

Original Research Article

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Effect of the Nutrients on Yield and Yield Attributing Characters in Rice Crop

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ABSTRACT

The field experiment on rice crop was conducted at research farm of C.S.A. University of Agriculture & Technology Kanpur, during Kharif season 2013-14. The doses of experiment were 50% NPK, 50% NPK+ S40, 50% NPK + S40 + Zn5, 50% NPK + Zn5, 100% NPK, 100% NPK + S40, 100% NPK + Zn5 and 100% NPK + S40 + Zn5. The results showed that the grain yield varied from 29.5 to 45.50q ha⁻¹ and straw yield from 60.50 to 98.50q ha⁻¹. The N content in grains ranged from 1.42 to 1.50%, P from 0.32 to 0.38 %, K from 1.24 to 1.32%, S from 0.20 to 0.25% and Zn from 13.0 to 18.0 mg kg⁻¹. The N content in rice straw ranged from 0.22 to 0.28%, P from 0.17 to 0.24%, K from 0.35 to 0.44%, S from 0.10 to 0.14% and Zn from 27.0 to 40.0 mg kg⁻¹. It was noted the N uptake varied from 55.21 to 105.82 kg ha⁻¹, P from 19.72 to 40.92 kg ha⁻¹, K from 85.34 to 150.04 kg ha⁻¹, S from 11.95 to 25.16 kg ha⁻¹ and Zn from 201.65 to 473.15 g ha⁻¹. The starch content varied from 65 to 70%, amylose from 28 to 34% and amylopectin from 66 to 72%. The dose of 100% NPK+S40+Zn5 were found most suitable in respect of crop yield, nutrient content uptake of nutrient and quality of rice.

Keywords

Rice (*Oryza sativa* L.), Nutrients

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Introduction

Rice is a staple food of more than 60% world population and most of the people of south East Asia, about 90% of rice grown in the world is produced and consumed in Asia. Rice is the important staple food crop for more than half of the global population. Rice (*Oryza sativa* L.) is one of the most important cereal crop of the world, grown in wide range of climates zones, to nourish the mankind. Rice is also a staple food in some countries of Latin

America and Africa. It is the agricultural commodity with the third-highest worldwide production, after sugarcane and maize, according to data of FAOSTAT 2012. One of the every three people depends on rice for more than half of their food and one in nine (approx. 700million) depends on rainfed rice. Rice is important energy source of more than half of the world and 65% of the Indian population (Liu *et al.*, 2008). Its production and consumption is concentrated in Asia, where more than 90% of all rice is consumed.

Asian rice production has increased by 24% during 1965-1980 and that was attributed to the higher rate of fertilizers, mainly nitrogen fertilizer.

The total production of rice in the world during 2013-2014 was recorded 476 million tonnes. China was the leading rice producer followed by India, Indonesia and Bangladesh in 2013-14. India produces 106.65 million tonnes during 2013-14 from 44.07 million hectare land (Commodity Profile for Rice March 2015). Globally, rice is grown on 160.9 M ha. In India rice is the most important and extensively grown food crop, occupying about 44.8 m ha of land. Rice occupies a pivotal place in Indian agriculture and is the staple food for more than 70% of population and a source of livelihood for about 120-150 million rural households. It accounts for about 43% of total food grain production and 55% of cereal production in country.

Rice is the seed of the grass species *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice). Genus *Oryza* have 24 species out of which two are cultivated i.e. *Oryza sativa* and *Oryza glaberrima*. Rice (*Oryza sativa* L.) originated from Indo-Burma. De Candolle (1886) and Watt (1892) suggested that South India was the place where cultivated rice has originated. According to Vavilov (1926) India and Burma should be regarded as the centre of origin of cultivated rice.

Nitrogen is one of the most important nutrients for plant growth and a major factor that limits agricultural yields (Xia *et al.*, 2011). Nitrogen plays a key role in rice production and it is required in large amount.

Nitrogen is the most important limiting nutrient in rice production and has heavy system losses when applied as inorganic sources in puddle field (Alam (b) *et al.*, 2009).

Phosphorus is second important major plant nutrient for crop production it has been called as the “bottleneck of world hunger” (Rorty, 1946). Phosphorus is a structural component of cell membranes chloroplast and mitochondria.

