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Efficacy of Protein Hydrolysate (Plant Force Advance) Based Formulation on Cotton Yield

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ABSTRACT

A field experiment was conducted using Bt. hybrid cotton (var. RS2013) in Sri Ganganagar district of Rajasthan during Kharif 2017. The agronomic and biological parameters were studied in the cotton crop grown using protein hydrolysate (Plant Force Advance) from waste human hair. The test plots were given the foliar spray of liquid formulation (having approx. 8% (v/v) nitrogen and diluted 1:200 with water) after 25 days of seed germination followed by three consecutive sprays after interval of 30 days. The comparisons of means showed increase in height of the treated plants by 20.46%, enhancement in the chlorophyll content of plant leaves by 16.32%, increase in weight of balls per plant by 19.21% as well as 14.32% reduction in immature ball formation per plant as compared to control and the total yield showed an increase of 13.63%. The study concluded that the foliar application of protein hydrolysate along with recommended package of practices in Bt. hybrid cotton have promising results on the yield and growth of cotton under the field conditions.

Keywords**:** Bt. hybrid cotton, protein hydrolysate, amino acid-based bio-fertilizer.

Introduction

Cotton is the most important fibre crop of India and has the largest area under cotton cultivation in the world. Bt. hybrids constitute 87 per cent worldwide with increased yield of 8-10% till the release of Bollgard II (Sudha et al. 2011). The present hybrids though high yielding but are susceptible to pests like boll worms and number of viral infestations transmitted by the whitefly. Currently it is grown over 6 per cent of the net sown area and the coverage under Bt. hybrids in India is almost saturated and further improvement in cotton yield is not possible (Rao and Alapati, 2007) and presently the agronomists and cotton breeders are suggesting an alternative strategy to optimize cotton productivity by reducing production costs. The availability of most suitable cultivars, more efficient options of weed, pest and disease management to modify morpho physiological frame, planting/harvesting tools has rekindled an interest in developing new types of fertilizer and exploring novel application patterns to ensure high fertilizer-use efficiency.

The increased crop production largely relies on the type of fertilizers used to supplement essential nutrients for plants, which has also led to over exploitation of chemical fertilizers and emerging environmental issues. So, there is a dire need to switch to natural biological based organic inputs as an alternative to agro-chemicals and the search to explore the cheap waste materials as new resources. Amino acid-based bio-fertilizers are gaining the high input in agricultural market because the formulation of amino acid bio-fertilizers are cheaper than the chemical fertilizers. Amino acids are fundamental

ingredients in the process of protein synthesis and studies have proved that amino acids can directly or indirectly influence the physiological activities of the plant (Mostafa et al. 2014). The amino acid-based bio-fertilizers also act as bio-stimulant and were reported to promote plant growth by increasing the nutrient uptake efficiency of plant; tolerance to bear the biotic and abiotic stress; improve soil quality (Calvo et al. 2014); stimulate the development of roots and leaves (Popko et al. 2018). This approach has led to utilization of human hairs to produce a liquid amino acid-based bio-fertilizer that is very useful for every crop and do not cause single hazard to environment.

Materials and Methods

The experiment was carried out using Bt. hybrid cotton (var. RS2013) in the Research Farm of Surender Kaur Memorial Agricultural College, Padampur, Sri Ganganagar district of Rajasthan during Kharif 2017. The farm is geographically situated at an altitude of 165 m above mean sea level at 29.70°N latitude 73.62°E longitude and average temperature in summer reaches around 41°C and in winter around 26°C. The temperature shots up to 50°C in June. The average annual rainfall is only 200 mm per annum and the soil was sandy loam. The approved package of practices of cotton for Rajasthan State, Department of Agriculture was followed and the agronomic and biological parameters were studied in the cotton crop grown in one acre. The land preparation was done with one deep ploughing followed by 2-3 harrows. Sowing was done in the month of June and seed rate was 16.0 kg/ha. In sowing method, the row to row spacing is 67.5 cm, plant to plant spacing is 30 cm and sowing depth was about 4-5 cm. The thinning was done 25-30 DAS to maintain plant to plant distance of 30 cm. The fertilizers used were Nitrogen 80 kg/ha, Phosphorus 40 kg/ha and Potash 20 kg/ha and $ZnSO_4$ 12 kg/ha. The experiment was carried out in randomized plot design with foliar spray as main treatment and control. The liquid formulation "Plant Force Advance" of Floritech Organo Industries, Nagpur was tested for its efficacy in the experiment. The test plots were given the foliar spray of liquid formulation (having approx. 8% (v/v) nitrogen and diluted 1:200 with water) 25 days after germination of the seeds followed by three more sprays each after the interval of 30 days. The colorimetric estimation of chlorophyll content in leaves at various stages of growth i.e square stage, flowering and boll initiation was performed by the method of Arnon (1949).

At harvest stage, the five randomly selected plants were taken from the treatment and control separately to record the observations on yield parameters in terms of seed yield plant^{-1}, boll weight and immature boll formation (%), the number of bolls per plant. The results were statistically analysed using Duncan's multiple range test.

