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Pre-sprouting Importance and Position in Potato Production

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ABSTRACT: Earlier harvest of potatoes (*Solanum tuberosum* L.) and achieve to the good yield can be influence by different treatments of the seed tubers such as pre-sprouting treatments. The aim of this study was assessment the pre-sprouting effects on the potato morphological properties and yield in the Erzurum region. This experiment had two cultivars of potato as Binella and Slaney and included four pre-sprouting treatments as control, 23 March, 3 April and 13 April. In this experiment was investigated some properties such as flowering time, plant height, tuber number, special weight of tuber and total tuber yield. The results showed that the forth pre-sprouting increased the tuber number but its tuber yield decreased. It indicated that the under forth pre-sprouting decreasesd the tuber size and following this case decreased the specific weight that resulted of the graphs. Also, under the second pre-sprouting increased the tuber yield. The Slaney cultivar had the significant differences for the plant height, tuber number, tuber yield and specific weight and more value for these properties in compare to the Binella cultivar. As conclusion can be noted that the pre-sprouting has an important effects on the yield and potato morphology properties.

Keywords: Potato, pre-sprouting, Slaney, Binella, cold climate.

Patates Üretiminde Ön-Sürgünlendirmenin Önemi ve Pozisyonu

ÖZ: Patateslerin (*Solanum tuberosum* L.) erken hasadı ve iyi verim elde edilmesi, ön-sürgünlendirme gibi tohum yumrularının üzerinde yapılan farklı muamelelerden etkilenmektedir. Bu çalışmanın amacı, Erzurum bölgesinde ön-sürgünlendirmenin patatesin morfolojik özellikleri ve verimi üzerine etkilerinin değerlendirilmesidir. Bu araştırmada, Binella ve Slaney olarak iki patates çeşidine, 23 Mart, 3 Nisan, 13 Nisan ve Kontrol'ü içeren dört ön-sürgünlendirme muamelesi uygulanmıştır. Çalışmada çiçeklenme süresi, bitki boyu, ocak başına yumru sayısı, yumrunun özgül ağırlık ve toplam yumru verimi gibi bazı özellikler incelenmiştir. Sonuçlar dördüncü ön-sürgünlendirme uygulamasının yumru sayısını arttırdığını, ancak yumru verimini ise azalttığını göstermiştir. Yumru boyutunun azaldığı dördüncü ön-sürgünlendirme uygulamasında, ocak başına yumru boyutunun azaldığı da grafiklerden görülmüştür. Ayrıca, ikinci ön-sürgünlendirme uygulamasında yumru verimi artmıştır. Slaney çeşidi Binella çeşidi ile karşılaştırıldığında, bitki boyu, ocak başına yumru sayısı, yumru verimi ile özgül ağırlığı bakımından önemli farklılıklar göstermiş ve daha iyi sonuç vermiştir. Sonuç olarak, ön-sürgünlendirmenin patates verimi ve morfolojik özellikleri üzerinde önemli etkilere sahip olduğu belirlenmiştir.

Anahtar Kelimeler: Patates, ön-sürgünlendirme, Slaney, Binella, soğuk iklim.

INTRODUCTION

The potato (*Solanum tuberosum* L.) tuber is an underground stem. Potato formation is as longitudinal growth stoppage and the subsequent swelling (Liu *et al.*, 2017). Potato plant has an indeterminate growth pattern. One of the important step for an adequate understanding of potato growth and development is quantifying above-and below-ground plant phenology in relation to different environmental factors and production. This evaluation has been done in afew environments, especially in relation to pre-planting thermal shock and pre-sprouting treatments (Eremeev *et al.*, 2007). Pre-sprouting can decrease yield losses that caused due to late blight, because it advances early crop development. Pre-sprouting increases apical dominance, so reducing the tubers number per plant number and decreasing competition between individual tubers for achieving confined N and water (Haase *et al.*, 2007). Although potato placed under suitable environmental conditions for growth potato tubers will not sprout at harvest stage (Delaplace *et al.*, 2008). Pre and post-harvest environment condition (Suttle, 2014) and cultivars differences can influence on the potato sprouting state (Hay and Porter, 2006; Carli *et al.*, 2010). Priming to sprout after potato harvesting is necessary for the seed potato tubers that are planted soon. So, sprouting is rapid after cold or heat shock during the early storage period (Mani and Hannachi, 2015). One of the most important methods is pre-sprouting method, in short growing season areas and for organic farming. The studies showed earlier and faster tuber formation for pre-sprouting seed tubers but these tubers had the less yield in compare to the non pre-sprouting tubers if there is no limitation of the growing season. Faster development and tuber initiation was resulted for the pre-sprouted tubers with stimulation of adventitious root formation method in compare to the conventional pre-sprouting. There was high yield for pre-sprouted treatments in compare to the control treatment (Hagman, 2012). Pre-sprouting indicated the number of stems and tubers per plant, significantly. Pre-sprouting decreased the undersized tubers percentage and increases the oversized tubers percentage. The pre-sprouted potatoes indicated higher marketable yields, significantly (Karalus anad

