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IMPACT OF POTASSIUM POLYACRYLATE ON UREA FERTILIZER SUSTAINABILITY AND WHEAT YIELD

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ABSTRACT

This study investigated the effect of potassium polyacrylate on the sustainability of urea fertilizer applied at different growth stages and its subsequent impact on wheat yield. The experiment was conducted in 5 kg pots using a split-plot design with three replicates during the 2024-2025. The main plots comprised three urea application timings (AS): AS1: 33% at emergence, + 33% at tillering, + 34% at elongation. AS2: 25% at emergence + 25% at tillering + 25% at elongation + 25% at booting. AS3: 20% at emergence + 20% at tillering + 20% at elongation + 20% at booting + 20% at emergency inflorescence. The sub-plots included four concentrations of potassium polyacrylate (Po): Po1: 0 kg ha^{-1}, Po2: 25 kg ha^{-1}, Po3: 50 kg ha^{-1}, Po4: 75 kg ha^{-1}. The urea application timing AS2 and 50 kg ha^{-1} concentration (Po3) outperformed other treatments in most studied traits, including plant height (105.83-109.00 cm), chlorophyll content (0.757-0.753), flag leaf area (53.04-59.40 cm^2), number of tillers (438.0-418.9 tillers m^{-2}), number of grains per spike (66.92-69.00 grains spike^{-1}), and grain yield (7.425-7.154 tons ha^{-1}). The interaction treatment AS2Po3 recorded the top mean grain yield of 7.767 tons ha^{-1}, which did not significantly differ from AS2Po4, AS1Po3, AS1Po4, and AS2Po2 (7.733, 7.500, 7.400, 7.333 tons ha^{-1}). These findings underscore the critical role of potassium polyacrylate in enhancing water absorption and preserving general nutrients, particularly urea (as a nitrogen source).

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INTRODUCTION

The agricultural sector is paramount for achieving sustainable development. To maximize productivity in this sector, all success factors, including optimal field conditions, ideal environmental circumstances, and the judicious use of fertilizers and pesticides that do not adversely affect environmental, soil, and water pollution, are essential (Al-Saidan *et al*., 2019). Nitrogen is a crucial nutrient for achieving high wheat yields, especially when applied at optimal times when plant demand is high. As a vital nutrient, nitrogen is required by plants in large quantities because it is continuously absorbed throughout all growth stages. However, the availability of ready nitrogen to plants is often limited due to significant losses from leaching or volatilization. Therefore, precisely timing nitrogen application to coincide with critical growth stages is essential for maximizing cultivar productivity (Abbas, 2023). Urea fertilizer is a key source of nitrogen. Its application, regardless of quantity, is susceptible to substantial losses due to leaching or volatilization.

Consequently, applying urea at critical growth stages enhances yield components and overall grain yield. This approach also ensures optimal and efficient urea utilization, minimizing losses, as the timing of nitrogen application when crop demand is high is often more crucial than the recommended fertilizer quantity itself (Yasir, 2021a; Mohammed and Al Hamdani, 2025). Recently, numerous attempts have emerged to develop novel irrigation methods to prevent water loss, particularly given the global and, specifically, Iraqi experience with climate change, which has led to rising temperatures and dwindling water resources (Zangana and Aljburi, 2023; Al-Saidan, 2025). Among these innovations is the use of potassium polyacrylate. This modern strategy enables significant water absorption, thereby reducing water loss and the leaching of plant nutrients (Mnyika *et al*., 2020). Potassium polyacrylate effectively sustains and enhances the efficiency of nutrient and water use by providing water and nutrients to plants and releasing them slowly. It also improves the physical and chemical properties of soil and minimizes urea fertilizer loss through leaching or volatilization (Kumar *et al*., 2020). As a carrier of soil nutrients, potassium polyacrylate reduces nutrient loss via leaching, thereby mitigating environmental pollution and soil erosion (Pinzon-Moreno *et al*., 2022). This study, therefore, aimed to identify the optimal concentration of potassium polyacrylate and evaluate its impact on the sustainability of urea fertilizer applied at different rates across various growth stages, as well as its combined effects on wheat yield.

MATERIALS AND METHODS

This study investigated the effect of potassium polyacrylate on the sustainability of urea fertilizer applied at different growth stages and its subsequent impact on wheat yield. The experiment was conducted in 5 kg pots using a split-plot design with three replicates during the 2024-2025 agricultural season in a field within the Al-Mahina area, south of Dhi Qar Governorate.

