



## Effect of seed priming on grain growth rate and effective filling period in bread wheat (*Triticum aestivum* L.) cultivars

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### ABSTRACT

A field experiment was conducted during winter, 2015-16 with the objective to investigate the effect of bread wheat cultivars (Abu-Ghraib3, Ibaa99, and Alfeteh) and seed priming 100, 100, 150 mg L<sup>-1</sup> of benzyl adenine, salicylic acid, gibberellic acid (GA3), respectively, ethanolic extract of *Salix Sp.*, water extract of *Glycyrrhiza glabra* and distilled water (control) on grain growth rate (GGR), effective filling period (EFP) and accelerating of physiological maturity. Randomized complete block design with three replicates was applied. GA3×Ibaa99 surpassed others in grain yield (7.432 tonne ha<sup>-1</sup>) when gave the highest grain weight (45.13 mg grain<sup>-1</sup>) and GGR (1.5 mg grain<sup>-1</sup> day<sup>-1</sup>) with the fastest time to start and end EFP (5 and 34 days), which mean it reached to physiological maturity earlier. It can be conclude that seed priming led to accelerating the physiological maturity with increase grain yield through enhancing GGR and EFP in bread wheat.

**Key words:** Benzyl adenine, Gibberellic acid, *Glycyrrhiza glabra*, Growth regulators, Physiological maturity, Salicylic acid, *Salix Sp.*

### INTRODUCTION

The grain weight of bread wheat is determined by two main components; the rate and duration of grain filling. The grain weight is determined by grain filling duration only (Al-Hadithi, 2008), while Al-Baldawi (2006) recorded that the rate and duration of grain filling had the same importance in final grain weight. Monpara (2011) studied 21 different genotypes and found that the grain yield of bread wheat was correlated positively with the grain filling rate and time between fertilization and physiological maturity; the long duration of grain filling was associated with higher grain weight and grain yield; also, suggested that yield improvement could be possible through selection for higher grain weight and longer grain filling period. Guendouz *et al.* (2013) noted the absence of significant correlation between grain yield and 1000 kernel weight during the period of grain filling in 10 durum wheat cultivars. The technique of seed priming is being used as an adequate and effective technique to improve wheat seed performance under normal or adverse conditions like soil salinity or irrigation water, water deficit and inappropriate temperature exist (Hamza, 2012; Fuller and Hamza, 2013). Wheat seed priming improved plant stand and led to significantly higher grain yield (17%) over non-primed, in addition to significant difference between cultivars (Ramamurthy *et al.*, 2015). Many studies indicate well the importance of priming to get a good crop stand in many crops of tropical region (Singh *et al.*, 2015). Priming with GA3 and ammonium molybdate

allowed repair system to activate enzyme synthesis and combat sub-cellular damage due to accelerated ageing (Arun *et al.*, 2017). The changes in the enzymes activation upon priming suggest that mobilization of storage material may be responsible for increased germination and vigour in primed seeds compared to unprimed aged seed (Arun *et al.*, 2017). Seed priming is a method to improve plant growth and yield because of producing functional food with increased amounts of important regulatory components (Janeczko *et al.*, 2015). Bagdi *et al.* (2011) concluded that soaking seed with benzyl adenine (75 mg L<sup>-1</sup>) before planting could reduce the negative effect of salinity on physiological traits and growth of wheat. The extract of *Glycyrrhiza glabra* was used by Al-Hadithi (2008) and led to increase grain yield. *Salix Sp.* contains salicylic acid which affected on grain filling (Hussain, 2015). The aim of this study was to find out the effect of seed priming with some growth regulators and plant extracts on grain growth rate, effective filling period, accelerating of physiological maturity to get higher grain yield through three cultivars of bread wheat.

