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A study on the interaction between seedling density and cultivar on mini-tuber production in greenhouse conditions

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ABSTRACT

To study the effect of various laboratory seedlings planting densities on potato mini-tuber yield, a research was conducted in the form of two-factor factorial design, in which factor A in 10 levels including Agria, Savalan, Marfona, Kaiser, Hermes, Arinda, Satina, Milva, Sante and Clone 397009-3 and the second factor included seedlings density at three levels of 100, 200 and 300 seedlings per square meter in the form of completely randomized design at the greenhouse of Ardabil Wilkij Company. During the research, traits such as number of tubers per pot, number of tubers to various diameters per pot and plant, number of tubers in area unit and average number of tubers per plant were assessed. After testing data to be normal, ANOVA was conducted. Results suggested that among various levels, factor A (studied cultivars) was significant at one percent on all assessed traits. Studies indicated that among various levels, factor B (seedlings density) was significant at one percent on number of tubers per pot, number of tubers with diameter of 5-7 mm per pot and number of tubers with diameter of 8-11 mm per pot, average number of tubers per plant and number of tubers in area unit. Also, there was a significant difference at 5 percent on the traits of number of tubers with diameter of 5-7 mm per pot and number of tubers with diameter of 8-11 mm per pot.

Keywords: mini-tuber, potato, seedling density per square meter

INTRODUCTION

Potatoes entered Europe some four hundred years ago in late 16th century and short while after planting them was so widespread and potatoes were considered as a crop. This plant was first entered Iran two centuries ago and now it is planted as a crop in various regions and provinces such as Ardabil, East Azerbaijan, West Azerbaijan, Hamadan, Kermanshah, Khorasan, Isfahan and Tehran [1]. Mini-tuber is an intermediate level in potato seed production between laboratory micropropagation and field proliferation stages. Rapid proliferation systems in producing seed potatoes for providing more laboratory seedlings, micro- tubers and small tubers (mini-tubers) with high quality have been developed. Micro- tubers, seedlings and mini-tubers (small tubers) are the initial materials for producing seeds with high quality, so that they could be produced in high density in laboratory conditions (seedling and micro-tubers) and outside laboratory conditions (mini-tuber in Venthouse Greenhouse). Producing laboratory tubers or tubers in small sizes (with a 5-10 mm diameter) under laboratory sterile conditions is easy [2]. Producing mini-tuber resulted from planting laboratory seedlings is among simple common and classic methods for transferring from in-vitro to in-vivo. Producing mini-tuber from laboratory seedlings have provided higher proliferation speed in seed tuber production plans and it reduces the number generations needed for proliferation on the field [3]. Density of 15 to 20 shoots per square meter for edible crops and density of higher than 30 shoots per square meter for seed crops are common. Since the number of shoots is not determined by seeds predicting needed seed tubers is difficult. Generally, for edible crops, 35-45 thousand plants per hectare are used for 2.5-3 tons seed tubers [4]. Number of plants per square meter depends of two factors of number of seed tubers planted and the ratio of these tubers which succeed o produce shoots. Almost all planted tubers produce shoots, if the quality of seed tubers is suitable and they

are in a proper age physiologically. Hence, the number of plants per square meter is calculated from number of planted tubers on the average weight of each seed tuber [5]. The objective in this research is to identify high-cropped cultivars based on producing mini-tuber in greenhouse and introducing the best planting density of laboratory seedlings in greenhouse conditions.

MATERIALS AND METHODS

Research Location Specifications

The research was conducted at the laboratory and greenhouse of Ardabil Wilkij Company located on Ardabil-Astara road, 7 km East of Ardabil, in 2012. In this research, 10 potato cultivars including Agria, Savalan, Marfona, Kaiser, Hermes, Arinda, Satina, Milva, Sante and o2 (Clone 397009-3) were studied in the form of two-factor factorial, in which the first factor included the cultivar in 10 levels and the second factor including of seedlings density at three levels in the form of completely randomized design in laboratory and greenhouse conditions.

Laboratory assessments included

- 1-Disinfecting environment, containers, plating tools and plant materials
- 2-Preparing plating environment
- 3-Planting Meristem
- 4-Transferring seedlings to the greenhouse

Traits such as number of tuber per pot, number of tuber with diameter of 5-7 mm per pot, number of tuber with diameter of 5-7 mm per plant, number of tuber with diameter of 8-11 mm per pot, number of tuber with diameter of 8-11 mm per plant, average number of tuber per plant and number of tuber in area unit were studied.

SPSS software was used to analyze data. Also, data mean comparison was done using multi-range Duncan test at 5%.

