

Original Research Article

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Evaluate the Effect of Pesticide and Integrated Nutrient Management System on the Content of Major Nutrients in Grain of Rice -Pusa Basmati-1509 (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during two consecutive years of *Kharif* 2016 and 2017 at Fertilizer Research Farm Uttari Pura, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh). The field experiment was imposed to evaluate the effect of pesticide and integrated nutrient management systems on the content of major nutrients in the grain of basmati rice PB-1509. The importance of the NPK component is greater because they are found in lower concentrations in most Indian varieties. The experiment was laid out in a split-plot design comprise of four main plot and ten sub-plot, in which main plots are: Control, Weedicide : Bispyribac Sodium (Nomnigold) 10 % SC @ 35 a.i. ha⁻¹, Fungicides : IFC- 110 (Tricyclazole 45 % + Hexaconazole 10 % WG) 1.0 g/lit., Insecticides : Malathion 25% @ 25 kg ha⁻¹, whereas the treatment combinations in sub-plots are: N (T1), NP (T2), NPK (T3), NPK + Zn (T4), NPK+ Fe (T5), NPK + Mn (T6), NPK+ Zn +Fe +Mn (T7), NPK +10 t FYM ha⁻¹ (T8), NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ (T9), Control (T10). Results have shown that treatment NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ recorded significantly higher value of N, P, and K contents in the rest of the treatment.

Keywords

Pesticides,
Nutrients contents,
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management

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Introduction

Rice belongs to the genus *Oryza* and has two cultivated and 22 wild species. The two cultivated species are *Oryza sativa* and

Oryza glaberrima. Rice is a major food grain for more than a third of the world's population. It has been consumed by humans for almost 5000 years (Zhao *et al.*, 2011). Rice holds a unique position among

domesticated crop species as it is a staple food and the first fully sequenced crop genome. It is consumed mainly in the form of whole-grain supplying 20% of daily calories for the world population. An increasing amount of available nutrients in rice food for human consumption is a challenge that is particularly important for developing countries. This could be achieved by increasing the total level of nutrients in the edible part of staple crops, such as rice grains (Michael and Richard, 2007).

According to a report of FAO, (2016) world population is growing at a rate of 160 persons per minute and we need to produce 70 % more food for an additional 2.3 billion people by 2050. Agriculture is the fundamental mode to satisfy the food demands of mankind and soil is the only medium to practice agriculture. To feed India's projected population of 1.35 billion in 2025. In Basmati rice aroma develops from a combination of more than 100 volatile compounds (Lewinsohn *et al.*, 2001). Among over 100 volatile compounds that constitute aroma in rice, 2-acetyl pyrroline (2-AP) is principally responsible for the unique popcorn fragrance of Basmati rice cultivars. The detection of this compound has been reported in different parts of rice plants, except for the roots (Lorieux *et al.*, 1996). The structure of 2-AP consists of a reactive methyl ketone group and a nonreactive pyrroline group (Nadaf *et al.*, 2006). With the advent of molecular maps and genomic sequences, a major gene for rice aroma was discovered on chromosome 8. The allelic variation at badh2 (betaine aldehyde dehydrogenase homologue 2; a gene with 15 exons) controls the aroma in Basmati rice (Sakthivel *et al.*, 2009).

Traditionally, the optimum rate of N-fertilization has been the rate that results in maximum economic yield. Required optimum N rate varies with soil type, yield potential of

cultivar, levels of phosphorus (P) and K in the soil, water management practices, and intensity of diseases, insects, and weeds. The use of adequate N rate is important not only for obtaining maximum economic return, but also to reduce environmental pollution (Singh 2008). Nitrogen is a key component of chlorophyll, proteins, and enzymes; and assists the plants in the synthesis and use of carbohydrates (Sara *et al.*, 2013). Split applications of N are necessary for obtaining high grain yield and improved quality (Kumar *et al.*, 2014).

Phosphorus plays a crucial role in the root proliferation, consistent grain filling, and higher grain yield, quality, and also being involved in many processes such as photosynthesis, mitotic activities, tissue growth, and development. Plants cannot reach their maximum yield without an adequate supply of phosphorus (Murtaza *et al.*, 2014). Potassium is essential for the maintenance of electrical potential across cellular membranes and cellular turgor enhancing the cell expansion and enlargement, opening and closing of stomata, and pollen tube development. The determination of optimum levels of NPK fertilizers is essential for obtaining maximum economic returns. According to Ananthi *et al.*, (2010) best rate of fertilizer application is that which gives maximum economic returns at the least cost.

