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Article

Naphthalene Acetic Acid and Irrigation Regimes Influence Paddy Yield and its Economics under Arid Conditions

Efeito do Ácido Naftalenoacético e Regimes de Irrigação na Produtividade do Arroz e sua Economia sob Condições Áridas

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ABSTRACT - The study aimed to highlight the impact of naphthalene acetic acid (NAA) and irrigation regimes on the productivity of coarse rice under agro-ecological conditions of Dera Ismail Khan, Pakistan. The experiment was comprised of two factors with four levels (0, 60, 90, 120 mL ha^{-1}) of NAA and irrigation at the depths (60, 75, 90 and 105 cm) of soil profile. The data was interpreted to observe the plant height (cm), productive tillers (m^{-2}), sterility percentage (%), biological yield (t ha^{-1}), and grain yield (t ha^{-1}) of coarse rice. The benefit cost ratio (BCR) was also calculated. The results indicated that the application of NAA was found very effective in improving paddy yield and hence resulted in better BCR value. The maximum paddy yield was attained under the application of NAA 90 mL ha^{-1} as PGR (NAA) at 75 cm irrigation depth. The experimental data confirm that the application of NAA at the rate of 90 mL ha^{-1} with irrigation upto depth of 75 cm increases grain yield in rice and ensures better economic returns, thus inclusion of 90 mL ha^{-1} as PGR (NAA) at 75 cm irrigation depth under arid conditions assist in boosting paddy yield.

Keywords: agronomic efficiency, soil moisture, growth regulator, benefit-cost ratio, *Oryza sativa*.

RESUMO - Este estudo teve como objetivo destacar o efeito do ácido naftalenoacético (ANA) e regimes de irrigação sobre a produtividade do arroz grosso sob condições agroecológicas de Dera Ismail Khan, no Paquistão. O experimento foi composto por dois fatores, com quatro níveis (0, 60, 90 e 120 mL ha^{-1}) de ANA e lâminas de irrigação (60, 75, 90 e 105 cm). Os dados foram descritos para observar a altura da planta (cm), perfilhos produtivos (m^2), porcentagem de esterilidade (%), rendimento biológico (t ha^{-1}) e rendimento de grãos (t ha^{-1}) de arroz grosso. A relação custo-benefício (BCR) também foi calculada. Os resultados indicaram que a aplicação de ANA foi muito eficaz em aumentar o rendimento de arroz e, consequentemente, resultou em melhor valor de BCR. A máxima produtividade de arroz foi obtida com a aplicação de 90 mL ha^{-1} de ANA como regulador de crescimento a 75 cm de profundidade de irrigação. Os dados experimentais confirmam que a aplicação de ANA a 90 mL ha^{-1} na profundidade de irrigação de 75 cm aumenta a produtividade de arroz e assegura melhor retorno econômico; assim, a inclusão deste tratamento sob condições áridas pode ser útil para impulsionar a produtividade de arroz.

Palavras-chave: eficiência agronômica, umidade do solo, regulador de crescimento, relação custo-benefício, *Oryza sativa*.

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INTRODUCTION

Rice crop ranks second after wheat among the cereals cultivated in Pakistan (Bakhsh et al., 2012). It provides 60% of the energy requirements of almost half of the global population, while 30% of the entire human energy is consumed by it. It is estimated that the global population expected rise by 65% by the year 2020, thus about 758 million tons of world's rice will have to be produced to meet the demand (Kanmani et al., 2017) Throughout the world, Asia produces and consumes the largest quantity of rice as 85% of its residents belong to developing countries (Guerra et al., 1998). In Pakistan, the rice consumption per person is very less i.e., 20.7 kg due to higher cost as compared to wheat flour (Shaikh and Kanasro, 2003). In Pakistan, rice accounts for 3.1% of value addition in agricultural products and 0.6% in GDP (Mo et al., 2016). In 2017-2018, the total production of rice in Pakistan stood at 7442 thousand tons from 2899 thousand ha with average yield of 2.56 t ha^{-1} (Pakistan, 2018). In comparison with the other rice growing countries of the world, e.g., Japan, China and India, average yield in Pakistan is still very low. Therefore, it is time scale need to improve the existing production practices to bring rice yield upto desired level.

