The Plant Regulator Soaking Seeds and its Reflections on Growth and Yield Quality of Wheat

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***Abstract*—A greenhouse pot experiment was carried out during November 2013 to May 2014. Winter wheat grains (*Triticum aestivum* L.), cultivars Abu-Ghureb and Cham6 were used to investigate the effect of soaking seeds in 300ppm of benzyl adenine (BA) or daminozide solutions for 6 hours before sowing vegetative, yield components, leaf chlorophylls and some chemical constituents of seeds. BA treatment led to significant increases in tiller number plant^{-1}, chlorophyll b, P, dry gluten, N and protein contents of seeds. It also led to significant decreases in number of leaves plant^{-1}. In addition, the number of tillers plant^{-1}, shoots dry weight plant^{-1}, P, N and protein contents of seeds were increased by daminozide treatment, but this caused a significant decrease in the plant height, number of leaves plant^{-1} and flag leaf area. Number of grains plant^{-1}, weight of 1000 grains and grains yield were significantly increased by both treatments. Cultivar variability was noted for some tested parameters. The tall, N, P content and protein content of Abu-Ghureb cultivar were higher significantly than Sham6. The case was opposite with number of leaves plant^{-1}, flag leaf area, shoots dry weight plant^{-1}, spike length and grain number plant^{-1}.**

***Index Terms*—BA, Daminozide, wheat (Triticumaestivum L.).**

I. Introduction

Cereals are one of the most important sources of food for the world's population, providing energy, protein, vitamins, minerals and fiber (Craig, et al., 2009). Common wheat or Bread wheat *(Triticum aestivum* L.) is one of the world's most important food crops along with rice and maize. It is a staple food crop for many countries in the world. Bread wheat is a part of the grass family Poaceae. The flour from soft wheat contains a high percentage of gluten and is generally used for making bread and cakes. White- and soft-wheat varieties are paler and have starchy kernels and their flour is preferred for piecrust, biscuits, and breakfast foods. The grain, the bran (the residue from milling) and the vegetative plant parts make valuable livestock feed.

Plant growth regulators (PGRs), either produced naturally by the plant or synthetically by a chemist, are small organic molecules that act inside the plant cells and alter the growth and development of plants. PGRs can be broadly divided into two groups: plant growth promoters and bioinhibitors. Growth promoters are involved in cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation. Bioinhibitors play an important role in plant responses to wounds and stresses of biotic and abiotic origin and they are also involved in various growth inhibiting activities such as dormancy and abscission (Giannakoula, et al., 2012). Cytokinins are essential hormones for plant growth and development (Moke, et al., 2000). Cytokinin are required for cell division, proliferation and differentiation of plant cells, and also controls various processes in plant growth and development, such as delay of senescence, control of shoot/root balance transduction of nutritional signals and increased crop productivity (Sakakibara, 2006). Daminozide is a growth retardant with proven effects and practical application on many plant species, as it inhibits the biosynthesis of certain plant hormones like gibberellins and generally induces shortening of internodes of higher plants and has some additional effects such as reduction in leaf size (Hazarika, 2003).

Pre-treatment sowing for seeds is consider as one of the best practices that used for improving plant growth and yield. Many studies were conducted by soaking seeds, such as chicory *Cichorium intybus* L. (Tzortzakis, 2009), wheat *Triticum aestivum* L. (Yari, et al., 2011) and shisham *Dalbergia sissoo* (Roxb.) (Al-Barzinji, et al., 2015)

The goal of this research is to study the effects of soaking seeds in CK or Daminzide solutions on some vegetative characteristics, yield characteristics and some chemical contents of leaves and seeds of two wheat cultivars.

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II. Procedure for Paper Submission

