

Response of Hybrid Rice (*Oryza sativa* L.) to Several Nitrogen Levels during *Kharif* (Autumn) Season in New Alluvial Zone of West Bengal

Rumi Saha¹, Megha Sana^{1*}, Subhajit Pal², Krishnendu Mondal¹
and Sukanta Pal¹

¹Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur- 741252, Nadia, West Bengal, India.

²Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar – 848125, Bihar, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author MS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KM and SP managed the analyses of the study. Author SP managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i1930801

Editor(s):

(1) Dr. Aydin Unay, University of Aydin Adnan Menderes, Turkey.

Reviewers:

(1) Deijanira Albuquerque, Federal University of Mato Grosso, Brazil.

(2) Mateus de Paula Gomes, Federal University of Viçosa, Brazil.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/58419>

Original Research Article

Received 01 May 2020
Accepted 06 July 2020
Published 25 July 2020

ABSTRACT

Introduction: Rice (*Oryza sativa* L.) is one of the most important staple foods for more than half of the world's population

Aim: To find out the most suitable nitrogen level for hybrid rice productivity in new alluvial zone of west Bengal.

Study Design: The experiment was laid out in Factorial Randomized Block Design (FRBD) with 10 treatment combinations and three replicates.

Place and Duration of Study: *Kharif* seasons of 2018 and 2019 at Regional-Research Sub-Station (RRSS) Chakdaha of BCKV under new alluvial zone of West Bengal.

Methods: Combinations having two hybrid rice varieties viz., V₁ (PAN 2112 Gold), V₂ (KRH-2) and five nitrogen levels viz. N₁ (0:60:60 N: P₂O₅: K₂O Kg ha⁻¹), N₂ (50:60:60 N: P₂O₅: K₂O Kg ha⁻¹), N₃ (100:60:60 N: P₂O₅: K₂O Kg ha⁻¹), N₄ (150:60:60 N: P₂O₅: K₂O Kg ha⁻¹), N₅ (200:60:60 N: P₂O₅: K₂O

*Corresponding author: E-mail: meghasana31@gmail.com;

Kg ha⁻¹) Generally, yield contributing characters were studied at maturity of the crop. For yield analysis samples were taken from each plot and yield attributes were calculated.

Results: Results revealed that almost all yield attributes gave significantly superior performance in the variety PAN 2112 Gold with N₄ level of fertilization. The maximum grain yield (5.10 t ha⁻¹) was recorded in the variety V₁ in combination with N₄ level of nitrogen which was 6.69% more than KRH-2. Highest harvest index (50.86%) was noticed in same treatment combination.

Conclusion: It may be concluded that PAN 2112 Gold with fertilizer dose N: P₂O₅: K₂O 150:60:60 Kg ha⁻¹ can be recommended for South Bengal locations contributing to a yield of 5.10 t ha⁻¹ as an Aman crop.

Keywords: Rice hybrids; nitrogen levels; wet season rice; yield; economics.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereal crops of India and is used as a staple food for more than 60% of the total population of the country and contributes with about 42% of countries food grain production [1]. In India, the state of West Bengal ranks first with acreage of 5.80 million ha with the largest production of 15.5 million tones [2]. But the demand for rice is still increasing day by day due to enormous population growth. In addition, due to yield plateauing in high yielding rice in our country, yield growth has slowed down like in other south-east Asian countries due to lack of expansion in acreage [3]. Hybrid rice technology has been proved to be one of the most feasible and readily adoptable approaches to meet the domestic demand. The hybrid rice, recently introduced in cultivation on an average, give 20-30% higher yield over the common high yielding varieties [4].

Enhancing the rice productivity through the improvement of yield potential of genotypes and appropriate nutrients management has been the main thrust of Indian rice policy. Inorganic fertilizer is one of the key factors to increase the rice productivity. Rice yield and biomass increased rapidly due to increased use of chemical fertilizers. Nitrogen (N) is the key element in the production of rice and also one of the yield limiting factors [5]. However, it is known that almost every farmer has tendency to apply costly N fertilizer in excess to get a desirable yield [6], but imbalance use of N fertilizer causes harm to the crop and decreases grain yield. Earlier studies have shown that judicious and proper use of fertilizers increase the yield and quality of rice [7]. Also, application of the optimum N rate in different splits and timing has significant effects on grain yield and yield components [8]. So, a strategy for increasing

food production might involve balanced use of fertilizers to hybrid rice, as hybrid rice gives their full potential under adequate supply of nutrients.

