Effect of organic manures on growth and yield of rice varieties (*Oryza sativa* L.) and yield validation using SPSS model

Abstract

The experiment was conducted during the *Kharif* season 2022, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj (U.P.) to find out the "**Effect of Organic manures on growth and yield of Rice varieties (*Oryza sativa* L.) and yield validation using SPSS model**". The experiment was laid out in Randomized Block Design comprising of 9 treatments which include 3 varieties NDR-359, BPT-5204 and MTU-7029 and 3 organic manures Poultry manure 5(t/ha), Vermicompost 10(t/ha) and Poultry manure 2.5(t/ha) + Vermicompost 5(t/ha). Whose effect is observed in Rice varieties. The result showed that the treatment with the application of MTU-7029 **+** Poultry manure 2.5(t/ha) and Vermicompost 5(t/ha) at 100 DAT was recorded higher in number of tillers per hill (13.1/hill), and also recorded significant and higher number of effective tillers per hill (11.33/hill), number of grains per panicle (112.33), test weight (22.20 g), grain yield (5.21 t/ha) and straw yield (6.49 t/ha), Harvest index (44.45 %). Higher gross return (1,50,920.91 INR/ha), net return (1,00,770.91 INR/ha) and benefit-cost ratio (2.01) was recorded in the application of (MTU-7029 + Poultry manure 2.5 t/ha + Vermicompost 5 t/ha) as compared to other treatments. Treatment 9 has shown 44.68 % increase over predicted yield whereas there was 26.58 % increase in treatment 8 over predicted yield through SPSS model.

KEYWORDS: *Manure, yield, poultry, vermicompost, yield validation and SPSS*

Introduction

“Rice is one of the most important cereal crops in the world, feeding half of the world'spopulation and accounting for 35–60% of all calories consumed by humans” **(Tayefe et al.2014).** Rice is derived from the cereal grass *Oryza Sativa*, a genus in the family Gramineae.Currently, Asia accounts for more than 90% of global rice production and consumption. Riceprovides 60–70% of the energy needs of more than two billion people in Asia **(Sridhar et al. 2019).**

India has the largest area (46 m ha) among the nations that grow rice and is the second largest producer (129.66 MT), after China (150.62 MT), with an average productivity of 2.8 t/ha. With a 5.9 million ha area, Uttar Pradesh produces 15.52 million tonnes of rice with a productivity of 2.042 t/ha **(GOI, 2021).** For the country's food security, India must produce an additional 1.7 million tonnes of rice per year (**Dass and Chandra, 2013)**.

“In India about 393,79 lakh ha area coverage under rice has been reported compared to corresponding period of last year (414.31 lakh ha). Rice is grown in almost all the states in the country however the major 5 states in rice production are West Bengal, UP, Andhra Pradesh, Punjab and Tamil Nadu. The west Bengal and Uttar Pradesh produces 30% of total quantity of rice produced in the country. The state with largest area under rice cultivation are Uttar Pradesh (5737.0 thousand hectares), West Bengal (5491.0 thousand ha), Odisha (3940.7 thousand ha), Chhattisgarh (3666.0 thousand ha) and Punjab (2920.0 thousand ha)” **(NFSM, 2023).**

Instead of artificial fertilizer, rice may be grown using the nutrient-rich poultry manure, but it must first be well mixed into the soil. Before using it in your field, you must give it time to mature. The least suggested time to mature chicken dung before putting it to a field is three to four months, and sooner than six months is more prudent. “Poultry manure is an excellent fertilizer material because it contains essential plant nutrients, especially nitrogen (N), phosphorus (P), and potassium (K). It contains a lot of nitrogen. In order to replace the usage of urea on the majority of commercial farms, chicken manure can improve the N content of soil. These nutrients plus others come largely from the bird faeces. Manures decompose (mineralize) in the soil releasing nutrients for crop uptake. Poultry manure has more nutrients than other animal manures. It contains significant amounts of micronutrients such Cu, Zn, Fe, Mn, and others as well as nitrogen (3-5 %), phosphorus (1.5-3.5 %), potassium (1.5-.03 %)” **(Mohamed,2010)**.

