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RESEARCH ARTICLE
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Effect of Potassium Nitrate on Seed Priming for Wheat Cultivars (Triticum aestivum L).

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ABSTRACT

A laboratory experiment was carried out in the Field Crops Department laboratory / College of Agriculture / University of Kirkuk, during 2023. The experiment studied the effect of seed stimulation to enhance wheat varieties germination by using potassium nitrate (KNO3). The factorial experiment was established by using a complete randomized design (CRD) with three replicates. The first factor includes concentrations of (KNO3) in distilled water (0%, 10%, 20%), where the seeds were soaked for 6 hours. While, the second factor involved wheat (Triticum aestivum L.) varieties (Buhooth 22, Al-Wafia, Alaa, Aras and Rezgary) the experiment aimed to determine the best concentration of (KNO3) due to the variety's response. The experiment results showed a significant influence of 20% (KNO3) by achieving the highest means for all the studied traits. While 10% of (KNO3) significantly increased the germination percentage (81.60%) and seedling vigour index (626.2) compared to 0% of (KNO3). For wheat varieties, Aras had a significant impact in all studied characteristics, except germination percentage% compared to other varieties, but the highest germination percentage% (95.11%) was for Al-Wafia variety. Interaction between the experiment factors had a significant effect, where the best combination was between 20% of (KNO3) with Aras variety in radicle length (9.33 cm), plumule length (7.10 cm) and seedling vigor index (1602.0). Whereas, for seedling wet and dry weight the interaction between 20% of (KNO3) with Buhooth 22 variety were the highest (73.75 mg) and (13.63 mg) respectively. The experiment results conclude the possibility of using 20% of (KNO3) to increase seeds priming and improve seedling traits, especially for the studied wheat varieties.

***Keywords*:** Seed priming, Potassium Nitrate (KNO3), Wheat cultivars.

INTRODUCTION

The sustainability of agriculture production in many regions of the world including Iraq is at risk due to seeds germination. Therefore, it considered as the most critical period in crop establishment, which determine crop production [1]. For promoting seed germination and seedling establishment many methods have been used under normal and stressful conditions. In this context, seed priming, identified as a pre-sowing management which includes controlled hydration of seeds during the germination first stages. Seed priming has been generally applied to enhance the germination rate and seedling growth under various stress conditions [2–5]. Similarly, successful applications of seed chemical treatment during imbibition have been made for basic research and for promoting seed germination and seedling vigor [6–8].

It has been shown that potassium nitrate (KNO3) breaks seed dormancy, encourages seed germination, and improves growth uniformity in a number of plant species, such as pea and maize [9–11]. Priming wheat seeds with KNO3 improved germination performance, early growth and vigor index, this led to increases in shoot and root length of wheat seedlings [12]. Seed priming is an easy technique with lots of advantages such as seeds fast emergence, enhancing root growth, improving seed germination at different temperatures. Also, it helps to reduce seed dormancy and plays a significant role in organic farming system. Therefore, priming may be considered as the best solution to overcome the germination problems [13]. Though, these outcomes were achieved during the wheat seedling stage, but the reproductive period is the most crucial stage for earning higher crop grain yield [14,15].

Wheat varieties (Razzek, Maali, Khiar, Oum Rabia, Nasr and Chili) responses differed due to KNO3 priming, where seeds were better germinated for Razzek and Khiar compared with other varieties. Also, seed priming had different effect on vigor index for all varieties except for Razzek. But it has a positive effect on shoot and root dry weight for all varieties, while, lowest shoot water content was recorded for Chili variety [16]. Differences in grain production and quality traits for wheat varieties mainly linked to their genetic background, which also influence by agronomic practices [17,18]. The experiment aimed to evaluate appropriate (KNO_3) concentration which influencing seed germination, growth enhancement for different wheat varieties and choosing the best pattern between (KNO_3) concentration and wheat varieties performance.

