Original Research Article

Effect of organic and inorganic sources of nutrients on growth and yield of timely sown wheat (*Triticum aestivum* L.)

Abstract

A comprehensive study examining the effects of organic and inorganic nutrient sources on the growth and yield of wheat was carried out during the Rabi season of 2020-21 at the Student's Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur. The experimental design was a Randomized Block Design, with each treatment replicated three times across eight different treatments: Control (T1), 100% Recommended Dose of Fertilizers (RDF) (120:60:40 NPK kg/ha) (T2), RDF + Azotobacter (T3), RDF + Azotobacter + Farmyard Manure (FYM) @ 2.0 tons/ha + Phosphate Solubilizing Bacteria (PSB) @ 6.0 kg/ha + Trichoderma @ 5.0 kg/ha (T4), RDF + Vermicompost @ 2.5 tons/ha (T5), RDF + FYM @ 2.0 tons/ha + Vermicompost @ 1.0 ton/ha + Trichoderma @ 5.0 kg/ha (T6), RDF + FYM @ 2.0 tons/ha + Vermicompost @ 1.0 ton/ha + PSB @ 6.0 kg/ha + Azotobacter (T7), and RDF + FYM @ 2.0 tons/ha + Vermicompost @ 1.0 ton/ha + Azotobacter + PSB @ 6.0 kg/ha + Zinc @ 5.0 kg/ha + Sulphur @ 25 kg/ha (T8). The soil type was sandy loam with a pH of 8.13. The wheat variety Shekhar (K-1006) was planted on November 30, 2020, with a seed rate of 100 kg/ha and row spacing of 20 cm.The results indicated that the T8 treatment, which combined RDF, FYM, Vermicompost, Azotobacter, PSB, Zinc, and Sulphur, significantly improved plant growth characteristics such as height, fresh weight, dry weight, and number of tillers per plant, as well as yield-contributing factors including spike length, number of grains per spike, and test weight, compared to all other treatments. Specifically, the T8 treatment produced the highest grain yield, straw yield, and biological yield, recording 52.77, 67.55, and 120.32 quintals per hectare, respectively, which was significantly higher than the yields in treatments T1, T2, T3, and T4, and comparable to those in treatments T5, T6, and T7. Moreover, the T8 treatment achieved the highest gross income (Rs. 143,076.00), net income (Rs. 86,300.00), and benefit-cost ratio (2.52) when compared to all other treatments.

Keywords:Wheat, Microbial inoculants, Organic manure, Trichoderma, Zinc, Sulphur,

INTRODUCTION

Wheat (*Triticumaestivum* L.) stands as the foremost essential cereal crop globally, pivotal to the diets of over two billion individuals—accounting for 36% of the global population. It surpasses all other grain crops in both acreage and production, including rice and maize, making it the world's most crucial cereal grain. Cultivated across a diverse array of climatic conditions, wheat enjoys universal cultivation, with leading producers including China, India, the United States, Canada, the European Union, and Australia. The global wheat cultivation spans approximately 217 million hectares, yielding an annual production of 760 million tonnes and an average yield of 3.50 tonnes per hectare.

In India, wheat occupies a significant place in agriculture, with a cultivation area of 31.4 million hectares, total production reaching 108.75 million tonnes, and an average productivity close to 3.46 tonnes per hectare. Uttar Pradesh emerges as the leader in both wheat production and cultivation area, with wheat sown over 97.86 lakh hectares, resulting in a production of 32.59 million tonnes and a productivity rate of 3.33 tonnes per hectare.The reliance on chemical fertilizers, despite their cost-

effectiveness, raises concerns due to their dependence on non-renewable fossil fuels, which are becoming increasingly scarce. In light of this, the integration of organic alternatives such as farmyard manure (FYM), vermicompost, and Trichoderma is advocated to supply nutrients to plants sustainably. Therefore, the conducted experiment aimed to evaluate the comparative impact of organic and inorganic nutrient sources on the wheat crop's production potential, highlighting the need for sustainable agricultural practices in the face of changing global resource availability.

