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Genetic diversity of the main potato genotypes on phenology and morphological traits

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Abstract: The phenotypic diversity of potato (*Solanum tuberosum* L.) was assessed using morphological traits, verifying how this diversity is distributed among the main potato cultivars in the growing areas, Iran. A total of eleven cultivars, Ramose, Sante, Shepody, Marfona, Maradona, Milova, Santana, Boren, Cosima, Granola and Agria, that practice traditional agriculture, were evaluated in the field and greenhouse experimental condition in Isfahan. Seven phenological, floral and morphological vegetative descriptors, Crop Growth Rate=CGR, Net Assimilation Rate=NAR, Leaf Area Duration=LAD, Leaf Area Ratio=LAR and specific Leaf Area=SLA were recorded. The descriptors were analyzed by SAS software and the means were compared by DMRT test. Certain defined groups were observed, indicating that, the diversity of the cultivars is structured with a considerable morphological variation in between with a very high significant growth index.
Key words: Assimilation rate, growth rate, leaf area ratio, cultivars and varieties

Introduction

Potato (*Solanum tuberosum)* is one of the main and strategic products and stands in fourth position after wheat, rice and corn .It has also a special role in feeding people of under developed countries. Thus for making secure feeding, increasing efficiency of this strategic product seems necessary. Potato is from the family of Solanaceae with 26 genera and 2800 species. Most of its species are from tropical and southern part of America. Potato is belonged to big and varied *Solanum* genus; with 2000 species. The cultivated potatoes belonge to *Solanum tuberosum* with 180 varieties, which produce tubers (Harris, 1992).

Most commercial varieties of *Solanum tuberosum* are tetraploid. There are two subspecies: Tubersum and Andigena. Tubersum is world with distributed expended. Root system of *Solanum tuberosum* is relatively weak and it is expanded easily in light soil with sandy clay texture. Methods of propagation of potato are asexual, with tubers division and sexual with true potato seed culture (Harris, 1992).

In propagation with tuber, the adventurous roots are formed from the base of divided tubers primarily, and then root and stem are initiated from top of underground nodes of tubers. In case of true potato seed culture plant have a thinly tap root and stolons with lateral branches, and some replicates roots initiated from stolons. The stem in *Solanum tuberosum* is green, herbaceous, and already thick. It's thickness is already 2-2.25 cm. Stem also has some trichomes .Plants which are formed from true seed has main stem with lateral branch but plants from tuber seed has many main and lateral stems (Croquets, 1988).

The leaves are compound pinnate, indicating That the leaflet can be seen on the top of main petiole. The main petiole is herbaceous and has light green color with 7-9 leaflets .The leaflets are ovate, irregular, entire margin ,and little lobed, with dark green color. The veins of leaflets are clear with light green color. The leaflets have trichomes on both sides with very short petiole (Jones and Luchsinger, 1987).

The flowers of *Solanum tuberosum* are two types; actinomorph and zygomorph. There are five Sepals, soft or corky and with green, red, or purple color with different length. The petioles are also different in length size. The corolla is star shape, rectangular, or circular. In case of color, most of them are white but they are clear in red, purple, blue, yellow, and pink type (Cutter, 1982).

The stamens are 5 and most of them have long and column anther with yellow or orange color. They show related groups which are individual or divergent .The pollen is expended from the top of another. The fruit is

the burry epigenous with two carpels with 5-8 mm thickness. Tiny seeds are spread in berry fruit. Modified stem, tuber, is the main reservation organ in potato (Jones and Luchsinger, 1987).

The size of tuber is depending on the kind of variety, soil properties, and also climatic conditions. The potato is commonly circular – elliptical or oval. The skin of tuber is soft, hard or nettled. The color of the tuber skin is white, and, purple and also pink or yellow .The tuber contains: 75 or 80% water-12% starch -1.5 or 2% protein 2 or 3% fiber –salts and also vitamin C (Elorit and Greub, 1984). Some lateral stems are horizontally grown on buds of underground stems. The lengths of them are varied and also are the main factor to recognize varieties. *Solanum tuberosum* can be produced in different ecological areas, in tropical, subtropical, desert, mountainous, and temperate areas. *Solanum tuberosum* is used for feeding herd and human. It contains vitamin C, potassium, calcium, groups of vitamin Band a little sodium.

