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Effect of organic and inorganic sources of nitrogen on yield attributes and yield of rice (*Oryza sativa* L.)

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Abstract
An experiment was conducted in the research farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during *Kharif* season, 2018 to study the Effect of nitrogen management on yield attributes and yield of rice (*Oryza sativa* L.). The texture of the soil in the experimental plot was sandy loam and calcareous in nature with low organic carbon content, low available Nitrogen, medium available Phosphorus and low available Potassium. Eight treatments with organic nitrogen sources namely Mycostraw @ 50% RDN, Mycostraw @ 75% RDN, Mycostraw @ 50% RDN + 25% RDN through Vermicompost, Mycostraw @ 50% RDN + 25% RDN through Vermicompost + green manure with dhaincha, Mycostraw @ 50% RDN + green manure with dhaincha, Mycostraw @ 75% RDN + green manure with dhaincha, Mycostraw @ 75% RDN + microbial consortium (Azospirillum + PSB) and Control and three treatment with inorganic nitrogen sources with 50% RDN, 75% RDN and 100% RDN were used in factorial Randomised Block Design with three replication. The result of the experiment revealed that Mycostraw @ 50% RDN + green manure with dhaincha recorded significantly higher number of grains/panicle (98.48), weight of panicle (2.78), grain yield (53.26 q/ha) and straw yield (67.37 q/ha) as compared to rest of the treatments but was statistically at par with Mycostraw @ 75% RDN + green manure with dhaincha and Mycostraw @ 50% RDN + 25% RDN through vermicompost +green manure with dhaincha. Under chemical fertilizer treatments, 100% RDN recorded significantly higher number of panicles/panicle (97.12), weight of panicle (2.70), grain yield (46.19 q/ha) and straw yield (58.56 q/ha) compared to 50% RDN but was found at par with 75% RDN.

Keywords: Rice, nitrogen sources, yield attributes, yield

Introduction
Rice (*Oryza sativa* L.) is one of the most staple food crops for more than half of the world population by providing 25% calories and 20% protein. Asia is the home of rice as more than 2 billion people get 60-70% of their energy requirement from rice and its derived products. Rice is the major source of calories for half the world's population as well as in our country (Roy and Bisht, 2012) [1]. In world rice is grown in 161.1 million ha of area with production of 487.46 million tonnes and productivity of 3.03 t/ha (The Statistics portal 2017-18) [2]. Among the rice growing countries, India ranks first in area of 44.1 million ha, second in production of 110.15 million tonnes with an average productivity of 22.97 q/ha (INDIA STAT-Advance Estimate 2017-18). In Bihar, area under rice cultivation is 3.23 million ha with production of 6.80 million tonnes and productivity of 21.05 q/ha (Directorate of Economics and Statistics, Govt. of Bihar, 2017-18) [3].
Exploiting the production potential of high yielding rice varieties through agronomic management is one of the alternatives to feed the ever rising population. For this, fertilizers have contributed substantially to the spectacular increase in rice yield. However, growing crop with indiscriminate use of fertilizers has resulted into degradation of lands owing to low yields with poor quality of produce. The use of inorganic fertilizer to sustain cropping was found to increase yield only for some few years but on long-term, it has not be effective and leads to soil degradation (Satyanarayana *et al*., 2002) [4]. On the other hand, continuous application of organic fertilizer alone on rice field resulting low yield and low N and K content at the mid-tillering stage of rice plant (Javier *et al*., 2004) [5]. This implies that the need of integrated nutrient management for rice production. Therefore the combined use of organic manures and inorganic fertilizers help in maintaining yield stability

Materials and Methods
A field experiment was conducted at University Research Farm, Dr. Rajendra Prasad Central

Agricultural University, Pusa, Samastipur during the *Kharif* season of 2018-19. The climate of the experimental area is sub-humid, sub-tropical climate with moderate rainfall, hot dry summer and cold winter. Generally, south-west monsoon sets in third or fourth week of June and continues up to September. Total rainfall during the period of investigation was 1234.7 mm of which maximum was received in the month August with 388.4 mm. The experiment was laid out in randomized block design. The treatments used in the experimental field included organic and inorganic sources of nitrogen. A total of eight organic nitrogen sources were used *viz*., Control, Mycostraw @ 50% RDN, Mycostraw @ 75% RDN, Mycostraw @ 50% RDN + 25% RDN through Vermicompost, Mycostraw @ 50% RDN + 25% RDN through Vermicompost + green manure (dhaincha seed rate @ 20 kg/ha), Mycostraw @ 50% RDN + green manure (dhaincha seed rate @ 20 kg/ha), Mycostraw @ 75% RDN + green manure (dhaincha seed rate @ 20 kg/ha) and Mycostraw @ 75% RDN + microbial consortium (*Azospirillum* + PSB) while three inorganic nitrogen sources were used as 50% RDN, 75% RDN and 100% RDN. All treatments were replicated three times.