Rauber, 1997). The aim of this study was evaluation the pre-sprouting effects on the potato production morphological properties and yield in the region with cold climate and short growth period.

MATERIALS AND METHODS

This experiment was done during two agricultural 2015-2016 years at Erzurum, Ataturk University, Agriculture faculty fields. The soil texture was loam and the general properties of the field soil if given in the Table 1.

The experiment region geographical coordinates is 39° 55' N and 41° 61' S. Also the region height is 1853 m and its climate is cold. The weather temperature between day and night shows high difference in this region. This experiment had two cultivars of potato as Binella and Slaney and included four pre-sprouting treatments as control, 23 March, 3 April and 13 April. In this experiment was used of 24 kg nitrogen, 6 kg triple super phosphate and 5 kg potassium phosphate per decare as fertilization. The harvest time was similar for the all treatments. In this experiment was measured some properties such as flowering time, plant height, tuber number, special weight of tuber and total tuber yield. Flowering time was noted every day and by appearance the flower the day date was written. To measure the plant height was selected 20 plants from the central of each plot and measure the plant height by using of the ruler. After harvesting the total tuber number was counted and noted. Special weight of tuber was measured by air-water method (İncekara, 1973) and total tuber yield was calculated according to the Günel (1976) references method.

Table 1. Field soil chemical properties

Soil Sample	pH	EC (dS/m)	O.M (%)	$CaCO_3$ (%)	N (ppm)	P (ppm)	K (ppm)	CEC (cmol/kg)
	7.07	0.973	1.090	1.26	1904	17.73	30.34	39.4

Pre-sprouting was performed as followed stages:

The seed tubers were stored in similar conditions at 4 °C until the start of the experiment.

a) Control: Untreated seed tubers were stored at 4 °C until planting.

b) Conventional pre-sprouting: The seed tubers were transferred from storage to an ambient temperature of 15-20 °C and natural light conditions (P).

c) Pre-sprouting with stimulation of adventitious roots (PR): The seed tubers were transferred from storage to an ambient temperature of 15-20 °C and natural light conditions. When the tubers were chitted and sprouts were visible, which took about 4-5 days, the tubers were moved to adventitious root formation conditions. Adventitious root formation was stimulated by spraying the seed tubers with small amounts of water for 2 seconds every 3 minutes, in order to keep them moist. Four pre-sprouting periods were tested in Experiment.

Different pre-sprouting periods were examined. With the PR method, there was a risk of the seed tuber roots becoming entangled when the pre-sprouting period was extended, for example by delayed planting. The field experiments were performed in a randomized split split plot design four replicates (blocks). All data and parameters were analyzed by using of the SPSS ver.20 software. The mean comparison was done by Duncan method at 1% probability level.

RESULTS AND DISCUSSION

According to the variance analysis results was showed significant difference for flowering time under pre-sprouting and cultivars treatment at 5% probability level and also there was significant difference for the tuber numbers under cultivars treatment at 5% probability level. The variance analysis of specific weight property had significant difference under cultivars treatment at 1% probability level. For the other properties under the performed treatment, the difference was non-significant (Table 2).

