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The Combined Effect of Seed Priming With UV-C Radiation and Hydro-Priming and Hormonal Priming by Gibberellic Acid on Physiological Parameters of Wheat (*Triticum aestivum* L.)

Samir K. Lazim*

Department of Agricultural Machines and Equipment, College of Agriculture, University of Basrah, Iraq

***Corresponding author-mail:**samir.lazim@uobasrah.edu.iq

Abstract:In this study, a pot experiment has been used to investigate the combined response of several physiological parameters following the presowing of wheat (*Triticum aestivum* L.) cultivar seed primed with UV-C radiation, hydro-priming, and hormonal priming with gibberellic acid. As a hydro-priming, seeds have soaked in distilled water for 24 hours (P_2). As hormonal priming, seeds were soaked in gibberellic acid (GA_3) solutions at 100 ppm for 24 hours (P_3). Then, presoaking and dry seeds (P_1) have irradiated with UV-C radiation (254 nm) for exposure times of 0 minutes (UV_1), 60 minutes (UV_2), and 120 minutes (UV_3). The results of this study show that all traits are much more affected by both priming treatments. Furthermore, the combination priming treatment $P_3 \times UV_3$ demonstrated a higher significant effect on the root length (RL), while $P_1 \times UV_1$ demonstrated a higher significant effect on the mean germination time (MGT). On the final germination percentage (FGP), Germination Rate Index (GRI), Seedling Length (SL), and seedling vigour index (SVI), the interaction between both treatments have shown to have no significant impact on these parameters. Overall, the findings imply that seed priming by UV-C radiation and hormone priming via gibberellic acid may be promising and practical techniques because of their favorable impacts on some physiological wheat characteristics.

Keywords:Wheat, physiological parameters, Gibberellic acid, UV-C radiation, hydro-priming

Introduction

Seed priming is a physiological strategy for improving germination and seedling growth under normal and stressful conditions. Moreover, priming methods have been applied to boost the vigour and uniformity of seedling establishment, promote vegetative growth, and increase the economic output of different field crops (Waqas *et al*., 2019). Pre-sowing seed treatments, also known as seed priming, can take various forms, including hydro (water soaking), hormone, osmopriming, redox, chemical, and nutrient priming. Among the various seed priming approaches, hydro and hormonal priming have demonstrated measurable benefits for farmers (Waqas *et al*., 2019, Raj & Raj, 2019). One of the most famous methods for starting seed germination without the development of the radicle is hydro-priming, which involves soaking seeds in water before sowing.It is the most straight forward, affordable, and environmentally friendly approach, and it enhances seed growth in a variety of crops by causing quick seedling emergence (Damalas *et al*., 2019). In contrast, hormonal priming often entails the priming of seeds with several hormones, including gibberellic acid, ascorbic acid, salicylic acid, and kinetin. Gibberellic acid (GA_3), a frequently utilized hormone, has been shown to aid in boosting seedling growth (Pawar & Laware, 2018). In numerous field crops, including wheat (Iqbal & Ashraf, 2013; Ghobadi *et al*., 2012, Bahrani & Pourreza, 2012), cowpea (Arun *et al*., 2020), cucumber (Anwar *et al*., 2020), sorghum (Shihab & Hamza, 2020), sunflower (Wahid *et al*., 2008), and maize (Tsegay & Andargie, 2018, Kumari *et al*., 2017), the benefits of GA_3 priming have been documented. On the other hand, recently, the interest in the uses of the physical seed priming materials (ultrasonic, laser, ultraviolet irradiation, magnetic field, and microwave) on seed germination, growth, and yield of various crop plants has increased (Lazim, 2022, Lazim & Ramadhan, 2020a, Siyami *et al*., 2018, Lazim & Nasur, 2017). One of the physical priming techniques accessible is seed priming with UV-C radiation, which has been found to improve morphological and physiological changes in a variety of agricultural plants, including wheat seed germination growth (Semenov *et al*., 2020; Rupiasih & Vidyasagar, 2014), maize (Sadeghianfar *et al*., 2019), soybean (Araujo *et al*., 2020), and green bean seeds (Aboul Fotouh *et al*., 2014). Ultraviolet (UV) light has defined as electromagnetic radiation emitted by a component of solar light or from an artificial source. UV-A (320-390 nm), UV-B (280-320 nm), and UV-C are the three wavelength bands that make up this non-ionizing radiation. These wavelengths are shorter than the visible spectrum, but longer than X-rays. Of these three forms of UV radiation, UV-C radiation is one of the electromagnetic waves that have the potential to vary the physiological and biochemical processes in plants (Sadeghianfar *et al*., 2019). The use of low-level ultraviolet-C irradiation as pre-sowing seed treatments have been popular in recent years as an eco-friendly and secure way to increase plant productivity, yield quality, germination, and seedling vigour, as well as to encourage beneficial effects on seed health (Hernandez-Aguilar *et al*., 2020, Semenov *et al*., 2020).

