

Effect of Hairamine and fertilizer application on grain yield and its attributes in wheat (*Triticum aestivum* L.) varieties

Comment [JM1]: Any wrong in spelling?. Hair amin or hairamine? Is it best to put hairamine or Hair-amine. May need to put hyphen.

Abstract

A field experiment was conducted at the Research farm of the Department of Agriculture, Maharishi Markandeshwar University, Mullana, Ambala during Rabi season of 2021. Response of three wheat (*Triticum aestivum* L.) varieties to integrated nutrient management involving Hairamine (protein hydrolyzate 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. Eight treatments comprising a control and seven combination application of Hairamine, *Azotobacter* and recommended dose of inorganic fertilizers were evaluated in three wheat varieties "DBW 222", "HD 2967" and "PBW 723" in a randomized block design (RBD) with three replication. The T₇ treatment, 75% recommended N,P,K dose throughout synthetic fertilizers and appropriate dose of Hairamine foliar spray, exhibited highest grain yield, biological yield and harvest index. This treatment was shown to be statistically comparable to T₆ (50% recommended N, P, K dose throughout synthetic fertilizers and appropriate dose of Hairamine Foliar spray). This increase in yield was reflected in higher expression of yield attribute in traits namely (ears per running meter row length, spikelets per ear, grains per ear, 1000 grain weight, grain yield, straw yield, biological yield and harvest index). Therefore use of Hairamine as bio-stimulant with reduced fertilizer doses is recommended for sustainable wheat production.

Comment [JM2]: Authors to verify is this is protein hydrolyzate or hydrolysate?

Comment [JM3]: Under USDA what is the classification of soil? If you do not have USDA, what is local classification of the soil?

Comment [JM4]: Is this a random block design experiment or 2 factorial experiment. There are 2 factors involved in the experiment. The first one is fertilizer treatment and second factor is varieties of wheat. Need a statistical factorial analysis. The spelling of azotobacter is wrong. Authors to search it. Three replication or replications? Grammatical error to correct it.

Overall abstract can reduced further.

Key words:- Wheat, Hairamine, *Azotobacter*, RDF

Comment [JM5]: Difficult to say the effect of fertilizer gave the high yield. What about the wheat varieties?

Comment [JM6]: Wrong spelling.

Comment [JM7]: What is RDF?

Introduction

Wheat (*Triticum aestivum* L.) 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. Compared to other cereals, wheat grains have greater protein content (12%) and a fairly high niacin and thiamine content (Singh *et al.*, 2019).

Globally, wheat occupies about 216.18 million hectares of land producing 763.6 million metric tonnes grain yield with an average yield of 3530 kg ha⁻¹ (USDA Report. 2020). India ranks 2nd in wheat production covering 29.32 million ha producing 103.6 million metric tonnes, with an average productivity of 3530 kg ha⁻¹.

Comment [JM8]: Authors to verify whether 3530 kg per ha of India's production same as world production? Any reference for it?

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 reasons. Intensive use of chemical fertilizers has manifold environmental impacts including degradation of soil fertility, organic matter absorption, decreased water holding capacity, nutrient mobilization and uptake by root as reported by (Xiao *et al.*, 2019). Shortage of arable land, limited water and nutrient resources necessitates increase in resource use efficiency without sacrificing production through effective use of modern technologies (Manonmani and Srimathi 2009). Bio-fertilizers are live microorganisms with the ability to mobilize plant nutrients in the soil (Klopper *et al.*, 1989). Hairamine a protein hydrolyzate 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 (Dhargalkar and Pereira 2005). Keeping in facts is view a present studies were conducted to explore the possibilities of reducing some doses of chemical fertilizers without compromising wheat production potential of different cultivars.

Comment [JM9]: Statements in Introduction to be provided with sufficient references.

Material and methods

A field experiment was conducted during the winter (*rabi*) season of 2021-2022 at research farm of Department of Agriculture, Maharishi Markandeshwar (~~Deemed to be University~~), Mullana, Ambala, Haryana is situated at 30^o17'0"N latitude, 77^o3'0"E longitude and at an altitude of 264 meters above mean sea level. The soil of experimental field's 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 replication and two factors comprising three wheat varieties DBW222, HD2967, PBW723 (Factor A) and eight treatments including T₁ Control (no fertilizer), T₂ (50% recommended N, P, K dose throughout synthetic fertilizers), T₃ (50% recommended N,P,K dose through synthetic fertilizers and seed treated with *Azotobacter*), T₄ (75% recommended N,P,K dose throughout synthetic fertilizers and seed treated with *Azotobacter*), T₅ (100% recommended N,P,K dose throughout synthetic fertilizers), T₆ (50% recommended N, P, K dose through

Comment [JM10]: Grammatical error.

