

Evaluation of Minitubers Yield and Scaling which Produced from Microtubers Transplanting Using Soilless Culture Technique

تقييم حاصل وتدرج الـ Minitubers الناتجة من زراعة الـ Microtubers للبطاطا باستخدام تقنية
الزراعة بدون تربة

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Abstract:

The results of the experiment showed that the variety Santa was significant superior than Draga in leaf area, mean number of tubers.Plant⁻¹, total yield. Plant⁻¹ and the percentage of number of tubers with the size 1.5- 2 cm, which reached 9.3, 26.56, 6.34 % and 47% respectively there were no differences between them in the tuber sizes of 2-3 cm. The Draga variety significantly differ than Santa on the tubers size 0.7-1.5 and 3-5 cm and the ratio was 2.5% and 79.8%, respectively. The growing media M₁ significantly superior than M₂ and M₃ in leaves area, numbers of minitubers and total yield.Plant⁻¹ reached 26.26Dcm², 19.69 minitubers and 427.37g .plant⁻¹ respectively. The media M₃ significantly differed from M₂ and M₁ in the tubers size 3-5cm and their ratio were 19.0%, 15.8% and 15.2% respectively. The Draga variety in M₂ media significantly differed than Santa in M₁ media in differed from tubers size and the ratio reached 20.5% and 10.1% respectively.

Key words: Microtubers , Minitubers , potato, Scaling, Soilless culture

المخلص

نفذت هذه الدراسة في البيوت الزجاجية والمختبرات التابعة لادارة البحوث الزراعية في وزارة العلوم والتكنولوجيا. اذ زرعت الدرناات الدقيقة micro-tubers للبطاطا المنتجة بتقنية زراعة الأنسجة النباتية للصنفين Santa و Draga ، بالزراعة في ثلاثة اوساط زرعيه من الرمال المحلية (رمل قاع الانهار M₁ و رمل الاخضر M₂ و رمل كربلاء M₃) وضعت بأحواض مبنية بالثرمستون وبأبعاد بطول 5.12م وعرض 1.25 م وبعمق 0.4م مبطن بالبولي أثيلين ومسقاة بمحلول مغذي مخزن بخزان مغلن سعة 7م³ من مضخة كهربائية وبواسطة منظومة الري بالتنقيط، ونفذت التجربة وفق تصميم القطاعات العشوائية الكاملة R.C.B.D وبثلاثة مكررات، يحتوي كل مكرر على 22 درنة مزروعة، قورنت المتوسطات حسب اختبار اقل فرق معنوي L.S.D عند مستوى احتمال 5%. وكانت النتائج على النحو الاتي: تفوق الصنف Santa معنويا على الصنف Draga في المساحة الورقية، ومتوسط عدد الدرينات الناتجة، والحاصل الكلي للنبات الواحد، وبنسب زيادة بلغت 9.3 و 26.56 و 6.3 % على التوالي. و في النسبة المئوية لعدد الدرينات ذات الاقطار 1.5- 2 سم، اذ بلغت 47 %، ولم يختلفا معنويا للأقطار 3-2 سم، في حين تفوق الصنف Draga معنويا على الصنف Santa ضمن الاقطار 0.7 - 1.5 و 3-5 سم لتصل النسبة المئوية لعدد الدرينات الى 2.5 و 79.8 % على التوالي. تفوق نباتات الوسط الزراعي M₁ (رمل قاع الانهار) في المساحة الورقية والحاصل الكلي للنبات الواحد وعدد الدرينات ليصل الى 26.26 دسم² و 292.97 غم و 19.69 درينه. نبات¹ على التوالي، بينما تفوق الوسط M₃ معنويا على بقية الوسطين M₁ و M₂ فقد بلغت نسبة اعداد الدرينات ضمن هذا التدرج 3-5 سم 19.0 و 15.8 و 15.2 % على التوالي، وكان للتداخل بين الاصناف والاوساط الزراعية تأثيراً معنوياً أيضاً في هذا المدى من التدرج فكانت أعلى نسبة لعدد الدرينات 20.5% في M₂ للصنف Draga في حين بلغت أقل نسبة لعدد الدرينات 10.1% في S₁ للصنف Santa.

الكلمات الدالة: الدرناات الدقيقة ، درينات صغيرة ، البطاطا ، تدرج الدرناات ، تقنية الزراعة بدون تربة

Introduction

Potato (*Solanum tuberosum* L.) is one of the most common cultivated species on earth and ranks on place four in produced crops after Wheat, Maize and Rice [1], It has the highest yield with 16.7tonnes among cereals, the root and the tuber crops [2]. The cultivated potato is used for food (with each containing 100 grams of tubers fresh weight on the 1-2 g protein, 17.1 g carbohydrates 0.7 mg calcium 0.53 mg phosphorus, 0.6 mg iron 0.3 mg sodium, 4.7 mg potassium, thiamin 0.1 mg, 0.4 mg Riboflavin 0.20 mg vitamin C added to contain vitamins), feed, medicine, processed foods (potato chips, alcoholic beverages) and industry products like plastic polymers. [3]. The production of potato crop in Iraq was 58,000 tons in 42000 Donum for the year 2013. (Production reached 1.381 tons per Dunam) [4].