Potassium play an important role in the maintenance of cellular organisation by regulating the permeability of cellular membranes and keeping the protoplasm in a proper degree of hydration by establishing the emulsion of high colloidal properties.

Sulphur serves many functions in plants. It is used in the formation of amino acids, proteins, and oils. It is necessary for chlorophyll formation, promotes nodulation in legumes, helps to develop and activate certain enzymes and vitamins, and is a structural component of two of the 21 amino acids that form protein.

Zinc (Zn) is an essential trace element for the growth and development of humans, animals and plants (Salgueiro *et al.*, 2002). Soil Zn application to Zn-deficient soil corrected the visible symptoms of Zn deficiency and significantly increased the total biomass, grain yield, harvest index of rice, as well as Zn concentrations of grain and straw (Srivastava *et al.*, 1999), increased maize grain yield by more than 22% and enhanced the Zn and N concentrations in maize grain (Hossain *et al.*, 2008). A similar positive effect on wheat was exerted by Zn fertilizer applied to soil, with the grain yield of 37 wheat cultivars increased by 30% on an average in a 2-year field experiment (Kalayci *et al.*, 1999).

Materials and Methods

The experiment was conducted at research farm Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the kharif season 2013-14. The rice variety NDR 359 were taken for study with 9

treatment and 3 replication the initial characteristics of soil (initial stage) were also analysed to know the nutrient status of soil. The soil of experimental field is low in organic carbon, available N₂ and available Zn but medium in case of available P K and available S. The pH and EC was soil in normal range. The pH EC and organic carbon are analysed by the method described by Jackson (1967). Available N₂ was determined by Alkaline permanganate method as described by Subbiah and Asija (1956). Available phosphorus was extracted with 0.5 M NaHCO₃ Olsen *et al.*, (1954). The P was determined in extract by vanadomolybdate yellow colour method Jackson (1967). The available K was determined by flame photometer. Available sulphur was determined by Chesnin and Yien (1950). Available zinc was estimated by atomic absorption spectrophotometer. The plant samples were also analysed for N P K, S and Zn. Nitrogen was determined by Kjeldal's method (Jackson 1967). Phosphorus was determined calorimetrically (Chapman and Pratt, 1961). Potassium was determined by flame photometric method. Sulphur was determined by Chesnin and Yien (1956). Zinc was determined by atomic absorption spectrophotometer. For quality characteristics the protein the protein content in grain amylose and amylopectin was also determined by the method described by Mc Cready and Hassid (1943).

Results and Discussion

Fertilizers play very important role in the yield of economy of the crop. Fertilizer alone contributed 55 to 60% to achieve the biological yield of a crop. In inceptisols five most limiting nutrients have been identified i.e. N, P, K, S and Zn. The element S and Zn are the recent additions in this list. The several side nutrient specific trials conducted at different locations both on farm and off farm

established the need of sulphur and zinc along with NPK for yield maximization. The results of present study are discussed as under:

Grain yield

The grain yield varied from 29.50 to 45.50 q ha⁻¹. The 100% NPK +S40 + Zn5 dose gave the highest grain yield. About 35.16% yield increases with the addition of N, P, K, S and Zn in comparison to control. The result is also clearly indicated that addition of S and Zn increases the about 5.5% grain yield in comparison to non-sulphur +zinc containing treatment. Several other scientists reported the results in conformity with the results of present study (Reddy *et al.*, 2010; Zea *et al.*, 2007 and Singh and Tripathi, 2008) (Table 1).

Straw yield

The straw yield varied from 60.50 to 98.50 q ha⁻¹. The dose of 100% NPK + S40+Zn5 gave the maximum straw yield. The results are statistically significant and all the treatment gave superior than control. Increased straw due to addition of N, P, K, S and Zn containing fertilizers has been reported by many workers Darde and Bankar (2009) Shekhara *et al.*, (2010), Muthu Kumarraja *et al.*, (2010). The results of present investigation are in agreement with these workers.

Nutrient content in grain

The nitrogen content in rice grain varied from 1.42 to 1.50 %. The treatment T₉ (100%NPK+S40+Zn5) gave the highest nitrogen content. All the treatments gave significantly higher nitrogen content in respect to control. The nitrogen content is increased by increasing nutrient doses. The phosphorus content varied from 0.32 to 0.38%. The treatment T₉ (100% NPK + S40 + Zn5) once again gave the highest phosphorus content in matured rice grain (Table 2).

