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Effect of integrated nutrients management on growth of wheat (*Triticum aestivum* L.) crop in central plain zone of Uttar Pradesh

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Abstract
The field experiments were conducted during 2024-25 in *rabi* season on Effect of integrated nutrients management on yield, crop quality of wheat (*Triticum aestivum* L.) crop in central plain zone of Uttar Pradesh with different treatments combination of inorganic nutrients (N, P, K, S, Zn and Fe) with organic manure (FYM) and biofertilizers i.e., *PSB* and *Azotobacter* with 11 treatments and 3 replications in Randomized Block design on a Inceptisols soil order of central plain zone of Uttar Pradesh. Results showed that plant growth were significantly increased in treatments over control.

Keywords: Wheat, *Triticum aestivum* L., integrated nutrient management

Introduction
After rice, wheat (*Triticum aestivum* L.) is the nation's most significant crop and a staple, accounting for over one-third of all food grain output. It is a member of the Poaceae (Graminae) family of grasses. For almost two billion people, it is the most essential staple food (36 percentage of the global populace). India's second-most significant cereal crop is wheat (*Triticum aestivum* L.). With a productivity of 2.98 million tonnes ha-1, it leads the globe in grain production and is a staple meal for about one-third of the world's population.

With an area of 341.29 million hectares, it produces 830.59 million tonnes and has a productivity of 3420 kg ha^{-1}. The European Union, China, India, and the United States of America are the world's top producers of wheat. Over the past 15 years, as the population has grown, so too has the consumption of wheat crops. Worldwide, wheat is grown, with China, India, the United States, Russia, Canada, and Australia being the main producers. India is the world's second-largest producer of wheat, after China, with 116.52 million tonnes produced year with a productivity of 3494 kg ha^{-1} (Anonymous, 2023-24) [3[]. Uttar Pradesh (31 million tonnes), Punjab (16.4 million tonnes), and Haryana (11.6 million tonnes) are the three major wheat-producing states. Their respective areas are 9.75 mha, 3.59 mha, and 2.52 mha. In terms of both area and wheat output, Uttar Pradesh leads India. Nevertheless, wheat productivity (2661 kg ha^{-1}) is below the national average (Anonymous, 2023-24) [3].

Manures have taken precedence over chemical fertilizers in order to supply the world's expanding population with food. Applying organic manures is the greatest way to increase soil organic carbon, which will maintain soil quality and future agricultural output (Jan and Boswal, 2015) [13]. Chemical fertilizers are now the most cost-effective way to maximize production per unit area and make up for resource scarcity. This results in higher production costs as well as the depletion of biological, water, and soil resources (Akbarabadi *et al*., 2015) [1].

Micronutrient deficiencies affect the majority of crops, including farmed grains. In addition to decreasing plant yield, deficiencies in these elements in the soil also decrease the amount of these elements that humans and livestock can absorb by lowering the concentration of these elements in the plant, which puts public health at risk and causes a number of diseases (Zirgoli and Kahrizi, 2015; Dixit, 2020; Zuo and Zhang, 2011). [21, 10, 22] Crops will thrive and generate substantial amounts of plant biomass when the soil is nutrient-rich. The primary goal of agriculture is to provide wholesome food for human societies in order to achieve food security, and the provision of nutrients in the soil influences the status of nutrients in the plant (Mohammadi *et al.*, 2015) [18]. Enhancing agricultural goods with chemical fertilisers improves human health, environmental protection, and food security (Jat *et al.*, 2015) [14].

A key component of wheat output is nitrogen (N) (Andrews *et al.*, 2004) [2]. The ability of wheat cultivars to utilize nitrogen efficiently has grown in importance in order to reduce the amount of N fertilizer used without lowering yield. A healthy supply of nutrients, particularly nitrogen, is essential for the growth and productivity of wheat, a significant cereal crop (Mandal *et al.*, 1992; Krylov and Pavlov, 1989). [16, 15] Important considerations for boosting wheat output include nitrogen rate, kind, and timing of treatment (Garrido-Lestache *et al.*, 2005) [12]. According to certain research, N fertilization raises the overall amount of flour proteins, which leads to an increase in both glutenins and gliadins (Dupont and Altenbach, 2003) [11]. The most crucial component of the cell's structure is nitrogen. It is therefore regarded as the most important nutrient for plant growth, which would not be conceivable without it. Without it, the grain shrivels, the foliage becomes yellow, crop growth is severely impeded, and the agricultural production eventually falls.

