Original research article

Influence of organic manure and spacing on growth and yield of wheat

ABSTRACT

A field experiment was carried out during *rabi* season of 2022-23 on wheat crop at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P.) to determine the "Influence of organic manure and spacing on growth and yield of wheat". The experiment was laid out in Randomized Block Design (RBD) with nine treatments and replicated thrice. The result showed that treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)] recorded significantly higher plant height (101.90 cm), number of tillers/running row meter (76.00), plant dry weight (23.10g), crop growth rate during the interval of 60-80 (23.08 g/m^2/day) number of effective tillers/running meter (84.00), Grains/spike (45.23cm), Test weight (29.89 g) grain yield (6.00 t/ha) and stray yield (8.99 t/ha) in Wheat.

Key words: *organic manures, wheat, spacing, yield, Rabi.*

INTRODUCTION

Wheat is one of the world's most important cereal crops, is widely cultivated and consumed in numerous countries and a staple crop of the world contributing as a food source for more than

40% of the world's population is the principle cereal crop since it is a staple crop in many countries and hence its consumption is directly proportional to the population growth. With its abundant cultivation and diverse uses, wheat plays a crucial role in global food security and various industrial applications. It is also a good source of essential nutrients such as carbohydrate, protein, fat and minerals (zinc, iron) and contain good amount of vitamins. Renowned for its versatility, wheat has a rich history dating back thousands of years and is deeply embedded in the cultural, economic, and agricultural fabric of many nations.

"In world-wide total area under wheat cultivation is of 221.84 million hectares with annual production of 779.33 million metric tons and productivity of 3510 kg/ha" **(USDA, 2022).** "In India the total sown area under wheat crop in India is around 31.61 million hectares. The total wheat production in India is around 109.52 million tonnes and productivity of 3464 kg/ha. Total area under Uttar Pradesh is 9.85 million hectares which is 31.16% of the total area under wheat cultivation in India. Total wheat production in Uttar Pradesh is 35.50 million tonnes and productivity of is 3604 kg/ha". **(GOI, 2022).**

The industrial revolution followed by the green revolution which fulfilled the food demands of the growing population caused an increase in yield per unit area in crop production, but they also increased the use of synthetic fertilizers in agriculture. Less soil fertility is one of the most vital constraints in improving the agricultural production. But the intensive use of inorganic fertilizer in agriculture worldwide for ensuring the world food security caused so many health problems and unrecoverable environmental pollution. The demand for plant nutrients is expected to increase continuously with population growth. According to **Chandini *et al*.(2019),** "world population is expected to increase by about 2.3 billion by 2020 and double by the year 2050. If meat and food consumption in developed countries are matched by the rest of the world by the mid-21st century, then grain and nutrient demand are expected to triple. All this implies that food production will have to be much more intensive and efficient than ever before".

"However, Problem rises over the use of chemical inducing fertilizer on the long run might create more unwanted consequence and problem to the soil due to inappropriate use of mineral fertilizers (i.e., when used in both excess or deficiency). Thus the over-use of chemical fertilizers can lead to soil acidification and soil crust thereby reducing organic matter content, humus content, beneficial organisms, stunting plant growth, can change the soil pH, increase pests, and even contribute to the release of greenhouse gases. The soil acidity diminishes phosphate intake by crops, increases the toxic ion concentration in the soil, and inhibits crop growth" **Cooke (1982).** This Special Issue addresses the task to find a balance between increasing yields using conventional and novel fertilizers, and the maintenance of soil and environmental health.

