EFFECT OF BRASSINOLIDE ON SOME GROWTH TRAITS AND BIOLOGICAL YIELD OF BREAD WHEAT

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ABSTRACT

A field experiment was conducted at the experimental farm, Dept. of Field Crop, Coll. of Agriculture of Engineering Sciences, University of Baghdad, Al-Jadiriya, Iraq during the winter seasons of 2018-2019 and 2019-2020, to study the effect of brassinolide on some vegetative growth traits of the bread wheat *Triticum aestivum L.* variety Rasheed by determining the best soaking periods and the spraying stage to production efficiency. A split plot arrangements were carried out according to RCBD design with three replicates, where the main plots contained three soaking periods of brassinolide (concentration 1 mg L^{-1}) 6,12,18 hours, as well as comparison of 18hour distilled water and dry seeds. While the sub plots contained three spraying stages the same of brassinolide concentration (S1: tillering + elongation stage, S2: booting + 100% anthesis stage, S3:100% anthesis + grain formation stage) and tap water was sprayed on plants as control treatment. The results showed that soaking wheat seeds with 12 hours of brassinolide gave highest means for growth traits and biological yield 13.76 and 13.90 Mg ha^{-1} for both seasons. In addition, the results showed that the spraying stage (tillering + elongation) recorded highest averages in the studies traits above for the both seasons. The interaction between two factors was significant in most studied traits. Therefore we recommend soaking of wheat seeds 12 hour with brassinolide and sprayed with the stage of (tillering + elongation) to obtain the highest vegetative growth and biological yield.

Keywords: soaking, foliar application, growth regulation, growth.
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تأثير البراسينولايد في بعض صفات النمو والحاصل البايولوجي لحنطة الخبز

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المستخلص

نفذت تجربة حقلية في حقل تجارب قسم المحاصيل الحقلية – كلية علوم الهندسة الزراعية / جامعة بغداد، الجادرية خلال الموسم الشتوي لعامي 2018–2019 و2019–2020 لدراسة تأثير البراسينولايد في بعض صفات النمو الخضرية لحنطة الخبز (*Triticum aestivum L.*) صنف الرشيد من خلال تحديد افضل مدة تنقيع ومرحلة رش لرفع كفاءة الانتاج. استعمل تصميم القطاعات الكاملة المعشاة بترتيب الالواح المنشقة بثلاث مكررات. شملت الالواح الرئيسية ثلاث مدد لتنقيع البذور بالبراسينولايد 18,12,6 ساعة فضلا عن معاملتي المقارنة وتشمل التنقيع بالماء المقطر لمدة 18 ساعة والبذور الجافة، في حين شملت الالواح الثانوية ثلاث مراحل للرش وهي : (S1: الرش بمرحلة الاشطاء + بمرحلة الاستطالة وS2 :الرش بمرحلة البطان + بمرحلة 100% تزهير و S3: الرش بمرحلة 100% تزهير + بمرحلة تكوين الحبة) والمقارنة الرش بالماء فقط. اظهرت النتائج تفوق مدة 12 ساعة تنقيع بالبراسينولايد في اعطاء اعلى المتوسطات في صفات النمو والحاصل البايولوجي (13.76 و13.90) ميكاغرام $هـ^{-1}$ للموسمين كليهما، كما تفوقت مرحلة الرش S1 (الاشطاء + الاستطالة) باعطاء اعلى المتوسطات في الصفات اعلاه وللموسمين، كان التداخل معنويا بين عاملي الدراسة في جميع الصفات المدروسة. لذا نوصي بتنقيع بذور الحنطة لمدة 12 ساعة بالبراسينولايد ورشه بمرحلة (الاشطاء+الاستطالة) للحصول على افضل صفات للنمو الخضري واعلى حاصل بايولوجي.