MATERIALS AND METHODS

The field experiment was meticulously conducted at the Students Instructional Farm (SIF) of C. S. Azad University of Agriculture & Technology, Kanpur (U.P.), during the Rabi season of 2020-21. This location is strategically positioned between latitudes 25°56' to 28°58' North and longitudes 79°31' to 80°34' East, at an elevation of approximately 125.9 meters above mean sea level, nestled within the fertile Gangetic plain. The region typically receives a seasonal rainfall of about 816 mm, primarily from the latter half of June or early July through mid-October, with occasional winter showers.

The experimental field's soil was characterized as sandy loam, consisting of 21.96% clay, 22.95% silt, and 55% sand, originating from the Indo-Gangetic alluvial deposits. The soil's pH was measured at 8.03, with an electrical conductivity (EC) of 0.10 dS/m. Prior to sowing, an initial soil sample analysis was conducted to ascertain levels of organic carbon, and available nitrogen (N), phosphorus (P), and potassium (K), which were found to be 0.41%, 180.0 kg/ha, 11.0 kg/ha, and 173.0 kg/ha, respectively.

For this experiment, eight distinct treatments involving various combinations of organic manure, microbial inoculants, and inorganic fertilizers were meticulously selected. The treatments included a Control (T1), Recommended Dose of Fertilizer (RDF) at 100% (120:60:40 NPK kg/ha) (T2), RDF + Azotobactor (T3), RDF + Azotobacter + Farmyard Manure (FYM) @ 20 t/ha + Phosphate Solubilizing Bacteria (PSB) @ 6.0 kg/ha + Trichoderma @ 5.0 kg/ha (T4), RDF + Vermicompost @ 2.5 t/ha (T5), RDF + FYM @ 2.0 t/ha + Vermicompost @ 1.0 t/ha + Trichoderma @ 5.0 kg/ha (T6), RDF + FYM @ 2.0 t/ha + Vermicompost @ 1.0 t/ha + PSB @ 6.0 kg/ha + Azotobacter (T7), and RDF + FYM @ 2.0 t/ha + Vermicompost @ 1.0 t/ha + Azotobactor + PSB @ 6.0 kg/ha + Zinc @ 5.0 kg/ha + Sulphur @ 25 kg/ha (T8). The incorporation of farmyard manure, vermicompost, azotobacter, and PSB into the soil was done prior to sowing.

The experimental design was a Randomized Block Design (RBD) with three replications. The wheat variety "SHEKHAR" was sown on 30th November 2020 and harvested on 20th April 2021, at a row spacing of 20 cm. Seeds were inoculated with Azotobacter and PSB before sowing, and the crop received a total of four irrigations during its growth period. Standard wheat cultivation practices were adhered to throughout the experiment.

For the analysis of the data collected from this experiment, the Statistical Product and Service Solutions (SPSS) Version 10.0, a window-based software from SPSS, Chicago, IL, was utilized. The analysis of variance (ANOVA) conducted with SPSS helped in determining the statistical significance of the treatment effects at a 5% probability level. Further statistical examination, including the F-test and the significance of differences between treatments, was assessed using the critical difference (CD) method as outlined by Gomez and Gomez.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Growth attributes

The data regarding growth characteristics and yield attributes are concisely presented in Table 1. The findings indicate that the initial plant population status was unaffected by the application of both organic and inorganic nutrient sources, with the differences observed being statistically non-significant. This pattern was consistent in the case of crop plant population, which displayed more or less similar outcomes across treatments.A significant impact was observed in the number of tillers per plant, which were notably influenced by the organic and inorganic nutrient treatments. The highest number of tillers per plant was observed in treatment T8, recording an average of 5.43 tillers, in stark contrast to the control treatment T1, which had the lowest average at 2.79 tillers per plant. Similarly, plant height showcased a significant variation among the treatments, with T8 achieving the maximum average height of 97.03 cm, significantly surpassing the control treatment T1, which had the minimum average height of 74.63 cm.Further analysis revealed that both fresh weight and dry weight per plant were significantly higher in treatment T8, registering 57.76 g and 28.90 g, respectively. These figures starkly contrast with the control treatment T1, where the lowest weights were recorded at 40.26 g for fresh weight and 20.90 g for dry weight. These observations align with the findings reported by several scientists, including Mahato et al. (2018) and Bahara et al. (2007), underscoring the crucial role of nutrient management in influencing the growth parameters and yield attributes of crops.

