International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133, Print ISSN: 2664-7125, Impact Factor: RJIF 5.28
Received: 25-04-2021, Accepted: 11-05-2021, Published: 28-05-2021
Volume 3, Issue 2, 2021, Page No. 178-182

Effect of different climate resilient nutrient management practices on yield and yield attributes of rice (*Oryza sativa* L.) under temperate conditions of Kashmir valley

M Anwar Bhat[1*], IA Jehangir[2], Ashaq Hussain[3], FA Bahar[4], SS Mahdi[5]
[1] Professor and Head, Division of Agronomy, Faculty of Agriculture, SKUAST-K, Wadura Sopore, Jammu and Kashmir, India
[2] Assisstant Professor, Mountain Research Centre for Field Crops, SKUAST-K, Khudwani, Anantnag, Jammu and Kashmir, India
[3] Associate Professor, Mountain Research Centre for Field Crops, SKUAST-K, Khudwani, Anantnag, Jammu and Kashmir, India
[4] Associate Professor, Division of Agronomy, Faculty of Agriculture, SKUAST-K, Wadura Sopore, Jammu and Kashmir, India
[5] Assisstant Professor, Division of Agronomy, Faculty of Agriculture, SKUAST-K, Wadura Sopore, Jammu and Kashmir, India

Abstract
To address the issues of sustainability of food production on account of changing climate, it is imperative to evolve nutrient management practices aimed at sustained productivity of rice in rice-based cropping system. To study the influence of different nutrient management strategies, a field experiment was undertaken for three consecutive *kharif* seasons of 2014-2016 on silty clay loam soil of Kashmir under temperate environment. Seven nutrient management practices; Recommended fertilizer dose (RDF) (T_1), *Azotobacter* + PSB (Biofertilizer) + 75% RDF (T_2), Biofertilizer + Green manure (GM)+ 75% RDF (T_3), Biofertilizer + GM + residue mulch (RM) + 75% RDF(T_4), Biofertilizer + GM + RM + 50% RDF (T_5), Biofertilizer + Farm yard manure (FYM) + 50% RDF(T_6), Biofertilizer + FYM +75% RDF(T_7) were evaluated. The results revealed that the mean crop yields obtained from the application of inorganic fertilizers (T_1) were significantly greater though remaining statistically identical to the conjunctive use of organic (bio fertilizers and FYM) and inorganic fertilizers along with other improved management practices i.e., split application of N under puddled conditions (T_7) and the lowest yield was obtained in T_2. The performance of split application of N T_1 and T_7 was also better with regard to panicle number and panicle weight.

Keywords: split n application, green manuring, bio fertilizers, *azotobacter*, PSB, rice

Introduction

Indian agriculture faces the dual challenge of feeding more than a billion people in the changing climatic and economic scenario. Agriculture is the main source of livelihood for almost 60 % of the country's total population. The impact of climate change on agriculture will be severely felt in India. It has been projected that under the scenario of a 2.5 °C to 4.9°C temperature rise, rice yields will drop by 32-40% and wheat yields by 41 to 52%. As Indian agriculture is highly dependent on specific climatic conditions, the research on the impact of climate change on agriculture in general and rice production in particular is a high priority in India. There is an urgent need to focus on climate resilient input management practices for improving use efficiency and sustaining the rice and rice-based cropping systems across the country.

