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Genetic Variability among Winter Cereal Genotypes for Response to Protein Hydrolysate (PH) for Grain Yield and Its Attributes

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ABSTRACT

A field experiment-based study was conducted using 19 different varieties of cereal crops i.e. eight of wheat (black wheat, WH1105, WH1142, HD2967, WH1124, DBW88, WH1025, WH1080), seven of triticale (TL3003, TL3002, TL3001, TL3004, TL2942, TL3005, TL2969 and four of barley (BH885, BH902, BH946, BH393) in research facility at agriculture farms of Jagan Nath University, Bahadurgarh, Jhajjar during Rabi 2020-21. The physiological and agronomical parameters were analyzed in three cereal crops wheat, triticale and barley using a waste human hair (amino acids hydrolysate developed by protein hydrolysis techniques). The test plot given the treatment of foliar spray having approximately 8% (v/v) nitrogen and 8-10% (w/v) carbon diluted 5ml/l with water after seed germination of 40 days followed by three sprays after interval of 25 days. The comparison of control and test showed increase in height of wheat (2.9±0.25%), triticale (3.5±0.45%), and barley (2.2±0.22%). The increase in spike length observed in wheat (2.01±0.6%), triticale (1.73±0.17%), and barley (2.9±0.27%). The overall production of plots increased as in wheat (11.9±0.86%), triticale (12.14±0.86%), and barley (12.8±0.29%) comparison to control plot. This analysis from this study concludes that the foliar application of protein hydrolysate shows significant results on the plant height, spike length and yield of crops. The accumulation of protein hydrolysate varies among cereal genotypes. This type of protein hydrolysate having short peptide and free amino acids are accumulated directly by plants and enhance the growth and maintained plants health. The application can be an alternative of chemical-based fertilizers and reduce the environment pollution.

Keywords: Amino acid, human hair "waste" hydrolysate, cereals, wheat, triticale, barley

Introduction

Wheat is a major crop in India and considered as second-largest producer of wheat in the world. As per the trends of last few seasons reduced production need to be focused to tackle the problem. In recent years the production is reported to be above 100 million tones, but not sufficient to feed ever growing population of India. Recent year 2021-2022 the estimated production was 105 million tones which was 5.7% less than the previous few years. The fall in wheat production has compelled the government of India to pose ban on export of the wheat. Besides, the government also failed in procurement of wheat due to issue related (MSP) Minimum Support Price (Vasudeva and Munjal, 2022).

The challenging environment and deteriorating soil health conditions are held responsible for the reduction in sustainable wheat crop production. The northern states Punjab, Haryana and Uttar Pradesh provide largest count of wheat in India. But the increased temperature in March caused the reduction in production of crops during last season. Even after the wheat season continues rise in temperature affect the overall health and production of different other crops like cotton deteriorating the fruit development. It's time to think about heat tolerance in wheat crops to understand the cause of reduced production. The onset of heat waves during March season may in crops plants.

Triticale is considered to be more nutritive than wheat with the ability to stand against the events of biotic and abiotic stress. In India triticale is grown in lower Himalayan regions. The triticale is developed by crossing between wheat and rye with advantages of both crops. Its acceptance at global level has made superior to wheat due to its quality of being tolerant to adverse conditions like drought and ability to flourish well in less fertile soil. It is also popular worldwide and grown in the European region. As wheat production is decreasing the adoption of triticale can resolve low production problems. Inputs of bio-based fertilizers can enhance the production as well as the nutritional values of the grains.

Barley crop is a major part of winter crops in India, and it is also considered as a major source of animal feedstock. The biotic and abiotic stresses are continuously decreasing production of barley. The use of amino acid-based protein hydrolysate has impacted physiology of plants through various biochemical pathways improvement (Mostafa et al., 2014). The amino acids based biostimulants improve soil health and enhance tolerance to abiotic and biotic stress (Calvo et al., 2014), as well as enhance maturation of leaves and roots (Popko et al., 2018). The plant-based protein hydrolysate biostimulants show enhancement in seed germination and productivity of many agronomic (Kumar et al., 2021) and horticultural crops (Colla et al., 2017).