The main plots comprised three urea application timings (AS):

AS1: Addition 33% of the fertilizer amount at emergence + Addition 33% of the fertilizer amount at tillering + Addition 34% of the fertilizer amount at elongation.

AS2: Addition 25% of the fertilizer amount at emergence + Addition 25% of the fertilizer amount at tillering + Addition 25% of the fertilizer amount at elongation + Addition 25% of the fertilizer amount at booting.

AS3: Addition 20% of the fertilizer amount at emergence + Addition 20% of the fertilizer amount at tillering + Addition 20% of the fertilizer amount at elongation + Addition 20% of the fertilizer amount at booting + Addition 20% of the fertilizer amount at emergency inflorescence.

The sub-plots included four concentrations of potassium polyacrylate (Po): Po1: 0 kg ha^{-1}, Po2: 25 kg ha^{-1}, Po3: 50 kg ha^{-1}, Po4: 75 kg ha^{-1}. Potassium polyacrylate granules were mixed with the prepared soil for each pot according to the specified concentrations. One of the contemporary technologies utilized in agriculture is potassium polyacrylate. This technique enables significant water absorption, reducing water loss and nutrient leaching in plants (Mnyika *et al.*, 2020). By providing plants with water and nutrients and releasing them gradually, potassium polyacrylate efficiently maintains and improves nutrient and water utilization. Additionally, it enhances the soil's chemical and physical characteristics and reduces the loss of urea fertilizer due to volatilization or leaching (Kumar *et al.*, 2020). Potassium polyacrylate serves as a transporter for soil nutrients, minimizing nutrient loss through leaching and so reducing soil erosion and pollution (Pinzon-Moreno *et al.*, 2022). Wheat seeds of the Ibaa 99 cultivar were sown in the pots at a rate of ten seeds per pot. Phosphorus fertilizer was applied according to the recommendations in the Ministry of Agriculture's extension bulletin.

The following traits were studied: plant height, chlorophyll content (the content of chlorophyll was determined by estimating the vegetation ratio (Normalized Difference Vegetation Index, NDVI), which provides evidence of the variation in natural photosensitivity used to calculate vegetative growth. Using a model (Trimble Navigation, Sunnyvale, CA) and a device called Handle Green Seeker, the model receives the reflected rays from the vegetation after the radiation is released onto it. This indicates the vegetation's efficiency in terms of the amount of chlorophyll it produces (Manack et al. 2014), flag leaf area, number of tillers, number of grains per spike, 1000-grain weight, and grain yield. Data were statistically analyzed using Genstat 12, employing LSD at the 5% probability level.

THE RESULTS AND DISCUSSION

Plant Height

Table (1) shows a considerable effect of application timings, potassium polyacrylate concentrations, and their interaction on plant height. Application timing AS2 (25% urea at emergence + 25% at tillering + 25% at elongation + 25% at booting) resulted in the highest average plant height of 105.83 cm, whereas AS3 (20% at emergence + 20% at tillering + 20% at elongation + 20% at booting + 20% at emergency inflorescence) yielded the bottom mean of 96.75 cm. This may be attributed to the split application of urea, which reduced nutrient loss during critical wheat growth stages and enhanced plant efficiency in absorbing nutrients, particularly nitrogen, which is essential for vital metabolic processes. Nitrogen, being highly mobile within the plant, translocates to meristematic tissues responsible for apical growth, leading to increased cell division and elongation, thereby increasing plant height. This finding aligns with Abbas (2023).

Potassium polyacrylate concentration Po3 significantly outperformed the others, achieving the highest mean of 109.00 cm, while Po1 had the lowest mean of 89.00 cm. At this concentration, potassium polyacrylate likely retained an optimal amount of water and nutrients, increasing their availability during plant growth stages and acting as an ideal reservoir for moisture and nutrients. Following water absorption, negative charges from the ionization of carboxyl and hydroxyl groups in potassium polyacrylate chains facilitate electrostatic repulsion, which expands the polymer network, allowing further water entry and increasing absorption capacity. Therefore, polymer concentration significantly influences absorption capacity; increasing concentration leads to a denser polymer, and despite more binding sites, absorption may decrease due to increased rigidity (Oksinska *et al*., 2019). The interaction AS2Po3 yielded the highest average plant height of 111.33 cm, whereas AS3Po1 resulted in the lowest average of 85.67 cm. This emphasizes the role of potassium polyacrylate in increasing nutrient availability and the importance of timing urea application.