Since zinc is necessary for several enzymes and plays a crucial part in DNA transcription, it is also said to be a significant micronutrient for wheat production. It is either a functional co-factor of several enzyme processes or a metal component of an enzyme. According to reports, pollen contains a significant quantity of zinc, the majority of which is only reversed to the seed during seed development, and applying zinc enhances grain formation (Chaudhary *et al.*, 2007) [7].

Methods and Materials

A field experiment was conducted during rabi season of 2024-25 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of integrated nutrients management on yield, crop quality of wheat (*Triticum aestivum* L.) crop in central plain zone of Uttar Pradesh. The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm-1, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha-1, respectively. The wheat variety HD-2967 was used. The treatments were T1: CONTROL, T2: 100% NPK, T3: 100% NPK + 5 ton FYM, T4: 100% NPK + *PSB* + *Azotobacter*, T5: 125% NPK + *PSB* + *Azotobacter* + 5 ton FYM, T6: 100% NPK + S40, T7: 100% NPK + Zn5, T8: 100% NPK + S40+ Zn5,T9:100%NPK+S40+Zn5+Fe10,T10:100%NPK+S40+Zn5+ Fe10+*Azotobacter* + *PSB* + 5 ton FYM, T11: 125% NPK data were gathered on five plants chosen from each plot.

Results

Growth characters

1. Plant Population

The results indicate that T10 (100% NPK + S_{30} + $Zn_{7.5}$ + $Fe_{5.0}$+ Azotobacter + PSB + 5 tonne FYM) had the largest plant population (108.10 plants m^{-2}), followed by T_8 -100% NPK+S40+ Zn7.5 (107.35 plants m^{-2}) and T_3-100%NPK +5 ton FYM (107.15 plants m^{-2}). The Control (T_1) treatment had the smallest plant population (105.45 plants m^{-2}). The data was determined to be non-significant (NS), meaning that there were no discernible changes between the treatments. Similar result reported by Akbarabadi *et al*, (2025) [1], Bargaz *et al*, (2018) [4]

2. Plant height (cm)

According to the results, T_{10} (100% NPK + S_{30} + $Zn_{7.5}$ + $Fe_{5.0}$ + Azotobacter + PSB + 5 tonne FYM) had the greatest value (24.75) at 30 DAS, which was statistically comparable to T9-100%NPK +S40+Zn5+Fe5.0 (24.38) and T_8 -100%NPK+S40+ Zn7.5 (24.23). The Control (T_1) had the lowest value (15.30). A similar pattern was seen at 60 DAS, with T_{10} -100%NPK +S30+Zn7.5+Fe5.0+*Azotobacter* +*PSB*+5 ton FYM recording the highest increase (47.92), closely followed and statistically comparable by T_9 - 100%NPK +S40+Zn5+Fe5.0 ((47.18) and T_8 -100%NPK+S40+ Zn7.5 (47.00). The lowest value (22.32) was still shown by the Control (T_1). The Control (T_1) treatment showed the slowest growth (43.61). T_{10} -100%NPK +S30+Zn7.5+Fe5.0+*Azotobacter* +*PSB*+5 ton FYM attained the highest plant growth (101.32) at harvest, which was statistically comparable to T_9 - 100%NPK +S40+Zn5+Fe5.0 (100.12) and T_8-100%NPK+S40+ Zn7.5 (98.97). T_1(Control) showed the lowest plant growth (57.41). Similar result reported by Bhaduri *et al*, (2012) [5], Chandel *et al*, (2014) [6].

