Article AR2008

DOI: HTTPS://DOI.ORG/10.23910/IJBSM/2019.10.4.2008

International Journal of Bio-resource and Stress Management

Crossref

August 2019

Print ISSN 0976-3988
Online ISSN 0976-4038

IJBSM 2019, 10(4):382-388

Research Article *Natural Resource Management*

Studies on Effect of Age of Seedling and Levels of Nitrogen on Performance of Hybrid Rice (*Oryza sativa* L.)

Govinda Kumar[1], Shivasankar Acharya[1*], S. K. Pathak[1], Sunil Kumar[2], Fozia Homa[3] and Arun Kumar[4]

[1]Dept. of Agronomy, [2]Dept. of Soil Science and Agricultural Chemistry, [3]Dept. of SMCA, [4]Dept. of Seed Science and Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar (813 210), India

Open Access

Corresponding Author

Shivasankar Acharya

e-mail: acharya.ss@rediffmail.com

Citation: Kumar et al., 2019. Studies on Effect of Age of Seedling and Levels of Nitrogen on Performance of Hybrid Rice (*Oryza sativa* L.). International Journal of Bio-resource and Stress Management 2019, 10(4):382-388. HTTPS://DOI.ORG/10.23910/IJBSM/2019.10.4.2008

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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

Abstract

A field experiment was conducted during *kharif* season of 2018 at Bihar Agricultural College Farm, Sabour, Bhagalpur, Bihar, to study the effect of age of seedling and levels of nitrogen on performance of hybrid rice (*Oryza sativa* L.) variety Arize-6444 Gold. The experiment was laid out in a split-plot design, replicated thrice with main plot assigned to three levels of age of seedling and subplot with four nitrogen levels. The result revealed highest grain yield (5374 kg ha^{-1}) recorded with 15 days seedling, being at par with 20 days seedling (5216 kg ha^{-1}), but differed significantly with 25 days seedling (4934 kg ha^{-1}). Among the nitrogen levels, significant difference in grain yield and harvest index was found with 150 kg N ha^{-1} with values of 6050 kg ha^{-1} and 45.21% respectively, being at par with 180 kg N ha^{-1}, whereas the highest straw yield (7439 kg ha^{-1}) was recorded with 180 kg N ha^{-1}, being at par with 150 kg N ha^{-1}. The highest net return (Rs. 60,850 ha^{-1}) was obtained with 15 days seedling, which was found at par with 20 days but differed significantly from 25 days seedling. Nitrogen levels significantly influenced the net return and B:C ratio, with the highest net return (Rs.73014 ha^{-1}) and B:C ratio (1.67) obtained with 150 kg N ha^{-1} respectively, being at par with 180 kg N ha^{-1} with net return and B:C ratio of Rs. 69,139 ha^{-1} and 1.56 respectively, differing significantly from 120 kg N ha^{-1} and no nitrogen plot.

Keywords: Age of seedling, nitrogen, hybrid rice, yield, economics

1. Introduction

Rice (*Oryza sativa* L.), also known as global grain, is a major cereal crop and most important staple primary food source for more than 60% of the world's population (Prasad et al., 2010). India has the largest area under rice cultivation with an area of 43.19 mha., accounting for 29.40% of the global rice area. However, production of rice in India is 110.15 mt, with a national productivity of rice is 2.55 t ha^{-1} (Anonymous, 2019). The current world population of 7.6 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100 (World Population Prospects: The 2017 Revision). The yield of high yielding varieties of rice is plateauing and is rather difficult to achieve the target with the present day varieties. Therefore, to sustain self-sufficiency in rice, among the available technological options to enhance rice production and productivity, hybrid rice is the most practically feasible and readily adoptable technology. Hybrid rice technology has been identified as

