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The effect of gibberellic acid on stimulating the germination of two wheat varieties (local and imported) (*Triticum aestivum* L.)

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Abstract

The laboratory experiment on seed germination was conducted in the Seed Technology Laboratory, Department of Field Crops, College of Agriculture, University of Karbala, utilizing a completely randomized design (CRD).to evaluate the effect of gibberellic acid (GA3) at four concentrations (0, 50, 100, and 150 mg L^{-1}) on germination characteristics of two wheat cultivars (local Ibaa and imported Nizar) The results indicated that all applied concentrations of gibberellic acid (50, 100, and 150 mg L^{-1}) significantly improved germination percentage, plumule length, and radicle length compared with the control treatment. The concentration of 150 mg L^{-1} recorded the highest values for germination percentage, plumule length, and radicle length (48.500%, 26.667 mm, and 8.833 mm, respectively), whereas the control treatment recorded the lowest values (21.000%, 14.000 mm, and 4.000 mm, respectively).

The imported cultivar Nizar significantly outperformed the local cultivar Ibaa in all studied traits, recording higher mean values for germination percentage, plumule length, and radicle length (38.250%, 21.750 mm, and 6.750 mm, respectively) compared with Ibaa (29.500%, 18.333 mm, and 5.583 mm, respectively). Moreover, the interaction between gibberellic acid at 150 mg L^{-1} and the imported cultivar Nizar showed a significant superiority in all germination traits, achieving the highest mean values (55.000%, 29.000 mm, and 9.666 mm, respectively), compared with the control treatment, which recorded the lowest values (18.000%, 13.000 mm, and 3.666 mm, respectively).

Keywords: germination, gibberellic acid, local variety, imported, Nizar, wheat.

Introduction:

Wheat (*Triticum aestivum* L.) is regarded as a crucial strategic food grain and is the most extensively grown and consumed worldwide. It serves as a fundamental source of carbs and protein for millions, with one-third of the global population depending on it for sustenance. The burgeoning world population has outstripped wheat output. In 2020, global wheat production totaled 761.7 million tons, an increase from 732.4 million tons in 2019, reflecting a 4.0% rise (FAO, 2020). In Iraq, wheat output in 2021 totaled 4,234,000 tons, reflecting a 32.1% decline from 2020, which had already declined by 10.4%, with a planted area of 8,574,000 dunams (Central Statistical Organization, 2021).

The yield of this crop is contingent upon various factors, including seed quality, environmental circumstances, and agricultural processing methods. Germination is the critical phase that dictates the success of following plant development; thus, enhancing germination conditions is essential for augmenting yield and ensuring food security (4).

Plant hormones are essential in controlling physiological processes in plants, such as the stimulation of germination. Gibberellic acid (GA3) is a crucial gibberellin that facilitates the alleviation of seed dormancy and enhances seedling development by stimulating the synthesis of starch-degrading enzymes, such as α-amylase, thereby supplying the sugars essential for nourishing the embryo during its initial phases (3)

The reaction of wheat types to gibberellic acid differs based on genetic characteristics and the environmental conditions under which they were cultivated. Local varieties exhibit adaptation to the regional climatic conditions, potentially conferring resilience to environmental stresses such as drought and heat. In contrast, imported varieties may possess superior productivity traits but often lack adaptation to local conditions, thereby influencing their response to gibberellic acid. Examining these disparities aids in identifying optimal methods to enhance germination and augment crop yield (5). This research aims to investigate the impact of gibberellic acid at varying concentrations on specific germination characteristics of two wheat varieties, one local and one imported, thereby assessing the physiological differences in their responses to gibberellic acid, which may enhance agricultural productivity.

