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EFFECT OF THE SEED PRIMING AND DURATION ON THE SEED GERMINATION AND SEEDLING VIGOR OF SUNFLOWER CROP

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ABSTRACT

A factorial experiment was carried out according to a completely randomized design CRD with four replications in the laboratory of seed certification and testing department, Wasit Branch in 2019. The main aim was to study the seed priming of sunflower with water and salicylic acid at a concentration of 50 $mg.L^{-1}$ and gibberellic acid at a concentration of 150 $mg.L^{-1}$, as well as a comparison treatment (dry seeds) for a duration of 6, 8 and 10 hours. The results showed that the highest percentage of germination in the first and second count and seedling vigor index was achieved when priming the seeds with water, as it reached 85%, 86%, and 1266 respectively. Consequently, the priming treatment with gibberellin was superior in the plumule length by an average of 8.84 cm, as, for priming seeds with salicylic acid, the highest average radicle length was 6.35 cm. In the role of the priming duration, the 10-hour priming duration gave the highest rate of germination in the first and second count of 85.98 and 86.81%, and the maximum plumule length 8.84 cm, and the seedling dry weight 0.37 mg, as well as the highest seedling vigor, reached 1274. In addition, all the interactions of materials and priming durations were superior in the presence of the comparison treatment over the comparison treatment, which gave the lowest average for the mentioned characteristics.

Keywords **:** Gibberellic acid, salicylic acid, seed imbibition, seedling vigor, sunflower.

Introduction

The sunflower crop *(Helianthus annuus* L.) is one of the most important oil seed crops, where its oil is distinguished by its nutritional, industrial, and medicinal value, and its percentage of seeds reach 74%. In addition, it's considered one of the best vegetable oils consumed at the global level (Al-Khafaji, 2009). The seed meals are also used as good forage for animals due to their high content of protein, oil, carbohydrates, and other nutrients (Al-Awdah *et al*., 2009). Despite the great importance of the sunflower crop, its productivity in Iraq is still low, compared to global production. Besides, it is necessary to investigate techniques that help to achieve this improvement, including the technique of priming seeds to improve the performance of seed during the process of germination and field emergence. However, the results of its use have shown a positive effect by the results of the applications according to the (Saudi, 2012, and Najm, 2016, and Al-Salhi, 2019) findings. Plant growth regulators are among the means used for priming seeds because they need an effective enzyme system to carry out the anabolism and catabolism processes during the germination process (Attia and Judoua, 1999). Gibberellic acid is one of the important germination stimuli to break the seed dormancy and increase the germination and emergence speed, and cell division and expansion, as it stimulates the enzymes for hydrolysis such as Alpha-amylase (Al-Shammari, 2014). (Manjunatha *et al*., 2018) pointed out that priming sunflower seeds with gibberellic acid at a concentration of 400 $mg.L^{-1}$ for 12 hours has improved the seed viability and seedling vigor, as it increased the germination percentage and speed, seedling length, and its dry weight. Salicylic acid also stimulates the seeds in the germination process and increases the emergence speed and growth of seedlings. In addition, it is considered as one of the hormones that have a phenolic nature, as it affects the physiological and morphological processes (Al-Obaidi, 2015). Furthermore, (Haidar and Saba, 2017) mentioned that treating seeds with salicylic before planting helps to the seed imbibition, which provides additional storage for the embryo. The stimulating of wheat seeds with salicylic acid at a concentration of 50 $mg.L^{-1}$ has led to an increase in germination percentage, seedlings freshness, and dry weight compared to dry non-activated seeds (Mohamed *et al*., 2019). (Moghanibashi *et al*., 2012) stated that priming sunflower seeds with water has improved the performance of the crop seeds and reduced the average germination time, and indicated that priming sunflower seeds in water for 24 hours led to give the highest values of the plumule and radicle weight, and their length. Also, the priming of sunflower seeds in water for 20 hours led to an increase in the germination percentage and the normal seedlings percentage, plumule and radicle length, and fresh and dry seedling weight (Matias *et al*., 2018). Finally, (Farooq *et al*., 2010) noted that there is a correlation between the priming substance and the duration of priming seed, and indicated that the priming should be with solutions of specific durations of time. Moreover, an appropriate diluted concentration to ensure that the seeds are not damaged or destroyed, as plant species differ in the optimal duration of the priming process, it may be several hours, several days, or weeks.

