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Effect of different nutrients and biofertilizer on nutrient concentration and their uptakes in hybrid rice (*Oryza sativa* L.) in inceptisol of central U.P.

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Abstract
A field experiment was conducted on Pot culture house of Department of Soil Science and Agricultural Chemistry at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the kharif season 2017, In the present experiment 9 treatments T_1 (Control), T_2 (100% RDF), T_3 (100% RDF+ S_{40}),T_4 (100% RDF+Zn_5), T_5 (100% RDF+ Azotobacter), T_6(100% RDF + S_{40}+Azotobacter), T_7 (100% RDF + Zn_5+Azotobacter), T_8 (100% RDF+ S_{40}+ Zn_5+Azotobacter), T_9 (125% RDF), were laid out in Randomized Block Design(RBD) with four replication. Hybrid rice variety PHB-71 was taken for study. The results revealed that the N, P, K, S and Zn content in hybrid rice grain varies from 1.41 to 1.51 %, 0.35-0.39%, 0.35-0.45%, 0.20-0.25% and 15.0-18.5% mg/kg and the N, P, K, S and Zn content of rice straw varies from 0.21 to 0.29%, 0.17 to 0.24, 1.23 to 1.31%, 0.10 to 0.14% and 28.5-40.0 mg/kg respectively. The total uptake values of N, P, K, S and Zn varied from 90.70 to 159.38 kg/ha, 30.29 to 58.83 kg/ha, 100.25 to 161.42 kg/ha, 17.50 to 36.23 kg/ha and 269.85 to 585.25 g/ha. The maximum nutrient concentration and uptakes in case of all treatments was found in T_8 (100% RDF+ S_{40} + Zn_5 + Azotobacter) and lowest in T_1 (Control).

Keywords: *Oryza sativa* L., nutrient concentration, uptake, Azotobacter, PHB-71, grain, straw

Introduction

Rice is very important energy source of more than half of the world and 65% of the Indian population (Liu *et al*., 2008) [16]. The production and consumption of rice is concentrated in Asia, where more than 90% of all rice is consumed. The Asian rice production has increased significantly during 1965 to 1980 and that was attributed to the higher rate of fertilizers, mainly nitrogen fertilizer.

The total production of rice in the world during 2017-2018 was recorded 484 million tonnes. China was the leading rice producer followed by India, Indonesia and Bangladesh in 2017-18 (FAOSTAT 2018).

India produces 110.15 million tonnes during 2017-18 from 44.8 million hectare land (Commodity profile of Rice March-2018). Globally, rice is grown on 160.9 M ha.

Rice is the most important and extensively grown food crop in India and occupying about 44.8 m ha of land. Rice occupies a prime 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 contributes for about 40% of total food grain production and 43.5% of cereal production in India.

The cereal crop 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) [6] and Watt (1892) suggested that South India was the place where cultivated rice has originated. According to Vavilov (1926) [26] India and Burma should be regarded as the centre of origin for cultivation of this crop.

Rice is required hot and humid climate because it is a C_3 plant crop which is grown in wet tropical climate and also grown in tropical regions of subtropics. The optimum temperature for rice cultivation is 30 °C (maximum) and 20 °C (minimum). Soils having good water retention capacity with good amount of clay and organic matter are ideal for rice cultivation.

It grows well in soils having pH range between 6.5 and 8.5.

The cultivation of hybrid rice is one of the best technology has been discovered to increase rice production for meeting burgeoning demand for staple food in India. Hybrid cultivars are more responsive to higher doses of nutrients and thereby the yield potentiality is also high. Introduction of hybrid rice is an important step towards augmentation of rice yield. Hybrid rice is any genealogy of rice produced by crossbreeding different kinds of rice and produced 30% more rice. High-yield crops, like hybrid rice, are one of the most important tools for fighting the world food crises.

According to the present rate of population growth we required about 140 million tones of rice in 2025. In 1999-2000 the rice requirement was 89.5 million tonnes achieving the target production would be a challenging task as the productivity increase has to come from the declining and degrading resource base in terms of lands, water, labour and other inputs. To achieve food security hybrid rice can be one of the most feasible options to increase 15-20% of food production**.**

The primary nutrient nitrogen is one of the most important nutrients for plant growth and a major factor that limits agricultural yields (Xia *et al.,* 2011) [27]. 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 (Alam (b) *et al.,* 2009) [1]. Nitrogen is essential component of many compounds of plant such as chlorophyll, nucleotides, proteins, alkaloids, enzymes hormones and vitamins, when sufficient N is applied to the crop, the demand for other nutrients such as P and K also increase. The amount of nutrient absorption changes with growth of rice crop. It is low at seedling stage and highest at heading stage. Increasing the nitrogen application level could significantly increase rice production within limits. The highest nitrogen uptake is observed at the tillering stage, followed by the young panicle developmental stage. About 70-80% Yield increase due to application of Nitrogenous fertilizers (IFC, 1982) [12]. Proper fertilization is an important management practice which can increase the yield of hybrid rice.