Table (1) Effect of Potassium Polyacrylate and Urea Application Timings on Plant Height

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	89.67	104.67	110.33	105.67	102.58
AS2	91.67	109.33	111.33	111.00	105.83
AS3	85.67	97.00	105.33	99.00	96.75
Means	89.00	103.67	109.00	105.22	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	2.04	3.03	4.75		

Chlorophyll Content

Table (2) indicates a significant effect of urea application timings, potassium polyacrylate concentrations, and their interaction on chlorophyll content. Application timing AS2 achieved the top mean of 0.757, which did not significantly differ from AS1 (0.728), while AS3 resulted in the lowest average of 0.678. The superiority of AS2 might be due to its ability to provide the required amount of urea during each critical growth stage. Since urea is a nitrogen source directly involved in many biological processes, including activating enzymatic activities within the plant and directly contributing to the chlorophyll molecule, this leads to increased photosynthetic efficiency and dry matter production. Additionally, nitrogen stimulates plant growth by promoting cytokinin production, which significantly promotes new growth and generally increases vegetative mass (Table 1) and, specifically, chlorophyll content (Joudah Yasir, 2022). This result aligns with Al-Jobouri and Alabar (2021).

Potassium polyacrylate concentration Po3 recorded the top mean of 0.753, which did not significantly differ from Po4 (0.738), whereas Po1 showed the lowest average of 0.682. Mixing potassium polyacrylate granules with soil improved nutrient absorption in the root zone. The polymer helps retain water and nutrients, enhances physical and chemical soil properties, and loosens the soil, facilitating root growth. Furthermore, it boosts microbial activity, increasing soil vitality and fertility, which in turn promotes root growth and consequently enhances vegetative growth (Table 1) and chlorophyll content in the plant. This finding aligns with Oksinska *et al*., (2019). The treatment AS2Po3 yielded the highest average of 0.783, while AS3Po1 showed the lowest average of 0.657. Applying urea at the required amount during growth stages coinciding with leaf emergence and development significantly increases chlorophyll content, especially when the optimal amount of polymer is available to enhance nutrient availability absorbed by the roots (Some *et al*., 2021).

Table (2) Effect of Potassium Polyacrylate and Urea Application Timings on Chlorophyll Content

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	0.670	0.720	0.777	0.743	0.728
AS2	0.720	0.747	0.783	0.777	0.757
AS3	0.657	0.660	0.700	0.693	0.678
Means	0.682	0.709	0.753	0.738	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	0.03	0.04	0.07		

Flag Leaf Area

Results in Table (3) demonstrate that urea application timings significantly influenced flag leaf area. Application timing AS2 showed the top mean of 53.04 cm², which did not significantly differ from AS1 52.08 cm², compared to AS3, which had the bottom mean of 46.39 cm². This could be attributed to the continuous nitrogen supply from the beginning of cultivation until the booting stage, which encompasses the development of the flag leaf. Nitrogen is crucial for the biological processes within the plant, significantly affecting cell division and increasing meristematic activity, consequently expanding the leaf surface area. Moreover, increased nitrogen availability enhances chlorophyll content in leaves (Table 2), thereby increasing photosynthetic efficiency, which positively impacts leaf area (Yasir, 2021b). This finding aligns with Abbas, (2023).

Similarly, potassium polyacrylate concentrations significantly differed. Potassium polyacrylate concentration Po3 yielded the top mean of 59.40 cm², while Po1 had the bottom mean of 38.83 cm². Potassium polyacrylate plays a role in retaining water and nutrients, as leaf area develops during vegetative growth stages. Optimal plant growth is achieved with increased availability and abundance of water and nutrients, especially nitrogen, which significantly contributes to increased leaf area (Al-Falahy et al., 2022). This result aligns with Al-Jobouri and Alabar (2021). The interaction AS2Po3 produced the top mean of 62.56 cm², which did not significantly differ from AS1Po3 60.80 cm², whereas AS3Po1 yielded the lowest average of 34.18 cm². This confirms potassium polyacrylate's ability to preserve nutrients during critical growth stages and prevent their loss from the soil.