There is little information about the combined influence of priming soaking seeds and physical priming methods on wheat seed germination. In addition, there hasn't been enough research found in this respect. Thus, this research aimed to study the combined effect of seed priming between UV-C radiation and hydro and hormonal priming by GA_3 on some physiological parameters of wheat seeds.

Material and Methods

This study was carried out in the physics laboratory of the Agriculture College, Department of Agricultural Machinery and Equipment, University of Basrah, to examine the physiological aspects of priming wheat seeds with UV-C radiation and hydro and hormonal priming by gibberellic acid. Experimental date during the November 2021. Seeds of wheat (*Triticum aestivum* L.) of uniform size and shape were used. Dry wheat seeds without a primer are used as the control treatment (P_1). While the same wheat seed were soaked for 24 hours in distilled water as a hydro-priming (P_2) or in a 100 ppm solution of Gibberellic acid, GA_3 (P_3). After the priming procedure, the priming seeds were dried to their original moisture content at room temperature. Then, using a UV source of 254 nm provided by a lamp of the ZW6S15W type, the treatment sets of soaking priming seeds P_2 and P_3, as well as P_{31} were immediately exposed to UV-C radiation (254 nm) exposure lengths of 0 min (UV1) as a control, 60 min (UV2), and 120 min (UV3) as per the procedure described by Lazim & Ramadhan (2020b). Each treatment was replicated three times in randomized complete design. Each treatment was planted in plastic pots (20 cm) in diameter and 15 cm in depth) for each treatment in 2 cm depth of soil (each pot ten seeds). From the time seeds were planted until the end of the germination, each pot group treatment received a daily, separate watering of roughly 200 ml/pot.

Data Collection:

The germination seed was observed after two days of planting. The measurements and observations were recorded daily at a specific hour until the tenth day when there have no more germinated seeds.

Measurements of the germination and growth of seeds:

Every day, the total number of seeds that germinated was counted. Then, on the tenth day following sowing, the final germination percentage was determined using the formula shown below:

$FGB\% = \frac{N_g}{N_t} \times 100$, where Ng is the number of seeds that germinated 10 days after being sown, and N_t represents the total number of seeds planted.

The following formula was used to determine the Mean Germination Time (MGT) by Ellis & Roberts (1981):

$MGT = \frac{\sum nD}{\sum n}$ (Day), where D is the number of days counted from the beginning of germination, and n is the number of seeds that were observed to have germinated on day D (not the total quantity).

The following equation Al-Mudaris (1998) was utilized to generate the Germination Rate Index (GRI):

GRI= $G_1/D_1 + G_2/D_2 + \ldots + G_n/D_n$ (%/day), where G_1, G_2, G_3,... Gn is the number of freshly germinated seeds on the 1, 2, 3, and n^{th} days, respectively, and D_1, D_2, D_3, and Dn are the counts on the corresponding days.

Mean seedling length (cm): Ten days after sowing, five healthy seedlings from each treatment were chosen at random, and shoot (SL) and root (RL) lengths were calculated using a graduated scale in centimeters. The mean seedling length (SL+RL) has then been computed.

According to Abdul-Baki *et al*. (1973), the following formula has been used to determine the Seedling Vigor Index (SVI):

SVI= FGB% × Seedling Length (SL+RL).

***Statistical analysis*:** The statistical analyses have been used in the experimental study, according to a completely randomized design (CRD), with three replications, pot represents one replicate. To analyses, the results mean comparisons between the treatments have performed by Tukey test using SPSS 20 (Table 4).

Results and discussion:

Data from Table (1) showed that seed priming with water (hydro-priming) and GA_3 significantly improved seed performance with increasing FGB, GRI, SL, and SVI compared to the unprimed seeds. Significantly higher FGP (91.11%), GRI (2.72 %day), SL (22.59 cm), and SVI (31.72) had reported in treatment P3 (GA3). The priming GA3 improvement over unprimed seeds was 15.50% for FGB, 53.67% for GRI, 47.93% for SL, and 66.50% for SVI. These results agree with those shown by Ardebili *et al*. (2019) or Abnavi & Mokhtar (2012), who could report the seed priming of wheat with distilled water and GA_3 found a significant increase in seed germination and seedling growth parameters compared with unprimed seeds. Similar results were recorded by Lamichhane *et al*. (2021) on okra; Aziz & Peksen (2020) on chickpea; Arun *et al*. (2020) on cowpea; Bankaji *et al*. (2018) on cucumber; Tsegay & Andargie (2018),

