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Determining the Effect of Organic and Inorganic Fertilizers on Growth and Yield in Wheat (*Triticum aestivum* L)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled Effect of organic and inorganic manures on growth and yield in wheat **(***Triticum aestivum* L.**)**. was conducted at Agriculture Research Farm of Brahmanand post graduate college, Rath (southern U.P.) on Rath, Mahoba road during *rabi* of 2022- 23. The experiment was laid out into Randomized Complete Block Design (RCBD) with 3 replication and consisted. Four organic treatments *viz.* O_0 = Control (No Organic sources), O_1= Vermi compost @ 2.5t ha^{-1}, O_2 = Compost @ 5t ha^{-1}, O_3 =Liquid consortia @ 250ml /50 kg seed 5 and four inorganic treatments *viz*. I_0 = Control (no inorganic sources), I_1 = Nano urea @ 250ml/50 kg seed, I_2 (60:30:30) NPK kg ha^{-1}, I_3 = (90:45:45) NPK kg ha$^{-1.}$ The result of the study revealed that maximum Initial Plant population (24.44 and 28.22), Height of main shoot (91.06 and 89.89cm)

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Number of functional leaves(10.87 and 10.65) Number of tillers per plant (3.87 and 3.65), Length of spike per plant (11.65 and 10.75), Number of grain per plant (52.38 and 45.46) Weight Grain of ear (2.11 and 2.02 gm), Number of fertile spikelets per plant (5.02 and 4.), Number of sterile spikelets per plant (20.66 and 19.86), Test weight (39.12 and 39.09 g), Grain yield, (44.36 and 45.04q ha^{-1}), Straw yield (76.57 and 74.05q ha-1), Harvest Index (42.79 and 44.45 %) was reported in O_2 = Compost @ 5t ha^{-1} and I_1 = Nano urea @ 250ml/50 kg seed respectively.

Keywords: Wheat; fertile spikelets; sterile spikelets; harvest Index.

1. INTRODUCTION

Wheat (*Triticum aestivum L*.) is the most important cereal crop for the majority of world's population. It is the most important stable food of about two billion people (36% of the world population) world wide. Wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. Wheat belong to family poaceae (graminae) which includes major crop plant such as wheat *(Triticum aestivum L.)* barley *(Hordeum vulgare L.)* oat *(Avena sativa L.)* maize *(Zea mays L.)* and rice *(Oryza sativa L.).* All wheat whether wild or cultivated belong to the genus Triticum of the family Grammineae (Poaceae). The cul ivated wheat (*Triticum aestivium L.)* is an allo hexaploid (2n = 42). Wheat is grown in all the states in india except southern and north Eastern states, Uttar Pradesh, Haryana, Punjab Rajsthan are the major wheat producting states and accounts for all most 80% of total production in India. Major Rainfed wheat areas are in Madhya Pradesh, Gujrat, Maharashtra West Bengal and Karnataka, Central and peninsular Zone accounts for total 1/3rd of wheat area in india.All India basis only 1/3 irrigated wheat received disired irrigation and remaining is limited irrigation only.

