Response of Growth and yield of two potato cultivars (Solanum tuberosum L.) for soaking with Gibberellic, and Plant and seaweed extracts, and humic fertilization for autumn Season

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ABSTRACT

This study was conducted in the field of one of the distinguished potato farmers in Babylon province, Dibla region, which lies about 17 km south of Hilla city during the autumn season (2016) to study the effect of three factors: First: two cultivars of potatoes (Arizona and Burren), The second is the addition of the humic fertilizer with two levels (250, 500 kg.ha^{-1}) in addition to the control treatment (chemical fertilizers). Third: soaking the tubers before cultivating with four treatments (water only, gibberellic acid with a concentration of 5 mg.L^{-1}, licorice solution with a concentration of 10 g L^{-1}, seaweed extract (Alga 2008-1) at a concentration of 1 g.L^{-1}) for 5 min and for all treatments. The experiment was designed with Split-Split Plot Design in The Randomized Complete Block Design (RCBD), with three replicates. The experiment included 24 a factorial treatments (2 × 3 × 4), followed by a fixed spraying irrigation system. After the data were recorded, the averages were compared using the Duncan's Multiple Range Test and at the probability level of 0.05. The results can be summarized as follows: Burren was significantly excelled in the yield of one plant, total number of tubers / plant and total yield of tubers with an increase of (26.73, 26.73, 21.78%), respectively. In the percentage of dry matter and starch in the tubers, while Arizona was significantly excelled in the percentage of protein in the tubers. The soaking treatment of tubers with gibberellic acid led to a significant increase in the marketable yield of the plant, the total number of tubers / plant and the total yield of tubers, with an increase of (45.45, 39.62, 36.29%), respectively compared with control treatment (water soaking only). There was no significant effect of fertilizer treatments added in all the studied traits. The triple interaction between the studied factors gave significant differences between the treatments.

Keywords: Potato, Gibberellic acid, Plant extracts, Dormancy phase.
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استجابة نمو وحاصل صنفين من البطاطا *Solanum tuberosum* L. للتغطيس بحامض الجبريليك والمستخلصات النباتية والبحرية والتسميد بالهيوميك للعروة الخريفية

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المستخلص

اجريت هذه الدراسة في حقل احد مزارعي البطاطا المتميزين في محافظة بابل / منطقة دبلة والتي تبعد حوالي 17 كم جنوب مدينة الحلة خلال الموسم الخريفي / 2016 , لدراسة تأثير ثلاثة عوامل : الاول : صنفين من تقاوي البطاطا (Arizona و Burren), الثاني :اضافة سماد الهيوميك وبمستويين (250 و 500 كغم. هكتار$^{-1}$) بالإضافة الى معاملة المقارنة (سماد كيمياوي), الثالث: تغطيس الدرنات قبل الزراعة بأربعة معاملات هي (ماء فقط – حامض الجبرليك بتركيز 5 ملغم. لتر$^{-1}$ محلول عرق السوس بتركيز 10 غم. لتر$^{-1}$ مستخلص النباتات البحرية (Alga 2008-1) بتركيز 1 غم. لتر$^{-1}$ ولمدة 5 دقائق ولجميع المعاملات. صممت التجربة حقليا بنظام القطع المنشقة مرتين Split-Split Plot Design في تصميم القطاعات العشوائية الكاملة RCBD وبثلاث مكررات, وبهذا اشتملت التجربة على 24 معاملة عامليه (2×3×4) , واتبع نظام الري بالرش الثابت , وبعد تسجيل البيانات قورنت المتوسطات باستخدام اختبار دنكن متعدد الحدود وعند مستوى احتمال 0.05 , ويمكن تلخيص النتائج كما يلي : تفوق الصنف Burren معنويا في حاصل النبات الواحد وعدد الدرنات الكلية /نبات والحاصل الكلي للدرنات وبنسب زيادة بلغت 26.73 % و 26.73% و 21.78% على التوالي, وفي النسبة المئوية للمادة الجافة والنشأ في الدرنات, في حين تفوق الصنف Arizona معنويا في نسبة البروتين في الدرنات. ادت معاملة تغطيس الدرنات بحامض الجبرليك الى زيادة معنوية في الحاصل التسويقي للنبات وعدد الدرنات الكلية/نبات والحاصل الكلي للدرنات وبنسبة زيادة بلغت 45.45%,39.62%, 36.29%

على التوالي قياسا بمعاملات التغطيس بالماء. ولم يلاحظ أي تأثير معنوي لمعاملات الأسمدة المضافة في جميع الصفات قيد الدراسة . وأعطى التداخل الثلاثي بين العوامل المدروسة الى اختلافات معنوية بين المعاملات.

