# THE ROLE OF PERLITE AND IRRIGATION MANAGEMENT IN WATER CONSUMPTIVE, GROWTH AND YIELD OF POTATO SOLANIUM TUBEROSUM L. IN SANDY LOAM SOIL

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# THE ROLE OF PERLITE AND IRRIGATION MANAGEMENT IN WATER CONSUMPTIVE, GROWTH AND YIELD OF POTATO *SOLANIUM TUBEROSUM* L. IN SANDY LOAM SOIL

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**ABSTRACT : A field experiment was conducted in the district of Hit - Anbar province for the 2018 spring season in sandy soil to study the role of perlite, the quantity and the irrigation interval in water consumption and the growth and yield of potatoes. Add the perlite mixture with the soil at three levels 0, 4 and 8% of the size of the soil and a depth of 30 cm and add irrigation water levels of 100 and 50% of the net depth of the irrigation at the intervals of irrigation every 3 and 6 days. The parameters of the study were distributed according to the splintered splint system as part of the design of the complete random design. Plant height, leaf area, dry weight, total yield and water use efficiency were measured. The results showed the highest values of plant height, leaves area, dry weight, total yield of 66.5 cm, 64 dcm/ plant, 86.870 gm/plant and 28 tons/ha for perlite 8%, and irrigation at 3 days, at level 100% of the depth of irrigation. The dry weight of the plant decreased by 16.27% during irrigation every 6 days, 50% of the depth of the irrigation and 8% perlite compared to irrigation every 3 days and 100% of the depth of the irrigation and the same level of the perlite. The water consumption for potato crop was 472 mm and 235 mm in the season when irrigating every 3 days and adding 100%, 50% of the net depth of irrigation on respectively. The highest water use Efficiency of 21.26 kg. $m^{-3}$at addition of perlite level 8%.**

*Key words :* Perlite, irrigation management, consumptiveuse, potato, sandy soil.

## INTRODUCTION

Soil with high sand content is soil with low or no productivity. Because its weak water retention capacity, where water is quickly discharged downwards with nutrients and fertilizer added away from the reach of the roots. Because of high evaporation and evaporation rates, these soils are constantly dry and subject to wind erosion. The effect of previous production determinants of these soils can be minimized by using some industrial or natural enhancers. Many organic and inorganic materials have been added to the soil, which contributes to improving the soil and physical properties of the soil, which is positively reflected on the growth of the plant in order to reduce water consumption (Evans, 2004). The addition of perlite is a result of the heating of silicon volcanic rocks to 1500 m (Nelson, 2012), the presence of air gaps caused by heating increases the absorption of water by 430% of its size to make it within the reach of plant roots, and the perlite is a sterile medium free of bush and pathogens and excellent medium for germination (Hanna *et al*, 2006; Jerca *et al*, 2015). Several studies have shown that industrial enhancers have the ability to improve some sandy soil properties and overcome some of their agricultural parameters. However, the effectiveness of these preservatives may not last long because they are affected by salinity and heat, which leads to their instability and low water retention ability. In addition, the costs of using these enhancers are very high when used widely (Choudhary *et al*, 1998; Al-Harbi *et al*, 1999). Bhardwaj Shainberg *et al* (2007) fin that mixed sandy soils with water-resistant industrial polymers by reducing the infiltration rate and increasing the amount of water available to the plant. The amount of water absorbed by acrylic acid polymers mixed with sandy soils was 40-140 kg per kg of polymers between Akher *et al* (2004). The Role of Super Absorbent Polymer (SAP) in increasing soil ventilation when added to the surface of soil and under water stress conditions, which was clearly reflected in the rise of maize crop. That the use of polymer (gel water) levels of three levels of 0, 60 and 120 $kg.hectare^{-1}$ led to an increase in art effect of wheat plants grown in pots after two months of cultivation from 25.45 cm for the treatment of comparison to 32.50 and 36.24 cm for the treatments 60 and 120 $kg^{-1}$ hectares, respectively, Yazdani *et al* (2007) found that the use of SAP polymer under drought conditions led to the addition of the SAP polymer at levels 0, 10, 20, 30 and 40 kg was significantly increased in the dry matter yield of the maize crop and the highest values were 13.3% And 17.4% for levels 30 and 40 kg. Hectar[1] and also led to an increase in plant height of 208 cm when compared to 212, 217, 225 and 225 cm Levels above, respectively.

Irrigation management is an important process in irrigation agriculture, and has received the attention of many studies, both those that dealt with increasing the efficiency of water use by rationalizing consumption and reducing waste by adopting the real need of the plant to ensure that the plant is not subjected to water stress and obtain acceptable economic production (Malash and Ragab, 2005). Various methods have been adopted to reduce water needs and innovative scientific methods, including underwater irrigation by adding water quantities below actual water requirements. The decrease in the quantity of the crop will be insignificant if compared to the available quantities of water that can be used to irrigate other crops (Sam and Raes, 2009). Plant exposure to water stress during its development stages scientifically (not causing significant decrease in yield) results in the provision of quantities of water that may be exploited for other agricultural purposes (Star, 2013). The use of modern irrigation methods is an evolution to understand the transfer of water from soil to plant, resulting in optimal use of water, resulting in optimal water use, and the transfer of water in the root zone is characterized by soil and plant characteristics and climatic factors (Shanker *et al*, 2013). Potatoes are grown widely in the world because they are highly nutritious and energy-rich, and despite the increase in cultivated area, their production in Iraq still does not meet their local needs (Thalaj and Al-Najjar, 2010). The cultivated area in Iraq is 40,000 hectares (FAO, 2013). Between Badr *et al* (2012), the irrigated potatoes drip under irrigation levels 40, 60, 80 and 100% of evaporated water resulted in a significant increase in growth indicators and tubers with increased irrigation level. Irrigation of crops that are sensitive to water stress such as potatoes requires a regular approach to irrigation scheduling (Ayas, 2013). Al-Jubouri *et al* (2017) found that irrigation spacing resulted in a significant decrease in vegetative growth and potato yield, with irrigation treatment every 10 days giving the lowest values for plant height, dry weight, leaves the area and total yield of 69.47 cm and 52.80 g. plant$^{-1}$ and 46.01 dcm. Plants $^{-1}$ and 37.0 tons. Hectar$^{-1}$, respectively, compared to the highest values for the treatment of each 6 days, which gave 87.75 cm and 66.03 g. Plants$^{-1}$ and 66.72 dcm.Plants$^{-1}$ and 53.92 tons. hectare, respectively.