Reviews show that, there is no any coherent study on this subject. Therefore, because of the importance of the subject, these studies were carried on eleven varieties of potato in greenhouse and field in Isfahan, Iran.

Material and method

For the phenology and morphological analysis and also testing varieties in field and green house, these experiments were done based on classical method in Isfahan. For analyzing the soil, some samples were taken from the field and green house. The treatments were composed of 11 commercial varieties of *solanum tuberosum* species growing mainly in Iran: Ramoae, Santeh, Shepody, Marfona, Maradona, Milova, Santana, Granola, Cosima, Agria. Experimental treatments were based on statistical bias used 4 replicates in field and 5 replicates in green house.

Table1- The soil analysis in field and green house

Soil sample	Clay	Silt	Sand	Exchangeable potassium	Exchangeable phosphor	Organic Carbon	Total N	Acidity	EC
	%mg/kg					%		7.4	2.29
Greenhouse	9.4	28	62.6	89.3	8.5	1.35	0.03		
Field	17.4	24	58.6	1.35	6.35	2	0.2	7.7	5.54

For preparation of the soil 20 Ton/ha fertilizer was distributed in the field on January 2010, 300 kilogram/ hector potassium sulfate, 200 Kg/ha Super triple phosphate and 350 Kg/ha ammonium sulfate were added proportionately to the field soil. At the end, the field was divided to 4 replications. There were 2 raw with 3 meters width and 75 Cm distance .Also, for preparing pots soil, ratio of 1: 1: 1 of sand, fertilizer and clay mixed together for the glass - house. These pots were sterilized and sufficient NPK was added too.

Each plot contained 11 raw. Each variety was sowed in each raw. The distance between sowed raw were 75 cm and the length of each raw was 3 meters. Tubers in the density of 5.33 bushes square meter were sowed. For avoiding soil diseases, tubers were disinfected by fungicide for 3 minutes in suspension each variety was sowed in 45 pots. The depth of sowing tubers was 10 cm.

In green house, also tubers were disinfected by fungicide for 3 minutes. Watering in the field and green house was based on the temperature and moisture of the soil. For avoiding and controlling early blight disease RTS 2/1000 and Paconal 3/1000 were used. For controlling mite pest Neuron 1/1000 and larvin 0.5/1000 were used. For aphis pest, Kenfidor 1/1000, and for *Bemisia* Diazinon 1/1100 was used. One month after sowing 150 kg Ammonium sulfate in each pot was used.

Harvesting of varieties Ramoae, Santeh, Shepody, Marfona in green house and field was done on 28th of May and 10th of June2010. Also varieties like: Maradona, Milova, Santana, Boren were harvested on 8th of June and 24th of June2010. Agria, Granola, Cosima were harvested on 24th f Jun and 9th of July2010. In harvesting time, the average of bush height and length of root varieties were calculated. Also, the average weights of fresh and dry root were calculated in the same time.

Statistical analysis of data was done by SAS software. Their averages were compared by DMRT. Also, their comparisons and differences for showing different varieties in under studied factors stated graphically (Paul and Southgate, 1978).

Harvesting tubers of each item were classified based on mini tuber, big and too big. The yield average of each group and the number of tubers in each bush were calculated.
Sampling for determination of understudied factors in the field and green house were done repeatedly, after every two weeks. Varieties: Ramose, Sante, Shepody, Marfona, Maradona in the field and green house were sampled 6 and 5 replicates. Santana, Maradona, Milova, Boren varieties were sampled 7 replicates in the field and 6 replicates in the green house. Also, for Granola, Cosima, Agria the sampling was done 8 replicates in the field and 7 replicates in the green house. In each field sampling, 4 bushes of each item were analyzed. In green house sampling, 5 pots were analyzed.