الكلمات المفتاحية: بطاطا- حامض الجبريليك- مستخلصات نباتية- طور الراحة.

البحث مستل من رسالة ماجستير للباحث الثالث

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) belonging to Solanaceae family is considered one of the most important vegetable crops in the world and comes in fourth place after wheat, rice and corn (5). The country's potato production is 162915 tons and the cultivated area is 6122 hectares with an average productivity of 26.611 tons. The total global production of potatoes for 2013 according to Food and Agriculture Organization (FAO) statistics is 376 million tons (33). One of the main reasons for the decline in potato productivity for the unit area in Iraq, especially in the autumn season is the using of non-good seeds, including the phenomenon Apical Dominance and cultivating seeds with low-order and disease carrier, led to low productivity, as well as a reduction of interest in high-quality seeds, especially spring-produced potatoes, some of which are mostly stored in non-specialized private stores, which reduce many good storage characteristics for planting in autumn season (27). In order to improve the growth and production of quality and quantity in the autumn season, it is necessary to treat the seeds produced from the spring season and before cultivating them in the autumn season with some materials that have the effect of increasing the speed and percentage of germination for the tubers, Thus allowing more space and time for the plants growth and the tubers formation, and increase the yield and improve the quality of produced tubers. Studies have proved that soaking the tuber with sulfuric acid before cultivating can improve growth. Boras et al. (1) found that when soaking two potato cultivars (Diamant and Spunta) with Gibberellic acid, immersion at a concentration of 10 $mg.L^{-1}$ for 15 min led to increase the number of Aerial stem / plant. Al-Bayati (2) showed a significant difference between the two cultivars (Desiree and Latona) in vegetative growth. Desiree was significantly excelled in plant height and leaf area. Latona has excelled in number of tubers / plant, the yield of one plant and total yield of tubers in unit area. There is no significant difference between the two cultivars in the percentage of dry matter in the tubers and the percentage of protein in the tubers. Al-Hasnawi and Al-Ajaily (6) mentioned in Al-Qadissiya province in the autumn season significant superiority of the Burren cultivar in the number of Aerial stem / plant, plant height, the yield of one plant and total yield of Aladin and Arnova cultivars. Matar et al., (25) observed that when soaking the potato tubers (Burren cultivar) before cultivating in the autumn season with 5 $mg.L^{-1}$ of gibberellic acid and 5 $g.L^{-1}$ of licorice extract in addition to the control treatment (soaking in water only), The soaking of the tubers with gibberellic acid caused a significant increase in the length of the plant, while the soaking with licorice solution was significantly excelled in the percentage of dry matter and starch in the tubers. There was no significant effect for the soaking treatments on the total yield, number of tubers / plant and the percentage of proteins in the tubers. Jasim et al., (46) studied in Babylon province growth and yield of seven cultivars of potato (Draga, Provento, Desiree, Kurado, Elpaso, Aladin and Red Brown) and observed that the Elpaso cultivar were significantly excelled on the rest of cultivars in plant length, while Draga cultivar excelled in the total number of tubers. Matar et al., (26) showed in their study of three cultivars of potatoes (Burren, Lozita and Orela in Ramadi), Burren was significantly excelled in total yield of tubers and the percentage of protein in tubers for both spring and autumn cultivating seasons. Al-doughaji et al., (12) when cultivating three cultivars of potatoes (Arizona, Arnova and Revera) in Basra province in the autumn season, Revera was significantly excelled in the leaf area of plant, the yield of one plant and the total yield of tubers, while Arnova has excelled in plant height. Al-Mohammedi and Al-Abtan (22) showed, In the city of Al-Ramadi, Desiree cultivar was excelled on Riviere cultivar in the plant height and leaf area / plant, the

superiority of the Riviera cultivar on the Desiree cultivar in the yield of one plant and the number of tubers / plant, while no significant effect was observed between the two cultivars in the total yield of tubers. EL-Hamady (33) found that the soaking of potato seeds (Spunta cultivar) with three concentrations of gibberellic acid (10, 20, 30 $mg.L^{-1}$) where the soaking in a concentration of 30 $mg.L^{-1}$ was significantly excelled in plant length, number of tubers / plant, the yield of one plant, the total yield of tubers, the percentage of dry matter in the tubers and the percentage of starch in tubers in the soaking treatment compared to other treatments.

2. MATERIALS AND METHODS

The experiment was conducted in the field of one farmers in Dibla region, which lies south of Babylon province during the autumn season (2016), Samples of field soil were taken from the surface layer and at a depth of 0-30 cm to study some physical and chemical traits of the soil before cultivating, as shown in Table (1)

Table 1: Some physical and chemical traits of the experiment soil before cultivating*.