Comment [JM11]: Objective appeared to be vague. Not strong enough on subject matter. Need to rewrite with stronger emphasis on the objective of the work.

Comment [JM12]: To delete

Comment [JM13]: The abstract sentence to be removed and write it in Materials and Method. However, it is pity that the research farm has not identify the soil type of the experimental farm.

Comment [JM14]: The authors to indicate total how many plots? Is the varieties too replicated in 3 plots. Design of experiment was not clearly briefed.

Comment [JM15]: For all fertilizer doses when was applied? Urea when and at what rates, P when and what rates? K when and what rates? Is there a split application of each nutrients?

Comment [JM16]: Spelling wrong *Azotobacter*. Authors have to correct this in entire text. Is this *azotobacter* cultured by the authors or purchased from somewhere? If cultured themselves please write the methodology. If purchased how did authors verify the culture purchased is *azotobacter*? The authors may put the verification method of *azotobacter* in methodology. Or else how sure they are the product is the right one?

Comment [JM17]: Muriate of potash is not a synthetic fertilizer. It is a mined fertilizer.

synthetic fertilizers and appropriate dose of Hairamine Foliar spray), T₇ (75% recommended N,P,K dose through synthetic fertilizers and appropriate dose of Hairamine foliar spray) (Factor B) The recommended dose of fertilizer was applied as 150 kg ha⁻¹ Nitrogen (N) through urea + DAP, 60 kg ha⁻¹ Phosphorus (P) through DAP and 60 kg ha⁻¹ Potassium (K) through MOP. Hairamine was applied as foliar spray twice (4ml Hairamine per liter water). *Azotobacter* was applied through seed bacterization before sowing at the rate of CFU 10⁹ The mean data recorded on five randomly selected plants from each treatment for different characters (ears per running meter row length, spikelets per ear, grains per ear, 1000 grain weight, grain yield, straw yield, biological yield and harvest index) was statistically analyze for analysis of variance and critical differences among treatments was calculated to compare treatment means.

Comment [JM18]: This hairamine foliar spray extracted or purchased by authors? Is there a lab methodology to extract the hairamine. If there is please describe in the methodology

Comment [JM19]: To improve English sentence.

Comment [JM20]: Sprayed twice? How? At what month of growth stage of wheat? How did the authors spray? Spray volume per hectare? The overall methodology appeared to be dicey.

Comment [JM21]: This must be factorial analysis.

Result and Discussion

The mean data for different characters was used for analysis of variance as described by Panse and Sukhatme 1968. The salient features of results are presented here under:

Effect on varieties (Factor A)

Among three different wheat varieties DBW 222 performed best for all parameters, yield attributes like number of ears per running meter row length (66.23) (Table 1), spikelets per ear (21.10) (Table 2), grains per ear (39.55) (Table 3) and 1000 grain weight (42.42 g) (Table 4). Yield parameters like Grain yield (43.93 q ha⁻¹) (Table 5), Straw Yield (58.70 q ha⁻¹) (Table 6), Biological Yield (102.63 q ha⁻¹) (Table 7) and Harvest Index (42.65 %) (Table 8).

Comment [JM22]: How do you measure it. Explain in materials and methodology

Comment [JM23]: All these measurement how is being carried out must explain in materials and methodology. Readers must understand it.

Comment [JM24]: What is biological yield? Define. This must be explain in materials and methodology

Comment [JM25]: How do you measure it? Put the formula in the text. Must have detailed in the materials and methodology

Effect on treatments (Factor B)

Different yield attributes of wheat were significantly enhanced by treatments of integrated nutrient management 50% RDF and 50% RDF with *Azotobacter*, 75% RDF with *azotobacter*, 100 % RDF, 50% RDF with Hairamine Spray and 75 % RDF with Hairamine spray resulted in significantly higher number of ears per running meter row length, spikelets per ear, grains per ear and 1000 grain weight over the control. Number of ears per running meter row length of wheat was significantly enhanced by application of 75 % RDF with Hairamine spray over the control. 75% RDF and Hairamine spray significantly increased the number of ears per running meter row length (72.07) (Table 1), spikelets per ear (26.33) (Table 2), grains per ear (45.29) (Table 3) and

1000 grain weight (45.42 g) (Table 4) and found superior to rest of the treatments. These finding were similar to Jafarzadeh *et al.*, 2013.

