Original Research Article

Effect of organic manures and nano zinc on growth and yield of wheat

ABSTRACT

A field experiment was conducted during *Rabi* season 2022 at experimental field of Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, Uttar Pradesh, India. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH7.3), low in organic carbon (0.48%), available nitrogen (230 kg/ha), available phosphorus (13.60 kg/ha) and available potassium (215.4 kg/ha). The treatments consist of organic manures (FYM 10t/ha, panchagavya 3%, FYM 5t/ha + panchagavya 1.5%) and nano zinc (30, 40, 50 ppm) along with control plot (RDF). The experiment was layout in Randomized Block Design with ten treatments each replicated thrice. Higher plant height (91.90 cm), higher plant dry weight (27.27 g), number of tillers/hill (8.67), Crop Growth Rate (11.82), grains/spike (45.12), effective tillers/row meter (73.57), Spikes/running row meter (77.57), grain yield (6.01 t/ha), straw yield (8.49 t/ha), maximum gross return (127712.50 INR/ha), net return (85765.70 INR/ha) and B:C ratio (2.04) were also obtained highest in the treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm].

Keywords: *Wheat, Organic manures, Nano zinc, Growth, Yield and Economics.*

Introduction

According to FAO; estimate, world would require around 840 million tonnes of wheat by 2050 from its current production level of 642;million tonnes. This demand excludes the requirement of animal feed and adverse impacts of climate change on wheat production. To meet this demand, developing countries should increase their wheat production by 77% and more than 80% of demand should come from vertical expansion (FAO 2009). According to FAO estimate, world would require around 840 million tonnes of wheat by 2050 from its current production level of 642 million tonnes. This demand excludes the requirement of animal feed and adverse impacts of climate change on wheat production. To meet this demand, developing countries should increase their wheat production by 77% and more than 80% of demand should come from vertical expansion (**FAO 2009**).

Wheat (*Triticum aestivum* L.) is a major source of diet for India's growing population, providing half of the dietary protein and more than half of the calories. As a result, scientists are constantly striving to increase yields in order to feed the nation. (**Khan *et al.,* 2015**). It is estimated that annual cereal production should be increased by 1 billion tonnes to feed the 9.1 billion people expected by 2050. To meet the increased food supply requirements, crop productivity must be increased in the current scenario. Consumption of wheat in rural India has increased apparently due to the availability of nutritious cereal. The share of wheat in total cereals consumption has increased from 25.43 per cent (3.88 kg/month) in 1972-73 to 37.36 per cent (4.24 kg/month) in 2009-10 (rural India) while a marginal increase from 42.88 per cent (4.82 kg/month) to 43.54 per cent (4.08 kg/month) was observed in urban India (**Sendhil *et al.,* 2012**).

According to FAO estimates, the world will need approximately 840 million tonnes of wheat by 2050, up from the current production level of 642 million tonnes. This demand does not include animal feed requirements or the negative effects of climate change on wheat production. To meet this demand, developing countries should increase wheat production by 77%, with vertical expansion accounting for more than 80% of demand. (**FAO 2009**).

Nanotechnology is a new frontier for the scientific community, and it can be used as an alternative strategy in a variety of fields, including agriculture (**Bhattacharyay *et al.,* 2020**). In this context, nanotechnology, such as the use of nanoscale fertilizers, suggests novel crop management strategies (**Hossain *et al.,* 2021; Seyed *et al.,* 2021**). In recent years, there has been a lot of focus on using nanotechnologies and plant biotechnology in agriculture to increase plant production, improve plant tolerance to environmental stress, improve nutrient use efficiency, and mitigate hazardous environmental effects, as opposed to traditional bulk materials methods (**Abdel *et al.,* 2022**). The nano particles have the potential to make plants use fertilizers more efficiently and environmentally benign since their nano-scales enable for uptake through stomata and the base of trichomes, increasing fertilizer use efficiency. The most important use of nanotechnology in agricultural crop production is the field of nano fertilizers, which, unlike traditional fertilizers, can feed plants gradually and in a controlled manner. These nano fertilizers have the potential to be more effective, reducing soil pollution and other environmental problems associated with chemical fertilizers (**Salhy *et al.,* 2021**).