Traits and units	autumn season (2016)
pH	7.7
Electrical conductivity EC ($dc.m^{-1}$)	2.2
Organic matter (%)	1.4
Nitrogen (%) by Kjeldahl method	0.33
Phosphorus availability (%) in Sodium Bicarbonate Method	0.13
Potassium in ammonium acetate Method	1.07
Sand (%)	22
Silt (%)	54
Clay %	24
Texture	**Silty loam**

* The analysis was conducted in College of Agriculture laboratories, Al-Qasim Al-green University.

The soil was plowed with the trio moldboard plow, with two perpendicular plows, and then the soil was smoothed and settled. The compound fertilizer (DAP 18-46-0) was added at a ratio of (600 $kg.ha^{-1}$) on the ground before ten days of seeds cultivating. The fertilizer was mixed with soil, the experiment ground divided into three sectors. The seeds were obtained from the yield of spring season in the northern region of Iraq and for the two cultivars (Arizona and Burren) through the private sector, which are widespread and desirable to be cultivated in the Middle Euphrates region of Iraq. The field was cultivated on 15/9/2016. The experimental unit included 4 furrows with length of 2 m and width of 0.75 m. Thus, the experimental unit area reached 6 m^2. The number of cultivated tubers in each furrow was 8 tubers and thus the experimental unit contained 32 tubers. Agricultural service operations were conducted in a similar manner to all experimental units of weeding and control of diseases, insects, Grubbing, thicket control and Covering tubers as practiced in the commercial fields.

The study included three factors:

First factor: two seed cultivars: Arizona cultivar: produced by the Dutch company Agrico, Burren cultivar: produced by Dutch company HZPC

The second factor: soaking tubers before cultivating: included:

1- Soaking the tubers with water only.
2- Soaking tubers with gibberellic acid solution at a concentration of 5 $mg.L^{-1}$ and for 5 min.
3- Soaking the tubers with licorice solution at a concentration of 10 $g.L^{-1}$, Which was prepared 24 hours before the date of soaking.
4- Soaking the tubers with seaweed extract (Alga 2008-1) at a concentration of (1 $mg.L^{-1}$) then soak the tubers by the above treatments for five minutes.

1- Control treatment: Chemical fertilizer, with a rate of (600 $kg.ha^{-1}$) of the compound fertilizer (DAP 18-46-0), it was added before

cultivating and for one time and urea fertilizer 46% nitrogen, with a rate of (400 kg.ha^{-1}), which was added it to the first two batches after the completion of germination and the second after 15 days of the first batch.

2- Humic fertilizer with a level of 250 kg.ha^{-1}.

3 - Humic fertilizer with a level of 500 kg.ha^{-1}.

The study was conducted using Split Plot design in the Randomized Complete Block Design (RCBD), The cultivars were placed in the Main plot, and tubers soaking in the sub-plot as more important, with three replicates. The single replicate included 24 treatments, and the treatments were randomly distributed according to the design.

Experimental readings and measurements:

First: Traits of quantitative yield:

1- Total number of tubers/plant (tuber. plant^{-1}).

2 - marketable yield of plant (kg).

3 - The total yield of tubers (tons.ha^{-1}).

Second: Traits of Qualitative yield:

1. Percentage of dry matter in tubers after harvest.

2- Percentage of starch in tubers after harvest: The percentage of starch in tubers was estimated as in the following equation:

Percentage of starch = 55.17 + 89.0 × (percentage of dry matter in tubers - 18.24).

3. Percentage of protein in tubers after harvest: The percentage of protein was calculated as follows:

Percentage of protein = Percentage of Nitrogen × 6.25 (39).

The statistical analysis using the program of (41) and the Duncan's Multiple Range Test was used at a probability level of 0.05 (11)

3. RESULTS AND DISCUSSION

First: Traits of quantitative yield:

1- Total number of tubers / plant

Table (2) shows Burren cultivar has excelled on the Arizona cultivar in the total number of tubers / plant, with an increase ratio was 26.37%. No significant effect was observed between the fertilization treatments with humic in the total number of tubers / plant. The soaking tubers treatment in the Gibberellic acid was significantly excelled in the total number of tubers / plant gave the highest values with an increase of (39.62, 37.44, 17.62%) compared to soaking with water, licorice and seaweed extracts. In the bi-interaction between cultivars and humic, the results of the same table indicate to significant excelling of Burren cultivar treatment with the control treatment by giving it the highest values, it was significantly different with all treatments except Burren and fertilization by (250 kg.ha^{-1}), the lowest total number of tubers of plant was in Arizona cultivar treatment and fertilization by (500 kg.ha^{-1}) Humic. In the interaction between the cultivar and the soaking of tubers gave the highest total number of tubers for the plant in the Burren cultivar treatment and soaking tubers with Gibberellic acid and differed significantly with the Burren cultivar treatment and soaking tubers in water, with the Arizona cultivar treatment and soaking tubers in water, seaweed extract and licorice. The latter gave the lowest total number of tubers. In the interaction between humic and soaking of tubers, It is noted that the most total number of tubers for the plant were in the control treatment and soaking the tubers with Gibberellic acid and differed significantly with all the treatments except for the fertilization treatment of 250 kg.ha^{-1} and soaking the tubers with Gibberellic acid, fertilization treatment 500 kg.ha^{-1} and soaking the tubers with seaweed extract, and the control treatment of and soaking the tubers with seaweed extract.