### MATERIALS AND METHODS

A field experiment was carried out at College of Agriculture, University of Baghdad during winter, 2015-16. Three cultivars of bread wheat (Abu-Ghraib3, Ibaa99, and Alfeteh) and six treatments of seed priming were studied. The seeds were primed by soaking it for 10 hours in 100, 100, 150 mg L<sup>-1</sup> of benzyl adenine, salicylic acid, gibberellic acid (GA3), respectively, ethanolic extract of *Salix Sp.*, water

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extract of *Glycyrrhiza glabra*, and distilled water (control). The treatments were fitted in randomized complete block design and replicated thrice. *Glycyrrhiza glabra* extract was prepared from 5 g of roots after drying and well grinding, and then placed in 50 ml of hot water (60-65°C) for 3 hours, then the extract was filtered, and leachate was collected. The *Salix Sp.* extract was prepared by dissolving 20 g of dried and well grinding of Willow phloem in 200 ml of ethanol solvent (95%) for 24 hours by soxhlet device. The rotary evaporator (40-45°C) was used to concentrate the extract. The concentrated extract (2 g) was dissolved in 10 ml of distilled water to obtain the concentration 0.2 g ml<sup>-1</sup> of the stock solution (Naseem and Patil, 1998). The seeds were sown on 25<sup>th</sup> of November in 54 experimental plot sand each one had dimensions 2×3 m. Soil and crop management were done according to the recommendations.

Grain weight (mg grain<sup>-1</sup> week<sup>-1</sup>) was calculated according to weekly samples of the middle third of ten spikes of main stems after a beginning of pollination and fertilization until the sixth week. Seeds were dried in an oven at 80°C for 48 hours until stability of weight stability (Hampton and TeKrony, 1995). The actual physiological maturity (PM<sub>A</sub>) was represented the time and weight that reached by the grain at the harvest and that was at the sixth week of beginning pollination and fertilization. The following traits were studied.

1. Grain weight (mg grain<sup>-1</sup>) represented the grain weight at the PM<sub>A</sub>.
2. Estimated physiological maturity (PM<sub>E</sub>) is represented the expected time and grain weight which was calculated according to the resulting intersection point from intersection the straight line drawn by a horizontal line extending from the point of PM<sub>A</sub> to the straight line drawn according to the means of grain weight that were represented the second phase of the grain growth. This method was invented by Crookston and Hill (1978) and called broken stick. The readings which represented the first and third phases of grain growth were neglected because it represented a slow growth rate phases (Dennis, 1998).
3. Grain growth rate (GGR) (mg grain<sup>-1</sup> day<sup>-1</sup>) was calculated according to the following equation:

$$GGR = \frac{\text{Maximum grain weight}}{\text{Effective filling period (EFP)}}$$

**Table 1:** Mean of squares according to the analysis of variance for effect of cultivars, seed priming and their interaction on some traits in bread wheat during the winter, 2015-16.

Source of variance	df	Grain growth rate (GGR)	Effective filling period (EFP)	Grain weight	Grain yield
Blocks	2	0.005	8.423	3.545	0.127
Cultivars	2	0.005	3.371	6.658*	0.419
Seed priming	5	0.284*	7.987*	188.036*	12.34*
Cultivars × Seed priming	10	0.013*	7.988*	2.69*	0.075
Error	34	0.002	1.498	0.293	0.198
Standard error		0.05	1.2	0.542	0.445
Coefficient of variance		3.5	4	1.4	7.3

\*Significant at P ≤ 0.05

4. Effective filling period (EFP) (day) represented the time between the PM<sub>E</sub> and the point at which the x-axis intersects with the straight line drawn according to the grain weights (Dennis, 1998), and was calculated from the following equation:

$$EFT = \frac{\text{Maximum grain weight}}{\text{Grain growth rate (GGR)}}$$

5. Grain yield (tonne ha<sup>-1</sup>) was calculated according to the harvest of three intermediate lines with an area of 1.35 m<sup>2</sup> and based on moisture 12%.

Statistical analysis: Data were collected and analyzed according to the analysis of variance. Means of treatments were compared according to the test of least significant difference at P≤0.05 (LSD 5%) (Steel *et al.*, 1997).

## RESULTS AND DISCUSSION

The analysis of variance (Table 1) showed significant effect of cultivars on grain weight, but it had insignificant effect on GGR, EFP, and grain yield. Seed priming had significant effect on all traits studied. The interaction between cultivar and seed priming had significant effect on GGR, EFP, and grain weight, but not on grain yield. The highest variance ratio in the above traits was due to the seed priming effect.