كلمات مفتاحية: التنقيع، الرش، منظم نمو، النمو.
*** البحث مستل من اطروحة دكتوراه للباحث الاول.**

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INTRODUCTION

The land of rafidain has been famous for its cultivation of wheat since ancient times. However, the productivity of this crop represented by the grain yield, is still low, possibly due to the lack of use improved varieties, the lack of management of the field as required, in addition to the climatic conditions of high temperatures, drought and salinity. Because of the importance of wheat in the local and international markets and its different food uses, it was necessary to improve vegetative characters to increase the efficiency of production (2,19). Plant growth regulators have known since their used in 1930 to play a key role in the growth and development of plants, as small amounts of them encourage, inhibit or mutine the vital and physiological processes of the plant, A lot of researches has been mentioned on the importance physiological roles of the brassinolide growth system and its effect in increasing the production of different crops 20-60% (5,9,15). All the scientific techniques used by plant growth regulators depend on the effect the time of addition, concentration and pH on plant depending to. The basis for the absorption of the growth regulator. Application method one of the most commonly influence growth regulators, Seed soaking, a simple and low-cost physiological technique that applied before cultivation, through which the seeds are partially hydrated to the point, where the metabolism activity begins before emergence, It reduces the duration of seed emergence of seedling and make them more resistant to environmental stress as well as improve the efficiency of the nutrients use by the seedling, which allow for the highest growth, Spraying method on the vegetative stage is an effective way through which to use growth regulator several times during the various plant stages growth (18,23). Sairam (16) reported when soaking two varieties of wheat seeds with a concentration 0.01 and 0.05 ppm of brassinosteroids or plant foliar spray with same concentrations, producing the highest values of the of vegetative growth characteristics compared to the control treatment. Eleiwa et al (6) reported through their study on wheat that brassinosteroids had an important role through the significant increase in growth parameters, metabolic efficiency and photosynthesis, increase crop productivity. In another study, El-Feky and Abo-Hamad (7) explained that the seeds treated with brassinolide, particularly the concentration of 1 mg L^{-1}, caused a significant increases in growth traits, carbohydrates, proteins in the roots and green parts. The aim of the study was: to determine the best soaking period and the stage of spraying of the bread wheat var. Rasheed to increase the efficiency of production.

MATERIALS AND METHODS

An experiment was conducted at the experimental field, Department of Field Crops, College of Agricultural Engineering Sciences, University of Baghdad, Jadiriya, during the winter season 2018-2019 and 2019-2020. Randomized Complete Block Design (RCBD) within Split Plot arrangement was used with three replicates, Soaking periods 6,12,18 hours of brassinolide concentrations 1 mg L^{-1}, as well as control of 18 hour distilled water and dry seeds without soaking occupied the main plots. Spraying stages in same concentrations of brassinolide according to Zadoks scale (24) (S1: Tillering + elongation stage, S2: booting + 100% anthesis stage, S3:100% anthesis + grain formation stage) and Control treatment without spraying brassinolide were in sub plots. The net of sub plot area was $4m^2$, which contained 13 lines, 2m long, 15 cm apart, 5 cm depth, Al-Rasheed cv. seeds were planted on 11/12 and 22/11 both seasons the seeding rate 160 kg ha^{-1} were sown with hand drilling. Before sowing, soil was analyzed for its mechanical and chemical properties (0-30) cm are shows in Table 1.

Table 1. Some chemical and physical characteristics of the study soil

character	pH	EC ds.m^{-1}	N ppm	P ppm	K ppm	O. M %	Sand%	Clay%	Silt%
2018-2019	7.20	1.6	101.5	14.90	83.56	0.94	414	288	298
2019-2020	7.28	3.95	9.45	2.13	462.5	0.73	510	80	410

The compound fertilizer 15:15:15 was added at land preparing while the nitrogen fertilizer (260 kg ha^{-1}) was applied in a form of urea (46%N) in two split doses 120 kg ha^{-1} at tillering stage ZGS:20,second 140 kg ha^{-1} at booting stage ZGS:40 (12). Wheat samples were collected from 0.3 m^2 for each treatment

at 100% anthesis stage to determine following the growth parameters :

plant height cm: Ten random main stems were taken and their length was measured then the average was recorded.