The field was prepared using mould board plough followed by puddling operation and the layout of the field was done as per the treatment details. Pusa Sugandh 5 variety was used during the experiment. Recommended dose of fertilizer with 120 kg nitrogen, 60 kg phosphorus, 40 kg potassium per hectare was applied. Full dose of phosphorus and potassium was applied as basal and nitrogen was applied as per the treatment. Other intercultural operations were done as per the need of the crop. The crop was harvested manually with the help of sickle. Crop from each net plot was harvested individually and allowed for sun drying. After 6-7 days of harvesting, produced from each net plot was tied with the rope and tagged as per the treatment.

The number of panicles per meter square was counted from each plot using iron frame square meter. Panicle length of five randomly selected panicles was counted and average panicle length was calculated for each treatment. The total grains of five randomly selected panicles were counted and average grains per panicle were calculated for each treatment. Grains samples were drawn from the field of five selected hills and dried in sun. The weight of 500 grains was recorded in gram and then converted into thousand grain weight. The data was taken at 14 per cent moisture level of grains. The yield of clean and dry grains in the net plot was recorded in kilogram/plot and was later converted into q/ha to give the grain yield. The straw from each net plot was air-dried and weighted. The straw yield, thus converted in q/ha. Harvest index is the ratio of grain yield (economical yield) and biological yield. It was calculated by using formula given by Donald (1958) [11].

$$\text{Harvest index} = \frac{\text{Grain yield (q/ha)}}{\text{Grain yield + straw yield (q/ha)}} \times 100$$

Data pertaining to various parameters were statistically analysed by using the 'Analysis of Variance Technique' for randomized block design (RBD) as per the procedures described by given by Gomez and Gomez (1984) [6]. The treatment means were compared at 5% level of significance.

Results and Discussion

Number of panicles/m^2, Length of panicle, Number of grains/panicle, weight of panicle, test weight, harvest index, grain yield and straw yield was significantly influenced by different organic and inorganic sources of nitrogen presented in table -1 & 2.

Organic manure treatments varied significantly on number of panicles/$m^2$of rice crop. It was found that number of panicles/m^2 was significantly higher in mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure *viz.,* 295.66, over rest of the treatments except in treatment mycostraw @ 50% RDN + green manure and mycostraw @ 75% RDN + green manure which was statistically comparable to the significantly higher value. Chemical fertilizer treatments influenced significantly on number of panicles/m^2 with 100% RDN 284.24 during first year it had non-significant effect on number of panicles. However, maximum number of panicles/m^2 was obtained with 100% RDN.

Mycostraw @ 50% RDN + green manure recorded significantly higher length of panicle in rice 23.69 over rest of the treatments except in treatment mycostraw @ 75% RDN + green manure which was statistically at par to each other. Length of panicle was significantly higher with 100% RDN treatment *viz.,* 23.52 over 50% RDN but statistically at par with 75% RDN.

Organic manure treatment with mycostraw @ 50% RDN + green manure resulted in significantly higher number of grains per panicle *i.e.,* 98.48 that surpassed rest of the treatments but statically at par with mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure and mycostraw @ 75% RDN + green manure. Chemical fertilizers also produced significant effect on number of grains/panicle. Significantly maximum number of grains/panicle was obtained in100% RDN *i.e.,* 97.12 over 50% RDN but statistically at par with 75% RDN.

Weight of panicle in rice was significantly higher with organic manure treatment with mycostraw @ 50% RDN + green manure during years and pooled mean respectively, *viz.,*2.78 over mycostraw @ 50% RDN, mycostraw @ 75% RDN and control while it was statistically comparable with rest of the treatments. Chemical fertilizers had showed significant impact on weight of rice panicle. Significantly maximum weight of panicle was observed in 100% RDN treatment *i.e.,* 2.70 respectively over 50% RDN but statistically at par with 75% RDN.