3. Number of tiller plant^{-1}

The findings indicate that there were substantial differences in the initial number of tillers per plant among the various treatments. T_{10} (100% NPK + S_{30} + $Zn_{7.5}$ + $Fe_{5.0}$+ Azotobacter + PSB + 5 tonne FYM) had the most tillers, with 11.00 tillers per plant, which is comparable to T_9 -100%NPK +S40+Zn5+Fe5.0 and T_8-100%NPK+S40+ Zn7.5. The control (T_1) had the fewest tillers (5.54). Similar result reported by Choudhary *et al*, (2022) [8], Darjee *et al*, (2023) [9].

Table 1: Effect of integrated nutrients management on plant population (m^{-2})

Treatment Symbol	Treatment Combination	Plant Population (m^{-2})
T1	Control	105.45
T2	100%NPK	106.35
T3	100%NPK +5 ton FYM	107.15
T4	100%NPK +PSB+Azotobacter	107.05
T5	125%NPK +PSB+Azotobacter+5tonFYM	107.00
T6	100%NPK +S30	106.95
T7	100%NPK +Zn7.5	106.70
T8	100%NPK+S40+ Zn7.5	107.35
T9	100%NPK +S40+Zn5+Fe5.0	106.05
T10	100%NPK+S30+Zn7.5+Fe5.0+*Azotobacter* +*PSB*+5 ton FYM	108.10
T11	125%NPK	106.50
	S.E.(m)(±)	0.49
	C.D.(p = 0.05)	NS

Table 2: Effect of integrated nutrients management on plant height at 30, 60, 90 DAS and at harvest stage

Treatment Symbol	Treatment Combination	30 DAS	60 DAS	90 DAS	At harvest
T1	CONTROL	15.30	22.32	43.61	60.71
T2	100%NPK	18.60	37.95	69.51	87.49
T3	100%NPK +5 ton FYM	19.90	40.70	73.04	90.67
T4	100%NPK +PSB+ Azotobacter	19.75	39.76	71.41	89.24
T5	125%NPK +PSB+Azotobacter+5tonFYM	21.10	42.30	74.58	91.76
T6	100%NPK +S30	21.91	44.62	78.92	96.51
T7	100%NPK +Zn7.5	22.29	45.26	79.22	97.73
T8	100%NPK+S40+ Zn7.5	24.23	47.00	82.52	100.13
T9	100%NPK +S40+Zn5+Fe5.0	24.38	47.18	83.59	101.56
T10	100%NPK +S30+Zn7.5+Fe5.0+*Azotobacter* +*PSB*+5 ton FYM	24.75	47.92	84.93	102.79
T11	125%NPK	21.46	43.60	76.75	94.29
	S.Em±	0.27	0.53	0.63	0.52
	C.D.(*P*=0.05)	0.84	1.66	1.99	1.53

Table 3: Effect of integrated nutrients management on number of tillers plant^{-1}

Treatment Symbol	Treatment Combination	Tillers plants^{-1} (Initial)
T1	Control	5.54
T2	100%NPK	5.79
T3	100%NPK +5 ton FYM	7.06
T4	100%NPK +PSB+ Azotobacter	6.71
T5	125%NPK +PSB+Azotobacter+5tonFYM	7.81
T6	100%NPK +S30	8.09
T7	100%NPK +Zn7.5	8.81
T8	100%NPK+S40+ Zn7.5	9.37
T9	100%NPK +S40+Zn5+Fe5.0	10.32
T10	100%NPK +S30+Zn7.5+Fe5.0+*Azotobacter* +*PSB*+5 ton FYM	11.00
T11	125%NPK	7.96
	S.E.(m)(±)	0.13
	C.D.(p = 0.05)	0.36

Conclusion

The study revealed that integrated nutrient management significantly influenced wheat growth parameters. Although plant population showed no significant variation among treatments, the highest count was observed in T10 (100% NPK + S30 + Zn7.5 + Fe5.0 + Azotobacter + PSB + 5 t FYM). Plant height and tiller numbers per plant were significantly improved by enriched nutrient combinations. T10 consistently recorded the highest values across growth stages, followed closely by T9 and T8, indicating the beneficial impact of combining inorganic fertilizers with micronutrients, biofertilizers, and FYM. In contrast, the control (T1) showed the lowest performance, underscoring the importance of integrated nutrient strategies for optimal crop growth.

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