Yield attributes

Yield attributes, including spike length, number of grains per spike, and test weight of grain, showed significant improvement (Table 1). The highest spike length (10.75 cm) and the greatest number of grains per spike (53.46) were achieved in treatment T8 (RDF + FYM @ 2.0 t/ha + Vermicompost @ 1.0 t/ha + Azotobacter + PSB @ 6.0 kg/ha + Zinc @ 5.0 kg/ha + Sulphur @ 25 kg/ha), while the control group (T1) recorded the lowest spike length (6.26 cm) and number of grains per spike. The other treatments exhibited results that were statistically comparable to each other. The integration of

organic and inorganic nutrients notably enhanced the test weight of the grain, with the maximum test weight observed in T8 (39.20 g). These outcomes are in concordance with the research findings of Borse et al. (2019) and Satyavan et al. (2018), highlighting the positive impact of nutrient management on yield parameters.

Yield and Economics

The comprehensive data on biological yield, grain yield, straw yield, and economic analysis are encapsulated in Table 2. The synergistic application of organic manures (FYM and Vermicompost) alongside microbial inoculants (Azotobacter and PSB) in conjunction with the recommended dose of fertilizer (RDF) demonstrated superior efficacy in enhancing both the biological and grain yields of wheat, compared to the sole application of either organic manure or microbial inoculants with RDF. The highest yields in terms of biological yield (120.32 q/ha), grain yield (52.77 q/ha), and straw yield (67.55 q/ha) were observed in Treatment 8. In contrast, the control group (Treatment 1) exhibited the lowest yields, with biological yield at 72.62 q/ha, grain yield at 30.75 q/ha, and straw yield at 42.87 q/ha.This combination of organic manure and microbial inoculants with RDF significantly contributed to the increased yields of grain and straw in wheat, a finding corroborated by the research of Kulkarni et al. (2018) and Kumar et al. (2020).Regarding the economic analysis, the total cost of cultivation reached its peak in Treatment 8 (Rs. 56,776) and was the lowest in the control group (Treatment 1) at Rs. 44,717 per hectare. The highest gross income was recorded in Treatment 8 (Rs. 143,076), while the control group yielded the least (Rs. 83,396). Similarly, the maximum net return was achieved in Treatment 8 (Rs. 86,300), significantly surpassing that of the control group (Rs. 38,679), with Treatment 8 also showcasing the highest benefit-cost ratio (2.52). The economic benefits of wheat cultivation, influenced by the application of these agricultural inputs, have been previously documented by Fazily et al. (2019) and Kumar et al. (2020).

Conclusion

The investigation at C.S. Azad University of Agriculture and Technology, Kanpur, on wheat crop nutrition during Rabi 2020-21, clearly demonstrates the superior efficacy of combining organic and inorganic nutrient sources. The standout treatment, T8, which amalgamated RDF with FYM, Vermicompost, Azotobacter, PSB, Zinc, and Sulphur, significantly enhanced wheat growth and yield parameters. This blend outperformed other treatments in plant height, weight, tiller number, spike length, grain number, and test weight. Notably, T8 achieved the highest grain, straw, and biological yields, marking a stark improvement over control and other nutrient combinations. Financially, T8 led with the highest gross and net income, and an impressive benefit-cost ratio of 2.52. This comprehensive approach, integrating various nutrient sources, holds great promise for sustainable and profitable wheat cultivation, offering a viable template for similar agronomic conditions.

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Table 1: Effect of Organic and Inorganic nutrients on growth characters and yield attributes of wheat.