Vermicompost was employed as an organic source for the nutrient’s nitrogen, phosphorus, and potassium, as needed for the treatment. It has 1.0-1.5% K, 1.8-2.1% P, and 1.5-2.2% N. The term "vermicompost" refers to the compost created by the use of earthworms, and "vermiculture" or "Verm technology" refers to a contemporary method of harnessing the ecosystem for efficient utilisation of the organic waste with the aid of earthworms, which results in the emergence of useful organic manure. With this method, we can compost biodegradable waste while also utilising the composts by products to boost crop production and cut down on the use of artificial fertilisers **(Sujit, 2012).**

Weather has an impact on crop development at various phenological stages, which explains why yields vary from year to year and location to location. The response of crops to weather has been measured using a variety of statistical approaches, including multiple regressions, principal component analysis **(Jain et al., 1984),** Markov chain **analysis (Ramasubramanian et al., 1999),** and agro-meteorological models **(Walker, 1989).** In India, agricultural yields were predicted using multiple regression models **(Appa Rao, 1983).** To assess yield patterns and forecast yields in various circumstances, time series analysis is utilised.

Materials and methods

The experiment was conducted during the *Kharif* season 2022, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25.4071753 N latitude, 81.8490776 E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River of Prayagraj - Rewa road about 12 km from the city. The soil of the experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.51%), available N (78.9 kg/ha), available P (32.88 kg/ha), available K (385.10 kg/ha). Nutrient sources were Poultry manure and Vermicompost to fulfil the requirement of Nitrogen, Phosphorus, Potassium, respectively. The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated thrice. The treatments were 1- NDR-359 + Poultry manure 5(t/ha), 2- NDR-359 + Vermicompost 10(t/ha), 3- NDR-359 + Poultry manure 2.5(t/ha) + Vermicompost 5(t/ha), 4- BPT-5204 + Poultry manure 5(t/ha), 5- BPT-5204 + Vermicompost 10(t/ha), 6- BPT-5204 + Poultry manure 2.5(t/ha) + Vermicompost 5(t/ha), 7- MTU-7029 + Poultry manure 5(t/ha), 8- MTU-7029+ Vermicompost 10(t/ha), 9- MTU-7029+ Poultry manure 2.5(t/ha) + Vermicompost 5(t/ha). The growth parameters of the plants were recorded at frequent intervals from transplanting up until 100 DAT and finally, the yield parameters were recorded after harvest. Analysis of Variance (ANOVA) was used statistically to examine these variables using the Randomized Block design. The Pearson's correlation between the measured yield and the individual weather parameters as well as the combination of weather parameters was calculated using SPSS (Statistical Product and Service Solutions). The correlation coefficient has been obtained from the sum of weather parameters and the sum product of various weather parameters. The dependant variable (yield) and the independent variables (time, sum, and sum products for various meteorological conditions) were regressed many times. The regression formula was used to create the regression equation.

Result and Discussion

Plant height (cm)

The highest plant height (108.3 cm) was recorded with application of treatment 3 [NDR 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha] as compare to other treatments and statistically at par with NDR- 359 + Poultry manure 5t/ha. Whereas minimum plant height was recorded in treatment 8 [MTU-7029 + Vermicompost 10t/ha].

The increased concentration of N in poultry manure, which is also more easily available to crops, may account for the taller plants in treated plots. The findings of **Edward and Daniel (1992), Suvarna Latha and Sankara Rao (2001), and Santosh Kumar Jha et al. (2004)** are all in agreement with these findings. Vermicompost may perform better than FYM because of the nutrients' increased concentration and quicker release.

Number of tillers per hill

The highest number of tillers (13.1) was recorded with application of treatment 9 [MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha] as compare to other treatments and statistically at par with MTU-7029 + Poultry manure 5t/ha. Whereas minimum number of tillers was recorded in treatment 1 [NDR- 359 + Poultry manure 5t/ha].

