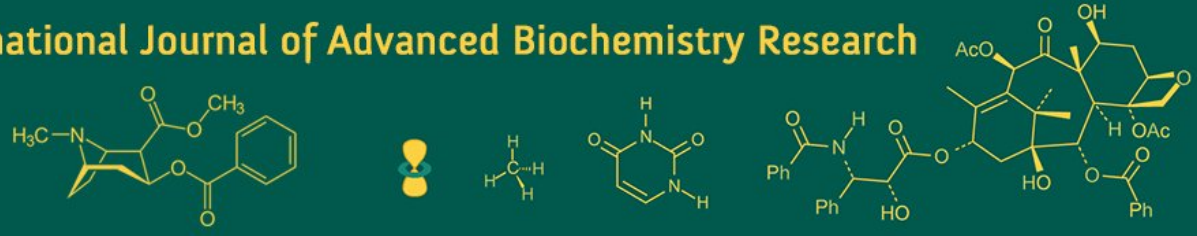
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(11): 114-120
www.biochemjournal.com
Received: 16-08-2025
Accepted: 19-09-2025

Chandrakant Chaubey
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Satendra Kumar
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Anand Kumar Chaubey
Banda University of Agriculture and Technology, Banda, Uttar Pradesh, India

Vaishali Singh
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Sachin Kumar Singh
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Corresponding Author:
Chandrakant Chaubey
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Residual effect of humic acid and inorganic nutrients on growth and yield of succeeding wheat under rice wheat cropping system in western plain zone of U.P.

Chandrakant Chaubey, Satendra Kumar, Anand Kumar Chaubey, Vaishali Singh and Sachin Kumar Singh

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i11Sb.6200

Abstract
Restoring soil fertility in farming systems is essential to sustain crop productivity. Thus, the present study was conducted to assess the residual effect of the combined application of humic acid and inorganic nutrients on growth parameters and yield of wheat under the rice-wheat cropping system in the western plain zone of Uttar Pradesh. The treatments applied in the present study included: T_1: control, T_2: 75% recommended dose of nitrogen (RDN), T_3: 100% RDN, T_4: humic acid (@10 kg ha^{-1}), T_5: humic acid (@20 kg ha^{-1}), T_6: humic acid (@30 kg ha^{-1}), T_7: 75% RDN + humic acid (@10 kg ha^{-1}), T_8: 75% RDN + humic acid (@20 kg ha^{-1}), T_9: 75% RDN + humic acid (@30 kg ha^{-1}), T_{10}: 100% RDN + humic acid (@10 kg ha^{-1}), T_{11}: 100% RDN + humic acid (@20 kg ha^{-1}), T_{12}: 100% RDN + humic acid (@30 kg ha^{-1}). The residual effect of combined humic acid and inorganic nutrient application significantly improved wheat growth parameters and yield attributes. Among the different residual treatments, T_{12} (100% RDN + humic acid @30 kg ha^{-1}) showed the maximum plant height (81.9 cm at 90 DAS), highest tiller count (190 m^{-2} at harvest), and dry matter accumulation (420 g m^{-2} at harvest). Additionally, it recorded the highest grain yield (42.51 q ha^{-1}), straw yield (52.54 q ha^{-1}), and biological yield (95.05 q ha^{-1}). The integrated application of humic acid with 100% recommended nitrogen dose significantly enhanced nutrient uptake and growth, which in turn sustained wheat productivity. Thus, the integrated use of humic acid with recommended doses of inorganic nutrients could be employed to sustain wheat productivity and maintain soil fertility, which often deteriorates under the sole application of chemical fertilizers. This integrated nutrient management approach presents a promising strategy for improving wheat production sustainably under rice-wheat cropping systems in the western plain zone of Uttar Pradesh.

Keywords: Humic acid, inorganic nutrients, residual effect, wheat yield, rice-wheat cropping system, soil fertility, integrated nutrient management, Uttar Pradesh

Introduction
Wheat (*Triticum aestivum* L.) is a major cereal crop globally, serving as a staple food for two-third of the world's population and contributing significantly to nutritional security (Salihi *et al.* 2024; Malik 1985) [16, 11]. In the western plain zone of Uttar Pradesh, the rice-wheat cropping system is a predominant agricultural practice, ensuring food production and farmer livelihoods. However, continuous rice-wheat cultivation has led to challenges such as declining soil fertility, nutrient depletion, and lower wheat yields, largely attributable to soil degradation and improper nutrient management (Dhanda *et al.* 2022; Kuykendall *et al.* 2023) [3, 10]. The excessive use of inorganic fertilizers, while increasing yields, causes environmental concerns through nitrogen losses by volatilization and leaching, urging the adoption of sustainable nutrient management strategies (Kumar *et al.* 2020; Verma and Prasad 2002) [9, 20].