Water plays a pivotal role in the agricultural production. According to an estimate, agriculture consumes 70% of world's annual fresh water, and in Asia, large portion of water is utilized by rice crop (Dissanayaka and Dahanayake, 2014). An efficient irrigation system should, therefore, be devised to ensure better crop yield and food security along with environmental sustainability.

Pakistan as an agriculture based economy relies mainly on cereal crops and their better water use efficiency (WUE) is an important consideration of agriculture to boost the economy. Unfortunately, the gap between demand and supply of water is increasing at an alarming rate due to drought and excessive use, thus there is an effective approach to highlight the significance of developing new water sources and conservation of the limited available water (Wang et al., 2012).

Plant growth regulators (PGRs) counter effect with growth and physiological and morphological attributes of plants and determine the direction, type, quantity and quality of plant growth (Anjum et al., 2011). Although the plant growth regulators are synthesized by plants themselves, however, many studies have encouraged the use of exogenous application of synthetic PGRs as well (Bakhsh et al., 2011). According to Kato et al. (2004) exogenous application of PGRs offers great opportunity to enhance plant growth and improve the associated traits.

Developmental strategies which could guarantee efficient use of irrigation water will be beneficial in determining the future aspects of rice production. Goal can be achieved by adopting improved agriculture policies and practices and modern rice farming techniques to minimize the yield gap.

The study hypothesized to find-out the optimum irrigation level along with the best interactive levels of irrigation and NAA for better paddy yield.

MATERIALS AND METHODS

The research was undertaken at the Postgraduate Agricultural Research Farm, Gomal University, Dera Ismail (DI) Khan, Pakistan, during rice growing seasons of 2014 and 2015. The experimental soil was clay texture and calcareous with pH 8.0 and 8.2. The experiment was laid out in a randomized complete block design (RCBD) with split plot arrangements, replicated 4 times. The plot size was 3 x 5 m^{-2}. Four different levels of plant growth regulator naphthalene acetic acid (NAA) (0 mL ha^{-1}, 60 mL ha^{-1}, 90 mL ha^{-1} and 120 mL ha^{-1}) were kept in main plots and applied at panicle initiation stage. While, sub-plots were occupied by irrigation regimes.

Irrigation regimes were I_1=60 cm, I_2=75 cm, I_3=90 cm and I_4=105 cm. All these treatment were maintained till the maturity of the crop. The depth of irrigation water was kept at 7.5 cm for each irrigation level in order to keep the root zone of the crop at field capacity during the entire crop growth period was maintained as per following equation (Chaudhary, 2001);

$$R = \frac{(FC - MC)}{100} \times BXD$$

where "R" represents the requirement of water on the sampling day, FC represents field capacity, MC is the percent weight of moisture content in the sample, B is the soil bulk density, D is the root zone depth in cm).

$$\textit{The required volume of water} = \textit{Width} \times \textit{Length} \times \textit{Depth} = 3 \times 5 \times 0.075 = 1.25\ \text{m}^3$$

Urea and SSP were utilized as fertilizer sources for 120 kg and 100 kg per hectare of N and P, respectively. During nursery transplantation, entire phosphorus and half of the recommended nitrogen was applied. The remaining half of the nitrogen was applied at panicle initiation stage. Seeds of variety "IR-6" were sown for the purpose of nursey raising. After 35 days of sowing, the seedlings were transplanted with 20 x 20 cm row to row and plant to plant distance in the main field. The recommended agronomic practices for rice were adopted throughout the growing season of the crop. The data were taken on plant height (cm), productive tillers m^{-2}, sterility percentage, biological yield (t ha^{-1}), paddy yield (t ha^{-1}) and BCR, which was calculated according to Phulare and Upadhyay (1978). Statistical analysis of the obtained data was done with the help of analysis of variance (ANOVA) technique while the differences among the mean values were examined using the Least Significance Difference Test (LSD at 1%) using SPSSv. 20.0 statistical package (SPSS Inc., Chicago, IL).

