

## POTATO MINITUBERS PRODUCTION AND FIELD PERFORMANCE EVALUATION

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### ABSTRACT

A field comparison of different sizes of minitubers < 2.5, 2.5- 3.5 and > 3.5 cm *in vitro* produced from two cultivars Emma and Bureen. yield traits and Morphological characteristic of vegetative growth were taken after 90 days of planting. In yield traits, Results showed significant differences in all these traits. Minituber of Emma at size > 3.5 cm gave higher number of tubers, diameter and weight reached 5.90 tuber plant<sup>-1</sup> 45.43 mm and 36.20 g respectively. In contrast, the ability of minitubers of Bureen at size < 2.5 cm was negatively reflected on all yield trait (3.90 tuber plant<sup>-1</sup>, 37.77 mm and 33.10 g). All morphological characteristic of vegetative growth except the percentage of chlorophyll were significantly affected by the size of the minitubers, Emma cultivar at size >3. 5 cm surpassed in Plant height, number of shoots and leaves, shoot and root fresh weight were reached 35.40 cm, 4.00 shoot, 30.40 leave, 36.82 g and 4.71g respectively.

**KEYWORDS:** Potato, Minituber size, *In Vitro*, field performance, plantlet.

### INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops in the world. Potato follows wheat and rice in terms of food and production (Hassan, 2003). In addition to industrial use, it sometimes substitutes for wheat. In the Arab world according to activated area, Iraq was ranked as the fourth producer after Egypt, Algeria and Morocco (Nada *et al.*, 2017). In Iraq, Despite the cultivated area, potato production failed to meet the needs of Iraqi consumers due to low productivity as a results of viral infection. Moreover, Iraq is one of the countries that depends on the annual import of seeds from European countries, which is approximately 68.1% of the total consumption costs (AL-Mashhadani and Mohammed, 2005).

Plant tissue culture technique was widely used in the 1970s until now as a seed Potato production (free of viruses) by culturing plantlets which *in vitro* propagated either directly to produce minitubers (Särekanno *et al.*, 2010; 2012; Ashwani and Pandey, 2013; AL-Ani *et al.*, 2017) or produced microtubers after planted in medium MS (Murashige and Skoog, 1962) salt supplemented with different

types of growth regulator with high concentration of sugar under controlled conditions (AL-Taweel *et al.*, 2004; AL-Hussaini *et al.*, 2015), which harvested after 60-90 days and stored under a low temperature approximately seven months then transferred to field for minitubers production after encouraging sprouting. Directly producing minitubers (*in vitro* plantlets way) provided many advantages, including, Shortenin the duration of *in vitro* microtuberization, storage, as well as the requirements associated with the production of microtubers in terms of nutrient medium, growth regulators, laboratory space and manpower (Ashwani and Pandey, 2013).

Minitubers were defined as a progeny tubers produced from *in vitro* propagated plantlets (Struik, 2007), it is smaller in size than conventional seed potato and larger than microtubers (Lommen and Struik, 1990), the size and weight of minitubers varies from 5-25 mm (Ashwani and Pandey, 2013) and 0.1-10 g (Struik, 2007). According to Several studies were mentioned to the effect of minitubers size on yield and morphological characteristics, Ilze and Zinta (2015) studied the effect of minitubers size (weight) ranges 3-5 , 5-10 , 10-20 g, >20 g on

some plant development characteristics (emergence, canopy closure) and yield parameters (tuber number and tuber yield of seed size grade >25 mm) for three cultivars at different maturity ('Monta' – early maturity, 'Prelma' – medium early and 'Mandaga' – medium late maturity) were planted in field, they found that smaller minitubers produced significantly less progeny tubers, that 51 progeny tubers obtained from minitubers 3-5 g, 54 from minitubers 5-10 g, 59 from minitubers 10-20 g and 70 tubers from minitubers >20 g. Also they mentioned to the relationship between number of main stems m<sup>-2</sup> and tuber yield, kg m<sup>-2</sup>, which were moderate. Canopy closure correlated strongly negatively with the number of main stems m<sup>-2</sup> and progeny tuber number >25 mm per m<sup>2</sup>. Finally they recommended that many experiments must be carried out to find more certain minituber size effects on various yield parameters, i.e. progeny tuber size distribution. Therefore, the aim of this study to investigate the response of different size of minitubers of two cultivars of potato ( Emma and Daimant) on yield and morphological traits.