Table 1: Effect on various treatments of fertilizers and organic manures in wheat varieties on ears per running meter row length

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	55.32	54.43	55.23	54.99
T ₂	50% RDF	62.33	61.37	62.17	61.95
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	65.23	64.37	65.17	64.92
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	67.84	66.53	67.33	67.23
T ₅	100% RDF	69.56	68.67	69.47	69.23
T ₆	50% RDF and Hairamin spray	70.68	69.51	70.31	70.14
T ₇	75% RDF and Hairamin spray	72.67	71.33	72.13	72.07
	Varieties means over treatments	66.23	65.17	65.97	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		2.09		1.04	0.74
Variety		1.09		0.55	0.39
Interaction		3.62		1.81	1.28

Comment [JM26]: What is the real spelling of hairamin? Some places it was written hairamine

Comment [JM27]: What is C.D? Is this critical difference? Where it is written? At least for Table 1 write critical difference (C.D) or put as foot note below the table.

Comment [JM28]: What is SE (d) ? What is RDF?

Comment [JM29]: What is SEm+/- As said earlier if authors are using short forms SE first say at least in Table 1 standard error (SE). At least use foot note for expanded version of the abbreviated form

Table 2: Effect on various treatments of fertilizers and organic manures in wheat varieties on spikelets per ear

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	15.23	14.32	15.11	14.88
T ₂	50% RDF	19.93	18.93	19.33	19.39
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	20.73	19.53	20.43	20.23
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	20.93	19.13	20.33	20.13
T ₅	100% RDF	21.73	20.73	21.43	21.29
T ₆	50% RDF and Hairamin spray	22.43	21.83	22.23	22.16
T ₇	75% RDF and Hairamin spray	26.73	25.93	26.35	26.33
	Varieties means over treatments	21.10	20.05	20.74	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		3.19		0.59	1.06
Variety		0.62		0.31	0.22
Interaction		4.06		1.03	1.35

Comment [JM30]: For all the tables authors to incorporate a complete Analysis of variance table with sources of variation for replications, varieties of wheat, type of fertilizer treatments and interaction values of treatments and response to varieties, degree of freedom, sum of squares, mean square calculated and theoretical F values, in addition to CD, SE etc.,

Table 3: Effect on various treatments of fertilizers and organic manures in wheat varieties on number of grains per ear

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	33.86	32.62	33.62	33.36
T ₂	50% RDF	36.28	35.91	36.16	36.11
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	38.98	37.52	38.22	38.24
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	39.51	38.51	39.64	39.22
T ₅	100% RDF	40.77	39.09	40.95	40.27
T ₆	50% RDF and Hairamin spray	41.84	40.93	41.94	41.57
T ₇	75% RDF and Hairamin spray	45.62	44.64	45.62	45.29
	Varieties means over treatments	39.55	38.46	39.45	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		3.43		1.72	1.21
Variety		1.79		0.90	0.63
Interaction		5.95		2.97	2.10

Table 4: Effect on various treatments of fertilizers and organic manures in wheat varieties on 1000 grains weight (g)

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	37.45	36.57	37.36	37.12
T ₂	50% RDF	40.82	39.38	40.24	40.14
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	41.52	40.39	41.04	40.98
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	42.84	41.46	42.77	42.35
T ₅	100% RDF	43.45	42.58	43.28	43.10
T ₆	50% RDF and Hairamin spray	44.98	43.68	44.67	44.44
T ₇	75% RDF and Hairamin spray	45.88	44.66	45.72	45.42
	Varieties means over treatments	42.42	41.24	42.15	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		3.00		1.50	1.06
Variety		1.57		0.78	0.55
Interaction		5.19		2.59	1.83

Effect on Yield

The highest grain yield and straw yield was obtained by application of 75% RDF and Hairamine spray which remained at par with 50% RDF and Hairamine spray recorded a significant increase

of 102.2, 104.7 and 107.4 % in grain (Table 5) and 102.7, 104.9 and 105.9 % in straw (Table 6) over control, respectively. Integrated nutrient management with 75% RDF and Hairamine spray significantly increased biological yield (109.45q ha⁻¹) and harvest index (43.15%). Grain yield increased significantly as a result of enhanced growth, which resulted to an improvement in the various yield attributes described above. This is in agreement with the findings of Neelam *et al.*, 2013.