For sustained crop productivity constant renewal of nutrients is imperative to overcome the constraints of limited growth and development owing to poor nutritional environment. Nutrient application is one of the decisive factors in realizing enhanced levels of productivity from the high yielding cultivars. However long-term use of compound fertilizers on unprecedented scale have led to the deterioration in soil as well as environmental health. Efforts have been made to reduce the use of chemical fertilizers and the use of organics like organic manures and bio fertilizers have proved to be better alternatives to achieve this goal without decrease in grain yield (Liang *et al*., 2014) [7]. Balanced supply of inorganic fertilizers is important for enhanced yield and to sustain soil fertility (Yadav *et al*, 2000) [13]. Application of organic manures have been found to increase soil organic matter in relatively short time period and its addition in conjunction with crop residue has been reported to be one of the best soil fertility management practice (Zhang *et al*., 2019) [14]. In the aspect of sustainable agriculture, biofertilizers have always played a promising part on the account of crop yield and soil fertility. Soil micro-organisms play a significant role in regulating the dynamics of organic matter decomposition and the availability of plant nutrients such as nitrogen (N), phosphorus (P), potassium (K) and other nutrients. They are also strongly involved in soil formation, nutrient mineralization, and soil organic matter turnover (Schimel *et al*, 1995; Doran *et al*, 2000). Rice yield per unit area per unit time is dependent on adequate fertilization. The strategy of combined application of inorganic fertilizers and biofertilizers for rice cultivation offers the opportunity to boost rice yields with less external inputs. Several studies found gradual increase in the efficiency of biofertilizer and its compatibility with inorganic fertilizers resulting in dual objectives of significant increase in yield of the crop along with substantial improvement in the fertility status of soil (Subashini *et al.*, 2007). Durrah *et.al.* (2011) claimed that application of biofertilizers (PSB) enhanced most of the growth and yield parameters in rice. Another study found that composted goat manure and compost mixture as organic fertilizers in PSB Rc 18 lowland rice gave similar grain yield as inorganic fertilizer implying that these materials are viable alternatives to expensive inorganic fertilizers (Escasinas and Zamora, 2011) [3]. Huang *et al.,* (2013) observed positive response to crop residue retention, which increased with increasing experimental duration. Furthermore, crop residue retention substitutes a part of inorganic fertilizers and offer a potential alternative to on-field burning of crop residues. Keeping in view the impact of different nutrient sources on improving the productivity while sustaining the soil fertility, the experiment was intended to examine the effect of different nutrient management strategies on productivity of rice.

Material and Methods

The field experiment was conducted for three consecutive years during *kharif* season from 2014-2016 to study the effect of different nutrient management practices on rice yield at Khudwani, Anantnag, Jammu and Kashmir. Properties of the upper 15 cm revealed that the soil of experimental site was silty clay loam in texture, neutral in reaction (pH 7.3), low in available nitrogen, medium in available phosphorous and potassium. The treatments consisted of T_1: Recommended fertilizer dose (RDF) with split application of Nitrogen (50% basal + 25% active tillering + 25% panicle initiation (PI)) in puddled soil; T_2: Bio (Azotobactor + PSB) + 75% RDF; T_3: Bio + GM (Green manuring with berseem) + 75 % RDF; T_4: + GM + residue mulch (RM) + 75% RDF; T_5: B+ GM + residue mulch + 50% RDF; T_6: Bio + FYM t/ha + 50% RDF; T_7: Bio +FYM +75% RDF. The treatments were replicated four times in a randomized complete block design. As per the treatments, well decomposed farm yard manure (FYM) @ 5t ha^{-1} and bio fertilizers (*Azotobactor* and PSB @ 3.5 kg/ ha each) were incorporated in experimental plots uniformly during land preparation. Residue of the previous crop (rapeseed) and in situ green manuring (berseem) was carried out as per the treatment. For green manuring berseem was grown in the concerned plot and was incorporated one month prior to transplanting using tractor. The soil was prepared by puddling as per treatment and the entire quantity of phosphorus and potassium in the form of diammonium phosphate (DAP) and muriate of potash (MOP) and nitrogen in the form of urea was applied as per the treatments as basal at the time of transplanting, while remaining N was applied in two equal splits at active tillering and PI stages as per the treatment. Each year rice was transplanted during the first week of June, using three seedlings hill^{-1}, at 20×10 cm spacing. Weeds were controlled using pyrazosulfuran ethyl + pertilachlor; (30 g+ 0.45 kg *a.i.*ha^{-1}). Yield components like panicles m^{-2} and grains panicle^{-1} were recorded by using a quadrat (50x50 cm= 0.25 m^{-2}) whereas the yield (grain + straw) was determined from the net plot area in m^2 from each plot at maturity, excluding the border effect and then converted to t ha^{-1}. The crop was manually harvested during last week of September every year.