Table.1 Yield % increased over control

S. No.	Treatment	Grain yield (q ha ⁻¹)	% Increase over control	Straw yield (q ha ⁻¹)	% Increase over control
1	T ₁	29.50		60.50	
2	T ₂	34.00	13.23	70.00	13.57
3	T ₃	36.00	18.05	75.00	19.33
4	T ₄	38.50	23.37	80.50	24.84
5	T ₅	37.00	20.27	76.50	20.91
6	T ₆	40.50	27.16	85.50	29.23
7	T ₇	42.00	29.76	90.00	32.77
8	T ₈	43.00	31.39	94.00	35.63
9	T ₉	45.50	35.16	98.50	38.57
	SE ±	1.135		0.915	
	CD (at 5%)	2.407		1.940	

Table.2 Effect of different treatments on nutrient concentration in rice grain

S. No.	Treatments	N%	P%	K%	S%	Zn(mgkg ⁻¹)
1	T ₁	1.42	0.32	1.24	0.20	13.00
2	T ₂	1.44	0.34	1.25	0.21	14.00
3	T ₃	1.45	0.35	1.26	0.23	15.00
4	T ₄	1.46	0.37	1.27	0.24	17.00
5	T ₅	1.46	0.36	1.28	0.24	16.00
6	T ₆	1.47	0.37	1.30	0.23	16.00
7	T ₇	1.48	0.36	1.29	0.23	15.00
8	T ₈	1.49	0.37	1.31	0.24	17.00
9	T ₉	1.50	0.38	1.32	0.25	18.00
	SE ±	0.019	0.008	0.008	0.009	0.777
	CD (at 5%)	0.042	0.017	0.017	0.020	1.648

Table.3 Effect of different treatments on nutrient concentration in rice straw

S. No.	Treatments	N%	P%	K%	S%	Zn(mg kg ⁻¹)
1	T ₁	0.22	0.17	0.35	0.10	27.0
2	T ₂	0.23	0.18	0.37	0.11	29.0
3	T ₃	0.24	0.20	0.38	0.12	31.0
4	T ₄	0.26	0.21	0.39	0.13	34.0
5	T ₅	0.27	0.22	0.40	0.12	33.0
6	T ₆	0.27	0.23	0.42	0.12	34.0
7	T ₇	0.26	0.22	0.42	0.12	36.0
8	T ₈	0.27	0.23	0.43	0.13	38.0
9	T ₉	0.28	0.24	0.44	0.14	40.0
	SE ±	0.011	0.010	0.014	0.006	0.808
	CD (at 5%)	0.023	0.021	0.029	0.014	1.715

Table.4 Effect of different treatments on uptake of N P K S and Zn in rice crop

S No.	Treatment	Total uptake				
		N(kgha ⁻¹)	P(kgha ⁻¹)	K(kgha ⁻¹)	S(kgha ⁻¹)	Zn(gha ⁻¹)
1	T ₁	55.21	19.72	85.34	11.95	201.64
2	T ₂	65.06	24.15	100.07	14.83	250.40
3	T ₃	70.18	27.59	108.18	18.27	286.46
4	T ₄	77.12	31.16	117.25	19.7	339.16
5	T ₅	75.03	30.15	112.71	18.05	311.65
6	T ₆	82.59	34.63	128.16	19.56	354.76
7	T ₇	85.56	34.9	133.73	20.36	386.89
8	T ₈	89.44	37.52	141.61	22.53	430.34
9	T ₉	105.82	40.92	150.04	25.15	473.14
	SE ±	1.336	0.636	1.177	0.532	6.819
	CD (at 5%)	2.584	1.339	2.497	1.130	14.088

Table.5 Effect of different treatments on starch, amylose and amylopectin content (%)

S.N.	Treatments	Starch (%)	Amylose (%)	Amylopectin (%)
1.	T ₁	65.00	34.00	68.00
2.	T ₂	67.00	31.00	69.00
3.	T ₃	66.00	33.00	67.00
4.	T ₄	68.00	30.00	70.00
5.	T ₅	67.00	29.00	71.00
6.	T ₆	66.00	28.00	72.00
7.	T ₇	67.00	32.00	68.00
8.	T ₈	68.00	33.00	67.00
9.	T ₉	70.00	28.00	66.00
	SE	2.356	0.942	1.904
	CD	N.S	1.998	N.S

It is clear from the data in table 4 all treatments gave significantly higher phosphorus content than control. The trends of variation in nutrient concentration were more or less like nitrogen content.