"Therefore, to solve this crisis we have to ensure both the enhanced and sustainable agricultural production and to safeguard the environment integrated use of different types of nutrient suppliant such as chemical fertilizer, organic manures, biofertilizers and other slow released or controlled released fertilizers should opt" **Pandiselvi *et al.* (2017**). "Organic matter is the basis of soil fertility. Microbial fertilizers are distinctly environment-friendly, non-bulky; cost-effective which plays a significant role in plant nutrition" Pandiselvi et al. (2017). Maintaining soil quality is of great importance for crop growth and enhancing productivity. Microorganisms living in the soil are important for decomposing, mineralizing, and recycling organic matters. Microbial populations intensively induce the production of phytohormones such as gibberellin and auxin in plant roots grown in fertile soil with rich organic manures which stimulate plant growth which can be achieve only by the use of natural organic matters that continuously enhance the fertility of the soil without compromising the soil health for the later generation after generation, improve ecosystem of the living organisms and environment thus revitalising the cycle of nature without the interference of foreign chemically induce apparatus.

"Farmyard manure occupies an important position among organic manures. FYM seems to act directly by increasing crop yield by acceleration of respiratory process or by cell permeability or by hormonal growth action. Good quality farmyard manure (FYM) is perhaps the most valuable organic manure. FYM has predominant role in the improvement of soil fertility, physical-chemical properties and biological activity, besides its nutrient combinations" **Roopashree *et al.* (2019). "**Poultry industry is one of the largest and fastest growing livestock production systems in the world. Poultry waste comprise all essential nutrient and also micronutrients it is also a good source of rare plant nutrients among the animal manures, poultry droppings have higher nutrient contents. It has nitrogen (4.55 to 5.46 %), phosphorus

(2.46 to 2.82 %), potassium (2.02 to 2.32 %), calcium (4.52 to 8.15 %), magnesium (0.52 to 0.73 %) and appreciable quantities of micronutrients like Cu, Zn, Fe, Mn etc. In addition to this cellulose (2.26 to 3.62%), hermicellulose (1.89 to 2.77 %) and lignin (1.07 to 2.16 %) are also present in poultry waste" **(TNAU, 2009).**

"The *vermicompost*ing is bio-oxidation and stabilization of organic material involving the joint action of earthworm and microorganisms. Although, microbes are responsible for the biological degradation of the organic matter, earthworms are the important drivers of the process, conditioning the substrate and altering biological activity" **Devi *et al*. (2011)**. "*Vermicompost* contains 3% N, 1% P, 1.5% K. it helps in preventing environment pollution and protect soil health, improves soil structure and water holding capacity. it stimulates activity of micro-organisms that make plant to get macro and micronutrients through biological process, increase nutrient solubility, alter soil salinity, solidity and pH. Phosphate-solubilizing microorganisms (PSM) involve different character of micro-organisms which turn insoluble organic compound of phosphorus to soluble form" (**Raju and Reddy, 1999; Sundara *et al*., 2002)**

"Among various agronomic factors, the row spacing of wheat is very important for proper distribution of plants over cultivated area, thereby better utilization of available soil and atmospheric resources. Wheat is generally sown in straight unidirectional rows at 22.5 cm apart. At 22.5 cm spacing the space between the rows of plants is so much that the plants are not able to fully utilize the available solar radiation and nutrients from the soil, due to which plants could not make sufficient use of available resources for photosynthesis" **Reddy and Reddi, (2002).** It is important that plants utilize the available resources fully and yield is maximized.

MATERIALS AND METHODS

The experiment was carried out during *Rabi* season of 2022-2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) which is located at 25.39"42" N latitude, 81.50"56" E longitude, and 98m altitude above the mean sea level. This area is situated on the right side of the river Yamuna and by the opposite side of Prayagraj City. All the facilities required for crop cultivation were available. The soil of experimental plot was sandy loam in texture, soil pH was 8.0, low in organic carbon (0.62 %), available N (225 kg/ha), available P (38.2 kg/ha) and available K (240.7 kg/ha). The organic manure was applied at FYM (20 t/ha), Poultry (3.3 t/ha), and *Vermicompost* (3.3 t/ha) as a major nutrient source. The crop was sown on 14th December 2022. The experiment was laid out in Randomized Block Design with 9 treatments each replicated thrice. The treatment combination were T_1- FYM (20 t/ha) + Spacing (20 cm × 15 cm), T_2- FYM (20 t/ha) + Spacing (22.5 cm × 10 cm), T_3- FYM (20 t/ha) + Spacing (25 cm × 25 cm), T_4- Poultry (3.3 t/ha) + Spacing (20 cm × 15 cm), T_5- Poultry (3.3 t/ha) + Spacing (22.5 cm × 10 cm), T_6- Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm), T_7- *Vermicompost* (3.3 t/ha) + *Vermicompost* (3.3t/ha) + Spacing (22.5 cm × 10 cm), T_9- *Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm). The data recorded on different aspects of crop such as, growth attributes and yield attributes were subjected to statistical analysis by analysis of variance method.