**Grain growth rate (GGR) (mg grain<sup>-1</sup> day<sup>-1</sup>):** The data in (Table 2) showed the cultivars had no significant effect on the GGR. GA3 exceeded others in the GGR (1.5 mg grain<sup>-1</sup> day<sup>-1</sup>), while the lowest mean was associated with control (1 mg grain<sup>-1</sup> day<sup>-1</sup>). Ibaa99×GA3 exceeded others (1.5 mg grain<sup>-1</sup> day<sup>-1</sup>) without differ with Alfeteh×GA3 (1.5 mg grain<sup>-1</sup> day<sup>-1</sup>) significantly, while the lowest mean was related to Abu-Ghraib3×control (0.9 mg grain<sup>-1</sup> day<sup>-1</sup>).

**Effective filling period (EFP) (day):** Table 3 showed the cultivars had insignificant effect on the EFP. Control exceeded others in the EFP (31.9 days), while the lowest mean was related to the salicylic acid (29 day) which didn't differ significantly with GA3 and benzyl adenine (29.8 and 30.1 day), respectively. Alfeteh×benzyl adenine exceeded others (33.3 day) without differ with Ibaa99×control, Alfeteh×*Glycyrrhiza glabra* and Abu-Ghraib3×control significantly (32.9, 32.3 and 32.1 day), respectively, while the lowest mean was related to Abu-Ghraib3×benzyl adenine (28.2 day) which didn't differ with some treatments significantly.

**Table 2:** Effect of cultivars, seed priming and their interaction on grain growth rate (GGR) (mg grain<sup>-1</sup> day<sup>-1</sup>) in bread wheat during winter, 2015-16.

Seed priming	Cultivars			Mean
	Abu-Ghraib3	Ibaa99	AlfeteH	
Control	0.9	1.0	1.0	1
Benzyl adenine (100 mg L <sup>-1</sup> )	1.4	1.4	1.3	1.4
Salicylic acid (100 mg L <sup>-1</sup> )	1.3	1.4	1.3	1.4
GA3 (150 mg L <sup>-1</sup> )	1.4	1.5	1.5	1.5
<i>Salix Sp.</i> extract	1.3	1.2	1.3	1.3
<i>Glycyrrhiza glabra</i> extract	1.4	1.4	1.3	1.4
Mean	1.3	1.3	1.3	
LSD5%	Cultivars NS		Interaction 0.08	Seed priming 0.04

NS: Non significant at P ≤ 0.05

**Table 3:** Effect of cultivars, seed priming and their interaction on effective filling (day) in bread period (EFP) wheat during the winter, 2015-16.

Seed priming	Cultivars			Mean
	Abu-Ghraib3	Ibaa99	AlfeteH	
Control	32.1	32.9	30.6	31.9
Benzyl adenine (100 mg L <sup>-1</sup> )	28.2	28.9	33.3	30.1
Salicylic acid (100 mg L <sup>-1</sup> )	29.5	28.6	28.9	29
GA3 (150 mg L <sup>-1</sup> )	30.3	30.8	28.4	29.8
<i>Salix Sp.</i> extract	30.2	31.0	30.2	30.5
<i>Glycyrrhiza glabra</i> extract	28.6	30.8	32.3	30.6
Mean	29.8	30.5	30.6	
LSD5%	Cultivars NS		Interaction 2.0	Seed priming 1.2

NS: Non significant at P ≤ 0.05

**Table 4:** Effect of cultivars, seed priming and their interaction on grain weight (mg grain<sup>-1</sup>) in bread wheat during the winter, 2015-16.