Fageria *et al.* (2014) [8] conducted green house experiment to evaluate N uptake and use efficiency as influenced by N 0, 50, 100, 200 kg/ha. The N rates significantly influenced the N uptake in grain and straw yield. Over all N recovery was 33-37%. They found that in this experiment four treatment including T_1 (control), T_2 (60 kg N/ha) T_3 (90 kg N/ha) T_4 (120 N kg/ha) were compared. Results show that the total biomass (83.86q/ha) grain yield (36.62Q/ha), plant height (127.9cm), tillers 250.22 panicle per square meter reached the highest value at highest dose of N.

Sharma *et al*. (2012) [22] noticed that increasing NP levels significantly increased all the crop growth parameters viz. plant height, tillers/m^2, dry matter accumulation. The yield contributing characters (panicles/m^2, grains/panicle), yield (grain and straw), net profit and benefit cost ratio were higher with $N_{90,}$ P_{45}kg /ha. Application of N_{90}, P_{45} kg/ ha also showed highest N and P uptake.

Arivazhagan and Ravichandran (2005) [2] reported that the nutrient uptake in grain and straw increase with the increase in the level of N and K. The uptake of N and K also increases with increasing doses of fertilizers.

Chaudhary *et al*. (2008) [5] studied the response of rice cultivars (IR 36, 130d, Kanak 145d, Mahsuri 160d and Rajshree 150d) of varying maturity groups to rates of N (0, 40, 80 and 120 kg/ha) NP and K uptake was maximum at the highest level of N.

Kumar and Prasad (2008) [14] studied the direct and residual effects of inorganic fertilizers and green manure on yield and nutrient availability under rice – wheat cropping system in calciorethents. P uptake by rice under the NPK treatment was 9.9 kg /ha which increased to 11.8 and 13.5kg /ha, respectively with the treatment of green manuring and crop residue incorporation.

Phosphorus is the second very important plant nutrient. It plays a vital role in several physiological processes i.e. photosynthesis, respiration, energy storage and cell division/ enlargement. It prevents from lodging by providing strength to straw. The highest P uptake were found in young panicle developmental stage, followed by the tillering stage, but P is also absorbed at the maturity stage. Applying P fertilizer can improve the nutritional quality of rice (Hao *et al.,* 2009) [11].

Potassium is the third important nutrient for plants. It is required for physiological activities such as the maintenance of membrane potential, activation of enzymes, regulation of osmotic pressure, stomata movement and tropisms (Golldack *et al.,* 2003) [10].

Adequate Potassium supply is also desirable for the efficient use of Fe, while higher K application results to competition with Fe (Celik *et al.,* 2010) [4]. Increase in K rate increased grain, yield and narrowed the grain: straw ratio, and also improved the harvest index. Potassium in rice producing soils is one of the limiting factors for increasing rice yield. The lowest at highest potassium uptake will be before the heading stage and lowest at after heading stage.

The secondary nutrient sulphur (S) is involved in amino acid and protein synthesis, enzymatic and metabolic activities in plants, which account for approximately 90% of organic S in the plant. The S requirement of rice varies according to the N supply. When S becomes limiting, addition of N does not change the yield or protein level of plants. Sulphur is required early in the growth of rice plants. Sulphur, however, is taken up by the roots of most plants in the oxidized sulphate form. Application of sulphur increases the availability of some micronutrients in soil like Zn.

Niraj *et al*. (2014) [17] Study was conducted an individual and interactive effect of S and Zn on yield and uptake of nutrients by hybrid rice. Application of 60 kg S/ha recorded significantly higher grain and straw yield and sulphur uptake. Similarly significant response of rice to Zn addition recorded upto 15 kg/ha increase in S and Zn levels increased significantly their uptake by rice crop.

Kumar *et al*. (2010) [13] experiment was conducted in 2006-07 on hybrid rice the combined application of inorganic, organic and bio-fertilizer sources of plant nutrient. Application of 100% RDF + 5t FYM/ha + BGA + Azotobacter maximum grain and straw yield with higher nutrient uptake of hybrid rice were recorded

The bio-fertilizer Azotobacter increases the nitrogen content in the roots of seedling of hybrid rice and after transplantation of these seedlings into the field the nitrogen content of soil also increased. Combined application of N, P, K, S, Zn and Azotobacter increases the yield uptake and quality of rice. (Sahu *et al.,* 2017) [20].