After moving each sample to the lab, the total fresh weight of each sample and dry stem (48h, 75˚C) and leaves were measured. At the next stage, Leaf area of each sample was determined by leaf area meter. For determining understudies factors, the following actions were done. (Gardner et al., 1985).

1) Crop growth rate

$$CGR= (W2-W1) (T2-T1) \times GA$$

In the above equation CGR is calculated based on gr/m^2.
W1 and W2 are the total dry weight in the first and second sampling. T1 and T2 are times of sampling and GA is the sampling level based on square meter.

2) Net assimilation rate

$$NAR=1/LA \times dw/dt$$

In this equation, NAR is the speed of photosynthesis based on gr/m^2 of LA, LA is the leaf area and dw/dt is the changes of dry weight of plant × time.

3) Leaf area index

$$LAI=LA/P$$

In this equation, LAI is the leaf area of one side which occupies the land. LA is the leaf area and P is the surface of sampled land based on square meter.

4) Leaf area duration

$$LAD= (LA2+LA1) \times (T2-T1)/2$$

In this formula LAD is the largeness and leaf area based on growing time of product.
LA1 and LA2 are leaf area of plant in the first and second sampling. T1 and T2 are times of first and second sampling.

5) Relative growth rate

$$1/w \times dw/dt$$

In this equation, RGR is based on the changes of dry plant per day, W is the weight of dry plant, and dw/dt is the changes of dry weight of plant × time.

6) Leaf area ratio

$$LAR=LA/W$$

LAR is the relationship between photosynthesis tissue and the total weight of plant. LA is the leaf area and W is the total weight of plant.

7) Specific leaf area

$$SLA= LA/LW$$

In the above equation, LA is the leaf area and LW is the weight of leaves. For determining the height of bushes in the time of harvesting, sampling of varieties was accidentally done. In each Crete 5 bushes were chosen and the height of each was measured. Then the average of them was calculated. Also the same thing was done in green house for 5 pots.

Result and Discussion

The phonological and morphological analysis and its yield shows that understudied varieties and their factors are different and they can be significantly differentiated from each other. The result of this study is shown on the summary in the following tables and diagrams. These tables and diagrams are shown in base of variance analysis and average tables of parameters like growth, the effect of variety on culture period and the number of stems, the length of stem, the number of tuber, and yield of sale varieties.

Leaf area index

The total leaf area of a bush based on the occupied land surface is called leaf area index (LAI).It has effect on plant growth and the final yield of dried material. According to variance analysis table 2, the highest and lowest LAI in field were related to Cosima, Sante and the lowest LAI related to Ramoae. For varieties like: Ramoae, Sante, Shepody, Marfona the highest of LAI was calculated before flowering period in field and green house. But for varieties like: Santana, Maradona, Milova, Boren. The highest of LAI in field and green house was before flowering period. For varieties like Cosima, Granola, and Agria, it was calculated at the end and at the beginning of flowering period. The highest LAI in field was because of sufficient space for growing and also the large number of lateral stems. The average of LAI for understudied items in field and green house were 3/23 and 1/37 for early maturity, 1/5 and 5/19 for middle maturity, and 6/12 and 1/9 for late maturity. All of the analysis showed positive coefficient among the highest LAI level of varieties. These results agree with the finding Annandal , Kawakami and Gremew which reports that ,the growth factors including stems and leaf area are having positive correlation with yield measures (Gremew et al., 2007; Kawakami et al.,
2004).

