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THE GROWTH AND YIELD RESPONSE OF FIVE POTATO VARIETIES (*SOLANUM TUBEROSUM* L.) TO INDUCED WATER STRESS USING POLYETHYLENE GLYCOL

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Abstract

The experiment was carried out at the field of Al-Mussaib Technical College on Babylon province during 2016-2017 season. In this study, in order to investigate the Effect of polyethylene glycol PEG 8000 concentrations (0, 15, 20 and 25) % to find out the effect on growth and yield to five varieties of potatoes (Burren, ElMundo, Riviera, Seferan and Argos). The experiment was laid out in Factorial Experiment conducted in C.R.D with three replications. The results are summarized as follows:

1. That the increased in polyethylene glycol (PEG 8000) concentration had reduced of all characters in each cultivars except root length.
2. The response of varieties of all characters to PEG 8000 was significant. The maximum all characters was recorded statistically significant in Burren variety
3. Interaction between varieties and PEG was not significantly affected on all characters except number of tuber.

***Key words*:** Potato cultivars, Polyethylene glycol, PEG-8000, Water stress

Introduction

Potato (*Solanum tuberosum* L.) belongs to the Solanaceae family. They make up about 75-90% of daily diet of most countries. Potato is native to the Andes Mountains in Chile, Peru and Bolivia in South America and has been cultivated for about 2400 years (Weisser, 2010). Is one of the most important vegetables in the world, Worldwide, more than 320 million tons of potatoes are currently produced from 20 million hectares. This ranks potato as the fourth most important staple crop in the world after maize, rice and wheat. It is important because it contains some vitamins such as (thiamine, riboflavin and vitamin C. It is also a rich source of energy with high levels of carbohydrates and minerals (Muthoni and Nyamongo, 2009). The tubers are a source of starch, protein, antioxidants and vitamins (Burlingame, Mouille & Charrondie, 2009). Global potato production reached 373158351 tons (FOA, 2013). The potato area in Iraq reached 7947 ha in 2016 and its production reached 190702 tons (Central Bureau of Statistics, 2016). Water deficit affects potato production, leading to reduced yield and tuber quality (Hassanpanah, Gurbanov, Gadimov & Shahriari. 2008). Drought stress severely limits plant production and performance in addition to impairing growth and development more than any other environmental factor (Shao, *et al.*, 2009). Polyethylene glycol (PEG) is a polymer produced in a range of molecular weights. PEG of higher molecular weight (4,000 to 8,000) was commonly used in physiological experiments to induce controlled drought stress in nutrient solution cultures (Hassanpanah, 2009). Polyethylene Glycol (PEG) of high molecular weights has been widely used to simulate drought stress in plants as a non-penetrating osmotic agent, lowering the water potential in a way similar to soil drying (Larher *et al.,* 1993). (AL.zubaidi, 2015) show while study 20 varieties of potatoes through two different seasons under effects of water stress by used different concentration of PEG8000 that most of these varieties have got impact by increase concentration and decreased the rate of vegetative growth but there 3 varieties of resistant to drought. this study applied to Five varieties of potato and different concentrations of the PEG.

Materials and Methods

The present investigation The Growth and yield Response of Five Potato Varieties to Induced Water Stress Using Polyethylene Glycol (PEG) 8000 was carried out during Autumn Season 2017 at the Plastic House of the Technical College, Musayyib, North of Babil province. The experiment was laid out in complete randomization (CRD) with three replication. The treatments consisted of four concentrations of PEG8000 (0%, 15%, 20%, 25%) and five cultivars (Elmundo, Burrun, Riviera, Argos and Safrane). Entire quantity of P and K 100 kg per ha were applied as a basal dose before sowing and well mixed with the soil and adding 200 kg per ha N, half of the dose of N was applied at seedling stage, remaining dose of N was

applied at 30 days after first time. Polyethylene Glycol (PEG) 8000 was irrigated at four true leave stage and after 45 days after first time. The fertilizer N P K were given in the form of urea, triple supper phosphate and potassium sulfate respectively

