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Research Article

EFFECTS OF DIFFERENT PLANTING DENSITY ON THE PRODUCTION POTENTIAL OF MINI-TUBERS FROM THE AGRIA POTATO MICRO-TUBERS

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ABSTRACT
This study was designed to investigate the effect of micro-tubers planting density on the production of Agria potato mini-tubers in the greenhouse of Vilkij Company in Ardebil in 2012. Agria potato micro-tubers from the vitro plantlets were planted in a completely randomized design with three replications with three planting densities (5×5, 10×10 and 15×15 cm). micro-tubers were produced in vitro with alternate light and 8 hours of darkness and 16 hours of lighting to produce the first micro-tubers and then in complete darkness and temperatures of 22-18 C° in MS medium. In this study, the characteristics of mini-tubers, mini-tuber weight, average weight of mini-tuber 7-5 mm diameter and weight of tubers per plant, number of tubers per plant with diameter 7-5 mm, 8-11 mm diameter and weight of tubers - meters per plant, number of tubers per plant with diameter 8-11 mm, weight of tubers per plant and tuber diameter mm 12 ≤ mm diameter per plant were examined. Analysis of variance showed that there is a significant difference between the planting densities of micro-tubers in terms of all traits except the tuber weight with diameter 7-5 mm per plant. Minimum number and weight of mini-tubers per plant in plant density 5×5 cm with 2 numbers and Weight of 8.24 g mini-tubers and average weight of 4.34 gram and the maximum number and weight of mini-tubers per plant with density 15×15 cm with a number of 4.33 mini-tubers and weight of 25.52 g and average weight of mini-tubers 6.31 g were observed. In the experiment with reduced planting density, all traits increased.

Keywords: *Micro-Tubers, Mini-Tubers, Potatoes, Planting Density*

INTRODUCTION
Potato arrived in Europe in the late sixteenth century more than four hundred years ago and after a while its cultivating began and it was raised as a crop. This plant arrived in our country for the first time in nearly two centuries ago and is currently planted as a staple crop in most parts of the country including Ardebil, East and West Azarbaijan, Hamedan, Kermanshah, Khorasan, Isfahan and Tehran (Hassan Panah *et al.*, 2007). Tuber yield is a complex trait that is influenced by a number of physiological and morphological processes and environmental conditions may affect the genetic structure of plants and their interactions (Monneveux and Belhassen, 1996). Potato is one of the young plants among the crops in the world. Nutritional, social and economic aspects of the plant in recent years have been remarkable. With the steady increase in world population, the need for food increases every day with dramatic speed. World Food Organization has stated that the world population in 2030 will be more than 8 billion people and supplying food for this population needs work in agriculture and allied sciences. Despite remarkable progress in the past three decades, the annual consumption of food has increased by only about 20 percent. Based on current estimates, the amount of food production countries should be more than current production by 2030 so that they could keep pace with the growing population movement, and meet their needs (Asghari, 2009).
Mini-tuber is an intermediate stage of potato seed production, between the stage of laboratory micro propagation and farm Proliferation. In recent years, the rapid proliferation systems to supply large quantities of seed potato production in vitro seedlings, tubers and tuber of small thumbnails (mini-tubers) have been developed with high quality. Small tubers, plants and mini-tubers (small lumps) are the high quality seed production materials so that they can be produced at a high density throughout the year

(seedlings and micro-tubers) or the environment outside the laboratory (mini-tubers in Went House greenhouse). Small glands Production in Laboratory (diameter 5 to 10 mm) under sterile laboratory conditions is not difficult (Rolot and Seutin, 1999). Mini-tubers are small glands produced from plants under high-density culture conditions in vitro and in greenhouses for the production of pre-basic and basic seed production (Ritter *et al.*,, 2001). Micro-tubers are small tubers with a diameter of 10.2 mm and weighs less than 1 gram of which are free of viruses and other diseases. Micro tuberization can be grown on farms, but they are planted in greenhouses due to their delicate nature and high value. They are affordable because of the ease of transportation as a nucleus for the production of healthy seed of potatoes (Hagg, 1998).