Comment [JM31]: What is "q" Is this quintal? Some part of the text expressed yield in kg per hectare (Introduction). Standardise the unit of expression. If use "q" in the text it must quintal (q) for the first time. Thereafter can express with "q"

Comment [JM32]: What experiment Neelam et al., 2013 studied? Is it same hair amine or azotobacter?

Comment [JM33]: q/ha/cultivation?

Table 5: Effect on various treatments of fertilizers and organic manures in wheat varieties on grain yield q/ha

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	35.57	34.97	35.07	35.20
T ₂	50% RDF	42.89	40.76	42.25	41.96
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	43.98	42.77	43.07	43.27
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	44.68	43.32	44.02	44.00
T ₅	100% RDF	45.77	44.06	45.67	45.16
T ₆	50% RDF and Hairamin spray	46.91	45.68	46.21	46.26
T ₇	75% RDF and Hairamin spray	47.75	46.48	47.02	47.29
	Varieties means over treatments	43.93	42.57	43.33	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		1.83		0.91	0.65
Variety		0.96		0.48	0.34
Interaction		3.17		1.58	1.12

Table 6: Effect on various treatments of fertilizers and organic manures in wheat varieties on straw yield q/ha

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	51.98	50.3	51.47	51.25
T ₂	50% RDF	57.53	56.34	57.29	57.05
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	58.31	57.10	58.40	57.93
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	59.91	58.65	59.35	59.30
T ₅	100% RDF	59.78	58.46	59.01	59.08
T ₆	50% RDF and Hairamin spray	60.84	59.53	60.54	60.30
T ₇	75% RDF and Hairamin spray	62.56	61.31	62.35	62.07
	Varieties means over treatments	58.70	57.38	58.34	
Factors		C.D.(p=0.05)		SE(d)	SEm ±

Nutrient source	1.34	0.67	0.44
Variety	0.85	0.42	0.28
Interaction	2.57	1.28	0.85

Table 7: Effect on various treatments of fertilizers and organic manures in wheat varieties on biological yield q/ha

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	87.55	85.27	86.54	86.45
T ₂	50%RDF	100.42	97.10	99.54	99.02
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	102.29	99.87	101.47	101.21
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	104.59	101.97	103.37	103.31
T ₅	100% RDF	105.55	102.52	104.68	104.25
T ₆	50% RDF and Hairamin spray	107.75	105.21	106.75	106.57
T ₇	75% RDF and Hairamin spray	110.31	107.79	109.37	109.45
	Varieties means over treatments	102.63	99.96	101.67	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		3.66		1.83	1.29
variety		1.91		0.96	0.68
Interaction		6.34		3.17	2.24

Table 8: Effect on various treatments of fertilizers and organic manures in wheat varieties on harvest index (%)

		DBW222	HD2967	PBW723	Treatment means over varieties
T ₁	Control	41.29	40.07	41.19	40.85
T ₂	50%RDF	42.62	40.86	41.36	41.61
T ₃	50% RDF and Seed treated with <i>Azotobacter</i>	42.31	41.17	41.76	41.74
T ₄	75% RDF and seed treated with <i>Azotobacter</i>	42.18	41.27	41.97	41.80
T ₅	100% RDF	43.32	42.12	42.64	42.69
T ₆	50% RDF and Hairamine spray	43.34	42.36	42.78	42.82
T ₇	75% RDF and Hairamine spray	43.51	42.72	43.22	43.15
	Varieties means over treatments	42.65	41.51	42.13	
Factors		C.D.(p=0.05)		SE(d)	SEm ±
Nutrient source		0.25		0.13	0.09
variety		0.13		0.07	0.05
Interaction		0.43		0.22	0.15

