Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(3): 1691-1694
Received: 15-03-2018
Accepted: 17-04-2018

Reshma Bora
Department of Agriculture, UCBMS&H, Dehradun, Uttarakhand, India

Aaradhana Chilwal
Research scholar, Punjab Agricultural University, Ludhiana, Punjab, India

Santosh K Yadav
Department of Agronomy, GBPUA&T, Pantnagar, Uttarakhand, India

Ankita Negi
Department of Agronomy, GBPUA&T, Pantnagar, Uttarakhand, India

Correspondence
Reshma Bora
Department of Agriculture, UCBMS&H, Dehradun, Uttarakhand, India

Influence of balance fertilizer application in a long term on yield and yield attributing characters of rice (*Oryza sativa* L.)

Reshma Bora, Aaradhana Chilwal, Santosh K Yadav and Ankita Negi

Abstract
In the year of 2017, a field experiment was conducted in *kharif* season, A2 Block of Norman E. Borlaug Crop Research Center (NEBCRC) of G.B.P.U.A&T. Pantnagar, Udham Singh Nagar, (Uttarakhand) to evaluate the influence of balance fertilizer application in a long term on yield and yield attributing characters of rice (*Oryza sativa* L.). These treatments were a part of long-term fertility experiment since 1984. Nine treatments out of fourteen consisting different combination of N, P, K, Znf and FYM were tested in a Randomized Block Design with four replications. The variety sown was HKR 47. In the present study addition or deletion of nutrient or nutrient sources in the recommended fertilizer dose responded in an almost similar way in affecting yield over the period of 33 years. Reduction in nutrients sources in recommended dose of fertilizer led to 33-50% reduction in yield while addition of FYM led to 7% increase in rice grain yield. The grain yield over 33 years of experimentation revealed that highest production (6.10 t ha^{-1}) was obtained with the application of $N_{120}P_{40}K_{40}$+Znf+FYMr which was statistically at par with $N_{120}P_{40}K_{40}$+FYMr and $N_{120}P_{40}K_{40}$+Znf. This could be due to the additional supply of N, P, K and Zn with FYM applied @ 5 t ha^{-1} since last many years that led to better fertility status resulting the good supply of nutrients. The increased yield of rice in FYM consisting treatment was however mainly due to increase in 1000-grain weight and of a lower number of unfilled spikelets compared to other treatments. The incomplete fertility treatments i.e. N_{120}, $N_{120}K_{40}$ had resulted in the maximum number of unfilled grains and lowest total spikelets per m^{-}results in yield reduction as compared to FYM added treatments. It suggested that FYM, that is known to add all type of nutrients in the soil and maintaining soil health in all respects i.e. biological, physical and chemical, was able to maintain the productivity and fertility status of soil over the years compared to a recommended dose of fertilizer in which 26% reduction was noticed.

Keywords: HKR 47, Znf, FYMr, long-term fertility experiment, spikelets

Introduction
Rice and wheat have been grown in sequence on the same land over 26 mha of South and East Asia to meet the food demand of increasing population. The study of soil fertility and crop productivity under long-term cropping has long been the subject of immense importance. There are indications of declining productivity due to depletion in soil organic matter, over mining of nutrients reserves and losses of nutrients as clearly evolved through long-term fertilizer experiments being conducted in different parts of the country. Presently, the major concern in agriculture is to arrest any further decline in the crop productivity and soil quality. Sustainable high yields of crops can support food security of the rapidly growing population (Palm *et al.*, 2014) [7]. Rice consumption is increasing and demand for rice will outstrip supply if production does not increase faster than its current rate. This means there is a need to produce even more rice for food security. Improved fertility status of soil health and could support sustainable crop production. Long-term fertility experiments have significantly contributed to our understanding of soil fertility management and sustainable crop production in different agroecosystems (Rawal *et al.*, 2017) [13]. Under intensive cropping system, high use of fertilizer can cause a deficiency of primary, secondary and micronutrients. Presently farmer is using only NPK, that too in imbalance ratio and there is no attention paid for secondary and micronutrients. Long-term fertility experiments, however, are a good indicator for monitoring soil quality and crop productivity and is of vital importance in nutrient management as well as soil health also (Paul *et al.*, 2013) [9].
The combined application of manure with inorganic fertilizers was more effective as compared to inorganic fertilizers alone in building up fertility status of soil and increasing the productivity of rice and wheat (Bharambe and Tomar, 2004) [1]. Managing N application to rice is an essential activity to reduce N losses and to improve N use efficiency which in turn