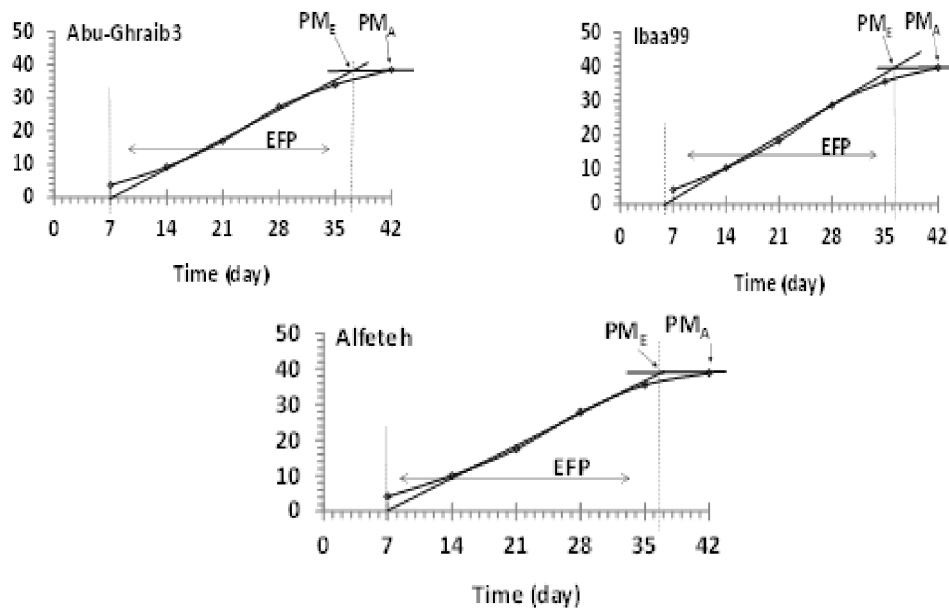
Seed priming	Cultivars			Mean
	Abu-Ghraib3	Ibaa99	AlfeteH	
Control	29.36	32.23	30.21	30.6
Benzyl adenine (100 mg L <sup>-1</sup> )	40.50	40.77	41.59	40.96
Salicylic acid (100 mg L <sup>-1</sup> )	39.81	40.16	37.52	39.16
GA3 (150 ml L <sup>-1</sup> )	43.08	45.13	43.72	43.98
<i>Salix Sp.</i> extract	37.73	37.85	38.89	38.16
<i>Glycyrrhiza glabra</i> extract	40.24	41.79	41.37	41.13
Mean	38.45	39.65	38.88	
LSD5%	Cultivars 0.37		Interaction 0.90	Seed priming 0.52

NS: Non significant at P ≤ 0.05

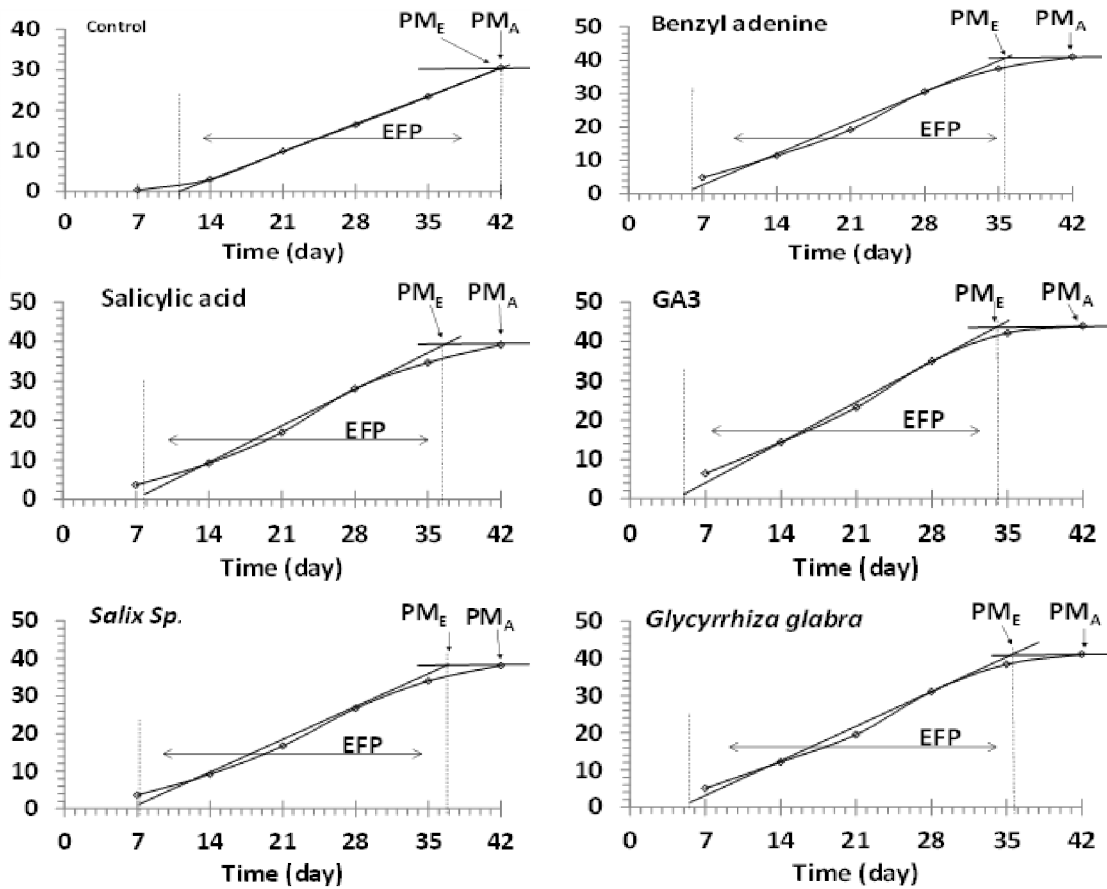
**Table 5:** Effect of cultivars, seed priming and their interaction on grain yield (tonne ha<sup>-1</sup>) in bread wheat during the winter, 2015-16.

