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

ABSTRACT

A field experiment was conducted at the Research farm of the Department of Agriculture, Maharishi Markandeshwar University, Mullana, Ambala during Rabi season of 2022-2023. Response of three wheat varieties to integrated nutrient management involving Hairamine (protein hydrolysate from human hair) and inorganic fertilizers (NPK) for grain yield and its attributes was studied in a field experiment. The soil 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 d/Sm. Four treatments including T_1: RDF (Recommended dose of fertilizer), T_2: 75% RDF + 25% nutrients from Vermicompost, T_3: 75% RDF + Foliar application of Hairamine at 30, 60 and 90 DAS @ 10 ml/l water and T_4: 50%RDF + 25% Vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water were evaluated in three wheat varieties “WH 1124”, “WH 1105” and “WH 1184” in factorial randomized block design with three replications. The treatment, T4: 50%RDF + 25% Vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water, exhibited highest plant height, number of tillers and dry matter accumulation which was statistically at par with the treatment T_2: 75% RDF + 25% nutrients from Vermicompost. Therefore, use of Hairamine as biostimulant with reduced fertilizer dose is recommended for sustainable wheat production.

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

INTRODUCTION

Wheat (*Triticum aestivum*) is one of the most important staple food crops in the world, as it provides 21% of the food calories, 20% of the protein and 55% of the carbohydrates in the dish to more than 4.5 billion people worldwide. Globally, wheat is cultivated in around 215.91 million hectares with an annual production of around 765.77 million tons (Anonymous, 2023). The area under wheat cultivation in Haryana (2022-23) is 2364.14 ha with the production of 12 mt (Kaur *et. al*. 2024).

Wheat varieties differ in their phenology, requirement of thermal and photoperiod units and growth habits which cumulatively determine the varietal adaptation at different locations and sowing times. Therefore, comparative evaluation of varieties suitable for early, normal and late sown conditions is warranted to identify the growth patterns, physiological traits and yield attributes that will favorably influence the grain yield and biomass in wheat under normal and late sown conditions (Nagora *et. al*. 2023). The grain and straw yield in wheat is determined by the genotype of the varieties and the supply of nutrients. To achieve higher grain and straw production for food and feed purposes higher doses of inorganic fertilizers are being used especially in irrigated wheat production regions. Intensive use of chemical fertilizers has manifold environmental impacts including degradation of soil fertility, organic matter absorption, decreased water holding capacity, nutrient mobilization and up taken by root. The nutrients (N, P, K and Zn) can be supplied through fertilizers, organic manures, biofertilizers, biostimulants and their combined applications under integrated nutrient management (Fazily *et. al*. 2021). Bio-fertilizers are live microorganisms with the ability to mobilize plant nutrients in the soil. Hairamine, a protein hydrolysate obtained from human hair is a new generation, highly effective natural organic fertilizer that promotes growth, yield and enhances the resistance to biotic and abiotic stress of many crops (Mohan *et. al*. 2024). However, the available information is scanty and more studies are needed. Several workers have reported beneficial effects of integrated nutrient management (Sharma *et. al*. 2020). However, the efficacy of integrated nutrient management depends upon the proportion of each component of inorganic (fertilizers for macro and micro-nutrients) and organic sources like vermicompost. Present studies were

conducted to explore the possibilities of reducing some doses of chemical fertilizers without compromising wheat production potential of different cultivars.

MATERIALS AND METHODS

A field experiment was conducted during the *Rabi* season (2022-23) at Research Farm of Department of Agriculture, Maharishi Markandeshwsar University, Mullana, Ambala (Haryana) is situated at 30°17'0" N latitude, 77°3'0" E longitude and at an altitude of 264 meters above mean sea level. The soil of experimental site was sandy loam in texture, well-drained, had an alkaline reactivity (pH 7.23), low in nitrogen, medium in phosphorus, with a conductivity of 0.89 d/Sm.

The experiment was conducted in factorial randomized block design with three replications and two factors comprising three wheat varieties WH 1124, WH 1105 and WH 1184 (Factor A) and four treatments including T_1 : RDF (Recommended dose of fertilizer), T_2: 75% RDF + 25% nutrients from Vermicompost, T_3 : 75% RDF + Foliar application of Hairamine at 30, 60 and 90 DAS @ 10 ml/l water and T_4 : 50%RDF + 25% Vermicompost + 3 foliar spray of hairamine at 30, 60 and 90 DAS @ 10 ml/l water (Factor B). Plant height of wheat was measured from the base of the plant at ground surface to the tip of the tallest leaf/panicle using a standard meter scale and was expressed in cm. The number of tillers was counted by using a ruler; place it at random between two rows of crop. Count and record the number of tillers along each row on both sides of the ruler. Tillering mainly depends upon the green photosynthetic area which is responsible for carbohydrate formation, grain filling and final grain yield. Dry matter accumulation is directly proportional to number of tillers and plant height.

The gross and net size of the plots was 5 m × 1.5 m and 4.56 × 1 m respectively with a row spacing of 22 cm and plant to plant spacing of 10cm. Seeds were sown at the 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 here under:

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_4: 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water followed by the treatment T_2: 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_4: 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water followed by the treatment T_2: 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), Tripathi *et. al*. (2009) and Sandhu *et. 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_4: 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water followed by the treatment T_2: 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 Sirohi *et. al*. (2021). Keshiri *et. 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 (Keshiri *et. al*. 2003) (Lakshman K.P. 2014).

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

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

Table 2. Effect of Integrated Nutrient Management on number of tillers m^{-2}

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

Table 3. Effect of Integrated Nutrient Management on Dry matter accumulation (g) per meter row length

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

T3: 75% RDF + Foliar application of Hairamine at 30, 60, 90 DAS @ 10 ml/l water	**39.14**	**335.72**	**693.05**	**866.21**
T4: 50% RDF + 25% Vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water	**42.16**	**344.45**	**712.64**	**877.49**
S.Em ±	**0.345**	**0.589**	**0.611**	**0.515**
C D (5%)	**1.332**	**1.274**	**1.321**	**1.264**
Varieties				
V1-1124	**39.08**	**327.87**	**695.32**	**859.82**
V2-1105	**41.77**	**342.52**	**707.09**	**870.73**
V3-1184	**39.95**	**339.61**	**702.60**	**867.43**
S.Em ±	**0.282**	**0.476**	**0.524**	**0.432**
C D (5%)	**1.158**	**1.051**	**1.172**	**1.089**

CONCLUSION

From the present study, it can be concluded that application of 50% RDF + 25% vermicompost + 3 foliar sprays of hairamine at 30, 60 and 90 DAS @ 10 ml/l water gave higher results in terms of growth parameters followed by the application of T2: 75% RDF + 25% nutrients from vermicompost whereas, in the case of wheat varieties, WH-1105 performed best and the minimum growth parameters were recorded from WH-1184 respectively. These results indicate that Hairamine is a potential biostimulant which promotes plant growth traits in all wheat varieties due to its effect on photosynthesis and other plant metabolic activities. Also, integrated nutrient management including mineral fertilizer vermicompost and Hairamine is far superior to the mineral fertilization alone.

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