Article History

RECEIVED in 29th June 2019 RECEIVED in revised form 23rd August 2019 ACCEPTED in final form 30th August 2019

one of the alternative means to meet the challenge of food security for the increasing population (Islam et al., 2009). The success of hybrid rice cultivation depends on the exploitation of the full potential of the hybrids with improved package of practices such as suitable genotype, optimum plant population and optimum nutrition. The use of appropriate aged seedlings for transplantation and its timely planting are important non-cash inputs for attaining the higher yield of rice. Transplanting of younger aged seedlings utilizes phyllochronic potential to produce significantly higher grain yield of rice (Shukla et al., 2014). Hybrid rice crop is a heavy feeder of fertilizers and in addition to other nutrients; nitrogen is key nutrient of increased production, which directly influences the growth, development, yield and economics of hybrid rice. Nitrogen fertilization has a vital role in determining the percentage nitrogen in the rice grains and nitrogen uptake by the rice plants. Insufficient or inappropriate fertilizer nitrogen management may account for one-half to two-third of the gap between actual and potential irrigated rice yield. Thus, keeping in view of above facts into consideration, one experiment entitled "Studies on effect of age of seedling and levels of nitrogen on performance of hybrid rice (*Oryza sativa* L.)" was conducted with the objectives to study the effect of age of seedling and nitrogen level on growth, yield attributes, yield and economics of hybrid rice.

2. Materials and Methods

The present experiment was conducted at Bihar Agricultural College Farm, Sabour, Bihar Agricultural University, Sabour, during *kharif* season of 2018, which comes under Agro-climatic Zone III A of Bihar and Middle Gangetic plain region of India, situated at 25°50' N latitude and 87°19' E longitude with an altitude of 52.73 meters above mean sea-level. The monthly mean maximum temperature during the crop growth period ranged from 29.6 °C in the month of November, 2018 to 35.5 °C, recorded in June, 2018, whereas the monthly mean minimum temperature ranged from 12.9 °C in the month of November to 25.3 °C in the month of August, 2018. The total rainfall recorded during cropping period was 749.6 mm, out of which highest precipitation of 254.9 mm was recorded in the month of July, 2018 and 66.3 mm in September, 2018, which coincide with reproductive stage of the crop. However, no rainfall was received in the month of November during the crop period. The rainfall received during the crop growth period which was not sufficient for crop growth, for which need based irrigations were given.

The experiment was laid out in a spilt plot design, with three age of seedling treatments viz., 15 days, 20 days and 25 days in main plot and four levels of nitrogen viz., Control (No nitrogen), 100% RDN (120 kg N ha^{-1}), 125% RDN (150 kg N ha^{-1}) and 150% RDN (180 kg N ha^{-1}) in sub plot. Recommended doses of phosphate and potash (60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1}), along with nitrogen were applied as per treatments. The rice variety Arize-6444 Gold, developed by Bayer Bio-Science Pvt. Ltd. notified by Government of India, having 130-140 days duration, resistant to bacterial sheath blight, having milling percentage of more than 70% was selected for the present investigation.

All the recommended agronomic package of practices was implemented for the experiment. Fertilizer applications were done as per the fertilizer dose of the treatments. 50 per cent N, along with full dose of P_2O_5 and K_2O were applied at the time of transplanting as basal dose for different aged seedlings. The remaining 25% N was applied at maximum tillering stage and another 25% N at panicle emergence stage. The source of fertilizers for N, P_2O_5 and K_2O were Urea, SSP and MOP respectively. No N fertiliser was applied in control treatment plot.

The observation of growth and yield attributes were taken by taking five tagged hills into consideration. The physico-chemical properties of soil were also examined after the harvest of the crop. The Internal Nitrogen Use Efficiency, which is the additional grain yield produced by the application of nutrients over unfertilized plot per unit of nutrient applied, was calculated by the formula.

Internal Nitrogen Use Efficiency=(Economic yield with N plot-Economic yield without N Plot)/Quantity of N applied

The Partial Factor Productivity of Applied N was calculated by dividing grain yield of rice with the quantity of nitrogen applied and it was expressed in kg kg^{-1}.

Partial Factor Productivity of Applied N = Grain yield/Quantity of nitrogen applied

The Physiological Nitrogen Use Efficiency was calculated by the formula.

