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Response of inorganic fertilizer and biofertilizer on biological yield and quality of hybrid rice (*Oryza sativa* L.) in indo-gangetic plan of central Uttar Pradesh

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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 grain and straw yield of rice respond significantly with the different treatment combination. The highest grain (85.0 q/ha) and straw yield (107.0q/ha) was obtained in) T_8 (100% RDF+ S_{40}+ Zn_5+Azotobacter). The treatment T_8 cause 55.96% increase in hybrid rice grain yield and 62.12% increase in straw yield over control. Quality characteristics of hybrid rice showed that the starch content, protein content in grain and head rice recovery increase with increasing nutrient doses and varied from 67 to 72%, 8.10 to 8.68% and 61 to 71% respectively. The treatment combination T_8 (100% RDF+ S_{40}+ Zn_5+Azotobacter), gave the best result in terms of yield and crop quality.

Keywords: *Oryza sativa* L., yield, quality, azotobacter, PHB-71, grain, straw.

Introduction
Rice is the one of most important food crop for more than 60% world population. About 90% of rice grown in the world is produced and consumed in Asia. Rice is a primarily a high caloric food while protein content is less than wheat. The protein content of rice is 6-7 % but the biological value of rice protein is high. The fat content of rice is low about 2.0-2.5% and much of fat is lost during milling. It contains as much as B group of vitamins. Rice (*Oryza sativa* L.*)* is one of the most vital cereal crop of the world and grown in wide range of climatic 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 2018).

Rice is very important energy source of more than half of the world and 65% of the Indian population (Liu et al., 2008) [17]. 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 (International grains council).

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

Condolle (1886) [7] and Watt (1892) suggested that South India was the place where cultivated rice has originated. According to Vavilov (1926) [30] India and Burma should be regarded as the centre of origin for cultivation of this crop.

The hybrid rice crop needs many nutrients for its growth from soil or fertilizers. Judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice. There has been serious concern about long term adverse effect of continuous and indiscriminate use of inorganic fertilizer on soil health, biodiversity and environment. Because of continuous growing of HYV rice and injudicious fertilizer management, many soils are getting exhausted. This is resulting in problems of P, K, and S deficiency in soils (Ali *et al*., 1997; Saleque *et al.*, 1998a; Saleque *et al*., 1998b) [3, 23]. Judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice (Alam (a) *et al.*, 2009) [2].

Ranjitha *et al.* (2013) [20] reported that hybrid KRH-2 recorded significantly higher grain and straw yield as well as nutrient uptake. Among the different nutrient management options, application of 50 per cent recommended dose of N (through urea) and remaining 50 per cent RDN through vermi-compost resulted in significantly higher grain (5520.8 kg/ ha) and straw yield (6264.9 kg/ ha) in addition to nutrient uptake (157.9, 30.7 and 166 N, P and K kg/ha respectively) followed by 100 % RDN (through urea) application. Fageria *et al.* (2014) [9] conducted greenhouse 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) [25] 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.

Hasanuzzaman *et al.* (2012) [11] found that the effect of N and P showed significant variation in respect of yield contributing characters and yield. At harvest, maximum grain yield (9.42 t/ha), straw yield (13.33 t/ha) was obtained from the application of urea super granules. About 10% more grain yield was measured from urea super granules than prilled urea. Phosphorus at 50 kg P_2O_5 gave the highest grain yield (7.85 t/ha). Interaction effect showed that application of urea super granules along with 50 kg P_2O_5/ha gave the highest (9.83 t/ha) grain yield. On the other hand application of 160 kg N/ha and 120 kg N/ha prilled urea along with 50 kg P_2O_5/ha gave grain yield as 8.83 t/ha and 7.67 t/ha, respectively. Tabar (2013) [29] reported that plant height, stem height, total tiller and yield increased significantly with N and P fertilizer with 150kg/ha and 75kg/ha, respectively. Lavkush *et al.* (2014) [16] found that the treatment combination with P_2O_5 60kg/ha was recorded significantly higher plant growth attribute, yield, nutrient content in grain and straw yield of rice. Baishya *et al.* (2015) [4] found that crop receiving 2.5 t poultry manure/ha along with 75kg N+16.5kg P+31.3kg K/ha improved yield attributes and yield (6.03t/ha) as well as nutrient uptake and crop profitability over the treatment.