## MATERIALS AND METHODS

The (*in vitro* and *Ex vitro*) experiments were conducted at the Plant Tissue Culture Laboratories of the Genetic Engineering Department and AL-Latifya research station of the Center of Plant Breeding in Agricultural Research Directorate / Ministry of Science and Technology /Iraq.

### ***In vitro* initiation, multiplication and *Ex vitro* Minituber production**

Sprouts were removed from the potato tubers Emma and Bureen after breaking the dormancy under 25 ° C ± 2 and indirect lighting. The sprouts were cleaned and sterilized at 2% sodium hypochlorite for 10 min (Al-Taweel *et al.*, 2004). Meristems (0.1-0.3 mm with a pair of leaf primordial) were isolated from vegetative growth and cultured on initiation medium MS (Murashige and Skoog, 1962) salt supplemented with 0.4, 100, 2, 2, 1, and 30.000 mg l<sup>-1</sup> of Thiamine HCL, Inositol, Glycin, Nicotinic Acid, Indole Acetic Acid, and sugar respectively. after 2-3 subcultures, shoot multiplication was performed in the previous media, after cutting into 1-2 cm long stem cuttings (with 1-2 nod) and cultured in glass container. All cultures were

placed in a growth room chamber at 25±1 °C with (16:8 h) light / dark. After month of multiplication, the propagules (rooted plantlets) were washed in tap water to remove the agar and transplanting in polyethylene bags filled with a mixture of sand: peatmoss with 1:1 ratio and covered with transparent plastics bags. After 90 days minitubers were harvested and classified according to the size (diameter) to < 2.5 cm, 2.5-3.5 cm and > 3.5 cm by using vernier.

### **Evaluation of field performance**

First generation ( G1) of minitubers at different size < 2.5, 2.5-3.5 and > 3.5cm were planted at Al-Latifya field, in trophs at distance 1x20 meters contains sandy soil in two lines. Drip irrigation was used for all minitubers and was fertilized according to fertilizer recommendations ( ) with the use of leaf fertilization every 2 weeks. Data was analyzed as a factorial in Randomized Completely Block Design (R.C.B.D) with three replicates. Yield characteristic (number, diameter and weight of minitubers) and morphological characteristic (plant height (cm), number of shoots and leaves, fresh and dry weight for vegetative and root system and Chlorophyll percentage ) were recorded, Data was analyzed using GenStat software program, means were compared using Duncan's test at a probability level of 5%

## RESULTS AND DISCUSSION

### **Effect of cultivars, size of minitubers and their interaction on Yield characteristics**

Among yield characteristics no significant differences were found between the two cultivars in the number, diameter and weight of the minitubers ( Table 1). While the size of minitubers were significantly affected on yield characteristics, except weight of minituber, in which the size (> 3.5 cm) significantly exceeded in number and diameter of minituber (5.63 minituber plant<sup>-1</sup>, 42.92 mm respectively) ( table 1).

According to the same table the effect of the interaction between cultivars and minitubers size was significant in all yield characteristics. It showed that the two size 2-5 -3.5 and > 3.5cm approached significantly in their effect in yield traits, that size >3.5 cm of Emma cultivar was significantly surpassed in number of minituber, diameter and weight averaged 5.90 minituber plant<sup>-1</sup>, 45.43mm and 36.20g respectively. On

the contrary, the poor response of the Bureen and Emma cultivars appeared when minituber are grown in size <2.5 cm on the progeny tuber

number, diameter and weight were averaged 3.90 minituber plant<sup>-1</sup> 37.77 mm and 23.60 g respectively.