The wheat straw forms an important ingredient of dry fodder for cattle in India. It furnished the "bread of life" for most of the people in the country. Wheat grain have important place in Indian economy as well as daily human diet [1]. In India, during past three decades, intensive agriculture involving exhaustive high yielding varieties of cereals particularly wheat has led to heavy mining of nutrients from the soil Use of chemical fertilizers increased to get the higher yield. These erratic fertilizers use patterns, if continued for years, would cause much greater drain on native soil fertility. The need of the time is to maintain the soil fertility for stability and sustainability in the productivity of wheat crop. The crop removes annually large quantities of plant nutrients from soil. Wheat responds well to NPK fertilizer all over the country and a rapid increase in fertilizer use started with the introduction of dwarf Mexican wheats and the total NPK consumption almost double from 0.78 million tonnes in 1965-66 to 1.54 million tonnes in 1967-68, the year of Green Revolution in India. There has been no looking back in the fertilizer consumption since then and in 2010-11, 28.1 million tonnes of NPK were consumed about 55% of this was in the major wheat-growing states With increased chemical fertilizer use and increased agricultural production the demand of micronutrients has also increased many folds and the removal from soil is not replenished by use of micronutrient fertilizers or other multiple nutrient supplying material like organic manures, and green manuring of rotations Hence, number of degree of micronutrients is increasing at fast pace (Gajanan *et al.,* 2002). Wheat grain contain 9-18% moisture, 12% protein,2.0-2.5% cellulose, 1.5 -2.5% minerals and 62-71% carbohydrate. The cultivated wheat *(Triticum aestivum L.)* is hexaploid (2n = 42). It is C_3 long day and self pollinated crop. Wheat growing area in the world is 224.49 million hactares resulting in 792.40 million metric tonnes production with an average productivity of 3.39 tonnes ha^{-1} at global level [2-6]. The major wheat cultivating countries in the world are China, India, UK, USA and Egypt. UP is one the important wheat growing state in the india with an area about 9.8 million ha. With the production 35.50 million tonnes and productivity 3681 kg ha^{-1} during 2020- 21. The area under wheat in Bundelkhand region was 9.8 lakh hactare with the production of 25.22 lakh tonnes and productivity 25.61 quintal hactare. The Bundelkhand region of U. P. is sub-tropical part of state and soil are more suitable for oil seeds and pulses but wheat crop is also grown under rainfed and irrigated condition in large areas. The production and productivity of wheat in this region is low due to limited irrigation facility. Application of less amount of fertilizers (NPK) and showing of local or unimproved varieties and limited of number of irrigation. The judicious fertilization together with improved varieties and irrigation have an important role in maximizing the yield of wheat crop in this region. The production and productivity of wheat increased at a high level, which was achieved on the basis of the use of high yielding varieties, heavy doses of chemical fertilizers, Pesticides, and heavy mechanization that led to unprecedented pressure on our natural resource base [7]. Continuous use of chemical fertilizers, agro-chemicals, and other practices were very exhaustive in nature, which results in removal of nutrients much higher than their replenishment and also depleted the physical, chemical, biological properties and ultimately hampers the soil fertility and productivity. The excessive use of chemicals over time has started cousing problems to animal and human health due to the persistence of residues in food items. Besides, this chemical residues also harm the beneficial soil microbes and fauna (earthworms) resulting in the degradation of soil fertility [8], (Kumar & Bohra, 2006). Consequently, in recent years farming practices have been changing and organic agriculture has emerged as a good alternative for sustainable agriculture. Declining factor productivity, worldwide energy crises and high increment in the price of synthetic fertilizers had led to the present focus on supplementation or replacement of inorganic fertilizers with low priced nutrition sources such as organic compost and manure [9]. The use of organic sources of nutrients in the form of manure, compost and in another form will be effective to further increase the crop yield on a sustained basis. In order to sustain agricultural productivity, a desirable level of soil organic matter needs to be maintained through repeated applications of organic amendment and proper management practices [10]. Use of organic sources of nutrients for crop production can help in achieving long term sustainable agriculture productivity. Addition of organic matter through application of organic manures and compost improves soil physical, chemical and biological properties which contributes higher productivity.

2. MATERIALS AND METHODS

The present experiment was conducted during *rabi* of 2022- 23 at the Agriculture Research Farm of Brahmanand post graduate college, Rath (southern U.P.) on Rath ,Mahoba road . The experiment was laid out into Randomized Complete Block Design (RCBD) with 3 replication and consisted. Four organic treatments *viz.* O_0 = Control (No Organic sources), O_1= Vermi compost @ 2.5t ha^{-1}, O_2 = Compost @ 5t ha^{-1}, O_3 =Liquid consortia @ 250ml /50 kg seed 5 and four inorganic treatments *viz*. I_0 = Control (no inorganic sources), I_1 = Nano urea @ 250ml/50 kg seed, I_2 (60:30:30) NPK kg ha^{-1}, I_3 = (90:45:45) NPk kg ha^{-1} .The wheat Variety- Karan vandana (PVW-187) was used for sowing at the experimental trial . Standard culture practices recommended for wheat was followed uniformly in all experimental plots.