improves rice grain yields (Premalathan 2017). It has been observed that even with the balanced application of N, P and K fertilizers, crop yields showed declining trend for rice at Pantnagar and in Kharif rice with lateritic soils of Bhubaneswar. The declining trends in yield in these soils have been found to be associated with the deficiencies of secondary nutrients like sulfur and micronutrients, like zinc. While at Pantnagar, after 4 years of rice-wheat cropping with N, NP, NK and NPK, the grain yield of rice did not differ significantly and response to N (NPK over PK) was 43 percent in rice (Bisht, 1990, Puniya 2010 and Paul 2012) [2, 11, 8]. Raju and Reddy (2000) [12] reported that rice- rice system for higher grain yield required the application of 100% recommended a fertilizer in both the seasons at; it was assessed after 6 years of continuous cropping. The yield decline was found to be arrested more with FYM consisting NPK or NPK+Zn treatment, however, little declined in grain yield was also noticed in the NPK+FYM and NPK+Zn+FYM full fertilizer treatments (Bisht *et al*., 2006) [3]. An AICRP, rice-wheat-cow pea long-term experiment established in 1971 at Pantnagar on a virgin Mollisol, the yields of the rice crop was found declining from initial levels, but there was no such substantial decline in wheat was noticed with NPK (Nand Ram, 1998) [6]. Available phosphorus status of soil declined sharply when phosphorus fertilizer was not applied, whereas application of 60 kg P_2O_5 ha^{-1} with or without farmyard manure during both the seasons showed the marked build-up in available phosphorus status of the soil (Yadav *et al*., 1998) [6]. The decline in rice yield was noticed by Dhyani *et al*. (2007) [4] due to skipping P and K from recommended dose of NPK, respectively, at Bulandshahar. (Singh *et al*., 2015) [14] observed that, the nutrients sources like N_{75} (FYM) + N_{45}(Urea) significantly enhanced the growth and yield of rice, number of panicles per m^2, panicle length, panicle weight, number of filled spikelets per panicle, filled spikelets per m^2, 1000 grain weight and yield of rice (5.17t/ha, averaged over two years) compared to nitrogen through urea alone.

Numerous other studies also investigated the effect of variation in fertilizers application rice on its yield and yield attributing characters. The present study, a part of long term fertility experiment on rice, was conducted with the major aim to investigate the problem of yield decline and locate when and what nutrient(s) would become limiting in rice-based cropping systems.

Material and methods

In *Kharif*, 1984, the long-term fertility experiment on rice-wheat cropping system was initiated under the flagship of International Network on Soil Fertility and Fertilizer Evaluation for Rice (INSFER) programme of Indian Council of Agricultural Research (ICAR) and International Rice Research Institute (IRRI) and the same rice-wheat cropping system with same sets of treatments is practiced on the same piece of experimental site.

