Effect of potassium addition and several levels of nitrogen on growth and yield of two cultivars of wheat under sprinkler irrigation system

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Abstract:

For the purpose of evaluating the effect of adding the potassium and several levels of nitrogen in the growth and yield two cultivars of wheat under sprinkler irrigation system. Afield experiment was carried out during the 2016-2017 season in Ain Tamur in Karbala City. The study contained two factors. The first factor was two cultivars of wheat Adnan 99 and G5 while the second factor was addition of chemical fertilizers T1 addition of 200 kg h^{-1} of urea without adding potassium, T2 addition of 260 kg h^{-1} of urea without adding potassium, T3 addition of 400 kg $h^{-1}$of urea without adding Potassium, T4 addition of 200 kg h^{-1} of urea and 50 kg$h^{-1}$of potassium sulphate, T5 addition of 260 kg $h^{-1}$of urea and 50 kgh^{-1} of Potassium Sulphate, T6 addition of 400 kg$h^{-1}$of urea and 50 kgh^{-1} of potassium. The Randomized Complete Block Design (RCBD) was used with two factors and five replicates. The results showed the exceeding of Adnan 99 cultivar by giving the highest rates of spike length 7.34 cm, grains number in the spike 32.30 grain $spike^{-1}$, weight of 1000 grains 35.16 gm, grains yield 2.58 ton h^{-1} harvest index 34.9%; and the exceeding of G5 in the plant height 60.88 cm, spikes number 283.6 spike m^{-2}, and biological yield 7.71 ton h^{-1}. In addition, the results showed the exceeding of T6 treatment by giving the highest rates of plant height 67. 29 cm, spikes number 320.5 spike m^{-1}, spike length 8.77 cm, weight of 1000 grain 37.75 gm grains yield 3.57 ton h^{-1}, biological yield 10.00 ton h^{-1} , and harvest index 36.3%.The results also showed a significant interaction between Chemical fertilization and cultivars in the most studied characters. It can be concluded from this study that the addition of potassium and nitrogen has anobvious effect in increasing grain yield.

Key words: Chemical fertilization , Sprinkler irrigation , Grains yield.

تأثير إضافة البوتاسيوم وعدة مستويات من النتروجين في نمو وحاصل صنفين من الحنطة تحت نظام الري بالرش

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المستخلص:

بهدف تقييم تأثير إضافة البوتاسيوم وعدة مستويات من النتروجين في نمو وحاصل صنفين من الحنطة تحت نظام الري بالرش اجريت تجربة حقلية خلال الموسم 2016 – 2017 في قضاء عين التمر– محافظة كربلاء وتضمنت الدراسة عاملين الأول صنفين من الحنطة هما عدنان 99 وG5 ، والعامل الثاني إضافة الأسمدة الكيميائية T_1 إضافة 200 كغم هـ$^{-1}$ من اليوريا بدون إضافة بوتاسيوم و T_2 إضافة 260 كغم هـ$^{-1}$ من اليوريا بدون إضافة بوتاسيوم وT_3 إضافة 400 كغم هـ$^{-1}$ من اليوريا بدون إضافة البوتاسيوم و T_4 إضافة 200كغم هـ$^{-1}$ من اليوريا و50 كغم هـ$^{-1}$ من كبريتات البوتاسيوم وT_5 إضافة 260 كغم هـ$^{-1}$ من اليوريا و50 كغم هـ$^{-1}$ من كبريتات البوتاسيوم و T_6 إضافة 400 كغم هـ$^{-1}$ من اليوريا و50 كغم هـ$^{-1}$ من كبريتات البوتاسيوم. استخدم تصميم القطاعات العشوائية الكاملة RCBD بعاملين وبخمس مكررات. أظهرت النتائج تفوق الصنف عدنان 99 بإعطائه أعلى المعدلات لصفات طول السنبلة 7.34 سم وعدد الحبوب في السنبلة 32.30 حبة سنبلة$^{-1}$ ووزن 1000 حبة 35.16 غم وحاصل الحبوب 2.5 طن هـ$^{-1}$ ودليل الحصاد 34.9%، تفوق الصنف G5 في صفات ارتفاع النبات60.88 سم وعدد السنابل 283.6 سنبلة م$^{-1}$ والحاصل البايولوجي 7.71 طن هـ$^{-1}$. كما أظهرت النتائج تفوق المعاملة T_6 بإعطائها أعلى المعدلات لصفات ارتفاع النبات 67.29 سم وعدد السنابل 320.5 سنبلة م$^{-1}$ وطول السنبلة 8.77 سم ووزن 1000 حبة 37.75 غم وحاصل الحبوب 3.57 طن هـ$^{-1}$ والحاصل البايولوجي10.00 طن هـ$^{-1}$ ودليل الحصاد 36.3%. واظهرت النتائج تأثيرا معنويا للتداخل بين معاملات التسميد الكيميائي والاصناف في اغلب الصفات المدروسة. نستنتج من هذه الدراسة بان إضافة البوتاسيوم والنتروجين له أثر واضح في زيادة حاصل الحبوب .