Physiological Nitrogen Use Efficiency (kg kg^{-1})=(Biological yield with N applied plot- Biological yield with control plot)/(N uptake of N applied plot-N uptake of control plot)

The cost of cultivation of different treatments was calculated on the basis of inputs used and their prevailing costs for the year 2018. Net return was calculated on the basis of grain and straw yield and their existing price for the year 2018. These values were used to calculate net return. Benefit: cost ratio was determined by dividing gross return with cost of cultivation. The data related with each parameters of rice was statistically analyzed as described by Cochran and Cox (1977). The significance of "F" test was tested at 5% levels of significance. The critical difference value was determined when "F" test was significant.

3. Results and Discussions

3.1. Effect on growth attributes

3.1.1. Plant height

The data of effect of age of seedling and levels of nitrogen on growth attributes of hybrid rice has been given in Table 1.

The plant height of the crop at harvest as influenced by age

Table 1: Effect of age of seedling and levels of nitrogen on growth parameters of hybrid rice

Treatments	Plant height at harvest (cm)	Leaf area index			CGR (g m^{-2} day^{-1})			NAR (g m^{-2} day^{-1})	
		30 DAS	60 DAS	90 DAS	30-60 DAS	60-90 DAS	90 DAS-harvest	30-60 DAS	60-90 DAS
Main Plot (Age of seedling)									
15 days seedling	128.15	0.74	2.39	5.11	10.46	12.57	11.41	7.39	3.63
20 days seedling	128.17	0.63	2.23	4.92	10.11	12.93	12.34	7.97	3.85
25 days seedling	126.23	0.56	2.10	4.57	9.71	13.03	11.47	8.34	4.15
SEm±	2.28	0.01	0.05	0.10	0.24	0.77	0.61	0.14	0.29
CD (p=0.05)	NS	0.05	0.22	0.39	NS	NS	NS	0.55	NS
Sub plot (Nitrogen levels)									
Control	114.33	0.58	1.76	3.21	7.33	9.26	7.59	6.89	3.99
120 kg N ha^{-1}	127.11	0.65	1.98	5.07	9.98	13.69	12.37	8.48	4.24
150 kg N ha^{-1}	133.47	0.66	2.51	5.50	10.82	14.20	14.14	7.87	3.71
180 kg N ha^{-1}	135.16	0.68	2.72	5.70	12.23	14.22	12.87	8.37	3.57
SEm±	1.31	0.01	0.05	0.10	0.27	0.57	0.46	0.29	0.18
CD (*p*=0.05)	3.89	0.02	0.13	0.31	1.06	1.70	1.38	0.39	NS
Interaction	NS	S	NS	NS	S	NS	NS	S	NS

of seedling did not differ significantly. However, the highest plant height (128.17 cm) was recorded with 20 days seedling. Significant difference in plant height of hybrid rice was noticed among nitrogen level treatments, with the highest plant height (135.16 cm), noticed with 180 kg N ha^{-1}, being at par with 150 kg N ha^{-1} (133.47 cm). The interaction effect of age of seedling and N levels was found non-significant for plant height of rice at harvest, which might be due to the fact that plant height is a genetical character of a variety (Patel et al., 2010).

3.1.2. Leaf area index (LAI)

Significant difference in LAI was noticed for age of seedlings at 30 DAS, with highest LAI of 0.74, recorded for 15 days seedling, differing significantly with 20 days seedling (0.63), whereas, at 60 DAS and 90 DAS, significant difference in LAI was noticed among the age of seedling treatments, with highest value observed with 15 days seedling having values of 2.39 and 5.11, respectively. LAI at 30, 60, 90 DAS and at harvest influenced significantly by nutrient level during the period of experimentation, with the highest LAI noticed with 180 kg N ha^{-1}, with the value of 0.68, 2.72, 5.70, which were found at par with 150 kg N ha^{-1}, with the value of 0.66, 2.51, 5.50 respectively, whereas, it was found highest with 150 kg N ha^{-1}, having values of 3.85, being at par with 180 kg N ha^{-1} (3.82). The interaction effect of age of seedling and nitrogen levels was found significant for LAI of rice at 30 DAS only. After that, it resulted in non-significant result. Zeeshan et al. (2017) also reported a positive correlation of LAI with nitrogen application rate.