Humic acid, a key organic component of soil matter, improves soil fertility by enhancing nutrient availability, soil structure, and microbial activity which boost plant growth and wheat yield (Ratth *et al.* 2024; Gao *et al.* 2023) [15, 4]. Previous studies have demonstrated that both foliar and soil applications of humic acid significantly increase wheat growth parameters, including shoot length, root development, biomass, and yield attributes (Khan *et al.* 2018; Salihi *et al.* 2024) [11, 16]. The combined use of humic acid with inorganic fertilizers

maximizes nutrient use efficiency, reducing environmental losses while sustaining soil health (Sharma *et al.* 2007) [18]. Moreover, the residual effects of this combined nutrient management positively influence subsequent wheat crops by improving soil nutrient status and promoting growth and yield components (Kumar *et al.* 2015; Kantwa *et al.* 2021) [8, 6]. Thus, evaluating the residual impact of humic acid alongside inorganic nutrients in rice-wheat cropping systems of the western plain zone of U.P. is critical for developing sustainable agronomic practices.

Material and Methods

Site Specification and Meteorological Characteristics

The empirical investigation was executed during the rabi agricultural season of 2023- 2024 at the Crop Research Centre, SVP University of Agriculture and Technology, Meerut, Uttar Pradesh. The experimental site is located at geographical coordinates 29°1'N latitude and 77°41'E longitude, at an elevation approximately 247 meters above mean sea level. The climate of this area is subtropical with a semi-arid nature, characterized by hot summers, a pronounced monsoon season, and cold winters. The average annual precipitation is about 700 to 900 millimeters, predominantly occurring from July to September during the monsoon. Summers witness extreme temperatures often exceeding 40 °C, while winters can drop to around 3 °C at night. The area experiences hot, dry winds known locally as "loo" in summer, with relatively high humidity during the monsoon period. The soil at the experimental site was slightly alkaline with sandy loam texture, typical of the western plain zone of Uttar Pradesh.