RESULTS AND DISCUSSION

Analysis of Variance

After testing the data distribution to be normal, ANOVA of experiment was conducted in the form of factorial in the form of completely randomized design and it suggested that there was a significant relation between various levels of factor A (studied cultivars) on all studied traits at one percent (Table 1). Studies indicated that there was a significant relation between various levels of factor B (seedlings density) on traits such as number of tuber per pot, number of tuber with diameter of 5-7 mm per pot and number of tuber with diameter of 8-11 mm per pot, average number of tuber per plant and number of tuber in area unit at 1 percent. Also, there was a significant difference at 5 percent on the traits of number of tuber with diameter of 5-7 mm per pot and number of tuber with diameter of 8-11 mm per pot.

Number of Tuber per Pot

ANOVA results indicated a significance on number of tuber per pot at 0.01 percent (Table 1) so that, mean comparison by Duncan method at 5 percent indicated that Savalan was at class "a" and had the highest value (Table 2). Studies indicated that density of 300 seedlings had the highest number of tuber per pot and density of 100 seedlings had the lowest number of tuber per pot (Table 3). The interaction between cultivar in density was significant at 0.01 percent so that, results suggested Hermes at 200 seedlings density had the highest number of tuber per pot (Figure 1).

Number of Tuber with Diameter of 5-7mm per Pot

ANOVA results indicated a significance on number of tuber with diameter of 5-7 mm per pot at one percent (Table 1) so that, mean comparison by Duncan method at 5 percent indicated that Agria, Savalan, Kaiser, Marfona, Hermes and o2 (Clone 397009-3) were at class "a" and had the highest value (Table 2). Results suggested that there was no significant difference between 200 and 300 seedlings on number of tuber with diameter of 5-7 mm per pot, which had the highest value (Table 3).

Number of Tuber with Diameter of 5-7mm per Plant

There was a significant difference between studied cultivars on number of tuber with diameter of 5-7 mm per plant at 1 percent (Table 1) so that, mean comparison results indicated that Agria, Savalan, Kaiser, Marfona, Hermes and o2 (Clone 397009-3) were at class "a" and had the highest value (Table 2). Results suggested that there was no significant difference between 100 and 200 seedlings, which had the highest value (Table 3).

Number of Tuber with Diameter of 8-11mm per Pot

There was a significant difference between studied cultivars on number of tuber with diameter of 8-11 mm per pot at 1 percent (Table 1) so that, mean comparison results indicated that Savalan and o2 (Clone 397009-3) were at class "a" and had the highest value, while Milva had the lowest number of tuber with diameter of 8-11 mm per pot and it was at class "e" (Table 2). Results suggested that 200 seedling density had the highest number of tuber with diameter of 8-11 mm per pot, while 100 seedling density had the lowest number of tuber with diameter of 8-11 mm per pot (Table 3).

Number of Tuber with Diameter of 8-11mm per Plant

There was a significant difference between studied cultivars on number of tuber with diameter of 8-11 mm per plant at 1 percent (Table 1) so that, mean comparison results by Duncan method indicated that Savalan, Hermes, and o2 (Clone 397009-3) were at class "a" and had the highest value (Table 2). Results suggested that there was no significant difference between 100, 200 and 300 seedlings density on number of tuber with diameter of 8-11 mm per plant (Table 3).

Average Number of Tuber per Plant

ANOVA results indicated a significance on average number of tuber per plant at one percent (Table 1) so that, mean comparison indicated that Savalan, Marfona, Kaiser, and Hermes were at class "a" and had the highest value (Table 2). Results suggested that there was no significant difference between 100 and 200 seedlings on the average number of tuber per plant, which had the highest value (Table 3).

Number of Tuber in Area Unit

There was a significant difference between studied cultivars on number of tubers in area unit at one percent (Table 1) so that, mean comparison by Duncan method at 5 percent indicated that Savalan and Hermes were at class "a" and had the highest value, while Agria, Arinda, Satina, and Sante were at class "d" and had the lowest value (Table 2). Studies indicated that density of 300 seedlings had the highest number of tubers in area unit and density of 100 seedlings had the lowest number of tubers in area unit (Table 3). The interaction between cultivar in density was significant at 0.01 percent so that, results suggested Hermes at 300 seedlings density had the highest number of tubers in area unit (Figure 2). Ifenkow and Allen (1978) claimed that number of tubers in area unit increases in higher plat densities [6].