## MATERIALS AND METHODS

A field experiment was conducted in Anbar province in Hit district during the spring season 2018 for the period from February 2018 to 2018 in sandy soil. The physical and chemical properties of the soil were estimated according to the methods described in (Page *et al*, 1982) as well as the volumetric moisture, field capacity and permanent wilting point.

### Study parameters

1. Perlite/A/ Add the perlite mixture with the soil at three levels 0, 4 and 8% of the size of the soil and a depth of 30 cm.
2. Quantity of irrigation water/B/ add irrigation water levels of 100 and 50% of the net depth of the irrigation.
3. Irrigation interval/C/ intervals of irrigation every 3 and 6 days.

### Design of the experiment

The study parameters were distributed according to the Split - Split Plot Design system within the design of RCBDwith three replicates. The irrigation interval coefficients were placed in the main panels and each main plate was divided into two secondary plates, where irrigation was randomly distributed. Each secondary plate was divided into three sub-sections, randomly distributed to the perlite, where the number of treatments was 3 × 2 × 2 = 12 treatment.

### Field initialization and agriculture

The land was plowed and divided into three sectors and each sector was divided according to the experimental design. The splintered pieces were divided into a length of 10 m and a width of 0.75 m. Dap fertilizer and potassium sulphate were added at the rate of 300 kg $P_2O_5$ and $k_2O$/ha, respectively, where half the amount of potassium was added before planting and the second half was added after 45 days of planting with urea fertilizer added at 300 kg/ha. The potato tubers class (Riviera) were grown at a depth of 8 cm and 0.4 m between one plant and another after immersing them in the fungicidal fungusagersef at 250 ml/100 liters of water for 10 minutes. The tubers were then placed with a gebrileic discs solution for 200 liters of water. The irrigation was determined according to the procedures by compensating the water evaporated from the American evaporation basin class A every 3 and 6 days by adding 50% and 100% of the net depth of the irrigation where the net depth of the irrigation was calculated according to the following equations:

The potential evapotranspration (ETo) calculated according to the equation mentioned in Hadithi *et al* (2010).

$$ETo = Kp – Epan \quad (1)$$

Where,

ETo : evapotranspiration potential (mm day-$^{1}$).

ETa : actual evapotranspiration (mm day$^{-1}$).

Kp: Special coefficient of evaporation basin varies depending on the type of basin and vegetation surrounding the basin and the nature of the surface of the soil, as mentioned in Alhadithi *et al* (2010). The value (0.8) in this study was based on Yildrim *et al* (2002).

Epan: evaporation from pan (mm).

Calculation of actual evapotranspiration (Eta), which is practically equal to the actual water consumption of the irrigated potato yield by surface irrigation or spray method according to the following equation:

$$ETa = ETo – Kc \quad (2)$$

Where,

ETa : actual evapotranspiration (mm day$^{-1}$).

Kc : crop factor

The values of 0.75, 1.15, 1.00 and 0.80 which mentioned in ShiriJanagrad *et al* (2009) were used to represent crop coefficient values for the periods (03/7 - 03/27), (27/03 - 04/16) and 04/16 - 05/11 and 05/11 - 05/20), respectively.

The water budget equation was adopted in estimating water consumption:

$$ETa = (P + Ir) - (D + R + In + \Delta S) \quad (3)$$

Where,

ETa: water consumption (mm), P amount of precipitation, Ir: depth of irrigation and D: deep percolation, R:surface runoff, In: water held by the plant, and " S: difference in soil moisture. Assuming that both the surface runoff and the water held by the plant and the deep percolation are equal to zero, the equation becomes as follows:

$$ETa = (P + Ir) – \Delta S \quad (4)$$

The amount of water to be added as leaching requirements is calculated according to the formula given by Dorata (2000) for the drip irrigation systems of agencies

$$L.R = Ecw / (2Max\ Ece) \quad (5)$$

LR represents the requirements for leaching (%), Ecw electrical conductivity of irrigation water (ds.m$^{-1}$), and MaxECe maximum electrical conductivity (ds.m$^{-1}$) for cultivated crop soil, where the yield is zero and equal to 10 for potatoes crop (Ayers and Westcot, 1976).

Drip irrigation system was used aGR drippers with 4 liter/hour. The irrigation water was added according to the dual addition method by dividing the quantities of water added by 6 hours (Khatib *et al*, 2016). The irrigation time was calculated according to the equation mentioned in Hadithi *et al* (2010).

$$q \times t = a \times d \quad (6)$$

Where,

q : the discharge given to the sidelines (m$^{3}$.h$^{-1}$), t: irrigation time (h), a: cultivated area (m$^{2}$) and d: added water depth (m).

The height of the plant (cm) was measured for five plants from the treatment and then their average according to Issawi (2010). The leaves area was measured (dcm$^{2}$.plant$^{-1}$) by taking 30 discs of the area and dried in an electric oven at a temperature of 70$^{0}$C according to the following formula:

Vegetable leaf area = (dry weight × leaf area /dry discs weight) (Wien, 1997) (7)

The total yield of each treatment was estimated separately and the yield berhectare was calculated using the equation mentioned below:

Yield/hectar = (Experimental unit yield(Kg)/ Experimental unit Area (m$^{2}$)) × 10000 (8)

Water use efficiency (W.U.E) or water productivity (Hillel, 2008) was calculated by dividing the total yield (kg.hectar$^{-1}$) by the volume of water added (m$^{3}$.h$^{-1}$. season). Using the equation mentioned in (Doorenbos and Pruitt, 1977).

$$(W.U.E)\ (kg.m^{-3}) = \frac{\text{Total yield (kg.hectar}^{-1})}{\text{Volume of water added (m}^{3}.\text{h}^{-1}.\text{season)}} \quad (9)$$

Data were analyzed according to the design followed and the averages were tested according to the least significant difference (L.S.D) at the probability level of 0.05 using the Genistat program.