The application of K increased gel consistency and grain protein content but did not significantly affect gelatinization temperature or kernel amylose content (Bahmaniar and Ranjbar, 2007). Besides its role in kernel quality, K fertilization is known to improve stem strength and yield of Basmati rice (Zaman *et al.*, 2015).

Suwanarit *et al.*, (1997) observed that aroma, softness, whiteness, and glossiness in the grain is dependent on P content in grain and

not on P content in the plant. High dose P application to the crop produced lower quality grains. The application of P increased grain protein content. Shivay *et al.*, (2007) reported that zinc fertilization had no deleterious effect on the quality of Basmati rice. P even increased hulling percentage and produced longer and better grains.

Materials and Methods

At field experiment will be conducted at Fertilizer research Farm Uttari Pura, of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur for two the consecutive year of 2015-16 and 2016-17 in Kharif season. The initial Physico-chemical and mechanical characteristics of the experimental soil were: sand 57.66 %, silt 22.30 % and clay 20.14 %, mild high in reaction (pH 8.32), and low EC 0.46 medium in organic carbon (0.41%) with 182, 11.70 and 171.0 kg ha⁻¹ of available N, P, and K, respectively. DTPA extractable Zn, was 1.83 mg Kg⁻¹, Fe 12.7, and Mn 7.26 mg Kg⁻¹, respectively.

Forty treatment combinations were replicated three times in split-plot design. Surface (0-0.15 cm) soil samples taken after the harvest of Rice were analyzed for pH, organic carbon, cation exchange capacity, available N, P, and K using standard analytical methods. Samples were analyzed for their nitrogen content by the modified Kjeldahl method (Jackson 1973), phosphorus was determined by vanadomolybdate, yellow color method, and potassium by flame photometer in the di-acid digest. Organic cation in post-harvest soil was determined by Walkley and Black method. Available nitrogen, phosphorus, and potassium in soil samples were determined by the methods described by Subbiah and Asija (1956), Olsen's, and flame photometer (Jackson, 1973), respectively.

All the treatments were evaluated in a split-plot design with three replications. Twenty-one days old seedlings of 'Pusa Basmati-1509' rice were transplanted in the third week of July in each year with 20 x 10 cm row to row and plant to plant spacing. The half dose on nitrogen and full doses of P, K, Zn, Mn, and Fe were applied as basal at the time of transplanting through ammonium sulphate, single super phosphate, Muriate of Potash (MOP), MnSO₄ and FeSO₄, respectively and remaining nitrogen was applied in two equal splits at maximum tillering and panicle initiation stage.

After taking the weight of total biomass, the produce of each net plot was threshed separated manually. The grains of each plot were cleaned and air dried to maintain the moisture content at a standard level of 14 percent and recorded the weight in kg per net plot by balance. Finally, grain yield per plot was converted into q/ha by the conversion factor. The straw yield was recorded by subtracting the weight of grains from the weight of the total harvested produce of each net plot.

Results and Discussion

Effect of pesticides application on N content (%) in rice grain

It is evident from the Table 1 showed that nitrogen content (%) in grain was influenced significantly due to pesticides application during first year but did not affected second year of the study. It ranged varied from 1.159 to 1.232 percent during first year and 1.479 to 1.563 during second year. Among the pesticides application the nitrogen content was recorded significantly highest with the range of 1.085 to 1.338 percent under the application of Weedicide : Bispyribac Sodium (Nomnigold)10 % SC @ 35 a.i. ha⁻¹ at 4-6 leaves stage followed by Insecticides:

Malathion 25% @ 25 kg ha⁻¹ (1.053 to 1.306%) during first year. These applications were also exhibited at par with each other. The lowest nitrogen content in grain was noticed in control treatment viz. 1.012 to 1.265% during first year.

During second year, the application of weedicide : Bispyribac Sodium (Nomnigold)10 % SC @ 35 a.i. ha⁻¹ at 4-6 leaves stage was recorded statistically maximum nitrogen content percent in grain as compared to all the pesticides application. The least nitrogen content was recorded in control treatment during second year of the observation. Similar finding was also reported by Murali and Setty (2004) and (Yadav and Raskar, 2011).