RESULTS AND DISCUSSION

Growth attributes.

Plant height (cm)

Significantly higher plant height (101.90 cm) was recorded in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. However, treatment 4 [Poultry (3.3 t/ha) + Spacing (20 cm × 15 cm)], treatment 6 Poultry [(3.3 t/ha) + Spacing (25 cm × 25 cm)], treatment 7, [*Vermicompost* (3.3 t/ha) + Spacing (20 cm × 15 cm)], treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] were found to be statistically at par with treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. .Significant and higher plant height was recorded with application of *Vermicompost* (3.3 t/ha) might be due to increase in the level of the organic nutrient source which help improved the physical properties of the soil and supplying the plant with the necessary nutrients, resulted in higher plant height. Similar result is found in **Zaid *et al*. (2019).** Further, higher plant height was recorded with Spacing (22.5 cm × 10 cm) might be due to maintaining an adequate spacing which perhaps eventually help in the enhancement of the uptake in resources through the aggregation of biomass. Similar finding was reported by **Chauhan *et al.* (2005); Hussain *et al*. (2020) in rapeseed.**

Number of tillers/ running row meter

Significantly higher number of tillers/running row meter was (84.00) recorded at treatment 8 [*Vermicompost* 3.3t/ha and Spacing 22.5cm × 10cm]. However, treatment 5 [Poultry (3.3 t/ha) + Spacing (22.5 cm × 10 cm)], treatment 6 [Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm)], treatment 7 [*Vermicompost* (3.3 t/ha) + Spacing (20 cm × 15 cm)] and treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] were found to be statistically at par with treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)].Significant and higher number of tillers/ running row meter was recorded with application of *Vermicompost* (3.3 t/ha) might be due maintaining sufficient available nutrients during the growth period which enable it to be achieved through organic materials application. Similar results are in support with **Tawfik and Gomaa (2005); Ahmed et al. (2011).** Further, significant and higher number of tillers was recorded with Spacing (22.5 cm × 10 cm) might be due interactions between neighbouring plants; such as competition for resources (nutrient & sunlight) and active morphogenetic responses triggered by neighbours' plant perceptions. Similar results have been recorded by **Alzueta *et al.* (2012)**.

Dry weight (g/plant)

Significantly higher plant dry weight was (23.10 g) recorded in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. However, treatment 4 [Poultry (3.3 t/ha) + Spacing (20 cm × 15 cm)], treatment 6 [Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm)], treatment 7 [*Vermicompost* (3.3 t/ha) + Spacing (20 cm × 15 cm)] and treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] were found to be statistically at par with treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. Significant and higher plant dry weight was with application of *Vermicompost* (3.3 t/ha) might be due to the incorporation of *Vermicompost* and rate of mineral fertilizers significantly influenced shoot dry matter yield which in turn resulted in the increase of dry weight. Similar finding was reported by **Nyangani (2010).** Further, significant higher plant dry weight was with spacing (22.5 cm × 10 cm) might be due to attribute of spacing such that high plant density was involved in the production of higher reproductive dry matter and also high plant density may increase total dry matter production per unit land area. Similar result was reported by **Hakoomat *et al.* (2009); Samani *et al.*, (1999).**