Therefore, to know the best dose of N to increase the yield and quality of rice as well as its influence on components of yield, in the present experiment, we evaluated the effect of N on two varieties of hybrid rice and showed that application of N₄ level of nitrogen in the hybrid PAN 2112 Gold can be performed better in the South Bengal locations.

2. MATERIALS AND METHODS

A field experiment was conducted in 2018 and 2019 during *kharif* season at Regional Research Sub-Station, Chakdaha under Bidhan Chandra Krishi Viswavidyalaya West Bengal. The climate of the experimental site is subtropical. Therefore, it is mostly hot, humid and long summer with a mild and short winter.

The experiment was conducted under irrigated shallow medium land situation, having medium fertility status with good drainage facility. The soil of the experimental field was sandy clay loam in texture (Entisol) with pH 7.0, EC 0.61 ds m⁻¹, organic carbon 0.38%, available N 184 kg ha⁻¹, and available P 16.00 kg ha⁻¹ and available K 126.10 kg ha⁻¹. The data were laid out in Factorial Randomized Block Design (FRBD) with three replicates [9]. The 4 m × 3 m experimental plots were made with 0.5 m bunds leaving 1 m irrigation channel in between. Hybrid rice varieties used in the experiment were PAN 2112 Gold and KRH-2. Five levels of nitrogen [Control, 50 kg ha⁻¹ nitrogen, 100 kg ha⁻¹ nitrogen, 150 kg ha⁻¹ nitrogen and 200 kg ha⁻¹ nitrogen] were applied to prescheduled experimental plots. 60 kg ha⁻¹ P₂O₅ and 60 kg ha⁻¹ K₂O were common in all the above treatments. One fourth of total N, entire amount of P and three fourths of K were applied as basal after draining out the standing

water but before final puddling. Remaining N was top dressed in three equal splits, each at three weeks after transplanting, panicle initiation and panicle emergence stages. Remaining one fourth of K was also applied at panicle initiation stage. Well germinated seeds of hybrid rice (PAN 2112 Gold and KRH-2) @ 15 g m⁻² were and 23 days old seedlings were transplanted. The seedlings were uprooted and transplanted at the spacing of 20 cm x 15 cm. Single seedling were planted hill⁻¹ at a depth of 2-3 cm per all treatments. Nitrogen, phosphorus and potassium in the form of urea, single super phosphate and muriate of potash were applied as per treatment. Gap filling was done seven days after transplanting to keep same plant population density for every plot. All other cultural and plant-protection measures were also adopted as recommended for the region [10]. The crop was harvested when the plant become yellowish to brown and had around 14% grain moisture level. Data on different yield components were recorded at harvest. Plot-wise crops were harvested threshed. Grain and straw were then properly sun-dried, weighed and finally converted into t/ha.

Post-harvest soil samples were analyzed for total available N, P and K content following standard procedures. The economic assessment in terms of gross return, net return and benefit:cost (B:C) ratio of wet season rice was worked out on the basis of prevailing market prices for inputs and minimum support price for outputs (as per Govt. of WB).

3. RESULTS AND DISCUSSION

3.1 Yield Components

To get a good amount of yield from a crop different yield attributes play an important role. There was a significant influence of all yield

attributing characters like number of panicle m⁻², panicle length, panicle weight, total grains/panicle except filled grains/panicle and test weight. Significantly higher number of panicle m⁻² (399.38), highest panicle length (27.81 cm), weight of panicle (3.40 g) and no of filled grains panicle⁻¹ (132.20) was observed in the variety PAN 2112 Gold than the variety KRH-2. It is also reported that panicle m⁻² in hybrid rice was more than any other inbred line due to their genetic build up [11]. Influence of nitrogen level was significant in case of all yield attributing characters namely number of panicle m⁻², panicle length, panicle weight, total grains/panicle, filled grains/panicle and test weight (Table 1 and Table 2) and application of 150 kg N ha⁻¹ showed the best result accounting 38.83, 30.77, 32.70, 16.40, 23.47 and 4.30% increase over control respectively. Similar findings have shown that increasing nitrogen levels increases panicle weight [9]. Except total grains/panicle all yield components showed significant result in case of combination approach. All yield attributes like number of panicle m⁻² (446.90), panicle length (29.5 cm), weight of panicle (3.85 g) and filled grains/panicle (149.00) were reported highest in the PAN 2112 Gold in combination with 150 kg N ha⁻¹ level. But the highest test weight (23.1 g) was obtained from the treatment KRH-2 in combination with 150 kg N ha⁻¹. These findings confirm the observation [12]. Similar observations were also recorded in hybrid Sahyadri [13].