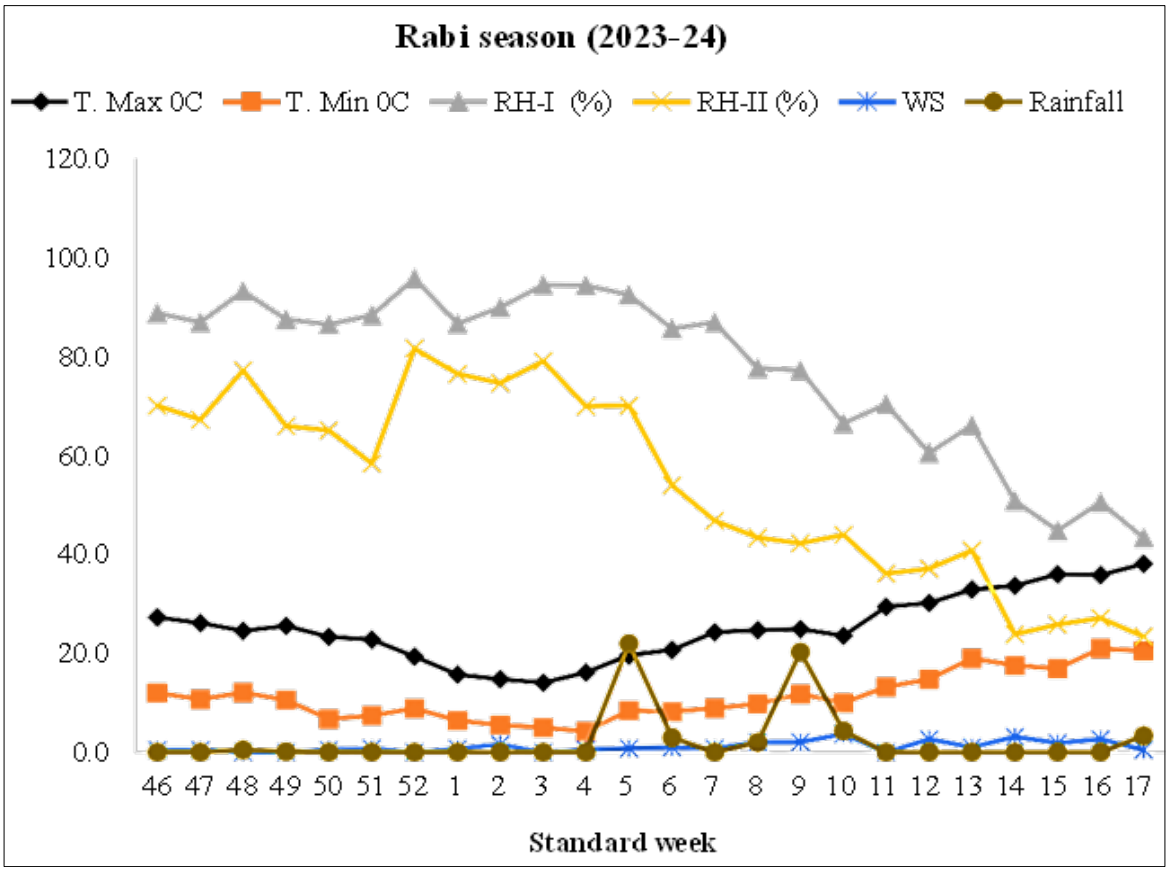


Fig 1: Mean weakly meteorological data during Kharif season 2023-24

Experimental Design and Treatment Details

The experiment was conducted at crop research farm of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut using Randomized Complete Block Design (RCBD) replicated thrice and consisting of twelve treatments as follows: T_1: control, T_2: 75% recommended dose of nitrogen (RDN), T_3: 100% RDN, T_4: humic acid (@10 kg ha^{-1}), T_5: humic acid (@20 kg ha^{-1}), T_6: humic acid (@30 kg ha^{-1}), T_7: 75% RDN + humic acid (@10 kg ha^{-1}), T_8: 75% RDN + humic acid (@20 kg ha^{-1}), T_9: 75% RDN + humic acid (@30 kg ha^{-1}), T_{10}: 100% RDN + humic acid (@10 kg ha^{-1}), T_{11}: 100% RDN + humic acid (@20 kg ha^{-1}), T_{12}: 100% RDN + humic acid (@30 kg ha^{-1}). The Humic acid was added to the soil once a year only before transplanting of basmati rice, and their residual effects was examined on wheat crop. Among the different treatments, only the nitrogen level varied per treatment, however the phosphorus and potassium level was same for all treatments. The sowing of wheat variety DBW 303 was performed in November with a row to row spacing of 15-20 cm and plot size of 5.0 × 4.0 m^2. The wheat crop was sown with a seed-cum-fertilizer drill method at a depth of 4-6 cm. The recommended doses of N (120 kg ha^{-1}), P_2O_5 (60 kg ha^{-1}) and K_2O (40 kg ha^{-1}) were applied to the wheat crop. A half dose of N and full dose of P & K was applied at the time of sowing, whereas the remaining N was divided into two split doses, i.e., at first and second irrigation.

Experimental Methods

Plant height was measured from the ground level to the tip of the tallest leaf or panicle. Five randomly selected plants per replication were measured, and their mean was calculated (cm) at 30, 60, 90 and at harvest stage. The total

number of tillers per plant was counted, and the mean value was computed per treatment. Dry matter accumulation was assessed by harvesting plants from the one-meter row length of each plot at 30, 60, and 90 days after sowing (DAS) and at harvest stage. Samples were oven-dried at 65 ± 5°C until constant weight was achieved, and dry weight was recorded in grams per square meter (g m^{-2}). When the crop reached physiological maturity, it was manually harvested. Grain and straw yield were recorded from a net plot area at harvest. Additionally, the wheat yield was calculated from the net plot area, leaving border rows, and was later changed to q ha^{-1}.

Statistical Analysis

Data were analysed statistically using OPSTAT packages. One-way analysis of variance (ANOVA) was performed in order to assess critical difference (CD) at a probability of 0.05 between the treatment results on the crop.

