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IMPROVEMENTS OF CROP PRODUCTIVITY IN WHEAT (*TRITICUM AESTIVUM* L.) BY THE APPLICATIONS OF PHYTOHORMONES

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Abstract

Experiments were conducted at University of Gujrat, Pakistan during 2018-2019. Plant growth regulators i.e. Indole Butyric Acid (IBA), Indole Acetic Acid (IAA) and Gibberellic Acid (GA_3) were applied on four varieties of wheat i.e. Faisalabad-2008, Aas-2011, Gandum-1 (2017) and Ujala-2016. Treatments were applied as foliar spray and seed priming. Results indicated that the foliar spray and seed priming of IAA, GA_3 and IBA expressively increased the morphological parameters (shoot and root fresh and dry weights, shoot and root lengths, number of leaves/plant, net assimilation rate and leaf area/plant). Chlorophyll a, b, total chlorophyll & carotenoids, total carbohydrate and soluble protein had highly significant impact of Plant growth regulators. Variations in antioxidant activities (CAT & POD) have been also noted. Yield attributes (total yield & no. of seeds/plant) were enhanced by seed priming and foliar applications of hormones. Seed yield was increased up to 12% as linked to control. Foliar applications produced significant result as compared to seed priming especially for yield and biochemical contents. Better results were produced by IBA as compared to GA_3 and IAA. It was concluded that the foliar applications of Plant growth regulators epically IBA can be employed to improve morphological, biochemical and yield parameters of wheat. Variations of various morpho-physiological and antioxidant activities can be utilize to predict the promising varieties of wheat responding to various plant growth regulators.

Key words: Wheat, IAA, GA_3, IBA Growth, Yield, Economic values.

Introduction

Wheat (*Triticum aestivum* L.) that belongs to family Triticeae (Hordeae) has the primary and major role as cereal crop in most of the countries of the world (Ajayi *et al*., 2011). Wheat flour also lacks minerals and vitamins that may cause nutritional disorders and digestive problems and extensive intake may leads to constipation (Kumar *et al*., 2011). All over the world ab0ut 36% of the population (two billion people) has wheat as a staple food (Hayat *et al*., 2008). It contains almost protein (60-80%), (2-2.5%) glucose, fat (1.5-2%) and mineral matter (2-3%) but the variations exists from area to area and variety to variety (Munns, 2008). Wheat is a winter crop and it is grown-up all over the Pakistan widely but production of wheat is about 23888 kg ha^{-1} and this productivity much lower as compared to the other regions in the world producing wheat (Turki *et al*., 2012).

Plant hormones have basic role for development and growth of plant, they also have an imperative role in natural fruit scenery, blossoming, modifications in maturing and biochemical amid capacity (Gemici *et al*., 2006). PGRs are natural compound which shows great effect on the development of the plant in very low concentration (Ahmad *et al*., 2007). Different studies suggest that the pre- sowing application of plant growth regulators enhances the reallocation of nutrient reserve, enhance respiratory activities, improves tissues hydration and trigger the seedling growth, initial flowering and yield (Vamil *et al*., 2011).

Seed germination, cell multiplication in cambial part and intermodal length is stimulated by mostly important phytohormone which is GA_3. It can also stimulate growth and elongation of the cell, improve the leaf size, enhanced photosynthesis, influences the plant metabolism and growth of hypocotyl. It also increases the yield of plant underneath stress and standard condition (Kabar, 1987). Gibberellic acid sprinkled on plants to improve their yield and growth of plant (Al-Shaheen & Soh, 2016).

IAA is most important auxin in the plants. It plays a vital role in regulation of anatomical functions of plants like: tissue differentiation, gravity and cell multiplication. It's now approved that IAA is the chief and the plenteous auxin in plant due to its role in regulating the growth of plant and enlargement of plant. Few last years ago a significant effort has been finished in order to understand the role of IAA in signal transduction pathway (Shahab *et al*., 2009). Indole-3-acetic acid controls the cell elongation because they have proper conditions such as; enhance the water penetrability into the cell, decrease pressure of wall, improve cell wall synthesis, specific RNA and protein synthesis and improvement in osmotic cell contents. Indole acetic acid also regulates the cambial activity, induces the fruiting and flowering and inhibits abscission of leaves (Zhao, 2010). Growth effected by expanding leaves and growing rate of photosynthesis. IAA association with Kinetin causes degeneration in the length, enlargement of main stem width, production of internodes and number of leaves (Naeem *et al*., 2004). Deficiency of IAA contents produced drought in wheat leaves (Xie *et al*., 2003).

Indole-3-Butyric Acid regulates cell growth, fruit setting, apical dominance, ethylene biosynthesis, cell division, variation of vascular tissues and root development (Finet & Jaillais, 2012). IBA is applicable for rotting and also their effect on formation of wood cutting (Ludwig-Muller *et al*., 2000). The ability of Indole Butyric Acid to stimulate initiation of adventitious root has been attributed to the larger constancy of Indole-3-butyric acid against Indole Acetic Acid equally in plant tissue and in solution (Ludwig-Muller *et al*., 2005).

Materials and Methods

Pot experiments were carried out in the Botanical Garden of University of Gujrat, Pakistan during 2018-2019. This experimental area of District Gujrat stands between 32° to 35° North latitudes and 73° 45' East longitudes and has moderate climate. During highest summer, the temperature rises up to 45°C during daytime, but the hot spells are relatively short as a result of the proximity of mountains of Azad Kashmir. Minimum temperature fall may be below 2°C during the months of winter. Average rainfall in Gujrat is 67 cm. Four varieties of wheat were used in these experiments i.e., Aas (2011), Faisalabad (2008), Gandum-1 (2017), Ujala (2016). Plant growth regulators that were used are: Gibberellic Acid (GA_3), Indole-3-Acetic Acid (IAA) and Indole-3-Butyric Acid (IBA). Seven level of treatment of IAA, GA_3 and IBA that were:

T0 = Control
T1 = 25ppm IAA (seed priming)
T2 = 25ppm GA_3 (seed Priming)
T3 = 25ppm IBA (seed priming)
T4 = 25ppm IAA (foliar spray)
T5 = 25ppm GA_3 (foliar spray)
T6 = 25ppm IBA (foliar spray)

There was a use of complete randomized design with four replicas to carry out experiments. Data was assembled at the vegetative and maturity stages both for the morphological and biochemical parameters including shoot and root fresh weight, dry weight, lengths, no. of leaves, leaf area, chlorophyll contents, antioxidant activities, Carbohydrates and protein contents. Yield attributes were noted at maturity i.e. no. of grains per plant and the total yield. Chlorophyll a & b, total chlorophyll and carotenes were measured following the method of Arnon (1949). Activities of peroxidase (POD) and Catalase (CAT) were measured by using Chance & Maehly (1995) method. The use of Procedure of Bradford (1976) was made to quantify the protein content. Method of Rasool *et al*., (2010) was employed to calculate total carbohydrates. Analysis Variance was brought in computed by COSTAT computer package. To compare the mean values at 5% level of probability (Steel & Torrie, 1980), yield per plant the Duncan's New Multiple Range test (DMRT) was used.