3.2 Yield and Harvest Index

The grain yield, straw yield and harvest index of paddy hybrid significantly varied among the varieties and different levels of nitrogen. The grain yield of PAN 2112 Gold (5.10 t ha⁻¹) was 6.69% higher than KRH-2. The difference in their

Table 1(a, b). Effect of nitrogen levels and varieties on yield components of hybrid rice during wet season (mean data of 2 years)

Nitrogen management	No. of panicles m ⁻²			Panicle length (cm)			Panicle weight (g)		
	Variety								
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
N1	324.82	267.90	296.36	22.10	21.90	22.00	2.80	2.51	2.66
N2	374.96	349.68	362.32	28.32	25.90	27.09	3.20	2.70	2.95
N3	414.20	357.20	385.70	28.70	26.50	27.58	3.33	2.95	3.14
N4	446.90	376.00	411.45	30.50	27.00	28.77	3.85	3.20	3.53
N5	436.00	361.90	398.95	29.50	26.50	28.01	3.80	3.10	3.45
	Sem±	CD 5%		Sem±	CD 5%		Sem±	CD 5%	
N	4.465	13.027		0.315	0.920		0.038	0.110	
V	2.824	8.239		0.199	0.582		0.024	0.069	
NxV	6.315	18.422		0.446	1.301		0.053	0.155	

Nitrogen management	Filled grains/panicle			Total grains/panicle			Test weight (g)		
	Variety								
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
N1	122.40	122.60	122.50	153	149	150.68	22.80	21.30	22.05
N2	125.80	118.50	122.15	165	156	160.30	22.40	22.30	22.36
N3	126.20	125.40	125.80	173	173	173.15	22.30	21.10	21.70
N4	137.60	120.20	142.60	190	182	186.05	22.90	23.10	23.00
N5	149.00	136.20	128.90	184	188	185.68	21.10	22.70	21.93
	Sem±	CD 5%		Sem±	CD 5%		Sem±	CD 5%	
N	1.50	4.376		1.988	5.799		0.256	0.747	
V	0.949	2.768		1.257	NS		0.162	NS	
NxV	2.761	8.277		2.811	NS		0.362	1.057	

V1= PAN 2112 Gold, V2= KRH-2, N1=Control, N2=50:60:60 kg ha⁻¹, N3=100:60:60 kg ha⁻¹, N4=150:60:60 kg ha⁻¹, N5=200:60:60 kg ha⁻¹

yield was due to their variation in yield component. Highest straw yield and harvest Index was 6.10 t/ha and 44.96% respectively in case of PAN 2112 Gold variety. Regarding to nitrogen levels highest grain yield (6.27 t ha⁻¹) showed with the application of N₄ (i.e. 150:60:60 N: P₂O₅: K₂O Kg ha⁻¹) nutrient level which was 85.50% more than the control treatment. But the highest straw yield was recorded from N₅ level of nitrogen dose i.e. 200 kg ha⁻¹. There was progressive and significant increase in straw yield with each incremental dose of nitrogen applied during the course of investigation. It was also shown that increasing trend of nitrogen level increased yield [14]. Except the grain yield the interaction between varieties and nitrogen levels was statistically significant in case of straw yield and harvest Index. PAN 2112 Gold in combination with 100 kg N/ha gave the highest straw yield.

3.3 Nutrient Status of Post-harvest Soil

The available nitrogen and phosphorus in soil after harvest of hybrid rice varied significantly with the varieties, nitrogen levels and interaction effect between variety and nitrogen. On the other hand, available potassium in soil after harvest of hybrid rice was not significant in terms of variety but it had significant relationship between different nitrogen levels and interaction effect. Among the varieties V1 i.e. PAN 2112 Gold showed more available nitrogen (184.42 kg ha⁻¹) than other variety tested which was 2.5% inferior. But in case of available phosphorus KRH-2 (44.37 kg ha⁻¹) was significantly superior than PAN 2112 Gold (43.87 kg ha⁻¹) (Table 3).