Flag leaf area cm^2 : Determined using the equation : flag leaf length × width at the middle × 0.95 (21).

Number of tiller m^{-2}: total number of tillers was counted and converted to one meter square.

Content of chlorophyll : Determined in the fresh leaves and calculated according to the formulae Total Chlorophyll = 20.2 D (645) + 8.02 D (663) (8) then it was converted into a $100g^{-1}$ wet weight according to the following formulae: mlg $liter^{-1}$× final size of extract (liter) x 100/ sample weight (g).

Crop growth rate (CGR): Samples were dried in oven at 70^o C for 48 hours and then calculated as follows $(W_2 - W_1)/ (T_2 - T_1)$ where W_1 and W_2 are shoot dry weights taken at two consecutive harvests over time intervals T_1 and T_2 (11).

Biological yield (Mg ha^{-1}): Determined from harvested from each plot after drying, were weighed and was recorded in kg h^{-1} and then converted into t ha^{-1}.=

Data were analysis using analysis of variance. The means were compared using the least significant differences at 5% level (20).

RESUITS AND DISCUSSION

Plant height: Data in Table 2. shows the significant effect of soaking period, spraying stages, and their interaction on this trait for both seasons. Seeds soaking at 12h with brassinolide produced highest plant height (111.64 and 113.00 cm), while plants at the drying seed treatment produced (85.25 and 88.43 cm) for both seasons, respectively due to its role soaking as the growth regulators of the cell cycle and the process of elongation (13),These results are in agreement with those obtained by other authors (1,3). Regarding spraying stages, results in Table 2. show that the highest values (111.50 and 116.02 cm) for both seasons, respectively were recorded at S1 stage compared to other stages which could be due to the role of brassinolide affects the activity and divisions of the merstim cells (6). A significant interaction due to differences in response of soaking period to spray stage. 12h soaking of brassinolide gave the highest plant height (122.41 and 124.82 cm) for both seasons, respectively when sprying in S1 stage, It later decreased significant to the stage of S2, S3 and control for both seasons.

Table 2. Effect of soaking periods, spraying stages and their interaction in the height of wheat plant (cm) for 2018-2019 and 2019-2020

Soaking periods	2018-2019 Spraying stages					2019-2020 Spraying stages				
	S0	S1	S2	S3	Mean	S0	S1	S2	S3	Mean
Dry Seed	85.25	101.07	89.48	86.77	90.64	88.43	105.90	92.57	89.61	94.13
18h distilled water	91.78	107.48	94.18	92.11	96.39	94.94	112.11	96.70	95.19	99.73
6h	94.66	111.41	96.75	94.69	99.38	97.18	115.69	100.27	97.19	102.58
12h	107.15	122.41	109.59	107.39	111.64	107.98	124.82	110.97	108.24	113.00
18h	101.91	115.13	103.20	100.22	105.12	101.23	121.57	103.79	101.26	106.96
Lsd 5%			1.4		1.3			1.74		1.53
Mean	96.15	111.50	98.64	96.24		97.95	116.02	100.86	98.30	
Lsd 5%			0.65					0.78		

Flag leaf area: It is reved from the results in Table 3. that period of soaking, spraying stage and their interaction affected significantly the flag leaf area in both seasons. Highest leaf area (53.28 and 53.91 cm^2) was from 12h soaking obtained, while the lowest flag leaf area (42.29 and 43.52 cm^2) were produced from dry seed in both seasons, respectively. Similar results were reported by Chakma (3) who concluded that the different flag area for wheat differed significantly due to the period of soaking. Highest leaf area were recorded with spraying stage S1 (52.19 and 53.15cm^2) followed by S2 (48.99 and 49.69 cm^2) in both seasons, respectively, whereas lowest leaf area were recorded from plants of S3 and S. This observation indicated that variation among the spraying stage could be due to the fact that the emergence and development of the leaf area was during the stage of vegetative growth