## RESULTS AND DISCUSSION

### Plant height (cm)

Fig. 1 shows the effect of the study coefficients on the height values of the potato plant. It is noted that the values differed according to the levels of the added perlite, where the highest values were 66.5 cm compared to 10.33 and 27.17 cm at levels 0 and 4% on respectively and for any added depth of irrigation. The rate of increase in plant height was 140% and 20% when increasing the level of addition from 0 to 4% and to 8% on the relay. This may be attributed to the positive role of perlite in

**Table 1 :** Some physical and chemical properties of soil.

| Value | Units | Property | |
|---|---|---|---|
| 7.6 | .......... | pH | |
| 2.3 | DS.m$^{-1}$ | EC1:1 | |
| 57.3 | kg.mg$^{-1}$ | N | Available elements |
| 13.4 | | P | |
| 146.5 | | K | |
| 10.5 | g. kg $^{-1}$ | Organic mater | |
| Nill | | $CaSO_4$ | |
| 184 | | $CaCO_3$ | |
| 775 | | Sand | Separated soil |
| 95 | | Silt | |
| 130 | | Clay | |
| Sandy loam | | Soil texture | |
| 43.3 | % | 0 kps | Volumetric soil moisture% |
| 27.0 | | 33kps | |
| 8.5 | | 1500 kps | |
| 1.39 | Mgm.m$^{-3}$ | Bulk density | |
| 2.55 | Mgm.m$^{-3}$ | Particle density | |

increasing water conservation and reducing the water stress in the plant and has the ability to exchange cations and thus helps to increase the growth and activity of roots, which is reflected in the increase in vegetative growth and yield this may bethe reason is that plants planted in both levels of perlite, and have the moisture produced by perlite around the roots of the plant makes them grow and spread superficially and increase their branches and thus increase the height of the plant. These results are consistent with what he found (Haghighi *et al*, 2016).

The results of Fig. 1 shows significant differences between the height values of the plant according to the interval of irrigation interval, and for any added perlite level. The highest irrigation values for every 3 days were 66.5, 60.33 and 24.13 cm compared to irrigation every 6 days 45.17, 32.17 and 15.5 cm for the levels of 8%, 4% and 0%, respectively. Of the plant is negatively reflected in the inhibition of the average division and elongation of cells and the lack of absorption and transport and hence the increase of plant height (Mojaddam *et al*, 2011). In addition, plants change their rate of growth as a response to water stress by controlling and modulating many important processes such as cell division, biological cell wall representation, cellular membranes and protein metabolism (Awad, 2009) and consistent with what he found. The results are shown in Fig. 1 that the addition of 100% of the net depth of the soil increased the plant height significantly compared with the addition of 50% of the depth of the irrigation and of any irrigation interval. The values were 45.17, 32.17 and 15.5 cm for irrigation depth 100% on irrigation interval 6 days compared to 38.0, 27.17 and 10.33 cm for irrigation depth of 50% at irrigation every 6 days for perlite levels 8, 4 and 0%, respectively. The decrease in plant height values for 50% irrigation depth and 6 days interval compared to 100% irrigation depth for 6 and 3 days may be due to the fact that water stress affects physiological activity, biochemical processes and reduces the rate of carbonation, metabolism, flowers, nodes, hormones and plant respiration. And the absorption of ions and nutrients in non-stress-resistant (Bhatt *et al*, 2009; Boutraa, 2010; UNDP, 2015).

**Dry weight of plant (g. plant$^{-1)}$**

Fig. 2 shows the effect of the study parameters on dry weight values of the plant. It is noted that the values differed according to the levels of perlite, where the highest values were 86.870 gm$^{-1}$ at the level of the addition of 8% and the lowest value was 22.5 and 65.43 gm$^{-1}$ for 0 and 4% perlite.

This may be due to the role of perlite in improving the physical properties of the soil. It increases its granulation, which increases porosity, permeability and ventilation of the soil, providing the oxygen needed to breathe the roots and activity of living organisms, increases the soil's ability to retain water and reduces loss by evaporation. Ideal for plant roots to increase the qualities of vegetative, syphilis and root growth, which is positively reflected on the traits of the crop and its components (Hamdi, 2017).

The results of Fig. 2 shows significant differences between the dry weight values of the plant according to the salinity interval and for any added perlite level. The highest values were for irrigation every 3 days and were 86.87, 84.43 and 58.0 g. Plants$^{-1}$ compared with irrigation every 6 days 74.77, 69.73 and 30.47 g. Plants$^{-1}$ for the levels of 8%, 4% and 0%, respectively. The water deficit is one of the most important environmental factors in determining plant growth and reducing production in quantity and quantity. The spacing of the irrigation period reduces the process of carbonation and increases the aging of the leaves with low nutrient uptake and lack of cell growth and elongation and lack of expansion of the leaves leading to closing the gaps and determining the growth of crops (Akinci *et al*, 2012).

The results shown in Fig. 2 that the depth of irrigation 100% increased the dry weight values of the plant significantly compared to the depth of the irrigation 50% as the depth of the irrigation 100% for the interval of irrigation every 3 and 6 days increased the dry weight