Results

There were following results of wheat obtained by the treatment of IAA, GA_3 and IBA.

Morphological and derivative attributes: Different morphological attributes showed that main effect of shoot and root length, fresh weight, and dry weight had significant change in response to seed priming and foliar applications of growth regulators GA_3, IAA and IBA at vegetative and maturity stages (Table 1). The varietal interactions with foliar spray showed significant result in shoot and root lengths, fresh and dry weights at maturity stages. Result of interactions of foliar spray and seed priming was noteworthy too but the seed priming, foliar spray and variety was non-significant at vegetative as well as maturity stages except root fresh weight (Table 1). T_1 (25ppm IAA) indicated maximum shoot length and shoot weight were shown in V1 (Faisalabad 2008) at vegetative and maturity stage (Fig. 1A & B, 2A & B). Root fresh weight was maximum at vegetative stage was noted in V2 (Aas) at T2 for maturity data.

It was observed that Aas-2011 had higher shoot dry weight as than other treatment at vegetative and maturity stage as well with the treatments of 25ppm GA_3 and IBA (Fig. 3A & B). Foliar spray and seed priming affected root dry weight, number of leaves and leaf area significantly both at vegetative and maturity stages. At vegetative stage varietal association was non-significant for root dry weight and number of leaf. The interaction in the variety x seed priming was significant for root dry weight and leaf area per plant at maturity stage. The interaction of foliar spray x seed priming was significant and the interaction of foliar spray x seed priming x variety was non-significant (Table 2). Fig. (3C & D) revealed that maximum dry root weight perceived at T6 in variety Gandum-1 (2017) at vegetative while, at maturity the maximum root dry weight was also noted at T6 in Ujala 2016. Fig. (4. A &B) displayed that in Aas (2011) number of leaves increased at vegetative at T2. Fig. (4C & D) revealed maximum leaf area at vegetative stage at T5 in V2 while at maturity stage, maximum leaf area was observed in Gandum-1 (2017) at T2. From the data calculated in ANOVA (Table 2), it was revealed that application of foliar spray and seed priming under different hormones had been non-significant for four wheat varieties and the varietal response with its interactions on relative growth rate was non-significant. Fig. (5A) illustrated that the higher relative growth rate (RGR) was observed at T2 in V4 (Ujala). The main effect of seed priming and foliar spray of variety was noted significant and the relations for all factors was also noteworthy maximum net assimilation rate was observed at T2 level in variety Faisalabad (Fig. 5B).

Biochemical attributes: Chlorophyll a, & b, total chlorophyll and carotenoid contents studied at vegetative and maturity stages showed significant result for seed priming and foliar spray under different hormones (Table 3). Response of variety was significant except chl. b and total chl. at vegetative stage. Varietal interaction with foliar spray and seed priming was notable too. The correspondence of seed priming, foliar spray and variety was significant except in total chlorophyll at vegetative stage (Table 3). From Fig. (6A &B) related to maximum chlorophyll a & b contents at vegetative stage was calculated in V3 (Gandum-1) at T5 while at maturity stage higher chl. a content were noted for V3 (Gandum-1) at T2 as compared to control and chl. b in V1 (Faisalabad) at T4. Result for total chlorophyll and carotenoids showed the maximum result in V1 (Faisalabad) at vegetative in T2 as well as maturity stages while carotenoids showed the maximum amount at T1 (Fig. 6C & D).

Table 1. Means squares (MS) from the Analysis of Variance (ANOVA) for morphological attributes of Wheat (*Triticum aestivum* L.) under the effect of IAA, GA_3, IBA.

Source of variance	df	MS of shoot length at vegetative stage	MS of shoot length at maturity stage	MS of root length at vegetative stage	MS of root length at maturity stage	MS of shoot fresh weight at vegetative stage	MS of shoot fresh weight at maturity stage	MS of root fresh weight at vegetative stage	MS of root fresh weight at maturity stage	MS of shoot dry weight at vegetative stage	MS of shoot dry weight at maturity stage
Main effects of seed priming	3	148071.247**	16591925.068***	25861.232**	127921.230***	0.208***	4385.064*	0.027***	1.727*	0.0146***	11.3038***
Main effects of foliar spray	3	1420790.845 ***	227605416.92***	603444.237***	3388745.113***	0.957***	9006.734***	0.498***	6.117 ***	0.2568 ***	53.603***
Variety	3	65049.717ns	578468.776***	7958.444ns	154777.823***	1.098***	1603.864ns	0.019***	31.839***	0.0014ns	40.7340***
Interaction											
Variety x Seed priming	9	41960.954ns	927179.036***	5808.246ns	30827.191***	0.042 **	3020.869*	0.002ns	2.760 ***	7.479 ns	15.472***
Interaction											
Variety x Foliar spray	9	31802.216ns	358139.890***	12798.826*	23797.607***	0.025ns	2658.372ns	0.002ns	3.961***	0.0010 ns	8.1502***
Interaction											
Seed Priming x Foliar spray	9	107742.046***	15570061.96***	78413.470***	282934.893 ***	0.054***	2584.899ns	0.026***	0.740 ns	0.0163***	8.5819***
Interaction											
Variety x Seed priming x Foliar spray	27	28553.016ns	111807.067ns	3770.799ns	4003.267ns	0.003ns	1666.889ns	0.001ns	1.304 **	8.604ns	0.5887ns
Error	192	26399.399	84720.635	6137.187	6192.546	0.014	1458.885	0.0019	0.637	7.3081	0.496
Total	255										

Table 2. Means squares (MS) from the Analysis of Variance (ANOVA) for morphological attributes of Wheat (*Triticum aestivum* L.) under the effect of IAA, GA_3, IBA.

