The Pharma Innovation Journal 2022; 11(12): 5870-5874

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 5870-5874

www.thepharmajournal.com
Received: 26-10-2022
Accepted: 29-11-2022

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Growth and yield as influenced by different nitrogen management practices in rice

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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 different nitrogen sources of nutrients on productivity 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 plant height (123.02 cm), number of tillers/m^2 (319.33) and leaf area index (5.31) were recorded significantly higher in treatment Mycostraw @ 50% RDN + 25% RDN through Vermicompost + green manure with dhaincha as compared to rest of the treatments while in chemical fertilizer treatments, 100% RDN recorded significantly higher plant height (119.88 cm), number of tillers/m^2 (289.75) and leaf area index (4.82), dry matter production (1205.73 g/m^2), grain yield (46.19 q/ha) and straw yield (58.56 q/ha) as compared to 50% RDN but was statistically at par with 75% RDN. Mycostraw @ 50% RDN + green manure with dhaincha recorded significantly higher dry matter production (1227.82 g/m^2), grain yield (53.26 q/ha) and straw yield (67.37 q/ha).

Keywords: Rice, nitrogen sources, growth attributes, yield

Introduction
Rice is one of the most important staple food crop of India. In India, it is grown in area of 43.2 mha which produced 117.47 mt with average productivity of 2.67 t/ha. (Directorate of Economics and Statistics, 2020-21). In Bihar, it is grown in area of 3.23 mha which produced 6.80 mt with average productivity of 2.1 t/ha (Directorate of Economics and Statistics, 2017-18). Average daily intake of rice provides 20-80 per cent of dietary energy and 12-17 per cent dietary proteins for the Asians (Chopra *et al.*, 2001) [3]. In Bihar, rice is grown in some fragile agro-ecosystem, which are beset with problems of poor soil fertility. Farmers are using higher doses of chemical fertilizer especially nitrogen for increasing their rice production. But due to application of higher doses of nitrogen through chemical fertilizer, multi-nutrient deficiencies are emerged and also polluting ground water and the environment through nitrate (NO_3) poisoning. So, blanket application of chemical fertilizers should be avoided. Recommended dose of NPK fertilizers alone does not sustain soil productivity under continuous intensive cropping (Kumar *et al*., 2007) [8] whereas, inclusion of organic resources improve soil fertility and crop yields (Diwedi and Diwedi, 2007) [5]. Use of organic sources of nutrient for the crop production was a very old practice. organic sources of nutrients concurrently improve soil physical, chemical and biological property in one way and meet a part of chemical fertilizer requirement of crops in other hand (Sharma and Subehia, 2014) [17]. Organic sources alone cannot fulfil the entire nutrient requirement of the crop. Significant efforts have been made to economise the use of fertilizers in field crops through application of bio-fertilizer, vermicompost and farmyard manure (FYM). Integration of various sources of nutrients (organic, inorganic and biofertilizer) is more suitable because this reduces the application of chemical fertilizers and cost of cultivation, besides being an environment friendly approach (Ram and Mir, 2005) [15].

Among organic sources of nutrient mycostraw have a potential to supply nutrient to the rice crop. Vermicompost release nutrient slowly which can be utilized by the crop more efficiently. Green manuring of rice with Dhaincha (*Sesbania aculeta*) has been recommended to improved the soil fertility significantly. They act as a nutrient pump which uptake the nutrients from the lower layer of the soil and after mineralization, nutrients are released in root zone of crop, which can be utilized by our crop plant. Besides that, Dhaincha also fix atmospheric nitrogen and add organic matter to the soil which improves the physical and biological properties of the soil. But application of only organic source of nutrient are not able to meet the requirement of high yielding varieties of rice. Due to bulky nature of manures their handling is also very difficult. Considering all the facts into the view the combine application of organic manures, green manure and chemical fertilizer may be a suitable option for increasing productivity, profitability of rice crop and it also improver the soil health.

The emerging scenario necessitates the need of adoption of the practice which maintains the soil health, keeps the production system more sustainable and provides quality food for meeting the nutritional requirement. Introduction of Mycostraw, Vermicompost, Biofertilizers, Green manures and their combination application with chemical fertilizer can serve as a means for sustainable farming aimed at meeting the needs of the present generation without endangering the future generations.

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.

Plant height and number of tillers/m^2 were recorded at harvest. Five plants were selected randomly from each plot and height was recorded from the base of the plant up to panicle tip and then averaged out while number of tillers/m^2 was recorded before harvesting.

Randomly selected plants from sample row were harvested and sun drying was done. After sun drying, plant sample was kept in oven at 65 ± 5 ℃ at harvest. Weight of the sample was recorded till the constant weight was obtained.