Table 1. Analysis of variance of the number density of potato plantlets

Source of Variations	df	Number of tubers in pot	Mean Square					Tuber number per unit area
			Number of tubers with diameter in pot (5-7 mm)	Number of tubers with diameter in plant (5-7 mm)	Number of tubers with diameter in pot (8-11 mm)	Number of tubers with diameter in plant (8-11 mm)	Average number of tubers per plant	
Rep	3	51.231	6.48	0.06	3.17	0.06	0.23	14230.56
Factor A	9	620.575**	21.23**	0.3**	58.25**	0.61**	7.58**	172382.33**
Factor B	2	3518.36**	19.6*	0.24*	367.008**	0.18 ^{ns}	3.06**	977323.26**
A×B	18	122.50**	13.66*	0.17**	17.25**	0.17*	1.24**	34027.11**
Error	87	41.55	5.09	0.07	6.24	0.09	0.56	11542.32
CV (%)	-	9.5	10.4	9.3	2.9	12.05	3.82	4.9

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

Table 2. Average traits in potato cultivars

Genotypes	Characters													
	Number of tubers in pot		Number of tubers with diameter in pot (mm 5-7)		Number of tubers with diameter in plant (mm 5-7)		Number of tubers with diameter in pot (mm 8-11)		Number of tubers with diameter in plant (mm 8-11)		Average number of tubers per plant		Tuber number per unit area	
Agria	160	d	3.91	a	0.41	a	4.91	de	0.52	c	1.62	d	266.66	d
Savalan	29	ab	4.5	a	0.49	a	9.66	ab	0.96	a	3.01	ab	483.33	ab
Marfona	28.17	b	2.75	ac	2.76	ab	6.5	cd	0.65	bc	3.05	ab	469.44	b
Kaiser	28.17	b	4.08	a	0.48	a	6.08	cd	0.58	bc	2.93	ab	469.44	b
Hermes	34	a	3.25	ab	0.39	a	7.66	bc	0.81	ab	3.46	a	566.66	a
Arinda	14.25	d	1.41	bc	0.13	b	4.75	de	0.45	c	1.39	d	237.50	d
Satina	42.13	d	1.08	c	0.11	b	4.91	de	0.47	c	1.33	d	223.61	d
Milva	22.42	c	1.41	bc	0.13	b	3.66	e	0.38	c	2.27	c	373.61	c
Sante	17	d	0.91	c	0.07	b	4.25	de	0.41	c	1.59	d	283.33	d
Clone 397009-3	24.50	bc	2.66	ac	0.31	ab	9.91	a	1	a	2.69	bc	408.33	bc

Differences between averages of each column which have common characters are not significant at probability level of 5%

Table 3. Comparison average traits of potato cultivars in plantlets density

Factor B	Characters											
	Number of tubers in pot			Number of tubers with diameter in pot (mm 5-7)			Number of tubers with diameter in plant (mm 5-7)			Number of tubers with diameter in pot (mm 8-11)		
100	12.25	c		1.8	b		0.36	a		3.47	c	
200	25.43	b		2.9	a		0.29	ab		5.75	b	
300	30.4	a		3.1	a		0.2	b		9.47	a	

Differences between averages of each column which have common characters are not significant at probability level of 5%

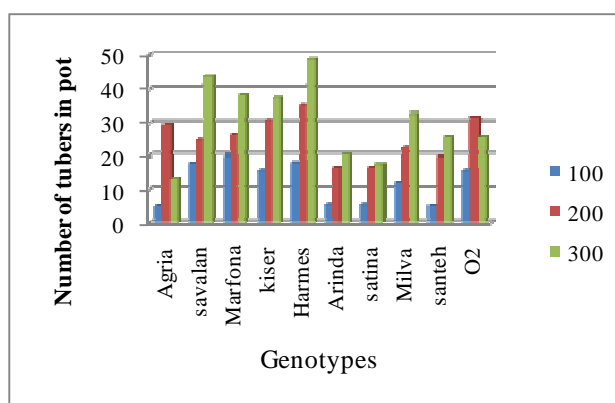


Figure 1. Number of tubers in pots in a variety of densities evaluated separately

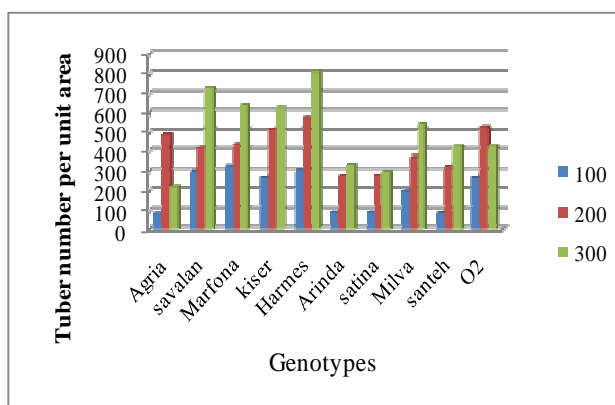


Figure 2. Number of tubers per unit area density of cultivars evaluated separately

CONCLUSION

There was a significance on studied traits among studied cultivars at one percent. Savalan and Hermes had higher means and had higher values, comparing to other studied cultivars on the studied traits.

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