**Table (1):** Effect of cultivars, minitubers size and their interaction on potato yield traits

Cultivars	Treatments			Mean
	Minitubers size			
	< 2.5 cm	2.5-3.5 cm	> 3.5 cm	
<b>Number of minitubers. plant<sup>-1</sup></b>				
Emma	4.40 bc	5.00 abc	5.90 a	<b>5.10 a</b>
Bureen	3.90 c	3.90 c	5.40 ab	<b>4.40 a</b>
<b>Mean</b>	<b>4.15 b</b>	<b>4.45 b</b>	<b>5.63 a</b>	
<b>Minitubers diameter (mm)</b>				
Emma	40.19 ab	41.55 ab	45.43 a	<b>42.39 a</b>
Bureen	37.77 b	41.44 ab	40.40 ab	<b>39.87 a</b>
<b>Mean</b>	<b>38.98 b</b>	<b>41.50 ab</b>	<b>42.92 a</b>	
<b>Minitubers weight (g)</b>				
Emma	23.60 b	27.10 ab	36.20 a	<b>29.00 a</b>
Bureen	34.90 a	33.10 b	25.80 ab	<b>31.30 a</b>
<b>Mean</b>	<b>29.50 a</b>	<b>30.10 a</b>	<b>31.00 a</b>	

Means followed by the same letters are not significantly different (P<0.05) according to Duncan's multiple range test

#### **Effect of cultivars, size of minitubers and their interaction on characteristics vegetative growth**

It seems from the results in Table (2) that cultivars significant effect on some morphological traits plant height , number of shoots and leaves , dry weight of roots and chlorophyll, that Emma was significantly superior in plant height, number of shoot and leaves ( 33.07 cm ,3.50 shoot plant<sup>-1</sup> and 27.23 leaf plant<sup>-1</sup>). While Bureen surpassed in the dry weight of root and the percentage of chlorophyll ( 0.94 g and 34.24 %). Results in the same table showed that the different sizes of minitubers had no significant in effect on some morphological traits of the vegetative growth ( plant height, number of shoots and leaves, fresh and dry weight of shoot and percentage of chlorophyll ), While effected on the fresh and dry weight of roots, that minituber at size > 3.5 cm superior and given 4.50 g and 1.06 g respectively. The

analysis of the interaction between cultivars, minitubers size in table (2) showed significant differences in all morphological traits of the vegetative growth except the percentage of chlorophyll. It is clear that minituber at size > 3.5 cm superiority in plant height, number of shoot ,leaves, shoot fresh weight and root fresh weight ( 35.40 cm, 4.0 shoot , 30.40 leaves, 36.82 g and 4.71 g respectively). While the size of minitubers at 2.5-3.5 cm gave higher rate in shoot dry weight ( 10.88g). The dry weight ratio of root for both cultivars was approximated when minitubers were grown in size > 3.5 cm ( 1.05 and 1.08 g of Emma and Bureen ). On the other hand, minitubers at size 2,5-3.5 cm gave lowest rates in plant height, shoot ,leaves number and dry weight of shoot and root (29.78 cm , 2.80 shoot plant<sup>-1</sup> , 20.50 leaf plant<sup>-1</sup>, 7.49g and 0.56 g ),as well as minituber at size less than 2.5 gave lowest rates in fresh weight of shoot and root( 14.70 g and 2.41 g).