Seed priming	Cultivars			Mean
	Abu-Ghraib3	Ibaa99	AlfeteH	
Control	3.879	4.219	3.506	3.868
Benzyl adenine (100 ml L <sup>-1</sup> )	6.599	6.498	6.395	6.498
Salicylic acid (100 ml L <sup>-1</sup> )	5.962	6.120	6.125	6.069
GA3 (150 ml L <sup>-1</sup> )	7.355	7.432	7.128	7.305
<i>Salix Sp.</i> extract	5.992	6.040	5.927	5.986
<i>Glycyrrhiza glabra</i> extract	6.697	6.860	6.277	6.611
Mean	6.08	6.2	5.89	
LSD5%	Cultivars NS		Interaction NS	Seed priming 0.426

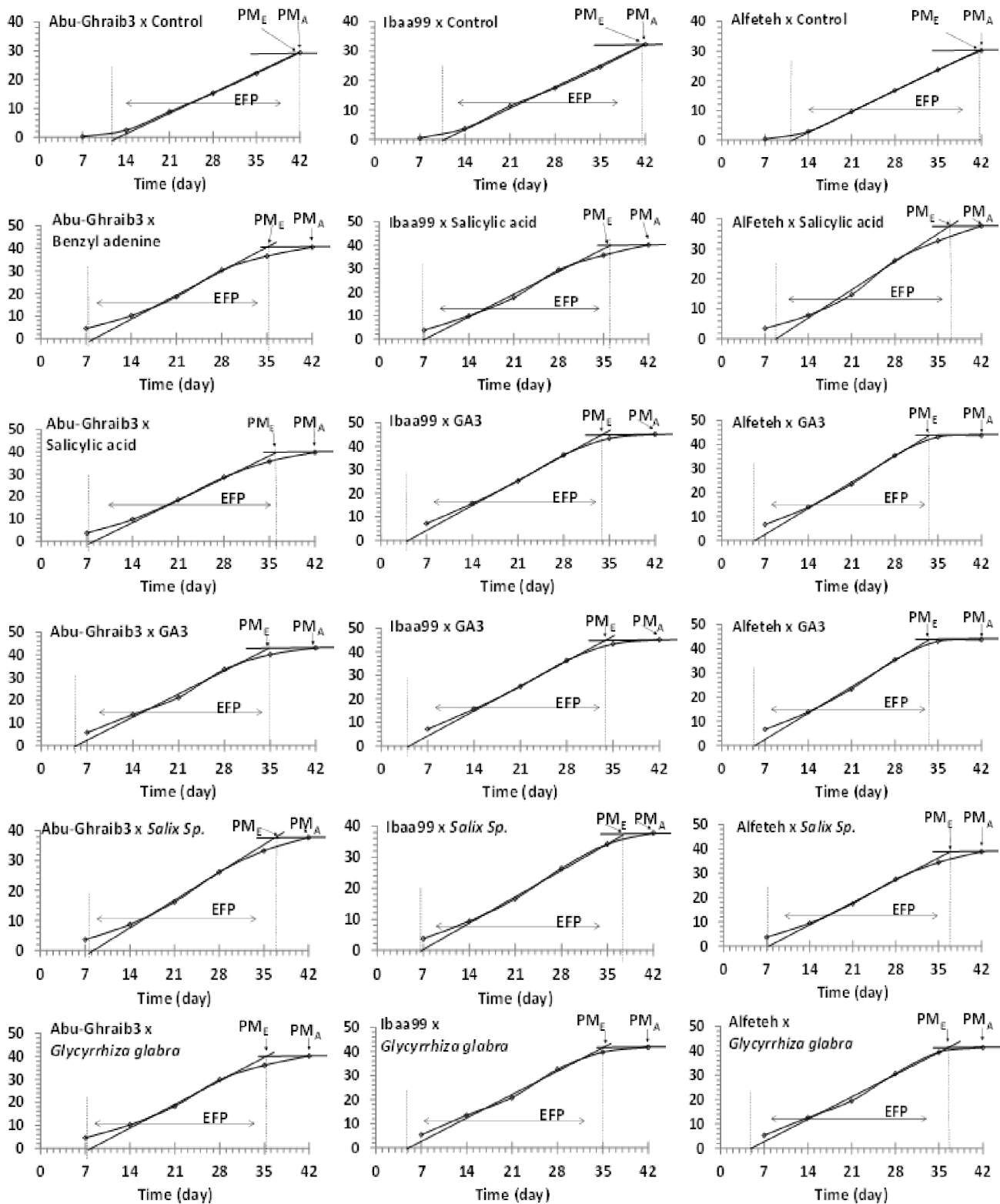
NS: Non significant at P ≤ 0.05



**Fig 1A:** Effect of cultivars on PM<sub>E</sub>, GGR, and EFP in bread wheat during winter, 2015-16. The curved line represents the grain weight (mg grain<sup>-1</sup> week<sup>-1</sup>) and the straight line represents the GGR (mg grain<sup>-1</sup> day<sup>-1</sup>).



**Fig 1B:** Effect of seed priming on PM<sub>E</sub>, GGR, and EFP in bread wheat during winter, 2015-16. The curved line represents the grain weight (mg grain<sup>-1</sup> week<sup>-1</sup>) and the straight line represents the GGR (mg grain<sup>-1</sup> day<sup>-1</sup>).