In the present study, the protein hydrolysate formulated from human hair waste and experimented on 19 varieties of wheat, triticale and barley. Application of amino acids-based formulations showed an increase in plant growth, spike length and overall yield. Human hair waste is of no use in industries, and it is not degraded or broken down by microorganisms. This causes soil pollution and remains undegraded for so many years. Human hair is a rich source of amino acids, and these amino acids can directly support the growth of plants. The current scenario of fertilizers not supporting enough growth so it's time to change focus on alternative sophisticated methods that contribute directly to overall growth and health of plants. The formulation prepared by hydrolysis of human hair which converts complex protein into smaller peptides and free amino acids molecules. This formulation is applied as a biofertilizer in wheat, triticale, and barley varieties to analyze the impact on growth and health of crops. After harvesting and studying different parameters of plant growth, it was observed that this formulation has a significant effect on overall production of crops.

Materials and Methods

Investigations were undertaken using 19 different varieties of cereals crops: with eight varieties of bread wheat (black wheat, WH1105, WH1142, HD2967, WH1124, DBW88, WH1025, WH1080), seven varieties of winter triticale (TL3003, TL3002, TL3001, TL3004, TL2942, TL3005, TL2969 and four varieties of barley one is two-rowed BH885 and three are six-rowed BH902, BH946, BH393) at agriculture farms of Jagan Nath University, Bahadurgarh, Haryana. The study was carried out as an approved package of practice of wheat by the Department of Agriculture, Haryana. The agronomic and biological parameters were analyzed on wheat, triticale, and barley crops. The 19 varieties were sown in randomized complete block design in three replication and two plots for each genotype were assigned including one for control (no foliar spray) and one for treatment. In the control plot, all normal practice followed and in treatment with normal practice of foliar spray of protein hydrolysate formulation at the rate of 5 ml/1 ltr was carried out. Each plot was 2m x 2m in size accommodating 120 plants. The farm was situated at a height of 214 meters above mean sea level at 28.38°N, 76.45°E, and its average summer temperature was about 38°C, and its average winter temperature is around 12°C. In June, the temperature soars to 43°C. The soil was sandy loam alluvial. The experiment investigation varies crop wise on the basis of crops sowing and harvesting seasons because each crop have a different response to environment conditions.

According to ICAR, the Department of Agriculture in Haryana State adhered to the approved package of practices for growing wheat, and the agronomic and biological parameters of the cereal crops grown on a single acre were examined. One deep ploughing and a total of two to three harrowing's were used to prepare the ground. The seeds were sown at a rate of 100 kg per hectare in the month of November with row to row spacing 15 cm, plant to plant spacing 10 cm, and the sowing depth was approximately 4-5 cm. The fertilizer dosages were 150 kg of nitrogen, 80 kg of phosphorus, 60 kg of potash, and 12 kg of zinc sulfate per hectare. Applied 1/3 of the nitrogen fertilizer along with the full doses of phosphate and potash at the time of sowing; the remaining nitrogen was supplied evenly after the first and second irrigations.

After 21 days of sowing, the first irrigation was carried out, followed by additional irrigation as per the need of crop. At 27–35 day after sowing, Clodinafop Propargyl 15% WP (400 g/ha) was used to control weeds. Using two sprays as a tank mix at the first node and flag leaf stages: chlormequat chloride (Lihocin) at 0.2% + tebuconazole (Folicur® 430 SC) at 0.1% of commercial product dose foliar spray was used as the primary treatment and control in a randomized plot design experiment.

In this experiment, the liquid formulation was obtained from human hair waste (amino acids) hydrolysate trademark "Plant Force Advance" from FloritechOrgano Industries, Nagpur, was evaluated for effectiveness on cereal plant growth sprayed after 25 days of seed germination. The test plots received a foliar spray of a liquid formulation with approximately 8% (v/v) nitrogen that was diluted to 1:200 with water. This was followed by three additional sprays, each after 30-day interval. Five randomly chosen plants were taken from the treatment and control groups at harvest time (in the month of mid-April) to record observations on the plant height, spike length, and overall yield parameters (total grains weight and yield of experiment plot). The Duncan multiple range test was used to statistically assess the results.