**Table (2):** Effect of cultivars, minitubers size and their interaction on vegetative growth traits .

Cultivars	Treatments			Mean
	Minitubers size			
	< 2.5 cm	2.5-3.5 cm	> 3.5 cm	
<b>plant height (cm)</b>				
Emma	30.90 ab	32.90 ab	35.40 a	<b>33.07 a</b>
Bureen	31.20 ab	29.78 b	28.80 b	<b>29.90 b</b>
<b>Mean</b>	<b>31.05 a</b>	<b>31.30 a</b>	<b>32.10 a</b>	
<b>Number of shoots plant<sup>-1</sup></b>				
Emma	3.20 ab	3.30 ab	4.00 a	<b>3.50 a</b>
Bureen	3.10 b	2.80 b	2.80 b	<b>2.90 b</b>
<b>Mean</b>	<b>3.15 a</b>	<b>3.05 a</b>	<b>3.40 a</b>	
<b>Number of leaves. plant<sup>-1</sup></b>				
Emma	27.00 ab	24.30 bc	30.40 a	<b>27.23 a</b>
Bureen	22.00 c	20.50 c	20.70 c	<b>21.07 b</b>
<b>Mean</b>	<b>24.50 a</b>	<b>22.40 a</b>	<b>25.55 a</b>	
<b>Shoots fresh weight (g)</b>				
Emma	14.70 b	22.40 ab	36.82 a	<b>24.6 a</b>
Bureen	27.80 ab	23.80 ab	25.30 ab	<b>25.6 a</b>
<b>Mean</b>	<b>21.20 a</b>	<b>23.10 a</b>	<b>31.10 a</b>	
<b>Shoots dry weight (g)</b>				
Emma	8.53 ab	10.88 a	9.41 ab	<b>9.60 a</b>
Bureen	9.17 ab	7.49 ab	6.61 b	<b>7.76 a</b>
<b>Mean</b>	<b>8.85 a</b>	<b>9.18 a</b>	<b>8.01 a</b>	
<b>Roots fresh weight (g)</b>				
Emma	2.41 b	2.73 b	4.71 a	<b>3.28 a</b>
Bureen	2.71 b	4.25 a	4.28 a	<b>3.75 a</b>
<b>Mean</b>	<b>2.56 c</b>	<b>3.49 b</b>	<b>4.50 a</b>	
<b>Roots dry weight (g)</b>				
Emma	0.58 b	0.56 b	1.05 a	<b>0.73 b</b>
Bureen	0.75 ab	0.98 a	1.08 a	<b>0.94 a</b>
<b>Mean</b>	<b>0.66 c</b>	<b>0.77 b</b>	<b>1.06 a</b>	
<b>Percentage of chorophyl (%)</b>				
Emma	37.45 a	35.91 a	37.10 a	<b>36.82 b</b>
Bureen	33.98 a	34.94 a	33.80 a	<b>34.24 a</b>
<b>Mean</b>	<b>35.71 a</b>	<b>35.42 a</b>	<b>35.45 a</b>	

Means followed by the same letters are not significantly different ( $P < 0.05$ ) according to Duncan's multiple range test .

## CONCLUSIONS

In general, the process of the seed potato formation is influenced by a number of factors, including environmental conditions, fertilization, cultivars, physiological age of seeds. this starting with the germination of the apical buds stage which called apical dominance (Kumar and Knowles, 1993), followed by other eyes in germination as a result of the loss of inhibitory hormones, it is considered suitable for growing tubers at 15°C (Wiersema, 1985). After 20-30 days of emergence of the plant over the soil, sub apical region of ground stems was swelled

which represents the beginning of the formation of tubers. The difference in the size of seed potato (tubers) leads to difference in the number of stems, rate of emergence of seedling, total number of vegetative growth and the size of the progeny tubers during the first weeks after germination. (Abu Raddha and Abu Sherbi, 2011).

It is clear from the results that cultivars ( Emma and Bureen ) differed in their ability to form the progeny tubers. According to this ability, minitubers at size more than > 3.5 cm showed high ability to produce the progeny tubers and yield, vegetative growth

characterization when compared with minitubers at size less than < 2.5 cm). While minitubers at size 2.5- 3.5 cm were approached significantly in progeny tubers. This results agreed with (Ilze and Zinta ,2015) who mentioned to the smaller minitubers produced significantly less progeny tubers. The difference between two cultivars maybe explained to the methods used to grow the seed tubers ( Powell *et al.*, 1989).