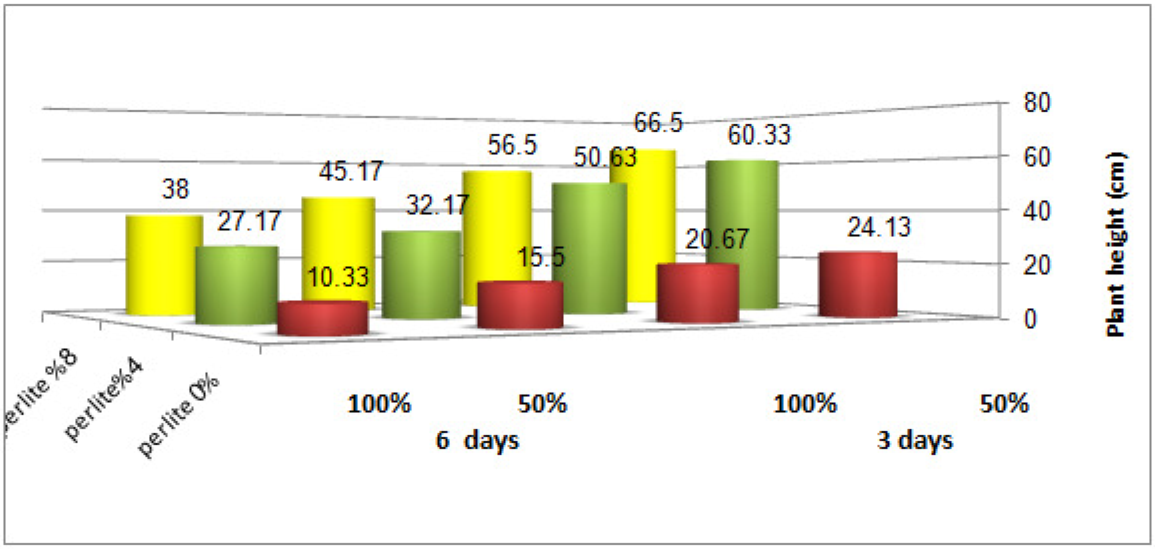


**Fig. 1 :** The effect of perlite, level and irrigation interval on plant height.

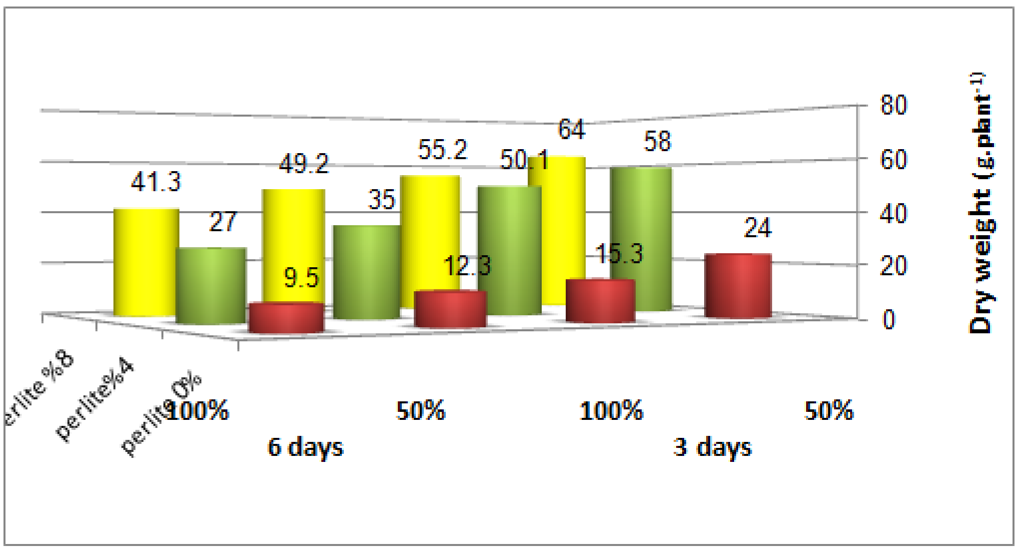


**Fig. 2 :** The effect of perlite level and irrigation interval on dry weight values of the plant.

values of the plant significantly compared to the depth of irrigation 50% 6 days, with a value of 74.77, 69.73 and 30.47 g.Plants$^{-1}$ for irrigation depth 100% at irrigation every 6 days compared to 72.73, 65.43 and 22.5 g.plants$^{-1}$ to 50% irrigation depth at irrigation every 6 days for perlite levels 8, 4 and 0%, respectively. The decrease in the dry weight values of the plant for 50% depth of irrigation and 6 days interval compared to 100% depth of irrigation for 6 and 3 days may be due to the lack of irrigation water effect on the expansion of leaves, stems and tubers due to the low pressure of filling which is necessary for elongation and then decreased photosynthesis. Water stress also inhibits the function of hormones, especially oxygen, so that plant height, number of steppes and other vegetative traits decrease (Abdel-Latif *et al*, 2011).

### Leaf area (dcm$^2$.plant$^{-1}$)

Fig. 3 shows the effect of study coefficients on leaf area values. It is noted that the values differed according to the levels of perlite where the highest values were 64 at the level of the addition of 8% compared to levels 0 and 4% and for any added depth of the soil and the lowest value of 9.5 and 27 fat 2 plants$^{-1}$ levels of 0 and 4% perlite. The addition of perlite reduced the evaporation in the soil and increased the proportion of water tip in the soil and then increase the amount of water stored and ready in the soil. Which leads to increased vegetative growth and leaf area (Olle, 2016 and Salas-Perez *et al*, 2017).

The results of Fig. 3 showed significant differences between the values of the leaf area according to the interval of the irrigation, and for an added level of perlite. The highest values of irrigation for each 3 days were 64,