2- The marketable yield of the plant (kg):

Table (3) indicates that Burren cultivar was significantly excelled than the Arizona cultivar in the marketable yield of the plant with an increase ratio of 26.73%. No significant differences were observed between the fertilization treatments with humic in the marketable yield of the plant. The soaking tuber treatment with Gibberellic acid was significantly excelled in this trait and did not differ significantly with soaking tubers in licorice and seaweed extract. It was differed significantly from the treatment of soaking tubers in water, which gave the lowest marketable yield of the plant and the percentage of increase between them was 46.17%. In the bi-interactions, from the same table observed in the interaction between the cultivar and humic a significant excelling of Burren and fertilization with 500 kg.ha^{-1} humic by giving it the highest marketable yield of the

plant and significantly different with the treatments of Arizona cultivar and fertilization with (250, 500 kg.ha^{-1}) which gave the lowest marketable yield of the plant. In the interaction between the cultivars and soaking tubers, it was observed that the Burren treatment and soaking tubers with Gibberellic acid gave the highest marketable yield of the plant and differed significantly with all the treatments of this interaction. The treatment of Arizona cultivar and soaking tubers in water gave the lowest water marketable yield of the plant.

Table 2: Effect of cultivars, soaking of tubers and Fertilization with Humic in the number of tubers / plant.

Cultivars	Humic	Soaking Tubers				Cultivar × Humic	Effect of cultivar
		Water	GA_3	licorice	Seaweed extract		
Arizona	Control	5.53 ef	9.00 abc	4.86 f	6.13 c-f	6.38 c	6.41 b
	250	5.60 def	9.06 abc	5.33 ef	6.93 c-f	6.73 bc	
	500	6.00 c-f	7.06 b-f	4.80 f	6.60 c-f	6.11 c	
Burren	Control	6.70 c-f	10.20 a	9.06 abc	10.06 ab	9.00 a	8.10 a
	250	6.46 c-f	10.00 ab	8.33 a-e	6.53 c-f	7.83 ab	
	500	7.60 a-f	7.53 a-f	6.06 c-f	8.66 a-d	7.46 bc	
Effect of soaking tubers		6.31 c	8.81 a	6.41 c	7.48 b	Effect of humic	
Humic × Soaking Tuber	Control	6.11 bc	9.60 a	6.96 bc	8.10 ab	7.69 a	
	250	6.03 bc	9.53 a	6.83 bc	6.73 bc	7.28 a	
	500	6.80 bc	7.30 bc	5.43 c	7.63 ab	6.79 a	
Humic × Soaking Tuber	Arizona	5.71 de	8.37 ab	5.00 e	6.55 cde		
	Burren	6.92 bcd	9.24 a	7.82 abc	8.42 ab		

The averages with the same letters within the same column and the interaction treatments are not significantly different according to the Duncan test at probability level of 0.05

Table 3: Effect of cultivars, soaking of tubers and Fertilization with Humic in the marketable yield of the plant.

Cultivars	Humic	Soaking Tubers				Cultivar × Humic	Effect of cultivar
		Water	GA_3	licorice	Seaweed extract		
Arizona	Control	0.430 bc	0.503 bc	0.536 bc	0.590 b	0.515 abc	0.449 B
	250	0.366 bc	0.516 bc	0.533 bc	0.413 bc	0.457 bc	
	500	0.210 c	0.516 bc	0.353 bc	0.423 bc	0.375 c	
Burren	Control	0.606 b	0.536 bc	0.400 bc	0.573 b	0.529 ab	0.565 A
	250	0.416 bc	0.676 ab	0.520 bc	0.573 b	0.546 ab	
	500	0.480 bc	0.916 a	0.573 b	0.506 bc	0.619 a	
Effect of soaking tubers		0.418 b	0.611 a	0.486 ab	0.513 ab	Effect of humic	
Humic × Soaking Tuber	Control	0.518 abc	0.520 abc	0.468 bc	0.581 ab	0.522 a	
	250	0.391 bc	0.596 ab	0.527 abc	0.493 abc	0.502 a	
	500	0.345 c	0.716 a	0.463 abc	0.465 bc	0.497 a	
Humic × Soaking Tuber	Arizona	0.335 c	0.512 bc	0.474 bc	0.475 bc		

The averages with the same letters within the same column and the interaction treatments are not significantly different according to the Duncan test at probability level of 0.05.