Table 2. The variance analysis of the studied properties

		M.S				
	DF	Flowering time	Plant height	Number of tubers	Tuber yield (kg/da)	Specific weight (gr/cm^3)
Pre-sprouting	3	25.3^{*}	53.9^{ns}	6.5^{ns}	974673.4^{ns}	$8.28\times10^{-5\,ns}$
Cultivars	1	14.1^{*}	57.2^{ns}	37.9^{*}	807473.3^{ns}	0.00^{**}
Pr. × C	3	2.1^{ns}	46.7^{ns}	1.2^{ns}	634326.1^{ns}	$3.23\times10^{-5\,ns}$
Error	72	2.6^{ns}	18.6^{ns}	4.6^{ns}	230783.5^{ns}	$3.89\times10^{-5\,ns}$

ns, * and ** are non-significant, significant at 5 and 1% probability level, respectively.

According to the Figure 1, flowering time mean comparison results indicated that the fourth pre-sprouting treatment (control) had the most value of flowering time and the first pre-sprouting treatment (23 March) had the less value of the flowering time. Also, the most value of the flowering time belonged to the Binella cultivar and the less value of flowering time was under Slaney cultivar (Figure 1).

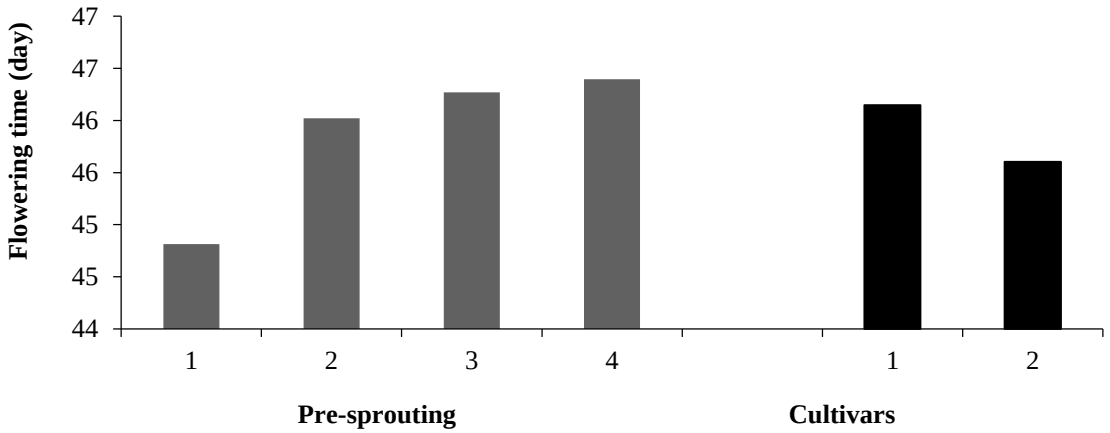

Figure 1. Flowering time mean comparison of the pre-sprouting and cultivars treatments (pre-sprouting 1, 2, 3 and 4 are 23 March, 3 April, 13 April and control respectively and cultivar 1 and 2 are Binella and Slaney, respectively).

According to the Figure 2, plant height mean comparison results indicated that the second pre-sprouting treatment (3 April) had the most value of plant height and the first pre-sprouting treatment (23 March) had the less value of the plant height. Also, the most value of the plant height belonged to the Slaney cultivar and the less value of plant height was under Binella cultivar (Figure 2).

According to the Figure 3, tuber number mean comparison results indicated that the fourth pre-sprouting treatment (control) had the most value of tuber number and the first pre-sprouting treatment (23 March) had the less value of the tuber number. Also, the most value of the tuber number belonged to the Slaney cultivar and the less value of tuber number was under Binella cultivar (Figure 3).