Table 1: Physicochemical characteristics of soil and water used in the study

Analysis	Soil	Water
Sand (%)	62	-
Silt (%)	23	-
Clay (%)	15	-
pH	7.4	7.3
EC	1.8 $ds.m^{-1}$	1.33$ds.m^{-1}$

Results

Chlorophyll (SPAD)

It is evident from (Table 2) that Chlorophyll was significantly affected due to applied PEG, where control gave highest Chlorophyll (41.882), superior over other concentrations. The minimum Chlorophyll was noticed with 25% PEG (32.667). Chlorophyll was significantly affected by varieties, where (Burren) variety plants gave highest mean (39.875), superior over other varieties. The lowest mean of Chlorophyll was noticed with (Argos) variety which was recorded (35.460). PEG interaction with varieties had not significant influence on Chlorophyll

Table 2: Effect of Water Stress of Different PEG-8000 Concentrations on the Chlorophyll Content

Treatments	Cultivars					Means
	Burren	Elmundo	Riviera	Seferan	Argos	
0%	45.433	42.717	43.090	39.387	38.783	41.882
15%	42.873	40.890	41.037	37.910	38.123	40.166
20%	36.513	34.050	35.240	34.843	32.560	34.641
25%	34.680	31.233	33.623	31.340	32.377	32.667
Means	39.875	37.233	38.248	35.870	35.460	
L.S.D 5%	Cultivars		Treatments		Interaction	
	1.846		2.063		Ns	

Plant Height (cm)

The effect of PEG treatments was significant on Plant height (Table 3). The maximum Plant height (55.599) cm was obtained with control treatment, while the lowest value was produced under 25% treatment which was recorded (39.631) cm. Plant height was significantly affected by variety. The maximum Plant height was recorded withBurren variety which was recorded (51.650) cm superior over other varieties. The minimum Plant height was noticed with (Argos) variety which was recorded (44.533) cm. Interaction between varieties and PEG was not significantly affected on Plant height.

Table 3 : Effect of Water Stress of Different PEG-8000 Concentrations on Plant Height (cm)

Treatments	Cultivars					Means
	Burren	Elmundo	Riviera	Seferan	Argos	
0%	58.730	56.407	57.003	53.220	52.633	55.599
15%	56.190	52.843	55.133	50.157	47.303	52.325
20%	49.730	43.113	48.970	44.067	41.260	45.428
25%	41.950	39.560	41.063	38.647	36.937	39.631
Means	51.650	47.981	50.543	46.523	44.533	
L.S.D 5%	Cultivars		Treatments		Interaction	
	3.452		3.859		Ns	

Leaf numbers

PEG application had a significant effect on Leaf numbers (Table 4),The maximum Leaf numbers recorded statistically significant in control which was recorded (39.044) superior over other concentrations. The minimum Leaf numbers was noticed with 25% which was recorded (27.015). The response of variety to Leaf numbers was significant. The maximum Leaf numbers was recorded statistically significant in Burren variety which was recorded (35.924). The minimum leaf number was noticed with aragos variety (32.426). PEG interaction with varieties had not significantly affected on leaf numbers.

Table 4 : Effect of Water stress of Different PEG-8000 Concentrations on Leaf Number

Treatments	Cultivars					Means
	Burren	Elmundo	Riviera	Seferan	Argos	
0%	40.610	37.260	43.110	36.727	37.513	39.044
15%	38.440	34.854	37.267	36.110	36.170	36.568
20%	35.377	31.080	34.853	33.737	31.333	33.276
25%	29.270	27.137	28.420	25.560	24.690	27.015
Means	35.924	32.583	35.913	33.033	32.426	
L.S.D 5%	cultivars		Treatments		Interaction	
	1.400		1.565		Ns	

Branches number

According to the analysis of variance (Table 5). The effect of PEG treatments was significant on Branche's number. The maximum Branches number (4.400) was obtained with control treatment, while the lowest value was produced under 25% treatment which was recorded (2.513). Branches number was significantly affected by variety factor. The maximum Branches number was recorded in (Burren) variety which was recorded (3.909) superior over other varieties. The minimum Branches number was noticed with (Safrane) variety which was recorded (3.325). Interaction between varieties and PEG was not significantly affected on Branche's number.

