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

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, *Azotobecter* 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 T_7 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 T_6 (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.

Key words:- Wheat, Hairamine, *Azotobecter*, 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 2^{nd} in wheat production covering 29.32 million ha producing 103.6 million metric tonnes, with an average productivity of 3530 kg ha^{-1}.

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 (Kloepper *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.

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 $30^0$17'0"N latitude, $77^0$3'0"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 T_1 Control (no fertilizer),T_2 (50% recommended N, P, K dose throughout synthetic fertilizers), T_3 (50% recommended N,P,K dose through synthetic fertilizers and seed treated with *Azotobecter*), T_4 (75% recommended N,P,K dose throughout synthetic fertilizers and seed treated with *Azotobecter*), T_5 (100% recommended N,P,K dose throughout synthetic fertilizers), T_6 (50% recommended N, P, K dose through synthetic fertilizers and appropriate dose of Hairamine Foliar spray), T_7 (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). *Azotobecter* was applied through seed bacterization before sowing at the rate of CFU 10^9 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.

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).

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 *Azotobecter*, 75% RDF with *azotobecter*, 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 *Azotobecter*	65.23	64.37	65.17	64.92
T_4	75% RDF and seed treated with *Azotobecter*	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

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 *Azotobecter*	20.73	19.53	20.43	20.23
T_4	75% RDF and seed treated with *Azotobecter*	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

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 *Azotobecter*	38.98	37.52	38.22	38.24
T_4	75% RDF and seed treated with *Azotobecter*	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 *Azotobecter*	41.52	40.39	41.04	40.98
T_4	75% RDF and seed treated with *Azotobecter*	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.

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 *Azotobecter*	43.98	42.77	43.07	43.27
T_4	75% RDF and seed treated with *Azotobecter*	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 *Azotobecter*	58.31	57.10	58.40	57.93
T_4	75% RDF and seed treated with *Azotobecter*	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 *Azotobecter*	102.29	99.87	101.47	101.21
T_4	75% RDF and seed treated with *Azotobecter*	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 *Azotobecter*	42.31	41.17	41.76	41.74
T_4	75% RDF and seed treated with *Azotobecter*	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 *azotobecter* 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.

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