represented by the elongation to the end of the booting stage, when the blade of the leaf area was completed, as the plant depends on these stages mainly on the elongation and expansion of the cells of its merstim tissue. Interaction results Table 4. show that the response to the spraying stage was the highest significant for all the periods of soaking, especially soaking for 12h which had at S1 stage (56.48 and 57.29 cm^2) for both seasons, respectively followed by the stage S2 and then decreased later significantly for the stage S3 and the control for both seasons.

Table 3. Effect of soaking periods , spraying stages and their interaction in the Flag leaf area of wheat (cm^2) for 2018-2019 and 2019-2020

Soaking periods	2018-2019 Spraying stages					2019-2020 Spraying stages				
	S0	S1	S2	S3	Mean	S0	S1	S2	S3	Mean
Dry Seed	38.51	47.63	43.77	39.24	42.29	40.08	49.34	44.34	40.32	43.52
18h distilled water	42.88	50.06	45.54	42.71	45.30	43.62	51.35	46.25	43.88	46.28
6h	44.33	52.60	48.94	45.53	47.85	46.87	53.06	50.36	46.70	49.25
12h	50.72	56.48	54.96	50.96	53.28	51.69	57.29	54.88	51.78	53.91
18h	47.74	54.17	51.72	47.68	50.3	48.81	54.71	52.60	48.98	51.28
Lsd 5%			1.39		1.12			1.56		1.38
Mean	52.19	48.99	45.22	44.84		53.15	49.69	46.33	46.22	
Lsd 5%			0.62					0.70		

Content of chlorophyll: Results in Table 4. indicate that period of soaking had a significant effect on content of chlorophyll. Period of soaking at 12h of brassinolide attained the highest content of chlorophyll (554.13 and 554.02 Mg per 100 g wet weight), compared with those obtained when period of soaking at 18, 6 , distiller water and seed drying which gave (528.03, 514.13, 487.38 and 457.68 Mg per 100 g wet weight) for first season, and 534.36, 519.52, 467.90 and 467.06 Mg per 100 g wet weight) for second season, respectively. The increase in this trait with seed wheat soaking of brassinolide could be due to the influencing transcription and translation processes by BR-Signalling during the biosynthesis of chlorophyll and reducing its degradation (10). Regarding the spraying stage, results in Table 4 show a significant difference among spraying stage. Generally, the highest spraying stage in chlorophyll content was S1 which had (539.16 and 541.85 Mg per 100 g wet weight) Superior to all stages of brassinolide spraying and control (water spray only), for both seasons respectively. A significant interaction due to differences in response of soaking period to spraying stage and 12h soaking of brassinolide had the highest content of chlorophyll (574.23 and 585.93 Mg per 100 g wet weight) at sprying in S1 stage.

Table 4. Effect of soaking periods , spraying stages and their interaction in content of chlorophyll of wheat (Mg per 100 g wet weight) for 2018-2019 and 2019-2020

Soaking periods	2018-2019 Spraying stages					2019-2020 Spraying stages				
	S0	S1	S2	S3	Mean	S0	S1	S2	S3	Mean
Dry Seed	433.40	489.40	461.60	446.32	457.68	429.90	501.30	476.65	460.65	467.06
18h distilled water	455.34	528.50	494.33	471.33	487.38	474.01	526.07	504.87	486.67	497.90
6h	489.45	544.30	519.33	503.45	514.13	500.41	539.73	525.27	512.67	519.52
12h	533.40	574.23	561.40	547.49	554.13	529.20	585.93	556.63	544.31	554.02
18h	502.07	559.37	533.77	516.93	528.03	513.87	556.20	539.93	527.44	534.36
Lsd 5%			10.63		6.30			11.36		8.10
Mean	539.16	514.09	497.10	482.73		541.85	520.62	506.35	489.48	
Lsd 5%			4.7					5.08		