Table2- Variance analysis of the POTATO varieties in the field and greenhouse

Source variation	DF		RGR		NAR		CGR		SLA		LAR		LAD		LAI	
	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G
Treatment	10	10	00000190/**	/000160**	/642**	/621**	/7140**	/0756**	/5857**	/113**	/851843**	/72403**	/58360**	/5235**	/376**	0/26**
Error	33	44	0000010/	0000000/47	0220/	0360/	/0170	/0530	/0830	/960	1/62	/4900	0/115	00040/7	0020/4	00080/3
Total	43	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CV%	-	-	0/07	1/21	/182	/322	0/69	2/33	1/3	/382	0/95	0/92	1/3	0/25	1/04	1/87

**Significant at 0.01 probability level.

Crop growth rate

The speed of plant growth is dry weight increase in plant organs based on gr/m^2 per day. According to variance analysis treatment table 2 of CGR, there was significant difference (in ratio of 1%) among the cultivated varieties in field and green house. As shown in table 3, the maximum of CGR in field belonged to Boren and the minimum to Sante variety. And in greenhouse the maximum level belonged to Cosima and the minimum level to Ramoae. According to tables CGR in plant is sigmoid. All of varieties in field and green house had low trend then their trend were increased. Early maturity varieties (Ramoae, Sante, Shepody, and Marfona) reached their maximum CGR before flowering in both field and green house. Middle maturity Varieties (Santana, Maradona, Milova, and Boren) reached the maximum CGR level at the beginning of flowering and in green house before flowering. For late maturity varieties (Cosima, Granola, Agria) they were reached maximum level of CGR at the end period of flowering. After this period the CGR was slow

down because of reduction of pure absorption and leaves falling (Isoda et al., 1987, Borego et al., 2000; Fonseka et al., 1996). The increase of structural tissues in comparison to active meristem tissues, the age of leafs ,the reduction of leaf area and pure absorption ,shading of upper leafs over lower leafs were all factors which have effect on CGR among *Solanum tuberosum* varieties in field and green house (Smeets and Garretson 1986).

Table 3- The average maximum amount in varieties of potato in level of field and green house

Cultivar	LAI		LAD		LAR		SLA		CGR		NAR		RGR	
	(F)	(G)	(F)	(G)	(F)	(G)	(F)	(G)	(F)	(G)	(F)	(G)	(F)	(G)
Ramoae	3/25ef	1/3 d	16/23 e	5/66g	105f	82/6b	17/03 i	13/23b	16/93g	8/2f	6/97d	7/76 d	0/0671e	7/76 d
Sante	3/07g	1/31 d	15/27 f	5/85f	125e	71/6d	18/04h	11/66c	16/16 i	9/15e	6/44f	7/98 d	0/0676c	7/98 d
Shepody	3/19 f	1/35cd	15/32 f	5/89e	129d	77/6c	22/36e	13 b	16/9 g	8/28f	7/99a	8/33bc	0/0681b	8/33bc
Marfona	3/34e	1/4 c	16/6 e	5/78 f	130d	87/4a	19/02g	11/76c	18/08e	9 e	7/97a	6/96 e	0/0681b	6/96 e
Santana	5/17 d	1/45 b	28/21 c	8/54c	140c	70/6d	27 a	13/25b	22/8 c	9/93 cd	6/76e	9/12 a	0/0676c	9/12 a
Maradona	5/14 d	1/5 b	27/2 d	8/16 d	100g	62/2e	20/05f	11/78c	22/11d	11/07 a	6/77e	8/33bc	0/0674d	8/33bc
Milova	5/23d	1/48 b	27/27cd	8/14 d	141c	65 f	17/32 i	13/25b	23/45b	10/4 b	7/06c	8/44 b	0/0673d	8/44 b
Boren	5/2 d	1/49 b	27/27 d	8/12 d	167b	62 g	25/53c	13/57b	24/26a	11/15 a	7/43b	8/84 a	0/0687a	8/84 a
Cosima	6/23a	1/89 a	39/39 a	12/13a	131b	87 a	25/52c	13/07b	17/12 f	11/29 a	5/58i	7/99 d	0/064 f	7/99 d
Granola	6 c	1/89 a	37/07 b	12/13a	127e	82/6b	26/31b	14/86a	16/43h	10/24bc	5/71h	8/48 b	0/0663j	8/48 b
Agria	6/13 b	1/85 a	39/28 a	11/83b	170a	82/8b	24/64d	13/14b	17/85e	9/73 d	6/08g	7/94 d	0/0674d	7/94 d

- Means followed by at least one same letter are not significantly different at the 0.01 probability level according to DMRT test
- F : Field, G : Glasshouse.