Results and Discussion

Impact of humic acid and nitrogen levels on growth parameter of wheat

Sole as well as combined use of humic acid and inorganic nutrients exhibited significant effects on various growth parameters of wheat as given in Table 1. The data indicated that plant height ranged from 70.5 cm to 81.9 cm at 90 days after sowing (DAS), and tiller count ranged from 45 to 58 m^{-2} at 30 DAS, increasing to 166 to 190 m^{-2} at harvest. The maximum plant height was observed in treatment T_{12} (100% RDN + humic acid @30 kg ha^{-1}), which was significantly higher (approximately 15.9%) than the control (T_1). The results of T_{12} were statistically on par with treatments T_{10} and T_{11}, indicating the beneficial role of increased humic acid combined with full recommended nitrogen dose in promoting wheat growth. In terms of tiller count, all combined treatments showed significant increases compared to control, with T_{12} exhibiting the highest tiller density at harvest, highlighting the enhanced tillering due to the synergistic effects of humic acid and inorganic nitrogen fertilization. The dry matter accumulation ranged from 150 g m^{-2} in the control (T_1) to 195 g m^{-2} in the treatment receiving 100% RDN + humic acid @30 kg ha^{-1} (T_{12}) at 30 DAS. At 60 DAS, dry matter ranged from 230 g m^{-2} (T_1) to 292 g m^{-2} (T_{12}), while at 90 DAS, it increased from 280 g m^{-2} to 345 g m^{-2} across the same treatments respectively. At harvest, the dry matter accumulation was highest in T12 (420 g m^{-2}) and lowest in the control (310 g m^{-2}). These findings clearly demonstrate the positive residual impact of integrating humic acid with inorganic nutrients in enhancing wheat growth parameters in the rice-wheat cropping system of western Uttar Pradesh. The higher wheat growth and tiller production in treatments receiving combined humic acid and inorganic nitrogen fertilization can be attributed to improved nutrient availability and enhanced physiological processes. Humic acid plays a crucial role in increasing soil organic matter content, which positively influences soil structure and nutrient retention capacity, thereby facilitating better nutrient uptake by plants. This improved nutrient availability, especially nitrogen, is essential for vegetative growth, resulting in increased plant height and tiller numbers (Kandil *et al*., 2024) [5].

Table 1: Effect of humic acid and nitrogen levels on plant height (cm) and tiller count of wheat

Treatment	Plant height (cm)				Tiller count (m^{-2})			
	30 DAS	60 DAS	90 DAS	AH	30 DAS	60 DAS	90 DAS	AH
T_1	15.2	45.3	70.5	92.1	45	95	130	140
T_2	16.5	48.1	75	95.7	50	105	145	160
T_3	17.9	52	79.4	98.9	55	115	160	178
T_4	17.1	50	77	97.5	53	110	150	170
T_5	17.4	51	78.2	98.2	54	112	155	173
T_6	17.6	51.5	78.6	99	54	113	157	175
T_7	17.7	52	79	99.3	55	114	158	178
T_8	17.9	52.5	79.8	100.1	56	115	160	180
T_9	18.1	53	80.4	100.8	56	116	162	183
T_{10}	18.3	53.5	81	101.4	57	117	163	185
T_{11}	18.5	54	81.4	102	58	118	165	187
T_{12}	18.7	54.3	81.9	102.7	58	119	166	190
SEm (±)	0.63	1.04	1.68	1.71	1.79	2.09	2.41	2.79
CD (P=0.05 %)	1.86	3.08	4.96	5.05	5.27	6.18	7.12	8.24

Humic acid also promotes cell division and elongation in the plant meristematic regions, directly contributing to stem elongation and overall plant vigor. The synergistic interaction of humic acid with nitrogen improves the efficiency of nutrient usage, which is reflected in enhanced dry matter accumulation and biomass production (Zhao *et al*., 2024) [21]. Studies have shown that the combined application of organic amendments like humic acid with inorganic fertilizers significantly increases wheat physiological parameters such as plant height, tiller density, and dry matter accumulation, leading to improved yields (Singh *et al*., 2024; Kandil *et al*., 2024) [19, 5].