RESULTS AND DISCUSSION

Plant height (cm)

According to the data for plant height, significant differences were executed both the years by the mean values in response to the levels of NAA applied. However, among the various treatments of growth regulator (NAA), the maximum plant height (129.5 and 130.0 cm, respectively) was achieved during 2014 and 2015 by application of 90 mL ha^{-1} of NAA. Pandey et al. (2001) reported significant enhancement of plant stature with 50 ppm of Indole acetic acid (IAA). On the other hand, control treatment produced the shortest plants which is indicative of the positive effect of growth regulator on plant height in rice. Bakhsh et al. (2017) also validated our results by reporting maximum plant height with the application of 80 mL of growth regulator (IAA) - (Table 1).

Similar response of plant height was observed with varying irrigation levels. In this regard, irrigation level at the rate of 75 cm (I_2) produced significantly tallest plants (123.3 cm and 127.4 cm both the years) which was followed by I_3 = 105 cm, respectively producing 119.3 cm and 120.1 cm tall plants during 2014 and 2015. These results are supported by the findings of Anbumozhi et al. (1998) who also reported significant plant height with 9 cm depth, unlike 7.5 cm depth in our study. The difference may be attributed to different climosequence and edaphic conditions. In contrast, shortest plants measuring 104.75 cm and 106.25 cm were recorded with 60 cm irrigation level (I_1).

Table 1 **-** Effect of plant growth regulator (PGR) levels and different irrigation regimes on plant height at maturity (cm) in transplanted coarse rice during 2014 and 2015

Irrigation regime	2014					2015				
	PGR levels					PGR levels				
	G_0	G_1	G_2	G_3	Means	G_0	G_1	G_2	G_3	Means
I_1	97.0 j	106.0 i	116.0 e	100.00 j	104.75 d	99.0 i	108.0 fg	117.0 e	101.0 hi	106.25 d
I_2	112.0 fg	126.0 cd	140.0 a	115.00 ef	123.30 a	115.0 e	129.5 c	142.0 a	123.0 d	127.40 a
I_3	104.0 i	123.0 d	133.0 b	117.00 e	119.30 b	105.5 gh	124.0 d	135.0 b	116.0 e	120.10 b
I_4	100.0 j	110.0 gh	129.0 c	107.00 hi	121.50 c	102.0 hi	112.6 ef	126.0 cd	108.0 fg	112.20 c
Means	103.30 d	116.3 b	129.5 a	109.75 c		105.4 d	118.5 b	130.0 a	112.0 c	

2014: $LSD_{0.01}$ =1.742 (G. levels); $LSD_{0.01}$ =1.512 (Irrigation regimes); $LSD_{0.01}$ =3.023 (Interaction). 2015: $LSD_{0.01}$ =2.211 (G. levels); $LSD_{0.01}$ =2.543 (Irrigation regimes); $LSD_{0.01}$ =5.085 (Interaction). Within a column dissimilar letter(s) with the mean values determine significance at p≥1.

The interactive effect of PGR levels and irrigation regimes exhibited highly significant results for plant height during the both experimental years. The maximum plant height 140 cm and 142 cm, respectively was obtained with G_2I_2. This treatment maximally increased the internode and panicle length which in turn enhance the plant height. Furthermore, shortest plants of 97.00 and 99.00 cm height were recorded with G_0I_1 during 2014 and 2015, respectively.

The increase in plant height was thought to be due to more vegetative growth by rapid cell division and cell enlargement accelerated by growth hormones (Pareek and Pareek, 2000; Ben and Danial, 2017).

Number of productive tillers m^{-2}

Productive tillers are one of the most important yield attributes in tillering crops as they determine the extent of final yield that can be achieved. It was elucidated by the obtained data that all the treatment significantly enhanced the number of productive tillers as compared to un-treated control during 2014 and 2015. The maximum increase (394.7 and 389.8 m^{-2}) in this regard was observed with 90 mL ha^{-1} (G_2) of PGR which was followed by 60 mL ha^{-1} (G_1) showing 388.8 m^{-2} and 380.0 m^{-2} during 2014 and 2015, respectively. The un-treated plots had the least productive tillers which were 345.8 and 347.0 m^{-2}, respectively both the years. Reddy et al. (2009) justify that maximum productive tillers m^{-2} were produced by PGR i.e. NAA was applied at the rate of 100 g ha^{-1} (Table 2).