Materials and Methods

A factorial experiment was applied in the laboratory of seed certification and testing department, Wasit Branch in 2019, using three priming materials: water, salicylic acid at a concentration of 50 mg.$L^{-1,}$ and gibberellic acid at a concentration of 150 mg.L^{-1}. In addition to the comparison treatment (dry seeds) and three priming durations of 6, 8, and 10 hours of (CRD) with four replications. After preparing the solutions with the required concentration, the seeds were soaked in Petri dishes and according to the specified durations (10, 8, 6) hours, then 1000 seeds were taken at a rate of 100 seeds for each treatment (25 seeds per replicate). They were dried with blotter paper until reaching its moisture before soaking and placed in a cellulosic germination paper by rolling method, then placed in the germination device at a temperature of 25 °C (ISTA, 2005), in addition to the comparison treatment (dry seeds). The first count was carried out after 4 days of the placing seeds date on the germination device to calculate the germination speed according to the following equation:

$$\text{Number of normal seedlings in the first count} = \frac{\text{number of normal seedlings}}{\text{number of total seeds}} \times 100$$

After 10 days of placing the seeds in the germination device, the germination percentage in the second count was calculated according to the following equation:

$$\text{Germination percentage test (second count)} = \frac{\text{number of normal seedlings}}{\text{number of total seeds}} \times 100$$

Finally, the plumule and radicle length (cm), and the dry weight of the seedling after it was dried in an electric oven at a temperature of 80°C for 24 hours, then it was weighed with a sensitive balance, also the seedling vigor index was calculated according to the following equation: (Murti *et al*., 2004)

$$\text{Seedling vigor index} = \text{germination percentage} \times (\text{plumule length} + \text{radicle length})$$

Statistical analysis

The statistical analysis of the laboratory experiment was carried out in two stages, the first one was achieved using the arrangement of the factorial experiment according to the Complete Randomized Design (CRD) (3 × 3 × 4) without the dry treatment. Then, the second stage was applied using the CRD (3 × 10) with dry treatment.

Results and Discussion

Standard laboratory germination percentage at first count percentage

Table 1 indicates that the treatment of priming with water gave the highest percentage of germination in the first count reached 85.61%, and it did not differ significantly from the treatment of priming with salicylic, which gave 85.05%. However, it differed significantly from the treatment of priming with gibberellin that gave the lowest percentage of 84.90%. The reason may be due to the fact that water improves the performance of sunflower seeds in germination by reducing the mechanical resistance of the seed coatings as a result of softening and stimulating early physiological metabolic activities. As well as, its role in promoting antioxidants that improve germination rate, this result is agreed with the findings of (Donlod, 2000; Maiti *et al*., 2006; Moghanibashi *et al*., 2012) which they indicated that priming with water is a good way to improve seed vigor and reduce average germination time. Besides, it increases the percentage of sunflower seed germination, where the results showed a significant effect of priming durations, as the priming duration of 10 hours gave the highest average of 85.98%, while the priming duration 6 hours achieved the lowest average reached 84.29%. This indicates that sunflower seeds need time to start the germination process, which includes water imbibition and decomposing storage materials. It was noticed that priming the seeds in pure water for 10 hours was significantly exceeded in the laboratory germination percentage in the first count for treatments (interactions of materials and priming durations with the presence of comparison treatment). Similarly, the highest average amounted given to 86.78%, while the comparison treatment gave the lowest average for the characteristic reached 79.88%.