Materials and Methods

The experiment was conducted on hybrid rice during *kharif* season of 2017 under natural condition at Pot culture house of Department of Soil Science and Agricultural Chemistry at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The soil of the experimental field was alluvial in origin. Soil sample (0-15cm) depths were initially drawn from randomly selected parts of the field before sowing. The quantity of soil sample was reduced to about 500 gm through quartering technique. The soil sample was then subjected to mechanical and chemical analysis in order to determine the textural class and fertility status the soils were sampled to a depth of 0-30 cm of the soil, air-dried and sieved (2 mm) for soil analyses. Some physical and chemical properties of soils are given in Table 1.

Table 1: Some properties of the <2mm fraction of the top 30 cm of soil used for the site.

S. No.	Particulars	Values
1.	Sand (%)	44.00
2.	Silt (%)	34.00
3.	Clay (%)	22.00
4.	Textural Class	Loam
5.	pH (1:2.5)	8.4
6.	EC (1:2.5) (ds/m at 25^0C)	0.35
7.	Organic Carbon (%)	0.45
8.	Available Nitrogen (kg/ha)	190.00
9.	Available Phosphorus (kg/ha)	11.80
10.	Available Potassium (kg/ha)	170.00
11.	Available Sulphur (kg/ha)	12.54
12.	Available Zinc (ppm)	0.40
13.	Particle Density (Mg/m^3)	2.54
14.	Bulk Density (Mg/m^3)	1.30
15.	Pore Space (%)	46.0

Hybrid rice variety PHB-71 was taken for study. In the present experiment 9 treatments T_1 (Control), T_2 (100% RDF), T_3 (100% RDF+ S_{40}),T_4 (100% RDF+Zn_5), T_5 (100% RDF+ Azotobacter), T_6(100% RDF + S_{40}+Azotobacter), T_7 (100% RDF + Zn_5+Azotobacter), T_8 (100% RDF+ S_{40}+ Zn_5+Azotobacter), T_9 (125% RDF), were laid out in Randomized Block Design(RBD) with four replications having plot size 1 x 1 meter square. Doses of fertilizers are applied @ 150 Kg N, 75 Kg P_2O_5, 75 Kg K_2O/ha 40 Kg S/ha, 5 Kg Zn/ha through Urea, D.A.P and Murate of Potash, Elemental sulphur, Zinc oxide. Transplanting may be done at the 4 to 5 leaf stage. Transplant 2 to 3 seedlings per hill at 20×10 cm^2 distance on 14^{th} of July 2017.
Field Preparation: The field was prepared with fawda in the presence of sufficient moisture. After maintaining suitable moisture with the help of irrigation, the field was puddle. Seed Treatment: To ensure the seeds free from seed borne diseases, seeds were treated with thiram 75% WDP (slurry made by mixing 125g thiram in 500ml of water). Raising of Nursery: The nursery was prepared before sowing by three cross ploughing with the help of country plough followed by planking than the nursery beds are raised upto 5 cm above the ground level. Transplanting of Seedlings: The seedlings are uprooted from the nursery at the optimum age. Transplanting may be done at the 4 to 5 leaf stage. Transplant 2 to 3 seedlings per hill at 20×10 cm^2 distance. Fertilizer Application: Half dose of N and full dose of P, K, S and Zn were applied just before transplanting. Rest quantity of N was applied in two split doses in standing crop at tillering and panicle initiation stage respectively. Application of Azotobacter: Azotobacter should be used in Rice crop @ 200gm/acre. After one day of transplanting in solution form. Water Management: Tillering to flowering is the most critical stage for irrigation. Until the transplanted seedlings are well established, water should be allowed to stand in the field at a depth of 2-5 cm. Crop Management: First manual weeding was done 20 days after transplanting and second weeding was carried out 40 days after transplanting and third one was done just before panicle initiation stage. All required agronomical practices were adopted. Harvesting and Threshing: Harvesting is done when 80%panicles have about 80% ripened spikelets. The spikelets should be straw colored. The grain will contain about 20% moisture.

Plant analysis

Plant samples were dried first in air then kept in oven at 70°C for 8 hr to make the sample free from excess moisture. The samples were grounded in a Wiley mill having stainless parts and stored in polythene bags.