Effect of pesticides application on P content (%) in rice grain

It is evident from the Table 2 showed that phosphorus content (%) in grain was influenced significantly due to pesticides application during first year but did not affected second year of the study. It ranged varied from 1.159 to 1.232 percent during first year and 1.479 to 1.563 during second year. Among the pesticides application the nitrogen content was recoded significantly highest with the range of 1.085 to 1.338 percent under the application of Weedicide : Bispyribac Sodium (Nomnigold)10 % SC @ 35 a.i. ha⁻¹ at 4-6 leaves stage followed by Insecticides: Malathion 25% @ 25 kg ha⁻¹ (1.053 to 1.306%) during first year. These application was also exhibited at par with each other. The lowest nitrogen content in grain was noticed in control treatment viz. 1.012 to 1.265% during first year.

During second year, the application of weedicide : Bispyribac Sodium (Nomnigold)10 % SC @ 35 a.i. ha⁻¹ at 4-6 leaves stage was recorded statistically maximum nitrogen content percent in grain as

compared to all the pesticides application. The least nitrogen content was recorded in control treatment during second year of the observation. Similar result was also reported by Singh *et al.*, (2008), Singh, and Chhokar (2009).

Effect of pesticides application on K content (%) in rice grain

It is evident from the Table 3 showed that potassium content (%) in grain was influenced significantly due to pesticides application during both of the year of the study.

The potassium concentration ranged varied from 0.248 to 0.288 percent during first year and 0.322 to 0.427 during second year. Among the pesticides 0.352 percent under the application of Weedicide : Bispyribac Sodium (Nomnigold)10 % SC @ 35 a.i. ha⁻¹ at 4-6 leaves stage followed by Insecticides: Malathion 25% @ 25 kg ha⁻¹ (0.187 to 0.337%) during first year. This application was also exhibited significantly at par with each other. The lowest nitrogen content in grain was noticed in control treatment viz. 0.162 to 0.362% during first year.

During second year, the application of weedicide : Bispyribac Sodium (Nomnigold) 10 % SC @ 35 a.i. ha⁻¹ at 4-6 leaves stage was recorded significantly maximum potassium content percent in grain as compared to all the pesticides application. The minimum potassium content was recorded in control treatment during second year of the observation. Similar result was also reported by Jha *et al.*, (2004) and Mahmud *et al.*, (2016).

Effect of nutrients application on N content (%) in rice grain

The data presented in table 1 revealed that application of NPK+ Zn +Fe +Mn +

Vermicompost @ 3 ton ha⁻¹ significantly increased the nitrogen concentration in grain over control during first of the years but observed non-significant effect in second year. It ranged was between 1.051 to 1.305 percent during 2015-16 and 1.385 to 1.639% during second year, respectively. The N content was recorded maximum with the application of NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ which was significantly superior over all the treatments during first year. The least N content was recorded under control plot which was not received any nutrients.

Application of zinc, iron, manganese and Zn+Fe+Mn+ vermicompost gave superior values than corresponding nitrogen alone in case of grain during first of the year.

In second year, as regards N concentration in grain, the treatment, NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ showed the maximum N concentration and proved statistically superior to rest of the treatments.

It was varied from 1.345 to 1.418 % and 1.599 to 1.672% under control to NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹. Similar finding was also reported by Tripathi *et al.*, (2014) and Sudhakar (2016).

The lowest values of N concentration were observed under control and highest in NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ during both the year.

All the treatments contained statistically higher N content then control during both the year of investigation. Addition of Zn, Fe, Mn and combined with NPK and vermicompost gave significantly higher grain N content over rest of the treatments during both the year of study. Similar result was also reported by Bandyopadhyay *et al.*, (2004).

Effect of nutrients application on P content (%) in rice grain

The data presented in table 2 revealed that application of NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ significantly increased the phosphorus concentration in grain over control during both of the years . It ranged was between 0.180 to 0.330 percent during 2015-16 and 0.247 to 0.388% during second year, respectively.