Standard laboratory germination percentage at second count percentage

Table 2 indicated that the priming treatment with water gave the highest percentage of germination in the second count reached 86.58% and it was significantly different from the treatment of priming with gibberellin and salicylic, which did not differ significantly, as both achieved the lowest percentage amounted to 85.75%. The reason may be due to that water improves the performance of Sunflower seeds in germination through the effect of reducing the mechanical resistance of seed coatings because of softening and stimulating early physiological metabolic activities and enhancing antioxidants that improve germination percentage. This result was agreed with the findings of (Donlod, 2000) which stated that the sunflower seeds treated with water gave better germination of the seeds, and these positive effects are due to previous metabolic activities. This result also agreed with (Moghanibashi *et al*., 2012) indicated that activation with water is a good method to improve seed vigor, reduce average germination time, and increase the germination percentage. The 10-hour priming duration achieved the highest percentage of 86.83% and it did not differ significantly from the 8-hour priming duration, which achieved 86.50%, while the 6-hour priming duration gave the lowest percentage of 84.75%. The results also indicated that there was a significant effect of the interaction between materials and priming durations. As the treatment of priming with water for 10 hours gave the highest percentage of 88.25%, while the treatment of priming with water for 6 hours achieved the lowest percentage of 84.50%, which did not differ significantly from the treatment of priming with water for 6 hours. It was observed from the interaction results that the increase in priming duration from 6 to 8 and 10 hours under all priming materials increased the laboratory germination percentage for the second count. Besides, the results indicated the superiority of all treatments (interactions of materials and priming durations with the presence of comparison treatment) that gave the lowest value reached 81.88% for the standard laboratory germination percentage at the second count. The superiority of all priming treatments is due to the role of water in reducing the mechanical resistance of the seed coatings. As for gibberellin, it can regulate the synthesis and secretion of the Alpha amylase enzyme by regulating the accumulation of Alpha-amylase mRNAs, and its role in the Aleurone layer in stimulating hydrolysis enzymes. Besides, its active role in the decomposition of

large molecules into small molecules and simpler materials that move from the endosperm to the embryo (Attia and Jadoua, 1999). The salicylic works of synthesis the metabolism stimuli for germination during the process of imbibition, stimulating the protein synthesis and nucleic acids, increasing the effectiveness of antioxidants, and reducing chemical transformations within the seed.

Radicle length in standard laboratory germination test (cm)

It was observed from Table 3 the superiority of the treatment of priming with salicylic by giving the highest average of radicle length reached 6.35 cm, and it differed significantly from the two treatments of priming with water and gibberellin. Generally, the treatment of priming with water achieved the lowest average of 5.98 cm with a decreasing percentage of 5.83% compared to the superior treatment without the comparison treatment. The reason for the increase in the radicle length during the salicylic treating may be that it has a phenolic nature that affects the physiological processes inside the plant, including the metabolism that increases the radicle growth, and provides protection against several abiotic pressures (Kan *et al*., 2008). As well as, activating some physiological processes and enhance other processes, such as works with other substances such as Auxin, then regulating the elongation and division of meristematic cells in the radicle, thus increasing the radicle length (Khamseh *et al*., 2013). This result agreed with (Farooq, 2006 and 2007; Saad 2019) which indicated that salicylic acid has led to an increase the radicle length for seeds, rice, and mung bean. The results also showed a significant effect of priming durations in this characteristic, as the 8-hour priming duration achieved the highest average reached 6.40 cm. Similarly, the 6-hour duration gave the lowest average of 5.86 cm, where the reason for reducing the radicle length is to give the lowest average germination percentage in the first and second count as shown in Tables 1 and 2, which negatively affected the radicle length. The results also indicated that there was a significant effect of the interaction between the materials and the priming duration, as the treatment of priming with salicylic for 8- hours gave the highest average of 7.13 cm. Furthermore, the treatment of priming with salicylic for 6 hours achieved the lowest average reached 5.80 cm. Moreover, the results indicated the superiority of all study treatments and its interactions with the comparison treatment that gave the lowest average radicle length of 5.23 cm. This is due to the superiority of the priming treatments by the laboratory germination percentage in the first and second count as shown in Tables 1 and 2, which made it take longer in its growth, which was positively reflected in increasing the radicle length. It is also attributed to the role of gibberellin and salicylic in the process of cell division.