Results and Discussion

Yield attributes and yield varied significantly among the treatments (Table 1). Yield contributing parameters, *viz*. number of panicles m^{-2} and panicle weight varied significantly among treatments. In general, T1 registered higher values of yield attributes like number of panicles m^{-2} (404) and panicle wt. (2.95 g) though remaining at par with T7 with the superiority of 9.54 and 8.3 %, respectively over T2. This improvement in the yield contributing parameters can be attributed to better remobilization of nonstructural carbohydrates from source to sink.

Highest mean grain and straw yield (6.61 and 10.10 t ha $^{-1)}$ were recorded with T1closely followed by T 7 and the lowest grain yield of 5.50 t ha $^{-1}$ was recorded in T2. T1 reflected the yield superiority of 20.32 % over T2 (Fig. 1), though remaining at par with T7 (Table 2). This increased yield in T1 can be attributed to a greater number of panicles m^{-2} and grains panicle^{-1} (Table 1). Furthermore, regression analysis reflected that yield attributing parameters like panicles m^{-2} and panicle weight (g) were positively correlated with grain yield with the determination coefficient (R^2) values of 0.8758 and 0.8944, respectively. (Fig. 2), suggesting that increase in these yield contributing parameters led to an increase in the seed yield.

However, the performance of T_5, T_6 and T_7 were also found promising with respect to yield and yield attributes in comparison to other treatments. Increment in the seed yield was to the tone of 7.27, 10.2 and 19.0% respectively over T2 (Table 2.). The results also revealed that use of FYM proved superior over other organics tried, only when the chemical fertilizers were raised to the level of 75% of RDF (T7). Conversely when 50% RDF was used in combination with biofertilizers and FYM (T6), crop showed the poor performance with regard to yield and yield attributing parameters (Table 1 & 2). Similar results were also obtained by Haider Iqbal Khan (2018) [5]. Increment in the yield in FYM and biofertlizer augmented chemical fertilizer treatment could be ascribed to improvement in the soil physico-chemical properties and better root growth. This might have paved the way for gradual and sustained release of nutrients to synchronize the nutrient demand with supply and reduced N fertilizer losses. These results are also in conformity with Subehia *et al*. (2013). Ram *et al*. (2014) previously reported that combined application of organic manures improves the release of nutrient as against their sole application. Furthermore, Mohamed *et al.* (2008) reported that beneficial effects of organic manures are attained owing to the presence of adequate quantity of mineral substances, which help in stimulating the biochemical processes within the plant, ultimately leading to improved grain yield. These results are also in agreement with earlier findings of Chaudhary and Thakur (2007) [1], Gupta *et al*., 2006 [4]; Sharma *et al*., 2005 [11] and Urkurkar *et al*., 2010 [12]. Furthermore, the data revealed that magnitude of increase (%) in grain yield, number of panicles and panicle weight in T1 and T7 were to the tune of (20.32, 19.04 %), (10.09, 9.55%) and (12.45, 8.26%) respectively over T2, depicting the superiority of inorganic fertilizer management alone as expected or in combination with FYM and bio fertilizers over application of bio fertilizers in conjunction under sub optimal dose of inorganic fertilizers i.e. with 25% less chemical fertilizers. With regard to harvest index (HI) which is a variable factor under crop production, no significant variation was observed among the treatments and it ranged from 38 to 40 %.

Table 1: Effect of climate resilient nutrient management practices on yield attributes of rice.

Treatment	Number of panicles m^{-2}				Panicle weight (g)			
	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1: RDF	405	399	407	404	2.73	2.81	3.01	2.9
T_2: Bio + 75% RDF	343	373	384	367	2.58	2.58	2.71	2.6

T_3: Bio + GM+ 75% RDF	367	378	392	379	2.45	2.65	2.77	2.6
T_4: Bio+ GM + RM @ 2 t/ha + 75% RDF	386	379	392	386	2.46	2.66	2.7	2.6
T_5: Bio+ GM + RM @ 2t/ha + 50% RDF	407	365	368	380	2.88	2.53	2.62	2.7
T_6: Bio+ FYM @5.0t/ha + 50% RDF	421	366	373	387	2.83	2.56	2.66	2.7
T_7: Bio+ FYM@ 5 t/ha +75% RDF	416	410	379	402	2.91	2.93	2.98	2.9
C.D. (p=0.05)	31.05	12.16	11.18		0.19	0.24	0.19	

Table 2: Effect of climate resilient nutrient management practices on Yield and harvest index of rice.