Palora *et al*. (2010) [18] conducted an experiment under field condition and studied the effect of K (K_0, K_{16}, K_{90} and K_{120} kg /ha) on grain yield, dry weight of root, root volume, total root length. Nutrients uptake and flow rate of nutrients is higher. The grain yield significantly increased due to application of Potassium upto K_{90} treatment in rice crop. Das *et al.* (2015) [6] studied the effect of P and K on yield and nutrient uptake of rice under IPNS in an inceptisols of Assam. Plots receiving P and K fertilizers alone could significantly increase grain yield by 4.7% and 10.2% respectively over control. Uptake of all the nutrients was significantly correlated with yield, suggesting interdependence of nutrient uptake that influenced yield. Singh *et al*. (2017) [28] conducted an investigation to study the response of Zn and S, on Growth and yield of rice under sodic soil. The straw yield was increases due to levels of zinc and sulphur gradually as the doses were increased under the response of zinc there was significant response on straw yield (57.82 q/ha) was noted due to different doses of zinc level 15 kg Zn/ha responded the higher straw yield (55.10 q/ha) followed by 10 kg/ha and significantly superior over dose of 5 kg/ha and 0 kg/ha. The straw yield (56.54 q/ha) was recorded highest with higher dose of 45 kg S/ha being at par with 30 kg S/ha and significantly superior over doses of 15 kg and 0 kg S/ha. Kadam *et al*. (2018) [12] A field study were carried out during the growing season 2015-16 and 2016-17 at research farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola Maharashtra to study "Influence of zinc and iron fortification on yield of rice cultivars. The treatment were laid out in factorial RBD with three replications. Two years result shows that among varieties PBNR-03-02 explored highest yield whereas combine application of $ZnSO_4$ and $FeSO_4$ with RDF treatment recorded maximum yield. Kumar *et al* (2015) [14] study was conducted to evaluate the effects of eco-friendly organic matrix-entrapped bio-fertilizers (OMEB) (Azotobacter chroococcum + Bacillus subtilis) on Basmati rice. The entrapped bio-fertilizers significantly increased plant growth that is fresh organic nitrogen and free ammonium in leaves over free bio-fertilizers. The crop productivity that is grain and straw yield and quality of grains in terms of grain protein, percentage of moisture, grain starch, wet gluten in grains, as well as NPK in grains and straw were also enhanced by OMEB.

Singh *et al* (2011) [27] study was conducted to assess the influence of various fertility levels, S and Zn on yield, quality and chemical composition of rice CV Swarma (MTU-7029) during the kharif seasons of 2000-01. The experiment was laid out in split-plot design with three replication keeping three fertility levels (80-40-40, 120-60-60 and 160-80-80 kg N-P-K/ha) in main plot, three sulphur levels (control, 24 and 50 kg S/ha) in the sub-plot and three zinc levels (control, 0.75 and 1.50 kg Zn EDTA/ha foliar spray) in the ultimate plot. The results revealed the straw yield and quality parameters of rice i.e hulling percentage, milling percentage, head rice recovery, protein content in grain and grain protein yields improved significantly upto 160-80-80 kg NPK/ha, 50 kg S/ha and 1.5 kg Zn EDTA/ha foliar spray. Parihar *et al.* (2015) [19] experiment was conducted during kharif season of 2013 to assess the effect of inorganic fertilizers with and without FYM on yield, nutrient uptake and quality parameters (protein content) of rice Variety NDR-359. The 13 treatment consisted of NPK (120-60-60), sulphur (40 kg/ha) and Zinc (5 kg/ha) with FYM @ 10 t/ha and without FYM. The effect of these nutrient also affected a significant improvement in protein content of grain. The highest protein content 8.43%