كلمات مفتاحية : التسميد الكيميائي ، الري بالرش ، حاصل الحبوب .

Introduction:

Wheat crop *Triticum aestivum* L. is the main cereal crop in the world and more important than other grain crops.This importance is due to its seeds that contain glu-tenwhich is essential for producing high quality bread while the grain of other crops is lacking it . It is the first strategic crop in Iraq because it is the main source of food and has a role in economic development (Abu Rumaila, 1995). It also supplies human more than 25% of protein and calories (Bushuk, 1998). The harvested area of wheat in Iraq is 1.20 million hectares with a production quantity of 2.40 million tons at a

rate of 2 tons.ha^{-1} in 2012 with an increasing in the crop production(Kiliç & Gürsoy, 2010). Most of the metabolism activities and growth depend on the concentration of potassium in the cytosol and that the lack of addition of potassium fertilizer affects the production of crops grown(K. Mengel & and E, 1987). Nitrogen fertilization leads to longer vegetative growth of plants, which continues beyond flowering so that it is considered the main factor in increasing crop production. Therefore, varieties that respond to added fertilizer must be selected to achieve the goal from addition (Al-Baldawi 2006 and Kiliç, & Gürsoy, S.2010). Nitrogen has the main role in cell division and elongation because of the increasing of maristimia activity while potassium improves the growth and development of wheat crop (Al-Alousi, 2009). Because of this increasing of the productivity in the unit area is low for many reasons , one of the methods used to increase production is the adoption of new and distinctive varieties of wheat and the use of modern means as fertilization with appropriate quantities and recommended dates. The increasing of the macro elements level in the soil leads to be easily absorbed by the plant which will be reflected in the increased of the vital processes activity in plants and thus increase growth of the crops. The aim of this study was to test the addition of potassium according the fertilization recommendation or without it and interaction with three levels of nitrogen using a sprinkler irrigation system to keep up with the modern irrigation methods.

Materials and working methods

Field experiment was carried out in Ain Tamur – Karbala city by using sprinkler irrigation system axial Lindsey type to study the effect of potassium addition and several levels of nitrogen in the growth of two cultivars of wheat. The Randomized Complete Block Design (RCBD) was used in the experiment with five replicate and two factors. The first factor was two wheat's varieties Adnan 99 registered and certified by the national committee) and G5 (Australian type entrance by Icarda). The second factor was addition of chemical fertilizers T1= 200 kg ha^{-1} of urea without potassium , T2 = 260 kg ha^{-1} of urea without potassium , T3 = 400 kg ha^{-1} of urea without potassium , T4 = 200 kg ha^{-1} of urea + 50 kg ha^{-1} of potassium sulfate , T5 = 260 kg ha^{-1} of urea + 50 kg ha^{-1} of potassium sulfate, and T6 =400 kg ha^{-1} of urea + 50 kg ha^{-1} of potassium sulfate. A 1.5 ha of area of the total area of agriculture which is 20 ha was selected where the study was carried out. Samples of soil and irrigation water were taken before planting as shown in tables 1 and 2. The land was plowed two orthogonal plows and after leveling it was divided into 60 treatments and then planted at a seeding rate 140 kg ha^{-1} on 26/11/2016.phosphate fertilizer was added as recommended for all treatments.