Materials and Methods

Laboratory experiment was conducted in 2023 at field crops department/college of Agriculture/university of Kirkuk. The experiment aimed to examine the effect of soaking the seeds for 6 hours with Potassium nitrate (KNO_3) concentrations in distilled water (0 addition without soaking, 10% and 20%) on wheat (*Triticum aestivum* L.) varieties (Aras, Alaa, Buhooth 22; Rezgary and Al-Wafia). The varieties were obtained from field crops department -college of agriculture-Tikrit University, the experiment was established according to a complete randomized design (CRD) with three replicates. A standard laboratory germination test was conducted for each variety to confirm the seeds vitality before starting the experiment. (KNO_3) solution prepared according to the molecular mass, where a specific weight of (KNO_3) (100 % purity) was dissolved in distilled water for both concentrations (10 and 20%). After the solid is completely dissolved, the solution is diluted to a final volume with distilled water. Seeds were soaked in the specified concentrations of (KNO_3) for 6 hours, and then the seeds were dried by leaving them on a filter paper at room temperature for 24 hours before planting, while the (control) treatment seeds were left without soaking. 25 seeds were arranged in a Petri dish with equal dimensions on special paper in two layers and incubated at room temperature.

The seeds were moistened with the appropriate amount of distilled water, and the samples were monitored daily to ensure the moisture content [19]. The following traits were measured:

1. Germination percentage%: Total number of seedlings was calculated at day 8 after the seeds germination have done at the
2. laboratory. The result converted into a percentage according to the following equation:

$$GP\% = \frac{\text{Number of normally germinated seeds}}{\text{Total number of seeds sown}} \times 100 \qquad [20]$$

3. Radicle length (cm): Ten seedlings were selected randomly for each petri dish at the end of the germination test period (8 days). The radicle was separated from the connected point with the seed. Radicle length was measured by a measure type (cm), radicle length average was measured for ten seedlings [21].
4. Plumule length (cm): measurement was occurred as explained for radicle length.
5. Seedling wet weight (mg): 10 seedlings were randomly chosen from each replicate (petri dish), seed remaining coat was removed from each seedling. The seedling wet weight average was weighed by a laboratory scale (mg) [20].
6. Seedling dry weight (mg): same 10 seedlings that were used for the seedling wet weight (mg) were utilized again for seedling dry weight (mg) calculation. The seedlings were placed in perforated paper bags which putted in an electric oven at (65 ^{o}C) temperature for 24 hours, then weighed by a laboratory scale (mg) [20].
7. Seedling vigor index: This trait was calculated according to the following equation:

Seedling vigor = germination percentage % (radicle length + plumule length) [22].

Results and discussion

Germination percentage%

Significant main effects of KNO3 concentration and wheat variety were identified; germination percentage% differed significantly when the used KNO3 concentration increased gradually (Table 1). Also, significant differences in germination percentage% between wheat varieties were found, highest value (95.11) for Al-Wafia, compared to (52.44) for Buhooth. The variation between the varieties in germination percentage% might occurred due to the difference in physiological and biological processes according to the genetic background. Which are necessary for germination like enzymatic activity and growth regulators, this result is in context with [23]. The Interaction between studied factors had significant effect on germination percentage%, where highest numbers were noticed for 20% of KNO3 with Alaa and Rezgary (100%) respectively. While, the lowest value (10.67) was observed for the interaction between 0% of KNO3× Buhooth

Table 1: Effects of KNO3 concentration and wheat variety on germination percentage%, and their interaction

KNO3 concentration %	Variety Buhooth 22	Al-Wafia	Alaa	Aras	Rezgary	Average
0%	10.67 g	89.33 abcd	54.67 e	80.00 d	40.00 f	54.93 c
10%	49.33 ef	98.67 ab	84.00 cd	86.67 bcd	89.33 abcd	81.60 b
20%	97.33 ab	97.33 ab	100.00 a	96.00 abc	100.00 a	98.13 a
Average	52.44 d	95.11 a	79.56 c	87.56 b	76.44 c	

Means followed by different letters are significantly different Duncan's Multiple Range Test ($p<0.05$)

Radicle length (cm)

The data on the influence of KNO3 concentration and wheat variety on radicle length (cm) are presented (Table 2). A significant increase was observed in radicle length (cm) in response to KNO3 concentration, with higher level for 20% treatment of KNO3 (7.55 cm) compared with 0 and 10% (3.67 and 4.49 cm) respectively. Seed priming improves its performance which helps and stimulates root system growth [24]. Wheat varieties displayed same level of significance in terms of radicle length (cm), but not Al-Wafia where it was the lowest (2.78 cm). The radicle length (cm) affected significantly by the interaction between studied factors, where highest amount was observed for 20%

of KNO3 with Aras variety (9.33 cm). While, the lowest value (2.23 cm) was detected for the interaction between 0% of KNO3× Al-Wafia

Table 1: Effects of KNO3 concentration and wheat variety on radicle length (cm), their interaction