The experiment was conducted at the Glasshouse of Biology Department, College of Education, University of Salahaddin-Erbil, during December 20, 2013 to April 20, 2014. Two winter wheat (*Triticum aestivum* L.) cultivars (Abu-Ghureb and Sham6) were used, which were obtained from the Agricultural Research Center in Erbil. The plastic pots were used in the experiment. Each pot contains 7Kg of sandy loam soil. Diammonium Phosphate (DAP) fertilizers containing 18% N and 46% P were added to the pots as solutions, at the rate of (472mg) per each pot which is equivalent to 270Kg ha^{-1}. The experimental treatments consisted of soaking seeds in benzyl adenine (BA) or daminozide for 6 hours before sowing at concentration of 300ppm. In each pot, seven grains were sown; two week after seed germination the seedling were thinned to two per pot.The experiment has been conducted in completely randomized design, included (6) treatments with 3 replicates. Plant height (cm), tiller numbers $plant^{-1}$, leaf numbers $plant^{-1}$, flag leaf area, shoot dry weight $plant^{-1}$, leaf chlorophylls, spike length (cm), spike number $plant^{-1}$, spikelet $spike^{-1}$, grain number $plant^{-1}$, weight of 1000 grains, grains yield $plant^{-1}$, total nitrogen (mg g^{-1}), protein (mg g^{-1}), phosphorus (mg g^{-1}), potassium (mg g^{-1}), wet and dry gluten (%) of seeds were measured. The flag leaf area was calculated according to Hunts formula (leaf area = leaf length x leaf widthx0.905) (Hunt, 1982).Plant shoots were dried in oven at 75 °C for 72h. Total nitrogen was determined by Kjeldahl method (Ryan et al.,2001) and total phosphorus was determined using spectrophotometer method as described by (Ryan et al.,2001).Total potassium was determined, using Flame – photometer method as described by (Kalra, 1998). The total protein was calculated by multiplying the value of total nitrogen by 5.7 (Dalaly and Al-Hakim, 1987).The gluten was determined according to hand washing method (Williams et al.,1988).The wet gluten was then oven-dried to weight constancy.

The chlorophyll *a* and *b* were measured according to the methods applied by Wintermand and Demote (1965); chlorophyll *a* and Chlorophyll *b* were spectrophotometrically estimated on two wave length 665nm and 649nm as follow:

µg Chlorophyll *a*/ml solution = (13.70) (665nm) - (5.76) (A649nm)

µg Chlorophyll *b*/ml solution = (25.80) (A649nm) - (7.60) (A665nm)

Total Chlorophyll = Chlorophyll a + Chlorophyll b

The comparisons between means were made using least significant difference test (L.S.D.) at significant level of 5% for pot experiment parameters and 1% for chemical characteristics. SPSS version 16 was used for data analysis.

III. Results and Discussion

Table I shows the effects of soaking seeds in BA or daminzide solutions on some vegetative characteristics. It was observed that BA treatment led to significant decreases in number of leaves $plant^{-1}$ and increases in tiller number $plant^{-1}$ as compared with controls. On the other hand, daminozide treatment caused significant decreases in the plant height, number of leaves $plant^{-1}$ and flag leaf area. In addition, the number of tillers and shoot dry weight of plant were increased by daminozide treatment. These results disagree with (Gumani, et al., 2007) concerning wheat plants. While partially agreed with those obtained by by (Sorte, et al., 1991) concerning wheat plants. The increase in the number of tillers could be due to the suppression of apical dominance by BA, thereby diverting the polar transport of auxins towards the basal nodes leading to increased branching (Hopkins, 1999). The significant decrease of plant height, leaves number $plant^{-1}$ and flag leaf area by daminozide treatments and significant increases of tiller number $plant^{-1}$ and shoot dry weight by such treatment may be explained that the growth of many stems can be reduced or inhibited by synthetic chemicals that block gibberellin biosynthesis. This so-called growth retardant or antigibberellins, they reducing endogenous gibberellins levels, suppressing internodes elongation and promoting root formation (Simas, et al., 2007). It has been suggested that, daminozide is anti-gibberellins dwarfing agents, leading to a deficiency of gibberellins in the plant consequently reducing the growth by blocking the conversion of geranyl pyrophosphate to copalyl pyrophosphate which is the first step of gibberellins synthesis (Hazarika, 2003).

TABLE I
Effect of benzyl adenine (BA) or Daminozide on some vegetative characteristics

Treatments (ppm)	Plant height (cm)	Number of tillers $plant^{-1}$	Number of leaves $plant^{-1}$	Flag leaf area$(cm)^2$	Shoot dry weight (g)
Control	70.85	4.67	15.50	40.44	9.86
BA300	70.08	6.58	13.00	42.41	10.77
Daminozide300	66.94	6.50	9.67	29.34	11.52
L.S.D. (0.05)	3.55	1.48	2.13	5.18	1.56

Fig. 1 shows that plant height of Abu-Ghureb cultivar was significantly higher than that of Sham6 cultivar. The number of leaves, flag leaf area and shoot dry weight of Sham6 cultivar plant were significantly higher than that of Abu-Ghureb cultivar. Probably, this was due to genetic potential variation of the species.