The effective translocation of photosynthates from source to sink determines panicle length, number of grains per panicle, and panicle weight.. Panicle length, number of grains/panicle and panicle weight increased as photosynthates translocation increases from source to sink. Application of organic manures and green manure provide the favorable condition for the root development of crop and more nutrient availability to the crop through addition of nutrient and solubilization of native minerals resulted in increased yield attributes and final yield. This might be because the development of grains and the fertility of spikelets depend on environmental factors such as nutrient, moisture, and light. It may also be because of providing the plant with more food materials, moisture and light helped the plant to develop panicle length, grains/panicle and panicle weight. Kumar *et al.* (2021) [7] also reported that application of 25% nitrogen through organic sources together with application of fertiliser increased the production of straw of wheat and rice crop by 21.0-24.4% and 14.3-26.3% over

controls, respectively. Jat and Singh (2019) [8] also reported similar results.

Data presented in Table revealed that test weight and harvest index was not significantly influenced by different treatments. However, the maximum test weight was recorded in mycostraw @ 50% RDN + green manure (21.31g) and lowest in control. Similarly, maximum harvest index was recorded in mycostraw @ 50% RDN + green manure treatment (44.49%) and lowest in control. Chemical fertilizer treatments also did not produce any significant impact on test weight and harvest index. The maximum test weight and harvest index was obtained in 100% RDN over lower doses of nitrogen.

Jat *et al.* (2019) [8] also reported that harvest index of both rice and wheat crop was not influenced significantly due to application of integrated nutrient management approach in rice-wheat cropping system.

The grain and straw yield of rice were significantly influenced through organic manures. Significantly higher grain yield was recorded in treatment with mycostraw @ 50% RDN + green manure treatment (53.26q/ha) over rest of the treatments but was statistically at par with mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure and mycostraw @ 75% RDN + green manure. Similarly, significantly higher straw yield was obtained in treatment mycostraw @ 50% RDN + green manure treatment (67.37q/ha) over rest of the treatments but statistically at par with mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure and mycostraw @ 75% RDN + green manure.

This might be due to slow and steady release of nutrients, such as available nitrogen, soluble K, exchangeable Ca, P and Mg that could readily taken by the plants in balanced manner and subsequent conversion of assimilates in to yield attributes in larger fractions which ultimately resulted in higher grain yield and straw yield. Adhikari and Mishra (2002) [9] also reported that half dose of recommended nitrogen (60 kg) from urea in combination with half dose of recommended nitrogen (60 kg) from vermicompost or FYM resulted in equivalent yield of rice and wheat crop over full dose of recommended nitrogen through chemical fertilizer in rice wheat cropping system. The outcome of this research was similar to the findings previously described by Ovung and Sarkar (2013) [10].

Table 1: Effect of different treatment on yield attributes of rice

Treatments	No of panicles/m^2	Length of panicle (cm)	No of grains/panicle	Weight of panicle (g)
Organic Manure				
M_1: Control	206.15	22.00	87.69	2.44
M_2: Mycostraw @ 50% RDN	245.05	22.92	91.93	2.57
M_3:Mycostraw @ 75% RDN	246.89	23.01	92.12	2.57
M_4:Mycostraw @ 50% RDN + 25% RDN through vermicompost	256.47	23.33	94.45	2.64
M_5:Mycostraw @ 50% RDN + 25% RDN through vermicompost +green manure	295.66	23.43	95.67	2.71
M_6:Mycostraw @ 50% RDN + green manure	285.46	23.69	98.48	2.78
M_7:Mycostraw @ 75% RDN + green manure	290.09	23.66	97.88	2.73
M_8:Mycostraw @ 75% RDN + microbial consortium (Azospirillum + PSB)	249.96	23.25	92.33	2.63
SEm (±)	9.44	0.03	1.84	0.06
LSD (P≤0.05)	26.86	0.09	5.23	0.19
Chemical Fertilizer				
N_1: 50% RDN	250.08	22.76	90.59	2.58
N_2: 75% RDN	261.74	23.48	95.74	2.67
N_3: 100% RDN	266.57	23.52	97.12	2.70
SEm (±)	5.78	0.03	1.12	0.03
LSD (P≤0.05)	NS	0.09	3.36	0.10