The data further indicated significant variation for number of productive tillers with different irrigation regimes during 2014 and 2015. Nevertheless, among the treatments, best results were found with I_2 -75 cm which produced maximum number of productive tillers (396.2 and 390.0 m^{-2}) during the twin years. The treatment I_3=105 cm was next to follow with productive tillers of 385.9 m^{-2} and 379.3 m^{-2} during 2014 and 2015, respectively. Significantly better results pertaining number of productive tillers m^{-2} in rice were reported by He (2010) with furrow irrigation than with continuous flooding. Similarly Balasubramanian and Krishnarajan (2003) reported enhancement in grain yield when rice plants were continuously submerged in 2.5 cm as compared to 5 cm water level.

The number of productive tillers have a considerable response to the interaction of PGR and irrigation levels from 2014to 2015. Interaction of G_2I_2 presented the maximum number of productive tillers i.e. 403.8 m^{-2} and 401.0 m^{-2}, respectively, both the years. Whereas, least productive tillers of 366 m^{-2} and 373 m^{-2} were noted in G_0I_1 during 2014 and 2015, respectively. The rice plant may produce more productive tillers and panicles by the application of plant growth regulators (Bakhsh et al. 2017).

Sterility percentage

According to the results, NAA at the rate of 90 mL ha^{-1} (G_2) produced less sterile panicles (23.12 and 22.89 %) during 2014 and 2015, respectively. Chenniappan et al. (2004) revealed that with the application of GA_3, less sterile panicles with higher seed set (34.40%) were observed. GA_3 and NAA belong to the same group of plant growth regulators (Table 3).

Irrigation levels also presented significant results for sterility percentage both the experimental years. Among the irrigation treatments, I_1=60 cm produced the most sterile panicles (29.50% and 28.00%, respectively) during 2014 and 2015. Whereas, I_2=75 cm showed the least sterile panicles (23.50 and 22.63%) both the study years, respectively. Almost similar results were presented by Shimono et al. (2002) who reported that sterility percentage can be minimized by using exogenous growth regulators.

Sterility percentage was also significantly affected by the interactive treatments of NAA and irrigation regimes, wherein interaction of G_0I_1 (Control x 60 cm irrigation level) depicted maximum sterility of 34.00 and 32.00%, respectively during both the years. Whereas, less percent sterility was noted in the interaction of G_2 x I_2 during 2014 and 2015, respectively. This may be due to the availability of optimum irrigation water required during pollination and seed setting stage which resulted in higher seed set.

Table 2 **-** Effect of plant growth regulator (PGR) levels and different irrigation regimes on number of productive tillers m^{-2} in transplanted coarse rice during 2014 and 2015

Irrigation regime	2014					2015				
	PGR levels					PGR levels				
	G_0	G_1	G_2	G_3	Means	G_0	G_1	G_2	G_3	Means
I_1	366.0 l	382.0 hi	387.0 fg	370.0 k	376.3 d	358.0 k	373.0 hi	380.0 fg	362.0 k	368.3 d
I_2	389.0 ef	398.0 b	403.8 a	394.0 cd	396.2 a	381.0 f	391.0 bc	401.0 a	387.0 cd	390.0 a
I_3	377.0 j	390.0 ef	396.0 bc	380.5 i	385.9 b	369.0 ij	382.0 ef	392.0 b	374.0 h	379.3 b
I_4	371.0 k	385.0 gh	392.0 de	375.0 j	380.8 c	360.0 k	376.0 gh	386.0 de	368.0 j	372.5 c
Means	375.8 d	388.8 b	394.7 a	379.9 c		367.0 d	380.0 b	389.8 a	372.8 c	

2014: $LSD_{0.01}$ =2.033 (G. levels); $LSD_{0.01}$ =1.547 (Irrigation regimes); $LSD_{0.01}$ =3.094 (Interaction). 2015: $LSD_{0.01}$ =3.181 (G. levels); $LSD_{0.01}$ =2.467 (Irrigation regimes); $LSD_{0.01}$ =4.934 (Interaction). Within a column dissimilar letter(s) with the mean values determine significance at $p \geq 1$.