Net assimilation rate

Net assimilation rate shows the amount of natural materials which are made in leaf area in time (g/m2/d) .As shown in table 3, the maximum level of NAR in field belonged to Shepody, Marfona varieties and the minimum level to Cosima .Also in greenhouse the maximum level of NAR belonged to Santana and the minimum level to Marfona. At the beginning of growth season, the NAR was on the maximum level because of small plant and the radiation of the sun over all leafs. But over time the size of leafs area increased and they made shadow over lower leafs and also the age of leafs made the photosynthesis process low. At the end of growth period, NAR became so low that made the resulted items negative, this was because of increasing temperature, leafs falling and the low level of photosynthesis. The results were in agreement with the analysis of Fonsikaet.al (1996).

Leaf area ratio

The leaf area ratio shows the ratio of leaf area over the total weight of dry plant. It is calculated based cm^2/gr. According to variance analysis table 2, there was a significant difference among varieties in field and green house. The maximum level of LAR in field and green house belonged to Agria and Marfona and the minimum level belonged to Maradona and Boren. LAR is the largest of photosynthesis area in plant. The reduction of LAR in different *Solanum tuberosum* varieties showed this reality that the growth of tuber consumed more photosynthesis materials of plant. This matter caused that at the beginning of growth period LAR had decreasing trend in all *Solanum tuberosum* varieties (Smeets and Garretson, 1986; Midmore and Prange, 1992).

Specific leaf are

The balance between leaf extension and biomass distribution on leafs are shown by specific leaf area. This index is in effect of some environmental factors. According to variance analysis tables 2 and 3; the maximum level of SLA in field and green house belonged to Santana and Granola respectively. The minimum level of SLA in field and green house belonged to Ramoae and Sante respectively. Actually the total weight of any leafs were lower than the ratio of their specific leaf area at the beginning of growth season. But during the growing period, the total weight of plant was increased and it caused the reduction of SLA. In understudied varieties, the SLA of varieties in field was significantly different from the varieties in green house. As the result the leaves of *Solanum tuberosum* varieties in green house were thicker than leaves of varieties in field (Midmore and Prange, 1992; Smeets and Garretson, 1986).

Leaf area duration

LAD is related to plant dry material function. Because the more solar energy produces drier material. As shown in tables 2 and 3, the maximum level of LAD in field and greenhouse respectively belongs to (Cosima, Granola) and the minimum level belongs to (Sante, Ramoae). LAD in field potatoes varies is more than green house (Board et al., 1990, Gorden et al., 1997; Kooman and Rabbinge,1996).

The effect of varieties on the number of days from sowing date to flowering period

The effect of varieties on the number of days was significant in probability level of %1 as shown in table 6, Marfuna had the large number of days from sowing to germination. Agria was vice versa. Cosima had the large number of days from to calendar date to tuberization and Ramoae was vice versa. Cosima had the large number of days from calendar date to flowering and Cosima was vice versa in both field and green house. These differences among varieties were because of their genetic of late or early maturity, their responses to the length of the day and the temperature of the environment. In summary, in those varieties which had germination process lately, tuberization and flowering were happened early (Wurr, et al., 1992; Morrison et al., 1992).

Table 4 - Variance analysis of the number of days from calendar date to germination, tuberization and flowering, the number of stems and the length of the longest stem in a clone in the field.

Source variation (SV)	Degrees of Freedom	Mean square (MS)						
		Length of the longest stem(cm)		Number of stems in a clone		Number of days from calendar date to		
		Full grown time	A month after germination	Full grown time	A month after germination	tuberization	tuberization	germination
Treatment	10	388/39**	215/17**	3/59**	2/61**	19/85**	26/04**	19/64**
Error	33	5/39	2/55	0/42	0/18	0/45	0/4	0/99
Total	43	-	-	-	-	-	-	-
CV%	-	2/48	2/05	13/14	13/97	0/99	0/99	4/2