3.1.3. Crop growth rate (CGR)

The interaction effect of age of seedling and nitrogen levels was found significant for CGR at 30-60 DAS, with the highest CGR (12.95 g m^{-2} day^{-1}) recorded for 15 days seedling in combination with 180 kg N ha^{-1}. The lowest CGR was recorded for 25 days seedling with control nitrogen plot, having value 6.80 g m^{-2} day^{-1}. However, the interaction effect of age of seedling and nitrogen levels showed non-significant difference at 60-90 DAS and 90 DAS-harvest. However, irrespective of treatments, maximum CGR happened during 60-90 DAS was due to maximum accumulation of photosynthates during the period. This was in agreement with that of Islam et al. (2009).

3.1.4. Net assimilation rate (NAR)

Age of seedling significantly influenced the NAR at 30-60 DAS, the highest net assimilation rate (8.34 g m^{-2} day^{-1}) noticed with 25 days seedling, being at par with 20 days seedling, having value 7.97 g m^{-2} day^{-1}, while at 60-90 DAS, it did not influence significantly. With regard to nitrogen levels, NAR was influenced significantly at 30-60 DAS, with the highest NAR (8.48 g m^{-2} day^{-1}) obtained with 120 kg N ha^{-1}, being at par with 180 kg N ha^{-1}, having value of 8.37 g m^{-2} day^{-1} and but differed significantly with 150 kg N ha^{-1}. However, at 60-90 DAS, there was no significant difference found for NAR with regard to nitrogen level treatments.

The interaction effect of age of seedling and nitrogen levels was found significant difference for NAR at 30-60 DAS, with the highest NAR obtained with 25 days seedling in combination with 120 kg N ha^{-1}, having value of 9.33 g m^{-2} day^{-1}. The lowest

NAR was recorded in 15 days seedling with control nitrogen application, having value of 6.37 g m^{-2} day^{-1}, while at 60-90 DAS and 90 DAS-harvest, there was non-significant difference found for NAR.

3.2. Effect on yield attributes

3.2.1. Effective tillers

The data of effect of age of seedling and levels of nitrogen on yield attributes like effective tillers m^{-2}, panicle length, total grains $panicle^{-1}$, filled grainsper panicle and test eight at harvest by hybrid rice is given in Table 2.

Data of the effect of age of seedling on effective tillers m^{-2} revealed no significant difference, whereas, with respect to different nitrogen levels, the highest number of effective tillers (236.13 m^{-2}) was recorded with 150 kg N ha^{-1}, which was found at par with 120 kg N ha^{-1} and 180 kg N ha^{-1}, having values of 221.08 m^{-2} and 213.73 m^{-2} respectively. There was no significant interaction effect recognised between age of seedling and different nitrogen levels on effective tiller m^{-2} at harvest. The results are in conformity with those of Tripathi and Jaishwal (2006).

3.2.2. Panicle length (cm)

Age of seedling did not influence panicle length of rice significantly, whereas nitrogen levels significantly influenced panicle length of rice during in the experiment. Nitrogen levels at 150 kg N ha^{-1} recorded maximum panicle length (26.35 cm), which differed significantly with 120 kg N ha^{-1}, 180 kg N ha^{-1} and control plot, having values 25.51 cm, 25.19 cm and 21.86 cm respectively. There was no significant difference in interaction effect obtained with age of seedling and nitrogen levels on panicle length at harvest. Maximum panicle length was also reported with higher nitrogen application (Metwally et al., 2011).

