Effect of different moisture regimes and nutrient management on yield attributes, yield and economics of hybrid rice (*Oryza sativa* L.)

Mahendra Pratap Singh, BN Singh, Amit Kumar, Prashant Singh, Gyanendra Kumar and Pradeep Kumar Kanaujiya

DOI: https://doi.org/10.22271/chemi.2020.v8.i6u.10964

Abstract

A field experiment was conducted during two consecutive years of 2017-18 and 2018-19 at Division of Agronomy, ANDUAT, Kumarganj, Ayodhya to study the different moisture regimes and nutrient management on yield attributes, yield and economics of hybrid rice. Result data revealed that 7 cm irrigation given at 1 day after disappearance of ponded water produced significantly more yield attributes viz., length of panicles, number of grains per panicle, weight of grains per panicle and 1000 grain weight, yield viz., grain and straw yield and harvest index and economics of hybrid rice. Highest Gross and net returns and benefit: cost ratio was recorded with conventional irrigation. Application of 100% RDF of NPK (150: 75 : 60 kg ha) through inorganic fertilizers recorded significantly higher length of panicle, number of grains per panicle, weight of grains per panicle and 1000-grain weight, grain and straw yield, harvest index, gross and net returns and benefit cost ratio of hybrid rice as compared to rest of the nutrient management.

Keywords: disappearance of ponded water (DADPW), biocompost, conventional irrigation, gross and net return, nutrient management

Introduction

Rice (*Oryza sativa* L.) in a major staple food for the world’s population. To meet the demands of increasing population and maintain this self-sufficiency, the present production level of around 116 million tones, needs to be increased up to 130 million tonnes by 2025. Hybrid rice possess 10 to 15 percent yield advantage over inbred varieties due to more vigorous and extensive root system increased growth rate during vegetative stage, more efficiency sink formation, faster rate of translocation of photosynthates and greater sink size. Integrated nutrient supply involving conjunctive use of fertilizers, organic sources of nutrients and biofertilizers assumes greater significance in India. Integration of organic and inorganic sources of plant nutrients which improves the soil physical as well as chemical properties of soils which contributes to soil fertility and productivity. Appropriate water management provides a favorable water and nutrient supply under anaerobic conditions. The proper use of available irrigation water and application of suitable dose of fertilizer nutrients in respect to available soil moisture may play an important role in minimizing the present large gap between yield achieved and yield achievable. Taking these views into consideration, the present experiment was, therefore, under- taken to assess the effect of different moisture regimes and nutrient management on yield attributes, yield and economics of hybrid rice (*Oryza sativa* L.).

Materials and methods

The present field investigation on effect of different moisture regime and nutrients management on yield and yield attributes of hybrid rice (*Oryza sativa* L.) was conducted during kharif season of two consecutive years of 2017-18 and 2018-19 at Agronomy Research Farm, Narendra Deva University of Agriculture & Technology, Narendra Nagar, (Kumarganj), Ayodhya. The treatment combinations comprised with four moisture regimes viz. 7cm irrigation 1 DADPW, 7cm irrigation 4 DADPW, 7cm irrigation 7 DADPW and conventional
irrigation and five nutrient supply system viz. 100% NPK (150:75:60 kg/ha) through inorganic fertilizer, 75% NPK + 25% N through bio compost, 50% NPK + 50% N through bio compost, 75% NPK + 25% N through FYM, 50% NPK + 50% N through FYM were executed in split plot design with three replications. The soil of the experimental field was silty loam in texture with low in organic carbon (0.31%), available nitrogen (189.0 kg ha\(^{-1}\)) and phosphorus (16.2 kg ha\(^{-1}\)) and high in available potassium (282 kg ha\(^{-1}\)). The hybrid rice (Arize 6444) was transplanted on 8\(^{th}\) July and 12\(^{th}\) July and harvested on 10\(^{th}\) November and 14\(^{th}\) November during first and second years of experimentation, respectively. The observations on yield and yield attributed and economics were taken after harvest of crop.