and Kumari *et al*. (2017) on maize; Toklu (2015) on lentil; Chavan *et al*. (2014) on soybean and Abdel Hamid & Mohamed (2014) on barley. Under seed priming with GA_3, wheat germination rate and early development traits have increased; this could be because of an increase in the water absorption and higher activities of the enzyme α-amylase (Wang *et al*., 2016 and Sultana *et al*., 2000). Some authors suggested that enzymes like amylase might be active in various crop seeds pre-primed with GA_3, as in cowpea (Arun *et al*., 2017); rice (Sukifto *et al*., 2020); and chickpea (Thakare *et al*., 2011). They found that GA_3 exhibit positive effects through the stimulation of α-amylase expression. There is generally recognized that GA_3 has advantageous effects on seed germination. It regulates a variety of characteristics of how diverse plants grow and develop. Additionally, it has been demonstrated that particular hydrolase enzymes are produced and synthesized more quickly when certain seeds are allowed to germinate, making the endosperm available to the embryo (Ashraf *et al*., 2019). According to (Ghobadi *et al*. (2012),), seed priming with GA_3 allows some germination-related metabolic processes to occur without incident germination. Amylase, protease, and lipase, for example, play essential roles in the embryo's early growth and development. Every increase in these enzyme activities causes the seedling's early growth to accelerate.

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Table (1): Gibberellic acid's effects on the physiological parameters of wheat seedlings during hydro and hormonal priming,expressed as meanand standard error.

Priming soaking seeds	Seed Germination Characteristics					
	FGB %	MGT day	GRI % day^{-1}	SL cm	RL cm	SVI
P_1	78.88^{b}±2.94	7.31^{a}±0.61	1.77^{c}±0.17	15.27^{c}±1.42	8.71^{c}±0.75	19.05^{c}±2.36
P_2	85.55^{ab}±2.84	4.68^{b}±0.33	2.05^{b}±0.26	16.74^{b}±1.09	10.9^{b}±0.52	23.78^{b}±2.67
P_3	91.11^{a}±4.84	3.57^{c}±0.19	2.72^{a}±0.29	22.59^{a}±1.65	11.96^{a}±0.87	31.72^{a}±4.00
L.S.D	6.83	0.27	0.22	0.64	0.32	1.70

P_1: Unprimed (Control); P_2: Hydro priming with distilled water, P_3: Hormonal priming by Gibberellic acid (GA_3), FGP: Final Germination Percentage, MGT= Mean Germination Time, GRI: Germination Rate Index, SL= Seedling Length, RL: Root Length, SVI= Seedling Vigor Index. Different superscript letters in each column indicate a difference that is mean significant at the Tukey test $P < 0.05$ level.

On the other hand, one of the physical agents used for seed priming is UV radiation. According to data in Table 2, seed priming with various UV-C levels before germination significantly improved seed in terms of increasing FGB, GRI, SL, and SVI compared to unprimed seeds. Compare the values of UV-C priming seed treatment with unprimed seeds (p_1), the FGB (92.22%), GRI (2.41 %day), SL (20.77 cm), and SVI (30.26), at 90 hours of exposure, a greater and more significant effect was seen (p_3), which went up by 18, 58, 51, 57, 29, 56, 26.78, and 52.44 %, respectively (Table 2).The development of the wheat crop has also demonstrated a similar improvement in germination and growth, according to Semenov *et al*. (2020); Rupiasih & Vidyasagar (2014). Also, these findings may be similar to those of several types of research on different crop seeds,where authors discovered a rise in the
percentage of treated seeds that germinated. They found a positive response to different periods of exposure to UV-C radiation on water convolvulus (Changjan *et al*., 2022), Cowpea (Tayyar & Yalcin, 2021), soybean (Araujo *et al*., 2020), and maize, sugar beet (Sadeghianfar *et al*., 2019). The benefits of UV-C primed seed have been the subject of some studies, but little is understood about how UV-C impacts plants and how it works. According to (Sadeghianfar *et al*., 2019), maize and sugar may germinate more quickly when exposed to UV-C because the seed coat has broken down, the temperature rises, the seeds absorb oxygen and water more quickly, and the dormancy has lessened. Additionally, according to (Aboul Fotouh *et al*., 2014), green bean seedling growth was boosted by higher antioxidant enzyme levels in the leaves and roots of plants developed from UV-C treated seeds.

Table (2): Effects of seed priming with UV-C irradiation at different treatment period on physiological parameters of wheat,expressed as meanand standard error.