Among the organic manure treatments, the better performance of poultry manure-treated plots might be due to the involvement of certain growth-promoting substances, which might have also accelerated the number of tillers. This is in accordance with the findings of **Prabhakaran (2000), and Helen Belephant-Miller (2007).** Better performance of vermicompost might be due to its presence of macronutrients and micronutrients **(Shinde 1992)**.

In general, tiller number showed an increasing trend up to 60 DAT, and thereafter deceased up to harvest. A decrease in the number of tillers after 60 DAT could be due to the senescence of lower tillers because of the shading effect, which was also supported by **Singh's (2001)** findings. The variation in tiller production might be attributed to the availability of nutrients.

Dry weight (g/hill)

The highest Dry weight (53.32 g/hill) was recorded with application of treatment 3 [NDR 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha] as compare to other treatments and statistically at par with NDR 359 + Poultry manure 5t/ha. Whereas minimum Dry weight was recorded in treatment 5 [BPT5204 + Vermicompost 10t/ha].

Increased dry matter accumulation in plots treated with poultry manure and vermicompost may be attributed to the ongoing, slow release of nutrients that have allowed the leaf area duration to increase, giving plants the chance to increase their photosynthetic rate, which may have in turn resulted in higher dry matter accumulation. **Amanullah (2006), Suvarna Latha and Sankara Rao (2001) and Altaf Hussaine (2012)** all came to similar conclusions.

Crop growth rate (g/m^2/day) and Relative growth rate (g/g/day)

The significantly maximum crop growth rate (18.63 g/m^2/day) was recorded with application of treatment 8 [MTU-7029 + Vermicompost 10t/ha] as compare to other treatments and statistically at par with NDR 359 + Vermicompost 10t/ha and [BPT-5204 + Poultry manure 5t/ha]. Whereas minimum Crop growth rate was recorded in treatment 5 [BPT-5204 + Vermicompost 10t/ha].

The significantly maximum relative growth rate (0.0123 g/g/day) was recorded with application of treatment 8 [MTU-7029 + Vermicompost 10t/ha] as compare to other treatments and statistically at par with NDR 359 + Vermicompost 10t/ha and [BPT-5204 + Poultry manure 5t/ha].

The higher leaf chlorophyll content and better cellular nutrition appear to have accelerated photosynthetic activity. Therefore, it follows that the enhanced metabolic activities and photosynthetic rate that result in an improvement in the accumulation of dry matter at the successive growth stages may be the cause of the improved growth and development of the crop plants in the current investigation. This in turn leads to an increase in the crop growth rate and relative growth rate in all stages of plants. The current study takes into account the conclusions of **Das (2016).**

Yield parameters

The highest number of effective tillers per hill was recorded in Treatment T9 (MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (11.33) as compare to other treatments and statistically at par with (MTU-7029 + Vermicompost 10t/ha). Whereas minimum number of effective tillers per hill are seen in Treatment T1 (NDR- 359 + Poultry manure 5t/ha).

The highest number of panicles per hill was recorded in Treatment T6 (Bpt-5204 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (9.13) as compare to other treatments and statistically at par with (Bpt-5204 + Vermicompost 10t/ha). Whereas minimum number of panicles per hill are seen in Treatment T7 (MTU-7029 + Poultry manure 5t/ha).

The highest number of grains per panicle was recorded in Treatment T9 (MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (112.33) as compare to other treatments and statistically at par with (MTU-7029 + Vermicompost 10t/ha). Whereas minimum number of grains per panicle are seen in Treatment T1 (NDR- 359 + Poultry manure 5t/ha).

The highest test weight was recorded in Treatment T9 (MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (22.20 g) as compare to other treatments and statistically at par with NDR-359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha and (MTU-7029 + Vermicompost 10t/ha). Whereas minimum test weight is seen in Treatment T4 (BPT-5204 + Poultry manure 5t/ha).

The nutrients in the poultry manure are readily available to the crop due to well-developed decomposition, which may have led to increased yield attributes such as productive tillers, number of filled grains per panicle, 1000 grain weight, and significantly lower sterility percent, which in turn led to higher yield. Researchers like **Datta (1994), Singh (2001) and Hossan (2010)** all found similar findings.