The total leaf area determined by maximum length × width method, multiplied by correction factor (0.75) given by Yoshida (1981) [19]. The leaf area data was used for determining the leaf area index as described by Watson (1947) [18]:

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Unit land area}}$$

Grain and straw yield were recorded from each net plot area. Grain yield was recorded at 14% moisture level. After obtaining grain yield, straw yield was obtained by subtracting bundle yield from economic yield and later yield was converted into quintal per hectare.

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

Plant height, number of tillers/m2, Leaf area Index and dry matter accumulation measured at maturity was significantly influenced by different organic and inorganic sources of nitrogen (Table 1).

Plant height measured at maturity was significantly higher in the treatment with mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure *i.e.*, 123.02 cm which was statistically at par with treatment mycostraw @ 75% RDN + green manure (120.98 cm) and treatment mycostraw @ 50% RDN + green manure (116.92 cm) but superior over rest of the treatments. Sharma and Mittra (1988) [16] observed an increase in the plant height of rice with the incorporation of dhaincha. The variation in plant height due to nutrient sources was considered to be due to variation in the availability of major nutrients. Azad and Lehria (2001) [1] also recorded the increased plant height with the application of farm yard manure. Similar findings were also reported by Muhammad (2008) [12] that with application of organic manure and compost in rice increased plant height significantly. On the other hand, application of 100% recommended dose of nitrogen resulted in significantly higher plant height (119.88 cm) over rest of the treatments. Combined application of farm yard manure, crop residue, vermicompost and bio-fertilizer resulted in highest plant height compared to control as observed by Mehra and Singh (2007) [10].

Number of tillers per m^2 at harvest was also significantly affected by different sources of organic and inorganic nitrogen nutrient (Table 1). Significantly higher number of tillers per m^2 was recorded in the treatment wherein organic nitrogen source was used with mycostraw @ 50% RDN +

25% RDN through vermicompost + green manure *i.e.,* 319.33 that was statistically at par with treatment mycostraw @ 50% RDN + green manure (308.33 no.) and treatment mycostraw @ 75% RDN + green manure (313.33 no.). These results were in conformity with the findings of Hemalatha *et al.* (2000) [7]. Organic sources provide balanced nutrition to the plants, especially micro nutrients that positively affect number of tillers/plant (Miller, 2007) [11]. Whereas, application of 100% recommended dose of nitrogen resulted in significantly higher number of tillers per m^2 (289.75) over 50% recommended dose of nitrogen and at par with the application of 75% recommended dose of nitrogen (284.50). The increased in the number of tillers/plant might be due to favourable uptake of nutrients under the application of organic and inorganic sources of nutrients (Ovung and Sarkar, 2013) [14].

Similar trend was also recorded for leaf area index of rice crop. In case of organic treatments, significantly higher leaf area index was recorded in treatment mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure (5.31) over rest of the treatments, but was statistically at par with mycostraw @ 50% RDN + green manure and treatment mycostraw @ 75% RDN + green manure. Among chemical fertilizer treatment, 100% recommended dose of nitrogen recorded significantly higher leaf area index (4.82) over 50% recommended dose of nitrogen but was statistically at par with 75% recommended dose of nitrogen. It might be due to increase in the availability of nutrients from application of organic manure and green manure, especially nitrogen which help to increase in the leaf area resulted in increase in leaf area index.

Dry matter accumulation was significantly influenced by different treatments. application of mycostraw @ 50% RDN + green manure recorded significantly higher dry matter accumulation (1227.82 g/m^2) over rest of the treatments but it was statistically at par with mycostraw @ 75% RDN + green manure (1188.48 g/m^2) and mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure (1117.45 g/m^2) at harvest. While application of 100% RDN through inorganic source recorded significantly higher dry matter accumulation (1205.73 g/m^2) over 50% RDN but it was statstically at par with 75% RDN.

Yield in terms of grain yield and straw yield was significantly influenced by the application of organic and inorganic sources of nitrogen application in rice (Table -2 and Fig-1). Organic sources of nitrogen applied as mycostraw @ 50% RDN + green manure recorded significantly higher grain yield (53.26 q/ha) over rest of the treatments but it was statistically at par with mycostraw @ 75% RDN + green manure (50.70 q/ha) and mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure (50.58 q/ha). While application of 100% RDN through inorganic source recorded significantly higher grain yield (46.19 q/ha) over 50% RDN but it was at par with 75% RDN. Similarly, with application of mycostraw @ 50% RDN + green manure recorded significantly higher straw yield (67.37 q/ha) over rest of the treatments but it was statistically at par with mycostraw @ 75% RDN + green manure (64.14 q/ha) and mycostraw @ 50% RDN + 25% RDN through vermicompost + green manure (63.98 q/ha). While application of 100% RDN through inorganic source recorded significantly higher straw yield (58.56 q/ha) over 50% RDN but was at par with 75% RDN. Incorporation of green manures or vermicompost in combination with inorganic nitrogen significantly increased the grain yield of rice (Bajpai *et al.,* 2006) [2]. A higher rice yield due to organic manure application was mainly attributed to overall improvement in soil fertility including nitrogen supply. Naik and Yakadri (2004) [13] also supported that in-situ green manuring gave the highest, grain yield and straw yield. The application of organic manures improved the yield attributes, grain and biological yields compared to no organic manure. Higher biological yield was mainly due to combined effect of grains and straw. Similar results were also reported by Kumar *et al.* (2015) [9].