Among the nitrogen levels N5 treatment i.e. 200 kg N ha⁻¹ showed maximum available nitrogen (236.86 kg ha⁻¹) in the soil due to less soil mining by the crop. Available nitrogen in the soil after harvest gradually increased with increasing

levels of nitrogen. In case of available phosphorus and available potassium control plot showed significantly superior value as the crop did not develop enough vegetative parts. Available phosphorus and potassium gradually decreased with advancement in the dose of nitrogen. Percent increase in the available phosphorus and potassium from highest level to control was 42.11 and 58.27 respectively.

Regarding to interaction effect between varieties and nitrogen levels V2 i.e. KRH-2 recorded maximum value (233.85 kg ha⁻¹) in combination with N5 level of fertilization. But available phosphorus and potassium recorded maximum value (49.96 P₂O₅ kg ha⁻¹ and 102.31 K₂O kg ha⁻¹) in V1 in combination with N1 level of nitrogen dose. In an experiment [15] it was revealed that the increments in grain yield of rice with various composts were not much during two years experimentation, substantial improvement in soil fertility in terms of available NPK was observed.

3.4 Economic Analysis

The results revealed that the maximum net return (Rs. 206953.9 /-) was observed in 150 kg N/ha with the corresponding return per rupee investment of 3.81 (Table 4). The closest neighbor was N₅ with return per investment of rupees was 3.42. Among the varieties V₁ has a mean net return of Rs. 161248 at a corresponding economics of 3.01. V₁N₄ combination yielded the highest net return of Rs. 219689 and return per investment 4.04. Finding reported that N, P₂O₅ and K₂O as 100:60:60 kg/ha was the optimum dose which recorded higher economic return [16]. The economics, seemingly, was more of a contribution of price differential which hybrid rice enjoys over high yielding varieties of rice. This is because hybrid rice has more desired consumer characters are afforded by the prevailing market.

Table 2. Effect of nitrogen levels and varieties on yield and harvest index of hybrid rice during wet season (mean data of 2 years)

Nitrogen management	Grain yield (Kg/ha)			Straw yield (Kg/ha)			Harvest index (%)		
	Variety								
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
N1	3.46	3.30	3.38	5.47	5.34	5.41	38.76	38.20	38.48
N2	4.06	3.99	4.03	5.84	5.46	5.65	41.02	42.23	41.63
N3	5.59	4.86	5.23	6.6	6.02	6.31	45.86	44.66	45.26
N4	6.58	5.95	6.27	6.36	6.2	6.28	50.86	48.98	49.92
N5	5.83	5.79	5.81	6.24	6.48	6.36	48.32	47.20	47.76
	Sem±	CD 5%		Sem±	CD 5%		Sem±	CD 5%	
N	0.146	0.425		0.012	0.036		0.077	0.224	
V	0.092	0.269		0.008	0.023		0.121	0.354	
NxV	0.206	NS		0.018	0.051		0.172	0.501	

V1= PAN 2112 Gold, V2= KRH-2, N1=Control, N2=50:60:60 kg ha⁻¹, N3=100:60:60 kg ha⁻¹, N4=150:60:60 kg ha⁻¹, N5=200:60:60 kg ha⁻¹

Table 3. Effect of nitrogen levels and varieties of hybrid rice on residual soil nutrient status during wet season (mean data of 2 years)

Nitrogen management	Available N			Available P			Available K		
	Variety								
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
N1	116.81	119.93	118.37	49.96	49.86	49.91	102.31	97.96	100.14
N2	153.89	150.02	151.96	47.18	47.91	47.69	84.44	87.03	85.73
N3	187.57	180.52	184.05	45.11	46.72	45.91	80.11	83.06	81.58
N4	223.95	215.32	219.64	40.91	42.97	41.94	69.28	69.56	69.42
N5	239.85	233.86	239.86	35.87	34.38	35.12	63.80	62.75	63.27
	Sem±	CD 5%		Sem±	CD 5%		Sem±	CD 5%	
N	0.698	2.037		0.084	0.245		0.143	0.418	
V	0.442	1.288		0.053	0.155		0.091	NS	
NxV	0.987	2.88		0.119	0.346		0.202	0.591	

V1= PAN 2112 Gold, V2= KRH-2, N1=Control, N2=50:60:60 kg ha⁻¹, N3=100:60:60 kg ha⁻¹, N4=150:60:60 kg ha⁻¹, N5=200:60:60 kg ha⁻¹

Table 4. Economic analysis of cultivation of hybrid rice during wet season (mean data of 2 years)