Number of tillers: Results in Table 5. show that significant differences in tiller number regarding period of soaking. The highest number of tillers was recorded with soaking for 12h with brassinolide (541.0 and 552.6 m^2), all period of soaking treatments, with brassinolide or distilled water, surpassed treatment of dry seeds which had the lowest value of plants dry seed (425.8 and 447.0m^2) for both seasons, respectively. Technique of seed soaking due to improve the performance of plants as a result of increasing the growth,

spread of roots and make them more efficient to absorb water and nutrients from the soil and a result the formation of a plant density helps to cover a larger area. These results are in agreement with those obtained by Ali et al (1) It has been found that different soaking methods increase the number of tillers compared to dry seeds. Results clearly show significant variations among the tested spraying stage, spraying stage S1 had the highest number of tillers (542.2 and 552.7 m^2) for both seasons, respectively. While the another stages were did not differed significantly themselves. The reason behind the variation number of tillers could be due to the effect of brassinolide in increasing growth and the expansion of leaves merstim, and production of dry matter, as well as the formation of a radical system with high absorption of nutrients, especially in the period of their formation which is represented by tillering and the elongation stage (4). Regarding the interaction the combination 12h soaking and spraying stage S1 was significant differences by producing the highest number of tillers (588.8 and 598.8 m^2) for both seasons respectively, while the response was the same for all soaking treatment for the spraying stages S2 , S3 and control for both seasons.

Table 5. Effect of soaking periods , spraying stages and their interaction in the number tillers of wheat (m^{-2}) for 2018-2019 and 2019-2020

Soaking periods	2018-2019 Spraying stages					2019-2020 Spraying stages				
	S0	S1	S2	S3	Mean	S0	S1	S2	S3	Mean
Dry Seed	398.7	494.2	410.1	400.4	425.8	422.7	502.0	432.4	430.9	447.0
18h distilled water	464.5	518.9	469.4	465.4	479.6	488.6	529.8	494.2	491.2	500.9
6h	488.2	543.3	493.9	489.4	503.7	504.8	552.4	507.5	505.4	517.5
12h	522.1	588.8	528.6	524.4	541.0	535.9	598.8	539.5	536.0	552.6
18h	500.3	565.6	504.4	502.7	518.2	514.6	580.5	520.3	517.5	533.2
Lsd 5%		15.84			9.16		14.14			8.70
Mean	542.2	481.3	476.4	474.8		552.7	498.8	496.2	493.3	
Lsd 5%			7.09				6.32			

Crop growth rate: Period of soaking, spraying stage and their interaction significantly affected crop growth rate in both seasons (Table 6). Period of soaking 12h attained the highest crop growth rate (11.75 and 12.13 g m^{-2} day^{-1}), while the lowest value was with treatment dry seed (10.55 and 11.08 g m^{-2} day^{-1}) for both seasons, plants produced from seeds treated before sowing are faster in growing than non-treated due to stimulate various processes associated with protein synthesis and improve nutrient efficiency as a result of pretreatment to regulate the cell cycle and elongation processes. Regarding the spraying of stage, results in Table 6 showed Generally, the highest values in crop growth rates was S1 which produced (11.50 and 12.01 g m^{-2} day^{-1}) followed by S2 which produced (11.26 and 11.74 g m^{-2} day^{-1}) for both season, respectively. The superiority of S1 stage due to improving many of the plant's biological processes, which was reflected in increasing the solar radiation interception and its conversion to chemical energy, producing plants with a superior by the plant height, the area of the flag leaf, content of chlorophyll and the number of tillers (Table 2,3,4,5), this result is in agreement with the result obtained by Safi and Al-Baldawi (17) who found that spraying of growth regulator caused an increase the crop growth rate. As for the interaction, the highest means (11.95 and 12.37 g m^{-2} day^{-1}) were recorded with 12h, soaking of brassinolide and sprayed with the stage of S1 was for both seasons respectively, followed by the S2 and then decreased significant later for the stages S3 and the control for both seasons.