Yield (t/ha)

The highest grain yield was recorded in Treatment T9 (MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (5.21 t/ha) as compare to other treatments and statistically at par with (NDR- 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) and (BPT-5204 + Poultry manure 2.5t/ha + Vermicompost 10t/ha). Whereas minimum grain yield is seen in Treatment T4 (BPT-5204 + Poultry manure 5t/ha).

The highest straw yield was recorded in Treatment T9 (MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (6.49 t/ha) as compare to other treatments and statistically at par with NDR- 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha and (BPT-5204 + Poultry manure 2.5t/ha + Vermicompost 10t/ha). Whereas minimum straw yield is seen in Treatment T7 (MTU-7029 + Poultry manure 5t/ha).

The highest harvest index was recorded in Treatment T9 (MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha) (44.45%) as compare to other treatments and statistically at par with NDR- 359 + Vermicompost 10t/ha, NDR- 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha, BPT-5204 + Vermicompost 10t/ha, BPT-5204 + Poultry manure 2.5t/ha + Vermicompost 5t/ha and MTU-7029 + Vermicompost 10t/ha. Whereas minimum harvest index is seen in Treatment T4 (BPT-5204 + Poultry manure 5t/ha).

The supremacy of enriched poultry manure compost lies in the fact that it can supply the nutrients in soluble form for a quite longer period by not allowing the entire soluble form into solution to come into contact with soil and other inorganic constituents, thereby minimising fixation and precipitation from the enriched manures. The plant roots can very well compete with loss mechanisms and absorb more nutrients, leading to a better yield.

The maximum grain and straw yield were due to marked improvement in dry matter accumulation, yield attributes and greater nutrient content and their uptake by rice crop. These findings are in direct conformity with that of **Barik et al. (2008).**

Yield validation using SPSS model

The multi-regression analysis using SPSS has been employed for the estimation of rice yield. The regression for SPSS model is

Y = 13.661 + (0.263 x Z21 of prediction year) + (0.066 x time)

Here, Z21 is the sum product of minimum temperature.

The yield obtained in treatment 9 with MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha (5.21t/ha) showed 44.68% increase over the predicted yield through SPSS model (2.88 t/ha).