Discussion

Crop yield is influenced by genetic potential and management techniques used. The use of appropriate management methods is essential in order to fully use a variety's genetic potential. Crop production and quality can be significantly reduced as a result of nutritional deficiencies. For greater output, the correct amount of natural biological nutrients found in the soil and fertilizer are required. The various nutrient treatment exhibited positive significant effect on expression of various traits like number of ears per running meter row length, spikelets per ear, grains per ear, 1000 grain weight, grain yield, straw yield, biological yield and harvest index. This may be because of favourable root system or higher input use efficiency and better plant growth and sink source relationship resulting in higher grain yield and biomass in recently bred wheat varieties used in present studies. Such results have also been reported (Mishra and Singh, 2020). The plant's sink capacity primarily depends on its vegetative and reproductive growth, which is favourably impacted by the application of Bio stimulants such as Hairamine and bio-fertilizer, such as *azotobacter* as well as the availability of photosynthates for the synthesis of yield components. Similar result was also advocated by (Tarafdar *et al.*, 2013). Application of 100% NPK added with spray of nano Zn and Bio-stimulant increased straw yield by 2.6 q ha⁻¹ (3.6%) and 1.7 q ha⁻¹ (2.3%) over 100% NPK respectively. Choudhary *et al.*, (2017) and Kaur *et al.*, (2018) also observed similar results in wheat.

Conclusion

Based on the study, it was concluded that variety DBW 222 figured to be highest performing variety for grain yield (43.93 q ha⁻¹), straw yield (58.70 q ha⁻¹), biological yield (102.63 q ha⁻¹) and harvest index (42.65 %). In treatments the highest grain yield (47.29 q ha⁻¹) straw yield (62.07 q ha⁻¹), Biological yield (109.45 q ha⁻¹) and Harvest index (43.15 %) were obtained with the application of 75% recommended dose of fertilizer and Hairamine spray. Thus it is evident from our studies that 25% dose of inorganic fertilizers can be reduced by two foliar application of Hairamine which is rich in organic carbon (18-20%), organic nitrogen (6-8%), calcium (2%), and amides and amino acids. The Hairamine application is eco-friendly and may have positive impact on soil health by increasing soil organic carbon content. Inclusion of bio-stimulant in integrated nutrient management strategies would therefore be useful for sustainable wheat production system.

Comment [JM34]: Overall discussion is poorly written. References (Tarafdar 2013) work can be explained in more detail. The responses of Hair amine on yield to explain in more detail. Why the yields in T6 and T7 are higher than rest of the treatments need an explanation. The study area any variation of soils? Overall interactions with varieties, what is the authors recommendation. Can maintained yield with hair amine with 50% fertilizer?

References

- Dhargalkar VK and Pereira N. Seaweed promising plant of the millennium. *Science and Culture*. 2005; **71**: 60-66.
- Jafarzadeh R, Jami M. and Hokmabadi M. Response of yield and yield components in wheat to soil and foliar application of Nano Potassium fertilizer. *Journal of crop production research, Environmental stresses in Plant Sciences*. 2013; **5**(2): 189-197.
- Klopper JW, Lifshitz R. and Zablutowicz RM. Free-living bacterial inocula for enhancing crop productivity. *Trends in Biotechnology*. 1989; **7**(2):39-44
- Mishra CN. and Singh GP. DBW222 (Karan Narendra): A new high- yielding, lodging-tolerant wheat variety for North Western plains of India. *Crop Breed. Appl. Biotechnology*. 2020; **20** (3) <https://doi.org/10.1590/1984-70332020v20n3c41>.
- Manonmani V. and Srimathi P. Influence of mother crop nutrition on seed and quality of balckgram. *Madras Agriculture Journal*. 2009; **96** (16): 125-128.
- Neelam, Nanwal RK. and Kumar P. Productivity and quality of mungbean-wheat cropping system as influenced by organic and inorganic sources of nutrients in semi-arid environment. *Research on crops*. 2013; **14**(3):786-791.
- Singh A, Kumar N., Shahi UP, Pandey BR, Kumar P., Singh PD. and Singh RP. Evaluation of Customized Fertilizers in Respect to Yield, Soil Nutrients Status, Uptake and Economics of Wheat (*Triticum aestivum* L.) under Eastern Uttar Pradesh. *International Journal of Current Microbiology and Applied Sciences*. 2019; **8**(3): 883-894.
- Tarafdar JC, Sharma S. and Raliya R. Nano-technology: Interdisciplinary science of applications. *African Journal of Biotechnology*. 2013; **12**(3): 219- 226.
- USDA Report. 2020. pp: 11-12
- Xiao G., Zhao Z., Liang L., Meng FWW. and Guo Y. Improving nitrogen and water use efficiency in a wheat-maize rotation system in the North China Plain using optimized farming practices. *Agricultural Water Management*. 2019; **2**(12):172–180.

UNDER PEER REVIEW