Crop growth rate

, significantly higher crop growth rate was (23.08 g/m2/day) recorded at interval of 60-80 DAS in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. However, treatment 4 [Poultry (3.3 t/ha) + Spacing (20 cm × 15 cm)], treatment 5 Poultry (3.3 t/ha) + Spacing (22.5 cm × 10 cm), treatment 6 [Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm)], treatment 7 [*Vermicompost* (3.3 t/ha) + Spacing (20 cm × 15 cm)] and treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] were found to be statistically at par with treatment 8 [(3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. Significant and higher crop growth rate was with application of *Vermicompost* (3.3 t/ha) might be due organic manure provide supplement nutrients that is not found in chemical fertilizer which are beneficial for primary growth of the plant thus, might result in the increase of higher crop growth rate. Similar finding was recorded by **Khan *et al.* (2014).** Further, significant higher crop growth rate was with Spacing (22.5 cm × 10 cm) might be due to its innate ability to primarily compete for resources under a significant spacing such that light, water and nutrients are adequately sufficient, resulted increase in crop growth rate. Similar result has been reported by **Pan *et al*. (2023); Sial *et al.* (2010).**

Yield attributes

Number of effective tillers/ running meter

Significant and higher number of effective tillers/running meter (64.37) was recorded with treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. However, treatment 5 [[Poultry (3.3 t/ha) + Spacing (22.5 cm × 10 cm)], treatment 6 [Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm)] and treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] were found to be statistically at par with in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. Significant and higher number of effective tillers was with *Vermicompost* (3.3 t/ha) might be due to its bio-oxidation and stabilization of earthworm and microorganisms which might help alter the condition of soil thus improve biological activity, therefore, creating an ideal environment for the growth of effective tillers. Similar cases have been reported by **Devi *et al.* (2011).** Further, significant higher effective tillers was with Spacing (22.5 cm × 10 cm) might be due to equal planting density which may provide a better environment for the formation of tiller buds might resulted in the increase number of effective tillers/running meter. Similar report has been made by **Pan *et al*. (2023); Xu *et al*. (2016).**

Grain/ spike

Significantly maximum number of grains/spikes was (45.23) recorded in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. However, treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] was found to be statistically at par with in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. Significant and maximum number of grains/spikes was with application of *Vermicompost* (3.3 t/ha) might be due to the attribute of organic manures which are excellent source for multi-nutrient supply to crop plants depending on their type and quality thus caused increase in spike length. Similar report has been given by **Ahmad *et al*., (2007).** Further, significant higher number of grain/spikes was with Spacing (22.5 cm × 10 cm) might be due implication of distance which might have altered the plant architecture, photosynthetic efficiency of the leaves, grain size and grain yield thus increase the number of grain/ spikes. Similar finding has been reported by **Hakoomat Ali *et al*.(2009); Sendouka *et al.* (1980).**

Test weight (g)

Highest Test weight (29.89 g) was recorded in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)] though there was no significant different among the treatments.

Grain yield

Significantly higher grain yield (6.00 t/ha) was recorded in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. However, treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] is found to be at par with treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. Significant and higher grain yield was with application of *Vermicompost* (3.3 t/ha) might be attributed to higher uptake and recovery of applied nutrient, which might in turn, must have improve synthesis and translocation of metabolites to various reproductive structure of the plant resulting in favourable increase in yield attributes, which ultimately increased in grain yield. Similar report has been given by **Pradhan and Moharana (2015).** Further, significant and higher grain yield was with Spacing (22.5 cm × 10 cm) might be due to higher leaf area index (LAI) and light interception at wider spacing between plants gained from open plant structure which might have resulted in higher LAI and greater leaf size, leading to a vigorous root system and more adequate room to grow thereby increasing the final grain yield. Similarly, case was also reported by **Ali and Izhar (2017).**