Results and Discussion

The efficacy of protein hydrolysate (Plant Force Advance) formulation on yield and growth parameters of Bt. hybrid cotton (var. RS2013) was investigated under field conditions. Plant height is an important morphological character in cotton which provides seat for nodes and internodes from where monopodial and sympodial branches emerge and thus play an important role in determining morphological framework relating to productivity (Eaton 1955). Plant height was recorded at 40, 60 and 90 DAS representing square, flower and boll initiation stages of the crop. Height of plants treated with foliar spray of protein hydrolysate was found significantly higher than the control plants. The comparisons of means showed increase in height of the treated plants by 20.46% at all the three stages as compared to control (Table 1). Chlorophyll is the pigment primarily responsible for photosynthesis. It absorbs energy from sunlight and helps converts it into chemical energy during the light dependent reactions of photosynthesis. Chlorophyll determines the photosynthetic capacity and influence the rate of photosynthesis, dry matter product and yield (Gitelson 2003). The enhancement in the chlorophyll content of plant leaves treated with foliar spray of protein hydrolysate was found by 16.32% as compared to control (Table 1). The results suggested that the protein hydrolysate contains free amino acids and low molecular weight short peptides, which act as organic nitrogen source used for synthesis of macromolecules like chlorophyll (Subbarao et al. 2015).

The results showed that maximum boll weight was 2.42 g as compared to control plot. The increase in weight of balls per plant was 19.21% as well as 14.32% reduction in immature ball formation per plant in protein hydrolysate treated plants as compared to control. The overall total yield showed an increase of 13.63% in the test plot over the control (Table 2).

Several experimental studies testing the action of protein hydrolysate under both open-field and controlled conditions, have demonstrated that they stimulate shoot and root biomass, resulting in increased productivity of several crops such as corn, kiwifruit, lettuce, lily, papaya, passion fruit, pepper and tomato (Schiavon et al. 2008; Ertani et al. 2009; Colla et al. 2014, 2015, 2017; Halpern et al. 2015; Nardi et al. 2016). Foliar application of animal and

plant-derived protein hydrolysate has also been shown to promote the vegetative growth and yield of several fruit trees (Colla et al. 2015).

In the present study the foliar application of plant force represents a new range of biofertilizers obtained from human hairs as hydrolysate having short chain amino acids along with other peptides can easily assimilated by plant tissues. From earlier studies it is evident that a nitrogen nutrition enhances both plant growth as well as development due to improved overall metabolism and nutrient supply (Laghari et al. 2016). This innovative product possesses high amount of organic nitrogen and hence may be important element of organic agriculture. The application of protein hydrolysate stimulated an auxin like activity due to the presence of tryptophan and some peptides and could be of practical interest for promoting the growth of plants and their great efficacy in enhancing crop performances. The foliar and root applications of protein hydrolysate could exhibit hormone-like activities (specifically auxin and gibberellin-like activity) leading to stimulation of seed germination, plant growth, fruit set and enlargement (Yadav and Khosla 2020).

These results agreed with the reports of other researchers who evaluated the effects of amino acids on the yield and/or growth of common bean, two wheat cultivars and *Urtica pilulifera* plants and suggested that foliar application of amino acid liquid fertilizer showed agreeable results (Moreira et al. 2017; El-Said and Mahdy 2016; Wahba et al. 2015). However, previously reported amino acid liquid fertilizers were produced by one or a solution composed of different amino acids, whereas the amino acids used in the present study were created from human hairs resulted from the salons and local municipal waste. Due to the improvement of urban living standards, the increasing development of municipal waste and problem of choking with human hairs as non-degradable waste, especially for the scale causing a huge amount of animal hair waste in the city's sewage systems that can generate a great risk to the environment. Thus, this study provides an effective and ecological leaf fertilization method based on amino acids created from human hairs that will not only enhance crop yield but also make full use of human hairs to protect the environment. Plant force is a good complement to both inorganic fertilisers and microbial based biofertilizers. Since it can metabolise directly, it gives quick response in growth which is reflected by stably enhanced chlorophyll content of the leaf. Its mimic urea fertilisation as it provides organic nitrogen almost in the same manner. Since nutrient used efficiency is strongly determined by host genotype therefore the present study should be extended to more number of cotton genotypes and other crops to identify the most potential combinations of varietal genotypes and plant force doses. This work is continued to achieve better insights of future for novel biofertilizers applications towards sustainable agriculture.

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Table 1. The growth and physiological attributes of cotton plants during the different growth stages of crop.

	Square Stage		Flowering Stage		Boll Initiation Stage	
	Control	**Treatment**	**Control**	**Treatment**	**Control**	**Treatment**
Height (cm)	24.75±1.29	29.83±1.91	38.02±6.17	45.8±7.44	51.74±5.17	62.33±6.23
Chlorophyll (mg/g)	1.62±0.49	1.89±0.59	1.68±0.54	1.96±0.65	1.96±0.60	2.28±0.70

Table 2. The yield attributes during the two stages of boll initiation and boll burst stage of crop growth.

	Boll Initiation Stage		Peak Boll Burst Stage	
	Control	**Treatment**	**Control**	**Treatment**
Seed Yield (g) per plant	14.59±3.92	16.58±4.47	9.26±5.33	10.52±6.05
Boll weight (g)			2.03±0.31	2.42±0.35
Immature Boll formation (% decrease)			6.84±0.17	5.86±0.12

Figure 1. The photograph of cotton plants in field at mature harvest stage at SKM Agriculture College Research Farm, Padampur. (Original)

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