Field experiment was conducted in *kharif* season 2017 at A2 Block of Norman E. Borlaug Crop Research Center (NEBCRC) of G.B.P.U.A&T. Pantnagar, Udham Singh Nagar, (Uttarakhand). This center is situated at an altitude of 243.84 m above mean sea level, 29°N Latitude and 79.3° E longitude. It falls under foot hills of Shivalik range of Himalayas as a narrow belt called "*Tarai*". The *Tarai* belt falls under the sub-humid and sub-tropical climate zone with hot dry summers and cool winters. The soils are originated from alluvial sediments. The chemical analysis of top 15 cm soil showed that it was rich in organic matter and medium in phosphorus and potassium, and neutral to slightly alkaline in reaction. In the long term fertility experiment, fourteen treatments were tested in a Randomized Block Design 4 replications, however only nine important treatments (Control, N_{120}, $N_{120}P_{40}$, $P_{40}K_{40}$, $N_{120}K_{40}$, $N_{120}P_{60}K_{40}$, $N_{120}P_{40}K_{40}$ + Znf, $N_{120}P_{40}K_{40}$ + FYMr and $N_{120}P_{40}K_{40}$+Znf + FYMr) considered in the present study. The above mentioned symbols represent: N_{120}-120 kg N ha^{-1}, P_{40}-40 kg P_2O_5 ha^{-1}, K_{40}-40 kg K_2O ha^{-1}, Znf- Foliar Zinc (0.5% $ZnSO_4$+0.25% Slaked lime), FYMr- Farm Yard Manure applied @ 5 t ha^{-1} on the dry weight basis in rice crop only.

Results and discussion

Yield contributing characters

The data pertaining to yield contributing characters i.e. number of panicles m^{-2}, a total number of spikelets m^{-2}, number of filled spikelets per panicle, sterile percentage and 1000-grain weight are summarized in Table 1. The fertility treatments had a significant influence on yield contributing characters. The highest values of all the yield contributing characters except sterile percentage was reported under $N_{120}P_{40}K_{40}$+Znf + FYMr treatment followed by $N_{120}P_{40}K_{40}$ + FYMr treatment, values being 212, 34117, 137 and 25.37g and 209, 33306, 136 and 25.32 g for number of panicles m^{-2}, a total number of spikelets m^{-2}, number of filled spikelets per panicle and 1000-grain weight under $N_{120}P_{40}K_{40}$+Znf + FYMr and $N_{120}P_{40}K_{40}$ + FYMr treatment, respectively. Highest sterile spikelet percentage was observed in plot where phosphorus was not applied $N_{120}K_{40}$ (33%) which was statistically at par with N_{120} (31%) but significantly more than rest of the treatments. Application of $N_{120}P_{40}K_{40}$+FYMr (14%) being at par with $N_{120}P_{40}K_{40}$+Znf (17%) and $N_{120}P_{40}K_{40}$+Znf+FYMr (16%) treatments, had observed significant reduction in sterile percentage compared to remaining treatments.

Yield (Grain, Straw and Biological Yield, Grain to Straw Ratio and Harvest Index)

Data pertaining to grain yield, straw yield, biological yield, grain to straw ratio and harvest index are summarized in Table 2 and depicted in Fig1. The fertilizer treatments had significant effect on grain yield. The highest grain yield was recorded with $N_{120}P_{40}K_{40}$+Znf (5.66t ha^{-1}), $N_{120}P_{40}K_{40}$+FYMr (6.02t ha^{-1}) and $N_{120}P_{40}K_{40}$+Znf+FYMr (6.10t ha^{-1}) treatment was statistically at par to each other however the addition of Zn and FYM along with $N_{120}P_{40}K_{40}$ caused numerically highest grain yield. These three treatment led to significantly higher grain yield compared to remaining treatments. It was also observed that imbalanced fertilizers led to drastic reduction in grain yield. Least yield was noticed in control treatments. Similar was the trend noticed for straw yield at total biological yield. The fertilizer treatment did not influence grain to straw ratio and harvest index significantly. The grain to straw ration varied from maximum 0.96 in $N_{120}P_{40}K_{40}$ +FYMr to minimum 0.90 with $P_{40}K_{40}$. There was declining trend noticed in grain, straw ratio by deleting any nutrient from recommended $N_{120}P_{40}K_{40}$+Znf and enhancement in grain, straw ratio by addition of FYM increased over recommended dose. Applying only N_{120} or no nutrient (control) leads to the reduction in harvest index than remaining treatment. It varies from 47% in control to 49% in $N_{120}P_{40}K_{40}$.