Table (3) Effect of Potassium Polyacrylate and Urea Application Timings on Flag Leaf Area

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	38.12	56.78	60.80	52.60	52.08
AS2	44.20	51.29	62.56	54.11	53.04
AS3	34.18	46.42	54.85	50.10	46.39
Means	38.83	51.50	59.40	52.27	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	2.05	4.90	7.47		

Number of Tillers

Application timing AS2 continued to demonstrate superiority, yielding the highest average for the number of tillers at 438.0 tillers m^{-2}, while AS3 had the lowest average at 323.2 tillers m^{-2}. AS2 provided the required urea fertilizer, which positively influenced the production of the maximum number of tillers. The availability of urea during early growth encourages the development of roots and primary and secondary tillers. Furthermore, fertilizer availability during the elongation and emergency inflorescence stages reduces tiller mortality. It increases tiller survival, leading to an overall increase in the total tiller count due to reduced competition, a limiting factor in growing total tillers. This finding aligns with Abbas, (2023).

Potassium polyacrylate concentration Po3 also maintained its superiority, yielding the highest average of 418.9 tillers m^{-2}, which did not significantly differ from Po4 401.3 tillers m^{-2}, whereas Po1 had the lowest average at 340.8 tillers m^{-2}. This could be attributed to the role of Po3 in enhancing nutrient availability, especially nitrogen, which is crucial for increasing meristematic activity and cell division rates, thereby positively impacting plant tillering. Additionally, treating the soil with potassium polyacrylate improved soil properties, including porosity and adsorption, reduced losses, and increased the soil's ability to retain water and nutrients, thereby stimulating cell division and increasing tiller number. This finding aligns with

Krasnopeeva *et al*. (2022). The interaction AS2Po3 yielded the top mean of 477.0 tillers m^{-2}, which did not significantly differ from AS2Po4 472.3 tillers m^{-2}, while AS3Po1 had the bottom mean of 287.3 tillers m^{-2}. This may be due to improved soil structure, enhanced nutrient availability, and reduced loss through leaching or percolation.

Table (4) Effect of Potassium Polyacrylate and Urea Application Timings on Number of Tillers

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	345.0	375.0	435.0	390.7	386.4
AS2	390.0	412.7	477.0	472.3	438.0
AS3	287.3	320.0	344.7	341.0	323.2
Means	340.8	369.2	418.9	401.3	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	19.93	29.55	46.33		

Number of Grains per Spike

Results in Table (5) indicate significant differences among study factors and their interaction. Application timing AS2 yielded the top mean of 66.92 grains $spike^{-1}$, which did not significantly differ from AS1 62.25 grains $spike^{-1}$, whereas AS3 showed the lowest average of 57.67 grains $spike^{-1}$. The application timing AS2 improved overall plant vegetative growth (Table 1), which led to better utilization of light energy and increased photosynthetic efficiency, resulting in higher chlorophyll content (Table 2) and plant surface area (Table 3). Consequently, this stimulated nutrient demand and increased assimilate production, resulting in more grains per spike. This finding aligns with Al-Jobouri and Alabar (2021).

Potassium polyacrylate concentration Po3 recorded the top mean of 69.00 grains $spike^{-1}$, which did not significantly differ from Po4 66.32 grains $spike^{-1}$, whereas Po1 had the bottom mean of 55.00 grains $spike^{-1}$. The concentration of PO3 improved the physical properties of the soil by absorbing water and nutrients, thereby increasing their availability and enhancing plant vegetative growth (Tables 1, 2, 3, 4). This positively reflected on the number of grains per spike. This finding aligns with Oksinska et al., (2019). The interaction AS2Po3 yielded the top mean of 73.00 grains $spike^{-1}$, which did not significantly differ from AS2Po4, AS1Po3, and AS2Po4 (69.33, 69.00, 67.00 grains $spike^{-1}$, respectively). This demonstrates potassium polyacrylate's ability to absorb water and preserve urea fertilizer and other soil nutrients, preventing their loss.

Table (5) Effect of Potassium Polyacrylate and Urea Application Timings on Number of Grains per Spike

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	55.00	58.00	69.00	67.00	62.25
AS2	60.00	65.33	73.00	69.33	66.92
AS3	50.00	53.00	65.00	62.67	57.67
Means	55.00	58.78	69.00	66.33	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	9.2	5.1	10.5		

1000-Grain Weight

Application timing AS3 yielded the highest average for this trait at 44.69 g, which did not significantly differ from AS1 42.07 g, while AS2 showed the lowest average of 32.91 g. The decrease in 1000-grain weight at AS2 application timing might be due to the increased number of tillers per square meter and grains per spike (Tables 4, 5). This led to competition among individual plants for photosynthetic products, resulting in smaller grains due to insufficient filling materials, which negatively affected their weight. An increase in one or two yield components can sometimes lead to a decrease in another due to compensatory effects. This finding aligns with Joudah Yasir (2022).