Result and Discussion

The height of a wheat plant is considered an important parameter, but it varies based on type of variety. The plant height is measured by normal ruler scale at fully grown stage (end of month March) with grains. The plant height was compared to control and significant amounts of increase were observed in plants treated with protein hydrolysate formulation. The comparison of control plot wheat (75.69 cm), triticale (83.97 cm), and barley (66.65 cm) and treated plot showed an increase in height wheat (2.9±0.25%), triticale (3.5±0.45%), and barley (2.2±0.22%) mentioned in Table 1. The increase in height proved that chlorophyll content also increased and by the help of biochemical energy the uptake of biostimulant formulation supports the growth. in various studies investigated the overall impact of protein hydrolysate in both controlled and open field condition showed the enhancement in root and shoot development, enhanced production and others crops productivity like tomato, passion fruit, pepper, papaya, and corn (Halpern et al., 2015; Colla et al., 2014, 2015, 2017; Nardi et al., 2016). Protein hydrolysate prepared from alfalfa and it's foliar spray on pepper had shown an increase in number of fruits as well as the amount of secondary metabolites (Ertani et al., 2014). In another study on lettuce, foliar application of plant-based protein hydrolysate demonstrated increase in salinity tolerance and concentration of nitrogen, phosphorus in leaves (Lucini et al., 2015). The amino acids (protein hydrolysate) formulation possesses amino acids with low molecular weight short peptides that are rich in a source of nitrogen and nitrogen is one of the major macro elements required for plant growth and metabolism (Subbarao et al., 2015). The availability of nitrogen from free amino acids as reduced source of nitrogen supports the overall growth and health of plants. Protein hydrolysate also possess hormone like activity that supports in seed germination to fruit maturation (Yadav et al., 2020)

The maximum increase of spike length was observed in wheat (2.01±0.6%), triticale (1.73±0.17%), and barley (2.9±0.27%) as compared to control plot wheat (8.91 cm), triticale (8.08 cm), and barley (6.75 cm) mentioned in Table -2. The spike length also varies depending on the variety of wheat, triticale and barley crops. In the experiment, an increase of spike length proved the uptake of biostimulants in the formation of fruits parts of plants. The increase in spike length of wheat determines the total yield of wheat crops. The significant amount of yield increased was noticed in wheat (11.9±0.86%), triticale (12.14±0.86%), and barley (12.8±0.29%) as compared to control plot in wheat (10.25 kg), triticale (10.39 kg), and barley (13.82 kg) mentioned in Table 3.

The human hair waste-based protein hydrolysate containsshort chain peptides and free amino acids that can be used as new range of biofertilizers. Eearlier also nitrogen is considered as the most important factor in biofertilizers that determines the growth of plants but recent trends the amino acid-based fertilizers are catching attention due to high uptake of amino acids by plant metabolic processes at molecular levels and amino acids also provide reduced nitrogen to plants (Teixeira et al., 2018).

Conclusions

To increase the production of any crop various techniques are available. In recent times genetic editing is in trend to increase production and nutritional value of crops but genetic modification is still not sure for the stability of crops, and it may cause threat to food security so, its required scientific evidence-based exploration of crop at molecular levels. The alternative of genetic editing biofertilizers is a very convenient source of enhancing production but due to disturbance in the environment like heat waves these biofertilizers do not provide effective results. The protein hydrolysate technique is now catching the attention due to their uptake of molecular level and solution to increasing the salon waste that naturally is not degraded in soil. Human hair is rich in amino acids and in this study, we got excellent results of bio stimulant foliar prepared from the human hair waste. The protein hydrolysate can be an alternative of biofertilizers and also maintains overall plant health that leads to maturation of plants in abiotic and biotic stress. This study can conclude that bio stimulants based on protein hydrolysate technology are beneficial in terms of increase in growth, nutrient uptake and in minimization of chemical-based growth promoters. The application of protein hydrolysate in soil during cultivation and irrigation needs to be explored and studied the impact of soil health and microbiome of soil.