Results of the experiment revealed that the grain yield is a function of its different yield contributing characters such as panicles per unit area, the number of filled spikelets per panicle, and 1000-grain weight**.** The yield contributing characters observed during the experimentation were found to be influenced by different fertilizer treatment significantly. Application of FYM along with $N_{120}P_{40}K$ with or without Zn increased the yield contributing characters over chemical fertilizer alone or imbalanced fertilizer treatments. The increased yield of rice in FYM consisting treatment was mainly due to increase in 1000- grain weight and of a lower number of unfilled spikelets compared to other treatments. Grain yield variation on account of the continuous use of FYM enriched treatments caused a reduction in yield within the range of 16% in $P_{40}K_{40}$ to 53% in N_{120} when compared with initial yield level of 1984. However, there was more reduction with continuous use of imbalanced fertilizer dose i.e. N_{120} (53%), $N_{120}K_{40}$ (49%) and $N_{120}P_{40}K_{40}$ (32%) compared to FYM added treatments. It suggested that FYM was able to maintain the productivity and fertility status of soil over the years compared to a recommended dose of fertilizer in which 26% reduction was noticed. FYM is known to add all type of nutrients in the soil and maintaining soil health in all respect i.e. biological, physical and chemical. Combination of $N_{120}P_{40}K_{40}$ along with FYM and Zn increased the yields because of attaining better fertility status resulting the good supply of nutrients. Such inferences have also been drawn from several long-term experiments. The reduction in grain yield was more pronounced with chemically fertilized treatment. Such decline in yields over the years due to continuous cropping and fertilization under rice-wheat system has been reported in long-term fertility experiments established in different parts of the country (Nambiar and Abrol, 1989 and Yadav and Kumar, 2009) [5, 15].

Conclusion

The present study concluded that continuous application of N alone or its combination in the absence of P and K results in lower yield. On the other hand FYM, enriched fertilizer treatments ($N_{120}P_{40}K_{40}$+Znf+FYMr and $N_{120}P_{40}K_{40}$ +FYMr) increases the yield attributing charactersas well as grain, straw and biological yield, thus shows the importance of balanced fertilization in sustaining rice yield.

Table 1: Effect of treatments on yield attributing characters of rice.

Treatment		Panicles (m^{-2})	Spikelets			1000 grain weight (g)
			Total (m^{-2})	Filled/ panicle	Sterile (%)	
T_1	Control	130	19470	114	24	25.03
T_2	N_{120}	154	26865	121	31	25.00
T_3	$N_{120}P_{40}$	189	27947	112	25	25.19
T_4	$P_{40}K_{40}$	148	21603	121	18	25.07
T_5	$N_{120}K_{40}$	192	30089	105	33	25.06
T_6	$N_{120}P_{40}K_{40}$	198	31349	125	22	25.29
T_7	$N_{120}P_{40}K_{40}$ + Znf	202	31114	129	17	25.16
T_8	$N_{120}P_{40}K_{40}$ + FYMr	209	33306	136	14	25.32
T_9	$N_{120}P_{40}K_{40}$ +Znf + FYMr	212	34117	137	16	25.37
	S.Em ±	3	1358	6	2.3	0.05
	C.D. (5%)	10	3987	17	7	0.15
	C.V. (%)	4	9.55	10	21	0.42

Table 2: Effect of fertilizer on grain, straw and biological yield, grain straw ratio and harvest index of rice