The purpose of this study was to evaluate different planting densities of micro-tubers on Agria potato mini-tubers in greenhouse conditions.

MATERIALS AND METHODS

Micro-tubers smaller than 1 gram belonged to the Agria potato based on a statistical random statistics were evaluated with three replications and three planting densities (5×5, 10×10 and 15×15 cm) in Vilkij greenhouse in Ardebil in 2012. Micro-tubers were planted in Winter Stein peat moss and the mineral cartridge with the volume ratio of 1:1. During the development, f irrigation practices were regularly conducted. To fight against the pests, Confider poison was used with the amount of 2/5 ml per 100 square meters of fungicides to combat fungal diseases to 10 g per 100 m. Environmental conditions at all stages of growth in a greenhouse with a photoperiod of 16 h, 8 h dark, temperature 22-18 C° and relative humidity of 75-65 percent. 10 days before harvest aerial parts of mini-tubers were topping. After the lapse of 90 days, mini-tubers were harvested and traits of mini-tubers, mini-tuber weight, average weight mini - tubers, tuber weight, diameter 7-5 mm per plant, number of tubers with a diameter of 7-5 mm per plant, tuber weight per plant diameter 8-11 mm, 8-11 mm diameter, number of tubers per plant, weight of tubers per plant and tuber diameter mm 12 ≤ 12 ≤ diameter mm per plant were examined. Aanalysis of variance and mean values of the measured parameters were calculated using the software MSTATC. Mean comparisons were performed by LSD test at 5% probability level.

RESULTS AND DISCUSSION

Analysis of variance showed that there was a significant difference between the measured traits Inter-tuber planting density for all traits except weight of tubers per plant with diameter 7-5 mm (Table 1).

Table 1: Analysis of variance

S.O.V	df	Mean of Square				
		number of mini-tubers	mini-tuber weight	average weight mini - tubers	weight of tubers per plant with diameter 7-5 mm	number of tubers with a diameter of 7-5mm per plant
Rep	2	0.09	1.219	0.06	1.871	0.00004
plant density	2	3.823**	224.342**	2.926**	7.233	0.22**
Error	4	0.035	0.776	0.084	2.274	0.002
C.V.%						

** and ** Significantly at p < 0.05 and < 0.01, respectively*

Continued Table 1:

S.O.V	df	Mean of Square			
		weight of tubers per plant with diameter 8-11 mm	number of tubers with a diameter of 8-11mm per plant	weight of tubers diameter 12 ≤ mm per plant	number of tubers with a diameter of 12 ≤ mm per plant
Rep	2	0.078	0.006	0.182*	0.02
plant density	2	11.942**	0.669**	51.977**	0.577**
Error	4	0.047	0.0044	0.027	0.009
C.V.%					

** and ** Significantly at p < 0.05 and < 0.01, respectively*

Regression analysis showed that the number density, the number of mini-tubers has increased. The increasing number of mini-tubers and the equation of the regression line and the correlation coefficient of the model in Figure 1 are considered significant and positive regression relationship between the number of mini-tubers and planting density. Furthermore, the minimum number of mini-tubers per plant density of 5×5 cm 2 and a maximum of 15×15 mini-tubers density was observed (Figure 1). The minimum weight of mini-tubers per plant density of 5×5 cm, weight 24.8 g (Figure 2) and a maximum weight of mini-tubers per plant at planting densities of 15×15 cm with a weight of 52.25 mg (Figure 2) was observed.