The potassium content varied from 1.24% to 1.32% like nitrogen and phosphorus. The treatment T₉ (100% NPK + S40 + Zn5) once again found best in respect of potassium content in rice grain. All the treatment gave the significantly more potassium content than control. The sulphur concentration varied from 0.20 to 0.25%. The treatment T₉ (100% NPK +

S40 + Zn5) gave the highest sulphur content in rice grain. All the treatment gave significantly higher content of sulphur in comparison to control, like nitrogen, phosphorus and potassium.

The sulphur content also increased by increasing doses of fertilizer. Zn content are ranges from 13.0 to 18.0 mg kg⁻¹. The trends of variation have been more or less same as nitrogen, phosphorous, potassium and sulphur. The treatment T₉ (100% NPK + S40 + Zn5) once again provided maximum Zn content in rice grain.

Nutrient content in straw

The nitrogen content varied from 0.22 to 0.28%. The treatment T₉ (100% NPK + S40 + Zn5) gave the highest value of nitrogen content followed by T₅ T₆ and T₈ treatment. The nitrogen content also increase with increasing doses of fertilizer.

Phosphorous content in rice straw are presented in Table 3. It varied from 0.17 to 0.24%. All the treatment gave significantly higher phosphorus content in comparison to control. The treatment T₉ (100% NPK + S40 + Zn5) once again gave the highest nutrient content.

Potassium content varied from 0.10 to 0.44%. The treatment combination T₉ (100% NPK + S40 + Zn5) gave the maximum value of potassium content. The trends in the variation of potassium content are more or less like to phosphorus and nitrogen contents.

Sulphur content ranges from 0.10 to 0.14%. The analytical data indicated that there was very less variation in sulphur content among the treatments. The treatment T₉ (100% NPK + S40 + Zn5) gave the maximum concentration of sulphur content. The sulphur containing treatments provide more sulphur content than non-sulphur containing treatment.

The zinc content ranged from 27 to 40mg kg⁻¹. All the treatments were significantly superior to control. The treatment T₉ (100% NPK + S40 + Zn5) gave the maximum Zn concentration. All the zinc containing treatment gave more amount of zinc in comparison to non-zinc containing treatments. The concentration of these nutrients increases with increasing levels of nutrients has been also reported by Tripathi and Tripathi (2004) and Islam *et al.*, (2006).

Total uptake

The uptake values of nutrients in grain and straw increased due to concentration of these nutrients and biological yield of grain and

straw. It was recorded that N uptake varied from 55.21 to 105.82 kg ha⁻¹, P from 19.72 to 40.92 kg ha⁻¹, K from 85.34 to 150.04 kg ha⁻¹, S from 11.95 to 25.16 kg ha⁻¹ and Zn from 201.65 to 473.15 g ha⁻¹. The uptake values indicate the appropriate quantity of nutrients required for optimum yield in present investigation. The uptake value in indicated that the yield level of normal rice upto 45 to 48 q ha⁻¹ can be harvested from combined use of 120 kg N + 60 kg P₂O₅ + 60kg K₂O + 40 kg S+ 5 kg Zn for one ha. area. Any reduction in above dose level cause decline in yield of rice crop. Similar kind of results has been reported by Ravichandran *et al.*, (2006) and Jana *et al.*, (2009).

Crop quality

The maximum starch content in rice grain was observed in T₉ (100% NPK + S40 +Zn5) treatment and lowest in control. In case of amylose content the highest value was recorded in control and lowest in T₉ treatment combination. Thus there is a negative relationship appeared in between starch and amylose content. The increase in amylopectin contain at the cost of amylose. The data of current study are in agreement with several workers (Upadhyay and Pathak-1981, Alvarado and Lobes- 1986 (Table 5).

The dose of 100% NPK+S40+Zn5 was the best dose among all in terms of grain yield, straw yield, nutrient content, uptake values and crop quality. So it is concluded that application of Sulphur and Zinc along with the combination of NPK gave best results to the farmers.

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