3.2.3. Filled grains $panicle^{-1}$

The result revealed that age of seedling did not affect the filled grains $panicle^{-1}$ of hybrid rice, whereas, significant difference was observed for filled grains $panicle^{-1}$, with the highest number of filled grains $panicle^{-1}$ obtained with 150 kg N ha^{-1} with the value 145.44, which was significantly at par with that of 180 kg N ha^{-1} and 120 kg N ha^{-1}, with values of 144.32 and 132.95 filled grain $panicle^{-1}$ respectively. The interaction effect was found non-significant between age of seedling and different nitrogen levels on filled grains $panicle^{-1}$ at harvest. Wu et al. (1998) also reported similar results that with increasing levels of soil fertility, the number unfilled spikelets per panicle decreased with corresponding increase in filled spikelets.

Table 2: Effect of age of seedling and levels of nitrogen on yield parameters of hybrid rice

Treatments	Effective tillers m^{-2}	Filled grain $panicle^{-1}$	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
Main Plot (Age of seedling)						
15 days seedling	214.1	138.0	23.74	5374	6684	44.30
20 days seedling	209.6	134.1	23.53	5216	6552	44.05
25 days seedling	205.3	133.2	22.87	4934	6519	42.78
SEm±	7.21	5.80	0.72	75.29	184.57	0.83
CD (p=0.05)	NS	NS	NS	295.63	NS	NS
Sub plot (Nitrogen levels)						
Control	167.65	117.7	21.36	3348	4803	41.05
120 kg N ha^{-1}	221.08	132.9	23.62	5461	6788	44.61
150 kg N ha^{-1}	236.13	145.4	24.62	6050	7310	45.27
180 kg N ha^{-1}	213.73	144.3	23.93	5840	7439	43.90
SEm±	7.60	5.32	0.71	134.06	115.60	0.82
CD (p=0.05)	22.57	15.81	2.10	398.31	343.46	2.43
Interaction	NS	NS	NS	NS	NS	NS

3.2.4. Test weight of grain

Data related to the effect of age of seedling on test weight revealed no significant difference during the experimentation, with the highest test weight (23.74 g) observed for 15 days seedling, followed by 20 days seedling (23.53 g). With respect to different nitrogen levels, significant difference was observed for test weight with the highest test weight obtained with 150 kg N ha^{-1}, with value 24.62 g, which was at par with 180 kg N ha^{-1} and 120 kg N ha^{-1} with values 23.93 g and 23.62 g respectively and the lowest test weight was observed in control plot having value 21.36 g, which differed significantly with the rest of the subplot treatments. With respect to interaction effect of age of seedling and nitrogen levels no significant difference was observed for test weight during the experimentation. Brar et al. (2012) reported no significant effect of seedling age on 1000-grain weight and different age conceived statistically similar thousand grain weight, as test weight is a genetical character of a variety.

3.2. Effect on yield

3.2.1. Grain yield

The result of the effect of age of seedling treatments was found significant with respect to grain yield, with the highest grain yield (5374 kg ha^{-1}) recorded with 15 days seedling, which was statistically at par with 20 days seedling (5216 kg ha^{-1}) and the lowest grain yield (4934 kg ha^{-1}) was recorded at 25 days seedling. 15 days seedling registered an incremental grain yield of 3.02% and 8.9% superiority over 20 days and 25 days seedlings respectively. Ali et al. (2013) had tested effect of different seedling ages on Boro Rice BRRI Dhan-28 and also found maximum grain yield when young seedlings of 15 days were transplanted while minimum was observed in case of aged seedlings of 30 days.

Data inferred to different nitrogen levels revealed significant difference in grain yield with the highest grain yield (6050 kg ha^{-1}) for 150 kg N ha^{-1}, which was statistically at par with 180 kg N ha^{-1},with grain yield of 5840 kg ha^{-1}. Reddy et al. (2011) also observed increased grain yield with increase in N upto 150 kg N ha^{-1}. The interaction effect of age of seedling and different nitrogen levels was found non-significant with respect to grain yield of hybrid rice during the experimentation. Awan et al. (2011) also reported maximum grain yield of rice variety, KSK-133 when nitrogen was applied at higher rate (156 kg ha^{-1}) while minimum was recorded from low level of nitrogen fertilizer (110 kg ha^{-1}).