Source of Variance	df	MS of root dry weight at vegetative stage	MS of root dry weight at maturity stage	MS of number of leaves per plant at vegetative stage	MS of number of leaves per plant at maturity stage	MS of leaf area per plant at vegetative stage	MS of leaf area per plant at maturity stage	MS of relative growth rate	MS of net assimilation rate
Main effects of seed priming	3	0.005***	0.415**	553.274***	1121.326***	103325.915***	1460566575.1**	8628624832.3ns	1.519 ***
Foliar spray	3	0.079***	1.033***	5415.545***	18645.076***	1825099.357***	6269199992.4***	8655327063.6ns	0.004***
Variety	3	8.262ns	8.701***	4.9518ns	5469.878***	673535.585***	4053424324.9***	8589023379.3ns	4.509***
Interaction									
Variety x Seed priming	9	3.671ns	1.315***	14.059ns	203.441ns	17214.392ns	725831874.93**	8566640156.3ns	2.311 ***
Interaction									
Variety x Foliar spray	9	3.554ns	1.270 ***	18.469ns	721.0247***	143404.889***	695271509.85**	8587321389.7ns	4.644***
Interaction									
Seed priming x Foliar spray	9	0.007***	0.055ns	389.903***	1736.458***	121012.199***	790748502.03**	8584106051.1 ns	2.1208***
Interaction									
Variety x Seed priming x Foliar spray	27	3.225ns	0.023 ns	13.618ns	115.152 ns	6221.070ns	302980335.2ns	8588392137.6ns	1.848***
Error	192	5.266	0.079	10.977	118.524	10209.013	261847697.77	8589053748.8ns	6.709***
Total	255								

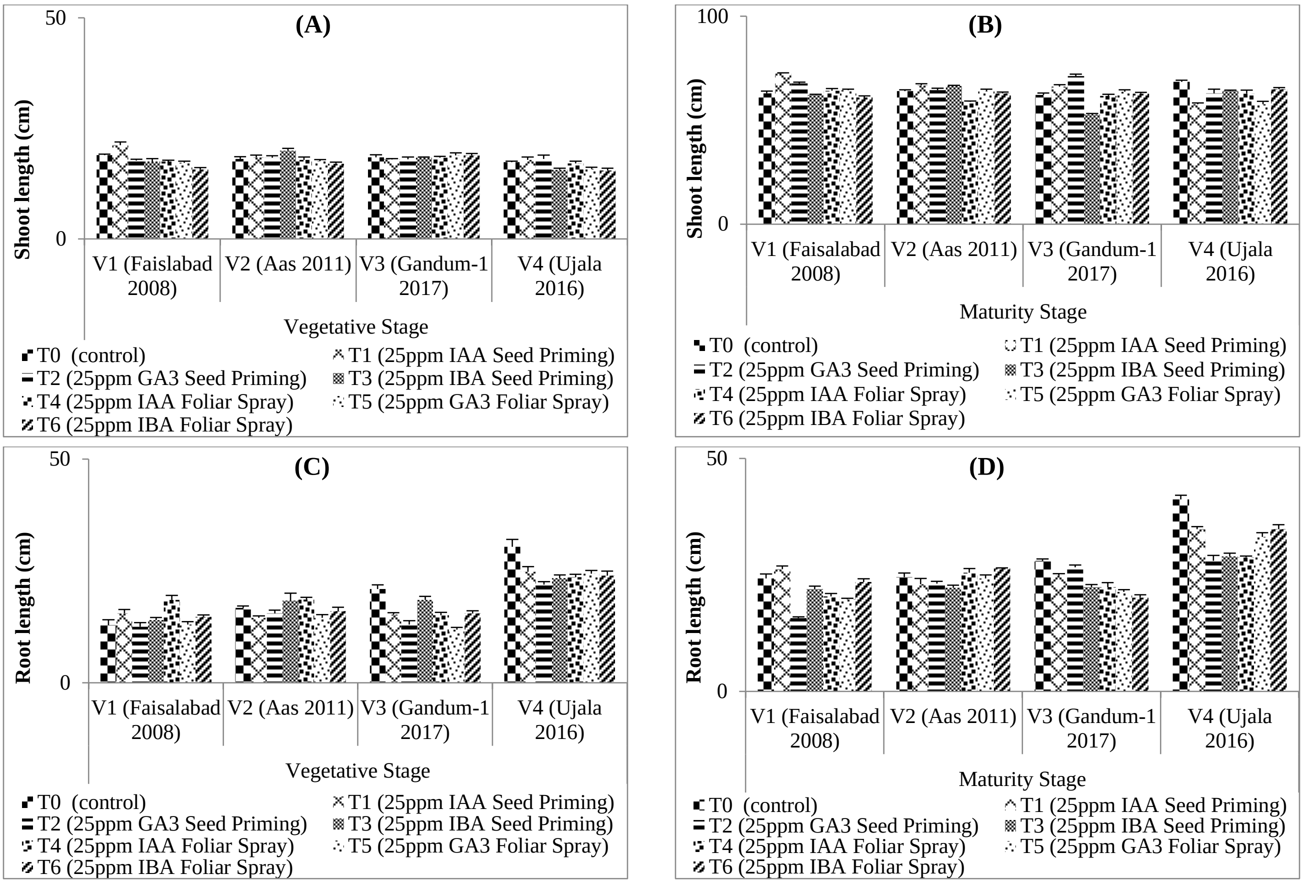

Fig. 1. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various morphological parameters of wheat at vegetative and maturity stages.