3. RESULTS AND DISCUSSION

3.1 Effect of Organic Sources and Inorganic Sources of nutrients on Growth Characters

3.1.1 Initial plant population

Data presented in Table 1 clearly indicate that organic sources of nutrients have no significant response on initial plant population per running meter. The minimum and maximum (28.06 and 29.44) number of plants per running meter were recorded with O_0 (control) and O_2 (compost) organic sources of nutrients, respectively. Similarly, Inorganic sources of nutrients have no significant response on initial plant population per running meter. The minimum and maximum (27.27 and 28.22) were recorded with I_0 (Control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and Inorganic sources (O×I) of nutrients on Initial Plant Population per running meter was found non - significant.

3.1.2 Height of main shoot

At maturity stage, the plant height differed significantly with each change in organic sources of nutrients. The significantly minimum and maximum (85.48 cm and 91.06 cm) plant height were recorded with O_0 (Control) and, O_2 (Compost) Organic sources of nutrients, respectively. Similarly, at maturity stage, the plant height differed significantly with each change in Inorganic sources of nutrients. The significantly minimum and maximum (85.59cm and 89.89cm) plant height were recorded with I_0 (Control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively.

3.1.3 Number of functional leaves

At maturity stage, there was also no significant variation observed due to organic sources of nutrients.

The minimum and maximum (9.80 and 10.87) number of functional leaves per plant were recorded with O_0 (control) and O_2 (compost) Organic sources of nutrients , respectively.Similarly, at maturity stage there was no significantly variation on number of functional leaves per plant due to inorganic sources of nutrients. The minimum and maximum (10.36 and 10.65) number of functional leaves per plant was recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of Organic sources and Inorganic sources (O×I) of nutrients on number of functional leaves per plant was found non - significant at maturity stage.

3.1.4 Number of tillers per plant

At maturity stage, there was no significant variation in number of tiller per plant recorded. The minimum and maximum (3.09 and 3.79) number of tiller per plant were recorded with O_0 (control) and O_2 (compost) Organic sources of nutrients, respectively. Similarly, at maturity stage there was no significantly variation on number of tiller per plant due to inorganic sources of nutrients. The minimum and maximum (3.34 and 3.65) number of tiller per plant was recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of Organic sources and Inorganic sources (O×I) of nutrients on number of functional leaves was found non - significant at maturity stage.

3.2 Effect of Oragnic Sources and Inorganic Sources on Yield Attributes and Yield

3.2.1 Length of spike per plant (cm)

Data presented in Table 1 clearly indicate that Length of spike per plant significantly highest (11.65cm) was recorded with O_2 (compost) and significantly lowest (9.35cm) average length of spike per plant was recorded with O_0(control). Similarly, the average length of spike was found to differ significantly among inorganic sources of nutrients. Lowest and highest (9.00 and 9.90cm) average length of spike per plant were recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of Organic sources and Inorganic sources (O×I) of nutrients on length of ear was found significant. Data presented in Table 1 clearly indicate that the significantly highest (11.27cm) average length of spike per plant was recorded with O_2I_1 (compost and nano urea) treatment combination. The minimum (9.00cm) average length of spike per plant was recorded with O_0I_0 (control and control) treatment combination which statistically (10.09cm) and O_1I_2 (11.17).

3.2.2 Number of grain per plant

Data presented in Table 1 clearly indicate that there was no significant response of organic sources recorded on number of grain per plant. The minimum and maximum (43.00 and 52.38) number of grains per plant was recorded with O_0 (control) and O_2 (compost) organic sources of nutrients, respectively. Similarly, the number of grains per plant there no significantly variation on number of grain per plant due to inorganic sources of nutrients. The minimum and maximum (44.81 and 50.71) number of grain per plant were recported with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on number of grains per plant was found Non - significant.