The reasons of low productivity are the low rank of tuber seeds planted as well as Iraq suffering from the salinity problem, especially in the central and southern regions, noting that 75% of the areas of the cultivation of potato crop are affected by salts, there are many attempts to improve the quality of potatoes and increase the amount of output per unit area. It is possible to overcome these problems through the cultivation of high-

ranking potato resulting from *In vitro* culture [5] by using the soilless culture technique [6]. The aim of this study is to evaluate two cultivars Draga and Santa Minitubers Scaling which produced from microtubers transplanting using soilless culture.

Materials and Methods

Two commercial Microtubers of potato (*Solanum tuberosum* L., cv. Draga and Santa) were used in this study. Microtubers were obtained from plant tissue culture technique in plant tissue culture labs. The objective of this study is to estimate the responses of the microtubers of both varieties to three medium of local sand washed by tap water (M1 River base sand, M2 Al-Ekader sand and Karbala sand M3) kept in trough with 12.5m length, 1.25m width and 40cm depth, these troughs build of concrete and thermo stone and covered with polyethylene sheet from inside and irrigated by drip irrigation system and injection pump to add the nutritional liquid (Table(1) which kept in tank (capacity 1m³) [7].

All agricultural practices were made as recommended for potato crop [8], before the shoots dry and yellowing, leaves area parameters were measured. Tuber harvesting has been done after 85 days and yield parameters were calculated: Number of tuber. Plant⁻¹. Average of tubers yield (g.plant⁻¹) and the present of Minitubers Scaling to the following diameters (0.7-1.5, 1.5-2, 2-3 and 3-5 cm) in each cultivars and media (type of sand).

The experiments design was factorial experiments using Randomized Complete Block Design with three replicates, twenty five microtubers of each cultivar were planted in each replicate, the means were compared using L.S.D. at 0.05 level of significant.

Results and Discussion

Leaf area

The results in Table (2) indicated that there were significant differences between the cultivars, the variety Santa gave the highest value of leaf area (23.53 dcm².plant⁻¹), as compared to Draga variety, the results recorded significant differences among media treatments in their effect on leaves area, river sand (M1) gave the highest effect on the rate of leaf area as compared with Al-Ekader sand (M₂) and Karbala sand (M₃). For the interaction between the cultivars and media in the plant leaf area, the result showed that Santa cultivar in M1 (River sand) gave highest plant leaf area reached 28.40 dcm².plant⁻¹, While Draga cultivar in M3 (Karbala sand) gave lowest plant leaf area (15.91 dcm².plant⁻¹).

The superiority of cultivars in leaf area maybe containing a high concentration of nutrient element have been absorbed by the roots of the plant and this may led to the accumulation of carbohydrates in the plant and that has led to increased activities vital to the plant and therefore reflected on the leaf area. The cause of the superiority of M1 may be due to increasing the nutrients availability in the soil which in turn increases the efficiency of transport and absorption of nutrients with water through root cells which in turn increased the protein in tissue content and thus increase the hormones activity that stimulate cell growth, division and elongation and which affected positively leaf area [9,10].

Yield and number of tubers

Results in the Table (2) showed significant differences between the cultivars in yield and number of tubers plant⁻¹. The cultivar of Santa gave highest yield and number of tubers reached 370.79g and 17.23 tubers. plant⁻¹ respectively as compared 348.68g and 12.53 tuber. plant⁻¹ respectively in cultivar of Draga. The results also indicated that there were significant differences between the media treatments. River sand (M1) gave highest rate 492.97g and 19.69 tuber. plant⁻¹ as compared with M3 treatment which gave 281.07g and 14.21 tuber . plant⁻¹, respectively.

The results of the interaction between cultivars and media, showed that the cultivar of Santa in M1 media gave highest average of yield and number of tuber(508.13g and 26.68 tuber) while the Draga cultivar in M3 media gave the lowest average 272.44g and 11.19 tuber.plant⁻¹ respectively.

The superiority of the yield and number of tubers parameters in the Santa cultivar and M1 media maybe due to the effected of important nutrient elements and thereby increase the biosynthesis of chemical compounds in the photosynthesis process and increase the leaf area Table (2), which led to increase the number of tubers and increase the tissue content of protein or growth hormones which leads to increase tubers weight and total yields [6, 11, 12, 13].

Minitubers scaling

The data presented in the Table (3) indicated that there were significant differences between cultivars in minitubers scaling parameter, Santa gave the highest percentage of number of tubers with the size 1.5 - 2 cm reached 39.4% which differed significantly from 26.7% in Draga with 47.5% of an increment percentage, and from the same table Draga were affected significantly percentage of number of tubers with the size 0.7-1.5 and 3-5cm gave highest rate reached 27.8 and 21.4% respectively, as compare with lowest rate percentage 27.1 and 11.9% respectively in Santa with an increment of 2.5 and 79.8% respectively. Moreover, significant differences were not found with the size 2-3 cm. Both of media M1 and M2 gave the highest percentage of number of tubers.