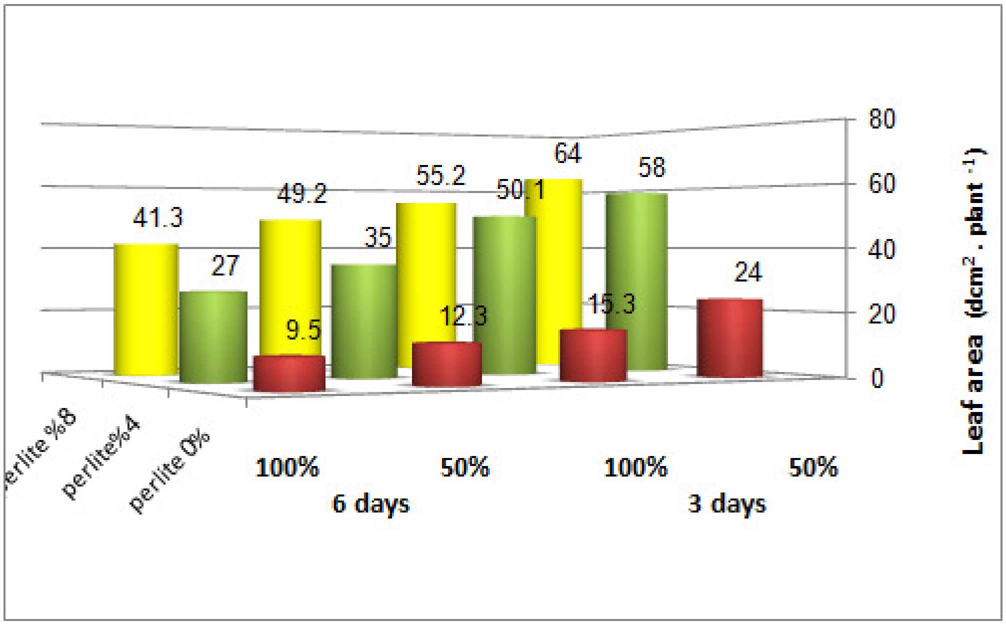


**Fig. 3 :** The effect of perlite level and irrigation interval on leaf area values of the plant.

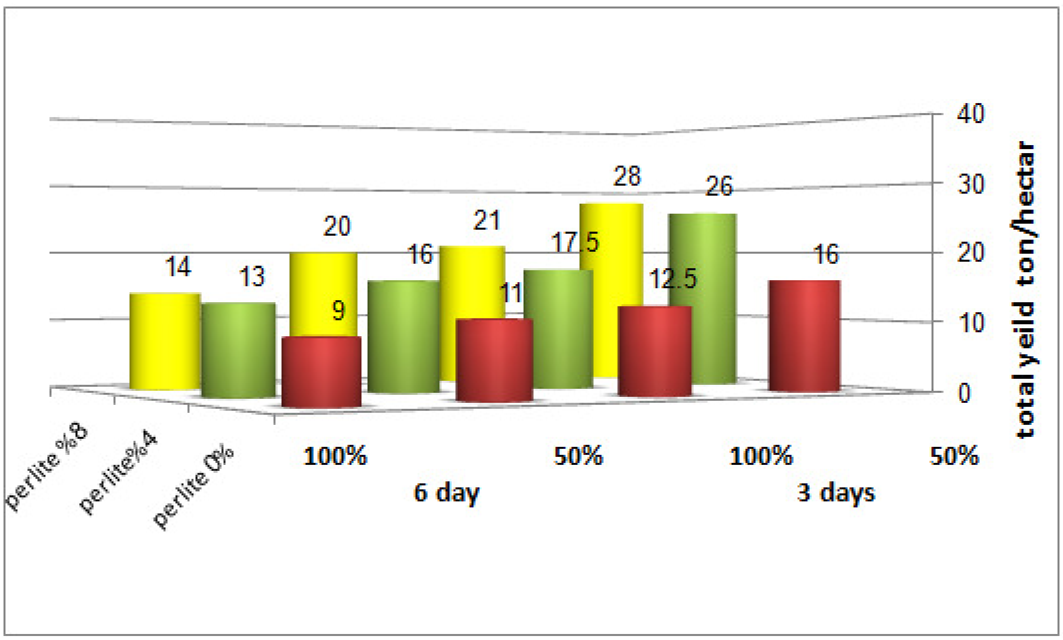


**Fig. 4 :** The effect of perlite level and irrigation interval ontotal yield values of the plant.

58 and 24 dcm$^2$.plant$^{-1}$ compared with irrigation every 6 days 49.2, 35.0 and 12.3 dcm$^2$.plant$^{-1}$ for the levels of perlite 8, 4 and 0%, respectively. The exposure of potato plants to the spread of irrigation periods and decrease the moisture content of soil (increased moisture tension) leads to a decline in indicators of vegetative growth, including leaf area and increase the tension on the plant reduces the growth process of division and expansion of cells, resulting in a shortage of leaf area. The reduction of leaf area occurs in response to drought by reducing the emergence of modern leaves and accelerate the aging of plants and fall leaves (Verma and Verma, 2010).

The results are shown in Fig. 3 shows that the depth of the irrigation 100% significantly increased the leaf area of the plant compared to the depth of the irrigation 50%. The depth of the irrigation 100% for the interval of the irrigation every 3 and 6 days increased the leaf area values of the plant significantly compared to the depth of the irrigation 50% 6 days, with a value of 49.2, 35.0 and 12.3 dcm$^2$. plant$^{-1}$ for irrigation depth 100% at irrigation every 6 days compared to 41.3, 27 and 9.5 dcm$^2$. plant$^{-1}$ for the depth of the irrigation 50% at irrigation every 6 days for the levels of perlite 8 and 4 And 0%, respectively. The decrease in leaf area may be due to the fact that the lack of irrigation water has an effect on the expansion of the

**Table 2 :** Shows the water consumption values of the potato crop and the four growth stages.

| Stages | Period (day) | Water consumption (mm. season$^{-1}$) Irrigation interval (day) | | | | Field water requirements($m^3.ha^{-1}$) |
|---|---|---|---|---|---|---|
| | | 3 Irrigation level | | 6 Irrigation level | | |
| | | 100% | 50% | 100% | 50% | |
| Germination | 27 | 40 | 20 | 40 | 20 | 167.44 |
| Vegetative growth | 20 | 54.13 | 27.065 | 64.63 | 32.315 | 226.588 |
| | | | | | | 270.541 |
| Tubers germination | 20 | 148.66 | 74.33 | 130.26 | 65.13 | 622.290 |
| | | | | | | 545.268 |
| Bulging tubersrain( 16,20) mm | 25 | 124.2 | 62.1 | 133.2 | 66.6 | 519.901 |
| | | | | | | 557.575 |
| Maturity | 10 | 105 | 52.5 | 103.1 | 51.55 | 439.53 |
| | | | | | | 431.576 |
| Total summation | | 471.99 | 235.995 | 471.19 | 235.595 | 1975.75 |
| | | | | | | 1972.4 |

leaves and the result of a decrease in the pressure of fullness which is necessary for elongation and then the reduction of photosynthesis. Water stress also inhibits the work of hormones, especially the oxygen hormone, so the leaf area is less (Abdel-Latif *et al*, 2011).

## Water consumption of potato crop

Table 2 shows the water consumption values of the potato crop and the four growth stages. The water requirement during the growing season was 471.99, 471.19, 235.995 and 235.595 mm for the three and six days of irrigation and 100 and 50% respectively for the irrigation depth. The reason for the increase in water consumption for 100% soil depth irrigation is due to increased plant transpiration and evaporation from the soil surface. The highest evaporation rate was obtained when treated with full irrigation compared to underage irrigation to increase soil moisture by adding more irrigation water than irrigation At 50% of the net depth of the irrigation. These results are consistent with (Al-Hadithi, 2002 and Aati, 2002). As it reached the stage of vegetative growth 54.13 and 64.63 mm and increased with the increase of plant growth and reached 148.66 and 130.26 mm for the tubers germination and reached 124.2 and 133.2 mm during the stage of bulging tubers. This is due to the increase of leaf area of the plant and increases the plant's need for water and nutrients to meet the requirements of tuber formation as well as a change in the climate as temperatures increased as the growth season progresses.