The P content was recorded maximum with the application of NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ which was significantly superior over all the treatments during first year. The least P content was recorded under control plot which was not received any nutrients. Application of zinc, iron, manganese and Zn+Fe+Mn+ vermicompost gave superior values than corresponding nitrogen alone in case of grain during first of the year. Similar result was also reported by and Sudhakar (2016) and Srivastava *et al.*, (2016).

In second year, as regards P concentration in grain, the treatment, NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ showed the maximum P concentration and proved significantly superior to rest of the treatments. It was varied from 0.227 to 0.377 % and 0.267 to 0.417% under control to NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹. The lowest values of P concentration in grain were observed under control and highest in NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ during both the year. All the treatments contained significantly higher P content then control during both the year of investigation. Addition of Zn, Fe, Mn and combined with NPK and vermicompost gave significantly higher grain P content over rest of the treatments during both the year of study. Similar findings was also reported by Tripathi *et al.*, (2014).

Table.1 Effect of pesticide and nutrient applications on N content (%) in grain of rice crop during 2015-16 and 2016-17

Treatments	N content (%) in grain									
	2015-16					2016-17				
	Control	Weedicide	Fungicides	Insecticides	Mean	Control	Weedicide	Fungicides	Insecticides	Mean
N	1.080	1.153	1.121	1.125	1.119	1.413	1.486	1.458	1.454	1.453
NP	1.129	1.199	1.166	1.171	1.166	1.429	1.532	1.504	1.499	1.491
NPK	1.155	1.228	1.196	1.200	1.195	1.455	1.561	1.533	1.529	1.520
NPK +Zn	1.177	1.250	1.218	1.222	1.217	1.511	1.584	1.556	1.552	1.550
NPK+ Fe	1.170	1.243	1.211	1.215	1.210	1.504	1.577	1.549	1.545	1.543
NPK + Mn	1.168	1.241	1.209	1.213	1.207	1.501	1.574	1.546	1.542	1.541
NPK+ Zn +Fe +Mn	1.204	1.276	1.244	1.248	1.243	1.471	1.576	1.515	1.578	1.535
NPK +10 t FYM ha⁻¹	1.233	1.306	1.274	1.275	1.272	1.567	1.648	1.608	1.608	1.608
NPK+ Zn +Fe +Mn + Vermicompost @ 3 t ha⁻¹	1.265	1.338	1.306	1.311	1.305	1.599	1.672	1.645	1.640	1.639
Control	1.012	1.085	1.053	1.057	1.051	1.345	1.418	1.390	1.386	1.385
Mean	1.159	1.232	1.200	1.204		1.479	1.563	1.530	1.533	
	W	N				W	N			
SEm	0.011	0.009				0.034	0.026			
CD @ 5%	0.038	0.026				NS	NS			
CV	5.06	6.72				12.09	15.03			

Table.2 Effect of pesticide and nutrient applications on P content (%) in grain of rice crop during 2015-16 and 2016-17

Treatments	P content (%) in grain									
	2015-16					2016-17				
	Control	Weedicide	Fungicides	Insecticides	Mean	Control	Weedicide	Fungicides	Insecticides	Mean
N	0.180	0.220	0.195	0.205	0.200	0.247	0.287	0.262	0.272	0.267
NP	0.220	0.260	0.235	0.245	0.240	0.287	0.327	0.302	0.312	0.307
NPK	0.240	0.280	0.255	0.265	0.260	0.307	0.347	0.322	0.332	0.327
NPK +Zn	0.270	0.310	0.285	0.295	0.290	0.337	0.377	0.352	0.362	0.357
NPK+ Fe	0.260	0.300	0.275	0.285	0.280	0.327	0.367	0.342	0.352	0.347
NPK + Mn	0.250	0.290	0.265	0.275	0.270	0.317	0.357	0.332	0.342	0.337
NPK+ Zn +Fe +Mn	0.290	0.330	0.305	0.315	0.310	0.357	0.397	0.372	0.382	0.377
NPK +10 t FYM ha⁻¹	0.280	0.320	0.295	0.305	0.300	0.347	0.387	0.362	0.372	0.367
NPK+ Zn +Fe +Mn + Vermicompost @ 3 t ha⁻¹	0.310	0.350	0.325	0.335	0.330	0.377	0.417	0.358	0.402	0.388
Control	0.160	0.200	0.175	0.185	0.180	0.227	0.267	0.242	0.252	0.247
Mean	0.246	0.286	0.261	0.271		0.313	0.353	0.324	0.338	
	W	N				W	N			
SEm	0.005	0.004				0.007	0.009			
CD @ 5%	0.017	0.010				0.026	0.024			
CV	10.30	11.88				12.30	22.39			