3.2.2. Straw yield

The age of seedling resulted no significant difference in straw yield of rice, with the highest straw yield (6684 kg ha^{-1}) obtained with 15 days seedling, followed by 20 days seedling and 25 days seedling, with that of 6552 kg ha^{-1} and 6519 kg ha^{-1} straw yield respectively.

Among the nitrogen levels, significant difference in straw yield was assessed with the highest straw yield (7439 kg ha^{-1}) obtained with 180 kg N ha^{-1} which was significantly at par with 150 kg N ha^{-1} with that of 7310 kg ha^{-1}. The interaction effect of age of seedling and different nitrogen levels was found non-significant with respect to straw yield at harvest. Pramanik and Bera (2013) also reported maximum straw yield (7734 kg ha^{-1}) with the application of higher rate (200 kg ha^{-1}) of nitrogen fertilizer while minimum value (5213 kg ha^{-1}) of straw yield was obtained at control with no nitrogen application.

3.2.3. Harvest index

No significant difference in the effect of age of seedling observed with respect to harvest index. However, maximum harvest index (44.30%) was recorded in 15 days seedling, followed by 20 days seedling and 25 days seedling. Nitrogen levels influenced significant difference among sub plot treatments, with the maximum harvest index (45.27%) accounted in 150 kg N ha^{-1}, being at par with 120 kg N ha^{-1} and 180 kg N ha^{-1}, with that of 44.61 and 43.90% respectively. The interaction effect of age of seedling and different nitrogen levels was found non-significant with respect to harvest index. The improved harvest index might be due to the healthier and vigorous plant growth, improved plant height, increased crop growth rate and net assimilation rate which ultimately ended in the increased harvest index. The results are in conformity with those of Bera and Pramanik (2012).

3.3. Nitrogen use efficiency and economics

3.3.1. Agronomic nitrogen use efficiency

No significant difference in agronomic nitrogen use efficiency, among the different age of seedling treatments was observed (Table 3). The highest agronomic nitrogen use efficiency (12.50 kg kg^{-1}) was recorded in 20 days seedling. Different nitrogen levels revealed significant effect on the agronomic nitrogen use efficiency, with the maximum value (18.01 kg kg^{-1}) recorded with 150 kg N ha^{-1}, which was found at par with 120 kg N ha^{-1}. The interaction effect of age of seedling and nitrogen levels was found non-significant with respect to agronomic nitrogen use efficiency. Tripathi et al. (2011) also found nitrogen use efficiency of hybrid and inbred rice cultivars which showed reverse trend against each increase in nitrogen level.

3.3.2. Partial factor productivity of applied nitrogen

Data on age of seedling recorded significant difference with respect to the partial factor productivity of applied nitrogen, with the highest partial factor productivity of applied nitrogen (26.16 kg kg^{-1}) obtained with 15 days seedling, which was statistically at par with 25 days seedling (25.49 kg kg^{-1}) and lowest partial factor productivity of applied nitrogen with 25 days seedling (23.86 kg kg^{-1}). The effect of different nitrogen levels also significantly influenced the partial factor productivity of applied nitrogen, with the maximum (40.33 kg kg^{-1}) partial factor productivity of nitrogen recorded in 150 kg N ha^{-1}, significantly differing from 120 kg N ha^{-1} and 180 kg N ha^{-1}, with that of 32.44 kg kg^{-1} and 27.90 kg kg^{-1}, respectively. The interaction effect of age of seedling and different nitrogen levels was found non-significant for partial factor productivity of applied nitrogen. That was in conformity with the findings of Sharma et al. (2007).