Table 3 **-** Effect of plant growth regulator (PGR) levels and different irrigation regimes on sterility percentage in transplanted coarse rice during 2014 and 2015

Irrigation regime	2014					2015				
	PGR levels					PGR levels				
	G_0	G_1	G_2	G_3	Means	G_0	G_1	G_2	G_3	Means
I_1	34.00 a	28.50 d	23.00 i	32.50 b	29.50 a	32.00 a	27.00 cde	23.00 g	30.00 ab	28.00 a
I_2	26.01 f	25.00 g	20.00 j	23.00 i	23.50 d	24.50 efg	23.00 g	20.00 h	23.00 g	22.63 c
I_3	27.00 e	26.00 f	24.00 h	25.00 g	25.50 c	25.00 defg	24.00 fg	23.58 fg	23.50 fg	24.02 b
I_4	29.00 d	27.50 e	25.50 fg	31.05 c	28.26 b	27.50 bcd	26.00 cdef	25.00 defg	28.50 bc	26.75 a
Means	29.00 a	26.75 d	23.13 c	27.89 b		27.25 a	25.00 b	22.89 c	26.25 ab	

2014: $LSD_{0.01}$ =0.58 (G. levels); $LSD_{0.01}$ =0.43 (Irrigation regimes); $LSD_{0.01}$ =0.87 (Interaction). 2015: $LSD_{0.01}$ =1.53 (G. levels); $LSD_{0.01}$ =1.31 (Irrigation regimes); $LSD_{0.01}$ =2.616 (Interaction). Within a column dissimilar letter(s) with the mean values determine significance at $p \geq 1$.

Biological yield (t ha^{-1})

The maximum biological yield of 29.50 and 29.89 t ha^{-1} was produced by plots applied with G_2= 90 mL ha^{-1} of NAA. Whereas, G_1= 60 mL ha^{-1} followed G_2 by producing 28.03 and 28.26 t ha^{-1}) biological yield during 2014 and 2015, respectively. The findings of Hayat et al. (2010) are in line with the present findings. They observed significant enhancement in biological yield of rice with the application of plant growth regulators. The control treatment remained ineffective and produced minimum biological yield (23.90 and 24.36 t ha^{-1}, respectively) both the years (Table 4).

Irrigation levels also posted significant results for biological yield during 2014 and 2015. The plots which received 75 cm of irrigation level showed maximum biological yield of 29.78 and 30.26 t ha^{-1} and was followed by 28.63 and 28.80 t ha^{-1} biological yield which was produced by plots receiving I_3= 105 cm, during 2014 and 2015, respectively.

Table 4 **-** Effect of plant growth regulator (PGR) levels and different irrigation regimes on biological yield (t ha^{-1}) in transplanted coarse rice during 2014 and 2015

Irrigation regime	2014					2015				
	PGR levels					PGR levels				
	G_0	G_1	G_2	G_3	Means	G_0	G_1	G_2	G_3	Means
I_1	20.30 i	23.30 g	25.00 f	21.75 h	22.59 d	21.00 k	23.45 i	25.25 h	22.00 j	22.93 d
I_2	27.00 e	31.13 b	32.00 a	29.00 c	29.78 a	27.60 f	22.50 b	32.75 a	21.20 d	30.26 a
I_3	25.30 f	29.40 c	31.60 a	28.20 d	28.63 b	25.60 h	29.60 cd	31.75 b	28.25 e	28.80 b
I_4	23.00 g	28.30 d	29.40 c	27.20 e	26.98 c	23.25 i	28.50 e	29.80 c	26.60 g	27.04 c
Means	23.90 d	28.03 b	29.50 a	26.54 c		24.36 d	28.26 b	29.89 a	26.51 c	

2014: $LSD_{0.01}$ =0.1704 (G. Levels); $LSD_{0.01}$ =0.2171 (Irrigation regimes); $LSD_{0.01}$ =0.4343 (Interaction). 2015: $LSD_{0.01}$ =0.2382 (G. Levels); $LSD_{0.01}$ =0.2719 (Irrigation regimes); $LSD_{0.01}$ =0.5439 (Interaction). Within a column dissimilar letter(s) with the mean values determine significance at $p \geq 1$.