Preparation of extract: Fine ground plant samples were digested in tri-acid mixture of conc. Nitric acid, sulphuric acid and per chloric acid for P and K determination in 10:4:1 ratio. Di-acids (9:4 mixture of HNO_3 and $HClO_4$) digestion method is adopted for Zn extraction.

Determination of N, P, K, S and Zn in plant

Nitrogen: N is determined by Kjeldahl method given by Jackson (1967).
Phosphorus: P is determined colorimetrically by vanadate-molybdate yellow colour method as advocated by Chapman and Pratt (1961).
Potassium: K determination has been done using flame photometric method (Chapman and Pratt, 1961) in sodium acetate and acetic acid buffer as outlined by Jackson (1967).
Sulphur: S is determined through turbidimetric method (Chesnin and Yien, 1956).
Zinc: Zn is extracted from plant with the help of atomic absorption spectrophotometer (Lindasey and Norwell, 1978).

Uptake: To calculate the uptake of N, P, K and S in grain as well as in straw, the following formula is used

$$\textbf{Uptake of Nutrients (kg/ha)} = \frac{\textbf{Nutrient content}(\%)\times\textbf{Yield}(\textbf{kg/ha})}{\textbf{100}}$$

The data on various characters studied during the course of investigation were statistically analyzed for randomized block design. Wherever treatment differences were significant (“F” test), critical differences were worked out at five per cent probability level. The data obtained during the study were subjected to statistical analysis using the methods advocated by Chandel (1990).

Results

The effect of different treatment on nutrient concentration and their uptakes of hybrid rice PHB-71 these are specified that

Nutrient concentration in rice grain

Nitrogen

Data given in the Table 2 showed that Nitrogen content in grain increase in linear order with increasing the levels of fertilizers. The Nitrogen content in rice grain is varied from 1.41 to 1.51%. The treatment T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter) gave the highest Nitrogen content in rice grain. All the treatments gave significantly higher N content than in control. The Nitrogen content increases by increasing nutrient doses.

Phosphorus

It is clear from the data illustrated in the Table 2 that there was significant increase in P content in rice grain with the application of graded level of fertilizers. The Phosphorus content varied from 0.35 to 0.39%. The treatment T_8 (100%

RDF+ S_{40} + Zn_5 +Azotobacter) once again gave the highest Phosphorus content in matured rice grain. It is clear from the data that all treatments were superior over the control. The trends of variation in nutrient concentration were more or less like Nitrogen content.

Potassium

The experimental data depicted in the Table 2 early revealed that there was significant increase in K content in grain with the integration of S, Zn, Azotobacter with NPK fertilizer. The Potassium content varied from 0.35% to 0.45% Like Nitrogen and Phosphorus the treatment combination T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter) once again found best in respect of Potassium content in rice grain. All the treatment gave significantly higher Potassium concentration than control.

Sulphur

The data related to the effect of state recommended and Recommended dose of fertilizers NPK with combination of S, Zn and Azotobacter depicted in the Table 2. The Sulphur concentration varied from 0.20 to 0.25%. The treatment T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter) 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 significantly and linearly with increasing doses of fertilizer.

Zinc

It is obvious from the data presented in the Table 2 that Zn content fairly influenced by the graded level of NPK fertilizers along with S, Zn and Azotobacter containing fertilizer. It ranges from 15.0 to 18.50 mg/kg. The trends of variation have been more or less similar to Nitrogen, Phosphorous, Potassium and Sulphur. The treatment T_8 (100%RDF+ S_{40} + Zn_5+azotobactor) provide maximum Zn content in rice grain. Lowest Zn content 15.0 mg/kg recorded in control.

Table 2: Effect of various treatments on nutrient concentration in rice grain

S. No.	Treatments	N%	P%	K%	S%	Zn (mg/kg)
1	T_1	1.41	0.35	0.35	0.20	15.00
2	T_2	1.42	0.36	0.37	0.21	16.00
3	T_3	1.43	0.37	0.38	0.21	16.00
4	T_4	1.44	0.38	0.38	0.22	17.00
5	T_5	1.46	0.37	0.40	0.23	16.00
6	T_6	1.47	0.36	0.41	0.23	16.50
7	T_7	1.48	0.38	0.42	0.24	17.00
8	T_8	1.51	0.39	0.45	0.25	18.50
9	T_9	1.50	0.38	0.44	0.24	18.00
	SE(diff.)	0.014	0.016	0.017	0.015	1.019
	CD (at 5%)	0.028	0.032	0.034	0.030	2.038

Nutrient concentration in rice straw

Nitrogen

The nitrogen content in rice straw is depicted in Table 3. It varied from 0.21 to 0.29%. The treatment T_8 (100% RDF + S_{40} + Zn_5 + Azotobacter) gave the highest value of nitrogen content in rice straw followed by T_7 (100% RDF + Zn + Azotobacter), T_6 (100% RDF+S + Azotobacter) and T_5 (100% RDF + Azotobacter) treatments. The treatment T_1 (control) gave the lowest N content (0.21%) in rice straw. The Nitrogen content of rice straw also increases with increasing doses of fertilizer.