3.2.3 Weight Grain of ear (g)

Data presented in Table 1 clearly indicate that the significantly highest (2.11g) average weight of grains per plant was recorded with O_2 (compost) The significantly lowest (1.93g) average weight of grains per plant were recorded with O_0 (control). Similarly, the average weight of grains per plant was found to differ significantly among inorganic sources of nutrients. Significantly lowest and highest (1.86 and 2.21 g) average weight of grains per plant was recorded with I_0 (control) and I_1 (Nano urea) inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on average weight Grain per plant was found significant.

Data presented in Table 1 clearly indicate that the significantly highest except (2.45g) average weight of grains per plant was recorded with O_2I_1 (compost and nano urea) treatment combination.The minimum (1.80g) average weight of grains per plant was recorded with O_0I_0 (control and control)treatment combination which was statistically at par O_0I_2 (1.84).

3.2.4 Number of fertile spikelets per plant

Data presented in Table 1 clearly indicate that there was no significant response of organic sources recorded on number of fertile spikeletes per plant. the significantly variance in number of fertile spikeletes per plant. The minimum and maximum (18.57 and 20.66) number of fertile spikelets per plant were recorded with O_0 (control) and O_2 (compost) organic sources of nutrients, respectively. Similarly, the number of fertile spikeletes per plant there was no significantly variation on number of fertile spikeletes per plant due to inorganic sources of nutrients. The minimum and maximum (17.30 and 19.55) number of fertile spikeletes per plant were recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on fertile spikeletes per plant was found non - significant.

3.2.5 Number of sterile spikelets per plant

Data presented in Table 1 clearly indicate that number of sterile spikelets per plant the significantly highest (5.02) Number of sterile spikelets per plant were recorded with O_2 (compost). The significantly lowest (3.79) Number of sterile spikelets per plant were recorded with O_0 (control). Similarly, the Number of sterile spikelets per plant was found to differ significantly among inorganic sources of nutrients. Significantly lowest and highest (4.59 and 6.97) Number of sterile spikelets per plant was recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on Number of sterile spikelets per plant was found significant. Data presented in Table 1 clearly indicate that The significantly highest except (5.07) Number of sterile spikelet per plant was recorded with O_2I_1 (compost and nano urea) treatment combination.The minimum (2.00) Number of sterile spikelet per plant was recorded with O_0I_0 (control and control) which statistically at par O_0I_1 (3.17).

3.2.6 Test weight (g)

Data presented in Table 1 clearly indicate that test weight the significantly highest (39.12) test weight were recorded with O_2 (compost). The significantly lowest (38.40) test weight were recorded with O_0 (control) organic sources of nutrients, respectively. Similarly, the test weight was found to differ significantly among inorganic sources of nutrients. Significantly lowest and highest (37.90 and 39.67) test weight was recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on test weight was found significant.

3.2.7 Grain yield (q ha^{-1})

Data presented in Table 1 clearly indicate that The maximum (44.36 q ha^{-1}) grain yield was recorded with O_2 (compost @ 5 t ha^{-1}) which was 102.09, 102.82 and 107.77 percent higher as compared with O_1 (Vermicompost @ 2.5 t ha^{-1}), O_3 (Liquid consortia @ 250 ml 50kg seed ha^{-1}) and O_0 (control) organic sources of nutrients, respectively. Similarly, The maximum (45.04 q ha^{-1}) Grain yield was recorded with I_1 (Nano urea @ 250 ml 50 kg ssed ha^{-1}) which was 102.62, 106.57 and 112.82 percent higher as compared with I_2 (60:30:30 NPK kg ha^{-1}), I_3 (90:45:45 NPK kg ha^{-1}) and I_0 (control) inorganic sources of nutrients, respectively.The interaction effect of organic sources and inorganic sources (O×I)of nutrients on Grain yield (q /ha) was found non-significant.