Studied properties in the experiment

Plant height cm: Plant height of 10 plants was measured and onlyfrom the soil surface to the end of the spike of the main branch without awn at the 100 % anthesis stage using measuring tape then their average was taken (Wiersma, E, & and S, 1986).

Spike number spike m^{-2} : This was calculated at the physiological maturity stage by determining one square meters and account the number of spikes in it for each experimental section then its average was taken.

Spike length cm : This was measured by a measuring ruler for ten spikes of ten plants at physiological maturity then their average was taken .

Seed number in each spike seed $spike^{-1}$: Seed number was calculated for ten spikes were selected randomly from each section then their average was taken.

weight of 1000 seed g : 1000 seeds were calculated by hands randomly from spike's seeds that have was weighed to calculate the total plant product for each experimental unit then was weighed with an accurate electronic scales.

Grain yield tons ha^{-1} : It was calculated from the average grain yield per square meter gm and adjusted on the basis of 14% moisture and then converted to $tonsha^{-1}$ (Briggs & and Ytinfisu, 1980).

Biological yield tons ha^{-1}: It was calculated from the rate of the total dry matter weight (straw + grain) of the same square meter that was taken in the grain yield (gm) and then converted to $tonsha^{-1}$.

Harvest index %: The harvesting index was calculated by dividing the grain yield by the biological yield × 100 according to the following equation (Sharma & and Smith, 1986).

Harvesting index % = (grain yield \ biological yield)× 100

Statistical analysis

The data were analyzed statistically using the analysis of variance according to The randomized complete block design (RCBD)with a factorial experiment arrangement. The means of the treatments were compared using the least significant difference (LSD)at the probability level (0.05) between the treatments using the statistical program Genstate to find out the nature of the differences between the treatments (Steel & H.Torrie, 1981).

Table 1: Some chemical and physical properties of the soil before planting at depth (0-30) cm.

The properties	Value	Measuring unit
PH	7.6	-
EC	2.4	ds m^2
NH4	130	meq L^{-1}
NO3	55	meq L^{-1}
K	6.8	meq L^{-1}
Ca	17.6	meq L^{-1}
Mg	2.4	meq L^{-1}
Na	9.3	meq L^{-1}
So4	25	meq L^{-1}

Table2: Some chemical and physical properties of irrigation water.

The properties	Value	Measuring
PH	7.4	-
EC	2.8	ds m^2
K	3	meq L^{-1}
Ca	8.8	meq L^{-1}
Mg	2.5	meq L^{-1}
Na	22	meq L^{-1}
So4	15	meq L^{-1}

Results and discussion:

Plant height cm:

The results of table 3 indicate a significant differents of the varieties and fertilizers addition and interaction between them . G5 cultivar gave the highest plant height 60.88 cm whereas Adnan 99 gave the lowest plant height 58.62 cm with an increasing percentage 3.86 % .The reason for that may be attributed to the genetic variation between the two cultivars in the length of internodes, in particular especially the higher inter node which represents about half the height of the wheat plant (Al-Baldawi, 2006).These results agreed with the last findings by (Bakht, Shafi, Zubair, Khan, & Shah, 2010). The results also showed significant differences for fertilizers addition treatments whereas T6treatment gave the highest plant height rate 67.29 cm not siginificantly differents from T5whileT1gave the lowest rate 52.08 cm and not significantly differents from T4 . The reason may be that the availability of fertilizers in sufficient quantities in the soil and its availability to the plant has led to increased growth and plant height.These results are consistent with (Glass, 2003). As for the overlap, the treatment T6 of the cultivar G5 gave him the highest rate of plant height 70.86 cm , while the treatment T1of the ccultivar Adnan 99 gave the lowest rate 51.82 cm.

Table 3: Effect of potassium addition and several levels of nitrogen on plant height .