According to results represented in Table II, it is found that chlorophyll *b* was increased significantly by BA. Other treatments showed no significant effects on leaf chlorophyll content. This results partially agree with those obtained by (Mehrotra, et al., 1983) and (Yang, et al., 2003) concerning wheat plants. The increase in chlorophyll content of BA treated plants could be referred to hormonal effects as it has been noted earlier that BA stimulate chlorophyll biosynthesis through acceleration of chloroplasts differentiation and stimulating photosynthetic enzymes and retard chlorophyll degradation (Abdul and Mohamad, 1986). On the other hand,

Fig. 2 showes that no significant differences were observed on chlorophyll content between both cultivars and the highest values of chlorophyll found with Abu-Ghureb cultivar.

TABLE II
EFFECTS OF BENZYL ADENINE (BA) OR DAMINOZIDE ON LEAF CHLOROPHYLL CONTENT

Treatment (ppm)	Chlorophyll a (mg g^{-1})	Chlorophyll b (mg g^{-1})	Total Chlorophyll (mg g^{-1})
Control	0.65	0.19	0.83
BA300	0.92	0.46	1.38
Daminozide300	0.63	0.13	0.76
L.S.D. (0.01)	n.s.	0.22	0.57

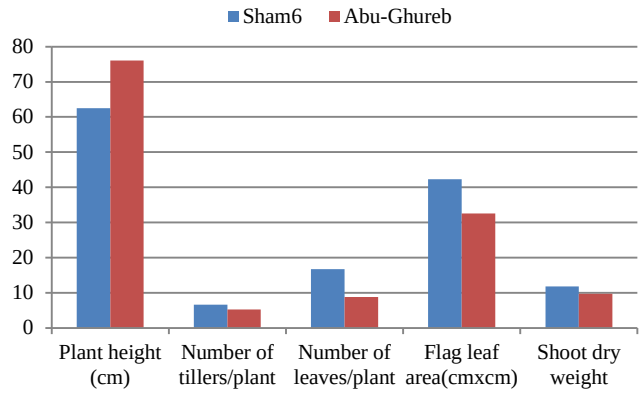

Fig. 1. Effect of cultivars on some vegetative characteristics.

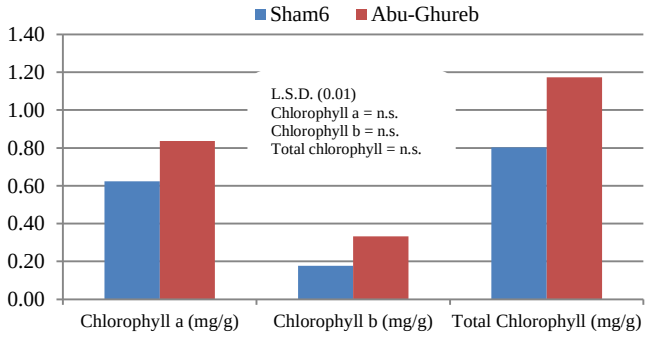

Fig. 2. Effects of wheat cultivars on leaf chlorophyll content.

The results indicated that the number of grains $plant^{-1}$, weight of 1000 grains and grains yield were significantly increased by both treatments as compared with controls (Table III). This results partially agree with those obtained by (Gurmani, et al., 2007) and (Sorte, et al.,1991) concerning wheat plants. The significant increases in grain number $plant^{-1}$ and weight of 1000 grains by BA treatments may be due to the essential role of this plant growth regulator in the regulation of different physiological processes including plant growth and development, increased cell division and high assimilate demand in the growing embryonic tissue and it was suggested that BA is required for early embryo growth (Crosby et al., 1981).

TABLE III
EFFECTS OF BENZYL ADENINE (BA) OR DAMINOZIDE ON SOME YIELD CHARACTERISTICS

Treatment (ppm)	Spike length (cm)	Number of spikes $plant^{-1}$	Number of spikelets $spike^{-1}$	Number of grains $plant^{-1}$	Weight of 1000 grains (g)	Grains yield (g $plant^{-1}$)
Control	14.18	4.00	12.06	100.17	33.12	3.31
BA300	13.71	3.67	13.04	120.84	34.68	4.19
Daminozide300	13.71	3.33	11.10	122.34	35.08	4.29
L.S.D. (0.05)	n.s.	n.s.	n.s.	9.39	1.46	0.71

The increased of grain number $plant^{-1}$ and weight of 1000 grains by daminozide treatments may be attributed to the retarded vegetative growth because growth inhibition in one plant part may enhance growth in other plant parts ordaminozide treatments increased nutrient supplies and metabolites for reproductive growth such as water soluble carbohydrates, sucrose, proteins, gliadin, glutenin, enzymes and plant hormones (Scott et al., 1967).

Cultivar variability was noted for some tested parameters Fig. 3, it shows that spike length and grain number of Sham6 cultivar were significantly higher than Abu-Ghurebcultivar. This means they are differing in their response to the studied treatments and this may be due to genetic factor.