In the interaction between humic and soaking tuber, it is noted that fertilization by (500 kg.ha^{-1} humic) and soaking tubers in Gibberellic acid gave the highest marketable yield of the plant, thus differed significantly only with the treatment of control and soaking tubers in licorice and with two fertilization treatments of (250, 500 kg.ha^{-1}) humic and the soaking tubers in water, which gave the lowest marketable yield of the plant. In the triple interaction of the studied factors, it is noted from the results of the same table that the highest marketable yield of the plant was in the treatment of Burren cultivar and fertilization with 500 kg.ha^{-1} humic and soaking tubers in Gibberellic acid and differed significantly with all treatments except Burren cultivar and 250 kg.ha^{-1} humic and soaking tubers in Gibberellic acid, the lowest marketable yield of the plant was in the treatment of the Arizona cultivar and fertilization with 500 kg.ha^{-1} Humic and soaking tubers in water only.

3- Total yield of tubers (kg.ha^{-1}):

Table (4) indicates that Burren cultivar was significantly excelled on Arizona cultivar in the total yield of tubers with an increase of 21.78%. No significant effect was recorded in the total yield of tubers between the addition treatments of humic acid. In the treatment of soaking tubers, the results showed a significant excelling in the total yield of tubers for treatment of soaking tubers with Gibberellic acid compared to the treatment of soaking tubers in water and licorice with an increase ratio of (36.2%, 37.73%), respectively. The treatment of soaking tubers with licorice gave the lowest total yield of tubers. The results indicate that the bi-interactions treatment between Burren cultivar and the addition of the humic (500 kg.ha^{-1}) gave the highest total yield of tubers and significantly differed with all Arizona cultivars and addition of humic. The lowest total yield of tubers were in the interaction treatment between Arizona cultivar and the addition of the humic (500 kg.ha^{-1}). The results showed that the interaction treatment between Burren cultivar and soaking tubers with Gibberellic acid gave the highest total yield of tubers and significantly different with those of Arizona cultivars and soaking tubers in seaweed extract, water and licorice. The results indicate the significant excelling the interaction treatment between soaking tubers with Gibberellic acid and the addition of hemic acid (250 kg.ha^{-1}) by giving it the highest total yield of tubers and differed significantly with some treatments of this interaction. The lowest total yield of tubers was in the treatment of soaking tubers in water and without the addition of the humic. The results indicate that the highest total yield of tubers was in the triple interaction between Burren cultivar, adding 250 kg.ha^{-1} of hemic fertilizer and soaking tubers with Gibberellic acid, and differed significantly with most of the treatments. The lowest total yield of tubers were inthe triple interaction between Arizona cultivars and the addition of humic (250 kg.ha^{-1}) and soaking tubers in the licorice.

The superiority of Burren cultivar on Arizona cultivar in the total number of tubers for the plant is due to the genetic variability among cultivars (23), to the cultivar' response to climatic conditions during the growing season and to the nature of the growth and yield of both cultivars. Burren tubers grew faster than Arizona tubers, this agree with (3, 8, 9, 19, 21, 22, 28, 42) showed that there were significant differences between the potato cultivars in the total number of tubers of the plant. In the marketable yield of the plant, the excelling of Burren cultivar on Arizona cultivar to its superiority in the total number of tubers for the plant as shown in Table (3) and the genetic variation between the two cultivars (14), to Burren response to climatic conditions during the growing season which caused all of the increase in the marketable yield of the plant. The reason for the superiority of Burren in the total yield of tubers to its superiority in the total number of tubers for the plant as shown in Table (2) the marketable yield of the plant as shown in Table (3), which was reflected in the significant increase in the total yield of tubers, to the existence of genetic differences between cultivars (23), to differences between

the potato cultivars in the total yield in units area (39). This agree with what is mentioned (9, 13, 18, 19, 26, 42) in the presence of significant differences between the potato cultivars in the total yield of tubers. The reason for the superiority of the treatment of soaking tubers with Gibberellic acid in the total number of tubers may be due to their superiority in the leaf area of the plant. Which caused the increase in the total number of tubers / plant, This agrees with what is mentioned (32) that the treatment of seeds with Gibberellic acid led to increase the number of tubers for one plant compared to the control treatment (water only).

Table 4: Effect of cultivars, soaking of tubers and Fertilization with Humic in the total yield of tubers.

