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Physiological effect of gibberellin (GA3) on growth and yield of some Wheat varieties

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ABSTRACT

A field experiment was conducted in the field affiliated to the Department of the field crops- College of Agriculture- University of Karbala during the winter season 2016-2017 to study the effect of spraying gibberellic acid on the growth and yield of three wheat varieties. The Randomized Complete Block Design (RCBD) included factorial experiments of two factors within three replicates was used. The first factor included three wheat varieties: Ipa99, Rasheed, and Latifya, while the second factor included four concentrations of gibberellic acids: 0, 30, 60, and 90 mg.L^{-1}. Results showed the superiority of Rasheed variety giving the highest values of plant height (cm), 1000- grains weight (g), grain yield (t.ha-1), biological yield, and harvest index. The concentration 60mg.L^{-1} was superior to the other gibberellic acid concentrations in the traits: 1000-grains weight, harvest index, and grain yield, while the concentration 90mg.L^{-1} was superior in the two traits flag leaf area and the number of grains. Results also showed a significant effect of the interaction between the wheat varieties and gibberellic acid concentrations in the number of grains. spikes^{-1}. We concluded that spraying gibberellic acid at the concertation 60mg.L^{-1} increases the grain yield significantly

Key words : *GA3, Wheat, Plant growth.*

Introduction

Wheat (*Triticum aestivum* L.) is one of the strategical cereal crops in the world and in Iraq in particular due to its great importance to the human life as it occupies a huge part of the main daily food because it is a major source of energy and nutrition. The wheat crop necessity lays in its grains used for producing bread that is the indispensable food to most of the world's people (Salim and Mahdi, 2012; Al-Juthery *et al*., 2018). Using plant regulators is considered one of the management methodsused for enhancing plant performance as a result of the vital activities done by hormones that are synthesized in plants naturally (AL-Taey, 2014; AL-Taey, 2018). Hamed (2015) reported that in an experiment of using different concentrations of gibberellic acid (0, 100, 200, and 300 mg.L^{-1}), spraying 300 mg.L^{-1} on wheat plants produced the highest values of plant height and the number of grains averaged 103 cm and 55.17 grains respectively. The gibberellins (GAs) are a large group of tetracyclic diterpenoid carboxylic acids, The GAs showpositive effects on seed germination, leaf expansion, stem elongation, flower and trichome initiation, and flowerand fruit development. They are essential for plants throughout their life cycle for growth-stimulatory functions. They also promote developmental phase transitions. Interestingly, there is increasing evidence for their vitalroles in abiotic stress response and adaptation

(AL-Taey, 2017; AL-Taey *et al*., 2018)

Gibberellic acid increases the stem elongation and flowering as well as it has a role in controlling the enzymatic activity in addition to activating the metabolic processes and carbohydrate production (Davies, 2004). This study aims to investigate the physiological effect of gibberellic acid on the growth and yield of some wheat varieties.

Materials and Methods

A field experiment was conducted in the field affiliated to the Department of the field crops- College of Agriculture- University of Karbala, during the winter season 2016-2017. Randomized Complete Block Design was used in the factorial experiment consisted of two factors and three replicates where the first factor included three wheat varieties: Ipa 99, Rasheed, and Latifya, while the second factor included spraying four concentrations of gibberellic acid GA3: 0, 30, 60, and 90mg. L^{-1} Field soil was prepared through plowing, smoothing, leveling, and dividing into plots of 3x4 m in size. Each plot contained 14 rows separated from each other by a 20cm distance. Seeds were planted on November 19, 2016, and irrigated immediately then the irrigation continued during the growing season according to the plant need. Weeding was performed when needed to get rid of weed plants. Fixed amounts of nitrogen (200kg.ha^{-1}) in a urea form (46%N) and phosphorus (100kg.ha^{-1}) in a tri- superphosphate were added, the first patch of nitrogen and the whole phosphorus amount were added during the planting, while the second, third, and fourth patches of nitrogen were added at the three- leaves, elongation, and booting stages respectively. Pure gibberellic acid was prepared according to the required concentrations with distilled water and sprayed, using a hand sprayer, on the vegetative parts at the booting stages during the early morning.

Studied traits

Plant height (cm), leaf area (cm^2): It was calculated as an average of flag leaves of ten major stems for each experiment unit (Roberston and Giunta, 1994)according to the following equation:

Flag leaf area= leaf length x leaf width at the middle x correction factor 0.95

Number of spikes.m^{-2}, Number of grain per spike, Weight of 1000 grains, Grain yield (t.ha^{-1}): It was calculated in one- meter square after adjusting the percentage of moisture to 14%

Biological yield: the weight of all plant parts including spikes in one square meter.

Harvest index: it was calculated according to the following equation

Harvest index= (economic yield / biological yield) x 100

Statistical analysis: data were statistically analyzed according to the Randomized Complete Block Design (RCBD) as a factorial experiment and the results were compared to the lowest significant difference (LSD) at the probability level 0.05 using the statistical software Genstat.