Potassium polyacrylate concentration Po1 yielded the top mean of 42.84 g, which did not significantly differ from Po2 41.01 g, while Po3 showed the lowest average of 36.24 g. The decrease in 1000-grain weight at the Po3 concentration might also be attributed to competition for photosynthetic products arising from the increased number of tillers and grains per spike in plants treated with this concentration (Tables 4, 5). Treatment AS3Po1 yielded the highest average of 49.74 g, whereas AS2Po3 showed the lowest average of 30.22 g. This confirms competition among plant organs (number of tillers, number of grains per spike, grain weight) for photosynthetic products, especially since AS2Po3 excelled in the number of tillers and grains, thereby intensifying competition and reducing grain weight (Tables 3, 4, 5).

Grain Yield

Results in Table (7) indicate a significant effect of application timings, potassium polyacrylate concentrations, and their interaction on grain yield. Application timing AS2 showed the highest mean of 7.425 tons ha^{-1}, which did not significantly differ from AS1 (7.211 tons ha^{-1}), while AS3 yielded the lowest average of 5.754 tons ha^{-1}. The positive effect of application timing AS2 on vegetative growth characteristics (Tables 1, 2, 3) was positively reflected in yield components (Tables 4, 5), thereby increasing grain yield. This finding aligns with Abbas (2023).

Concentration Po3 yielded the top mean of 7.154 tons ha^{-1}, which did not significantly differ from Po4 7.044 tons ha^{-1}, while Po1 showed the lowest average of 6.222 tons ha^{-1}. Concentration Po3 was more suitable for retaining water and nutrients in general, and urea and nitrogen in particular, which enhanced their availability and absorption by the plant, leading to increased vegetative growth (Tables 1, 2, 3). This, in turn, reflected on yield components (Tables 3, 4) and subsequently on grain yield. This finding aligns with Qiouch (2023). The interaction AS2Po3 excelled by yielding the top mean of 7.767 tons ha^{-1}, which did not significantly differ from AS2Po4, AS1Po3, AS1Po4, and AS2Po2, which yielded averages of 7.733, 7.500, 7.400, and, 7.333 tons ha^{-1}, respectively. This highlights the importance of using potassium polyacrylate as a modern method to sustain urea fertilizer and increase the availability of water and nutrients.

Table (6) Effect of Potassium Polyacrylate and Urea Application Timings on 1000-Grain Weight

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	44.11	43.80	37.16	43.21	42.07
AS2	34.68	33.59	30.22	33.15	32.91
AS3	49.74	45.66	41.33	42.03	44.69
Means	42.84	41.01	36.24	39.46	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	2.96	2.07	3.81		

Table (7) Effect of Potassium Polyacrylate and Urea Application Timings on Grain Yield

Addition stages	Potassium Polyacrylate				Mean
	Po1	Po2	Po3	Po4	
AS1	6.700	7.243	7.500	7.400	7.211
AS2	6.867	7.333	7.767	7.733	7.425
AS3	5.100	5.720	6.197	6.000	5.754
Means	6.222	6.766	7.154	7.044	
$L.S.D_{0.05}$	Addition stages	Potassium Polyacrylate	Interaction		
	0.799	0.421	0.893		

CONCLUSION

The use of potassium polyacrylate significantly contributed to the sustainability of urea fertilizer by enhancing water absorption and the adsorption of nutrients in general, and urea in particular. This positively impacted growth characteristics and the overall yield of wheat. This effect was particularly evident when urea fertilizer was applied at timing AS2 (25% at emergence + 25% at tillering + 25% at elongation + 25% at booting) in combination with a potassium polyacrylate concentration of 50 kg ha^{-1} (Po3).

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CONFLICT OF INTEREST

I declare that I have no conflicts of interest to disclose.