and 2.43% in grain and straw obtained with FYM in treatment (T_7) than lowest in control (6.31 and 0.56% respectively). Sahu *et al.* (2017) [12] Investigation was conducted on rice during kharif season of 2015 on combined application of fertilizer, micronutrient and bio-fertilizer on yield, nutrient uptake and soil fertility status along with microbial population in rice. The highest value of protein content in rice was due to dual application of Azotobacter and Azospirillum along with all inorganic fertilizer including NPK followed by N 80, P 40, K 0, S 10, Zn 10.5, Mo 1.0, B 1.0. Highest population of Azotobacter and Azospirilium was in combined application of bio-fertilizer inoculated treatments.

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 14th 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.

Yield of Crop

Grain Yield: The clean and dried grains from each plot weighed with the help of electronic balance in kg/ha and converted into q/ha.

Straw Yield: Straw yield can be obtained by subtracting grain yield from the biological yield.

Soil Analysis

Mechanical Separates: Soil separates analyzed by International pipette method as described by the Piper (1966).

pH: pH of the soil determined by using soil water suspension (1:2.5) with the help of digital pH meter.

EC: EC also determined using soil water suspension (1:2.5) with help of conductivity meter (Jackson, 1967).

Organic Carbon: Organic Carbon was determined by Walkley and Black's rapid titration method as described by Jackson (1967).

Available Nitrogen: It was determined by Alkaline Potassium Permagnate Method described by Subbiah and Asija (1956).

Available Phosphorus: It is determined by Olsen's method using 0.5 M NaHCO3 (Olsen et al. 1954**).**

Available Potassium: Potassium is determined by using Neutral Normal Ammonium Acetate (pH 7.0) by Flame Photometer.

Available Sulphur: Available Sulphur was determined by turbidimetric method (Chesnin and Yien, 1950) after extraction with 0.15%$CaCl_2$ solution.

Available Zinc: Available Zn is determined by Atomic Absorption Spectrophotometer with the help of DTPA extractant (Lindsey and Norvell, 1978).

Grain Quality Analysis

Protein Content: Protein is estimated by multiplying N% content with the factor 5.75.

Starch: The starch content was estimated by the method described by McCready and Hassid (1943).

Head Rice Recovery: The method given by Halick and Kelly (1959) was adopted which is outlined as below-

Head Rice Recovery indicates the recovery of whole rice (unbroken) from 100gm of milled rice. It can be find out by taking 100 gm of milled rice and the grains were separated by hand and the Head Rice Recovery was calculated by following formula:

$$\text{Head Rice Recovery (\%)} = \text{Weight of whole rice grain} / \text{Weight of raw rice} \times 100$$

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 biological yield and quality of hybrid rice PHB-71 these are specified that

Grain yield: It is clearly indicated that the data presented in Table 1 that there was significant increase in hybrid rice grain yield with the use of higher level of fertilizer along with secondary nutrients, micronutrient zinc and bio-fertilizer**.** According to current data the treatment combination T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter) gave the maximum grain yield that is 85.0 q/ha while the control gave the lowest yield of hybrid rice 54.50 q/ha. All the treatments gave significantly higher yield than control. The grain yield of rice varied from 54.50 to 85.0 q/ha. The grain yield increased significantly with increases the doses of fertilizers. About 30 q/ha yield increased due to application of fertilizers and bio-fertilizer.

Straw yield: The data depicted in Table 1 clearly showed that straw yield increases significantly with the application of different combination of fertilizers and bio-fertilizer. Like grain yield the treatment combination number T_8 (100% RDF+ S_{40} + Zn_5+Azotobacter) gave maximum straw yield that is 107 q/ha. All the treatments where significantly superior to control in terms of straw yield. The straw yield varied from 66 to 107 q/ha. The similar trends of variation where found in straw yield as in grain yield.