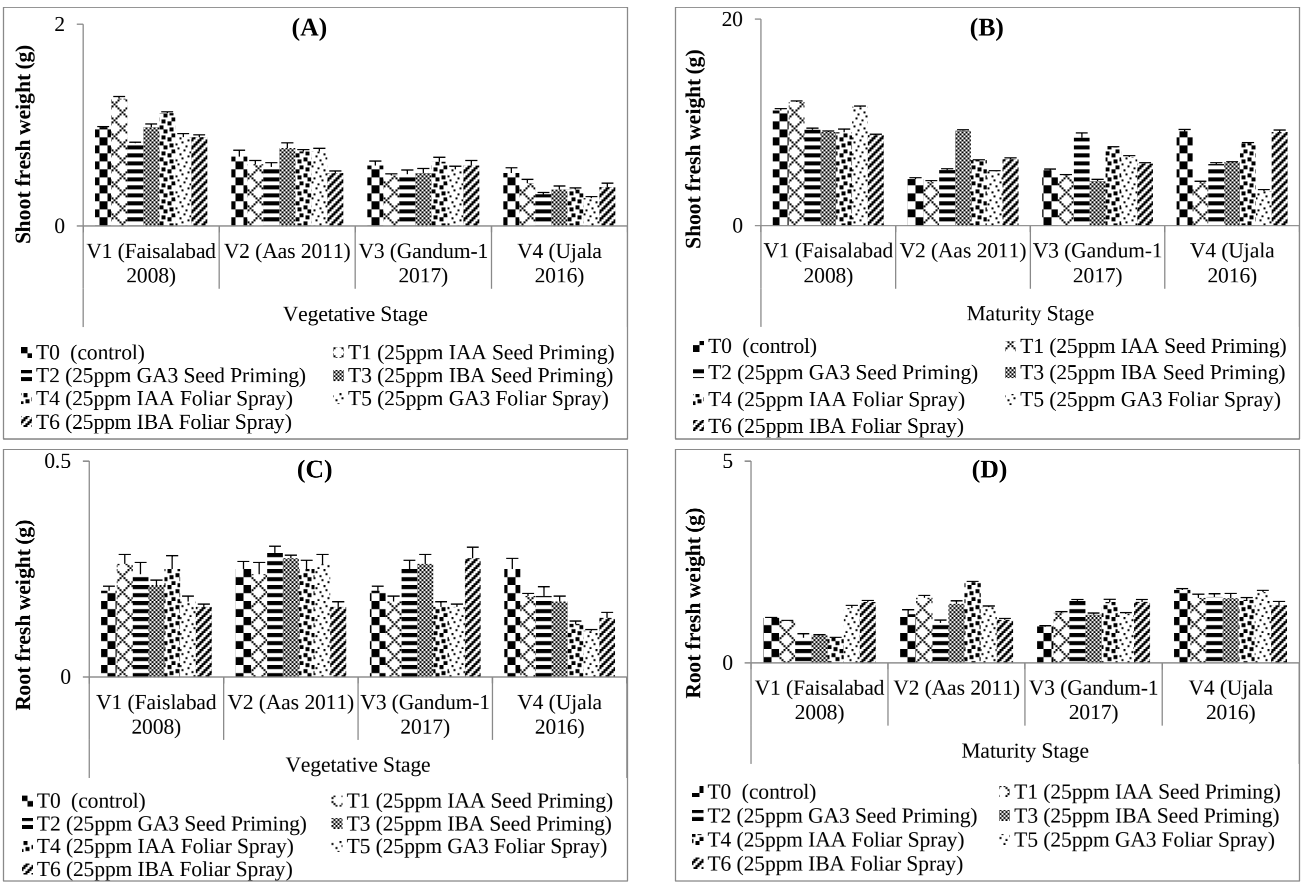

Fig. 2. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various morphological parameters of wheat at vegetative and maturity stages.

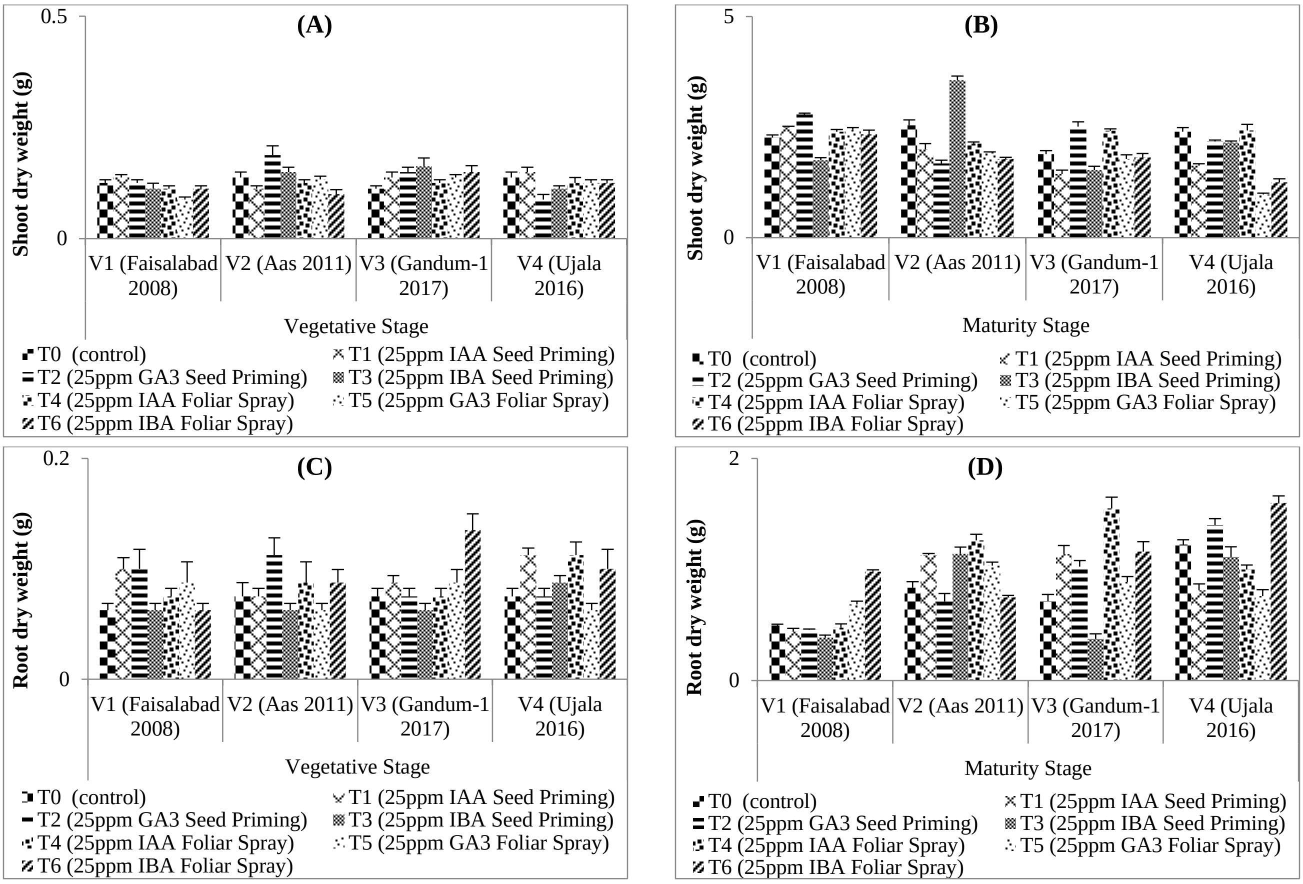

Fig. 3. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various morphological parameters of wheat at vegetative and maturity stages.