** Significant at 0.01 probability level.

Table 5: Variance analysis of the number of days from calendar date to germination, tuberization and flowering, number of stems and the length of the longest stem in a clone in the green house

Source variation	Degrees of Freedom	Mean square (MS)						
		The length of the longest (cm)	Number of stems in a bud	The number of days from calendar date to				
		Full grown time	A month after germination	Full grown time	Full grown time	A month after germination	Full grown time	Full grown time
Treatment	10	137/92**	56/65**	4/15**	4/09**	26/01**	14/75**	13/37**
Error	44	4/09	2/29	0/48	0/54	0/61	0/59	0/63
Total	54	-	-	-	-	-	-	-
CV%	-	3/93	4/23	12/94	19/81	1/48	1/52	4/18

**Significant at 0.01 probability level

Table 6: Comparison of the number of days from calendar date to germination, tuberization, the number of stems and the length of the longest stem in a clone in the field and green house.

Varieties	Length of the longest stem(cm)				Number of stems in a clone				The number of days from calendar date to					
	Full grown time		A month after germination		Full grown time		A month after germination		Tuberizatio n	Tuberizati on			Tuberizatic	
	G	F	G	F	G	F	G	F	G	F	G	F	G	F
Ramoa e	44c	87/5c	/5 29c	4 b	/2 2b	4b	/2 2b	2/25 b	50c	64/5c	47c	60c	20a	25/5 a
Sante	/2 46c	/25 89c	/6 31c	3/8 b	2b	3/8 b	2b	2b	/6 50c	65./25 c	/2 48	/25 61c	/6 20a	/25 26a
Shepod y	47c	/25 90c	31c	/25 4b	/6 2b	/25 4b	/6 2b	2/25 b	/4 50c	64/7c	48c	61c	21.6 a	/25 27a
Marfon a	48c	5 91/c	30c	4/5 b	/6 2b	4/5 b	/6 2b	2/2b	/6 50c	65c	/8 47c	/25 60c	21a	/25 26a
Santan a	/8 50b	98 b	/6 34b	5/5 b	4a	5/5 b	4a	3/5a	/8 52b	67/25 b	/8 50b	/75 65b	17/8 b	/25 21a
Marado na	/2 51b	96/5b	35b	6 a	/8 4a	6a	/8 4a	3/5a	/6 52b	75/67 b	51b	65b	17/8 b	/25 23b
Milova	/6	97 b	34b	6 a	/4	6a	/4	4a	53b	67b	51/4	/75	18b	5

	50b				4a		4a				b	65b		22/b
Boren	50b	95 b	33b	6/1 a	4a	6/1 a	4a	3/75 a	/2 52b	67/25 b	/6 50b	65/5 b	17/8 b	/25 21b
Cosima	/8 57a	/75 105a	/6 39a	/25 6a	/6 4a	/25 6a	/6 4a	3/5a	/6 55a	71a	/8 52a	68a	/8 178b	/25 22b
Granola	/2 58a	25105 a	/6 38a	6/2 a	/2 4a	6/2 a	/2 4a	4a	/4 55a	69/5a	/6 52a	67/1 a	18/6 b	23/5 b
Agria	58/ 6a	/25 108a	39/ 8a	356 a	5/ 1a	/35 6a	/1 5a	4/2a	/4 55a	70a	52a	/75 67a	17b	21b

- Followed by at least one same letter are not significantly different at the 0.01 probability level according to Duncan test.
- F : Field , G : Glasshouse

The effect of varieties on the number and length of stems in a bud

After one month of germination, the varieties had significant effect on the number and length of stems in a bud in the probability level of 1 %(tables 4 and 5). In the number of stems in a bud, Agria had the maximum density of stems and santé had the lowest density. Agria had the longest and Ramoae had the shortest stem after one month of germination .The rest of varieties didn't have significant differences. The difference among varieties in the length of main stem in a bud was because of their genetic differences, the distance between nodes, and the number of nodes in stem (Wurr et al., 1993, Ifenkwe and Allen, 1978).