تأثير بوتاسيوم بولي اكريلايت على استدامة سماد اليوريا وانتاجية محصول الحنطة

خضير جودة ياسر السعيدان

مركز أبحاث الاهوار- جامعة ذي قار- ذي قار-العراق

الخلاصة

لمعرفة تأثير بوتاسيوم بولي اكريلايت على استدامة سماد اليوريا المضاف خلال مراحل النمو وانتاجية محصول الحنطة , انجزت هذه الدراسة في اصص 5 كغم وبتصميم الالواح المنشقة وبثلاث مكررات خلال الموسم الزراعي 2024–2025. شملت الالواح الرئيسية ثلاثة مواعيد لإضافة سماد اليوريا (AS)(اضافة سماد اليوريا بنسب 33% من الكمية الموصى بها في مرحلة البزوغ + 33% في مرحلة الاشطاء + 34% في مرحلة الاستطالة)(AS1), (25% في مرحلة البزوغ + 25% في مرحلة الاشطاء +25% في مرحلة الاستطالة +25% في مرحلة البطان)(AS2), (20% في مرحلة البزوغ + 20% في مرحلة الاشطاء + 20% في مرحلة الاستطالة + 20% في مرحلة البطان + 20% في مرحلة طرد السنابل)(AS3), شملت الالواح الثانوية اربع تراكيز لبوتاسيوم بولي اكريلايت (Po) (0 كغم.هـ$^{-1}$(Po1), 25 كغم.هـ$^{-1}$(Po2), 50 كغم.هـ$^{-1}$(Po3), 75 كغم.هـ$^{-1}$(Po4)). تفوقا تركيز 50 كغم.هـ$^{-1}$(Po3) ومرحلة اضافة سماد اليوريا (AS2) في اغلب الصفات المدروسة في هذه الدراسة, ارتفاع النبات (105.83–109.00) سم , محتوى الكلوروفيل(0.753–0.757) , مساحة ورقة العلم (53.04–59.40) سم$^{-2}$, عدد الاشطاء (418.9–438.0) شطأ.م$^{-2}$, عدد الحبوب بالسنبلة (66.92–69.00) حبة.سنبلة$^{-1}$, حاصل الحبوب (7.154–7.425) طن.هـ$^{-1}$ على التوالي. اعطت معاملة التداخل AS2Po3 اعلى متوسط لحاصل الحبوب بلغ 7.767 طن.هـ$^{-1}$ والتي لم تختلف معنويا عن معاملات

التداخل AS2Po2, AS1Po4, AS1Po3, AS2Po4 (7.733, 7.500, 7.400, 7.333) طن.ه$^{-1}$ على التوالي والذي يؤكد على اهمية وتأثير بوتاسيوم بولي اكريلايت على امتزاز الماء والمحافظة على العناصر المغذية بصورة عامة واليوريا (مصدر النيتروجين) بصورة خاصة .

الكلمات المفتاحية: انتاجية الحنطة , امتصاص الماء , استدامة سماد اليوريا , بوتاسيوم بولي اكريلايت

REFERENCES

Abbas, S. H. (2023). Genetic stability of different genotypes of bread wheat (*Triticum aestivum* L.) grown under levels of nitrogen fertilizer. *Basrah Journal of Agricultural Sciences*, 36(2), 30-46. https://doi.org/10.37077/25200860.2023.36.2.03

Al-Falahy, M., Al Mahmada, D., Dawood, K., & Ahmed, S. (2022). Response of yield and its components traits for four promising genotypes of wheat to different levels of nitrogen fertilization. *Mesopotamia Journal of Agriculture*, 50(1), 11-19. https://magrj.uomosul.edu.iq/issue_13964_13965.html.

Al-Jobouri, S.,& Alabar, A. (2021). Physiological Effect of Nitrogenous Fertilizer, Application times, and Polymer Gel on the growth characteristics of bread wheat *Triticum aestivum* L. *Mesopotamia Journal of Agriculture*, 49(1), 120-130. https://magrj.uomosul.edu.iq/issue_13344_13345.html

Al-Saidan, K.J.Y. (2025). Effect of nano-aluminum silicate with different irrigation periods on the growth and yield traits of wheat (*Triticum aestivum* L.). *Sabrao Journal of Breeding and Genetics*, 57(1), 286–293. http://doi.org/10.54910/sabrao2025.57.1.28.

Al-Saidan, K.J.Y., Mahmoud, S.I.,& Mohamed, H.H. (2019). Overlap influence for the process of retail of mineral and nanoparticles fertilizers and stages of addition on growth and yield of wheat (*Triticum aestivum* L.). *Plant Archives*,19, 1268–1278. https://www.plantarchives.org/List%20SI%2019,%20SUPP-1,2019.html.

