

**Effect of Integrated Nutrient Management on growth indices in wheat varieties  
(*Triticumaestivum*L.)**

**ABSTRACT**

A field experiment was carried out at the Research Farm of the Department of Agriculture, Maharishi Markandeshwar University, Mullana, Ambala, during the Rabi season of 2022-2023. The study investigated the effects of integrated nutrient management, combining Hairamine (a protein hydrolysate derived from human hair) and inorganic fertilizers (NPK), on grain yield and related attributes across three wheat varieties. The soil at the site was sandy loam, well-drained, alkaline (pH 7.23), low in nitrogen, medium in phosphorus, and high in potassium, with an electrical conductivity of 0.89 dS/m. Four treatments were tested: T1: Recommended Dose of Fertilizer (RDF), T2: 75% RDF + 25% nutrients from Vermicompost, T3: 75% RDF + Foliar application of Hairamine at 30, 60, and 90 days after sowing (DAS) at 10 ml/l water, T4: 50% RDF + 25% Vermicompost + 3 foliar sprays of Hairamine at 30, 60, and 90 DAS at 10 ml/l water. These treatments were applied to three wheat varieties: "WH 1124," "WH 1105," and "WH 1184," using a factorial randomized block design with three replications. The results showed that T4 (50% RDF + 25% Vermicompost + 3 foliar sprays of Hairamine) produced the highest plant height, number of tillers, and dry matter accumulation, and these results were statistically comparable to those from T2 (75% RDF + 25% Vermicompost). Therefore, incorporating Hairamine as a biostimulant with a reduced fertilizer dose is recommended for sustainable wheat production.

Keywords: Wheat, hairamine, vermicompost, plant height, INM

## INTRODUCTION

Wheat (*Triticum aestivum*) is a crucial staple crop globally, providing 21% of food calories, 20% of protein, and 55% of carbohydrates to over 4.5 billion people. It is cultivated on approximately 215.91 million hectares worldwide, yielding around 765.77 million tons annually (Anonymous, 2023). In Haryana, the area under wheat cultivation for the 2022-23 season was 2,364.14 hectares, with a production of 12 million tons (Kaur et al., 2024).

Wheat varieties vary in their phenology, thermal and photoperiod requirements, and growth habits, which affect their adaptation to different locations and sowing times. Therefore, evaluating varieties suitable for early, normal, and late sowing conditions is essential to identify those with growth patterns, physiological traits, and yield attributes that enhance grain yield and biomass under varying sowing conditions (Nagora et al., 2023). Grain and straw yields in wheat are influenced by both the variety and nutrient availability. To increase production, especially in irrigated regions, higher doses of inorganic fertilizers are often used. However, intensive fertilizer use can lead to environmental issues such as soil fertility degradation, reduced organic matter, decreased water retention, and inefficient nutrient uptake by roots.

Nutrients (N, P, K, and Zn) can be provided through fertilizers, organic manures, biofertilizers, biostimulants, and their combinations under integrated nutrient management (Fazily et al., 2021). Bio-fertilizers, consisting of live microorganisms, help mobilize plant nutrients in the soil. Hairamine, a protein hydrolysate derived from human hair, is a new-generation, highly effective natural organic fertilizer that enhances crop growth, yield, and resistance to various stresses (Mohan et al., 2024). Despite its potential, there is limited information available, and further research is needed. Previous studies have highlighted the benefits of integrated nutrient management (Sharma et al., 2020), but the effectiveness of such management depends on the proportion of inorganic and organic components, such as vermicompost. The present studies aim to explore the feasibility of reducing chemical fertilizer doses without compromising the wheat production potential of various cultivars.

## MATERIALS AND METHODS

A field experiment was carried out during the Rabi season of 2022-23 at the Research Farm of the Department of Agriculture, Maharishi Markandeshwar University, Mullana, Ambala, Haryana. The farm is located at a latitude of 30°17' N, longitude of 77°3' E, and an altitude of 264 meters above sea level. The soil at the experimental site was sandy loam, well-drained, alkaline (pH 7.23), low in nitrogen, medium in phosphorus, and had an electrical conductivity of 0.89 dS/m. The study was designed as a factorial randomized block design with three replications, involving two factors: three wheat varieties (WH 1124, WH 1105, and WH 1184) as Factor A, and four treatments as Factor B. The treatments were: T1: Recommended Dose of Fertilizer (RDF), T2: 75% RDF + 25% nutrients from Vermicompost, T3: 75% RDF + Foliar application of Hairamine at 30, 60, and 90 days after sowing (DAS) at 10 ml/l water. T4: 50% RDF + 25% Vermicompost + 3 foliar sprays of Hairamine at 30, 60, and 90 DAS at 10 ml/l water. Wheat plant height was measured from the base to the tip of the tallest leaf or panicle using a standard meter scale and recorded in centimeters. The number of tillers was counted by placing a ruler randomly between two rows of the crop and recording the tillers along each row on both sides of the ruler. Tillering is primarily influenced by the green photosynthetic area, which contributes to carbohydrate formation, grain filling, and overall grain yield. Dry matter accumulation correlates directly with the number of tillers and plant height. The plots measured 5 m × 1.5 m in gross size and 4.56 m × 1 m in net size, with row spacing of 22 cm and plant-to-plant spacing of 10 cm. Seeds were sown at a rate of 100 kg/ha.