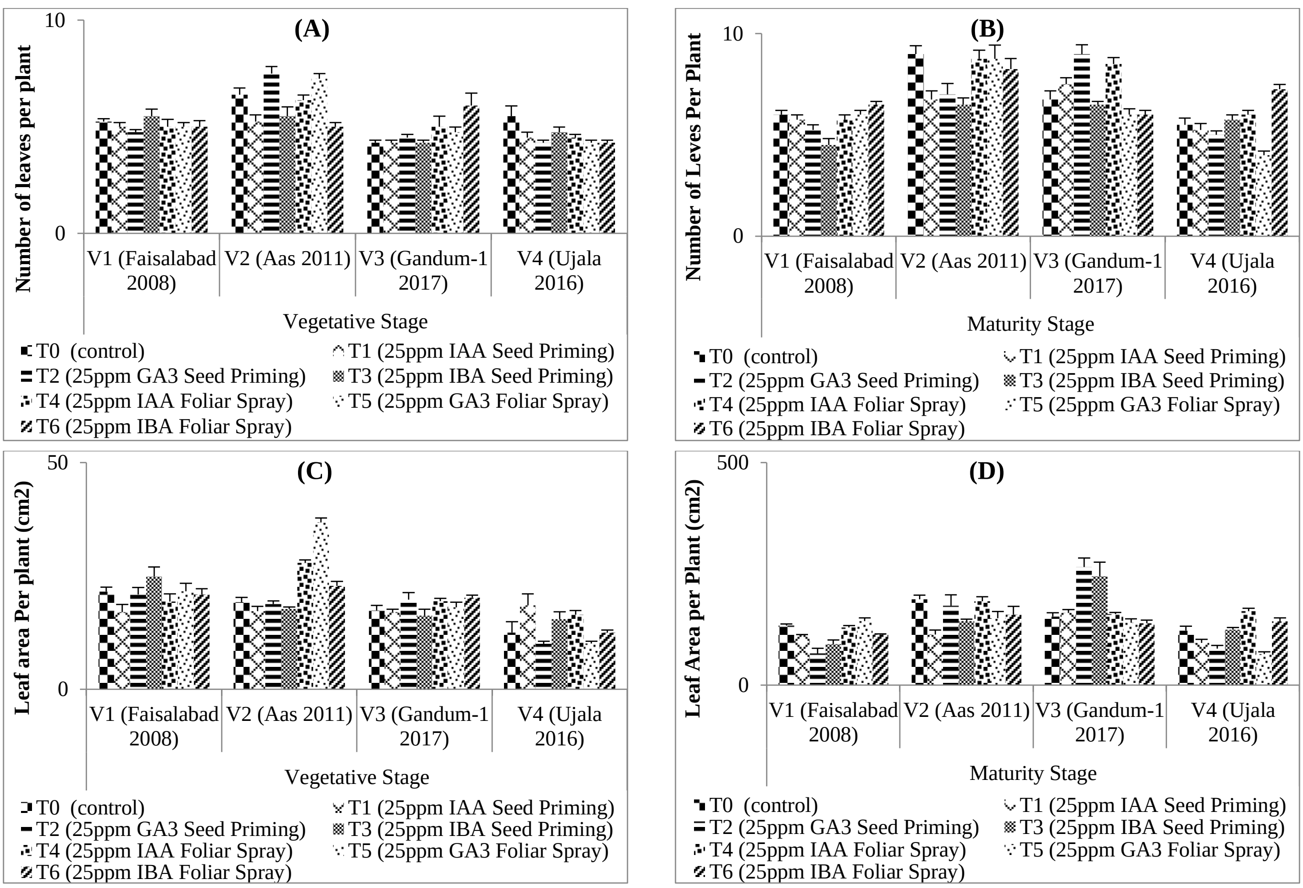

Fig. 4. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various morphological parameters of wheat at vegetative and maturity stages.

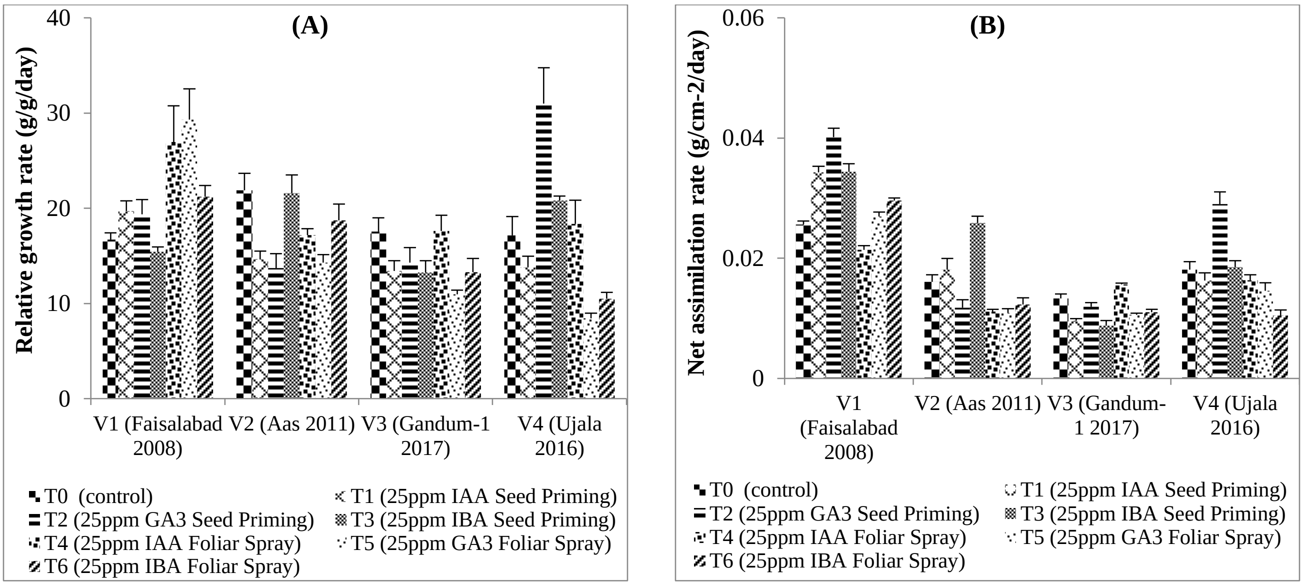

Fig. 5. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various morphological parameters of wheat at vegetative and maturity stages.