Cultivars	Humic	Soaking Tubers				Cultivar × Humic	Effect of cultivar
		Water	GA_3	licorice	Seaweed extract		
Arizona	Control	13.76 fg	23.20 a-e	18.51 b-f	23.10 a-e	19.64 b	18.64 B
	250	17.88 c-f	26.53 abc	13.23 g	18.11 b-f	18.94 b	
	500	15.77 ef	21.60 a-f	15.05 ef	16.92 def	17.34 c	
Burren	Control	20.45 a-e	23.12 a-e	16.68 def	25.96 a-d	21.55 ab	22.70 A
	250	17.11 def	29.34 a	21.62 a-f	21.95 a-f	22.51 ab	
	500	23.32 a-e	23.82 a-e	22.07 a-f	26.89 ab	24.03 a	
Effect of soaking tubers		18.05 b	24.60 a	17.86 b	22.16 ab	Effect of humic	
Humic × Soaking Tuber	Control	17.11 d	23.16 abc	17.60 cd	24.53 ab	20.60 a	
	250	17.50 cde	27.94 a	17.43 cde	20.03 bcd	20.67 a	
	500	19.55 bc	22.71 abc	18.56 cd	21.91 abc	20.68 a	
Humic × Soaking Tuber	Arizona	15.80 d	23.78 ab	15.60 d	19.38 bc		
	Burren	20.29 abc	25.43 a	20.12 abc	24.93 ab		

The averages with the same letters within the same column and the interaction treatments are not significantly different according to the Duncan test at probability level of 0.05.

The reason for the superiority of soaking tubers with Gibberellic acid in the marketable yield of the plant to its superiority in the total number of tubers for the plant as shown in Table (2). This result agrees with (4, 7, 30, 32) found that the treatment of potato tubers with Gibberellic acid before cultivating caused an increase in the marketable yield of the plant and the total number of tubers for the plant. The reason for the superiority of soaking tubers with Gibberellic acid in the total yield of tubers was due to their superiority in the number of tubers / plant as shown in Table (2), the marketable yield for the plant as shown in Table (3). This led to a significant increase in the total yield for the unit area and its role in stimulating vegetative growth through increasing the division and elongation of cells due to its effect on the enzymes of converting complex compounds into simpler compounds that are used by the plant in building the protein materials needed for growth (24). This increases the efficiency of the plant in the storage of carbohydrate materials manufactured in the storage areas which represented by potato plant through stimulating the activity of enzymes that accelerate the process of the transfer of materials from the places of production (Sources) to the places of storage (sinks) in the tubers, This agrees with what is mentioned (12, 32, 37, 41) that the soaking tubers with Gibberellic acid caused a significant increase in the total yield of tubers.

Second: Qualitative yield traits:

1. Percentage of dry matter in tubers:

Table (5) shows that Burren is significantly excelled on Arizona in the percentage of dry matter in tubers. No significant differences were observed between the treatment of the

adding humic and soaking tubers treatment in the percentage of dry matter in tubers. The results of the same table show that the interaction treatment between Burren cultivar and the addition of (250 kg.ha^{-1}) Humic was significantly excelled by giving it the highest percentage of dry matter in the tubers and differed significantly with all the treatments in this interaction, except for Burren cultivar and adding of 500 kg.ha^{-1} Humic, and the treatment of Arizona cultivar and control, respectively. The lowest percentage of dry matter in tubers was in the interaction treatment between Arizona cultivar and adding of 250 kg.ha^{-1} Humic. In the interaction between cultivars and soaking tubers, there were no significant differences between the interaction treatments in the percentage of dry matter in tubers. In the interaction between humic and soaking tubers, the highest percentage of dry matter in the tubers was in the treatment of adding of 250 kg.ha^{-1} humic and soaking tubers in licorice, while the lowest percentage of dry matter in the tubers was in the treatment of addition of 250 kg.ha^{-1} humic with soaking tubers in water only. it is noted from the same table that the highest percentage of dry matter in tubers was in the triple interaction treatment between Burren, adding of 250 kg.ha^{-1} humic and soaking tubers in licorice, and differed significantly with some treatments. The lowest percentage of dry matter in tubers was in the interaction treatment of (Arizona cultivar, adding of 250 kg.ha^{-1} Humic and soaking tubers in water only).

Table 5: Effect of cultivars, soaking of tubers and Fertilization with Humic in the percentage of dry matter in tubers.