Cultivars	The treatment						mean
	T1	T2	T3	T4	T5	T6	
Adnan	51.82	56.56	59.32	57.64	62.08	63.72	58.62
G5	52.34	57.44	64.12	53.04	67.48	70.86	60.88
LSD 0.05	5.04						2.06
The average	52.08	57.00	61.72	55.34	64.78	67.29	
LSD 0.05	3.57						

Spike number (spike m^{-2}):

The results of table 4 indicated asignificant differents of the varieties, fertilizer addition, and interaction between them.G5 gave higher rate for the spikes number which was 283.6 spike m^{-2}, whereas Adnan 99 gave lowest rate for the spikes number which was 263.3 spike m^{-2} with an increasing percentagewas 7.71 % . This may be

due to genetically different varieties in their ability to produce and maintain fertile species. These result are consistent with what noted in (Al-Azzawi, Al-Janabi, & Siddique, 2018). The results also showed significant differences for fertilizer additives Table 4. T6 treatment gave the higher rate which was 320.5 spike m^{-2} not significantly diferents fromT3.whereas T1gave the lowest rate which was 229.2 spike m^{-2} and not significantly diferents from T4 with an increasing rate was 39.83 % . This may be due to the positive role for nutrients especially nitrogen which stimulates growth and increases the number of the spike-bearing activities (Ahmed, 2014). As for the interaction,T6has exceeded for the G5variety which gave the higher rate 333.6 spike m^{-2}whereas T1for the Adnan 99 variety gave the lowest rate 216.2 spike m^2 .

Table 4: Effect of potassium addition and several levels of nitrogenon spike number (spike m^2).

Cultivars	The treatment						means
	T1	T2	T3	T4	T5	T6	
Adnan	216.2	243.2	263.0	246.2	303.8	307.4	263.3
G5	242.2	298.4	315.2	261.8	250.2	333.6	283.6
LSD 0.05	48.7						19.9
Means	229.2	270.8	289.1	254	277.0	320.5	
LSD 0.05	34.5						

Spike length cm:

The data in table 5 showed a significant diferents for the cultivars, fertilizers addition, and interaction between them. Adnan 99 gave the higher rate for the spike's length which was7.34 cm ,while G5 gave the lowest rate for the spike's length was 6.82 cm with an increasing rate reached 7.62 % .The reason could be due the variation of varieties genetically which vary in length of growth from elongation to 100 % flowering as well as the variation in response to the amount of added fertilizer (Bakht et al., 2010). The results also indicate significant differences for fertilizer additives.T6gave the higher rate for the length of the spike which was 8.77 cm not significantly diferents from T5whereas T1gave the lowest rate for the length of the spike 5.25 cm not significantly diferents from T2 . This increase may be attributed to availability of fertilizers during the stages of crops growth which has a positive role in the increasing of the length of the spike , it provides the building requirements for the spike axis and elongates more to the flowering (Al-Azzawi et al., 2018) .These result agreed with the last findings by (Hossain et al., M, 2004) . As for the intraction,T6for the variety Adnan 99 has exceeded by giving the higher rate of the spike length which was 9.12 cm whereas T1for the variety Adnan 99 gave the lowest rate 4.96 cm.

Table 5: Effect of Adding Potassium and Several Levels of Nitrogen in spike length cm.

Cultivars	The treatment						Means
	T1	T2	T3	T4	T5	T6	
Adnan	4.96	6.40	8.20	6.38	9.00	9.12	7.34
G5	5.54	4.60	7.70	6.54	8.10	8.42	6.82
LSD 0.05 to interaction	0.99						0.40
The means	5.25	5.50	7.95	6.46	8.55	8.77	
LSD 0.05	0.70						

The number of the grain in the spike grain's spike $^{-1}$.

The results of (table 6) indicated that there was not a significant differents of the cultivars but significant differents in addition of fertilizers and the interacton between them. The cultivar Adnan 99 gave the higher rate of number of the grain per spike which was 32.30 grain spike^{-1}, not significantly differents from the cultivar G5 These results agreed with the last findings (Al-Aseel, et al. 2018), which refer that the wheat cultivars have many differences in the number of the grain in the spike. The result also showed a significant differents of fertilizer addition. T5 gave the highest rate for the number of the grain in the spike which was 34.80 grain spike^{-1}) not significantly diferents fromT6 and T3whereas (T4) gave the lowest rate for that which was 26.20 grain spike^{-1} not significantly diferents fromT2 and T1with an increasing rate reached (32.82%). This increase could be because of the potassium role in increasing cytoplasmic activity and activation of important enzymes in grain formation and development (K. Mengel & E, 1987).These result agreed with the last findings (Khalifa, 2016). Regarding for the interaction,(T6) of the cultivar Adnan 99 exceeded by giving the highest rate which was (38.00 grain spike^{-1}), whereas (T1) of the cultivar G5 gave the lowest rate 26.40 grain spike $^{-1}$.