KNO3 concentration %	Variety					Average
	Buhooth 22	Al-Wafia	Alaa	Aras	Rezgary	
0%	4.33 cde	2.23 e	3.17 e	4.40 cde	4.23 cde	3.67 b
10%	5.23 bcde	2.33 e	5.50 abcde	5.50 abcde	3.90 de	4.49 b
20%	7.50 abcd	3.77 de	9.00 ab	9.33 a	8.17 abc	7.55 a
Average	5.69 a	2.78 b	5.89 a	6.41 a	5.43 a	

Means followed by different letters are significantly different Duncan's Multiple Range Test ($p<0.05$)

Plumule length (cm)

There was a significant effect of KNO3 concentration on plumule length (cm) of wheat varieties (Table 3), A much higher plumule length (cm) was observed for 20% treatment (4.91cm) than 10% and 0% (3.24 and 2.77 cm) respectively. This significant increase can be attributed to the seeds imbibition with stimulation solutions, which provides an additional food for seedling growth stages [24]. Wheat varieties exhibited a significant main effect for plumule length (cm), where the higher value was monitored for Aras (4.74 cm) variety composted to the lowest for Buhooth 22 (2.76 cm). There was a significant KNO3 concentration × variety interaction for plumule length (cm), where these interactions were further investigated, 20% resulted in significantly higher plumule length (cm) with Aras variety compared to 0% with Buhooth 22.

Table 3: Effects of KNO3 concentration and wheat variety on plumule length (cm), their interaction

KNO3 concentration %	Variety					Average
	Buhooth 22	Al-Wafia	Alaa	Aras	Rezgary	
0%	2.67 c	2.50 c	2.67 c	3.17 bc	2.83 c	2.77 b
10%	2.77 c	2.73 c	3.80 bc	4.00 bc	2.90 c	3.24 b
20%	2.83 c	3.50 bc	6.17 ab	7.10 a	5.00 abc	4.91 a
Average	2.76 b	2.91 b	4.21 ab	4.74 a	3.58 ab	

Means followed by different letters are significantly different Duncan's Multiple Range Test ($p<0.05$)

Seedling wet weight (mg)

Seedling wet weight (mg) was significantly higher for 20% of KNO3 (60.13 mg) than 10% and 0% (46.54 and 49.50 mg) respectively (Table 4). Wheat varieties resulted in significantly higher seedling wet weight (mg), where higher number was observed in Aras variety (56.92 mg) compared with the lowest for Rezgary variety (45.05 mg). The difference in seedling weight for wheat verities linked to genetic background [25]. KNO3 concentration x wheat variety interaction influenced seedling wet weight (mg) significantly, where the highest value was for 20% with Buhooth 22 (73.75 mg) compared to10% with Al-Wafia (33.83 mg).

Table 2: Effects of KNO3 concentration and wheat variety on seedling wet weight (mg), their interaction

KNO3 concentration %	Variety					Average
	Buhooth 22	Al-Wafia	Alaa	Aras	Rezgary	
0%	36.50 j	47.80 i	48.00 hi	62.64 d	52.60 f	49.50 b
10%	47.75 i	33.83 k	50.75 g	64.53 c	35.85 j	46.54 c
20%	73.75 a	60.71 e	69.91 b	49.60 gh	46.70 i	60.13 a
Average	52.67 c	47.45 d	56.22 b	58.92 a	45.05 e	

Means followed by different letters are significantly different Duncan's Multiple Range Test ($p<0.05$)

Seedling dry weight (mg)

The KNO3 concentration had a significant main effect on seedling dry weight (mg) (Table 5), where the highest significant value was for 20% (11.81 mg) compared to (9.13 mg) for 10% and (10.39 mg) for 0%. This happened due to the significant performance of 20% (KNO3) in all studied traits like germination percentage%, seedling length and seedling wet weight. The significant differences between wheat varieties remained relatively constant except for Alaa variety which was the lowest (9.47 mg) in terms of seedling dry weight (mg). There was a significant interaction for KNO3 concentration and wheat variety, where 20% used as KNO3 concentration with varieties like Buhooth 22 and Al-Wafia resulted in the highest values (13.63 mg) and (13.57 mg) respectively. In contrast, the lowest number for seedling dry weight (mg) was for 10% with Al-Wafia only (8.40 mg). Seedling dry weight incensement may be linked with increase in (Radicle + Plumule) length and seedling wet weight traits, same results been confirmed by [26].

