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Effect of nitrogen levels and green manuring on grain and straw yield in Basmati rice varieties

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Abstract
The field investigation entitled "Effect of nitrogen levels and green manuring on grain and straw yield of Basmati rice (*Oryza sativa* L.) varieties" was conducted at research farm of Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India during *kharif* 2022. The experiment treatments were arranged in split plot design with three replications. The treatment consisted of four Basmati rice varieties Punjab Basmati 7, Punjab Basmati 5, Pusa Basmati 1718 and Pusa Basmati 1121 and seven combination treatments of green manuring (GM) and urea (Nitrogen) *viz*. T_1 (No GM + 100% RDN), T_2 (No GM + 10% more than RDN), T_3 (GM + 10% more than RDN), T_4 (GM + 10% less than RDN), T_5 (GM + 20% less than RDN), T_6 (GM + 30% less than RDN), T_7 (No GM + 20% more than RDN) to supply nitrogen to the crop. The variety Punjab Basmati 7 had the highest growth, yield and yield attributes compared to other varieties. Likewise, for these traits treatment combination the treatment T_3 [GM + 10% more than RDN (Urea)] registered better growth and yield parameters over other treatments. Therefore, it is recommended to optimize nitrogen levels in combination with green manuring for sustainable rice production.

Keywords: Basmati rice, green manuring, *Dhaincha*, nitrogen levels, grain, straw yield

Introduction
Currently the world's population is 7.3 billion, and by the end of the 21st century, it is predicted to stabilise at 11.2 billion after rising to 8.5 and 9.7 billion in 2030 and 2050, respectively (UNDESA 2015). With a global consumption of 456 million tonnes, rice (*Oryza sativa* L.) serves as the primary source of carbohydrate and nutrients for more than half of the world's population (Sanodiya and Singh, 2018) [9]. Most rice is consumed in Asia at over 100 kg per person anually (Dwiningsih and Alkahtani, 2023) [4]. More food grain production will be required on diminishing land and water resources to ensure food and nutritional security for the projected population of the country in 2050. Rice provides up to 780 and 689 kcal/capita/day of the food supply is Asia and India, respectively, (Rathna Priya *et al*., 2019) [10]. In India, rice is cultivated over area 46.28 million hectare with total production of 129.47 million tonnes and productivity of 2.79 tonnes (Indiastat, 2023) [5]. With more than 11% of worldwide production, India is the second-largest producer of rice second to china (30%) (Anonymous, 2020). Rice is produced (5.1 MT, annually) in India in the states like Haryana, Punjab, Uttar Pradesh, Uttarakhand and Jammu & Kashmir. In Haryana, total rice area was 1281 hectares with a production of 4618.01 tonnes and productivity of 3605 kg ha^{-1} (Indiastat, 2023) [5].
The management of nitrogen in the production of Basmati rice is a crucial factor as the higher nitrogen dose leads to an increase in the incidence of pests, diseases, and crop lodging, which has a negative impact on the grain quality (Chau and Heong, 2005; Kowsalya *et al*., 2022) [2, 6]. Combined use of chemical and organic fertilizers is regarded as the best method for managing nutrients because it improves nutrient use efficiency, preserves soil health, increases output, and lowers cultivation costs. Leguminous green manure crops have been widely reported to play a significant role in managing soil health and they have lately drawn more attention for enhancing soil fertility and agricultural sustainability (Zhang *et al*., 2023) [12]. In addition, green manure legume products biologically fix atmospheric N (Meena *et al*., 2018) [7].

During the pre-*kharif* season, there is a significant opportunity to introduce *dhaincha* (*Sesbania aculeata*) as a green manure crop in rice-based cropping systems. Double cropping cereals with leguminous species may have an impact on the amount of nitrogen needed and used by the cereal component, and less commonly on the effectiveness of phosphorus use. *In situ* incorporation of *dhaincha* into paddy fields has been found to increase rice grain production, thereby enhancing the physico-chemical characteristics of the soil and to lower the greenhouse gas emissions by reducing the use of urea in paddy fields. This paper deals with elevating effect of nitrogen levels and green manuring on grain and straw yield of Basmati rice (*Oryza sativa* L.) Varieties.

Materials and Methods

The field study was conducted on "Effect of nitrogen levels and green manuring on grain and straw yield of Basmati rice (*Oryza sativa* L.) Varieties" during *kharif* season 2022 at the research farm of Department of Agriculture at Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India. The soil in the experimental field was a sandy clay loam consisting of Indo-Gangetic alluvium, with a pH of 7.98, low levels of organic carbon (0.31%), and readily available nitrogen, phosphorus, and potassium of 173.05 kg/ha, 9.96 kg/ha, and 469.73 kg/ha, respectively. The experiment was conducted in split plot design with three replications. The factor A comprised four *viz.* Basmati rice varieties (Punjab Basmati 7, Punjab Basmati 5, Pusa Basmati 1718 and Pusa Basmati 1121) and factor B consisted seven nutrient management practices, *viz*. T_1 [No GM + 100% RDN through urea], T_2 [No GM + 10% more than RDN through urea], T_3 [GM + 10% more than RDN through urea], T_4 [GM + 10% less than RDN through urea], T_5 [GM + 20% less than RDN through urea], T_6 [GM + 30% less than RDN through urea], T_7 [No GM + 20% more than RDN through urea]. The recommended doses of fertilizers including one third urea (36 kg N), and full dose of SSP (187.5 kg), MOP (40 kg) zinc sulphate (25 kg) and ferrous sulphate (25 kg) were applied as basal dose before sowing whereas rest of the urea (60 kg) was applied in two equal split doses 3 and 6 weeks after transplanting by broadcasting. Data were recorded on plant growth parameters and yield. The observations were recorded on five randomly selected plants on plant height (cm), number of tillers per plant, dry matter accumulation (g) and grain and straw yield (q/ha). The data were statistically analysed by the method of analysis of variance (ANOVA) as described by Panse and Sukhatme (1985) [8].