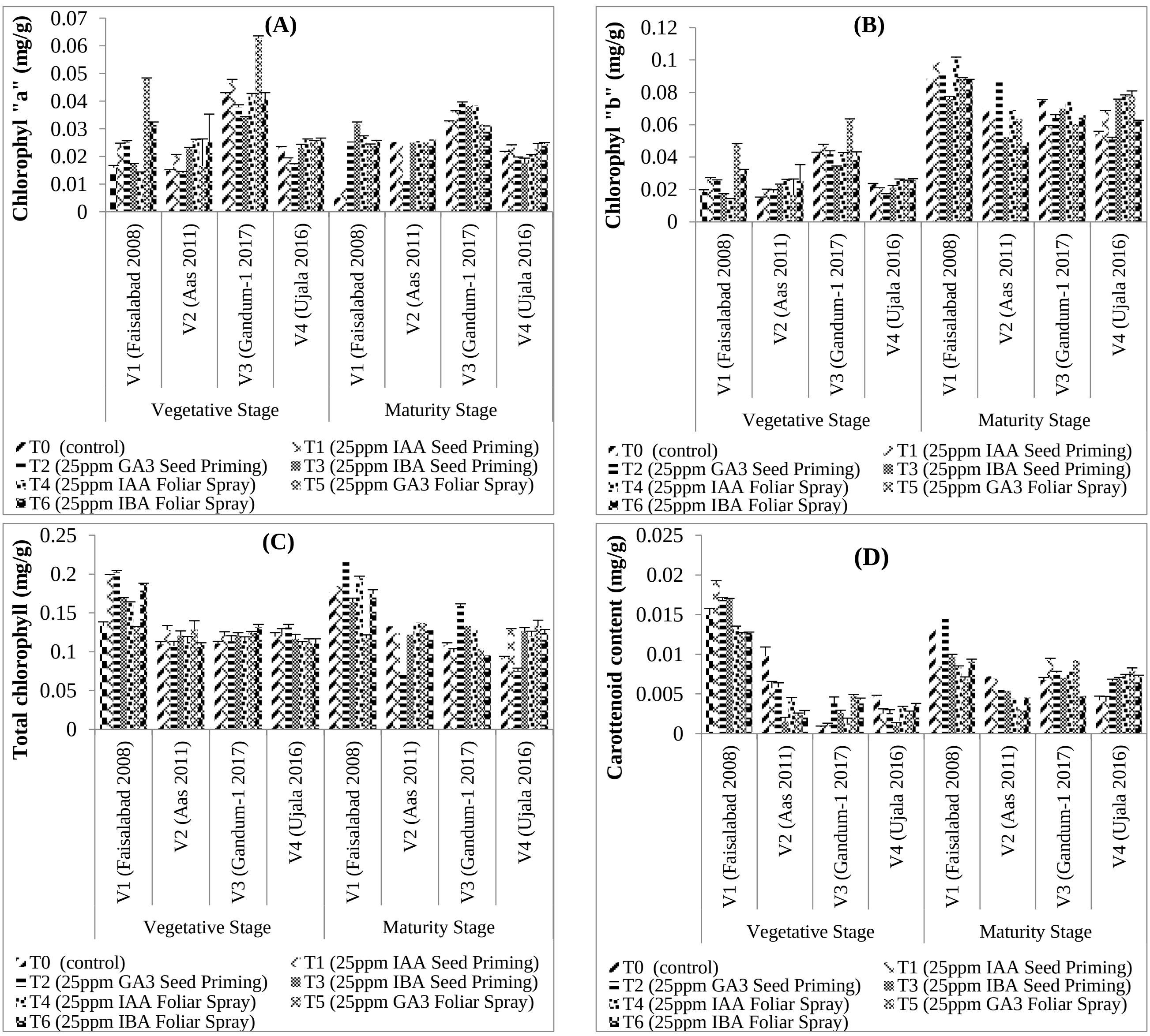

Fig. 6. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various biochemical parameters of wheat at vegetative and maturity stages.

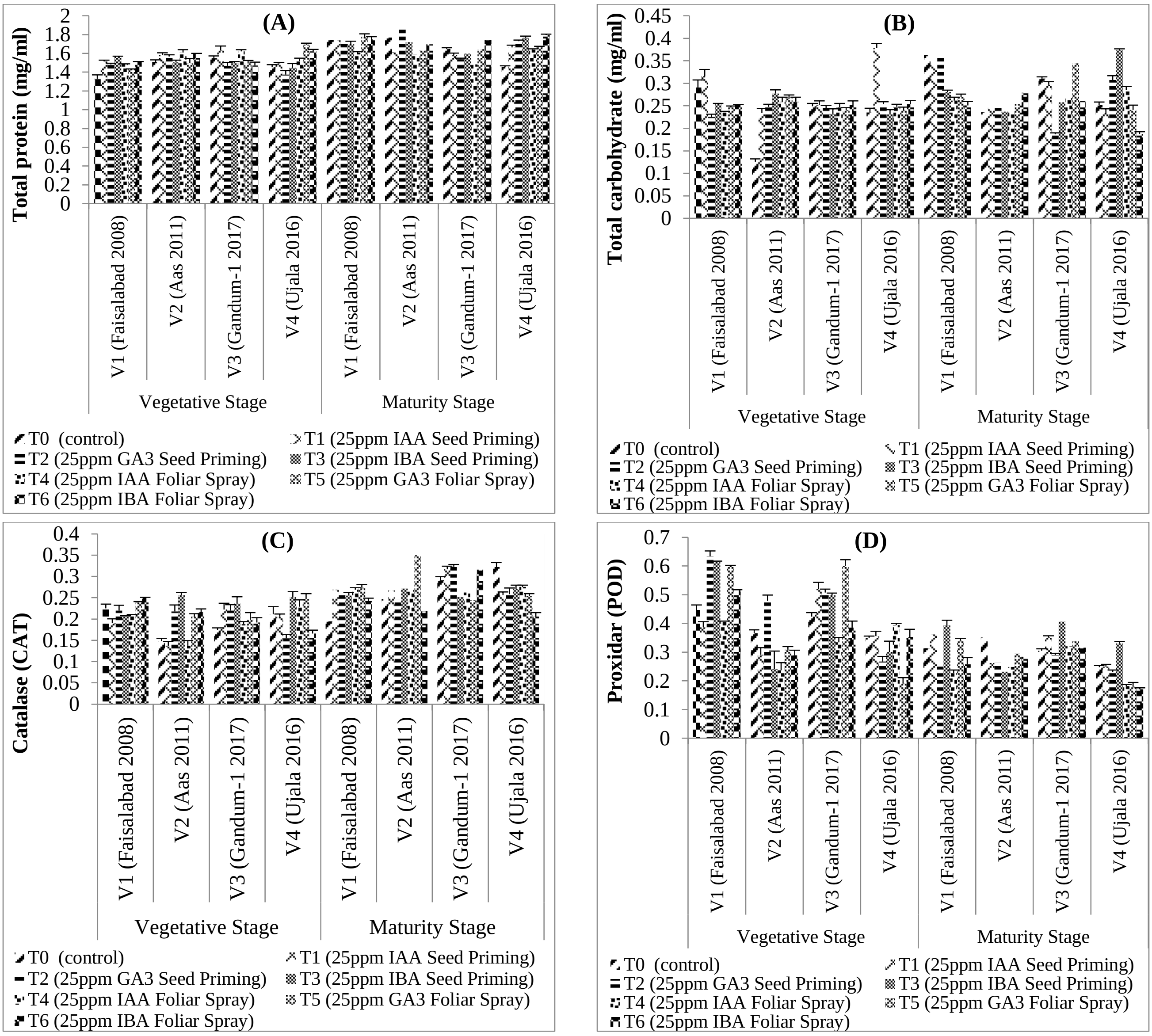

Fig. 7. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various biochemical parameters of wheat at vegetative and maturity stages.