Table 6. Effect of soaking periods , spraying stages and their interaction in the crop growth plant of wheat (g m^{-2} day^{-1}) for 2018-2019 and 2019-2020

Soaking periods	2018-2019 Spraying stages					2019-2020 Spraying stages				
	S0	S1	S2	S3	Mean	S0	S1	S2	S3	Mean
Dry Seed	10.33	10.99	10.53	10.36	10.55	10.85	11.60	11.02	10.86	11.08
18h distilled water	10.70	11.21	10.95	10.74	10.90	11.49	11.85	11.67	11.51	11.63
6h	11.22	11.57	11.40	11.25	11.36	11.65	12.02	11.83	11.68	11.80
12h	11.61	11.95	11.80	11.65	11.75	11.98	12.37	12.17	12.01	12.13
18h	11.41	11.76	11.60	11.45	11.55	11.80	12.19	11.99	11.82	11.95
Lsd 5%	0.14				0.09	0.16				0.10
Mean	11.50	11.26	11.09	11.05		12.01	11.74	11.57	11.56	
Lsd 5%	0.06					0.07				

Biological yield: Period of soaking had a significant effect on the biological yield for both seasons (Table 7). Highest biological yield (13.76 and 13.90 Mg ha^{-1}) was recorded by soaking for 12h with brassinolide, while the lowest value (12.40 and 12.46 Mg ha^{-1}) were produced from dry seed treatment in both seasons, respectively. It is known that the soaking of seeds before sowing had a positive effect in the establishment of the field in terms of early growth seedling and plant nutrition, resulting in a green cover with a leaf area capable of receiving the most amount of sunlight and increasing the efficiency of carbon representation and accumulation of dry matter (25,22). Regarding spraying stage, the S1 stage was superior in increasing the biological yield, of 13.90 and 13.99 Mg ha^{-1} in both seasons, respectively compared to the other spraying stages to increase vegetative growth associated with plant height, flag leaf area, content of chlorophyll and number of tillers (Tables 2,3.4,5) and the role of brassinolide in the plant's metabolic processes, which increased solar radiation interception and convert it to chemical energy resulted in accumulation of dry matter carbohydrates, this finding is similar to that of Nasralla et al (14) who reported higher biological yield of wheat with foliar application of brassinolide. Results in Table 7. show significant interaction between two factors in both seasons, this indicates different response of soaking period, which used in this experiment with spraying stage. Period of 12h with brassinolide produce highest biological yield (14.45 and 14.51 Mg ha^{-1}) at S1 followed S2 for both seasons. The lowest means of this trait were recorded with dry seed with spraying stage S3 and the control for both seasons, respectively.

Table 7. Effect of soaking periods, spraying stages and their interaction in the biological yield of wheat plant (Mg ha^{-1}) for 2018-2019 and 2019-2020

Soaking periods	2018-2019 Spraying stages					2019-2020 Spraying stages				
	S0	S1	S2	S3	Mean	S0	S1	S2	S3	Mean
Dry Seed	12.03	13.10	12.28	12.20	12.40	12.10	13.15	12.31	12.28	12.46
18h distilled water	12.27	13.58	12.47	12.42	12.68	12.30	13.79	12.49	12.47	12.76
6h	12.99	14.11	13.35	13.33	13.45	13.12	14.15	13.40	13.35	13.51
12h	13.30	14.45	13.64	13.63	13.76	13.55	14.51	13.78	13.77	13.90
18h	13.16	14.28	13.50	13.47	13.60	13.35	14.33	13.59	13.59	13.71
Lsd 5%	0.14				0.10	0.17				0.12
Mean	13.90	13.05	13.01	12.75		13.99	13.12	13.09	12.88	
Lsd 5%	0.06					0.08				

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