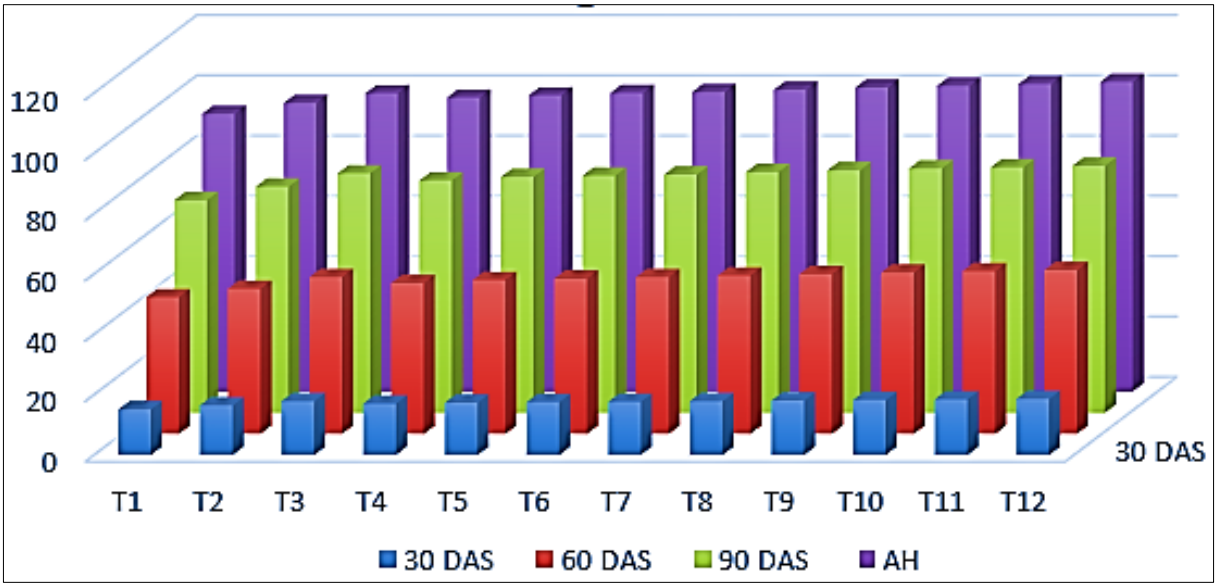


Fig 1: Plant height (cm)

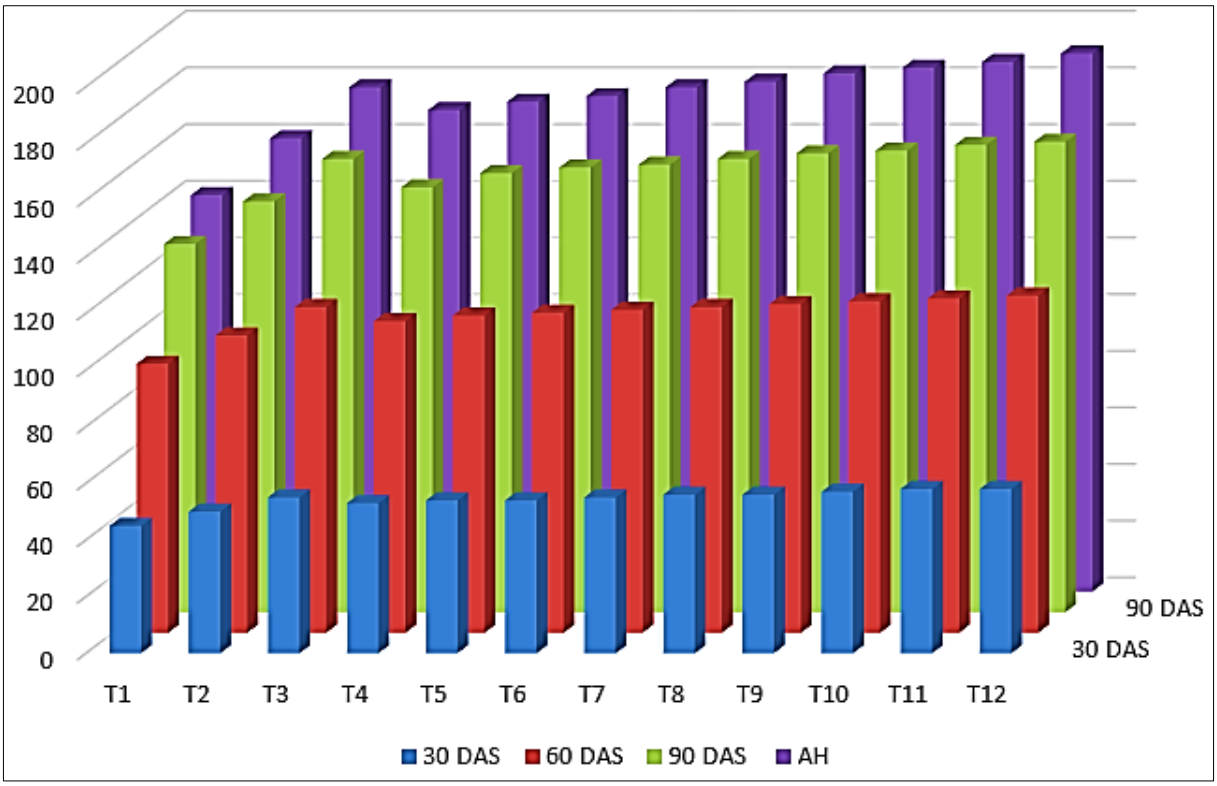


Fig 2: Tiller count (m^{-2})

Moreover, humic substances stimulate root growth by increasing root length, surface area, and root hair density, which enhances water and nutrient absorption (Rahman *et al*., 2024) [13]. This root system enhancement supports the increased growth parameters observed in wheat treated with humic acid along with recommended nitrogen doses.