Cultivars	Humic	Soaking Tubers				Cultivar × Humic	Effect of cultivar
		Water	GA_3	licorice	Seaweed extract		
Arizona	Control	11.68 abc	11.54 abc	11.02 a-d	11.80 abc	11.51 ab	11.15 b
	250	9.84 d	10.81 bcd	11.98 abc	10.97 a-d	10.90b	
	500	11.81 abc	11.25 a-d	10.82 bcd	10.37 cd	11.06 b	
Burren	Control	12.05 ab	10.78 bcd	10.77 bcd	11.17 a-d	11.19 b	11.57 a
	250	11.84 abc	11.86 abc	12.57 a	11.89 abc	12.04 a	
	500	11.36 a-d	11.23 a-d	11.84 abc	11.49 abc	11.48 ab	
Effect of soaking tubers		11.43 a	11.24 a	11.50 a	11.28 a	Effect of humic	
Humic × Soaking Tuber	Control	11.86 ab	11.16 b	10.89 b	11.49 ab	11.35 a	
	250	10.84 b	11.33 ab	12.28 a	11.43 ab	11.47 a	
	500	11.58 ab	11.24 ab	11.33 ab	10.93 b	11.27 a	
Humic × Soaking Tuber	Arizona	11.11 a	11.20 a	11.27 a	11.05 a		
	Burren	11.75 a	11.29 a	11.73 a	11.52 a		

The averages with the same letters within the same column and the interaction treatments are not significantly different according to the Duncan test at probability level of 0.05.

2 - percentage of starch in tubers%:

Table (6) indicates that there is no significant effect between the two cultivars in the fertilization treatments with humic and soaking tubers on the percentage of starch in tubers. The bi-interaction treatment between Burren cultivar and the addition of Humic (250 kg.ha^{-1}) has excelled by giving it the highest percentage of starch in tubers and did not differ significantly with two interaction treatments of (Burren cultivar and adding of Humic 500 kg.ha^{-1}) and (Arizona cultivar and non-addition of the humic), while significantly different with other treatments in this interaction. The lowest percentage of starch in tubers was in the interaction treatment between Arizona cultivar and the addition of Humic (250 kg.ha^{-1}). In the interaction

between the cultivars and tubers, no significant effect was observed between the treatments of this interaction in the percentage of starch in tubers.

Table 6: Effect of cultivars, soaking of tubers and Fertilization with Humic in the percentage of starch in tubers.

Cultivars	Humic	Soaking Tubers				Cultivar × Humic	Effect of cultivar
		Water	GA_3	licorice	Seaweed extract		
Arizona	Control	6.41 ab	6.29 ab	5.96 abc	6.53 ab	6.30 ab	5.99 A
	250	4.78 c	5.64 bc	6.68 ab	5.79 abc	5.72 b	
	500	6.53 ab	6.03 abc	5.65 bc	5.54 bc	5.94 b	
Burren	Control	6.74 ab	5.56 bc	5.61 bc	5.86 abc	5.94 b	6.31 A
	250	6.56 ab	6.58 ab	7.21 a	6.60 ab	6.74 a	
	500	6.13 abc	6.01 abc	6.56 ab	6.25 ab	6.24 ab	
Effect of soaking tubers		6.19 a	6.02 a	6.28 a	6.09 a	Effect of humic	
Humic × Soaking Tuber	Control	6.58 ab	5.92 b	5.78 b	6.19 ab	6.124 a	
	250	5.67 b	6.11 ab	6.95 a	6.19 ab	6.235 a	
	500	6.33 ab	6.02 ab	6.10 ab	5.90 b	6.093 a	
Humic × Soaking Tuber	Arizona	5.91 a	5.99 a	6.10 a	5.95 a		
	Burren	6.48 a	6.05 a	6.46 a	6.24 a		

The averages with the same letters within the same column and the interaction treatments are not significantly different according to the Duncan test at probability level of 0.05.

The results indicate that the interaction treatment between the addition of Humic (250 kg.ha^{-1}) and soaking tubers in licorice gave the highest percentage of starch in the tubers and differed significantly only with the control treatments (non-addition of the humic) and soaking tubers in Gibberellic acid, licorice and with treatment of adding (250kg.ha^{-1}) and soaking tubers in water and the addition of 500 kg.ha^{-1} Humic and soaking tubers in seaweed extract. In the triangular overlap between the studied factors, the results of the same table indicate that the highest percentage of starch in tubers was in the interaction treatment between Burren cultivar and the addition of Humic 250 kg.ha^{-1} and soaking tubers in licorice and differed significantly with some of the interaction treatments. The lowest percentage of starch in tubers was in the interaction treatment between Arizona cultivar and the addition of Humic 250 kg.ha^{-1} and soaking tubers in water.