The analysis of yield changes among the cultivated varieties in field

Among different varieties, in case of sale performance, there was significant difference in probability level of 1 %. Tables 7 and 8 show that the maximum level of sale yield among S. tuberosum varieties belonged to Agria and the lowest level to Sante. The maximum level of tuber production belonged to Maradona and the lowest level to Sante (lommen, 1999, Abdullah and Knutson, 1994).

Table 7- Variance analysis of the potato varieties in the field

Degrees of Freedom	Source variation	Mean square (MS)			
		Extra-large tuber	Macro tuber	Mini tuber	Total yield
10	Treatment	64/63**	87/18**	8/85**	183/81**
33	Error	17/74	15/33	0/73	11/38
43	Total	-	-	-	-
-	CV%	64/51	20/18	28/47	8/82

****** Significant at 0.01 probability level.

Table 8- Average yield comparison of the potato varieties in the field

Varieties	Extra-large tuber	Macro tuber	Seed tuber	Mini tuber	Total yield
Ramoae	11/49ab	17/01cd	8/28bc	2/23b	39/02cd
Sante	1/66c	12/79d	9/05bc	2/13b	25/64de
Shepody	3/77bc	20/85bcd	6/38c	1/96b	32/98de
Marfona	5/76abc	15/41d	7/05bc	1/6b	29/82ef
Santana	11/46ab	14/26d	11/3abc	3/22b	40/19bcd
Maradona	12/61a	17/57bcd	6/62c	1/68b	38/49cd
Milova	2/68	26/75a	11/87abc	3/13b	44/45abc
Boren	3/7c	25/55ab	8/39bc	2/54b	40/14bcd
Cosima	6/02abc	18/73abcd	16/21a	5/43a	46/4ab
Granola	2/23c	19/75abcd	10/74bc	3/11b	35/84de
Agria	4/07bc	24/73ab	12/43ab	6/13a	47/37a

- Followed by at least one same letter are not significantly different at the 0.01 probability level according to Duncan test.

- **Average number and weight of tuber**

- Tables 9 and 10 show that, the maximum level of tuber numbers belonged to Boren and Cosima in field and in green house to Agria. The minimum level of tuber numbers in a bud belonged to Shepody in field and it belonged to Boren and Sante in green house. Also, the maximum average of tuber weight in field found in Maradona and in green house to Cosima. The minimum level of tuber weight in field and green house was of Sante and Ramoae varieties respectively (Ahmed Ali, et al., 1994, lommen, 1999, Abdullah. and Knutson. 1994).

Table 9: Variance analysis of the average number and weight of the tubers in a clone in the field and green house

	Degrees of Freedom		Average number of tubers		Average Weight of tubers	
Source variation (SV)	G	G	F	F	G	F
Treatment	10	73/48**	480/75**	14/23**	73/48**	480/75**
Error	44	4/91	104/15	1/09	4/91	104/15
Total	54	-	-	-	-	-
CV%	-	10/75	12/44	11/6	10/75	12/44

** Significant at 0.01 probability level.

- F : Field, G : Glasshouse

Table 10- Comparison of the number and average of tubers weight in the field and green house

Varieties	Number of tubers in a clone		Average of tubers weight(g)	
	G	F	G	F
Ramoae	1/8bc	8/35bc	14g	89/02ab
Sante	1/4c	6/95cd	24/5abc	71/6b
Shepody	3/6b	8/35bc	20def	75/77b
Marfona	2/6bc	6/10d	21/48cde	93/32ab
Santana	2/2bc	9/45ab	17/44efg	80/52b
Maradona	3/2bc	6/80cd	17/04efg	107/5a
Milova	1/4c	11/55a	17fg	72/7b
Boren	2/2bc	9/40b	21/96bcd	81/5b
Cosima	2/4bc	11/55a	26/2a	76/17b
Granola	2/2bc	9/35ab	20/8cdef	71/81b
Agria	5/4a	10/95a	25/67ab	82/25b

- Followed by at least one same letter are not significantly different at the 0.01 probability level according to Duncan test.

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