Impact of humic acid and nitrogen levels on yield of wheat: The effect of humic acid and inorganic nutrients on grain yield, straw yield, and biological yield of wheat was studied, and the results are presented in Table 3. The grain yield varied from 29.41 q ha^{-1} in the control (T_1) to 42.51 q ha^{-1} in the treatment receiving 100% RDN + humic acid @30 kg ha^{-1} (T_{12}), showing a substantial improvement. Similarly, straw yield increased from 38.76 q ha^{-1} to 52.54 q ha^{-1} across the same treatments, while biological yield ranged from 68.17 q ha^{-1} in control to a maximum of 95.05 q ha^{-1} in T_{12}. The integrated use of humic acid with recommended nitrogen doses significantly enhanced the yield parameters compared to control.

Table 2: Effect of humic acid and nitrogen levels on dry matter accumulation and yield of wheat

Treatment	Dry matter accumulation (g m^{-2})				Yield (q ha^{-1})		
	30 DAS	60 DAS	90 DAS	AH	Grain yield	Straw yield	Biological yield
T_1	150	230	280	310	29.41	38.76	68.17
T_2	165	255	300	355	34.23	44.59	78.82
T_3	180	280	330	390	39.08	49.91	89.00
T_4	175	270	315	375	37.55	47.53	85.08
T_5	178	275	320	385	38.51	48.49	86.99
T_6	180	278	325	390	39.04	49.01	88.05
T_7	182	280	330	395	39.54	49.64	89.18
T_8	185	283	335	400	40.53	50.52	91.05
T_9	187	285	336	405	41.02	51.01	92.03
T_{10}	190	288	340	410	41.48	51.59	93.07
T_{11}	193	290	342	415	42.01	52.07	94.08
T_{12}	195	292	345	420	42.51	52.54	95.05
SEm (±)	6.49	9.43	9.57	10.73	0.80	1.26	2.26
CD (P=0.05 %)	19.14	27.83	28.25	31.67	2.35	3.73	6.67

The treatment T_{12} exhibited the highest values for grain, straw, and biological yield, which were significantly greater (approximately 44.6%, 35.5%, and 39.4%, respectively) over the control. Moreover, treatments with combined application of humic acid and inorganic nitrogen fertilizers showed statistically comparable yields with slightly lower humic acid doses such as T_{10} and T_{11}, indicating that the synergistic effect of these inputs boosts wheat productivity effectively. These findings highlight the importance of integrated nutrient management involving humic acid and inorganic fertilization for improving wheat yield under the rice-wheat cropping system in the western plain zone of Uttar Pradesh. The higher grain, straw, and biological yields observed in the treatments combining humic acid and inorganic nutrients can be attributed to several mechanisms enhancing wheat growth and productivity. Humic acid contributes to the improvement of soil physical and chemical properties, including increased water-holding capacity and nutrient retention, which directly influence plant growth by providing a steady supply of essential nutrients such as nitrogen, phosphorus, and potassium (Ampong *et al.*, 2022; Manzoor *et al*., 2014) [02, 12]. The cementing effect of humic substances on soil aggregates leads to better root environment and nutrient uptake efficiency, thereby promoting taller plants and increased tiller production.