Phosphorus

The data pertaining to P content in rice straw are presented in Table 3. It varied from 0.17 to 0.24%. Data depicted in the Table 3 revealed that P content in rice straw increased with the application of S, Zn and Azotobacter fertilizer in combination with NPK fertilizers. All the treatment gave significantly higher P content in comparison to control. The treatment T_8 (100% RDF+ S_{40} + Zn_5+Azotobacter) once again gave the best results.

Potassium

The data related to K content are presented in Table 3. It varied from 1.23 to 1.31%. The treatment combination T_8 (100% RDF + S_{40} + Zn_5 + Azotobacter) once again emerged as the best treatment combination and gave the maximum value of K content in rice straw i.e. 1.31%. All the treatments combinations are more efficient than control.

Sulphur

The data given in the Table 3 showed a significant increase in S content in rice straw with the increase in doses of fertilizers. The S content varied from 0.10 to 0.14%. The analytical data indicated that there was very less variation in S content among the treatments. The treatment T_8 (100% RDF+ S_{40} + Zn_5+Azotobacter) gave the maximum S concentration (0.14%) in rice straw. The S containing treatments provide more S content in rice straw than Non-S containing treatments. Treatment T_1 (control) showed lowest S content (0.10%) in rice straw.

Zinc

As perusal of data given in the Table 3 addressed the Zn concentration in rice straw. The Zn content in rice straw varied from 28.50 to 40.00 mg/kg. All the treatments were significantly superior to control. The treatment T_8 (100%RDF+S_{40}+Zn_5+Azotobacter) gave the maximum Zn concentration 40.00 mg/kg in rice straw. All the Zn containing treatment gave more amount of Zn content in rice straw in comparison to non-Zn containing treatments.

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

S. No.	Treatments	N%	P%	K%	S%	Zn(mg/kg)
1	T_1	0.21	0.17	1.23	0.10	28.5
2	T_2	0.23	0.19	1.26	0.11	30.5
3	T_3	0.24	0.20	1.27	0.12	31.5
4	T_4	0.25	0.21	1.27	0.11	32.6
5	T_5	0.26	0.22	1.28	0.12	33.4
6	T_6	0.27	0.23	1.29	0.12	37.4
7	T_7	0.28	0.22	1.29	0.12	38.0
8	T_8	0.29	0.24	1.31	0.14	40.0
9	T_9	0.28	0.23	1.30	0.13	38.5
	SE(diff.)	0.012	0.016	0.017	0.012	1.277
	CD (at 5%)	0.026	0.033	0.034	0.024	2.652

Nutrient uptake

The uptake of various nutrient elements i.e. N, P, K, S and Zn were worked out in grain and straw of hybrid rice and relevant data have been presented in the table 4 to table 8.

Nitrogen Uptake

The data related to N uptake are presented in Table 4. It is apparent from the data depicted in Table 4 that the grain uptake of rice ranged from 76.84 to 128.35 kg/ha. The treatment combination T_8 (100 %RDF+S_{40} +Zn_5+Azotobacter) gave the highest N uptake value in both grain and straw. The straw uptake varied from 13.86 to 31.03 kg/ha. The similar trend of variation was observed in case of total uptake. It varied from 90.70 to 159.38 kg/ha. The trends of variation in total uptake was more or less similar to grain and straw uptake. It is quite obvious from the data that in grain and straw nitrogen uptake increased in the linear sequence with the increase in nutrient levels.

Table 4: Effect of various treatment on uptake of Nitrogen in rice crop (kg/ha).