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Table 1. Comparison of plant height in both control and test plots of three crops wheat, triticale, and barley.

		Plant Height (cm)		
Line No.	**Crops**	**Variety**	**Control**	**Treatment**
1	Wheat	Black Wheat	71.7±1.33	73.9±1.69
2		WH 1105	73.4±1.96	75.7±0.31
3		WH 1142	79.2±0.40	81.3±0.40
4		HD2967	77.3±1.40	79.9±0.76
5		WH 1124	74.5±1.41	76.8±1.13
6		DBW88	74.9±1.20	77.1±1.39
7		WH1025	75.2±0.90	77.8±1.30
8		WH1080	78.6±0.90	81.1±1.60
9	Triticale	TL3003	80.9±1.15	83.8±1.30
10		TL3002	80.9±0.50	83.9±0.94
11		TL3001	83.4±1.13	86.5±0.49
12		TL3004	80.5±0.52	83.5±0.98
13		TL2942	86.6±1.50	90.1±0.85
14		TL3005	86.4±0.41	89.9±0.75
15		TL2969	88.2±0.70	91.8±0.64
16	Barley	BH885	63.9±0.94	65.2±0.52
17		BH902	75.5±0.83	77.2±1.13
18		BH946	69.1±0.52	70.8±1.91
19		BH393	57.9±1.30	59.4±1.31

Table 2. Comparison of plant spike length in both control and test plots of three crops wheat, triticale, and barley.

Spike Length (cm)				
Line No.	**Crops**	**Variety**	**Control**	**Treatment**
1	Wheat	Black Wheat	6.4±0.28	7.9±0.91
2		WH 1105	6.8±0.49	9.6±0.44
3		WH 1142	8.4±0.61	9.6±0.46
4		HD2967	7.3±0.54	9.3±0.22
5		WH1124	6.2±0.31	8.2±0.45
6		DBW88	8.3±1.07	9.6±0.80
7		WH1025	7.2±1.21	9.7±0.15
8		WH1080	7.3±0.44	8.8±0.29
9	Triticale	TL3003	7.3±0.15	8.5±0.73
10		TL3002	6.6±0.09	8.1±0.32
11		TL3001	6.5±0.45	7.8±0.55
12		TL3004	7.1±0.55	8.8±0.68
13		TL2942	7.1±0.41	8.6±0.26
14		TL3005	6.6±0.55	8.2±0.37
15		TL2969	6.1±0.34	7.5±0.63
16	Barley	BH885	5.0±0.32	6.9±0.29
17		BH902	4.7±0.28	7.1±0.22
18		BH946	4.9±0.18	6.7±0.15
19		BH393	5.1±0.47	7.1±0.15

Table 3. Comparison of total yield in both control and test plots of three crops wheat, triticale, and barley.

Plot Yield (kg)				
Line No.	**Crops**	**Variety**	**Control**	**Treatment**
1	Wheat	Black Wheat	17.57±0.46	20.27±0.77
2		WH1105	7.58±1.36	8.61±1.40
3		WH1142	10.21±2.86	11.73±2.06
4		HD2967	8.59±0.98	9.79±2.05
5		WH1124	11.17±2.69	12.57±1.49
6		DBW88	8.66±1.45	9.76±2.21
7		WH1025	5.67±2.35	6.37±2.04
8		WH1080	12.22±1.69	13.92±1.33
9	Triticale	TL3003	9.62±1.26	11.02±1.27
10		TL3002	13.37±0.96	15.37±1.59
11		TL3001	15.24±2.55	17.54±1.69
12		TL3004	7.55±1.77	9.65±2.39
13		TL2942	9.39±2.84	10.69±2.56
14		TL3005	8.33±1.37	9.43±1.69
15		TL2969	8.08±2.13	9.08±1.31
16	Barley	BH885	11.13±2.35	12.73±2.27
17		BH902	14.99±1.35	17.19±1.67
18		BH946	11.38±1.86	13.08±1.23
19		BH393	17.71±1.20	20.41±1.28

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