Parameter	N1	N2	N3	N4	N5	Mean
V1 Net return (Rs.)	97039	119527.6	181258.8	219689.9	188725	161248.16
(Return/Re)	1.92	2.26	3.38	4.04	3.43	3.01
V2 Net return (Rs.)	90418.5	116081.6	151072.8	194217.9	187533	147864.76
(Return/Re)	1.78	2.20	2.82	3.58	3.40	2.76
Mean Net return (Rs.)	93729	117804.6	166165.8	206953.9	188129	
(Return/Re)	1.85	2.23	3.10	3.81	3.42	

V1= PAN 2112 Gold, V2= KRH-2, N1=Control, N2=50:60:60 kg ha⁻¹, N3=100:60:60 kg ha⁻¹, N4=150:60:60 kg ha⁻¹, N5=200:60:60 kg ha⁻¹

4. CONCLUSION

Overall, from the study, it can be concluded that application of N4 level of Nitrogen in the hybrid PAN 2112 Gold can be recommended in the South Bengal locations contributing a yield of 6.27 t ha⁻¹ which can fetch an economics of Rs. 3.81 per rupees investment .

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Department of Agriculture & Cooperation, Ministry of Agriculture, Government of

- India. Guidelines for Seed Production of Hybrid Rice; 2010.
Available:<http://vikaspedia.in/agriculture/crop-production/package-of-practices/hybrid-rice-seed-production>
[Access on 26th April, 2020]
2. FAOSTAT, Statistical databases and datasets of the Food and Agriculture Organization of the United Nations; 2018.
Available:<http://faostat.fao.org>
[Accessed on 9th April, 2020]
 3. Siddiq EA. Rice production strategy for the 21st century. *Oryza*. 2006;30:186-196.
 4. Prasad R. Text book of field crops production commercial crop. ICAR, New Delhi (2nd Edn.). 2012;377.
 5. Sinclair TN. Nitrogen influence on the physiology of crop yield. In: Theoretical Production Ecology: Reflections and Prospects (Eds: Rabbinge R, Goudriaan J, van Keulen H, de Vries FWTP, van Laar HH). Pudoc Wageningen. 1990;41-55.
 6. Saleque MA, et al. Inorganic and organic phosphorus fertilizer effects on the phosphorus fractionation in wetland rice soils. *Soil Science Society of America Journal*. 2004;68(5):1635-44.
 7. Place GA, Sims JL, Hall UL. Effects of nitrogen and phosphorous on the growth yield and cooking, characteristics of rice. *Agron. J*. 1970;62:239-41.
 8. Bacon PE. Nitrogen application strategies for rice. In: Proceedings of the Australian Agronomy Conference 'Pathways to Productivity', Lawas, Australia. 1980;292.
 9. Gomez A. Kwanchai, Gomez. A. Arturo. Statistical Procedures for Agricultural Research. John Wiley & Sons; 1984.
 10. Pal S, Banerjee H, Mandal NN. Efficacy of low dose of herbicides against weeds in transplanted kharif rice (*Oryza sativa* L.). *The Journal of Plant Protection Sciences*. 2009;1(1):31-33.
 11. Singh PK, Bharadwaj V. Effect of different nutrient levels on yield and yield attributes of hybrid and inbred rice varieties. *Oryza*. 2007;44(2):137-139.
 12. Thakur DS, Patel SR. Growth and sink potential of rice as influenced by split application of nitrogen with and without FY in inceptisols of Eastern Part of Central Peninsular India. *Oryza*. 1999;36(3):280-282.
 13. Pal SK, Chowdhary A, Gunri SK. Effect of integrated nitrogen management and plant density on yield and nitrogen balance of rice under lowland situation. *Oryza*. 2005; 42 (1):41-47.
 14. Jaiswal VP, Singh GR. Effect of planting methods and levels of nitrogen on the growth and yield of rice and on succeeding wheat. *Indian Journal of Agronomy*. 2001; 46(1):5-11.
 15. Das A, Munda CG, Patel PD, Ghosh KP, Ngachan S, Baiswar P. Productivity, nutrient uptake and post-harvest soil fertility in lowland rice as influenced by composts made from locally available plant biomass. *Archives of Agronomy and Soil Science*. 2010;56(6): 671-680.
 16. Das K, Dutta S, Bhagawati PC. Nutrient management of hybrid rice during boro season under Irrigated mid land situation. *Haryana-Journal-of-Agronomy*. 2008; 24(1/2):19-22.

© 2020 Saha et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/58419>