S. No.	Treatments	Grain uptake	Straw uptake	Total uptake
1	T_1	76.84	13.86	90.70
2	T_2	101.95	21.62	123.57
3	T_3	105.82	23.71	129.53
4	T_4	109.15	25.35	134.50
5	T_5	113.44	26.72	140.16
6	T_6	117.89	28.21	146.10
7	T_7	121.36	29.40	150.76
8	T_8	128.35	31.03	159.38
9	T_9	126.00	29.82	155.82
	SE(diff.)	2.636	1.304	
	CD (at 5%)	5.390	2.666	

Phosphorus Uptake

The data regarding to Phosphorus uptakes are depicted in Table- 5. The Phosphorus uptake value of rice grain ranged from 19.07 to 33.15 kg/ha, while in case of straw uptake, the range of variation was 11.22 to 25.68 kg/ha. All the treatment combinations are superior to control in terms of P uptake. The total P uptake values varied in between 30.29 to 58.83 kg/ha. The highest uptake of P in grain as well as in straw 33.15 kg/ha and 25.68 kg/ha respectively, was observed in treatment combination T_8 (100%RDF+ S_{40} + Zn_5 + Azotobacter). The result of the investigation indicated that the removal of nutrient increased with increasing doses of nutrients.

Table 5: Effect of various treatment on uptake of Phosphorus in rice crop (Kg/ha).

S. No.	Treatments	Grain uptake	Straw uptake	Total uptake
1	T_1	19.07	11.22	30.29
2	T_2	25.84	17.86	43.70
3	T_3	27.38	19.76	47.14
4	T_4	28.80	21.29	50.09
5	T_5	28.74	22.61	51.35
6	T_6	28.87	24.03	52.87
7	T_7	31.16	23.10	54.26
8	T_8	33.15	25.68	58.83
9	T_9	31.92	24.49	56.41
	SE(diff.)	1.307	1.209	
	CD (at 5%)	2.672	2.472	

Potassium Uptake

The data depicted in the Table 5 revealed that the uptake of K was also significantly affected by graded level of fertilizers. The grain and straw uptake in rice crop varied from 19.07 to 21.25 kg/ha and 81.18 to 140.17 kg/ha respectively. It is clear from the data that K uptake increase in linear order with increasing the fertilizer doses, resulting highest K total uptake 161.42 kg/ha in treatment T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter) and lowest at control. The total uptake varied from 100.25 to 161.42 kg/ha. It is a subject of great importance to mention here that the removal of K from soil is more in comparison to N total uptake.

Table 6: Effect of various treatment on uptake of Potassium in rice crop (kg/ha).

S. No.	Treatments	Grain uptake	Straw uptake	Total uptake
1	T_1	19.07	81.18	100.25
2	T_2	15.07	118.44	133.51
3	T_3	15.54	125.47	141.01
4	T_4	16.67	128.77	145.44
5	T_5	17.87	131.58	149.45
6	T_6	18.44	134.80	153.89
7	T_7	19.68	135.45	155.13
8	T_8	21.25	140.17	161.42
9	T_9	20.16	138.45	158.61
	SE(diff.)	1.201	5.546	
	CD (at 5%)	2.456	11.341	

Sulphur Uptake

The result of present study related to S uptake values are depicted in Table 7. Similar to N and K uptake total S uptake was significantly influenced by the doses of applied fertilizers. The grain S uptake values ranged from 10.90 to 21.25 kg/ha. The straw uptake varied from 6.60 to 14.98 kg/ha, while total uptake values varied from 17.5 to 36.23 kg/ha. The treatment combination T_8 (100% RDF+ S_{40} + Zn_5 +Azotobacter) provided the highest grain (21.25 kg/ha), straw (14.98 kg/ha) and total uptake (36.23 kg/ha) values.

Table 7: Effect of various treatment on uptake of Sulphur in rice crop (kg/ha).

S. No.	Treatments	Grain uptake	Straw uptake	Total uptake
1	T_1	10.90	6.60	17.50
2	T_2	15.07	10.34	25.41
3	T_3	15.54	11.85	27.39
4	T_4	16.67	11.15	27.82
5	T_5	17.87	12.33	30.20
6	T_6	18.44	12.54	30.98
7	T_7	19.68	12.60	32.28
8	T_8	21.25	14.98	36.23
9	T_9	20.16	13.84	34.00
	SE(diff.)	0.607	0.914	
	CD (at 5%)	1.241	1.869	

Zinc Uptake

The data presented in the Table 8 showed that the grain and straw uptake values varied from 81.75 to 157.25 g/ha and 188.1 to 428.0 g/ha, respectively. The total uptake value ranged between 269.85 to 585.25 g/ha. The results are more or less similar to other nutrient content. The treatment T_8 (100% RDF+ S_{40} + Zn_5 + Azotobacter) was found best combination among all other treatments. It is also important to know that the Zn containing treatments gave the higher Zn uptake in comparison to non- Zn containing combinations.

Table 8: Effect of various treatment on uptake of Zinc in rice crop (g/ha).