Table (1): Components of inorganic salts of irrigation solution. [14]

The compounds	Con.(g/m ³)	Element Con.(ppm)
Ca(NO ₃) ₂ .4H ₂ O	1423.4	N=169 , Ca=241
KNO ₃	802.8	N=111 , K=310
KH ₂ PO ₄	175.4	K=50 , P=40
MgSO ₄ .7H ₂ O	307.5	Mg=30 , S=40
Fe – EDTA	50.0	Fe=5.5
MnSO ₄ .4H ₂ O	2.5	Mn=0.6 , S=0.3
H ₃ BO ₄	3.0	B=0.4
CuSO ₄ .5H ₂ O	0.8	Cu=0.2 , S=0.1
ZnSO ₄ .7H ₂ O	0.4	Zn=0.1 , 0.04
NH ₄ Mo ₇ O ₂₄ .4H ₂ O	0.6	Mo=0.05

Table (2): Effect of different media for two potato cultivars and their combination on the Leaf area (dcm².plant⁻¹), Number of Tubers (tuber.plant⁻¹) and Total yield (g.plant⁻¹)

Traits	Cultivar	Type of Media			Average of Cultivar
		M1	M2	M3	
Leaf area (Dcm ² .plant ⁻¹)	Santa	28.40	25.28	16.93	23.53
	Draga	24.13	23.98	15.91	21.34
	Average of media	26.26	24.63	16.42	
	L.S.D. _{0.05}	Cultivar=0.44 Media=0.54 Combination = 0.89			
Number of Tubers (tuber.plant ⁻¹)	Santa	26.68	18.34	17.23	20.75
	Draga	12.71	13.69	11.19	12.53
	Average of media	19.69	16.01	14.21	
	L.S.D. _{0.05}	Cultivar=3.2 Media=4.5 Combination = 5.4			
Total yield (g.plant ⁻¹)	Santa	508.13	314.55	289.70	370.79
	Draga	477.82	295.79	272.44	348.68
	Average of media	492.97	305.17	281.07	
	L.S.D. _{0.05}	Cultivar=12.89 Media=16.45 Combination =23.88			

Table (3): Effect of different media for two potato cultivars and their combination on the present of Minitubers Scaling diameters (0.7-1.5 ,1.5-2 , 2-3 and 3-5 cm).

Diameters (cm)	Cultivar	Type of Media			Average of Cultivar
		M1	M2	M3	
0.7-1.5	Santa	34.2	26.5	20.6	27.1
	Draga	27.2	33.3	22.9	27.8
	Average of media	30.7	29.9	21.7	
	L.S.D. _{0.05}	Cultivar=0.7 Media=0.9 Combination = 1.3			
1.5 - 2	Santa	37.2	39.9	41.3	39.4
	Draga	29.1	24.1	27.1	26.7
	Average of media	33.1	32.0	34.2	
	L.S.D. _{0.05}	Cultivar= 0.5 Media= 0.8 Combination = 1.3			
2 – 3	Santa	18.5	22.5	23.6	21.5
	Draga	23.4	22.1	26.4	23.9
	Average of media	20.9	22.3	25.0	
	L.S.D. _{0.05}	Cultivar= N.S Media= 1.7 Combination = 2.4			
3 – 5	Santa	10.1	11.1	14.5	11.9
	Draga	20.3	20.5	23.6	21.4
	Average of media	15.2	15.8	19.0	
	L.S.D. _{0.05}	Cultivar= 1.4 Media= 2.1 Combination =4.2			

0.7-1.5cm) reached (30.7 and 29.9%) respectively as compared with 21.7% in (M3) treatment. All so Media M3 was caused significant effect on the average of percentage of number of tubers 1.5-2 , 2-3 and 3-5cm gave highest rate reached 34.2 , 25.0 and 19.0% respectively as compare with M1 and M2.

Further more significant differences were found in the interactions between cultivars and media treatments, the combination of Santa in M1 treatments gave highest rate of percentage of number of tubers 1.5-2 cm in 34.2%. and the same cultivar in M3 media treatments 1.5- 2cm reached 41%, but Draga in M3 media gave highest rate of percentage of number of tubers 2-3 and 3-5cm reached 26.4 & 23.6% respectively.

The superiority of Draga cultivar in large size may be the genetic effect and media improving vegetative growth characters and due to the vital role of its elements contain such as phosphor which involves in stimulating cell division process through energy-rich compounds (CTP, GTP, ATP) which is the basis for the processing energy in the living cells, also its involved in coenzymes which responsible for growth namely (FAD, NADP, NADPH) (15), that's made the early yield as well as to come allow the tuber enlargement .

The obtained results recommended the possibility of controlling the number and rate of minitubers by changing the quality and size of the sand granules. Smaller sand fraction is accompanied by tuber number increases of small sizes, and vice versa.

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