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. Under organic management, nutrients release and crop demand synchrony is very much required; hence, a thorough understanding of nutrients release pattern from organic sources is essential to avoid nutrients stress. Thus, the development and implementation of efficient nutrient management practices are pivotal for successful organic production and to improve the product quality and yield, besides overall soil health improvement. it maintains soil health as well as productivity of crop. It has a predominant role in improvement of soil fertility, physical-chemical properties and biological activity **(Roopashree *et al*., 2019).**

Panchagavya is an organic product made from five different cow by-products, including cow dung, cow urine, cow milk, cow ghee, and cow curd. It may play a function in fostering growth and supplying immunity to the plant system, conferring resistance to pests and diseases. Panchagavya contains a variety of nutrients, including macronutrients like N, P, and K and micronutrients like various amino acids, vitamins, and growth regulators like Auxins and Gibberellins, as well as advantageous microorganisms like pseudomonas, azatobacter, and phosphor bacteria, among others, that are necessary for plant growth and development **(Raghavendra *et al.*, 2014).**

Materials and Methods

The experiment was conducted during *Rabi* season 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P,). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.62%), available nitrogen (225 kg/ha), available phosphorus (38.2 kg/ha) and available potassium (240.7 kg/ha). The treatments consist of organic manures (FYM 10t/ha, panchagavya 3%, FYM 5t/ha + panchagavya 1.5%) and nano zinc (30, 40, 50 ppm) along with control. The experiment was layout in Randomized Block Design with ten treatments each replicated thrice. The treatment combinations are T1- FYM 10t/ha + nano zinc 30 ppm, T2- FYM 10t/ha + nano zinc 40 ppm, T3- FYM 10t/ha + nano zinc 50 ppm, T4- Panchagavya 3% + nano zinc 30 ppm, T5- Panchagavya 3% + nano zinc 40 ppm, T6- Panchagavya 3% + nano zinc 50 ppm, T7- FYM 5t/ha + Panchagavya 1.5% + nano zinc 30 ppm, T8- FYM 5t/ha + Panchagavya 1.5% + nano zinc 40 ppm, T9- FYM 5t/ha + Panchagavya 1.5% + nano zinc 50 ppm, T10- Control (150:60:40 NPK kg/ha). The data recorded on different aspects of crop viz., growth parameters, yield attributes and yield were subjected to statistical analysis by variance method **Gomez and Gomez, (1984)** and economics is also calculated.

RESULTS AND DISCUSSIONS

Growth parameters

Plant height (cm)

At 120 DAS, [Table 1] higher plant height (91.90 cm) was recorded significantly in the treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was found to be statistically at far with treatment 9.

Increase in plant height might be due to improvement in nutrition status of the soil and creation of suitable environment for better root growth through secretion of growth promoting substances and availability of nitrogen fixed by microorganisms. Similar results are observed by **Bhandari *et al.* (2021).** The increase in plant height might be also due to more availability and absorption of Zn from soil solution which results in fastens the auxin metabolism, synthesis of cytochrome and stabilization of ribosomal fractions, faster the cell division and cell elongation. Similar results are observed by **Shalini *et al.* (2020).**

Plant dry weight (g)

At 120 DAS, [Table 1] maximum plant dry weight (27.27 g) was recorded significantly in the treatment no.9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 7 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm] and treatment no.8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was found to be statistically at far with treatment 9.

Increased dry matter accumulation due to FYM might be attributed due to the continuous steady release of nutrients which might have enabled the leaf area duration to extend, thus favoring the plants to increase the photosynthetic rate which in turn, could have led to higher accumulation of dry matter. Similar results are observed by **Ponmozhi *et al.* (2019).** Availability of small quantities of macronutrients, micronutrients and growth promoting substances in addition to huge beneficial microbial population in panchgavya and jeevamrut, thus when applied to the crop as foliar spray and through soil they trigger the necessary plant growth. Similar results are observed by **Patel *et al.* (2021).** Zinc acts as an enzyme activator in plants and is directly engaged in the manufacture of auxin, which results in the production of additional cells and dry matter, which is then stored as a sink in seeds. Similar results are observed by **Sannathimmappa *et al.* (2023).**

Tillers/hill

At 120 DAS, [Table 1] significantly higher tillers/hill (8.67) was recorded in the treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppmx]. However, treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was found to be statistically at far with treatment 9.