S. No.	Treatments	Grain uptake	Straw uptake	Total uptake
1	T_1	81.75	188.10	269.85
2	T_2	114.88	286.70	401.58
3	T_3	118.40	311.22	429.60
4	T_4	128.86	330.56	459.42
5	T_5	124.32	343.35	467.67
6	T_6	132.33	390.83	523.16
7	T_7	139.40	399.00	538.40
8	T_8	157.25	428.00	585.25
9	T_9	151.20	410.00	561.20
	SE(diff.)	2.432	16.817	
	CD (at 5%)	4.973	34.376	

Discussion

Nutrient Content

The analytical data regarding to nutrient content in hybrid rice grain and straw are presented in the Tables 1 and 2 respectively. It is clear from the data that the application of fertilizers increases the N, P, K, S and Zn absorption in rice and also affected the content significantly in both grain and straw. The application of Azotobacter also increase the N content in very small but significant quantity. Nitrogen content ranges between 1.41 to 1.51 % in rice grain. The trend of variation in case of other nutrient elements like P, K, S and Zn were similar to those describe for nitrogen. The P, K, S and Zn content in hybrid rice grain varies from 0.35-0.39%, 0.35-0.45%, 0.20-0.25% and 15.0-18.5% mg/kg respectively.

The experimental data presented in Table 1 and 2 clearly indicated that the hybrid rice contains more quantity of N, P, and S in grain but straw contains higher amount of K and Zn than the rice grain. It is due to the translocation of nutrient from vegetative parts of plant. The N, P, K, S and Zn content of rice straw varies from 0.21 to 0.29%, 0.17 to 0.24, 1.23 to 1.31%, 0.10 to 0.14% and 28.5-40.0 mg/kg respectively. Such type of variation occur due to use of inorganic fertilizers and bio-fertilizers. The treatment combination T_8 (100% RDF + S_{40} + Zn_5 + Azotobacter) gave the best result.

The results of present experiment regarding nutrient contents in rice grain and straw are lies with the findings of Sathiya *et al.* (2008) [21], Kumar *et al.* (2010) [13], Biswash *et al.* (2014) [3], Niraj *et al.* (2014) [17], Singh *et al.* (2014) [15] and Srivastava and Singh (2017) [25].

Nutrient Uptake

The uptake of nutrient in rice grain and straw is significantly affected partially by the nutrient concentration and major due to biological yields of rice crops. The uptake values of N, P, K, S and Zn are presented in the tables from 3 to 7. The data of Tables indicate the appropriate and optimum value of various nutrients which provides optimum yield of hybrid rice. The present study reveals that as the doses of N, P, K alone or in combination of S, Zn and Azotobacter increases and uptake values of different nutrients also increases in linear order. The total uptake values of N, P, K, S and Zn varied from 90.70 to 159.38 kg/ha, 30.29 to 58.83 kg/ha, 100.25 to 161.42 kg/ha, 17.50 to 36.23 kg/ha and 269.85 to 585.25 g/ha. The maximum nutrient uptake in case of all treatments was found in T_8 (100% RDF+ S_{40} + Zn_5 + Azotobacter) and lowest in control.

The finding of this study are lies with the finding of Rahi and Dixit (2012) [18], Kumar *et al.* (2014) [17], Ranjan and Reddy (2014) [19], Singh and Kumar (2014) [15] and Denre *et al.* (2017) [7].