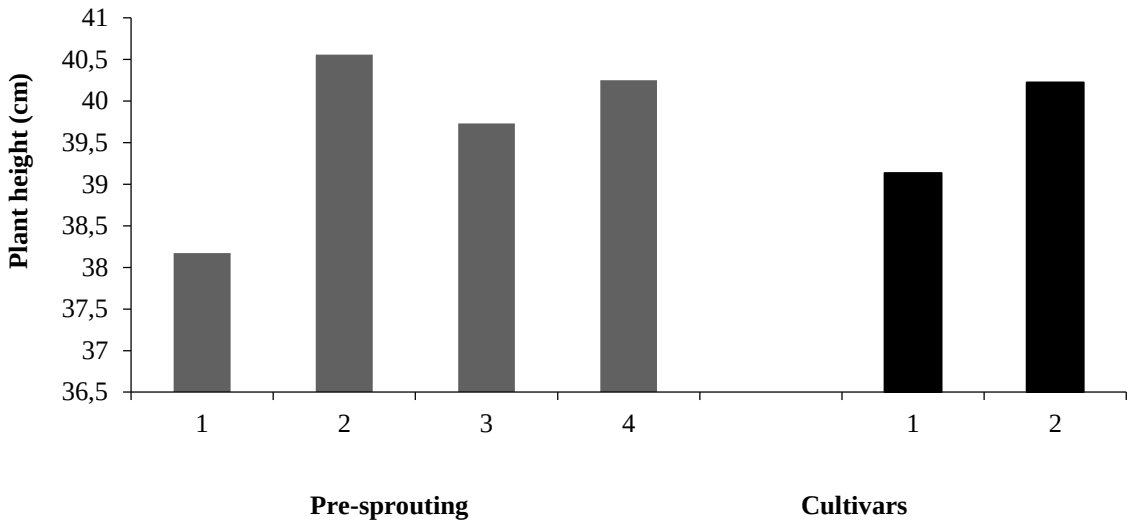

Figure 2. Plant height mean comparison of the pre-sprouting and cultivars treatments (pre-sprouting 1, 2, 3 and 4 are 23 March, 3 April, 13 April and control respectively and cultivar 1 and 2 are Binella and Slaney, respectively).

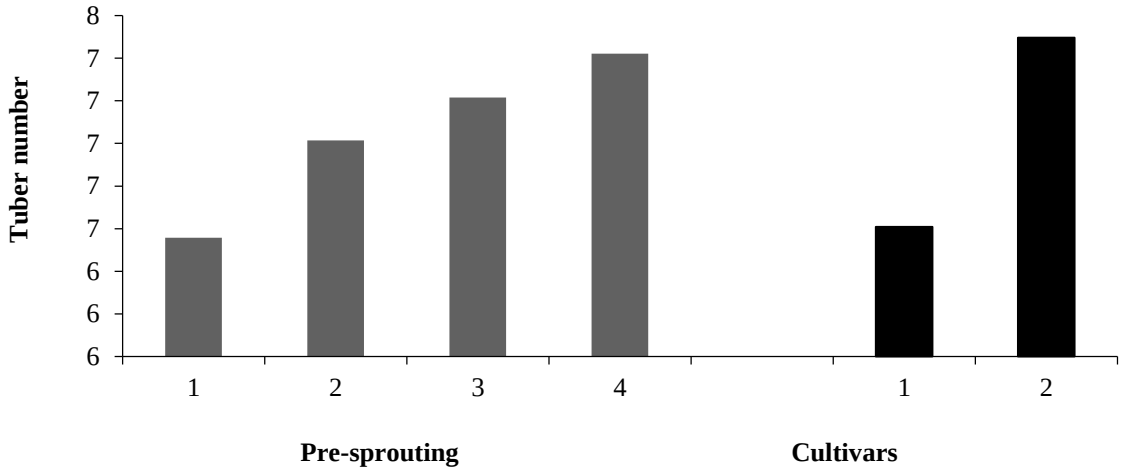

Figure 3. Tuber number mean comparison of the pre-sprouting and cultivars treatments (pre-sprouting 1, 2, 3 and 4 are 23 March, 3 April, 13 April and control respectively and cultivar 1 and 2 are Binella and Slaney, respectively).