Table 6: Effect of potassium addition and several levels of nitrogenon number of the grain spike $^{-1}$.

Cultivars	The treatment						The Means
	T1	T2	T3	T4	T5	T6	
Adnan	30.20	31.20	32.80	25.20	36.40	38.00	32.30
G5	26.40	24.60	31.20	27.20	33.20	30.60	30.60
LSD 0.05	4.20						1.71
The means	28.30	27.90	32.00	26.20	34.80	34.30	
LSD 0.05	2.97						

Weight of 1000 grains g.

The result of table 7 revealed a significant diferents of the cultivars and addition of fertilizers, and the interaction between themThe cultivar Adnan 99 gave the highest rate for the 1000 grains weight which was 35.16 g , whereas the cultivar G5 gave the lowest rate 30.99 g with an increasing rate was 13.46 % .The reason is due to the variation of wheat varieties among them genetically and to the length or short duration

from planting to flowering and to the length of the full grain and the response of the variety of nutrients and its ability to transfer to estuaries. These results agreed with previous studies (Kiliç & Gürsoy, 2010), The results also showed a significant effect of the cultivars and fertilizers addition whereT6 gave the highest rate of 1000 grains weight which was37.75 gwhileT4gave the lowest rate 28.95 g with an increasing rate reached 30.40 % . The reason for the increase in the average weight of 1000 is probably due to the potassium activity by activating the physiological processes and its involvement in stimulating enzymes, which leads to an increase in the ability of the leaves, especially the flag leaf to build and form nutrients, which later accumulates in the grain in the form of carbohydrates and protein stock, which leads to an increase in the weight of 1000 tablets. Moreoverhe role of potassium in increasing the absorption of macronutrients (N, P) by the plant and thus give good vegetative growth reflected on the average weight of grains (K. and K. Mengel, 2001) . As for the interaction, (T6) of the cultivar of Adnan 99 has exceeded by giving the highest rate of 1000 grains weight which was 42.28 g whereas (T2) for the variety G5 the lowest rate 27.47 cm .

Table 7:Effect of potassium addition and several levels of nitrogen on seed weight (g).

Cultivars	The treatment						The means
	T1	T2	T3	T4	T5	T6	
Adnan	33.28	32.11	35.68	28.03	39.59	42.28	35.16
G5	29.47	27.47	31.83	29.87	34.09	33.22	30.99
LSD 0.05	4.37						LSD 0.05 1.78
The means	31.37	29.79	33.76	28.95	36.84	37.75	
LSD 0.05	3.09						

Grain yield tons ha^{-1}

The result of (table 8) indicated that there was a significant effect for the variety, fertilizers addition, and the interactions between them in this property. The cultivar of Adnan 99 gave the highest rate for grain yield which was 2.58 tons ha^{-1} whereas the variety of G5 gave the lowest rate 2.12 tons ha^{-1} with an increasing ratioreached 21.70 % . This increase may be normal due to the superiority of this species in some productive traits such as the length of the spike table 5, the number of the grain in the spike table 6 and the weight of 1000 grain table 7. These result was consistent with the previous findings . who pointed out that the cultivars of wheat crop differ among them in the grain yield. The results also showed that there were significant differences in fertilizer application treatments, where (T6) treatment gave the highest rate of grain yield which reached 3.57 tons ha^{-1}, while (T4) treatment showed the lowest rate of grain yield 1.52 tons ha^{-1} By an increase proportion of 134.87%. The reason for the superiority of the treatment (T6) may be due to its highest average number of spikes table 4), spike length table 5 and weight of 1000 grains table 7. These results are consistent with other findings (Ottman & and T, 2009). As for the interference,

(T6) treatment of Adnan 99 was superior to the highest grain yield 4.21 tons ha^{-1}, while (T4) treatment gave Adnan 99 the lowest rate 1.37 tons ha^{-1}.