At the end of the growing season, the water requirement was reduced to 105 and 103.1 mm during maturity when 100% of the net depth of irrigation was added. This may be due to the reduced need for water to complete the formation of its tissues and cells and the dryness of a high proportion of its parts. As noted in table 2, the addition of 50% of the net depth of the irrigation led to thesaving of large quantities of irrigation water amounted to 235 mm.season$^{-1}$ and it was the ability to increase the area cultivated and the exploitation of new land, and the method of fragmentation of irrigation quantities added reduced the impact of water stress on Plant and keep soil moisture for longer as will be mentioned in the total yield.

## Total yield (ton.ha$^{-1}$)

Fig. 4 shows the effect of study treatments on tubers. It is clear that the values of the crop differed according to the levels of perlite added with the highest values of 28 tons.ha-1 at level 8% compared to levels 0 and 4% and for any added depth, and the lowest value was 9.0 and 13.0 tons.at levels 0% and 4% perlite, respectively. This may be due to the role of perlite, which works to encapsulate the soil particles with watercaps, thus reducing the strength of the correlation between the soil particles. This in turn facilitates the penetration of plant roots, thus making the plant highly capable of absorbing and maintaining water and nutrients. It works on the formation of easy corridors for the movement of water, which reduces the density of the virtual and this is reflected on the characteristics of vegetative growth, which increased than reflected on the yield and components, as well as perlite to improve the soil and increase the stability of soil aggregates, which is considered a good indicator of the ability of perlite to improve all the physical and chemical properties of the

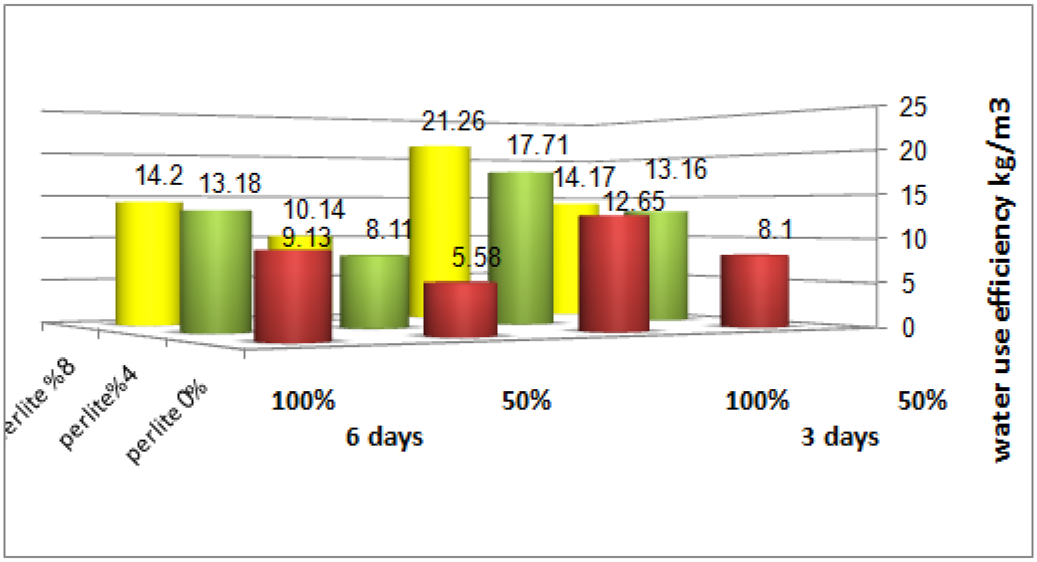


**Fig. 5 :** The effect of perlite level and irrigation interval onwater use efficiency.

soil and this has been confirmed by the results of the analysis of the components of the perlite, which greatly contributes to the increased yield and its components. In addition, perlite has a large surface area that increases the soil's ability to hold water and its effect increases by increasing the level of addition.

The increase in the yield and its components is also due to the addition of perlite to the decreases of evaporation and then increase the amount of water stored and ready in the soil when adding Perlite to it. Which lead to increased vegetative and flower growth, which in turn lead to increased yield and its components. These results are consistent with what they found (Moreno-Resendez *et al*, 2015; Olle, 2016 and Salas-Perez *et al*, 2017).

The results of Fig. 4 shows significant differences between the values of the yield according to the interval of the irrigation and for an added level of perlite. The highest values were for irrigation every 3 days and were 28.0, 26.0 and 16.0 tons.ha$^{-1}$ compared with irrigation every 6 days 20.0, 16.0 and 11.0 tons.ha$^{-1}$ levels of perlite 8, 4 and 0%, respectively. The reason for the decline is that the spread of the irrigation periods and the decrease in the moisture content of the soil (increase of moisture tension) has led to a decrease in the indicators of vegetative growth and the yield that water stress is one of the environmental stresses is not vital and get when the water is ready in the soil because of the loss of water continuously by transpiration or evaporation resulting in weak plant growth, reduced leaf size, elongation and leg weakness (Farooq and Kobayshi, 2009).

The results shown in Fig. 4 indicate that the addition of 100% of the net depth of the irrigation increased the total value significantly of total yield to the depth of the irrigation 50% as the depth of the irrigation 100% for the interval of irrigation every 3 and 6 days increased the values of the total yield significantly compared to the depth of the irrigation 50% each day 6, with values of 20.0, 16.0 and 11.0 tons. ha$^{-1}$ 100% irrigation depth every 6 days compared to 14.0, 13.0 and 9.0 tons. ha$^{-1}$. The depth of irrigation 50% at irrigation every 6 days to levels perlite 8, 4 and 0%, respectively. The decrease in the total values of 50% depth and 6 days interval coefficients compared to 100% depth irrigation for 6 and 3 days may be due to the effect of water stress on tubers yield. This is consistent with Abdel-Latif *et al* (2011). Water stress is one of the main causes of reduction and can reduce the yield average by 50% or more.

**Water Use Efficiency (kg.m$^{-3}$)**

Fig. 5 shows the effect of the study parameters on water use efficiency. It is clear that the values of water efficiency differed according to the levels of perlite added with the highest values at the level of 8% compared to levels 0 and 4% and for any added depth and the lowest value of 5.58 and 8.11 kg.m$^{-3}$ levels of 0 and 4% perlite compared to 10.14 kg. The reason for the high efficiency of the use of water to the increase in the yield and its components as a result of the addition of perlite, which led to a decreases of evaporation in the soil and increase the proportion of water tip in the soil and then increase the amount of water stored and readiness in the soil when the addition of perlite. Which lead to increased vegetative growth and branches, which in turn lead to the increase of the yield and its components. These results are consistent with what they found (Moreno-Resendez *et al*, 2015; Olle, 2016 and Salas-Perez *et al*, 2017).