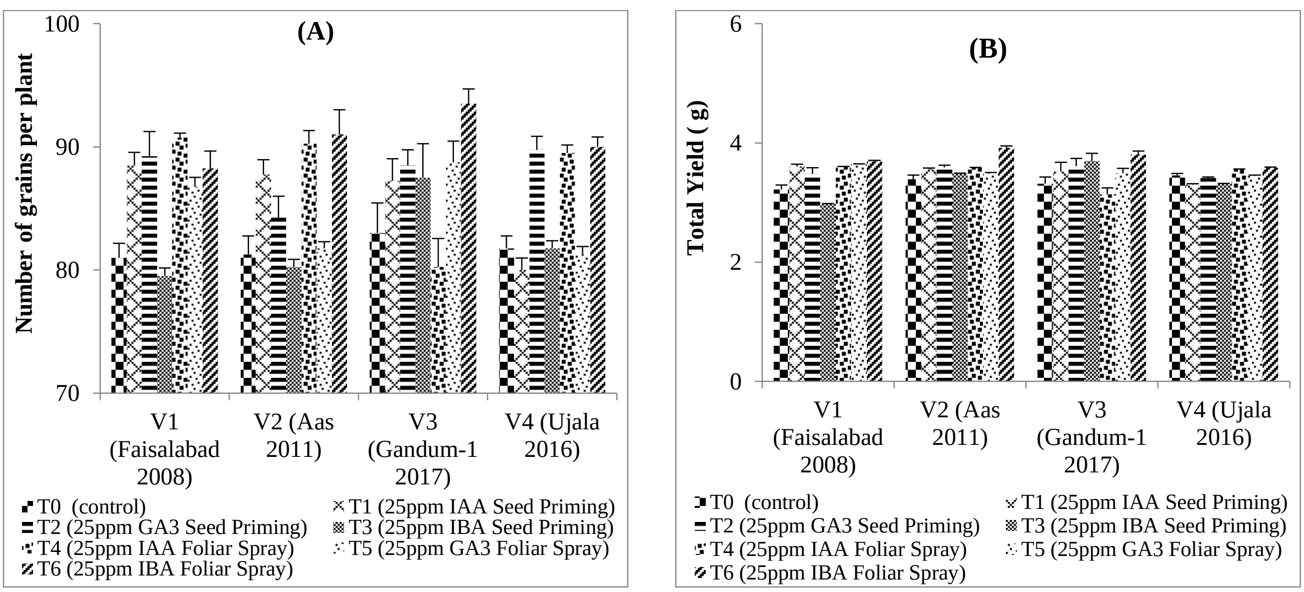

Fig. 8. Effect of Indole acetic acid, Gibberellic acid and Indole butyric acid on various yield parameters of wheat at vegetative and maturity stages.

Quality attributes: Table 3 showed significant result for total soluble protein and total carbohydrate for seed priming x foliar spray and variety at vegetative as well as maturity stages. The interaction on seed priming x foliar spray and variety x foliar spray was also significant but non-significant in protein at maturity and carbohydrates at vegetative. Higher protein contents were present in V4 (Ujala) in vegetative stage at T4 while at maturity stage T2 showed, maximum protein contents in V2 (Aas). Fig. (7A & B) showed that total carbohydrate concentration was increased at T1 as well as T3 in V4 (Ujala) at vegetative and maturity stage.

Antioxidant activities: The activity of catalase (CAT) and peroxidase (POD) showed significant result for seed priming, foliar spray and variety at vegetative as well as maturity stages. The interaction was also significant but the interactions of variety x foliar x seed priming was non-significant (Table 4). Fig. (7C) illustrated that catalase activities enhanced at T3 in Aas (2011) at vegetative stage and the highest catalase activity was found at T5 (25ppm GA_3) in Aas (2011) at maturity stage. Fig. (7D) showed that the activities of peroxidase were increased in V1 Faisalabad at T2 as compared to control. POD activities increased at maturity stage in V3 (Gandum-1) at T3 (25ppm IBA).

Yield attributes: Yield parameters including yield of seeds and no. of grains per plant were noted. The number of grains per plant and yield of seed showed notable result in all factor except the interaction of seed, foliar and varieties (Table 4). Variety (Gandum-1) had higher number of grains per plant at T6 (Fig. 8A). Higher seed yield was calculated in V2 (Aas) at T6 (Fig. 8B). The increase in the yield of seed was 12% as compared to influence in variety Aas at T6.

Discussion

The foliar and seed applications of three different hormones GA_3, IAA, and IBA improved the shoot length of wheat. Pavlista *et al*., (2013) exposed the different applications of GA_3 enhanced the stem growth of different wheat cultivars. Exogenous applications of auxins increased the wheat growth (Iqbal & Ashraf, 2007). Tada *et al*., (2008) described that 100ppm of GA_3 and IAA enhanced the plant height of red sorrel and soya bean when applied at early seedling stage. It was also stated that IAA and GA_3 positively affected the length of shoot.

Badoni & Chauhan (2009) stated that the combination of 0.01 mg/L NAA and 1.25 mg/L gibberellic acid enhanced the length of root. Some researcher reported that indole butyric acid and IAA containing medium help in increase the root length of different plants (Al-Taleb *et al*., 2011). The Ujala 2016 showed the positive effect at vegetative and maturity stages as compared to other three varieties. Application of indole butyric acid was shown to be help to enhance the moisture content in the soil for an optimum rooting and shooting development of cuttings (Tan *et al*., 2006; Akwatulira *et al*., 2011). Auxin plays a vigorous role in enhancing the root height of the plants (Ahmed & Hasnain, 2010).

Shohani *et al*., (2014) and James *et al*., (2005) described that fresh weights of root and shoot were enhanced in seed priming treatment of seed in lentils with gibberellic acid. Patel & Saxena (1994) described that fresh and dry weights were enhanced with GA_3 seed treatments. Foliar spray of IBA was significantly increased as compared to seed treatment. GA_3 and IAA treatment increased the efficacy of photosynthetic pigment which improve and enhance the yield quality and production (Azooz *et al*., 2004).

More number of leaves and expansion of the leaf area in *Verba scumthapus* were seen under the applications of phytohormones (Mishra *et al*., 2000). The decrease in relative rate of growth was apparent from results. It was stated by Dijkstra *et al*., (1990) that the growth rate of soybean plant was improved. Sarkar *et al*., (2002) reported that the application of GA_3 increased the net assimilation rate. Initial growth of Rice promoted by increased NAR with GA_3.