Treatments	Plant population(m^2)	Plant height (cm)	Fresh wt. plant^{-1} (g)	Dry wt. plant^{-1} (g)	Tillers plant^{-1}	Spike length (cm)	Grain Spike^{-1}	Test weight (g)
Control	104.30	74.63	40.26	20.90	2.79	6.26	39.06	33.72
RDF 100% (120:60:40 NPK kg (ha^{-1})	106.20	83.50	43.06	22.96	3.05	6.63	41.70	35.47
RDF + Azotobacter	106.50	85.36	44.03	23.30	3.19	7.53	42.58	36.68
RDF + Azotobacter + FYM @2.0t ha^{-1}+ PSB @6.0kg ha^{-1} + Tricho. @5.0kg ha^{-1}	107.10	88.86	48.03	24.36	3.54	7.78	45.76	37.21
RDF + Vermicompost @2.5t ha^{-1}	107.90	94.90	53.96	26.63	5.16	9.24	47.53	38.85
RDF + FYM @2.0t ha^{-1}+ Vermi.@1.0t ha^{-1}+ Trichoderma @5.0kg ha^{-1}	107.60	92.40	50.66	25.53	4.10	9.18	46.46	38.65
RDF + FYM@2.0t ha^{-1}+ Vermi. @1.0t ha^{-1}+ Azotobacter + PSB@6.0kg ha-1	108.40	95.90	54.60	27.63	5.23	9.81	51.36	38.98
RDF + FYM@2.0t ha^{-1} + Vermi.@1.0t ha^{-1}+ Azoto.+ PSB@6.0kg ha^{-1}+ Zn@5.0kg ha^{-1}+ Sulphur @25 kg ha^{-1}	109.40	97.03	57.76	28.90	5.43	10.75	53.46	39.20
S.E. (d) ±	**2.30**	**2.89**	**1.60**	**1.20**	**0.23**	**0.40**	**1.80**	**0.72**
C.D. at 5%	**N.S.**	**6.20**	**3.40**	**2.50**	**0.49**	**0.80**	**3.80**	**1.54**

Table 2: Effect of organic and inorganic nutrients on yield and economics of wheat.

Treatments	Biological yield(q/ha)	Grain yield(q/ha)	Straw yield(q/ha)	Harvest index(%)	Gross income (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
Control	72.62	30.75	42.87	41.77	83396	38679	1.86
RDF 100% (120:60:40 NPK kg (ha^{-1})	102.88	43.92	58.96	42.68	118644	67368	2.31
RDF + Azotobacter	109.79	47.12	62.67	42.91	126282	74806	2.45
RDF + Azotobacter + FYM @2.0t ha^{-1}+ PSB @6.0kg ha^{-1} + Tricho. @5.0kg ha^{-1}	111.72	48.22	63.50	43.16	128913	75737	2.42
RDF + Vermicompost @2.5t ha^{-1}	116.54	50.67	65.87	43.48	135035	78759	2.40
RDF + FYM @2.0t ha^{-1}+ Vermi.@1.0t ha^{-1} + Trichoderma @5.0kg ha^{-1}	113.42	49.14	64.28	43.32	131357	76761	2.41
RDF + FYM@2.0t ha^{-1}+ Vermi. @1.0t ha^{-1}+ Azotobacter + PSB@6.0kg ha-1	118.53	51.76	66.77	43.67	137681	82855	2.51
RDF + FYM@2.0t ha^{-1} + Vermi.@1.0t ha^{-1} + Azoto. + PSB@6.0kg ha^{-1}+ Zn@5.0kg ha^{-1}+ Sulphur @25 kg ha^{-1}	120.32	52.77	67.55	43.86	143076	86300	2.52
S.E. (d) ±	**3.32**	**1.80**	**2.0**	**0.35**	**2305**	**2775**	**0.10**
D. at 5%	**7.12**	**3.81**	**4.22**	**0.80**	**4944**	**6010**	**0.20**