.80, during 2022 and 2023 respectively which was statistically at par with application of Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT, While, significantly higher than rest of the weed management practices during both years. This might be due to effective control of weeds reduce the crop weed competition, increase maximum availability of moisture, nutrient, space and light to the plant resulted in higher crop growth rate and dry matter production. Similar results have been reported by Yadav et al. [12].

4. CONCLUSIONS

It is concluded that, 160 Kg N/ha and Pyrazosulfuron ethyl 10 % WP @ 20g a.i/ha (PE) at 0-3 DAT *fb* Bispyribac sodium 10 % SC @ 25g a.i/ha (PoE) at 25 DAT for weed management practices was found better for all growth indices crop growth rate (CGR), relative growth rate (RGR), and net assimilation rate (NAR) under transplanted rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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