**Results and Discussion**

**Yield attributes**

Significantly highest length of panicle, number of grains per panicle, weight of grains panicle\(^{-1}\) and 1000 grain weight of hybrid rice was obtained with 7 cm irrigation given at 1 day after disappearance of ponded water as compared to rest of the moisture regimes (Table 1). The increase in yield attributes with increase in moisture regimes might be due to favorable vegetative growth and development because it received adequate moisture during entire period of growth. As under adequate moisture the plant height, LAI and dry matter accumulation were highest which contributed to highest yield attributes, due to increased photosynthetic activity of leaves. Adequate moisture not only translocat photosynthats from source to sink but also increased higher uptake of nutrients led to better yield attributes. Lowest yield attributes were recorded under 7 cm irrigation given at 7 DADPW because plants were unable to extract more water and nutrients under moisture deficit condition which resulted in poor growth and yield attributes. These results are in close proximity of those obtained by Singh and Ingram (1995) \(^{[13]}\) and Harbir Singh and Ingram (2000) \(^{[11]}\). The yield attributes viz., length of panicle, number of grains panicle\(^{-1}\) and weight of grains panicle\(^{-1}\) were influenced significantly due to various nutrient supply system. However, significantly higher value of all these yield attributes were recorded with the application of 100% NPK (150:75:60 kg ha\(^{-1}\)) through inorganic fertilizer as compared to rest of treatments was found at par with 75% NPK + 25% N through bio compost. This might be attributed due to adequate nutrients supplying system favoured vegetative growth and development which resulting from increased was highest which contributed higher yield attributes. The lowest value were obtained under 50% NPK through inorganic fertilizers + 50% N through FYM because plants were unable to extract more nutrients, this nutrient supply system which resulted poor growth and yield attributes. These results are in close accordance with the findings of Singh et al., (2015) \(^{[15]}\); Singh et al., (2017) \(^{[9]}\) and Naorem et al., (2018) \(^{[5]}\). Higher test weight (23.05 g) of hybrid rice was obtained with the application of 100% RDF of NPK through inorganic fertilizers followed by 75% NPK + 25% N through bio compost (22.95 g), 75% NPK + 25% N through FYM (22.85 g), 50% NPK + 50% N through bio compost (22.75 g) and 50% NPK + 50% N through FYM (22.65 g). Minimum test weight of hybrid rice was obtained with the application of 50% NPK + 50% N through FYM. These results are in close conformity with the findings of Naorem et al., (2018) \(^{[5]}\).

**Table 1: Yield attributes of hybrid rice as affected by different moisture regimes and nutrient management (pooled of 2 years)**

| Treatments | Length of panicle (cm) | No. of grains panicle\(^{-1}\) | Weight to grains panicle\(^{-1}\) (g) | Test weight (g) |
|------------|-----------------------|-------------------------------|-----------------------------------|----------------|
| **Moisture regimes** | | | | |
| 7cm irrigation 1 DADPW | 26.28 | 214.59 | 5.10 | 23.75 |
| 7cm irrigation 4 DADPW | 24.77 | 206.53 | 4.82 | 23.35 |
| 7cm irrigation 7 DADPW | 23.06 | 190.41 | 4.18 | 21.95 |
| Conventional irrigation | 23.80 | 198.47 | 4.43 | 22.35 |
| SEm\(\pm\) | 0.57 | 4.12 | 0.09 | 0.50 |
| CD at 5% | 1.40 | 10.09 | 0.16 | NS |

| **Nutrient supply management** | | | | |
| 100% RDF of NPK(150:75:60 Kg/ha) through inorganic fertilizers | 26.93 | 218.62 | 5.04 | 23.05 |
| 75% NPK + 25% N through FYM | 24.52 | 207.53 | 4.77 | 22.95 |
| 50% NPK + 50% N through FYM | 23.51 | 192.42 | 4.38 | 22.75 |
| 75% NPK + 25% N through Bio compost | 24.32 | 204.51 | 4.67 | 22.85 |
| 50% NPK + 50% N through Bio compost | 23.11 | 189.40 | 4.29 | 22.65 |
| SEm\(\pm\) | 0.49 | 4.11 | 0.10 | 0.49 |
| CD at 5% | 1.43 | 11.86 | 0.29 | NS |