Treatment	Grain yield (t ha^{-1})				Straw yield (t ha^{-1})				Harvest index (%)			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1: RDF	6.87	6.33	6.64	6.61	10.51	9.43	10.56	10.17	39.5	40.2	38.6	39
T_2: Bio + 75% RDF	5.96	5.2	5.33	5.50	9.18	8.24	8.94	8.79	39.4	38.7	37.4	38
T_3: Bio + GM+75% RDF	5.58	5.53	5.62	5.58	8.64	7.89	8.57	8.37	39.2	41.2	39.6	40
T_4: Bio+ GM + RM @ 2 t/ha + 75% RDF	5.82	5.59	5.68	5.70	9.18	8.24	8.94	8.79	38.8	40.4	38.9	39
T_5: Bio+ GM + RM @ 2t/ha + 50% RDF	7.31	5.07	5.33	5.90	9.72	8.33	9.03	9.03	42.9	37.8	37.1	39
T_6:Bio+ FYM @5.0t/ha + 50% RDF	7.5	4.98	5.7	6.06	10.55	7.42	9.06	9.01	41.6	40.2	38.6	40
T_7: Bio+ FYM@ 5 t/ha +75% RDF	7.42	6.67	5.54	6.54	10.35	9.94	9.68	9.99	41.8	40.2	36.4	39
C.D. (p=0.05)	1.14	0.61	0.49	0.75	1.76	0.91	0.78		-	-	-	

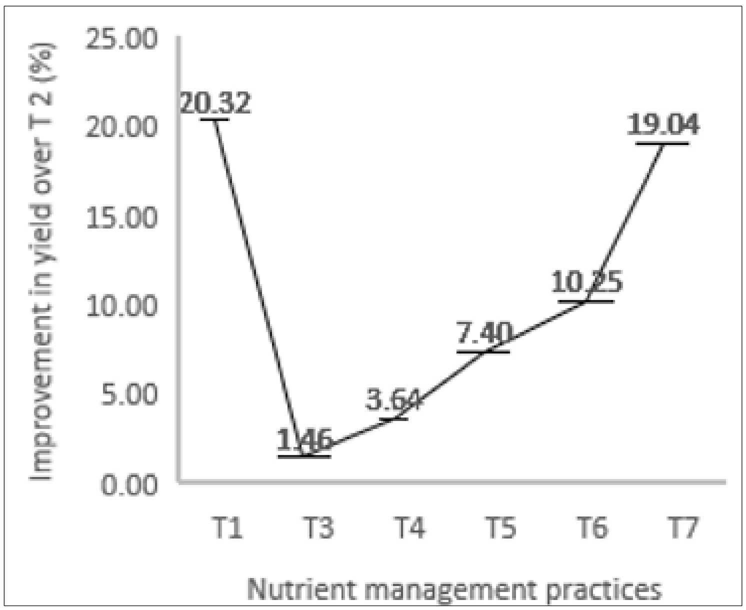
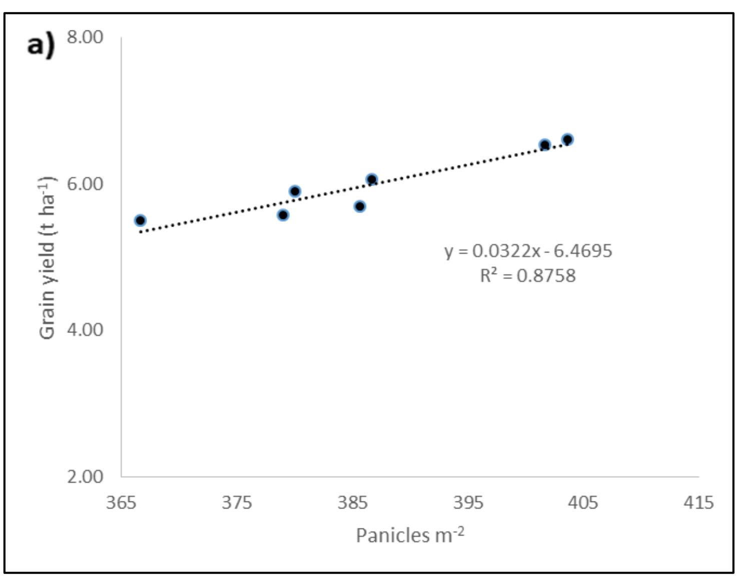


Fig 1: Percentage improvement in seed yield of different climate resilient nutrient management practices over combined application of bio fertilizers with 75% of RDF (T2).