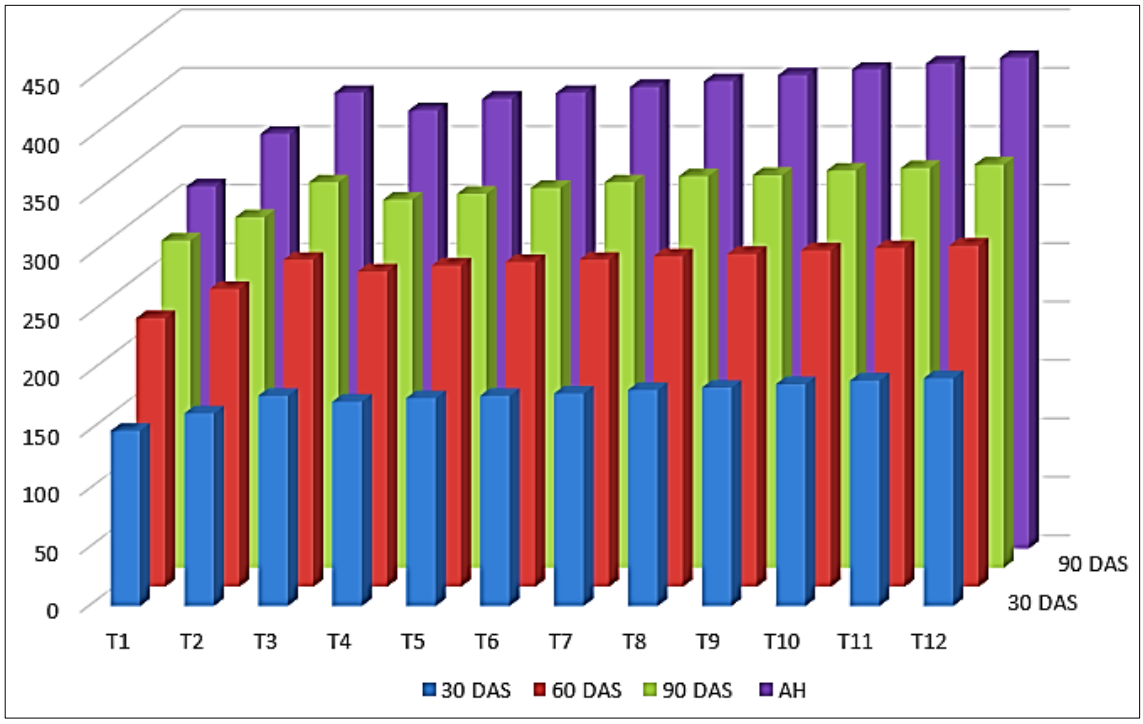


Fig 3: Dry matter accumulation (g m^{-2})

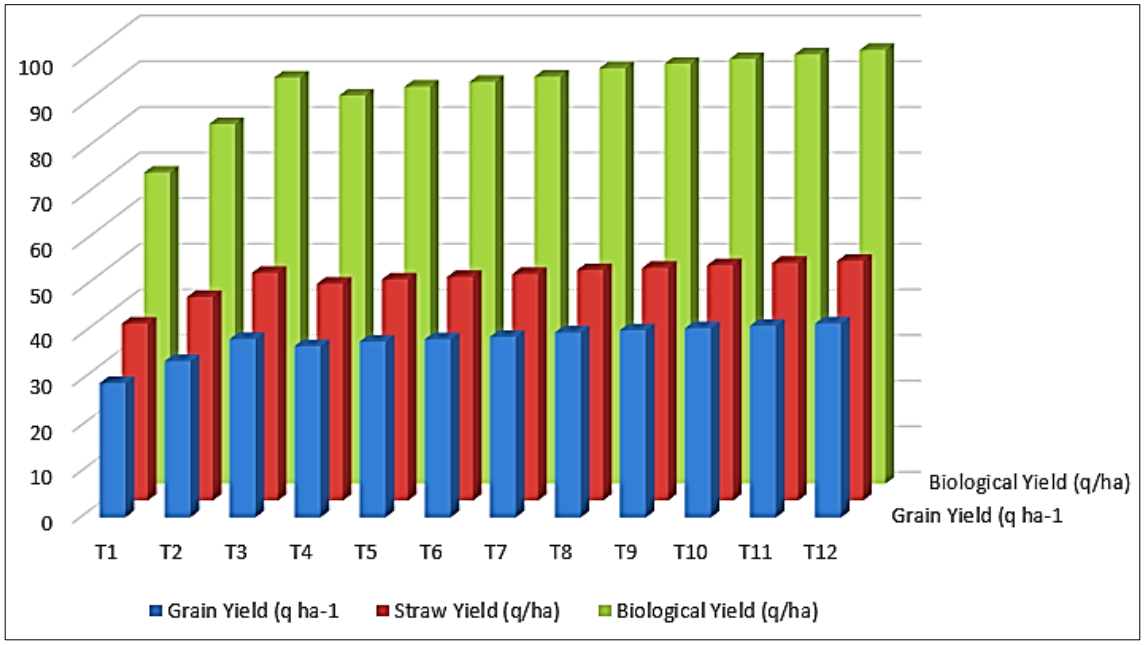


Fig 4: Yield (q ha^{-1})

The synergistic effect of humic acid with inorganic nitrogen fertilizers enhances nutrient availability and uptake, leading to improved chlorophyll synthesis, photosynthetic rates, and biomass accumulation (Ahmed *et al*., 2024) [1]. Humic acids also stimulate the biosynthesis of plant growth hormones like auxins and cytokinins, which regulate cell division and elongation, ultimately contributing to higher grain and straw yields (Rathor *et al*., 2024) [14]. Additionally, the enhanced root morphology induced by humic acid application supports efficient water and nutrient absorption, supporting sustainable yield improvement (Rahman *et al*., 2024) [13].