3.3.3. Physiological nitrogen use efficiency

Among the age of seedling treatments, no significant difference in physiological nitrogen use efficiency was observed, while, among the nitrogen levels, significant difference in physiological nitrogen use efficiency was recorded with the highest physiological nitrogen use efficiency recorded for 150 kg N ha^{-1}, having value of 98.19 kg kg^{-1}, which was found at par with 120 kg N ha^{-1}, having value 96.53 kg kg^{-1} due to inclusion of dry matter in calculating this efficiency (Fageria and Baligar, 2003). The interaction effect of age of seedling and different nitrogen levels did not show any significant difference with

Table 3: Effect of age of seedling and levels of nitrogen on nitrogen use efficiency of hybrid rice

Treatments	Agronomic NUE	Partial factor productivity of Nitrogen	Physiological NUE	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Main Plot (Age of seedling)						
15 days seedling	12.39	26.16	72.13	104072	60850	1.40
20 days seedling	12.50	25.49	70.68	101111	57889	1.33
25 days seedling	12.20	23.86	71.55	96126	52904	1.21
SEm±	1.04	0.41	4.22	1255.2	1255.2	0.03
CD (p=0.05)	NS	1.61	NS	4928.5	4928.5	0.11
Sub plot (Nitrogen levels)						
Control	0.00	0.00	0.00	65798	24397	0.59
120 kg N ha^{-1}	17.61	27.90	96.53	105754	62309	1.43
150 kg N ha^{-1}	18.01	40.33	98.19	116843	73014	1.67
180 kg N ha^{-1}	13.84	32.44	91.10	113352	69139	1.56
SEm±	0.92	0.82	2.28	2330.2	2330.2	0.05
CD (p=0.05)	2.74	2.43	6.78	6923.5	6923.5	0.16
Interaction	NS	NS	NS	NS	NS	NS

regard to physiological nitrogen use efficiency.

3.3.4. Net return

Age of seedling affected the net return of hybrid rice significantly, with the highest net return (₹ 60,850 ha^{-1}) obtained with 15 days seedling, which was statistically at par with 20 days (₹ 57,889 ha^{-1}) and significantly differed from 25 days seedling with that of ₹ 52,904 ha^{-1}. With respect to the effect of nitrogen levels, significant difference was also calculated for net return, with the highest net return (₹ 73,014 ha^{-1}) reported with 150 kg N ha^{-1}, being at par with 180 kg N ha^{-1}, with net return of ₹ 69,139 ha^{-1} and differed significantly from 120 kg N ha^{-1}. There was no significant interaction effect was recognised between age of seedling and different nitrogen levels, on net return of hybrid rice.

3.3.5. Benefit: cost ratio (B:C ratio)

Age of seedling affected B:C ratio of hybrid rice significantly, with the highest benefit: cost ratio (1.40) obtained for 15 days seedling, being at par with 20 days seedling having values of 1.33 and differed significantly from 25 days seedling with values of and 1.21.With respect to different nitrogen levels, significant difference in B:C ratio was recorded with the highest B:C ratio (1.67) in 150 kg N ha^{-1}, being at par with 180 kg N ha^{-1} (1.56) and differed significantly with 120 kg N ha^{-1} and control plot, having ratios of 1.43 and 0.59 respectively.

4. Conclusion

Hybrid rice cultivar Arize-6444 Gold may be transplanted with 15 days seedling and fertilized with 150:60:40 kg N:P_2O_5:K_2O ha^{-1}, for producing higher yield parameters, resulting in higher grain yield and net return to farmers.

5. References

Anonymous, 2019. Agricultural statistics at a glance- 2017. Directorate of Economics and Statistics, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India. Available from https://eands.dacnet.nic.in/PDF/Agricultural%20Statistics%20 at%20a%20Glance%20 2017.pdf

Ali, M.S., Hasan, M.A., Sikder, S., Islam, M.R., Hafiz, M.H.R., 2013. Effect of Seedling Age and Water Management on the Performance of Boro Rice (*Oryza sativa* L.) variety BRRI Dhan 28. Agriculturists 11, 28–37.

Awan, T.H., Ali, R., Manzoor, Z., Ahmed, M., Akhtar, M., 2011. Effect of Different Nitrogen Levels and Row Spacing on the Performance of Newly Evolved Medium Grain Rice Variety, KSK-133. Journal of Animal and Plant Sciences 21, 231–234.