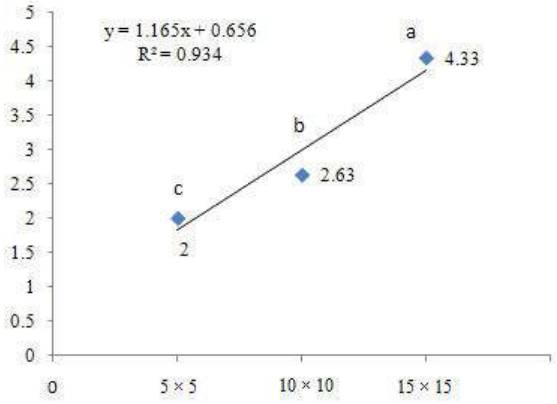

Figure 1: Linear regression between planting density levels and the number of mini-tubers per plant

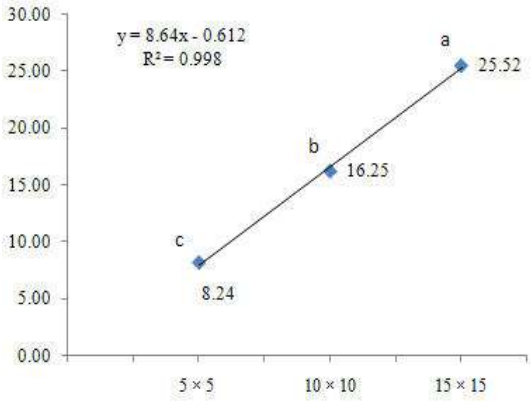

Figure 2: Linear regression between planting density levels and the weight of mini-tubers per plant

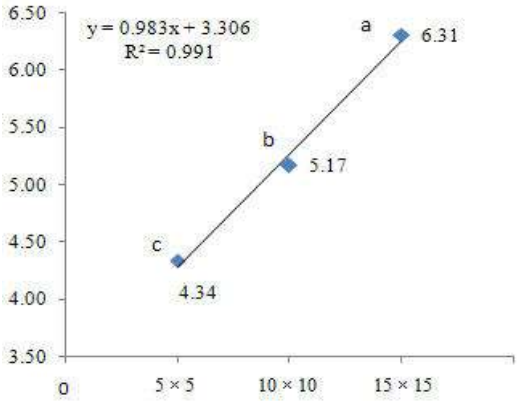

Figure 3: Linear regression between planting density levels and the average weight of mini-tubers per plant

Regression analysis showed that increasing the weight of mini-tuber planting density increased. The positive and significant regression was seen between mini-tubers weight and plant density levels (r^2 = 0.99). Thus, with increasing levels of planting density, the weight of mini-tubers per plant was increased. Results of regression to the mean weight of mini-tubers per plant with increasing density, the average weight of mini-tubers has increased. The increase in the average weight of mini-tubers and the equation of the regression line and the regression coefficient regression model in Figure 3 are considered significant and positive relationship between the average weight of mini-tubers, and planting density. However, the lowest average weight of mini-tubers per plant density of 5×5 cm with a 34.4 grams and the highest average weight of mini-tuber density of 15 × 15 with an average of 31.6 g accounted for by the top ranked group (Figure 3). The positive and significant regression) was seen between the weight of mini-tubers and plant density levels (r^2 = 0.96). Thus, with increasing levels of plant density, number of tubers per plant increased diameter of 7-5 mm (Figure 4).

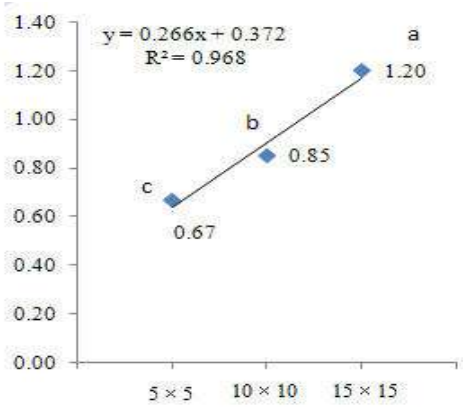

Figure 4: Linear regression between planting density levels and average number of tubers with diameter 7-5 mm per plant