Table 8: Effect of potassium addition and several levels of nitrogenon Grain yield(tons ha^{-1}).

Cultivars	The treatment						The Means
	T1	T2	T3	T4	T5	T6	
Adnan	1.68	2.07	2.50	1.37	3.66	4.21	2.58
G5	1.51	1.69	2.65	1.67	2.29	2.92	2.12
LSD 0.05	0.88						0.36
The means	1.60	1.88	2.58	1.52	2.98	3.57	
LSD 0.05	0.62						

Biological yield tons ha^{-1}.

The results of table 9 indicated that there was a significant effect of the cultivars and fertilizer additives while there was no significant effect of interaction between them in this trait. G5 gave the highest rate of biological yield 7.71 tons ha^{-1}, while Adnan 99 gave the lowest rate 7.06 tons ha^{-1} with an increase ratio of (9.21%). The reason may be that the two varieties are different in the production of lateral branches that contribute to the accumulation of dry matter (Mohammed, 2000). This also may be attributed to the superiority of G5 in giving the highest rate of plant height table 3 and number of spikes table 4. This finding is consistent with the findings of previous studies (Al-Rubaie, 2002) who indicated that the biological yield varies depending on the genotype. The results also showed that there were significant differences in fertilizer addition treatments, where T6 treatment gave the highest rate of biological yield which reached 10.00 tons ha^{-1}, while treatment T1gave the lowest rate of biological yield 5.80 tons ha^{-1} with an increase ratio of 72.41%.

Table 9: Effect of potassium addition and several levels of nitrogenon Biological yield tons ha^{-1}.

Cultivars	The treatment						The means
	T1	T2	T3	T4	T5	T6	
Adnan	5.79	5.97	6.91	5.66	8.35	9.66	7.06
G5	5.81	6.42	8.70	6.07	8.94	10.33	7.71
LSD 0.05	Ns						0.62
The means	5.80	6.20	7.80	5.87	8.64	10.00	
LSD 0.05	1.07						

Harvest index %

The results indicated that there was a significant effect of the cultivars and fertilizer additives while there was no significant effect of interaction between them in this trait table 10. Adnan 99 gave the highest harvesting index which reached 34.9%, While G5 gave the lowest harvesting index which was only 27.7% with an increasing ratio 25.99 % . The difference between the two cultivars in the harvesting index may be due to their differences in grain yield table 8 and biological yield table 9 as the va-

rieties differ in the ability to distribute and transport photosynthesis products to grains. These findings are consistent with the findings of previous researchers (Donaldson, E; W, Schilling E, & and S, 2001), who indicated that the varieties differ in their efficiency by converting dry matter into grains. The results also showed that there were significant differences in fertilizer addition treatments, where (T6) treatment gave the highest rate of harvesting index which was (36.3%), while (T4) treatment gave the lowest rate of harvesting index (26.2%) with an increase of (38.55%).

Table 10: Effect of potassium addition and several levels of nitrogen on harvest index (%).

Cultivars	The treatment						The means
	T1	T2	T3	T4	T5	T6	
Adnan	28.3	33.5	36.4	24.3	43.6	43.4	34.9
G5	25.6	26.9	31.1	28.0	25.6	29.2	27.7
LSD 0.05	Ns						4.2
The Means	27.0b	30.2	33.8	26.2	34.6	36.3	
LSD 0.05	7.2						

Conclusion :

It can be concluded from this study that the addition of potassium and nitrogen has anobvious effect in increasing grain yield. It was found that the addition of 50 kg $ha^{-1}$of potassium sulfate with 400 kg $ha^{-1}$of urea is the best in achieving the highest rates for most of the traits related to grain yield. It can also be concluded that the varieties vary in the studied traits when adding fertilizers, where it was found that the cultivar Adnan 99 has the ability to give the highest rates of traits related to grain yield of a crop. Therefore we suggest the cultivation of Adnan 99 and the addition of chemical fertilizers (NPK) in order to obtain the highest grain yield.

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