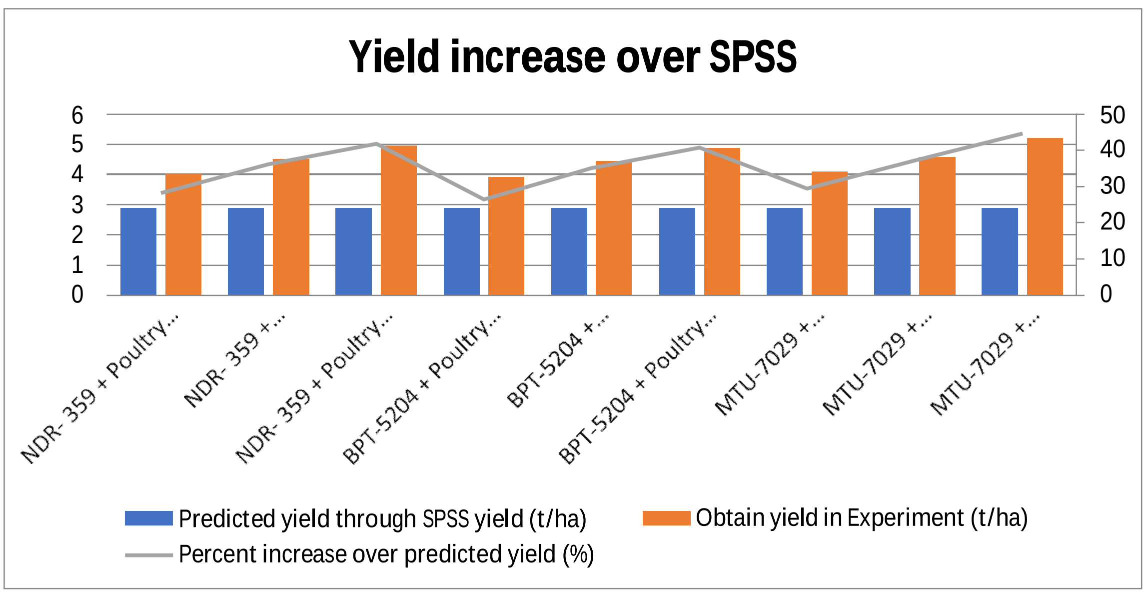

Fig 1. Percentage of yield increase over SPSS model

Table 1. Effect of organic manures on growth attributes of rice varieties

Sl. no	Treatments	100 DAT			80-100 DAT	
		Plant height (cm)	Number of tillers/hill	Dry weight (g/hill)	Crop growth rate ($g/m^2/day$)	Relative growth rate (g/g/day)
1.	NDR- 359 + Poultry manure 5t/ha	108.2	9.0	52.95	17.43	0.0110
2.	NDR- 359 + Vermicompost 10t/ha	106.3	9.3	51.88	18.23	0.0120
3.	NDR- 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha	108.3	9.9	53.32	17.76	0.0110
4.	BPT-5204 + Poultry manure5t/ha	106.7	9.5	52.13	18.13	0.0120
5.	BPT-5204 + Vermicompost 10t/ha	105.8	9.7	50.09	16.97	0.0110
6.	BPT-5204 + Poultry manure 2.5t/ha + Vermicompost 5t/ha	107.1	10.4	52.34	17.97	0.0113
7.	MTU-7029 + Poultry manure 5t/ha	106.5	11.8	52.64	17.90	0.0110
8.	MTU-7029 + Vermicompost 10t/ha	105.4	12.3	51.47	18.63	0.0123
9.	MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha	106.9	13.1	52.79	17.88	0.0110
	F test	S	S	S	S	S
	SEm(±)	0.20	0.36	0.13	0.21	0.0002
	CD(p=0.05)	0.60	1.09	0.38	0.64	0.0005

Table 2. Effect of organic manures on yield attributes and yield of rice varieties

Sl. no	Treatments	**No. of effective tiller/hill**	**No. of panicles/hill**	**No. of grains/panicle**	**Test weight (g)**	**Grain yield (t/ha)**	**Stover yield (t/ha)**	**Harvest index (%)**
1.	NDR- 359 + Poultry manure 5t/ha	8.33	6.00	99.33	19.84	4.02	5.90	40.52
2.	NDR- 359 + Vermicompost 10t/ha	8.60	6.27	103.00	20.58	4.51	6.14	42.33
3.	NDR- 359 + Poultry manure 2.5t/ha + Vermicompost 5t/ha	9.00	6.67	103.07	21.18	4.95	6.42	43.50
4.	BPT-5204 + Poultry manure5t/ha	9.13	8.13	101.60	13.96	3.92	5.86	40.08
5.	BPT-5204 + Vermicompost 10t/ha	9.13	8.67	103.47	14.61	4.45	6.17	41.89
6.	BPT-5204 + Poultry manure 2.5t/ha + Vermicompost 5t/ha	10.00	9.13	103.73	15.11	4.87	6.38	43.25
7.	MTU-7029 + Poultry manure 5t/ha	9.93	5.40	106.73	20.85	4.08	5.82	41.19
8.	MTU-7029 + Vermicompost 10t/ha	10.73	5.73	108.93	21.62	4.59	5.84	44.01
9.	MTU-7029 + Poultry manure 2.5t/ha + Vermicompost 5t/ha	11.33	6.13	112.33	22.20	5.21	6.49	44.45
	F test	S	S	S	S	S	S	S
	SEm(±)	0.31	0.18	1.53	0.34	0.15	0.07	0.88
	CD(p=0.05)	0.93	0.54	4.58	1.03	0.46	0.20	2.63

Conclusion

Based on the findings, it can be said that the inclusion of poultry manure at a rate of 2.5 t/ha alongside vermicompost at a rate of 5 t/ha improved the output and economic return among the three types of rice in MTU-7029. Additional studies are required to corroborate the outcomes because they are based on only one season.

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