Table 5: Effects of KNO3 concentration and wheat variety on seedling dry weight (mg), their interaction

KNO3 concentration %	Variety					Average
	Buhooth 22	Al-Wafia	Alaa	Aras	Rezgary	

0%	9.84 bcd	10.80 bc	9.63 bcd	10.96 b	10.72 bc	10.39 b
10%	9.38 bcd	8.40 d	9.00 cd	9.88 bcd	8.97 cd	9.13 c
20%	13.63 a	13.57 a	9.78 bcd	10.97 b	11.10 b	11.81 a
Average	10.95 a	10.92 a	9.47 b	10.60 a	10.26 ab	

Means followed by different letters are significantly different Duncan's Multiple Range Test ($p<0.05$)

Seedling vigor index

Significant main effects of KNO3 concentration and wheat variety on seedling vigor index were detected (Table 6). The significance level was sequenced from the highest value (1230.4) for 20% to (626.2 and 348.2) for 10% and 0% respectively. The number of observed variants between wheat varieties differed significantly in the seedling vigor index, where the highest was Aras (1027.2) compared to the lowest (495.9) for Buhooth 22. For the interactions between experimental factors, 20% with Aras variety showed the significant value (1602.0) in seedling vigor index compared to the lowest (64.7) for 0% of KNO3 concentration with Buhooth 22 variety. According to the studies, increasing in germination percentage% and seedling (Radicle + Plumule) length by seeds priming lead to an increase in seedling vigor index [27,28].

Table 6: Effects of KNO3 concentration and wheat variety on seedling vigor index, their interaction

KNO3 concentration %	Variety					Average
	Buhooth 22	Al-Wafia	Alaa	Aras	Rezgary	
0%	64.7 f	421.9 edf	314.0 ef	657.6 edf	282.7 ef	348.2 c
10%	413.6 def	500.7 def	787.9 cde	822.0 cde	606.8 def	626.2 b
20%	1009.3 bcd	707.3 de	1516.7 ab	1602.0 a	1316.7 abc	1230.4 a
Average	495.9 b	543.3 b	872.8 a	1027.2 a	735.4 ab	

Means followed by different letters are significantly different Duncan's Multiple Range Test ($p<0.05$)

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تأثير نترات البوتاسيوم في تحفيز الإنبات لأصناف من الحنطة (Triticum aestivum L).

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الخلاصة

نفذت تجربة مختبرية في مختبر قسم المحاصيل الحقلية / كلية الزراعة / جامعة كركوك خلال العام 2023 لدراسة تأثير تحفيز إنبات بذور أصناف من الحنطة بإستخدام نترات البوتاسيوم *(KNO3)*. طبّقت التجربة العاملية بإستخدم التصميم العشوائي الكامل *(CRD)* وبثلاثة مكررات شملت العامل الأول تراكيز من نترات البوتاسيوم (0 بدون إضافة ، 10%، 20%). والثاني خمسة أصناف من محصول الحنطة هي (بحوث 22، الوفية، الآء، ئاراس، رزكاري)، هدفت التجربة إلى تحديد أفضل تركيز لمادة التحفيز ومدى إستجابة الأصناف لهذه المعاملات.

أظهرت نتائج البحث تفوق تركيز 20% من نترات البوتاسيوم *(KNO3)* معنوياً في إعطاء أعلى المتوسطات لجميع الصفات المدروسة. بينما تفوق التركيز 10% معنوياً في صفتي نسبة الإنبات و دليل قوة البادرة بمعدل (81.60%) و (626.2) مقارنة بتركيز 0% من نترات البوتاسيوم *(KNO3)*. وبالنسبة لعامل الأصناف فقد تفوق الصنف ئاراس معنوياً في جميع الصفات المدروسة بإستثناء صفة نسبة الإنبات% مقارنة مع الأصناف الأخرى. في حين حقق الصنف وفية أعلى نسبة للإنبات بمعدل *(95.11%)*.

وكان للتداخل بين عاملي التجربة تأثيراً معنوياً إذ كانت أفضل توليفة بين تركيز 20% مع الصنف ئاراس في صفات طول الجذر (9.33 سم) وطول الرويشة (7.10 سم) و دليل قوة البادرة (1602.0). بينت نتائج التجربة إمكانية إستخدام نترات البوتاسيوم (*KNO3*) لتحفيز البذور بتركيز 20% لزيادة إنبات البذور وتحسين صفات البادرة خصوصاً لأصناف الحنطة المدروسة.

الكلمات المفتاحية : تحفيز البذور، نترات البوتاسيوم (*KNO3*)، أصناف الحنطة.