Materials and Methods

The experiment was performed in the germination incubator at the Seed Technology Laboratory, Field Crops Department, College of Agriculture, University of Karbala, situated in Al-Husayniyah District at the coordinates 44° 06′ 58″ East and 32° 32′ 17″ North, as illustrated in Figure 1. The objective was to examine the influence of gibberellic acid on the germination of two wheat types (local and imported) (Triticum aestivum L.). The seeds were cultivated in Petri dishes on filter paper following sterilization with a 1% sodium hypochlorite solution for 5 minutes. The specimens were thereafter subjected to the specified quantities of gibberellic acid through immersion for 24 hours. Twenty-five seeds were evenly allocated in each Petri dish under regulated circumstances within the germination incubator at a temperature of 20°C and a humidity of 60-70%. The experiment was structured as a two-factor factorial design employing a completely randomized approach. The initial factor was gibberellic acid at four concentrations (0, 50, 100, and 150 mg L^{-1}) applied by a 24 hours soaking technique. The second factor comprised two wheat varieties: the native variety, Ebaa, and the foreign variety, Nizar. The experiment used a two-factor (4 × 2)

design comprising eight treatments and three repetitions, as illustrated in Table 1. Statistical analysis of the data for all examined features was conducted in accordance with the experimental design utilizing a calculator and SAS statistical analysis software (2001). The treatment means were subsequently analyzed statistically using Duncan's Multiple Range Test.

Table (1) varieties (local and imported)

Number of Treatmeant	gibberellic acid **Mg/L^{-1}**	Varietas
1	**0**	**Local**
2	**0**	**Imported**
3	**50**	**Local**
4	**50**	**Imported**
5	**100**	**Local**
6	**100**	**Imported**
7	**150**	**Local**
8	**150**	**Imported**

Studied Characteristics:

1- Seed germination percentage (%).
2- Plumule length (mm).
3- Radicle length (mm).

Results and Discussion:

Results:

1- Estimation of wheat seed germination percentage (%)

The statistical analysis table (2) indicates that the germination % exhibited significant variation based on the specific factors examined (gibberellic acid concentration and variety). Subjecting wheat seeds to gibberellic acid concentrations of 50, 100, and 150 mg L^{-1} produced considerable enhancements in seed germination percentages, achieving 38.500%, 27.500%, and 48.500%, respectively, in contrast to the control treatment, which recorded the lowest rate of 21.000%. The table demonstrates that the imported variety displayed the most substantial significant difference in the examined feature, achieving 38.250%, in contrast to the local variety, which recorded a rate of 29.500%.

varieties in Seed germination percentage (%).

The table illustrating the two-way interaction among the examined factors indicates that the germination percentage peaked at 55.000% when seeds of the imported variety were treated with a gibberellic acid solution at a concentration of 150 mg/L. Conversely, the control treatment exhibited the lowest germination percentage at 18.000%.

Table (2) The effect of gibberellic acid on stimulating the germination of two wheat

Effect of gibberellic acid	**Wheat variety**		**Gibberellic acid concentration (mg L^{-1})**
	Imported	**Local**	
21.000 d	24.000 d	18.000 e	**0**
38.500 b	44.000 b	33.000 c	**50**
27.500 c	30.000 c	25.000 d	**100**
48.500 a	55.000 a	42.000 b	**150**
	38.250 a	29.500 b	**Effect of variety**

2- Plumule length (mm)

Table (3) indicates that the plumule length exhibited significant variation based on the examined factors. The exposure of wheat seeds to gibberellic acid concentrations of 50, 100, and 150 mg L^{-1} produced the most significant increases in plumule length, measuring 22,000, 17,500, and 26,667 mm, respectively, in contrast to the control treatment, which recorded the lowest average length of 14,000 mm. The table further reveals that the imported variety exhibited the greatest average length of the examined feature at 21.750 mm, whilst the native variety displayed the lowest at 18.333 mm.

The table illustrating the two-way interaction between the examined factors indicates that the maximum plumule length was observed when imported variety seeds were treated with a gibberellic acid concentration of 150 mg L-1, yielding a measurement of 29.000 mm, in contrast to the control treatment, which resulted in the minimum plumule length of 13.000 mm.