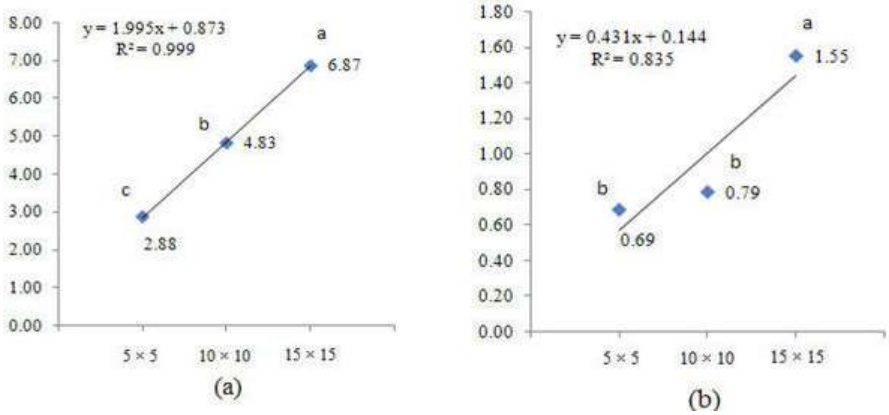

Figure 5: Linear regression between planting density levels and mean weight (a) and number (b) of tubers with diameter 8-11 mm per plant

Regression analysis showed that with increasing plant density, weight and number of tubers per plant increased diameter of 8-11 mm. The positive and significant regression was seen between weight and number of tubers per plant and plant density, diameter 8-11 mm, respectively (r^2 = 0.99 and 0.83). Thus, with increasing levels of planting density and weight of tuber 8-11 mm in diameter per plant showed an increasing trend (Figure 5). Regression analysis showed that the number density, weight (a) and (b) 12 ≤ mm diameter tubers per plant increased. Weight gain (a) and (b) 12 ≤ mm diameter tubers per plant and the equation of the regression line and the regression coefficient regression model in Figure 6 is considered significant and positive relationship between weight (a) and (b) 12 ≤ mm diameter tubers per

plant and plant density. Furthermore, the lowest weight (a) and (b) 12 ≤ mm diameter tubers per plant density of 5 × 5 cm, respectively, with the 38.5 mg and 0.76 and the maximum value of weight (a) and (b) 12 ≤ diameter of tubers per plant densities of 15×15 mm was observed (Figure 6). Manufacturer of mini-tuber parts of Ardabil province and country mini-tubers uptake of seedlings in the greenhouse, the average is around 3-2 pcs. In the experiment with increasing plant density, number, weight, and average weight of mini-tubers per plant decreased. Wurr *et al.,* (1992) reported that plant density had an effect on the number of tubers per plant with increasing plant density, number of tubers per plant decreases. This could be due to a decrease in the number of stems per plant and increasing competition within and outside the shrub. Roy *et al.,* (1995) showed that planting density without reducing the size of tubers per plant mini-tubers way to increase production. While Abdulnour *et al.,* (2003) reported that higher plant density is a good way to increase the number mini-tubers.

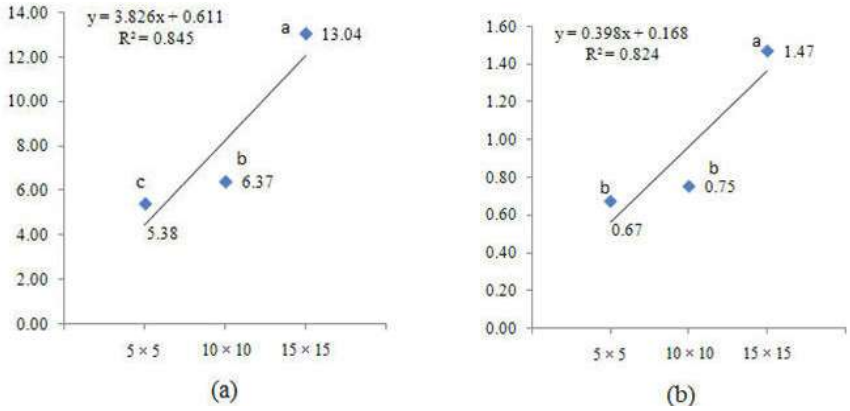

Figure 6: Linear regression between planting density levels and mean weight (a) and number (b) of tubers with diameter 12 ≤mm per plant

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