Straw yield

Significantly higher straw yield (8.99 t/ha) was recorded in treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)], which was superior over all other treatments as compared with other treatments. However, treatment 9 [*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)] is found to slightly statistically at par with treatment 8 [*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)]. Significant and higher straw yield was with application of *Vermicompost* (3.3 t/ha) might be due to subsequent increase in photosynthesis and the formation of ATP which the plant requires to fill the sieve tube to form compounds with large molecular weight and increase the mass of the plant thereby resulting in the increase of stray yield. Similar finding has been reported by **Zaid *et al.* (2019)**. Further, significant and higher straw yield was with Spacing (22.5 cm × 10 cm)] which might be due to appropriate row spacing which may improve crop productivity because plants growing too wide rows may not effectively utilize the surrounding resources, whereas growth in narrow may result in inter-row solid competition among plants. Similar cases has been reported by **Pan *et al.* (2023).**

CONCLUSION

Based on the findings it can be concluded that in wheat with the combination of *Vermicompost* (3.3 t/ha) along with Spacing (22.5 cm × 10 cm) in treatment 8 was observed highest growth and yield attributes.

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Table 1: Influence of organic manure and spacing on growth attributes of wheat.

S. No.	Treatments	Plant height (cm)	Number of tillers/ m^2	Plant dry weight (g)	Crop growth rate ($g/m^2/day$)
1.	FYM (20 t/ha) + Spacing (20 cm × 15 cm)	89.27	67.00	18.97	18.95
2.	FYM (20 t/ha) + Spacing (22.5 cm × 10 cm)	92.37	63.33	19.83	19.82
3.	FYM (20 t/ha) + Spacing (25 cm × 25 cm)	89.23	59.67	18.13	18.1
4.	Poultry (3.3 t/ha) + Spacing (20 cm × 15 cm)	93.73	72.00	22.03	22.01
5.	Poultry (3.3 t/ha) + Spacing (22.5 cm × 10 cm)	90.83	71.67	20.90	20.88
6.	Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm)	95.67	72.00	21.50	21.45
7.	*Vermicompost* (3.3 t/ha) + Spacing (20 cm × 15 cm)	99.43	75.00	22.77	22.74
8.	*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)	101.90	76.00	23.10	23.08
9.	*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)	96.63	71.00	21.60	21.55
	F – Test	S	S	S	S
	SEm (±)	2.71	2.56	0.81	1.04
	CD (p=0.05)	8.06	7.66	2.41	3.11

Table 2: Influence of organic manure and spacing on yield attributes of wheat.

S. No.	Treatments	Number of Effective tillers/ running meter	Number of grains /spike	Test weight (g)	Grain yield (t/ ha)	Straw yield (t/ ha)
1.	FYM (20 t/ha) + Spacing (20 cm × 15 cm)	57.75	40.48	28.74	3.80	6.43
2.	FYM (20 t/ha) + Spacing (22.5 cm × 10 cm)	58.50	38.87	28.61	4.03	5.86
3.	FYM (20 t/ha) + Spacing (25 cm × 25 cm)	53.42	36.38	27.43	3.75	5.60
4.	Poultry (3.3 t/ha) + Spacing (20 cm × 15 cm)	60.67	38.60	29.12	4.15	6.15
5.	Poultry (3.3 t/ha) + Spacing (22.5 cm × 10 cm)	62.84	42.16	27.96	4.04	5.95
6.	Poultry (3.3 t/ha) + Spacing (25 cm × 25 cm)	62.16	40.65	28.55	3.98	7.18
7.	*Vermicompost* (3.3 t/ha) + Spacing (20 cm × 15 cm)	60.78	39.98	29.07	4.25	6.81
8.	*Vermicompost* (3.3 t/ha) + Spacing (22.5 cm × 10 cm)	64.37	45.23	29.89	6.00	8.99
9.	*Vermicompost* (3.3 t/ha) + Spacing (25 cm × 25 cm)	63.52	43.71	29.38	5.70	8.60
	F – Test	S	S	NS	S	S
	SEm (±)	0.79	0.53	0.55	0.19	0.35
	CD (p=0.05)	2.36	1.59	-	0.56	1.06

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