Table (3) Effect of gibberellic acid on stimulating the germination of two wheat varieties in the trait of plumule length (mm)

Effect of gibberellic acid	Wheat variety		Gibberellic acid concentration (mg L^{-1})
	Imported	Local	
14.000 d	15.000 e	13.000 e	**0**
22.000 b	24.000 b	20.000 c	**50**
17.500 c	19.000 cd	16.000 de	**100**
26.667 a	29.000 a	24.333 b	**150**
	21.750 a	18.333 b	**Effect of variety**

3-Radicle length (mm).

Table (4) demonstrates that radicle length exhibited considerable variation due to all examined parameters. The application of gibberellic acid at concentrations of 50, 100, and 150 mg L^{-1} significantly enhanced radicle length, measuring 6.166, 5.666, and 8.833 mm, respectively, in contrast to the control treatment, which exhibited the lowest average length of 4.000 mm. The table indicates that the imported variety demonstrated the greatest average length of the examined trait at 6.750 mm, whilst the native variety exhibited the lowest average length at 5.583 mm.

The table illustrating the two-way interaction between the examined factors indicates that the maximum radicle length was observed in the treatment involving the soaking of imported variety seeds in a gibberellic acid concentration of (150 mg L^{-1}), achieving an average length of (9.666 mm), in contrast to the control treatment, which yielded the minimum radicle length at an average of (3.666 mm).

Table (4) Effect of gibberellic acid on stimulating the germination of two wheat varieties with respect to radicle length (mm)

Effect of gibberellic acid	Wheat variety		Gibberellic acid concentration (mg L^{-1})
	Imported	Local	
4.000 c	4.333 de	3.666 e	**0**
6.166 b	6.666 bc	5.666 cd	**50**
5.666 b	6.333 bc	5.000 cde	**100**
8.833 a	9.666 a	8.000 ab	**150**
	6.750 a	5.583 b	**Effect of variety**

Discussion:

The findings indicated that all concentrations of gibberellic acid employed (50, 100, and 150 mg L^{-1}) enhanced germination traits as well as plumule and radicle length in comparison to the control treatment. This phenomenon is ascribed to the physiological function of gibberellic acid in activating enzymes that

metabolize stored nutrients in the seed, such as amylase, hence expediting germination and promoting early vegetative growth (7). Gibberellic acid facilitates cell division and elongation, resulting in enhanced plumule and radicle length (6).

Moreover, the findings demonstrated the superiority of the imported species across all examined features. This illustrates the diverse reactions of genetic variants to hormonal therapies. Certain types have increased sensitivity to growth regulators, resulting in enhanced absorption efficiency and physiological responses, especially during germination and early growth phases (1).

The interaction between gibberellic acid concentrations and variety demonstrated that the combination of 150 mg L-1 concentration and the imported variety yielded the highest values in the examined traits. This indicates that the efficacy of gibberellic acid is contingent not only on concentration but also on the genetic characteristics of the cultivated variety (8). These interactions illustrate the interplay between genetic response and the physiological effects of growth regulators.

Conclusions:

The findings indicated that gibberellic acid significantly enhanced germination properties. The concentrations (50, 100, and 150 mg L^{-1}) significantly surpassed the control treatment in all examined parameters (germination %, plumule length, and radicle length). The maximum dose (150 mg L^{-1}) yielded optimal results across all parameters, demonstrating its efficacy in enhancing seedling growth during the initial phases of germination.

The findings indicated the superiority of the imported variety compared to the indigenous variety across all examined features, highlighting its enhanced efficacy and superior response to hormonal therapies within the study area's conditions.

The interaction between the maximum concentration of gibberellic acid (150 mg L^{-1}) and the imported variety exhibited a highly significant effect, with the latter demonstrating the highest values in the examined attributes. This underscores the need of choosing the suitable kind alongside the correct hormonal treatment to attain best outcomes

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