**Yield**

Significantly highest grain (73.05 q ha\(^{-1}\)) and straw (85.85 q ha\(^{-1}\)) yield of hybrid rice was obtained with 7 cm irrigation given at 1 day after disappearance of ponded water as compared to other moisture regimes. (Table 2). Significantly more grain (69.11 q ha\(^{-1}\)) and straw (78.74 q ha\(^{-1}\)) yield of hybrid rice was produced with 7cm irrigation given at 4 days after disappearance of ponded water. Minimum grain (60.76 q ha\(^{-1}\)) straw (73.82 q ha\(^{-1}\)) yield of hybrid rice was obtained with 7 cm irrigation given at 7 days after disappearance of ponded water. Grain and straw yield with irrigations given at 1 and 3 DADPW was also higher than 7 DADPW due to greater dry matter accumulation associated with larger number of tillers/m\(^2\) and taller and healthy shoots. The advantage in grain and straw yield due to relatively wet moisture regimes under frequent irrigation is likely due to higher net photosynthetic rate and dry matter accumulation in stem, leaves and grains. Similar results are in close conformity with the findings of (Pandey et al., 2010 and Shekara et al., 2010) \(^{[6,8]}\). Highest harvest index (46.74%) of hybrid rice was recorded with 7cm irrigation given at 4 days after disappearance of ponded water followed by 7 cm irrigation given at 1 day after disappearance of ponded water (45.94%), conventional irrigation (45.84%) and 7 cm irrigation given at 7 day after disappearance of ponded water (45.67%). The increase in harvest index of hybrid rice with increase in irrigation might be due to increase in grain and
straw yield. Similar results have also been reported by Kumar et al. (2000) and Shekara et al. (2010). Significantly higher grain (73.05 q ha⁻¹) and straw (85.85 q ha⁻¹) yield of hybrid rice was obtained with the application of 100% NPK (150:75:60 kg ha⁻¹) through inorganic fertilizer as compared to rest of the treatments (Table 2). This might be due to increase in yield attributes viz. number of effective shoots per running meter, length of panicle, number of grains panicle⁻¹, weight of grains panicle⁻¹. The better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yield of rice. Higher value of grain and straw yield of rice at higher fertility level may be owing to greater availability of nutrient in soil, improvement of soil environment resulting in higher root proliferation leading to better absorption of moisture and nutrient ultimately resulting in higher grain and straw yield (Kumar et al., 2013 and Singh et al., 2015). Significant enhancement in grain yield of rice over absolute control owing to the application of different organic sources of nutrients with significant increase in uptake of nutrients in the grains was observed by Singh et al. (2011). Highest harvest index (46.14%) of hybrid rice was obtained with the application of 50% NPK + 25% N through bio compost followed by 50% NPK + 50% N through FYM (46.04%), 100% RDF of NPK through inorganic fertilizer (45.89%), 75% NPK + 25% N through FYM (45.89%) and 50% NPK + 50% N through bio compost (45.84%). It might be due to proportionately increased grains over straw and large these poor harvest index is indicated of the fact that most of the energy of the plant is retained in vegetative parts and less translocated to fruiting organs. The significant enhancement in harvest index of rice with the application of organic and inorganic sources of plant nutrients was earlier observed by Singh et al., (2011); Manjunath et al., 2016 and Naorem et al., 2018.

Table 2: Grain and straw yield and harvest index of hybrid rice as affected by different moisture regimes and nutrient management (pooled of 2 years)

| Treatments                          | Grain yield (qha⁻¹) | Straw yield (qha⁻¹) | Harvest index (%) |
|-------------------------------------|---------------------|---------------------|------------------|
| **Moisture regimes**                |                     |                     |                  |
| 7 cm irrigation 1 DADPW             | 73.05               | 85.85              | 45.96            |
| 7 cm irrigation 4 DADPW             | 69.11               | 78.40              | 46.74            |
| 7 cm irrigation 7 DADPW             | 60.76               | 73.82              | 45.67            |
| Conventional irrigation             | 65.78               | 77.7               | 45.84            |
|                                    | SEₘ±                 |                     |                  |
| CD at 5%                            | 1.29                | 1.77               | 0.64             |
|                                    | 3.18                | 4.34               | NS               |
| **Nutrient supply management**      |                     |                     |                  |
| 100% RDF of NPK (150:75:60 Kg/ha)   | 71.24               | 83.98              | 45.89            |
| 75% NPK + 25% N through FYM         | 69.52               | 81.12              | 46.14            |
| 50% NPK + 50% N through FYM         | 64.37               | 76.21              | 45.84            |
| 75% NPK + 25% N through Bio compost | 67.8                | 79.91              | 45.89            |
| 50% NPK + 50% N through bio compost | 63.06               | 74.05              | 46.04            |
|                                    | SEₘ±                 |                     |                  |
| CD at 5%                            | 1.40                | 1.63               | 1.00             |
|                                    | 4.05                | 4.72               | NS               |

Economics

Highest gross (Rs 138817.0) and net (Rs 104739.0) return and benefit: cost ratio (3.07) was fetched with 7 cm irrigation given at 1 day after disappearance of ponded water followed by conventional irrigation. Minimum gross and net return and benefit: cost ratio was obtained with 7 cm irrigation given at 7 DADPW (Table 3). Similar findings have also been obtained by Yadav and Meena, (2014). Highest gross (Rs 135448.5) and net (Rs 93336.5) return of hybrid rice was fetched with the application of 100% RDF of NPK through inorganic fertilizers followed by 75% NPK + 25% N through bio compost (Rs 132133 and 916121 ha⁻¹), 75% NPK + 25% N through FYM (Rs 128897 and 90639 ha⁻¹) and 50% NPK + 50% N through bio compost (Rs 122401 and 76373 ha⁻¹), respectively (Table 3). Application of 50% NPK + 50% N through FYM recorded minimum gross and net return (Rs 119875 and 79469 ha⁻¹) of hybrid rice, respectively. The increase in net profit of hybrid rice with the application of organic and inorganic sources of plant nutrients are in close proximity with the finding of Singh et al., (2018) and Ram bharose et al., (2018). The highest benefit: cost (2.86) ratio recorded with 100% NPK followed by 75% NPK + 25% N through bio compost/FYM (2.36) and they proved more remunerative than the other treatment combinations. These results are in close proximity with the findings of Singh et al., (2018) and Ram bharose et al., (2018).