Table.3 Effect of pesticide and nutrient applications on K content (%) in grain of rice crop during 2015-16 and 2016-17

Treatments	K content (%) in grain									
	2015-16					2016-17				
	Control	Weedicide	Fungicides	Insecticides	Mean	Control	Weedicide	Fungicides	Insecticides	Mean
N	0.182	0.222	0.197	0.207	0.202	0.290	0.357	0.317	0.325	0.322
NP	0.222	0.262	0.237	0.247	0.242	0.317	0.391	0.323	0.372	0.351
NPK	0.242	0.282	0.257	0.267	0.262	0.324	0.411	0.329	0.382	0.361
NPK +Zn	0.272	0.312	0.287	0.297	0.292	0.333	0.440	0.337	0.406	0.379
NPK+ Fe	0.262	0.302	0.277	0.287	0.282	0.327	0.430	0.334	0.393	0.371
NPK + Mn	0.252	0.292	0.267	0.277	0.272	0.318	0.428	0.331	0.384	0.365
NPK+ Zn +Fe +Mn	0.292	0.332	0.307	0.317	0.312	0.354	0.480	0.378	0.437	0.412
NPK +10 t FYM ha⁻¹	0.282	0.322	0.297	0.307	0.302	0.332	0.468	0.344	0.424	0.392
NPK+ Zn +Fe +Mn + Vermicompost @ 3 t ha⁻¹	0.312	0.352	0.327	0.337	0.332	0.365	0.514	0.419	0.475	0.443
Control	0.162	0.202	0.177	0.187	0.182	0.262	0.351	0.310	0.290	0.303
Mean	0.248	0.288	0.263	0.273		0.322	0.427	0.342	0.389	
	W	N				W	N			
SEm	0.007	0.008				0.008	0.005			
CD @ 5%	0.026	0.023				0.028	0.015			
CV	15.29	26.07				12.09	12.29			

Effect of nutrients application on K content (%) in rice grain

The data presented in table 3 revealed that application of NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ significantly increased the potassium concentration in grain over control during both of the years. It ranged was between 0.182 to 0.332 percent during 2015-16 and 0.303 to 0.443% during second year, respectively.

The K content was recorded maximum with the application of NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ which was significantly superior over all the treatments during first year. The least K content was recorded under control plot which was not received any nutrients. Application of zinc, iron, manganese and Zn+Fe+Mn+ vermicompost gave superior values of K content than corresponding nitrogen alone in case of grain during first of the year. Similar result was also reported by Kumar *et al.*, (2014) and Tripathi *et al.*, (2014).

In second year, as regards K concentration in grain, the treatment, NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ showed the maximum K concentration and proved significantly superior to rest of the treatments. It was varied from 0.262 to 0.351 % and 0.312 to 0.352% under control to NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹. The lowest value of K concentration in grain was observed under control and highest in NPK+ Zn +Fe +Mn + Vermicompost @ 3 ton ha⁻¹ during both the year. All the treatments contained significantly higher K content then control during both the year of investigation. Addition of Zn, Fe, Mn and combined with NPK and vermicompost gave significantly higher grain K content over rest of the treatments during both the year of study. Similar result was also reported by Singh *et al.*, (2009), Tripathi *et al.*, (2014)

In conclusion, it is evident from the data Tables that N, P, K varied from with mean value of 1.051- 1.639 %, 0.180-0.388 % and 0.182-0.443, respectively. Imbalance use of major and micro nutrient either omission of N, P, K or though farmers fertilizer practices causes poor nutrition status/ availability of nutrients resulting adverse impact on productivity of rice grain as well as lower N,P and K contents. Use of pesticides *viz.* Weedicides, Insecticides and fungicides along with Vermicompost and fertilizer nutrients recorded highest nutrients content in grain of 'Pusa Basmati-1509' in irrigated transplanted system. Imbalance use of major nutrient and pesticides causes poor nutrition status/ availability of nutrients resulting adverse impact on N, P and K contents in grain of rice.

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