Plumule length in a standard laboratory germination test (cm)

The seeds treated with gibberellin recorded the highest average for the plumule length reached 8.84 cm, and it differed significantly from the treatment of priming with water and salicylic, as the treatment of priming with water achieved the lowest average of 8.13 cm as shown in Table 4. The reason may be due to that the priming with gibberellin enhanced the endogenous gibberellin, which led to the accumulation of mRNA nucleic acids. Then, the formation of glucose from the digestion of starch by synthesizing the degradation enzymes Alpha-amylase, which improves the synthesis of sucrose used for growth, this effect is reflected on plumule, as gibberellin contributes to activating the processes of division and elongation (Wahyuni *et al*., 2016). This result agreed with (Saudi, 2012; Jiyad, 2008; Jadoua and Silawi 2012) indicated that the gibberellin increased the plumule length for the sunflower, sorghum, and rice seedling. The results also showed that the priming duration 10 hours exceeded by giving the highest average for the characteristic, which was 8.84 cm, while the 6-hour duration gave the lowest average reached 8.07 cm. Accordingly, the results indicated that there was a significant effect of the interaction between the materials and the priming durations. As the treatment of priming with gibberellin for 10 hours gave the highest average amounted to 9.82 cm, while the 6-hour treatment of priming with water achieved the lowest value of 7.91 cm. Statistical analysis also indicated that there was a significant effect of the treatments (interactions of materials and priming durations with the presence of comparison treatment) on the plumule length, where all the priming materials of sunflower seeds exceeded the comparison treatment as shown in Table 4. Furthermore, the treatment of priming the seed with gibberellin for 10 hours gave the highest average for the characteristic compared to the comparison treatment, which gave the lowest average of 7.12 cm.

The dry weight of seedling in a standard laboratory germination test (mg):

Table 5 indicated that the priming treatment with salicylic gave the highest value of the dry seed weight, as it reached 0.38 mg. However, it differed significantly from the priming treatment with water and gibberellin, as the priming treatment with water achieved the lowest value reached 0.36 mg. The reason for increasing the dry weight at treating with salicylic may be due to the increase in the radicle length as shown in Table 3, which increases the ability and capacity of the seedling to transport and store metabolic activities. Also, it is attributed to the role of salicylic in promoting growth and increasing cell division in the apical meristem of the root, thus increasing the growth of seedlings as well as increasing biomass associated with improving nutrient absorption and enhancing the antioxidants. These results have coincided with (Rajasekaran *et al*., 2002; Shakirova *et al*., 2003; Khodary, 2004, El-tayeb, 2005 and Al-Obaidi, 2015) findings. The 10-hour priming duration achieved the highest value reached 0.37 mg and differed significantly on the priming duration of 6 and 8 hours, which gave the lowest average of 0.36 mg and 0.36, respectively.

On the other hand, the results indicated the superiority of all treatments (interactions of materials and priming durations with the presence of comparison treatment) that gave the lowest value of 5.32 mg for the seedling dry weight. The reason for the low seedling dry weight of the comparison treatment may be due to the low length of the plumule and radicle as in Tables 3 and 4. Otherwise, it may be due to that the comparison treatment (dry seeds) giving the lowest percentage for germination speed as shown in Table 1, which was negatively reflected in the dry weight of the seedling.

Seeding vigor in the standard laboratory germination test

Table 6 indicated that the treatment of priming with water gave the highest average of seeding vigor reached 1266, and did not differ significantly from gibberellin, while the treatment of priming with salicylic achieved the lowest average of 1230. The reason is attributed to the increase in the germination percentage in the first and second count as shown in Tables 1 and 2, as priming the seeds with water increases the germination speed and thus enhances the seedling vigor. As the seeds that grow quickly produce large and strong seedlings compared to the slow-growing seeds (Mcdonald, 2000; Jiyad, 2008; Al-Khafaji, 2009 and Nawaz *et al*., 2013). This result was agreed with (Pallavi *et al*., 2010) indicated that the priming of sunflower seeds has led to an increase in the seedling vigor. Besides, this result is also agreed with (Aziza *et al*., 2004 and Harris *et al*., 2007) which showed that the increase in the germination percentage in the first and second count gives a positive indication to obtain strong seedlings of barley and maize. The priming duration of 10 hours achieved the highest average of 1274, and it did not differ significantly from the priming duration 8, which achieved an average of 1257, and it differed significantly from the priming duration of 6 hours, which gave the lowest average of 1229. The results also indicated that the comparison treatment gave the lowest average for the characteristic, which amounted to 1007, compared to the study treatments (interactions of materials and priming durations).