**Fig 1C:** Effect of interaction of cultivars and seed priming on PM<sub>E</sub>, GGR, and EFP in bread wheat during winter, 2015-16. The curved line represents the grain weight (mg grain<sup>-1</sup> week<sup>-1</sup>) and the straight line represents the GGR (mg grain<sup>-1</sup> day<sup>-1</sup>).

**Estimated physiological maturity ( $PM_E$ ) (day):** Fig 1A showed all cultivars reached to  $PM_E$  at the same time, approximately, 36.2, 36.6 and 37.1 days for Ibaa99, Alfeteh, and Abu-Ghraib3, respectively. The plants reached to  $PM_E$  by difference 5-6 days before reaching to  $PM_A$  (42 days).

Fig 1B showed arrival time to  $PM_E$  was ranged from 34.3-42 days. The shortest time belonged to GA3 (34.3 days). The longest time belonged to control (42 days). The plants reached to  $PM_E$  by difference 6-8 days before reaching to  $PM_A$ . The highest difference was obtained by GA3 (8 days).

Fig 1C showed arrival time to  $PM_E$  was ranged from 33.6–42 days. The shortest times were obtained by Alfeteh×GA3 (33.6 days) followed by Ibaa9×GA3 (34.9 days) and Abu-Ghraib3×GA3 (35 days), while the longest times were obtained by Abu-Ghraib3×control (42 days). The plants reached to  $PM_E$  by difference 5-8 day before reaching to  $PM_A$ . The highest differences were obtained by Ibaa99×GA3 (8 days).