The results of Fig. 5 shows significant differences between the values of the water use efficiency according to the interval of the irrigation and for an added level of perlite. With the highest values at irrigation every 3 days and 50% of the depth of the irrigation was 21.26 and 17.71 and 12.65 kg. $m^{-3}$ compared to irrigation every 6 days and the level of 50% of the depth of irrigation 14.2, 13.18 and 9.13 kg.$m^{-3}$. For the levels of 8%, 4% and 0%, respectively. Water efficiency is reduced at high irrigation levels, and the highest efficiency is for the treatments that have the least amount of irrigation water added, which is consistent with what of Fouda *et al* (2012).

The results are shown in Fig. 5 that the depth of the irrigation 50% increased significantly the water use efficiency values compared to the depth of the irrigation 100% as the depth of the irrigation 50% for the interval of irrigation every 3 and 6 days increased the values of water use efficiency significantly compared to the depth of 100% 6 days, with a value of 14.2, 13.18 and 9.13 kg. $m^{-3}$ to the depth of irrigation 50% at irrigation every 6 days compared to 10.14, 8.11 and 5.58 kg. $m^{-3}$ to the depth of irrigation 100% at irrigation every 6 days of the levels of perlite 8, 4 and 0%, respectively. The increase in water use efficiency was due to the decrease in the amount of water added to the field. Feedds *et al* (1978) noted that the low efficiency of water use by increasing the amount of irrigation water processed is due to the lack of ventilation of the root area due to high humidity, Nutrient concentration and thus reduced productivity relative to the amount of total irrigation water used. Irrigation scheduling 50% of the depth of the added irrigation had an effect on the efficiency of the use of water and the saving of water to be used to irrigate additional areas of great importance in the expansion of the agricultural area.

## CONCLUSION

The addition of perlite to an increases in the properties of the growth and yield of potatoand irrigation management achieved the best results when using irrigation period every 3 days and 100% of the depth of the irrigation. The use of irrigation period every 6 days and net irrigation depth of 50% saving of water to be used to irrigate additional areas.

## REFERENCES


AatiAlaa S, Ramzi Muhammad S, Salah Abdul Qadir A and Fleih Hassan A (2002) Potable water efficiency and efficiency under underage irrigation. *Annals of Agricultural Research* **55**(1), 123 - 128. Ain Shams University, Cairo, Iraq.

Abdel-Latif K M, Osman E A M, Abdullah R and Abdelkader N (2011) Responce of potato plants to potassium fertilizer rates and soil moisture deficit. *Advances in Applied Science Research Journal* **2** (2), 388-397.

Ai AlaSaleh : Effect of undernourishment and addition of sorghum sorghum in water consumption Wheat crop *Triticum aestivum* L. *Journal of Agricultural Sciences* **34**(6), 7103 - 7113.

Akhter J, Mahmood K, Malik K A, Mardan A, Ahmad M and Iqbal M M (2004) Effects of hydrogel amendment on water storage of sandy loam and loam soils and graining growth of barley, wheat and chickpea. *Plant Soil Environ.* **50**, 463- 469.

Al-Harbi A R, Al-Omran M A, Shalaby A A and Choudhary M I (1999) Efficacy of ydrophilic polymer reduced with time under greenhouse experiments. *Horti-Science* **34**(2), 223-224.Akinci S, Ismail M M R and Losel D M (2012) Plant Water stress Response Mechanism, from Water- stress. In Tech for publishing, Croatia. pp:300 .

Al-Hadithi E K, Ahmad M K and Yass K H (2009) Modern irrigation techniques and other topics in the water issue. Ministry of Higher Education and Scientific Research. University of Anbar, Faculty of Agriculture.

Al-Hadithi S D and Abdul-Razzaq S (2002) Scheduling of underage irrigation of maize crop to increase water use efficiency. *PhD thesis*. College of Agriculture, University of Baghdad.

Al- Jubouri K H, Mohamed Z K, Ahmed Q H and Ahmad H M (2017) The effect of irrigation and spraying with salicylic acid in the growth and production of potatoes. *Journal of Iraqi Agricultural Sciences* **48**(1), 242 E 247.

Al-Issawi J S (2010) Effect of partial drying and incomplete irrigation on drip irrigation efficiency and potato growth and yield (*Solanum tuberosum* L.). *Master Thesis*. Faculty of Agriculture, Anbar University.

Al-Hadithi E K, Ahmad M K and Yass K H (2010) Modern irrigation techniques and other topics in the water issue. Ministry of Higher Education and Scientific Research. University of Anbar, Faculty of Agriculture.

Al-Hadithi S and Abdul-Razzaq S (2002) Scheduling of underage irrigation of maize crop to increase water use efficiency. *PhD thesis*. College of Agriculture, University of Baghdad.

Awad H O (2009) Inheritance and breeding of crops for environmental stress (drought - high temperature - environmental pollution) Part I. The Egyptian Library for Printing, Publishing and Distribution. Alexandria. The Egyptian Arabic Republic.

Ayas S (2013) The Effects of Different Regimes on Potato (*Solanum tuberosum* L. Hermes) Yield and Quality Characteristics under Unheated Greenhouse Conditions. *Bulgarian Journal of Agricultural Science* **19**, 87-95.

Ayers R and Westcot D (1976) Water quality for agriculture irrigation and drainage. Paper No. **29**. FAO publication, Rome.

Badr M A, El-Tohamy W A and Zaghloul A M (2012) Yield and Water Use Efficiency of Potato Grown under Different Irrigation and Nitrogen Levels in an Arid Region. *Agricultural Water Management* **110**, 9-15.

Bhardwaj A K, Shainberg D, Golstein D, Warrington N and Levy G J (2007) Water retention and hydrolic conductivity of cross - link ed polyacrylamid in sandy soils. *Soil Sci Soc*. N71-2007: 406-412.

Bhatt R M, Rao N K S, Upreti K K and Shobha H S (2009) Floral abscission and changes in sucrose phosphate synthase and invertase activities in water deficit tomato. *Indian J. Plant Physiol.* **14**(4), 370-376.

Boutraa T (2010) Improvement of water use efficiency in irrigated agriculture: a review. *J. Agron*. **9**, 1-8.