Table 1: Effect of various treatments on grain and straw yield (q/ha) in rice crop.

S. No.	Treatments	Grain yield	Straw yield
1	T_1 Control	54.5	66.0
2	T_2 (100% RDF)	71.8	94.0
3	T_3 (100%RDF +S)	74.0	98.8
4	T_4 (100% RDF +Zn)	75.8	101.4
5	T_5 (100%RDF+Azotobacter)	77.7	102.8
6	T_6 (100%RDF+S+Azotobacter)	80.2	104.5
7	T_7(100%RDF+Zn+Azotobacter)	82.0	105.0
8	T_8(100%RDF+S+Zn+Azotobacter)	85.0	107.0
9	T_9 (125% RDF)	84.0	106.5
	SE(diff.)	1.205	1.577
	C.D (at 5%)	2.502	3.274

Effect of nutrients on crop quality

Effect of Different Treatments on Starch content in Rice Grain: The data regarding to starch content in rice grain are presented in Table 2 The starch content in rice grain varied from 67.0 to 72.0% in which the lowest amount of starch content 67.0% was obtained from treatment T_1 (control) and the highest starch content in rice grain obtained from the treatment combination T_8. There were not very large variations found in the starch content of rice grain. The treatment combination T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter) again gave the best results. It gave the highest value of starch content (72%) in rice grain.

Effect of Different Treatments on Protein content in Rice Grain: The data provided in the Table 3 revealed that, as the doses of fertilizers increases the protein content of hybrid rice also increases. The highest protein content 8.68% was obtained with the integration of T_8 (100%RDF+ S_{40} + Zn_5+Azotobacter). Thus treatment combination T_8 serving as the best treatment combination in the present experiment provided the highest protein content in rice grain and the lowest protein content observed in control(T_1) 8.10%. The protein content of hybrid rice grain increased linearly with increasing the doses of fertilizers.

Effect of Different Treatments on Head Rice Recovery (%): The data representing Head Rice Recovery are mentioned in the Table 4 revealed that the Head Rice Recovery was lies between 61 to 71%. The treatment combination T_8 (100%RDF+ S_{40} + Zn_5 + Azotobacter) once again performed as the best treatment among all other treatment combinations. This treatment gave the highest Head Rice Recovery i.e. 71% while the control results lowest Head Rice Recovery i.e. 61%. From the data it is found that the Head Rice Recovery is proportional to fertilizer doses viz. As the doses of fertilizer increases the Head Rice Recovery also increase significantly in the similar way.

Table 2: Effect of various treatments on Starch content (%).

S. No.	Treatments	Starch (%)
1.	T_1 Control	67.00
2.	T_2 (100% RDF)	69.00
3.	T_3 (100%RDF +S)	68.00
4.	T_4 (100% RDF +Zn)	69.00
5.	T_5 (100%RDF+Azotobacter)	71.00
6.	T_6 (100%RDF+S+Azotobacter)	70.00
7.	T_7(100%RDF+Zn+Azotobacter)	71.00
8.	T_8(100%RDF+S+Zn+Azotobacter)	72.00
9.	T_9 (125% RDF)	71.00
	SE(diff.)	1.805
	CD (at5%)	N.S.

Table 3: Effect of various treatments on Protein content in Rice grain:

S. No.	Treatment	Protein (%)
1.	T_1 Control	8.10
2.	T_2 (100% RDF)	8.16
3.	T_3 (100%RDF +S)	8.22
4.	T_4 (100% RDF +Zn)	8.28
5.	T_5 (100%RDF+Azotobacter)	8.39
6.	T_6 (100%RDF+S+Azotobacter)	8.45
7.	T_7(100%RDF+Zn+Azotobacter)	8.51
8.	T_8(100%RDF+S+Zn+Azotobacter)	8.68
9.	T_9 (125% RDF)	8.62
	SE(diff.)	0.077
	CD (at5%)	0.160