Results and Discussion

Plant height (cm)

Results in Table 1 refer to significant differences among varieties in the plant height. Rasheed was superior variety giving the highest average of plant height (110.70 cm) compared to Latifya and Ipa (100.59 and 97.72 cm respectively) the superiority of Rasheed in this trait is due to its genetic superior capability to utilize the photosynthesis products. This result is consistent with those obtained by Kadam, (2015) and Abdulkarim, (2017) who referred to significant differences among wheat varieties in the plant height. On the other hand, the effect of the AG3 concentrations and the interaction between them and the varieties were not significant.

Flag leaf area (cm^2)

Results in Table 2 illustrate significant differences in flag leaf area among the concentrations of gibberellic acid, where spraying 90mg. L^{-1} AG3 was the superior concentration producing the highest area of the flag leaf averaged 21.07 cm^2 compared to the control treatment giving the lowest flag leaf area (12.22 cm^2). This superiority is attributed to the gibberellic acid effect on increasing cell division and elongation.

Spike number/m^2

Results in Table 3 refer to significant differences among varieties in the number of spikes, while the difference among the AG3 concentrations was not significant in this trait nor the interaction between the wheat varieties and the AG3 concentrations. The variety Lateefa was significantly superior produc-

ing the highest number of spikes (157.3 spikes.m^2) compared to other varieties in this trait where Ipa gave the lowest number of spikes per a square meter. This superiority is due to the tillering capability of this variety and this result was confirmed by the results of AL –hassan, (2011), and Zeboon *et al*. (2017) who reported that the high capability of a variety to produce tillers can give a high number of spikes compared to the varieties of low capability.

Grain number.spike^{-1}

Results in Table 4 show significant differences among varieties, concentrations, and the interaction between them in producing the number of grains. spike^{-1}. Latifya was significantly superior giving the highest number of grains averaged 32.425 grains compared to the two other varieties, Ipa 99 and Rasheed, which gave the number of grains averaged 29.325 and 21.425 grains respectively, i.e. the varieties differ from each other in the produced number of grains. This result goes in line with the results ofAL-Dawoodeand AL-Obaidi (2014) and Zeboon *et al.* (2017) who referred to the differences among wheat varieties in the number of grains.spike^{-1}, the difference is due to the competition between the external and internal growth factors of the plant. Regarding the gibberellic acid concentrations, spraying 90 mg.L^{-1} was superior producing the highest number of grains reached 29.433 grains on average, while the control treatment gave the lowest

Table 1. Effect of varieties and gibberellic acid concentrations and the interaction between them on the plant height (cm)

Varieties AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	91.00	112.17	100.17	101.11
30	95.27	108.92	103.95	102.71
60	95.93	109.44	97.83	101.07
90	108.68	112.25	100.42	107.12
Mean	97.72	110.70	100.59	
L.S.D$_{0.05}$	Varieties	Concentrations	Interaction	
	4.495	n.s	n.s	

Table 2. Effect of varieties and gibberellic acid concentrations and the interaction between them on the flag leaf area (cm^2)

Varieties/ AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	12.25	16.31	8.10	12.22
30	19.63	23.50	20.09	21.07
60	21.65	19.23	22.09	20.99
90	26.59	20.72	23.95	23.75
Mean	20.03	19.94	18.56	
L.S.D$_{0.05}$	Varieties	Concentrations	Interaction	
	n.s	5.487	n.s	

Table 3. Effect of varieties and gibberellic acid concentrations and the interaction between them on the spike number. m-^{2}

Varieties/ AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	119.3	118.3	147.3	128.3
30	108.0	136.0	180.0	141.3
60	123.3	125.3	146.7	131.8
90	124.7	126.0	155.0	135.0
Mean	118.8	126.4	157.3	
L.S.D$_{0.05}$	Varieties	Concentrations	Interaction	
	14.48	n.s	n.s	

number of grains per a spike (26.433 grains). The reason behind the superiority this concentration is attributed to the physiological effect of gibberellic acid reducing the percentage of the ovary abortion and thus increased the number of grains. Concerning the interaction between wheat varieties and gibberellic acid concentrations, the highest number of grains was 34.800 grans on average obtained from the interaction between Latifya and the control treatment, while the lowest number of grains (20.000) was gotten from the interaction between Rasheed and the control treatment.

Results of Table 5 refer to significant differences among wheat varieties in the weight of 1000 grains, while the differences among gibberellic acid concentrations and their interaction with the varieties are not significant. The superior variety in this trait was Rasheed producing the highest weight of 1000 grains averaged 41.59 g, whereas the Latifya gave the lowest weight of 1000 grains averaged 35.45 g. This superiority is due to the low number of grains.spike^{-1} (Table 4), that is called the principle of compensation as there are many factors affect the final grain weight including pre- fertilization factors determining the floret size and later the resulted grain size (Klepper *et al.,* 1998). Concerning gibberellic acid concentrations, 60mg.L^{-1} gave the highest weight of 1000 grains (40.20 g) and was significantly superior to the others, while the concentration 30mg.L^{-1} gave the lowest weight of 1000 grains (33.68g). This superiority may be due to the physiological effect of gibberellic acid on increasing the carbon assimilation efficiency and increasing the dry matter accumulation in the grains.