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## الخلاصة

اجريت مقارنة حقلية لأحجام مختلفة من الدرنات الصغيرة Minitubers > 2.5 ، 2.5 - 3.5 و < 3.5 سم المنتجة خارج الجسم الحي لصنفين من البطاطا إيما وبورين. أخذت صفات الحاصل والصفات المظهرية للنمو الخضري بعد 90 يومًا من الزراعة. في صفات الحاصل، أظهرت النتائج اختلافات معنوية في تلك الصفات حيث أعطت Minitubers الصنف إيما عند الحجم < 3.5 سم أعلى عدد ، قطر ووزن درنات بلغت 5.90 درنة نبات<sup>-1</sup>، 45.43 ملم و 36.20 غم على التوالي. على النقيض من ذلك، انعكست قدرة درنات الصنف Bureen عند الحجم > 2.5 سم سلبيًا على جميع صفات الحاصل (3.90 درنة نبات<sup>-1</sup>، 37.77 ملم و 33.10 جم). تأثرت كل الصفات المظهرية للنمو الخضري باستثناء النسبة المئوية للكوروفيل بدرجة كبيرة بحجم الدرنات Minitubers، تفوق الصنف إيما عند الحجم < 3.5 سم في ارتفاع النبات، عدد الأفرع والأوراق، الوزن الطري للفرع والجذر والتي بلغت 35.40 سم، 4.00 فرع، 30.40 ورقة، 36.82 غم و 4.71 غم على التوالي.

*الكلمات المفتاحية* : البطاطا، حجم الدرنات الصغيرة،، خارج الجسم الحي، الأداء الحقلية، النبيتات .

## پوخته

به راوردیبه کا کیلگه‌ی هاته کرن بو هنده‌ک پتاتوکیڤن بچویک کو دجیاواز د قه‌بارهی دا - ۲,۵, ۲,۵ > minitubers ۳,۵ و ۳,۵ سم کو هاتیه به‌رهه‌م ئینان ژده‌رقه‌ی جه‌سته‌یی زیندی دا بو دوو جورین پتاتان ئیما و بورین، کو سیفاتین به‌رهه‌می و یین شیوه‌کی یین گه‌شه‌کرنکا که‌سکاتیڤن وه‌رگرتن پشته‌ی بورینا ۹۰روزان ژ چاندنا وان.د سیفاتین به‌رهه‌می دا ، ده‌رئه‌نجامان جیاوازیڤن مه‌عنه‌وی دیارکرن د قان سیفه‌تان دا کو minitubers ژ جورئ ئیما د قه‌بارئ ۳,۵ سم دا بلندترین هژمار بده‌ست قه‌ ئینان کو \_\_ و کیشا پتاتوکان گه‌هسته ۵,۹۰ پتاکوکیڤن رووه‌کی-۱, ۴۵,۴۳ ملم و ۳۶,۲۰ غم ل دوویف ئیک.بیچه‌وانه‌کی قئ چه‌ندی شیاین پتاتوکیڤن ژ جورئ بورین د قه‌بارئ > ۲,۵ سم دا کارتیکنه‌کا نیگه‌تیف په‌یدا کر ل سهر هه‌می سیفاتین به‌رهه‌می (۳,۹۰ رووه‌که پتاتوک-۱, ۳۷,۷۷ ملم و ۳۳,۱۰ غم). هه‌می سیفاتین شیوه‌کی یین گه‌شا که‌سکاتیڤن کاریگه‌ر بوون بتنی ریزا سه‌دی یا کلوروفیلی نه‌بیت بریزه‌کا زور د قه‌بارئ پتاتوکیڤن minitubers دا کو قه‌بارئ وئ مه‌زنتر بو ژ جورئ ئیما > ۳,۵ سم د بلنداها رووه‌کی دا ، ژمارا چه‌ق و به‌لگان کو کیشا \_\_ یا چه‌قی و ره‌ئ کو گه‌هسته‌یه ۳۵,۴۰ سم ۴,۰۰ چه‌ق, ۳۰,۴۰ به‌لگ, ۳۶,۸۲ غم و ۴,۷۱ غم ل دوویف ئیک.