## RESULTS AND DISCUSSION

All investigational data (means) for different plant growth parameters from each treatment were statistically analyzed using analysis of variance (ANOVA) as stated by Panse and Sukhatme (1968). With the guidance of “F” variance ratio test the meaning of treatment effects (at 5%) was evaluated. For separating the effects of treatment from those of chance effects, appropriate typical errors and the critical difference (C.D.) at 5% level of significance were calculated. The salient features of results are presented hereunder:

### 1. PLANT HEIGHT

Plant height is an important attribute of development that provides an idea of predictable biomass and so on crop productivity (Kumar *et al.* 2017). From the observations taken, it was observed that maximum plant height at 30, 60, 90 DAS and at harvest was found in the treatment T<sub>4</sub>: 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water followed by the treatment T<sub>2</sub>: 75% RDF + 25% nutrients from vermicompost respectively (Table 1). Maximum number of tillers was recorded in cultivar WH 1105 and minimum number of tillers was recorded in cultivars WH 1124. Variation in plant height among cultivars might also be probably due to their genetic characters (Pal *et al.* 2021).

### 2. NUMBER OF TILLERS

From the data taken, it was observed that maximum number of tillers at 30, 60, 90 DAS and at harvest was found in the treatment T<sub>4</sub>: 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water followed by the treatment T<sub>2</sub>: 75% RDF + 25% nutrients from vermicompost respectively (Table 2). Maximum number of tillers was recorded in cultivar WH 1105 and minimum number of tillers was recorded in cultivars WH 1124. Variation

in plant height among cultivars might also be probably due to their genetic characters as well as climatic requirement of the different cultivars [9]. The results are corroborated with Bishnoi(2002),Tripathiet.al.(2009)andSandhuet.al.(2018).

### 3. DRY MATTER ACCUMULATION

The data of dry matter accumulation in table 3 indicated that maximum dry matter accumulation at 30, 60, 90 DAS and at harvest was found in the treatment T<sub>4</sub>: 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water followed by the treatment T<sub>2</sub>: 75% RDF + 25% nutrients from vermicompost respectively (Table 3). Maximum dry matter accumulation was recorded in cultivar WH 1105 and minimum dry matter accumulation was recorded in cultivars WH 1124. These findings are similar to Sirohiet. al. (2021). Keshiriet. al.(2003) and Lakshamen (2014) stated that during initial growth stages (30 DAS) of wheat crop, poor dry accumulation could be due to poor development of photosynthetic area, which peaks at flowering stage in cereals and then decreases due to mutual shading of the non-photosynthetic tissue (Keshiriet.al.2003)(LakshmanK.P.2014).

**Table 1. Effect of Integrated Nutrient Management on plant height (cm)**

Treatments	30 DAS	60 DAS	90 DAS	At Harvest
<b>T1: RDF (Recommended dose of fertilizer)</b>	<b>12.25</b>	<b>42.51</b>	<b>92.57</b>	<b>95.18</b>
<b>T2: 75% RDF + 25% nutrients from Vermicompost</b>	<b>14.87</b>	<b>45.07</b>	<b>94.07</b>	<b>97.01</b>
<b>T3: 75% RDF + Foliar application of Hairamine at 30, 60, 90 DAS @ 10 ml/l water</b>	<b>14.30</b>	<b>44.24</b>	<b>93.62</b>	<b>96.29</b>
<b>T4: 50% RDF + 25% Vermicompost + 3 foliar spray of hairamine at 30, 60 and 90 DAS @ 10 ml/l water</b>	<b>16.86</b>	<b>47.13</b>	<b>96.81</b>	<b>99.24</b>
<b>S.Em±</b>	<b>0.421</b>	<b>0.645</b>	<b>0.382</b>	<b>0.501</b>
<b>CD (5%)</b>	<b>1.242</b>	<b>1.322</b>	<b>1.218</b>	<b>1.303</b>
<b>Varieties</b>				
<b>V1-1124</b>	<b>15.59</b>	<b>44.06</b>	<b>87.20</b>	<b>95.54</b>
<b>V2-1105</b>	<b>18.45</b>	<b>45.72</b>	<b>99.60</b>	<b>97.88</b>
<b>V3-1184</b>	<b>16.92</b>	<b>44.42</b>	<b>96.01</b>	<b>97.36</b>
<b>S.Em±</b>	<b>0.364</b>	<b>0.582</b>	<b>0.369</b>	<b>0.445</b>
<b>CD (5%)</b>	<b>1.075</b>	<b>1.110</b>	<b>1.028</b>	<b>1.089</b>