Joudah Yasir, A.S.K. (2022). Response of wheat cultivars *Triticum Aestivum* L. to spraying with amino acid solution green (GREIT VG). *IOP Conference Series: Earth and Environmental Science*,1060 (1), 012100. https://iopscience.iop.org/issue/1755-1315/1060/1.

Krasnopeeva, E.L., Panova, G.G.,& Yakimansky, A.V. (2022). Agricultural Applications of Superabsorbent Polymer Hydrogels. *Int. J. Mol. Sci.*, 23, 15134. https://doi.org/10.3390/ijms232315134.

Kumar, R. S., Yadav,V., Singh,M.K.,& Kumar,M. (2020). Hydrogel and its effect on soil moisture stature status and plant growth. *J. of Pharmacognosy and Phytochemistry*, 9(3),1746-1753. https://www.phytojournal.com/archives/2020.v9.i3.11564/hydrogel-and-its-effect-on-soil-moisture-status-and-plant-growth-a-review.

Manack,N.B., Khim,CH., Mullock, J.,& Raun, W. (2014). In-Season prediction of Nitrogen use efficiency and geain protein in wheat *Triticum aestivum* L. *communication in soil science and plant analysis*, o (o), l-15. https://doi.org/10.1080/00103624.2014.904337.

Mnyika, A. W., S. M. Mbuvi, W. S. M., & Gogo, E. O. (2020). Superabsorbent polymer and rabbit manure improve soil moisture, growth and yield of Eggplant (*Solanum melongena* L.). *NASS J. Agric. Sci.*, 2(1), 12–20. https://doi.org/10.36956/njas.v2i1.93.

Mohammed, S. S.,& Al Hamdani, Z. B. (2025). Response of different Genotypes to growth and yield characteristics of bread wheat at different levels of nitrogen fertilizer. *Mesopotamia Journal of Agriculture*, 53, (2), 121-133. https://doi.org/10.33899/mja.2025.161255.1616.

Oksińska, M. P., Elżbieta, G., Magnucka, E. G., Krzysztof Lejcuś, K., Jakubiak-Marcinkowska, A., Ronka, S., Trochimczuk, A. W.,& Pietr, S. J. (2019). Colonization and biodegradation of the cross-linked potassium polyacrylate component of water absorbing geocomposite by soil microorganisms. *Applied Soil Ecology*, 133, (1) 2019, 114-123. https://doi.org/10.1016/j.apsoil.2018.09.014.

Pinzon-Moreno, D.D., Maurate-Fernandez, I.R., Flores-Valdeon, Y., Neciosup-Puican,A.A.,& Carranza-Oropeza, M.V. (2022). Degradation of Hydrogels Based on Potassium and Sodium Polyacrylate by Ionic Interaction and Its Influence on water. *Polymers*, 14(13), 2656. https://doi.org/10.3390/polym14132656

Somé, Y. S.C., Traoré, D., Zoromé, M., Ouoba, P.A., & Da, D. E. C. (2021). Assessment of the Effectiveness of Potassium Polyacrylate on Crop Production. *Journal of Agricultural Chemistry and Environment*, 10 (1), 113-123. https://www.scirp.org/journal/home?issueid=14724#107538.

Yasir, A.-S.K.J. (2021 a). The effect of agriculture for nano and mineral fertilization on qualitative and physiological traits for *Triticum aestivum* L. seeds. *International Journal of Agricultural and Statistical Sciences*,16, pp. 1235–1242. https://connectjournals.com/03899.2020.16.1235.

Yasir, A.-S.K.J. (2021 b). Effect of Magnetization of Nano Fertilization on the Growth and Yield of Wheat *Triticum Aestivum* L. *IOP Conference Series: Earth and Environmental Science*, 923(1), 012087. https://iopscience.iop.org/issue/1755-1315/923/1.

Zangana, D. D.,& Aljburi, J. M. (2023). Studying the Effect of Hydrogel and its Relationship to some Vegetative Growth and Yield Characteristics of Bread Wheat Genotypes (*Triticum aestivum* L.) *IOP Conf. Series: Earth and Environmental Science*, 1225, 012094. https://iopscience.iop.org/issue/1755-1315/1225/1.