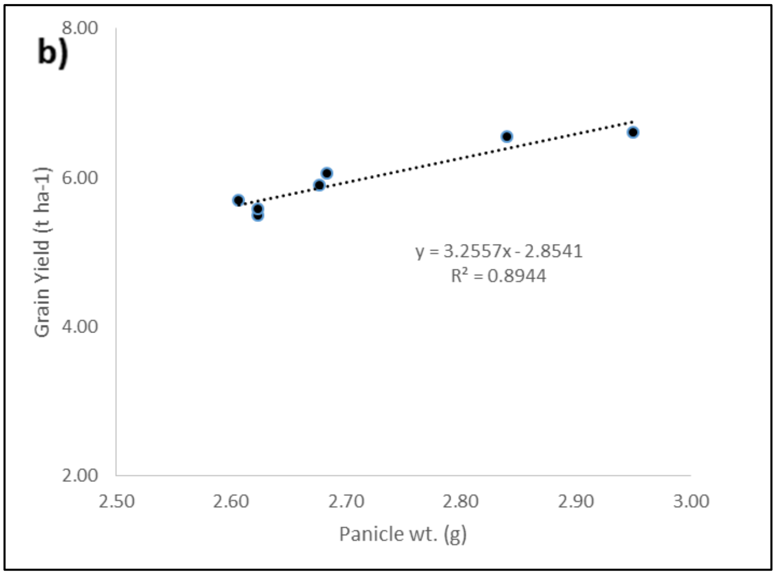


Fig 2: The positive co-relation between number of panicles m^{-2} and panicle weight (g) with grain yield. (R^2 is the determination coefficient)

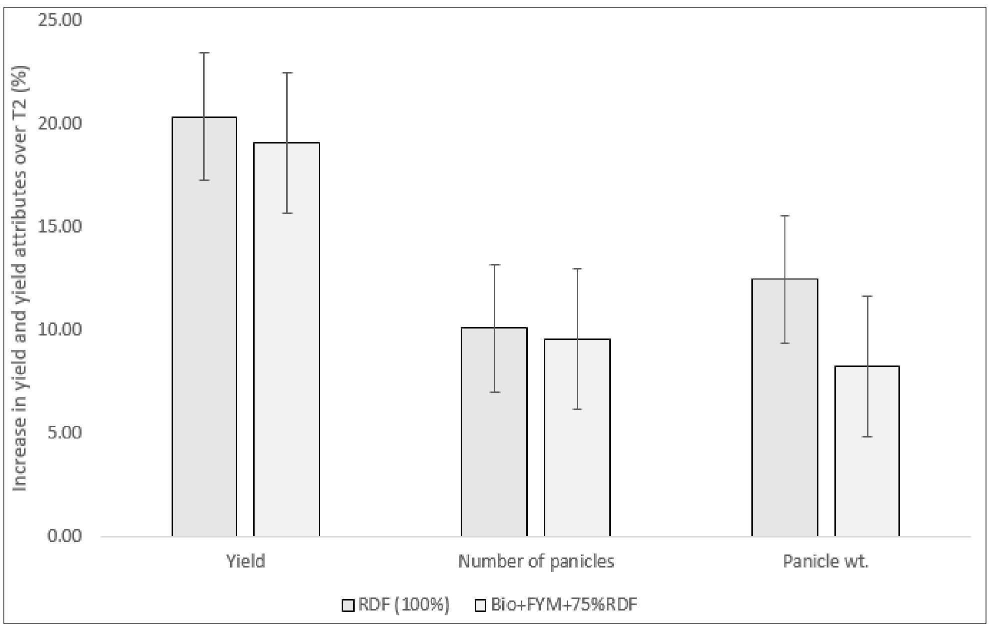


Fig 3: Mean percent change in yield and yield attributing components in RDF (100%) and combined application of 75% RDF+ Biofertilizer and FYM over 75% RDF in combination with biofertilizers (T2).