**Table2. Effect of Integrated Nutrient Management on number of tillers m<sup>-2</sup>**

Treatments	30 DAS	60 DAS	90 DAS	At Harvest
<b>T1: RDF (Recommended dose of fertilizer)</b>	<b>190.45</b>	<b>313.34</b>	<b>362.01</b>	<b>359.29</b>
<b>T2: 75% RDF + 25% nutrients from Vermicompost</b>	<b>226.94</b>	<b>352.48</b>	<b>379.04</b>	<b>376.75</b>
<b>T3: 75% RDF + Foliar application of Hairamine at 30, 60, 90 DAS @ 10ml/l water</b>	<b>214.42</b>	<b>328.77</b>	<b>371.24</b>	<b>369.52</b>
<b>T4: 50% RDF + 25% Vermicompost + 3 foliar spray of hairamine at 30, 60 and 90 DAS @ 10ml/l water</b>	<b>238.16</b>	<b>370.09</b>	<b>387.55</b>	<b>385.19</b>
<b>S.Em±</b>	<b>0.589</b>	<b>0.624</b>	<b>0.435</b>	<b>0.528</b>
<b>CD (5%)</b>	<b>1.326</b>	<b>1.384</b>	<b>1.219</b>	<b>1.309</b>
<b>V1-1124</b>	<b>216.34</b>	<b>331.71</b>	<b>360.95</b>	<b>357.09</b>
<b>V2-1105</b>	<b>219.48</b>	<b>346.26</b>	<b>399.81</b>	<b>397.74</b>
<b>V3-1184</b>	<b>216.65</b>	<b>345.54</b>	<b>383.61</b>	<b>380.48</b>
<b>S.Em±</b>	<b>0.462</b>	<b>0.518</b>	<b>0.371</b>	<b>0.487</b>
<b>CD (5%)</b>	<b>1.149</b>	<b>1.189</b>	<b>1.072</b>	<b>1.163</b>

**Table3. Effect of Integrated Nutrient Management on Dry matter accumulation (g) per meter row length**

Treatments	30 DAS	60 DAS	90 DAS	At Harvest
<b>T1: RDF (Recommended dose of fertilizer)</b>	<b>38.57</b>	<b>329.76</b>	<b>688.32</b>	<b>861.49</b>
<b>T2: 75% RDF + 25% nutrients from Vermicompost</b>	<b>41.20</b>	<b>342.08</b>	<b>709.34</b>	<b>873.46</b>

<b>T3:75%RDF+FoliarapplicationofHairamineat 30,60,90DAS@10ml/lwater</b>	<b>39.14</b>	<b>335.72</b>	<b>693.05</b>	<b>866.21</b>
<b>T4:50%RDF+25%Vermicompost+3foliar sprays of hairamineat30,60and90DAS@10 ml/lwater</b>	<b>42.16</b>	<b>344.45</b>	<b>712.64</b>	<b>877.49</b>
<b>S.Em±</b>	<b>0.345</b>	<b>0.589</b>	<b>0.611</b>	<b>0.515</b>
<b>CD (5%)</b>	<b>1.332</b>	<b>1.274</b>	<b>1.321</b>	<b>1.264</b>
<b>Varieties</b>				
<b>V1-1124</b>	<b>39.08</b>	<b>327.87</b>	<b>695.32</b>	<b>859.82</b>
<b>V2-1105</b>	<b>41.77</b>	<b>342.52</b>	<b>707.09</b>	<b>870.73</b>
<b>V3-1184</b>	<b>39.95</b>	<b>339.61</b>	<b>702.60</b>	<b>867.43</b>
<b>S.Em±</b>	<b>0.282</b>	<b>0.476</b>	<b>0.524</b>	<b>0.432</b>
<b>CD (5%)</b>	<b>1.158</b>	<b>1.051</b>	<b>1.172</b>	<b>1.089</b>

### Conclusion

The study concludes that the treatment of 50% RDF + 25% vermicompost + three foliar sprays of Hairamine at 30, 60, and 90 days after sowing (DAS) at 10 ml/l water yielded the highest growth parameters. This was followed by the treatment of 75% RDF + 25% nutrients from vermicompost (T2). Among the wheat varieties, WH-1105 demonstrated the best performance, while WH-1184 showed the lowest growth parameters. These findings suggest that Hairamine acts as an effective biostimulant, enhancing plant growth across all wheat varieties by positively influencing photosynthesis and other metabolic processes. Furthermore, integrated nutrient management combining mineral fertilizers, vermicompost, and Hairamine proves to be significantly more effective than using mineral fertilizers alone.

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