Grain yield (t.ha^{-1})

Results in Table 5 show significant differences among the varieties while the differences among the concentrations and among the interactions between varieties and concentrations were not significant. The wheat variety, Rasheed was superior in producing the highest yield of grains averaged 4.132 t.ha^{-1}, whereas Ipa produced the lowest yield averaged only 3.579t.ha^{-1}. Wheat varieties differ significantly from each other in yield of grains, this is consistent with the results of AL-baldawi, (2006) and Kadam, (2015). Regarding the gibberellic acid concentrations, spraying 60 and 30 mg.L^{-1} were the superior concentrations giving the highest yield of grains averaged 3.934 and 3.914 t.ha^{-1} respectively, while

Table 4. Effect of varieties and gibberellic acid concentrations and the interaction between them on the grain numer.spike^{-1}

Varieties/ AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	24.500	20.000	34.800	26.433
30	31.200	23.300	29.300	27.933
60	29.500	20.243	33.300	27.681
90	32.100	23.900	32.300	29.433
Mean	29.325	21.861	32.425	
$L.S.D_{0.05}$	Varieties	Concentrations	Interaction	
	0.1869	0.2158	0.3738	

1000-grains weight (g)

Table 5. Effect of varieties and gibberellic acid concentrations and the interaction between them on the 1000-grains weight

Varieties/ AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	37.95	43.04	35.24	38.74
30	32.82	34.03	34.17	33.68
60	36.80	46.13	37.89	40.27
90	37.26	43.16	34.51	38.31
Mean	36.21	41.59	35.45	
$L.S.D_{0.05}$	Varieties	Concentrations	Interaction	
	3.544	4.092	n.s	

the control treatment gave the lowest yield averaged 3.498 t.ha^{-1}. The superiority is due to the superiority in the trait of 1000- grains weight (Table 5).

Biological yield (t.ha^{-1})

Results in Table 7 refer to significant differences among the varieties, while the differences among concentrations and among the interaction between varieties and concentrations were not significant. Rasheed was the significantly superior variety giving the highest biological yield reached 11.45 t.ha^{-1} compared to Ipa giving the lowest biological yield was 10.59t.ha^{-1}. Rasheed superiority in this trait is attributed to its superiority in the traits: plant height (Table 1), 1000-grains weight (Table 5), and grain yield (Table 6).

Results in Table 8 illustrate significant differences among varieties as well as among gibberellic acid concentrations, while the differences among the interaction between varieties and concentrations were not significant. The Rasheed variety was superior in this trait and gave the highest harvest index reaching 36.11%, whereas Latifya gave the lowest harvest index (33.57%). The reason behind this superiority is due to the efficiency of this variety to utilize the photosynthesis products and to accumulating dray

Table 6. Effect of varieties and gibberellic acid concentrations and the interaction between them on the grain yield (t.ha^{-1})

Varieties / AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	3.113	3.113	3.561	3.498
30	3.859	3.859	3.739	3.919
60	3.780	3.780	3.706	3.934
90	3.564	3.564	3.554	3.783
Mean	3.579	3.579	3.640	
L.S.D$_{0.05}$	Varieties	Concentrations	Interaction	
	0.183	0.211	n.s	

Table 7. Effect of varieties and gibberellic acid concentrations and the interaction between them on the biological yield (t.ha^{-1})

Varieties / AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	10.51	11.49	11.16	11.05
30	10.81	11.50	11.14	11.15
60	10.46	11.60	10.27	10.78
90	10.56	11.23	11.12	10.97
Mean	10.59	11.45	10.92	
L.S.D$_{0.05}$	Varieties	Concentrations	Concentrations	
	0.642	n.s	xn.s	

Harvest index (%)

Table 8. Effect of varieties and gibberellic acid concentrations and the interaction between them on the biological yield (t.ha^{-1})

Varieties AG3 concentration	Ipa 99	Rasheed	Latifya	Mean
Control	29.61	33.32	32.33	31.75
30	34.98	37.51	33.29	35.26
60	36.91	35.90	36.62	36.48
90	33.68	37.72	23.05	34.48
Mean	33.79	36.11	33.57	
L.S.D$_{0.05}$	Varieties	Concentrations	Interaction	
	0.997	0.306	n.s	

natter in the seeds where this variety gave the highest yield of grains (Table 6). This result is consistent with those of AL-hassan, (2011) and Zeboon *et al.* (2017) who reported that wheat varieties differ from each other in the harvest index. Concerning the gibberellic acid concentrations, the treatment of spraying 60mg.L^{-1} was the superior AG3 concentration giving the highest harvest index (36.48%), while the control treatment gave the lowest harvest index (31.75%). The superiority of this concentration is due to its influence in increasing the leaf area (Table 2) and grain yield (Table 6), however, the effect of interaction between wheat varieties and gibberellic acid concentrations on the harvest index was not significant.

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