The biological yield was also significantly influenced by the interaction of NAA x irrigation regimes where G_2 x I_2 gave the highest results (32.00 and 31.75 t ha^{-1}, respectively) during 2014 and 2015. This may be because of the optimum supply of irrigation water which induced rapid phase of growth and development which in turn favored vegetative crop growth in both of the years. On the contrary, the interaction of control x 60 cm irrigation level presented lowest results in terms of biological yield (20.30 and 21.00 t ha^{-1}, respectively) during both the experimental years.

Paddy yield (t ha^{-1})

The application of NAA 90 mL ha^{-1} produced maximum paddy yield (8.62 and 8.38 t ha^{-1}) than all the other treatments during 2014 and 2015, respectively. Reddy et al. (2009) reported highest paddy yield with the application of 100 ppm ha^{-1} Naphthalene acetic acid (NAA). Choi et al. (2010) also reported enhancement in paddy yield with ICA, a plant growth regulating compound (Table 5).

Table 5 **-** Effect of plant growth regulator (PGR) levels and different irrigation regimes on paddy yield (t ha^{-1}) in transplanted coarse rice during 2014 and 2015

Irrigation regime	2014					2015				
	PGR levels					PGR levels				
	G_0	G_1	G_2	G_3	Means	G_0	G_1	G_2	G_3	Means
I_1	5.10 j	5.90 i	6.80 gh	5.50 ij	5.82 d	4.75 i	5.60 gh	6.20 fg	5.00 hi	5.39 d
I_2	7.50 ef	9.10 b	10.00 a	7.90 de	8.62 a	7.60 cde	8.70 b	9.60 a	7.60 cde	8.38 a
I_3	6.75 gh	8.20 cd	9.35 b	7.10 fg	7.82 b	6.20 fg	7.85 cd	8.90 ab	6.82 ef	7.44 b
I_4	5.80 i	7.70 e	8.50 c	6.50 h	7.12 c	5.20 hi	7.30 de	8.20 bc	6.20 fg	6.72 c
Means	6.26 d	7.72 b	8.66 a	6.75 c		5.94 d	7.36 b	8.22 a	6.41 c	

2014: $LSD_{0.01}$ =0.3428 (G. levels); $LSD_{0.01}$ =0.2413 (Irrigation regimes); $LSD_{0.01}$ =0.4827 (Interaction). 2015: $LSD_{0.01}$ =0.4494 (G. levels); $SD_{0.01}$ =0.4057 (Irrigation regimes); $LSD_{0.01}$ =0.8113 (Interaction). Within a column dissimilar letter(s) with the mean values determine significance at p≥1.

Among the different irrigation regimes, significantly higher paddy yield was obtained with I_2= 75 cm, which was 8.62 and 8.37 t ha^{-1} during 2014 and 2015, respectively. Whereas, the treatment I_1 -60 cm showed the lowest paddy yield of 5.82 and 5.39 t ha^{-1} both the years, respectively. He (2010) achieved more paddy yield in aerobic as compared to flooded condition. Kato et al. (2009) reported yield increase in rice with the application of 80-130 cm irrigation water. Similarly, Bouman et al. (2001) observed maximum yield with 60-70 cm water.

The interactive effect revealed that the maximum paddy yield (10.00 and 9.60 t ha^{-1}, respectively attain in the both of the years) where 90 mL ha^{-1} plant growth regulator coupled with 75 cm irrigation level was maintained. On the other hand the plots without growth regulator application and receiving 60 cm irrigation level produced the lowest paddy yield of 5.10 and 4.75 t ha^{-1}, during 2014 and 2015, respectively. As the interaction of $G_2 I_2$ produced more number of productive tillers and showed maximum seed set, therefore an overall enhancement was observed in the grain yield as well. This might also have been due to the fact that leaves remained functional for a longer period due to optimum quantity of growth regulator and irrigation water applied which might have encouraged better photosynthesis and translocation of photosynthates to the sink. Razi and Sen (1996) reported improvement in water use efficiency of rice when treated with mixture of 10^{-4} M each of IAA, Kinetin and GA_3.