Conclusion

Our results clearly indicate that judicious use of organic and inorganic fertilizers in appropriate combinations with proper time of application not only yields at par with inorganic fertilizers but can also mitigate the dependence on inorganic fertilizers under changing climatic scenario can be helpful in realizing the higher productivity in rice

References

1. Chaudhary SK, Thakur RB. Efficient farmyard management for sustained productivity of rice (Oryza sativa)–wheat (Triticum aestivum) cropping system. Indian Journal of Agricultural Sciences,2007:77(7):443-444.
2. Doran JW, Zeiss MR. Soil health and sustainability: Managing the biotic component of soil quality. Appl. Soil Ecol,2000:1:3-11.
3. Escasinas RO, Zamora OB. Agronomic response of lowland rice PSB Rc18 (Oryza sativa L.) to different water, spacing and nutrient management. Crop Science Cluster, 2011:36(1):37-46.
4. Gupta V, Sharma RS, Vishvakarma SK. Long-term effect of integrated nutrient management on yield sustainability and soil fertility of rice (Oryza sativa)–wheat (Triticum aestivum) cropping system. Indian Journal of Agronomy, 2006:51(3):160-164.
5. Haider IK. Appraisal of biofertilizers in rice: to supplement inorganic chemical fertilizers. Rice Science,2018:25(6):357-362.

6. Haider Iqbal Khan. Appraisal of biofertilizers in rice: to supplement inorganic chemical fertilizer. Rice Science, 2018:25(6):357-362.
7. Liang Q, Chen H, Gong Y, Yang H, Fan M, Kuzyakov Y. *et al*. Effects of 15 years of manure and mineral fertilizers on enzyme activities in particle-size fractions in a North China Plain soil. Eur. J. Soil Biol,2014:60:112-119.
8. Mohamed SA, Ewees Sawsan A, Seaf El Yazal, Dalia M El Sowfy. Improving maize grain yield and its quality grown on a newly reclaimed sandy soil by applying micronutrient, organic manure and biological inoculation. Research Journal of Agriculture and Biological Sciences,2008:4(5):537-544.
9. Ram M, Davari MR, Sharma SN. Direct, residual and cumulative effects of organic manures and bio fertilizers on yields, NPK uptake, grain quality and economics of wheat (*Triticum aestivum* L.) under organic farming of rice-wheat cropping system. Journal of Organic Systems,2014:9(1):16-30.
10. Schimel DS. Terrestrial ecosystems and the carbon cycle. Glob. Chang. Boil,1995:1:77-91.
11. Sharma SP, Singh MV, Subehia SK, Jain PK, Kaushal V, Verma TS. *et al*. Long-Term Effect of Fertilizer, Manure and Lime Application on the Changes in Soil Quality, Crop Productivity and Sustainability of Maize–Wheat System in Alfisol of North Himalaya. AICRP on Long-Term Fertilizer Experiments, Research Bulletin No 2, IISS, Bhopal (MP) and Department of Soils, CSK HPKV, Palampur, HP,2005:1-88.
12. Urkurkar JS, Tiwari A, Shrikant C, Bajpai RK. Influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rice *(Oryza sativa*) and wheat (*Triticum aestivum*) in Inceptisols. Indian Journal of Agricultural Sciences,2010:80(3):208-212.
13. Yadav R, Dwivedi BS, Prasad K, Tomar OK, Shurpali NJ, Pandey PS. Yield trends, and changes in soil organic-C and available NPK in a long-term rice–wheat system under integrated use of manures and fertilisers. Field Crops Research,2000:68:219-246.
14. Zhang Y, Li T, wu H, Bei S, Zhang J, Li X. *et al*. Effect of different fertilization practices on soil microbial community in a wheat–maize rotation system. Sustainability, 2019:4088:1-11.