Choudhary M I, Al-Omran A and Shalaby A A (1998) Physical properties of sandy soil as affected by a soil conditioner wetting and drying cycles. *Sultan Qaboos Univ. J. Sci. Res. Agric. Sci*. **3**(2), 69-74.

Doorenbos J and Pruitt W O (1977) Crop Water requirements Irrigation and drainage, P: 24. Food and Agricultural Organization of the United Nations, Rome, Italy.

Dorota Z Haman (2000) Irrigation with high salinity water. Florida. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Drãghici E M, Pele M and Dobrin (2013) Research concerning effects of perlite substrate on tomato in soilless culture. *Scientific Papers. Series B, Horticulture* **57**, 45-48.

Evans M R (2004) Ground bovine bone as a perlite alternative in horticultural substrates. *HortTechnology* **14**, 171-175.

FAO (2013) FAOSTAT Agriculture Data. Agriculture production crop. Primary available athttp;// FAO STAT. FAO . org/ FAO STAT.

Farooq M, Wahid A and Kobayshi N (2009) *Plant drought stress effect*.

Feedds R A, Kowalil P and Zaradny H (1978) Simulation of field water use and crop yield. Pudoc, Wageningen. Simulation Monographs.

Fouda T A, Lmaetwalli E and Ali E (2012) Response of potato to nitrogen and water deficit under sprinkler irrigation. Scientific papers Series Management. *Economic Engineering in Agriculture and Rural Development* **12**, 77-82.

Haghighi M, Mohammad R B, Jaime A and Teixeira D S (2016) The Effect of municipal solid waste compost, peat, perlite and vermicompost on tomato (*Lycopersicum esculentum* L.) growth and yield in a hydroponic system. *Int J Recycl Org Waste Agricult*. **5**, 231–242.

Hamdi G J (2017) The effect of perlite in reducing the water stress of three genotypes from tomatos. *Master Thesis*. Faculty of Agriculture, University of Diyala.

Hanna H Y (2006) A stir and disinfect technique to recycle perlite for cost-effective greenhouse tomato production. *Journal of Vegetable Science* **12**, 51–63.

Hillel D (2008) 40 years of drip irrigation. *Crops, Soils, Agronomy CSA News* **53**(9), 3-7.

Jerca I O, Sorin M C, George D and Daniela V B (2015) Study on the influence of the type of substrate and the quantity upon the tomato crop. Scientific papers.*Series b, Horticulture* 225-228.

Khatib B, Hisham B, Mohammed Y and Wael F ( 2016) Determination of water consumption, growth and yield of potatoes (*Solanum tuberosum* L.) under drip irrigation system. *Anbar Journal of Agricultural Sciences* **14**(2).

Malash N T, Flowers J and Ragab R (2005) Effect of irrigation systems and water management practics using saline and non-saline water on tomato production. *Agricultural Water Management* **78**, 25-38.

Mojaddam M, Lack S and Shokuhfar S (2011) Effects of water stress anddifferent levels of nitrogen on yield, yield components and water use efficiency of sunflower hybrid Euroflor. *Environmental Biology* **5**(10), 3410-3417.

Moreno- Reséndez A, Martínez-de-Vicente V, Márquez-Quiroz C, Reyes-Carrillo L, Puente- Manríquez J, Rodríguez-Dimas L and Hernández C M (2015) Development of tomato on different substrates and irrigation volumes undershade house conditions. J*ournal of Agriculture and Environmental Sciences* **4**(2), 124-130.

Nelson P V (2012) *Greenhouse operation and management*. 7th ed. Pearson, Upper Saddle River, NJ.

Olle M (2016) The Effect of vermicompost based growth substrates on tomato growth. *Journal of Agricultural Science* **27**(1), 38-41.

Page A L, Miller R H and Keeney D R (1982) Methods of soil analysis. Part2. 2nd edition.Chemical & Microbiological properties. Am. Soc. of Agr. S.S.S. Am. Inc., Madison, Wisconson, USA.

Pérez L, García-Hernández J L, Márquez-Hernández C, Fortis-Hernández M, Estrada-Arellano J R, Esparza-Rivera J R and Preciado-Range P (2017) Yield and nutraceutical quality of tomato fruits in organic substrates rendimiento y calidadnutracéutica de tomate en sustratosorgánicos. *Esosist. Recur. Agropec*. **4**(10), 169-175.

Robiul I M, Zeng Z, Mao J, EgrinyaEneji A, Xue X and Hu Y (2011) Feasibility of summer cornproduction drought affected areas ofnorthern China using water-saving superabsorbent polymer. *Plant Soil Environ*. **57**(6), 279- 285.

Salas-Pérez L, García-Hernández J L, Márquez-Hernández C, Fortis-Hernández M, Estrada-Arellano J R, Esparza-Rivera J R and Preciado-Range P (2017) Yield and nutraceutical quality of tomato fruits in organic substrates rendimiento y calidadnutracéutica de tomate en sustratosorgánicos. *Esosist. Recur. Agropec*. **4**(10), 169-175.

Sam G and Raes D (2009) Deficit irrigation as an on-farm strategy tomaximize crop water productivity in dry areas. *Agricultural Water Management* **96**, 1275-1284 .

Shanker V, Hari K S, Prasad C S, Ojha P and Govindaraju R S (2013) Optimizing Water Use in Irrigation- A review. *J Indian Institute Sci*. **93**(2), 209-226.

The Star, Hudhayfah Jassim Mohammed (2013) Effect of irrigation water salinity, magnetization and depletion in some physical properties of soil, growth and yield of potatoes. *PhD thesis*. faculty of Agriculture. University of Anbar.

United Nations World Water Development Report (2015) Water for a sustainable world. united nations water programme, (UN-Water).

Verma S K and Verma M (2010) *A text Book of plant physiology, Biochemistry and Biotechnology*. S. Chand and Company Ltd. Ramangar, New Delhi PP. 112.

Wein H C (1997) *The physiology of Vegetable Crops*. Cornell University CAB International , Ithaca, NY , USA.

Yildrim O, Uygan D and Boyaci H (2002) Irrigation Scheduling of drip-irrigated tomatoes using class Apan Evaporation. *Turk. J. Agric*. **26**, 171-178.

Yazdani F, Allahdadi I and Akbari G A (2007) Impact of superabsorbent polymer on yield and growth analysis of soybean under drought stress condition. *Pak. J. Biol. Sci.* **10**, 4190-4196.