References

1. Alam MM, Ali MH, Amin AKM, Rahul, Hasanuzzaman Mirza. Yield and harvest index of three irrigated rice varieties under different levels of phosphorus. Advances in Biological Research. 2009; 3(3-4):132-139.
2. Arivazhagan K, Ravichandran M. Interaction effect of N and K on yield and yield attributing character in rice IR 20. Adv. Pl. Sci. 2005; 18(1):425-427.
3. Biswash Md Romel, Sharmin Mashuka, Haque Md. Maksudul, Jahan Golam Sarwar, Ahmed MM Emam. Applied on various inorganic fertilizers in soil and to evaluate the effect of nutrient content and uptake of the aman rice (BRRI dhan 49). European Journal of Applied Sciences. 2014; 6(3):50-56.
4. Celik H, Asik BB, Gurel S, Katkat AV. Potassium as an intensifying factor for iron chlorosis. Int J Agric Biol. 2010; 12:359-364.
5. Chaudhary SK, Rao PVR, Jha PK. Productivity and nutrient uptake of rice varieties as affected by nitrogen levels under rainfed lowland ecosystem. Indian J Agric. Sci. 2008; 78(5):463-465.
6. De Condolle, Origin of cultivated & Plants, Kegan Paul, Trench & Co. London, 1886.
7. Denre M, Kumar A, Prasad R, Shahi DK. Effect of Zinc application on Zn content and uptake in grain, husk and straw of hybrid rice (*Oryza Sativa* L.). IJPSS. 2017; 18(1):1-6.
8. Fageria NK, Moreira A, Moraes LAC, Maraes MF. Nitrogen uptake and use efficiency in upland rice under two nitrogen sources. Communication in Soil Science & Plant Analysis. 2014; 45(4):461-469.
9. Food and Agricultural Organization (FAO) State. Retrieved from, 2018. http//www.fao.org
10. Golldack D, Quigley F, Michalowski CB, Kamasani UR, Bohnert HJ. Salinity stress-tolerant and sensitive rice (*Oryza sativa* L.) regulate AKT1- type potassium channel transcripts differently. Pl Mol Bio. 2003; 51:71-81.
11. Hao HL, Yang XE, Feng Y, Wu CY. Effects of P fertilizer level on distribution of Fe, Mn, Cu and Zn and brown rice qualities in rice (*Oryza sativa* L.). Plant Nutr Fer Sci. 2009; 15(6):1350-1356.
12. IFC (International Fertilizer Correspondent) FAO/FAIC working party on the economics of fertilizer use. 1982; 23(1):7-10.
13. Kumar J, Yadev MP, Prasad K. Research Production potential of hybrid rice as influenced by integrated nutrient management. Crop Research (Hisar). 2010; 39(1/2/3):20-23.
14. Kumar V, Prasad RK. Integrated effect of mineral fertilizers and green manure on crop yield and nutrient availability under rice-wheat cropping system in calciorthents. J Indian Soc. Soil Sci. 2008; 56(2):209-214.
15. Kumar V, Singh O, Chaurasiya A, Thorat TN, Porte SS, Parihar AKS. Effect of integrated nutrient management on yield and nutrient uptake of hybrid rice in partially reclaimed sodic soil. Journal of Soil and Crops. 2014; 24(2):241-246.
16. Liu G, Bernhardt L, Jia H, Wamishe A, Jia Y. Molecular characterization of the recombinant inbred line population derived from a Japonica–Indica rice cross. Euphytica. 2008; 159:73-82.
17. Niraj VPS, Kumar A, Prakash V. Effect of Sulphur and Zinc levels and nutrient uptake by hybrid rice in partially reclaimed sodic soil. International Journal of Agricultural Sciences. 2014; 10(1):241-243.
18. Rahi Talevar, Virendra Dixit. Effect of sulphur and zinc on yield quality and nutrient uptake of hybrid rice in sodic soil. Int. J Envi Sci. & Tech. 2012; 1(1):53-57.
19. Ranjitha P Sri, Reddy KI. Effect of different nutrient management options on rice under SRI method of cultivation- review. International Journal of Plant, Animal and Environmental Sciences. 2014; 4(1):201-204.
20. Sahu G, Chatterjee N, Ghosh GK. Integrated nutrient management in rice (*Oryza sativa*) in red and laterite soils of west Bengal. Indian journal of economy. 2017; 44:349-354.
21. Sathiya K, Sathyamoorthi K, Martin G James. Effect of nitrogen levels and split doses on productivity of aerobic rice. Res. on Crops. 2008; 9 (3):527-530.

22. Sharma Dinesh, Sagwal Pardeep Kumar, Singh Ishwer, Sangwan Ajit. Influence of different nitrogen and phosphorus levels on profitability, plant nutrient content, yield and quality in basmati cultivars. International Journal of IT, Engineering and Applied Sciences Research (IJIEASR), 2012, 1(1).
23. Singh Dashrath, Kumar Anil. Effect of sources of nitrogen on growth yield and uptake of nutrient in rice. Annals of Plant and Soil Research. 2014; 16(4):359-361.
24. Singh AK. Soil fertility, yield and nutrient uptake of hybrid rice (*Oryza sativa* L.) as influenced by integrated nutrient management. Advances in Plant Sciences. 2014; 24(1):189-192.
25. Srivastava AK, Singh AK. Growth, yield and nutrient uptake of hybrid rice as influenced by nutrient management modules and its impact on economic of the treatments. Journal of Applied and Natural Science. 2017; 9(4):2414-2420.
26. Vavilov NI. Studies on the origin of cultivated plants, Bulletin of Applied Botany and Plant Breeding, 1926, 16(2).
27. Xia L, Zhiwei S, Lei J, Lei H, Chenggang R, Man W, *et al*. High/Low nitrogen adapted hybrid rice cultivars and their physiological responses. African journal of biotechnology. 2011; 10(19):3731-3738.