Economic analysis and BCR

The data for benefit cost ratio (BCR) during 2014 and 2015 for transplanted coarse rice as influenced by the interaction of NAA levels and irrigation regimes are presented in Table 6. Among the different interactions of the two factors, treatment G_2I_2 stood first in terms of BCR (1.98 and 1.86) and net income amounting PKR. 199435 and 187435 ha^{-1} during 2014 and 2015, respectively. Reddy et al., (2009) also obtained maximum BCR values with the application of

Table 6 **-** Effect of plant growth regulator (PGR) levels and different irrigation regimes on economic analysis and BCR in transplanted coarse rice during 2014 and 2015

Plant growth regulator level + irrigation regime	2014						2015					
	Paddy yield	Total variable cost	Gross income	Total cost	Net income	BCR	Paddy yield	Total variable cost	Gross income	Total cost	Net income	BCR
	($t\ ha^{-1}$)	($Rs.\ ha^{-1}$)					($t\ ha^{-1}$)	($Rs.\ ha^{-1}$)				
G_0 (0 mL ha^{-1})	6.26	0	187800	99620	88180	0.88	4.94	0	178200	99620	78580	0.78
G_1 (60 mL ha^{-1})	7.72	45	231600	99665	131935	1.32	6.36	45	220800	99665	121135	1.21
G_2 (90 mL ha^{-1})	8.66	60	259800	99680	160120	1.60	7.22	60	246600	99680	146920	1.47
G_3 (120 mL ha^{-1})	6.75	75	202500	99695	102805	1.03	5.41	75	192300	99695	92605	0.92
I_1 (600 mm)	5.82	740	174600	100360	74240	0.73	4.39	740	161700	100360	61340	0.61
I_2 (750 mm)	8.62	900	258600	100520	158080	1.57	7.38	900	251400	100520	150880	1.50
I_3 (900 mm)	7.82	1010	234600	100630	133970	1.33	6.44	1010	223200	100630	122570	1.21
I_4 (1050 mm)	7.12	1220	213600	100840	112760	1.11	5.72	1220	201600	100840	100760	0.99
G_0X I_1	5.10	740	153000	100360	52640	0.52	3.75	740	142500	100360	42140	0.41
G_0X I_2	7.50	900	225000	100520	124480	1.23	6.60	900	228000	100520	127480	1.26
G_0 X I_3	6.65	1010	199500	100630	98870	0.98	5.20	1010	186000	100630	85370	0.84
G_0X I_4	5.80	1220	174000	100840	73160	0.72	4.20	1220	156000	100840	55160	0.54
G_1X I_1	5.90	770	177000	100390	76610	0.76	4.60	770	168000	100390	67610	0.67
G_1X I_2	9.10	930	273000	100550	172450	1.71	7.70	930	261000	100550	160450	1.59
G_1 X I_3	8.20	1040	246000	100660	145340	1.44	6.85	1040	235500	100660	134840	1.33
G_1 X I_4	7.70	1250	231000	100870	130130	1.29	6.30	1250	219000	100870	118130	1.17
G_2X I_1	6.80	785	204000	100405	103595	1.03	5.20	785	186000	100405	85595	0.85
G_2X I_2	10.0	945	300000	100565	199435	1.98	8.60	945	288000	100565	187435	1.86
G_2 X I_3	9.35	1055	280500	100675	179825	1.78	7.90	1055	267000	100675	166325	1.65
G_2X I_4	8.50	1265	255000	100885	154115	1.52	7.20	1265	246000	100885	145115	1.43
G_3 X I_1	5.50	800	165000	100420	64580	0.64	4.00	800	150000	100420	49580	0.49
G_3 X I_2	7.90	960	237000	100580	136420	1.35	6.60	960	228000	100580	127420	1.26
G_3 X I_3	7.10	1070	213000	100690	112310	1.11	5.82	1070	204600	100690	103910	1.03
G_3 X I_4	6.50	1280	195000	100900	94100	0.93	5.20	1280	186000	100900	85100	0.84

100 g ha^{-1} of NAA. Further the data revealed that the next highest BCR of 1.78 and 1.65 was found in G_2I_3, during both the years. However, control treatment exhibited the least net returns and BCR.

Irrigation regimes and plant growth regulator i.e. Naphthalene Acetic Acid (NAA) levels significantly improved all the traits of transplanted coarse rice IR-6 over the untreated control, however, the best results were obtained with the application of 75 cm irrigation level and 90 mL ha^{-1} NAA. Thus, this treatment is recommended for better paddy yield and maximum net return under arid cimosequence.

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