3.2.8 Straw yield (q ha^{-1})

Data presented in Table 1 clearly indicate that straw yield (q/ha) there was no significant response of organic sources recorded on straw yield (q/ha). The minimum and maximum (39.03 and 42.79 q/ha) straw yield were recorded with O_0 (control) and O_2 (compost) organic sources of nutrients, respectively. Similarly, the straw yield there was no significantly variation on straw yield q/ha due to inorganic sources of nutrients.The minimum and maximum (59.37 and 76.57q/ha) straw yield q/ha were recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on straw yield (q/ ha). was found non - significant.

3.2.9 Harvest index (%)

Study of the Data presented in Table 1 clearly indicated that there was no significant response of organic sources of nutrients recorded on harvest index. The minimum and maximum (39.03 and 42.79%) harvest index were recorded with O_0 (control) and O_2 (compost) organic sources of nutrients, respectively. Similarly, harvest index there was no significant variation on harvest index due to inorganic sources of nutrients. The minimum and maximum (40.97 and 44.45 %) harvest index were recorded with I_0 (control) and I_1 (Nano urea) Inorganic sources of nutrients, respectively. The interaction effect of organic sources and inorganic sources (O×I) of nutrients on harvest index was found non – significant.

Table 1. Effect of organic and inorganic manures on different growth and yield parameters

Treatments	Initial plant population per running meter	Height of main shoot At maturity	Number of functional leaves per plant	Number of tillers per plant at maturity	Length of spike (cm)	Number of grains ear per plant	Grain weight per ear (g)	No.of sterile spikelet per plant	No. of fetile spikeletes per plant	Test weight	Total produce (q ha $^{-1}$)	Grain yield (q ha $^{-1}$)	Straw yield (q ha^{-1})	Harvest index (%)
Organic sources														
O_0	28.06	85.48	9.80	3.09	9.35	43.00	1.93	3.79	18.57	38.40	88.43	41.14	59.37	39.03
O_1	28.25	87.10	10.67	3.09	10.75	45.46	2.02	4.59	19.86	39.09	109.34	43.45	74.30	41.37
O_2	29.44	91.06	10.87	3.79	11.65	52.38	2.11	5.02	20.66	39.12	112.67	44.36	76.57	42.79
O_3	28.19	89.84	10.69	3.78	9.73	44.68	2.06	4.08	19.23	38.52	110.45	43.16	75.03	40.22
S.E. (m)±	0.457	0.46	0.38	0.13	0.18	2.18	0.01	0.59	0.31	0.05	0.06	0.57	0.83	1.31
C.D.at 5%	NS	1.33	NS	NS	0.53	NS	0.03	0.25	NS	0.15	0.17	NS	NS	NS
Inorganic sources														
I_0	27.27	85.59	10.36	3.34	9.35	43.00	1.93	3.79	18.57	38.40	85.17	39.92	68.33	40.97
I_1	28.22	89.89	10.65	3.65	10.75	45.46	2.02	4.59	19.86	39.09	104.34	45.04	74.28	44.45
I_2	28.10	88.08	10.37	3.59	11.65	52.38	2.11	5.02	20.66	39.12	101.70	43.89	71.02	43.58
I_3	27.67	88.93	10.43	3.37	9.73	44.68	2.06	4.08	19.23	38.52	100.86	42.26	70.92	41.89
S.E. (m)±=	0.457	0.46	0.38	0.13	0.18	2.18	0.01	0.59	0.31	0.05	0.06	0.57	0.83	1.31
C.D.at 5%	NS	1.33	NS	NS	0.53	NS	0.03	0.25	NS	0.15	0.17	NS	NS	NS

4. CONCLUSION

Overall, the study suggests that organic nutrient sources, particularly compost, can positively influence wheat growth and yield attributes compared to inorganic sources. However, further research is warranted to explore the long-term effects of these nutrient sources on soil fertility and sustainability. Additionally, factors such as cost-effectiveness, environmental impact, and scalability should be considered when devising nutrient management strategies for wheat cultivation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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