Table 3: Economics of hybrid rice as influenced by different moisture regimes and integrated nutrients management (pooled of 2 years)

| Treatment                         | Gross return (Rs.ha⁻¹) | Net return (Rs.ha⁻¹) | Benefit: cost ratio (Rs. Re⁻¹ invested) |
|-----------------------------------|------------------------|----------------------|----------------------------------------|
| 7 cm irrigation 1 DADPW           | 138817.0               | 104739.0             | 3.07                                   |
| 7 cm irrigation 4 DADPW           | 131282.5               | 98614.5              | 3.01                                   |
| 7 cm irrigation 7 DADPW           | 115610.5               | 84822.5              | 2.75                                   |
| Conventional irrigation           | 125064.5               | 93336.5              | 2.94                                   |
| 100% RDF of NPK (150:75:60 Kg/ha) | 135448.5               | 100421.5             | 2.86                                   |
| 75% NPK + 25% N through FYM       | 132133.0               | 91612.0              | 2.25                                   |
| 50% NPK + 50% N through FYM       | 122401.5               | 76373.5              | 1.65                                   |
| 75% NPK + 25% N through Bio compost| 128897.5              | 90639.0              | 2.36                                   |
| 50% NPK + 50% N through bio compost| 119875.3             | 79469.0              | 1.96                                   |
References

1. Harbir Singh, Ingram KT. Sensitivity of rice (Oryza sativa L.) to water deficit at three growth stage. Crop Research Hissar 2000;20(3):355-359.
2. Kumar R, Singh G, Walia SS. Long term effect of manures and fertilizers on rice yield and soil fertility status in rice-wheat system. Environment and Eco 2000;18(3):546-549.
3. Kumari Niru, Singh CS, Prashad J, Singh MK, Kumar R. Influence of organic nutrient sources on productivity of rice (Oryza sativa) based cropping system in Jharkhand. Indian Journal of Agronomy 2013;58(3):277-281.
4. Manjunath BL, Mahajan Gopal R, Ramesh R, Singh NP. Effect of improved nutrient management on grain yield of rice (Oryza sativa) and soil health under organic management. Indian Journal of Agronomy 2016;61(1):25-32.
5. Naorem LC. Effect of Organic Manures and Chemical Fertilizers on the Yield of Rice Seed Lalat Int J Curr. Microbiol. App. Science 2018;7(10):2161-2166.
6. Pandey VP, Singh MM, Singh GR. Effect of moisture regime and integrated nutrient supply system performance and water use efficiency of transplanted rice. Abs. National Seminar on Soil security for Sustainable Agriculture 27-28, at college of Agriculture, Nagpur 2010, 23.
7. Ram Bhowase, Kumar S, Kumar M, Kumar R, Sarita, Kumar D. Effect of organic and inorganic sources of nutrient on productivity, nutrient uptake and economics of rice (Oryza sativa L.) Annals of Plant and Soil Research 2018;20(1):69-72.
8. Shekara BG, Sharnappa KN. Effect of irrigation schedule on growth and yield of aerobic rice (Oryza Sativa) to soil moisture regime and weed control. Indian Journal of Agronomy 2010;43(1):82-86.
9. Singh H, Singh AK, Alam S, Singh T, Singh VP, Parihar AKS et al. Effect of Various Integrated Nutrient Management Models on Growth and Yield of Wheat in Partially Reclaimed Sodic Soil. International Journal of Current Microbiology and Applied Sciences 2017;6(3):803-808.
10. Singh C, Zaidi SFA, Kumar M, Singh R, Singh V, Singh MK. Effect of INM Modules and Different Cultural Practices on Properties of Silty Clay Loam Soil. International Journal of Current Microbiology and Applied Science 2018;7(1):653-658.
11. Singh CS, Singh AK. Growth and yield response of rice to varying levels of fertility, sulphur and Zinc under transplanted condition. Environment and Ecology 2011;29(3):978-984.
12. Singh SK, Thakur R, Singh MK, Singh CS, Pal SK. Effect of fertilizer level and seaweed sap on productivity and profitability of rice (Oryza sativa). Indian Journal of Agronomy 2015;60(3):420-425.
13. Singh H, Ingram KT. Sensitivity of rice to water deficit at different growth stages. Philippine J of Crop Science 1995;16(1):511.
14. Yadav L, Meena RN. Performance of aromatic rice (Oryza sativa) genotypes as influenced by integrated nitrogen management. Indian Journal of Agronomy 2014;59(2):251-255.