Shaddad *et al*., (2014) described that the different levels of gibberellic increased the carbohydrate concentration in wheat. It might be the fact that GA_3 enhanced the synthesis of carbohydrate through the better chlorophyll content. It was reported the foliar applications of auxin improved the monosaccharide, chlorophyll "a" and protein content in *Citrullus vulgaris* L. (Piotrowska-Niczyporuk & Bajguz, 2014). Bideshki *et al*., (2013) described that; indole butyric acid improved the photosynthesis in *A. sativum*. Kaya *et al*., (2010) stated the foliar treatment of auxin and kinetin increased the chlorophyll content level in different plants increased the seed yield by foliar spray applications of IAA. It may increase the size of leaves, which enhance the assimilation and photosynthesis eventually further dry matter.

In plants Gibberellic acid may enhance the photosynthesis (Tuna *et al*., 2008). Lim *et al*., (2003) described that the gibberellic acid enhance the total chlorophyll amount in leaves of apple. Indole acetic acid exerts positive effect on plant growth by increasing the number of leaves and photosynthetic pigment in plants too (Naeem *et al*., 2004). (Mishra *et al*., 2000). GA_3 or IAA was associated with the enhancement of protein, active soluble sugars and amino acids. This increase the contents and revealed the excessive production of fresh & dry mass, length of the plant, water molecule and leaf area of both root and shoot of wheat (*Triticum aestivum* L.) plant (Hamdia, 1991; Shaddad & El-Tayeb, 1990). The foliar spray of phytohormones hydrolysis of fructose, sucrose and hydrolysis of starch enhanced to from fructose to glucose molecule and produce the energy, increased water potential, plasticity and cell expansion. This may improve leaf area and growth of leaf in plants (Agrawal & Dikshikt, 2008).

Due to starch hydrolysis sugar content is increased (Kumar *et al*., 1996). Same results are obtained in comparison with the results of Enid & About-Leila (2006) that the carbohydrate content of leaves is improved by GA_3 foliar treatments on ornamented plants. It is revealed that sugar content in different species of plants like *Phalaenopsis amabilis* and *Rosa hybrid* associated is enhanced by GA_3 with the initiation of flora (Chen *et al*., 1994) and branching of shoot (Choubane *et al*., 2012).

Table 3. Means squares (MS) from the Analysis of Variance (ANOVA) for biochemical attributes of Wheat (*Triticum aestivum* L.) under the effect of IAA, GA_3, IBA.

Source of variance	df	MS of Chl. a at vegetative stage	MS of Chl. a at maturity stage	MS of Chl. b at vegetative stage	MS of Chl. b at maturity stage	MS of total Chl. at vegetative stage	MS of total Chl. at maturity stage	MS of Carotenoids at vegetative stage	MS of Carotenoids at maturity stage	MS of total protein at vegetative stage	MS of total protein at maturity stage	MS of total carbohydrate at vegetative stage	MS of total carbohydrate at maturity stage
Main effects of seed priming	3	4.642***	3.260***	0.0021***	0.0044***	0.011***	0.005***	4.691***	3.922***	1.122***	1.552***	0.015***	0.041***
Main effects of foliar spray	3	0.006***	0.0073***	0.0381***	0.0499***	0.172***	0.124***	3.779***	6.188***	9.335***	20.561***	0.492***	0.635***
Variety	3	5.310***	1.665 ns	6.0224ns	2.650***	4.408ns	0.004***	8.122***	5.312***	0.411***	0.946***	0.001ns	0.020***
Interaction													
Variety x Seed priming	9	3.809***	5.056**	1.397***	2.0076***	4.160ns	0.002***	9.194***	1.973***	0.059ns	0.305***	0.007***	0.008***
Interaction													
Variety x Foliar spray	9	4.238***	2.302ns	1.931 ns	1.1815***	5.675ns	2.432ns	3.981***	4.191***	0.170**	0.096***	0.003*	0.009***
Interaction													
Seed priming x Foliar spray	9	5.341***	7.614***	0.0034***	0.0044***	0.0085***	0.014***	2.724***	4.075***	0.525***	1.053***	0.049***	0.037***
Interaction													
variety x seed priming x Foliar spray	27	2.1042***	5.029***	1.3988ns	1.341***	7.477ns	0.001***	1.353***	3.217***	0.016***	0.017ns	0.002ns	0.003*
Error	192	2.6000	1.648	3.4238	8.506	9.479	5.912	1.077	4.819	0.058	0.016	0.001	0.002
Total	255												

Table 4. Means squares (MS) from the Analysis of Variance (ANOVA) for biochemical and yield attributes of Wheat (*Triticum aestivum* L.) under the effect of IAA, GA_3, IBA.

Source of variance	df	MS of antioxidant activity "Catalase" at vegetative stage	MS of antioxidant activity "Catalase" at maturity stage	MS of antioxidant activity of peroxidase at vegetative stage	MS of antioxidant activity of peroxidase at maturity stage	MS of number of grains per plant	MS of total yield
Main effects of seed priming	3	0.020***	0.041***	0.076***	0.041***	65886194.962***	91.522***
Main effects of foliar spray	3	0.365***	0.679***	0.857***	0.679***	772517043.1***	1180.287***
Variety	3	0.006*	0.037***	0.334***	0.037 ***	1182905.066*	8.048***
Interaction							
Variety x Seed priming	9	0.005**	0.0082***	0.058***	0.008***	626504.674ns	3.893***
Interaction							
Variety x Foliar spray	9	0.002ns	0.003***	0.021***	0.003***	1422825.545***	4.065***
Interaction							
Seed priming x Foliar spray	9	0.028***	0.031***	0.066***	0.031***	51904797.941***	67.907***
Interaction							
Variety x Seed priming x Foliar spray	27	0.002ns	0.002***	0.019***	0.002***	95307.04673ns	0.616ns
Error	192	0.001	6.650	0.004	6.650	364128.772	1.092
Total	255						

Ducic *et al*., (2004) who found that the application of GA_3 in *Chenopodium rubrum* plant increased the activity of CAT. Higher activities of CAT and POD enzymes with progressive decrease along with the pending senescence was noted in the *heliconia* inflorescence is sprayed by GA_3 with concentration 100mg/L and 50 mg/L of BSA while, the activities were highly reduced in control plants with these enzymes (Asada, 1999). Foliar spray of different level of growth hormones on shoots produced an important incentive in PX, CAT and slightly enhanced in ascorbate activity as resistant compound in wheat (Hassanein *et al*., 2009). Gibberellic acid treatment improved the POD bustle in *C. roseus* in the foliar spray and soil soak (Jaleel *et al*., 2007). Pan *et al*., (2013) designated that the gibberellic acid increased the seed number, seed filling percentage and number of spike. Tiller growth, weight and number of seed as well as yield enhanced by applications of IAA (Goon *et al*., 2009).

Conclusion

It was concluded that the foliar applications of Plant growth regulators epically IBA can be employed to improve morphological, biochemical and yield parameters of wheat. Variations of various morpho-physiological and antioxidant activities can be utilize to predict the promising varieties of wheat responding to various plant growth regulators.

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