Treatment		Yield (t ha^{-1})						
		Initial 1984	Grain 2017	Decline Yield	Straw	Biological	Grain: strawratio	Harvest index (%)
T_1	Control	4.10	2.93	1.17	3.21	6.14	0.91	0.47
T_2	N_{120}	7.40	3.49	3.91	3.86	7.35	0.91	0.47
T_3	$N_{120}P_{40}$	7.10	5.09	2.01	5.57	10.66	0.91	0.48
T_4	$P_{40}K_{40}$	4.20	3.53	0.67	3.90	7.43	0.90	0.48
T_5	$N_{120}K_{40}$	7.40	3.78	3.62	4.08	7.86	0.93	0.48
T_6	$N_{120}P_{40}K_{40}$	7.50	5.11	2.39	5.42	10.53	0.94	0.49
T_7	$N_{120}P_{40}K_{40}$ + Znf	7.60	5.66	1.94	6.13	11.80	0.92	0.48
T_8	$N_{120}P_{40}K_{40}$ + FYMr	7.70	6.06	1.64	6.31	12.38	0.96	0.48
T_9	$N_{120}P_{40}K_{40}$ +Znf + FYMr	8.10	6.10	2	6.55	12.66	0.93	0.48
	S.Em ±		0.16		0.16	0.31	0.1	0.004
	C.D. (5%)		0.45		0.48	0.91	NS	NS
	C.V. (%)		7		7	6	2	2

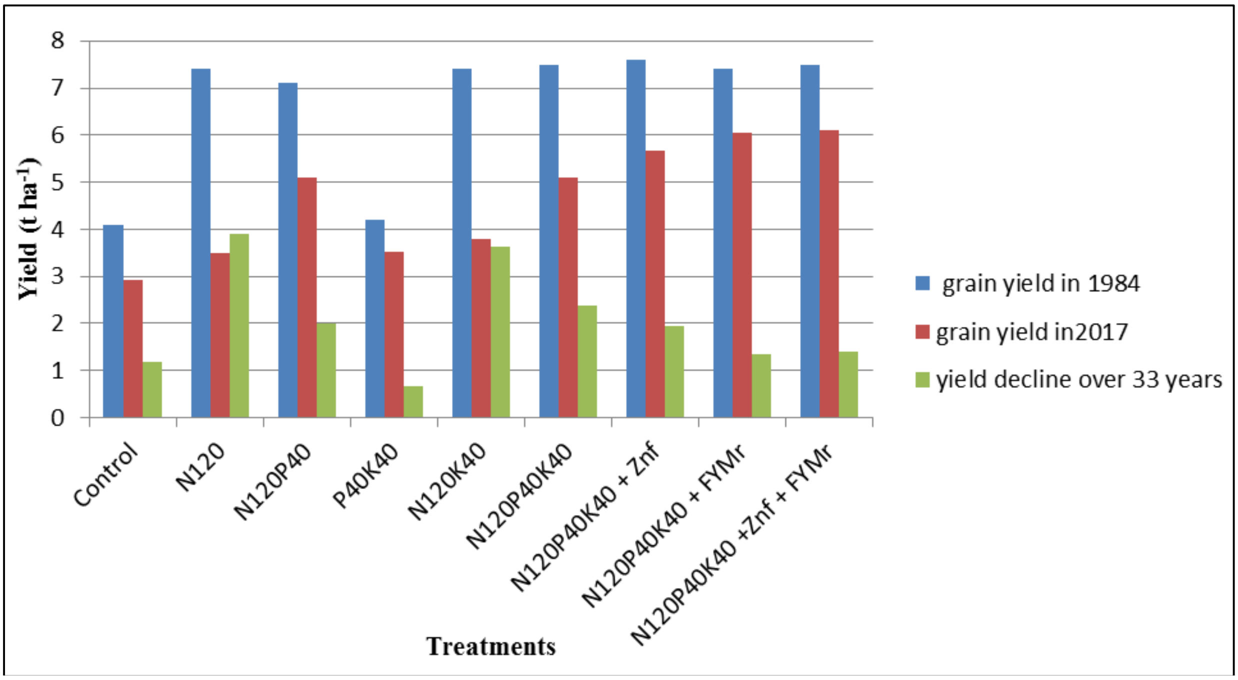

Fig 1: Grain yield in 1984, Grain yield in 2017 and total yield decline over 33 years