Bera, A.K., Pramanik K., 2012. Response of Hybrid Rice (*Oryza sativa* L.) to Varying Levels of Nitrogen and Homo-Brassinosteroids in Lateritic Zone of West Bengal 3(2), 165–168.

Brar, S.K., Mahal, S.S., Brar, A.S., Vashist, K.K., Sharma, N. and Buttar, G.S., 2012. Transplanting Time and Seedling Age Affect Water Productivity, Rice Yield and Quality in North-West India. Agricultural Water Management 115, 217–222.

Cochran, W.S., Cox, G.M., 1977. Experimental Designs, 2nd edition, Wiley, New York.

Fageria, N.K., Baligar, V.C., 2003. Methodology for evaluation of lowland rice genotypes for nitrogen use efficincy.

Journal of Plant Nutrient 26, 1315–1333.
Islam M.S., Akhter, M.M., Rahman, M.S., Banu, M.B., Khalequzzaman, K.M., 2009. Effect of Nitrogen and Number of Seedlings per Hill on the Yield and Yield Components of T. *Aman* Rice (BRRI Dhan 33). International Journal of Sustainable Crop Production 3(3), 61–65.
Metwally, T.F., Gewaily, E.E., Naeem, S.S., 2011. Nitrogen Response Curve and Nitrogen Use Efficiency of Egyptian Hybrid Rice. Journal of Agricultural Research 37, 73–84.
Patel, A.S., Patel, J.J., Patel, R.A., Patel, G.J., 2010. Effect of age of seedling, organic manures and nitrogen levels on the yield and yield contribution characters of rice cv. Gurjari. International Journal of Agricultural Sciences 6(2), 549–552.
Pramanik, K., Bera, A.K., 2013 Effect of Seedling Age and Nitrogen Fertilizer on Growth, Chlorophyll Content, Yield and Economics of Hybrid Rice (*Oryza sativa* L.). International Journal of Agronomy and Plant Production 4, 3489–3499.
Prasad, S.M., Mishra, S.S., Singh, S.J., 2010. Effect of establishment methods, fertility levels and weed management practices on rice (*Oryza sativa* L.). Indian Journal of Agronomy 46(2), 216–221.
Reddy, M.D., Ramulu V., Reddy, S.N., 2011. Response of rice (*Oryza sativa* L.) cultivars to nitrogen fertilization under aerobic and transplanted condition. International Journal of Bio-resource and Stress Management 2(1), 78–82.
Revision of World Population Prospects, UN, 2017. https://www.un.org/development/ desa/publications/world-population-prospects-the-2017-revision.html
Sharma, R.P., Patha, S.K., Singh, R.C., 2007. Effect of nitrogen and weed management practices in direct seeded rice (*Oryza sativa*) under upland conditions. Indian Journal of Agronomy 52, 114–119.
Shukla, U.N., Srivastava, V.K., Singh, S., Sen, A., Kumar, V., 2014. Growth, yield and economic potential of rice (*Oryza sativa*) as influenced by different age of seedlings, cultivars and weed management under system of rice intensification. Indian Journal of Agricultural Sciences 84(5), 628–36.
Tripathi, B.N., Tripathi, A.K., Aslam, M., Dixit, R.N., 2011. Response of hybrid and inbred rice (*Oryza sativa*) to nitrogen in central alluvial tract of Uttar Pradesh. Current Advances in Agricultural Sciences 3(2), 104–107.
Tripathi, H.P., Jaishwal, L.M., 2006. Effect of nitrogen yield attributes and yields of rice hybrids under irrigated conditions. Oryza 43(3), 249–250.
Wu, G., Wilson, L.T., McClung, A.M., 1998. Contribution of rice tillers to dry matter accumulation and yield. Agronomy Journal 90, 317–323.
Zeeshan, M., Khokhar, M.I., Rasul, F., Iqbal, M.Z., Jaime, A., Silva, T.D., Rehman, Su., 2017. Seedling age and nitrogen rates affect hybrid rice (*Oryza sativa* L.) productivity. Journal of Agriculture Research 55(3), 469–483.