The reason for the low seedling vigor of the comparison treatment (dry seeds) is due to the low germination percentage in the first and second count and the reduction of plumule and radicle length as shown in Tables 1, 2, 3, and 4, which negatively affected the reduction of average seedling vigor. This was confirmed by the results of (Silawi 2012) on the rice crop with (Ehsanullah *et al*., 2014) findings that showed an improvement of some vital properties and seedling vigor when priming the seeds with water for 24 hours.

Table 1 : Effect of materials, priming durations, and the interaction between them on the standard laboratory germination percentage in the first count percentage

Priming materials	Priming durations			Average priming materials
	6	8	10	
Water	84.30	85.75	86.78	85.61
Gibberellin	84.22	84.73	85.75	84.90
Salicylic	84.35	85.40	85.40	85.05
LSD	N.S			0.56
Average priming duration	84.29	85.29	85.98	
LSD	0.56			
Comparison	79.88			
LSD	0.95			

Table 2 : Effect of materials, priming durations, and the interaction between them on the standard laboratory germination percentage in the second count percentage

Priming materials	Priming durations			Average priming materials
	6.00	8.00	10.00	
Water	84.75	86.75	88.25	86.58
Gibberellin	84.50	86.50	86.25	85.75
Salicylic	85.00	86.25	86.00	85.75
LSD	1.04			0.60
Average priming duration	84.75	86.50	86.83	
LSD	0.60			
Comparison	81.50			
LSD	1.26			

Table 3 : Effect of materials, priming durations, and the interaction between them on the radicle length for the sunflower seedling (cm)

Priming materials	Priming durations			Average priming materials
	6.00	8.00	10.00	
Water	5.90	6.00	6.00	5.98
Gibberellin	5.90	6.10	6.14	6.05
Salicylic	5.80	7.13	6.14	6.35
LSD	0.41			0.24
Average priming duration	5.86	6.40	6.09	
LSD	0.24			
Comparison	5.23			
LSD	0.39			

Table 4 : Effect of materials, priming durations, and the interaction between them on the plumule length for the sunflower seedling (cm)

Priming materials	Priming durations			Average priming materials
	6.00	8.00	10.00	
Water	7.91	8.13	8.34	8.13
Gibberellin	8.30	8.40	9.82	8.84
Salicylic	7.99	8.21	8.37	8.19
LSD	0.29			0.17
Average priming duration	8.07	8.25	8.84	
LSD	0.17			
Comparison	7.12			
LSD	0.28			

Table 5 : Effect of materials, priming durations, and the interaction between them on the seedling dry weight in standard laboratory germination test (mg)

Priming materials	Priming durations			Average priming materials
	6.00	8.00	10.00	
Water	0.35	0.3**4**	0.36	0.3**5**
Gibberellin	0.37	0.3**6**	0.37	0.37
Salicylic	0.37	0.39	0.39	0.38
LSD	N.S			0.**006**
Average priming duration	0.3**6**	0.3**6**	0.37	
LSD	0.**006**			
Comparison	0.32			
LSD	0.**009**			

Table 6 : Effect of materials, priming durations, and the interaction between them on the seedling vigor in the standard laboratory germination test

Priming materials	Priming durations			Average priming materials
	6.00	8.00	10.00	
Water	1240	1263	1295	1266
Gibberellin	1251	1266	1275	1264
Salicylic	1196	1243	1252	1230
LSD	N.S			17.0
Average priming duration	1229	1257	1274	
LSD	17.0			
Comparison	1007			
LSD	29.5			

Conclusion

It can be concluded from this that priming the sunflower seeds has succeeded in forming strong seedlings, due to the high germination percentage, and its speed and increase in the seedling dry weight, which was reflected in achieved a good and homogeneous field establishment.

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