References

1. Bharambe AP, Tomar A. Direct and residual effect of FYM and inorganic nutrients on rice-wheat cropping system in vertisol. PKV Res. J. 2004; 28:47-52.
2. Bisht PS, Pandey PC, Lal P. Changes in soil fertility, crop productivity and nutrient status in long-term rice based cropping system. Proc. of Int. Symp. on Rice Research New Frontiers, DRD, Hyderabad, 279280. 1990, 15-185
3. Bisht PS, Pandey PC, Singh DK. Monitering of long-term fertility experiment after two decades of rice-wheat cropping. 2nd Int. Rice Congress. Science tech. and trade for peace and prosperity. New Delhi, 2006, 400.
4. Dhyani BP, Kumar Vijay, Shahi UP, Vivek, Sharma RD, Singh SP. Economics, yield potential and soil health of rice-wheat cropping system under long-term fertilizer experimentation. Indian J Agri. Sci. 2007; 72(12):859-861.
5. Nambiar KKM, Abrol IP. Long-term fertilizer experiments in India (1971-82), LTFE project, 1989, 11-20.
6. Nand Ram. Effect of continuous fertilizer use on soil fertility and productivity of a Mollisols. In: Swarup, A., Reddy, D.D., Prasad, R.N. (Eds.), Long-term soil fertility management through integrated plant nutrient supply. IISS, Bhopal, India, 1998, 229-237.
7. Palm C Blanco, Canqui H, Clerck F, Gatere L, Grace P. Conservation agriculture and ecosystem services: An overview. Agric Ecosyst Environ. 2014; 187:87-105. DOI: 10.1016/j.agee.2013.10.010
8. Paul T. Effect of nutrient management on rice productivity and soil fertility after 28 years of rice-wheat cropping system. Thesis submitted to G.B.P.U.A. & T., Pantnagar, India, 2012.
9. Paul T, Bisht PS, Pandey PC, Singh DK, Roy S. Rice productivity and soil fertility as influenced by nutrient management in rice (*Oryza sativa*)–wheat (Triticum aestivum) cropping system. Ind. J Agro. 2013; 58(4):495-499.
10. Premalatha BR. Use of leaf colour chart for nitrogen management as a tool in bridging the yield gap in rainfed rice (*Oryza sativa* L) production. Adv. Res. J of crop improvement. 2017; 8(1):36-44.
11. Puniya R. Long-term effect of nutrient management on crop productivity and soil quality under rice-wheat system. Ph. D. (Ag.) Thesis submitted to G.B.P.U.A. & T., Pantnagar, India, 2010.
12. Raju RA, Reddy MN. Sustainability of productivity in rice (*Oryza sativa* L)- rice sequential cropping system through integrated nutrient management in coastal ecosystem. Indian J Agro. 2000; 45(3):447-452
13. Rawal N, Ghimire R, Devraj Chalise. Crop Yield and Soil Fertility Status of Long-Term Rice-Rice-Wheat Cropping Systems. Indian Journal of applied science and biotechnology. 2017; 5(1):42-50.
14. Singh DK, Pandey PC, Ali, Naiyar, Gupta Shilpi. Stand establishment techniques of rice in conjunction with nutrient sources for soil health and productivity of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system Indian journal of Agronomy. 2015; 60(1):362-365.
15. Yadav DS, Kumar Alok. Long-term effect of nutrient management on soil health and productivity of rice (*Oryza Sativa*)-wheat (*Triticum Aestivum*) system. Indian J Agron. 2009; 54(1):15-23.
16. Yadav RL, Yadav DS, Singh RM, Kumar A. Long-“rice-wheat cropping system. Nutr. Cycl. Agroecosyst. 1998; 51:193-200.