Table 2: Effect of different treatment on yield of rice

Treatments	Test Weight (g)	Harvest Index (%)	Grain yield (q/ha)	Straw yield (q/ha)
Organic Manure				
M_1: Control	20.72	43.23	32.51	41.12
M_2: Mycostraw @ 50% RDN	20.75	43.99	38.81	49.10
M_3:Mycostraw @ 75% RDN	21.07	44.09	42.15	53.32
M_4:Mycostraw @ 50% RDN + 25% RDN through vermicompost	21.12	44.36	43.23	54.69
M_5:Mycostraw @ 50% RDN + 25% RDN through vermicompost +green manure	21.19	44.41	50.58	63.98
M_6:Mycostraw @ 50% RDN + green manure	21.31	44.49	53.26	67.37
M_7:Mycostraw @ 75% RDN + green manure	21.25	44.47	50.70	64.14
M_8:Mycostraw @ 75% RDN + microbial consortium (Azospirillum + PSB)	21.09	44.14	44.67	56.51
SEm (±)	0.41	1.24	1.28	1.66
LSD (P≤0.05)	NS	NS	3.63	4.73
Chemical Fertilizer				
N_1: 50% RDN	21.05	44.07	41.74	53.16
N_2: 75% RDN	21.05	44.17	45.54	57.90
N_3: 100% RDN	21.07	44.20	46.19	58.56
SEm (±)	0.25	0.76	0.78	1.02
LSD (P≤0.05)	NS	NS	2.22	2.89

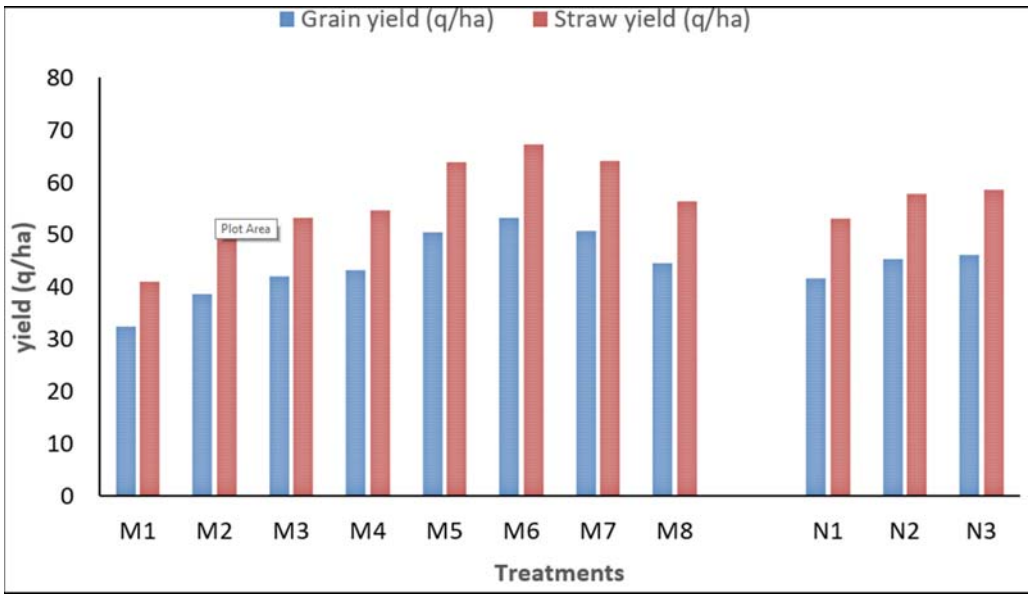

Fig 1: Effect of different treatment on grain yield and straw yield of rice

Conclusion

Significant improvement in yield attributes and yield *viz.,* number of grains/panicle, weight of panicle, grain yield and straw yield were recorded under the organic treatment mycostraw @ 50% RDN + 25% RDN through vermicompost along with green manure, But was statistically at par with Mycostraw @ 75% RDN + green manure with dhaincha and Mycostraw @ 50% RDN + 25% RDN through vermicompost +green manure with Dhaincha. Under chemical fertilizer treatments, 100% RDN recorded significantly higher number of grains/panicle, weight of panicle, grain yield and straw yield compared to 50% RDN but was found at par with 75% RDN.

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