**Grain weight (mg grain<sup>-1</sup>):** Table 4 showed Ibaa99 cultivar surpassed others in grain weight when gave the highest mean (39.65 mg grain<sup>-1</sup>), while the lowest mean was recorded by Abu-Ghraib3 (38.45 mg grain<sup>-1</sup>). GA3 exceeded others in grain weight when gave the highest mean (43.98 mg grain<sup>-1</sup>), while the lowest mean was related to control (30.6 mg grain<sup>-1</sup>). Ibaa99×GA3 exceeded others in grain weight when gave the highest mean (45.13 mg grain<sup>-1</sup>), while the lowest mean was obtained by Abu-Ghraib3×control (29.36 mg grain<sup>-1</sup>) (Table 4).

**Grain yield (tonne ha<sup>-1</sup>):** Table 5 showed cultivars and interaction between cultivars and seed priming had insignificant effect on grain yield. GA3 exceeded others in grain yield when gave the highest mean (7.305 tonne ha<sup>-1</sup>), while the lowest mean was related to control (3.868 tonne ha<sup>-1</sup>).

The results indicated that studied traits were limited in heterogeneity under the effect of cultivars according to their genetic composition nature in comparison to effect of seed priming which caused higher variance ratio than cultivars (Table 1). This is indicated the need to focus on seed priming as an important method to improve GGR, EFP, accelerating the physiological maturity, grain weight, and grain yield. This is in agreement with Hamza (2012); Fuller and Hamza (2013) and Ramamurthy *et al.* (2015).

Despite the significant effect of studied cultivars on grain weight (Table 4), there was insignificant effect on GGR, EFP and grain yield (Tables 2, 3 and 5). This may be due to their genetic composition nature, as the results showed that these cultivars were very similar in their field performance, which indicates to an absence of a wide genetic difference between them. On another hand, that may be

indicated the importance of other yield components, such as a number of grain per spike and number of spikes per area compared to grain weight under the effect of cultivars factor. The time of beginning and ending of EFP after pollination and fertilization were almost identical between the cultivars (Fig 1:A) and this is confirmed the results in Table 2 about insignificant effect of cultivars on GGR, taking into consideration that Ibaa99 cultivar was earlier than other cultivars at the time of beginning and ending EFP (Fig 1:A). This is in agreement with Al-Baldawi (2006) and Guendouz *et al.* (2013).

The superiority of GA3 treatment in grain weight (Table 4) was due to the previous superiority in GGR (Table 2) which led to the superiority in grain yield (Table 5). The results indicated that GGR is more important than EFP under the effect of seed priming with GA3 when gave lower mean than others in EFP (Table 3) and gave the highest means of GGR, grain weight and grain yield (Tables 2, 4 and 5). This is in agreement with Al-Hadithi (2008); Janeczko *et al.* (2015) and Bagdi *et al.* (2011).

The interaction effect was significant on GGR and grain weight because of the difference in quantity and trend of cultivars response to changing levels of seed priming factor (Tables 2, 3 and 4). GGR is more important than EFP under interaction effect between cultivar and seed priming, and that can be proved through the significant supremacy of Ibaa 99×GA3 in GGR and grain weight (Tables 2 and 4) and also through the biological supremacy in grain yield that belonged to Ibaa99×GA3, despite the fact that Ibaa99×GA3 gave shorter time of EFP compared to Alfeteh×benzyl adenine (Table 3). This is in agreement with Ramamurthy *et al.* (2015); Singh *et al.* (2015) and Arun *et al.* (2017).

The  $PM_E$  point represented end of dry matter deposition phase. It is the point that most of crop management practices should be stopped like irrigation to save time, effort and cost. The differences in  $PM_E$  may be due to the seed potential properties itself, or to the genetic composition nature, or to the extent to which it responded to seed priming, which had the greatest effect on studied traits in comparison to cultivars.

## CONCLUSION

It can be concluded that seed priming had effective role to improve GGR, which can be counted more important than EFP. The physiological maturity can be accelerate and at the same time maintain high grain yield. This indicates the need to focus on seed priming with GA3 which can improve GGR and reduce the required time to reach to physiological maturity without causing economic yield decline, as well as contributing to reduce time, effort and cost that required in a production process.

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