Results and Discussion

Growth parameters

The data on growth parameters *viz*. plant height (cm), number of tillers per plant and dry matter accumulation (g) of Basmati rice under various treatment combinations of inorganic fertilizer and green manure is presented in Table 1. The variety V_4 Punjab Basmati 7 showed significantly higher plant height followed by variety V_1 Pusa Basmati 1718. Among treatments, treatment T_3 [Green manuring + 10% more than recommended dose of nitrogen] showed the highest plant height followed by treatment T_7 [No Green manuring + 20% more than recommended dose of nitrogen]. The variety V_4 Punjab Basmati 7 had the highest number of tillers per plant which was statistically at par with variety V_1 Pusa Basmati 1718. Among treatments, treatment T_3 [Green manuring + 10% more than recommended dose of nitrogen] showed the highest number of tillers per plant which was statistically at par with treatment T_7 [No Green manuring + 20% more than recommended dose of nitrogen]. The variety V_4 Punjab Basmati 7 had the highest dry matter accumulation followed by variety V_1 Pusa Basmati 1718. Among treatments, treatment T_3 [Green manuring + 10% more than recommended dose of nitrogen] showed the highest dry matter accumulation which was statistically at par with treatment T_7 [No Green manuring + 20% more than recommended dose of nitrogen] and treatment T_2 [No Green manuring + 10% more than recommended dose of nitrogen].

Yield

The data on grain and straw yield of Basmati *rice* and various treatments combination of inorganic fertilizer and green manuring is presented in Table 2. The variety V_4 Punjab Basmati 7 showed significantly higher grain and straw yield which was statistically at par with variety V_1 Pusa Basmati 1718. Among treatments, maximum grain and straw yield was recorded with treatment T_3 [Green manuring + 10% more than recommended dose of nitrogen] which was statistically at par with treatment T_7 [No Green manuring + 20% more than recommended dose of nitrogen].

The higher grain and straw yield in T_3 could be attributed to better growth parameters and yield attributing characters such as plant height, dry matter accumulation, higher number of tillers per plant, higher panicle length, more number of grains per panicle and 1000-grain weight which ultimately resulted in maximum grain and straw yield (Choudhary and Suri *et al*., 2018) [3].

Table 1: Plant height, number of tillers per plant and dry matter accumulation as influenced by Basmati rice varieties and various treatment combinations

Treatments	Plant height (cm)	Number of tillers per plant	Dry matter accumulation (g)
Factor A: Varieties			
V_1:Pusa Basmati 1718	109.27	14.63	52.21
V_2:Pusa Basmati 1121	109.12	14.44	49.84
V_3: Punjab Basmati 5	107.13	13.28	42.84
V_4: Punjab Basmati 7	111.38	15.24	57.62
C.D. (p=0.05)	0.62	0.76	3.87
Factor B: combination of inorganic fertilizer and green manuring			
T_1: No GM + 100% RDN (Urea)	108.03	14.12	48.15
T_2: No GM + 10% more than RDN (Urea)	110.08	14.53	52.19
T_3: GM + 10% more than RDN (Urea)	113.16	15.59	55.27
T_4: GM + 10% less than RDN (Urea)	109.62	14.20	50.56
T_5: GM + 20% less than RDN (Urea)	106.44	13.85	48.06
T_6: GM + 30% less than RDN (Urea)	106.22	12.95	47.85
T_7: No GM + 20% more than RDN (Urea)	111.03	15.57	52.31
C.D. (p = 0.05)	0.74	0.65	3.20

Table 2: Grain yield (q/ha) and Straw yield (q/ha) as influenced by Basmati rice varieties and various treatment combinations

Treatments	Grain yield (q/ha)	Straw yield (q/ha)
Factor A: Varieties		
V_1: Pusa Basmati 1718	29.01	34.81
V_2: Pusa Basmati 1121	26.96	32.35
V_3: Punjab Basmati 5	21.57	25.89
V_4: Punjab Basmati 7	29.19	35.03
SEm ±	0.29	0.35
C.D. (p=0.05)	1.02	1.22
Factor B: combination of inorganic fertilizer and green manuring		
T_1: No GM + 100% RDN (Urea)	26.08	31.30
T_2: No GM + 10% more than RDN (Urea)	27.32	32.79
T_3: GM + 10% more than RDN (Urea)	28.63	34.36
T_4: GM + 10% less than RDN (Urea)	27.28	32.73
T_5: GM + 20% less than RDN (Urea)	25.97	31.16
T_6: GM + 30% less than RDN (Urea)	23.35	28.02
T_7: No GM + 20% more than RDN (Urea)	28.14	33.77
C.D. (p = 0.05)	1.02	1.11

Conclusion

From over studies it is evident that variety Punjab Basmati 7 was the highest yielding variety among the four varieties evaluated in present investigation. Likewise, among treatment T_3 (Green manuring + 10% more RDN) figured the best treatment as compared to other treatments. Therefore, it may be concluded that cultivation of Punjab Basmati 7 variety in a combination with green manuring + 10% higher dose of nitrogen may be recommended to the farmers for obtaining the highest grain and straw yield with best economic parameters.

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