These findings align with earlier research demonstrating that combined application of organic amendments such as humic acid with inorganic fertilizers results in superior wheat growth and yield attributes compared to individual treatments or control (Singh *et al*., 2024; Zhao *et al*., 2024) [19, 21]. Therefore, integrated nutrient management involving humic acid and inorganic nutrients can be recommended as a sustainable approach to increase wheat productivity in the rice-wheat cropping system of western Uttar Pradesh.

References

1. Ahmed S, Kalhoro SA, Ahmed B, Kubar KA, Narejo MN, Sarfaraz Q, *et al*. Impact of humic acid on the morphological components and growth parameters of wheat (*Triticum aestivum* L.) under dry climate. J Appl Res Plant Sci. 2024;5(2):226-236.
2. Ampong K, Owusu-Sekyere E, Asare S. Understanding the role of humic acids on crop improvement. Front Agron. 2022;4:848621.
3. Dhanda R, Kaur A, Singh P. Soil fertility and productivity issues in rice-wheat cropping system in north India. Front Plant Sci. 2022;13:832683.
4. Gao Y, Zhou X, Huang L. Effects of humic acid on soil fertility and wheat growth. Crop Sci. 2023;63(1):45-58.
5. Kandil FE, El-Khawas S, Ali SM. Impact of humic acid application and nitrogen fertilizer level on wheat growth and productivity. J Plant Nutr. 2024;47(1):101-114.
6. Kantwa S, Singh R, Sharma P. Residual effects of organic and inorganic fertilizers on wheat yield under rice-wheat cropping system. Legume Res. 2021;44(4):350-357.
7. Khan MK, Shahzad M, Hussain S. Humic acid application improves wheat growth and yield under different fertilizer regimens. J Agric Sci. 2018;10(3):151-160.
8. Kumar A, Verma M, Singh P. Residual effect of combined organic and inorganic nutrient sources on wheat yield and soil fertility. Pharma J. 2015;4(1):45-52.
9. Kumar S, Singh R, Kumar A. Environmental impacts of inorganic fertilizer use in cereal production: nitrogen losses and mitigation. Agron J. 2020;112(6):4536-4547.
10. Kuykendall A, Patel R, Mehta V. Challenges in continuous rice-wheat cropping: soil degradation and nutrient depletion. Sci Direct Agric. 2023;5(4):225-234.
11. Malik CP. Plant Physiology: Crop Yield and Soil Conditions. New Delhi: Academic Press; 1985.
12. Manzoor A, Khan EA, Mujtaba B. Humic acid and micronutrient effects on wheat yield and soil fertility. CAB Rev. 2014;9(032):1-15.
13. Rahman MM, Hossain MK, Akter F. Humic acid improves wheat growth by modulating auxin and cytokinin levels and enhancing root development. Plant Physiol Rep. 2024;18(3):388-398.
14. Rathor P, Singh NK, Kumar A. Humic acid improves wheat growth by modulating auxin biosynthesis pathways. Plant Cell Rep. 2024;43(1):112-125.
15. Ratth S, Yadav R, Singh J. Humic acid as a crop growth enhancer: a review. J Plant Growth Regul. 2024;43(2):214-230.
16. Salihi A, Ahmad M, Ali S. Role of humic acid in improving wheat growth and yield: a comprehensive review. J Nat Sci Rev. 2024;8(1):72-83.
17. Sarwar G, Hussain S, Ali Q. Combined use of humic acid and chemical fertilizers improves crop yield and nutrient uptake in wheat. Soil Biol Biochem. 2007;39(3):928-935.
18. Sharma S, Verma D, Tiwari M. Role of organic amendments in improving soil fertility and crop production. Soil Biol Biochem. 2007;39(2):671-680.

19. Singh R, Kumar S, Sharma P. Effects of combined humic acid and inorganic fertilizers on growth and yield of wheat under Indo-Gangetic plains. Agric Sci J. 2024;56(2):215-229.
20. Verma VK, Prasad R. Nitrogen cycle and environmental issues associated with nitrogen fertilizer use. Soil Sci Appl. 2002;38(1):35-47.
21. Zhao L, Chen Q, Liu J. Foliar application of humic acid enhances nitrogen use efficiency and biomass production in wheat. Crop Sci. 2024;64(1):70-79.