Profuse tillering was due to the fact that nano fertilizer enhanced emergence, more efficient nutrient utilization satisfying nutrient requirement of the crop and increased activity of chloroplast. Similar results are observed by **Singh *et al.* (2022).** The IAA and GA present in panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development. Similar results are observed by **Patel *et al.* (2021).**

Crop Growth Rate (g/m^2/day)

During 90-120DAS, maximum crop growth rate (11.82 g/m^2/day) was recorded significantly in the treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 4 [Panchagavya 3% + Nano-zinc 30ppm], treatment 5 [Panchagavya 3% + Nano-zinc 40ppm], treatment 6 [Panchagavya 3% + Nano-zinc 50ppm], treatment 7 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm] and treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] are found to be statistically at far with treatment 9.

Yield attributes and yield

Grains/spike (no.)

At Harvest, [Table 2] significantly higher grains/spike (45.12) in treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was statistically at par with treatment 9.

FYM might be due to the improvement in soil physico-chemical properties (viz., pH, bulk density, infiltration rate and microbial biomass carbon) and optimum availability of nutrients and organic carbon which acted as the growth and yield enhancing characters. Similar results are observed by **Ponmozhi *et al.* (2019).**

Effective tillers/row meter

At Harvest, [Table 2] significantly higher tillers/row meter (73.57) in treatment 9[FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 7 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm] and treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was statistically at par with treatment 9.

This might be due to the fact that nano-fertilizers have large surface area and less particle size than the pore size of root and leaves of the plant which can increase penetration into the plant from applied surface and improve nutrient uptake and increase yield attributing characters. Similar results are observed by **Singh *et al.* (2022).**

Spikes/running row meter

At Harvest, [Table 2] significantly higher spikes/running row meter (77.57) in treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was statistically at par with treatment no.9.

Grain yield (t/ha)

At harvest, [Table 2] significantly higher grain yield (6.01 t/ha) in treatment 9[FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 7 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm] and treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was statistically at par with treatment 9.

FYM contains more number of nitrogen fixing, phosphate solubilizing and other beneficial microbes, antibiotics, vitamins, hormones, enzymes, etc., which should better effect on the growth and yield of the plants. Similar results are observed by **Kavinder et al. (2019).** The use of nano fertilizer on wheat plants activates enzymes by fusing with the creation of chlorophyll in most plants, which speeds up the formation of growth hormones like tryptophan. This increase in production is the main place to store carbohydrates in plants, that eventually led to an increased number of seeds per plant as a source and storage of carbohydrates, and increased yield. Similar results are observed by **Sannathimmappa *et al.* (2023).** Panchagavya increased synthesis of growth promoting substances which is turn helped in increased growth and yield attributes and finally grain yield. Similar results are observed by **Choudhary et al. (2017).**

Straw yield (t/ha)

At harvest, [Table 2] significantly higher stover yield (9 t/ha) in treatment 9[FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm]. However, treatment 8 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm] was statistically at par with treatment 9.

FYM's contribution in supplying additional plant nutrients, improvement of soil physical, chemical and biological process in soil. Metabolites root activities increased resulting absorption of moisture and other nutrients enhanced resulting into higher production. Similar results are observed by **Singh *et al.* (2019).** Due to favourable effect of zinc on the proliferation of roots and thereby increasing the uptake of other plant nutrients from the soil, supplying it to the aerial parts of the plant and ultimately enhancing the vegetative growth of plants. Similar results are observed by **Poornima and Koti (2019).**

Economics

Gross return (INR/ha)

Gross return (127712.50 INR/ha) was found to be highest in treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm] and minimum gross return (105825.00INR/ha) was found to be in control.

Net return (INR/ha)

Net return (85765.70INR/ha) was found to be highest in treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm] and minimum net return (66072.00 INR/ha) was found to be in treatment 1 [FYM 10t/ha + Nano-zinc 30ppm].

Benefit Cost ratio (B:C)

The maximum Benefit cost ratio (2.04) was recorded in treatment 9 [FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm] which was superior to rest of all treatment combinations.