3- Percentage of protein in tubers%:

Table (7) shows that there is no significant difference between Arizona cultivar and Burren cultivar and the addition treatments of humic in the percentage of protein in tubers%. It is noted from the same table that the soaking tubers treatment in water and seaweed extract gave the highest percentage of protein in the tubers compared to the treatment of soaking tubers in licorice, which gave the lowest percentage of protein in the tubers. The bi-interaction between Arizona cultivar and the control (without humic) gave the highest percentage of protein in the tubers and differed only significantly with interaction treatment between Burren cultivar and the adding of 250 kg.ha^{-1} humic which gave the lowest percentage of protein in tubers. In the overlap between cultivars and tubers, no significant differences were observed between the treatments in the percentage of protein in tubers. it was noticed that the interaction treatment between the control and soaking tubers in Gibberellic acid gave the highest percentage of protein in the tubers and differed significantly only with the addition treatments of (500, 250 kg.ha^{-1}) humic and soaking the tubers with Gibberellic acid which gave the

lowest percentage of protein in the tubers. The results indicated that the highest percentage of protein in the tubers was in the triple interaction treatment of Burren cultivar, the control and soaking the tubers in Gibberellic acid, and differed significantly only with the interaction treatment of Burren, control and soaking the tubers in seaweed extract, and the treatment of Burren cultivar and the addition of 500 $kg.ha^{-1}$ humic and soaking tubers with Gibberellic acid, which gave the lowest percentage of protein in the tubers.

Table 7: Effect of cultivars, soaking of tubers and Fertilization with Humic in the percentage of protein in tubers.

Cultivars	Humic	Soaking Tubers				Cultivar × Humic	Effect of cultivar
		Water	GA_3	licorice	Seaweed extract		
Arizona	Control	10.26 ab	10.21 ab	8.65 abc	10.05 ab	9.79 a	9.22 A
	250	8.84 abc	9.10 abc	9.84 ab	9.89 ab	9.42 ab	
	500	8.12 abc	8.82 abc	8.07 abc	8.77 abc	8.44 ab	
Burren	Control	8.07 abc	10.87 a	8.54 abc	7.72 bc	8.80 ab	8.59 A
	250	10.12 ab	6.25 c	7.79 abc	8.57 abc	8.18 b	
	500	8.82 abc	7.79 abc	9.12 abc	9.40 ab	8.78 ab	
Effect of soaking tubers		9.04 a	8.84 ab	8.67 b	9.07 a	Effect of humic	
Humic × Soaking Tuber	Control	9.17 ab	10.54 a	8.59 ab	8.89 ab	9.30 a	
	250	9.48 ab	7.68 b	8.82 ab	9.23 ab	8.80 a	
	500	8.47 ab	8.30 b	8.59 ab	9.08 ab	8.61 a	
Humic × Soaking Tuber	Arizona	9.07 a	9.38 a	8.85 a	9.57 a		
	Burren	9.00 a	8.30 a	8.48 a	8.56 a		

The averages with the same letters within the same column and the interaction treatments are not significantly different according to the Duncan test at probability level of 0.05.

The reason for the superiority of Burren cultivar on Arizona cultivar in the percentage of dry matter in the tubers to the difference in the nature of the genotypes of the two cultivars and the response of Burren cultivar to the climatic conditions prevailing during the growing season, which led to the accumulation of manufactured carbohydrates in photosynthesis in the leaves and their transfer to storage places In tubers, which increased the proportion of dry matter in the tubers, these are consistent with (3, 8, 17, 18, 19, 28, 34, 40) that there are significant differences between the potato cultivars in the percentage of dry matter in the tubers. The reason for the superiority of Arizona cultivar on Burren cultivar may be due to the percentage of protein in the tubers to the genetic differences between the two cultivars, to the Arizona response to climatic conditions during the growing season, or possibly to high percentage of the nitrogen element in its leaves and perhaps to the strength, efficiency and activity of the total vegetative in the absorption and representation of the nitrogen element in the leaves of the plant and then transmission to the tubers, which caused the increase of the concentration of this element in the tubers and thus increase the percentage of protein in it, and this is consistent with (14, 15, 20, 26) variation of potato tubers cultivars in their protein content. it was observed that soaking tubers in licorice and water gave the highest percentage of dry matter in tubers compared with Gibberellic acid and seaweed extracts. However, this difference is not significant. This may be due to the fact that the treatment of soaking tubers in Gibberellic acid, whose important physiological effects elongation of the cells and give flexibility and increase the expansion in the walls and high water absorption rate (31), which helps to store the

largest amount of moisture in the gaps of cells and this in turn leads to increased humidity In contrast to the components of the cell, which helped to show the dilution state of the proportion of cytoplasmic components of the cells and thus led to a decrease in the percentage of dry matter and starch in it, Which helped to show their superiority together on the treatment of soaking in Gibberellic acid.

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