Table 4: Effect of different treatments on Head Rice Recovery:

S. No.	Treatments	Head Rice Recovery (%)
1.	T_1 Control	61.00
2.	T_2 (100% RDF)	64.00
3.	T_3 (100%RDF +S)	63.00
4.	T_4 (100% RDF +Zn)	66.00
5.	T_5 (100%RDF+Azotobacter)	65.00
6.	T_6 (100%RDF+S+Azotobacter)	67.00
7.	T_7(100%RDF+Zn+Azotobacter)	68.00
8.	T_8(100%RDF+S+Zn+Azotobacter)	71.00
9.	T_9 (125% RDF)	69.00
	SE(diff.)	1.577
	CD (at5%)	3.724

Discussion

The biological yield of any crop is the resultant effect of several factors of production combined together. The major factors are fertilizer, irrigation, plant protection and genetic factors etc. Among these factors the fertilizer alone has the highest contribution of about 55-60%. It is no gain saying that fertilizers are the major determinants in the economy and yield of the crop. The farmers are well aware the significant responses of fertilizers. The plant nutrients like N, P, K particularly N is very important because the apparent responses of nitrogen on crop foliage. Therefore it is imperative to go in balance nutrition of crop and particularly in case of limiting nutrient elements. The results of several experiments are suggested that the field scale study gave the best results. On broad area basis in our inceptisols five most limiting nutrients have been recognized i.e. N, P, K, S and Zn and later two elements are the recent additions in this list. Several site specific nutrient trails conducted at several locations both on farm and off farm established the need of sulphur and zinc along with NPK for yield optimization. The bio-fertilizer (Azotobacter) also provide nitrogen to crop and maintain our soil health.

Yield: A yield data presented in Table 1 clearly indicated that the grain and straw yield of hybrid rice were significantly influenced by the application of different doses of fertilizers containing N, P, K, S and Zn and some treatments are also treated with the Azotobacter. The treatment combination T_8 (100% RDF + S_{40} + Zn_5 + Azotobacter) gave the best grain yield. The results showed that the grain yield was received with the range of 54.50 to 85.00 q/ha. The lowest grain yield was received from control. The experimental data clearly indicated that the addition S, Zn and Azotobacter with NPK gave the best results in term of rice grain yield. It was analysed in table 1 that the experimental soil was poor in nitrogen as compared to sulphur. It is obvious that the grain yield was increased significantly with increasing doses of nutrients. The added nutrients by different treatments also showed significant increase in straw yield of hybrid rice. It varied from 66.0 to 107.0 q/ha. The highest yield of 107 q/ha was found in treatment number T_8 (100% RDF+ S_{40} + Zn_5+Azotobacter).

About 54% increase in grain yield over control and 66% increase in straw yield over control in current study. Our investigation supported by some pioneer scientist like Kumar S. *et al*. (2005) [15], Chaudhary *et al.* (2008) [5], Alam *et al.* (2009) [1], Yoseftabar S. (2013) [31], Kandali *et al.* (2015) [13], Das *et al.* (2015) [6], Singh *et al.* (2017) [28] and Kadam *et al.* (2018) [12].

Crop Quality: The data presented in Table 2 showed that there is non- significant relation found between various treatment combination and starch content of hybrid rice grain. Starch content varies from 67 to 72%. The maximum starch content in grain is found in T_8 (100% RDF + S_{40} + Zn_5 + Azotobacter) and minimum in control. The protein content in rice grain is presented in the Table 3 indicating the significant increase in protein content with different levels of fertilizers. The protein content varies from 8.10 to 8.68%. Similar results were recorded in case of head rice recovery. It varied from 61 to 71% and data are given in table 4.

These results are in agreement with those of the finding are Kumar *et al.* (2005) [15], Dwivedi *et al.* (2006) [8], Rao *et al.* (2014) [21], Singh and Kumar (2014) [26] and Sanam *et al.* (2014).

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