Priming soaking seeds	Seed Germination Characteristics					
	FGB %	MGT day	GRI % day^{-1}	SL cm	RL cm	SVI
UV_1	77.77^{b}±2.94	5.84^{a}±1.33	1.59^{c}±0.40	16.03^{c}±1.99	9.26^{c}±0.95	19.85^{c}±2.96
UV_2	85.55^{ab}±2.94	5.18^{b}±1.10	1.94^{b}±0.42	17.80^{b}±2.34	10.57^{b}±0.92	24.44^{b}±3.49
UV_3	92.22^{a}±4.84	4.55^{c}±0.89	2.41^{a}±0.52	20.77^{a}±2.39	11.74^{a}±1.01	30.26^{a}±4.64
L.S.D	6.83	0.27	0.22	0.64	0.32	1.70

The radiation exposure times for the pre-sowing seed are equal to UV_1, UV_2, and UV_3: respectively, 0 (control), 60, and 90 min of UV-C radiation, FGP: Final Germination Percentage, MGT= Mean Germination Time, GRI: Germination Rate Index, SL= Seedling Length, RL: Root Length, SVI= Seedling Vigor Index. Each column's various superscript letters mean significantly different values at the Tukey test $P < 0.05$ level.

The interaction of seed priming between UV-C radiation and water and hormonal priming by GA_3 on several physiological parameters of wheat seeds was given in (Table 3). Results for the interaction indicated that priming treatment interactions had a significant impact on MGT and RL. Among the combinations in Table 3, priming treatments $P_1 \times UV_1$ showed significantly higher MGT. However, the $P_3 \times UV_3$ combination had a higher RL (13.46 cm), however $P_1 \times UV_1$ had 7.36 cm. As far as my knowledge, no other studies on the effects of UVC radiation, hydro-priming, and gibberellic acid (GA_3) combined with seed priming on the physiological growth parameters of wheat before sowing. As a result, comparing our findings to those of other studies may be difficult.

Table (3): The interaction of physiological parameters of wheat seeds primed treatment between UV-C irradiation and hydro and hormonal priming by Gibberellic acid

Treatments	Seed Germination Characteristics					
	FGB %	MGT day	GRI % day^{-1}	SL cm	RL cm	SVI
$P_1 \times UV_1$	73.33	8.38^{a}	0.89	13	7.36^{f}	14.96
$P_1 \times UV_2$	80	7.33^{b}	1.15	14.93	8.83^{e}	19.02
$P_1 \times UV_3$	83.33	6.24^{c}	1.47	17.90	9.96^{d}	23.17
$P_2 \times UV_1$	76.66	5.32^{d}	1.58	15.30	10^{d}	19.40
$P_2 \times UV_2$	86.66	4.53^{e}	2.09	16.03	10.9^{c}	23.33
$P_2 \times UV_3$	93.33	4.21^{ef}	2.48	18.90	11.8^{b}	28.63
$P_3 \times UV_1$	83.33	3.83^{efg}	2.30	19.80	10.43^{cd}	25.19
$P_3 \times UV_2$	90	3.68^{fg}	2.58	22.46	12^{b}	30.97
$P_3 \times UV_3$	100	3.20^{g}	3.29	25.53	13.46^{a}	39

Different superscript letters in each column indicate a difference that is mean significantly different at the Tukey test $P < 0.05$ level; N.S=Non-significance

Table (4): Analysis of variance and mean square

Source of variences	df	FGP [%]	MGT [day]	GRI [%/day]	SL [cm]	RL [cm]	SVI
Priming_treatments	2	337.040**	33.281**	5.485**	135.080**	24.610**	368.775**
UV_treatments	2	470.370**	3.784**	1.553**	51.707**	13.829**	245.288**
Priming_treatments. UV_treatments	4	14.81	0.483**	0.055	1.059	0.301*	6.96
Error	18	44.44	0.072	0.049	0.408	0.094	2.959
Total	26						

Conclusions:

The results of this study demonstrate that hydro-priming and hormonal priming by Gibberellic acid, as well as UV-C radiation priming of seeds, had significantly impacted the parameters of wheat germination and growth development, including FGB, GRI, SL, and SVI. The data on MGT and RL exhibited significant responses to the combination priming treatment with UV-C radiation and soaking priming seeds with

Gibberellic acid. Moreover, the best results were obtained in the treatment combination with $P_3 \times UV_3$ in RL and $P_1 \times UV_1$ in MGT. According to the results, seed priming with UV-C radiation and hormone priming with gibberellic acid may be promising and practical strategies because of their favorable impact on a few physiological aspects of wheat seed growth.

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Prof. Samir Khairi Lazim: Orcid: https://orcid.org/0000-0002-8650-4829

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