Table 1: Effect of different treatment on growth of rice

Treatments	Plant height at harvest (cm)	No of tillers/m^2 at harvest	Dry matter accumulation (g/m^2)	Leaf area Index
Organic Manure				
M_1: Control	101.67	222.67	898.36	3.91
M_2: Mycostraw @ 50% RDN	107.77	264.67	971.05	4.31
M_3:Mycostraw @ 75% RDN	109.80	266.67	1037.08	4.38
M_4:Mycostraw @ 50% RDN + 25% RDN through vermicompost	111.83	277.00	1107.44	4.44
M_5:Mycostraw @ 50% RDN + 25% RDN through vermicompost +green manure	123.02	319.33	1117.45	5.31
M_6:Mycostraw @ 50% RDN + green manure	116.92	308.33	1227.82	4.95
M_7:Mycostraw @ 75% RDN + green manure	120.98	313.33	1188.48	5.16
M_8:Mycostraw @ 75% RDN + microbial consortium (Azospirillum + PSB)	110.82	270.00	1065.43	4.48
S.Em (±)	3.74	10.11	38.66	0.15
LSD ($p \leq 0.05$)	10.63	28.79	110.06	0.42
Chemical Fertilizer				
N_1: 50% RDN	107.67	266.50	924.62	4.33
N_2: 75% RDN	111.00	284.50	1149.56	4.70
N_3: 100% RDN	119.88	289.75	1205.73	4.82
S.Em (±)	2.29	6.19	23.68	0.09
LSD ($p \leq 0.05$)	6.51	17.63	67.40	0.26

Table 2: Effect of different treatment on yield of rice

Treatments	Grain yield (q/ha)	Straw yield (q/ha)
Organic Manure		
M_1: Control	32.51	41.12
M_2: Mycostraw @ 50% RDN	38.81	49.10
M_3:Mycostraw @ 75% RDN	42.15	53.32
M_4:Mycostraw @ 50% RDN + 25% RDN through vermicompost	43.23	54.69
M_5:Mycostraw @ 50% RDN + 25% RDN through vermicompost +green manure	50.58	63.98
M_6:Mycostraw @ 50% RDN + green manure	53.26	67.37
M_7:Mycostraw @ 75% RDN + green manure	50.70	64.14
M_8:Mycostraw @ 75% RDN + microbial consortium (Azospirillum + PSB)	44.67	56.51
SEm (±)	1.28	1.66
LSD (p≤0.05)	3.63	4.73
Chemical Fertilizer		
N_1: 50% RDN	41.74	53.16
N_2: 75% RDN	45.54	57.90
N_3: 100% RDN	46.19	58.56
S.Em (±)	0.78	1.02
LSD (p≤0.05)	2.22	2.89

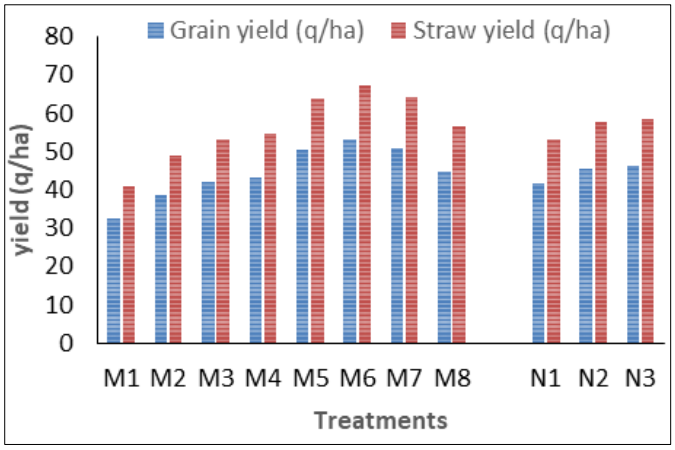

Fig 1: Effect of different treatment on grain yield and straw yield of rice

Conclusion

Significant improvement in growth parameters *viz.*, plant height, number of tillers per m^2 and leaf area index were recorded under the organic treatment mycostraw @ 50% RDN + 25% RDN through vermicompost along with green manure, But grain yield and straw yield were significantly higher in treatment mycostraw @ 50% RDN along with green manure. However, in chemical fertilizer, 100% recommended dose of nitrogen recorded significantly higher growth characters, grain yield and straw yield but it was found at par with 75% RDN.

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