Conclusion

Based on above findings, it is concluded that the application of FYM 5t/ha, Panchagavya 1.5% and Nano-zinc 50ppm has performed better in growth parameters and yield attributes in wheat.

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Table 1: Effect of organic manures and nano zinc on growth attributes of wheat

S. No.	Treatment combination	Plant height (cm)	Dry weight (g)	Tillers/hill	CGR (90-120 DAS)
1.	FYM 10t/ha + Nano-zinc 30ppm	87.90	25.61	6.53	9.48
2.	FYM 10t/ha + Nano-zinc 40ppm	88.53	25.88	6.60	9.84
3.	FYM 10t/ha + Nano-zinc 50ppm	88.87	26.22	7.07	10.49
4.	Panchagavya 3% + Nano-zinc 30ppm	89.23	26.43	7.40	10.84
5.	Panchagavya 3% + Nano-zinc 40ppm	89.63	26.59	7.53	10.91
6.	Panchagavya 3% + Nano-zinc 50ppm	89.97	26.64	7.80	10.87
7.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm	90.30	26.99	8.27	11.19
8.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm	91.43	27.14	8.47	11.49
9.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm	91.90	27.27	8.67	11.82
	F-test	87.18	25.29	6.20	9.36
	SEm(±)	S	S	S	S
	CD (p = 0.05)	0.24	0.19	0.10	0.35

Table 2: Effect of organic manures and nano zinc on yield attributes and yield of wheat.

S. No.	Treatments	Yield attributes and yield				
		Grains/spike (no.)	**Spikes/running row meter (no.)**	**Effective tillers/ row meter (no.)**	**Grain yield (t/ha)**	**Straw yield (t/ha)**
1.	FYM 10t/ha + Nano-zinc 30ppm	41.53	74.23	70.03	5.19	7.47
2.	FYM 10t/ha + Nano-zinc 40ppm	42.01	74.60	70.50	5.22	7.56
3.	FYM 10t/ha + Nano-zinc 50ppm	42.32	75.23	71.07	5.27	7.69
4.	Panchagavya 3% + Nano-zinc 30ppm	42.37	75.73	71.13	5.36	7.74
5.	Panchagavya 3% + Nano-zinc 40ppm	43.58	75.93	71.57	5.48	7.96
6.	Panchagavya 3% + Nano-zinc 50ppm	43.59	76.63	72.30	5.59	8.18
7.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm	44.28	76.90	72.57	5.77	8.27
8.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm	44.85	77.17	73.40	5.84	8.33
9.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm	45.12	77.57	73.57	6.01	8.49
10.	Control (RDF 150:60:40 NPK kg/ha)	40.52	74.13	69.80	4.98	7.38
	F-Test	S	S	S	S	S
	SEm (±)	0.19	0.22	0.36	0.08	0.07
	CD (p = 0.05)	0.58	0.64	1.07	0.25	0.21

Table 3 Effect of organic manures and nano-zinc on economics of Wheat.

S. No.	Treatments	Economics			
		Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net returns (INR/ha)	B C ratio (B:C)
1.	FYM 10t/ha + Nano-zinc 30ppm	44215.08	110287.50	66072.42	1.49
2.	FYM 10t/ha + Nano-zinc 40ppm	44218.44	110925.00	66706.56	1.50
3.	FYM 10t/ha + Nano-zinc 50ppm	44221.80	111987.50	67765.70	1.53
4.	Panchagavya 3% + Nano-zinc 30ppm	39664.08	113900.00	74235.92	1.87
5.	Panchagavya 3% + Nano-zinc 40ppm	39668.44	116450.00	76781.56	1.93
6.	Panchagavya 3% + Nano-zinc 50ppm	39671.80	118787.50	79115.70	1.99
7.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 30ppm	41940.80	122612.50	82156.56	1.95
8.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 40ppm	41943.44	124100.00	82156.56	1.95
9.	FYM 5t/ha + Panchagavya 1.5% + Nano-zinc 50ppm	41946.80	127712.50	85765.70	2.04
10.	Control (RDF 150:60:40 NPK kg/ha)	39205.00	105825.00	66620.00	1.69