Table 5 : Effect of Water stress of Different PEG-8000 Concentrations on Branches Number

Treatments	Cultivars					Means
	Burren	Elmundo	Riviera	Seferan	Argos	
0%	4.800	4.300	4.567	4.167	4.167	4.400
15%	4.303	3.767	4.067	3.667	3.700	3.901
20%	3.767	3.200	3.467	3.300	3.100	3.367
25%	2.767	2.600	2.600	2.167	2.433	2.513
Means	3.909	3.467	3.675	3.325	3.350	
L.S.D 5%	cultivars		Treatments		Interaction	
	0.161		0.180		Ns	

Root length (cm)

The result showed that PEG significantly affected on Root length (Table 6), where concentration 25% gave highest Root length (45.746) cm superior to other concentrations. The minimum root length was noticed with 0% which was recorded (32.747) cm. The result showed that the variety played a significant role in affecting Root length. The maximum root length was recorded statistically significant in Burren variety which was recorded (39.873) cm superior over other varieties. The minimum root length was noticed with Safrane variety (36.922) cm. PEG interaction with varieties was not significant role in affecting root length.

Table 6 : Effect of Water stress of Different PEG-8000 Concentrations on Root Length(cm)

Treatments	Cultivars					Means
	Burren	Elmundo	Riviera	Seferan	Argos	
0%	34.107	32.337	33.777	31.407	32.107	32.747
15%	36.320	34.053	36.057	33.497	33.727	34.731
20%	41.550	38.820	38.163	39.877	41.717	40.025
25%	47.517	46.343	45.673	42.907	46.290	45.746
Means	39.873	37.888	38.418	36.922	38.460	
L.S.D	cultivars		Treatments		Interaction	
	1.536		1.17		Ns	

Number of tubers

Based on the results given in (Table 7) indicated that the PEG significantly affected on number of tubers, where control gave the highest number of tuber (5.440) superior over other concentrations. The minimum number of tubers was noticed with 25% which was recorded (3.373). Cultivars lead to a significant increase in a number of tubers. The maximum number of tuber was recorded statistically significant in Burren variety which was recorded (5.042) superior over other varieties. The minimum number of tubers was noticed with Argos variety (3.850). PEG interaction with varieties had not significantly affected on Number of Tubers.

Table 7 : Effect of Water Stress of Different PEG-8000 Concentrations on Number of Tubers

Treatments	Cultivars					Means
	Burren	Elmundo	Riviera	Safrane	Argos	
0%	6.200	5.300	5.900	5.100	4.700	5.440
15%	5.700	4.700	5.100	4.500	4.200	4.840
20%	4.400	3.600	4.200	3.400	3.400	3.800
25%	3.800	3.300	3.600	3.200	3.100	3.373
Means	5.042	4.225	4.650	4.050	3.850	
L.S.D	cultivars		Treatments		Interaction	
	0.2505		0.2240		Ns	

Discussion

The repercussions of water deficit contain adverse impact on plant phenology, phasic development, growth, carbon assimilation, assimilate partitioning and plant reproduction processes. Water stress differentially affects the level of endogenous phytohormones. Phytohormones are surely occurring organic material, which affect physiological processes at low concentrations either in distant tissues to which they are transported or in the tissue where synthesis occurred (Davies, 1995a) Drought slows growth, motivate stomata closing and therefore reduces photosynthesis (Nemeth *et al*., 2002). In the case of potato, water shortage through the tuberization period reduces crop more than in other development stages (Anithakumari *et al.,* 2011). The main influences of drought stress on potato plant are lower in leaf area and number of leaves, plant height, number of tubers, tuber growth, quality and yield, and biomass (Tourneux *et al*., 2003; Schittenhelma *et al*., 2006; Arvin and Donnelly, 2008; Hassanpanah, 2009).

Conclusion

In this study, Results of this research revealed that Effect of polyethylene glycol PEG 8000 concentrations (0, 15, 20 and 25) % to find out the effect on growth and yield to five varieties of potatoes (Burren, ElMundo, Riviera, Seferan and Argos). The water stress at 25% of PEG, vegetative growth and the number of tubers decreased except root length. This result provided a useful understanding of drought responses to some varieties of potato.

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