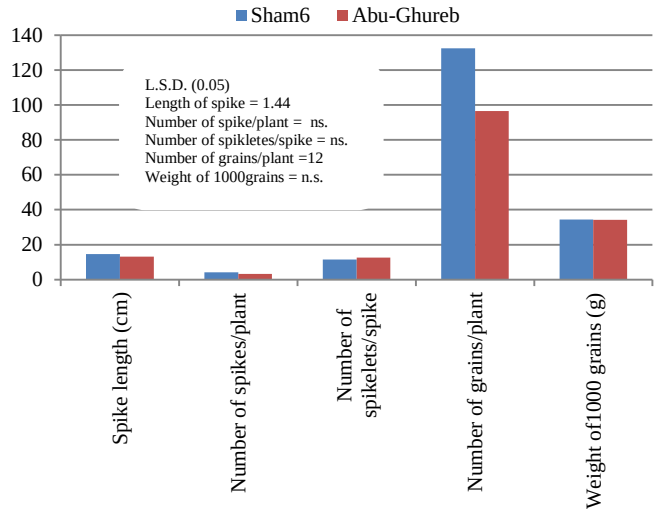

Fig. 3. Effects of wheat cultivars on some yield characteristics.

Table IV showed BA treatment significantly increased the P, dry gluten, N and protein contents of the seeds. Also daminozide treatment led to significant increases in the P, N and protein contents of the seeds. There were no previous studies concerning these parameters, it may be explained

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through role of daminozide in increasing osmotolerance metabolites include avariety of proteins, sugars (trehalose, sucrose, mannitol, etc.), amino acids (proline, glycinebetaine), glycerol, polyols and /or through regulating various processes including absorption of nutrients from soil solution might be the cause for increase root growth increases the hydraulic conductivity of the root or the increasing of nutrient content of the seeds may be due to the role of daminozide in reducing the vegetative growth, which led to decrease the competition between vegetative and reproductive organs for nutrients (Rathod, et al., 2015).

TABLE IV
EFFECTS OF BENZYL ADENINE (BA) OR DAMINOZIDE ON SOME SEED NUTRIENTS CONTENT

Treatment (ppm)	Phosphorus (mg g^{-1})	Potassium (mg g^{-1})	Wet Gluten (%)	Dry Gluten (%)	Nitrogen (mg g^{-1})
Control	3.24	3.82	26.95	10.39	11.24
BA300	4.80	4.04	31.89	14.00	20.98
Daminozide300	5.08	3.86	33.45	12.91	20.26
LS.D. (0.01)	0.60	n.s.	n.s.	3.44	3.09

The increase in nutrients content of BA treated plants could be referred to hormonal act as sink for mobilization of nutrients like amino acids, hormones and mineral nutrients (Hopkins, 1999). There were high significant differences among cultivars. Moreover, it was found that Abu-Ghureb cultivar had high significant more P, N and protein than that of Sham6 cultivar (Fig. 4). However, non-significant differences were observed between Abu-Ghureb and Sham6 with regarding to K, wet and dry gluten seed content.

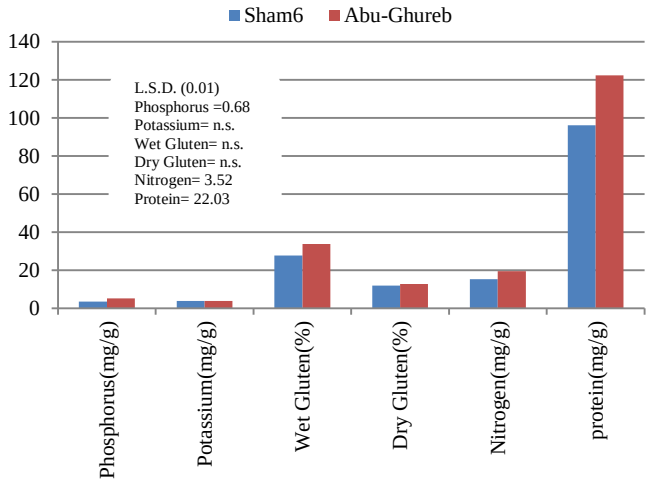

Fig. 4. Effect of wheat cultivars on some seed nutrients content.

IV. CONCLUSION

From the study, it might be concluded that both plant growth regulators (BA and daminozide) had the positive effect. In this respect, the impact of BA on quantitative and qualitative characteristics of wheat plant was greater than daminozide. The highest value of some vegetative characteristics and yield characteristics was obtained from Cham6, whereas, the highest value of plant height and some nutrient contents of seed was recorded from Abu-Ghureb.

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