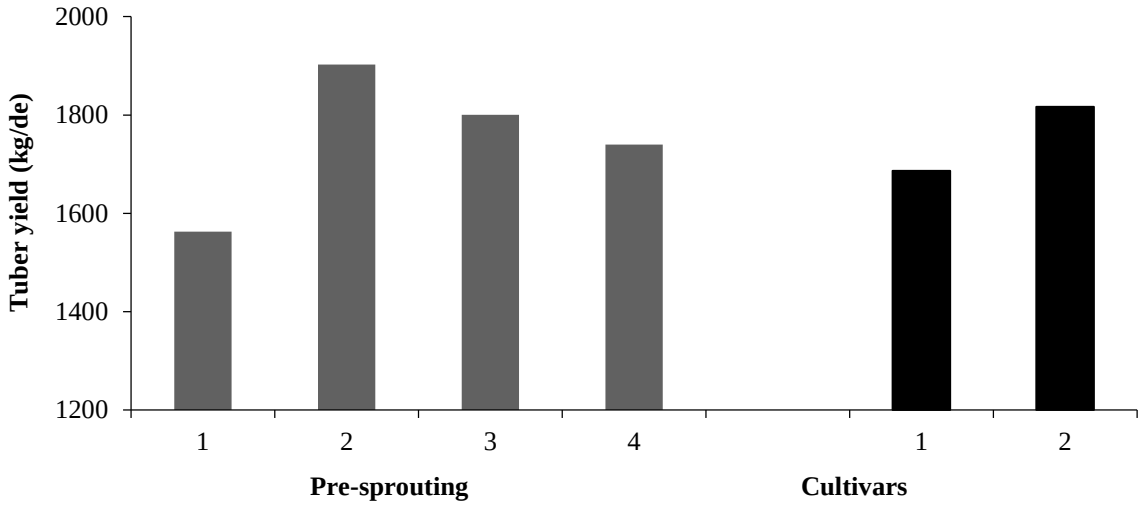

Figure 4. Tuber yield mean comparison of the pre-sprouting and cultivars treatments (pre-sprouting 1, 2, 3 and 4 are 23 March, 3 April, 13 April and control respectively and cultivar 1 and 2 are Binella and Slaney, respectively).

According to the Figure 4, tuber yield mean comparison results indicated that the second pre-sprouting treatment (3 April) had the most value of tuber yield and the first pre-sprouting treatment (23 March) had the less value of the tuber yield. Also, the most value of the tuber yield belonged to the Slaney cultivar and the less value of tuber yield was under Binella cultivar (Figure 4).

The mean comparison of the specific weight showed no significant differences for the pre-sprouting treatments but the most and the less amount of the specific weight was under the second (3 April) and the third (13 April) treatment of pre-sprouting, respectively. The Slaney cultivar showed the most amount of the specific weight and the Binella cultivar had the less amount of the specific weight (Figure 5).

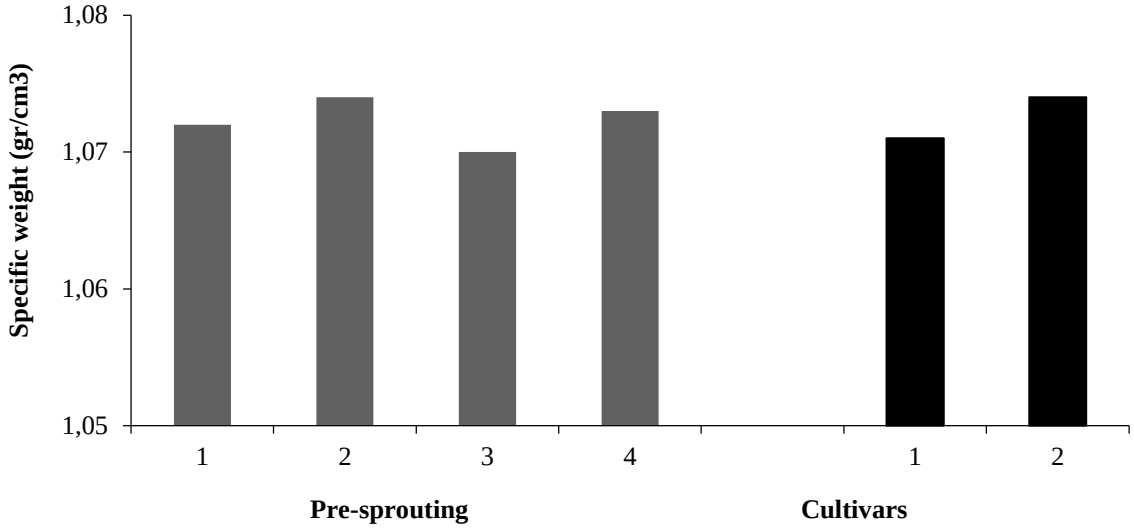

Figure 5. Specific weight mean comparison of the pre-sprouting and cultivars treatments (pre-sprouting 1, 2, 3 and 4 are 23 March, 3 April, 13 April and control respectively and cultivar 1 and 2 are Binella and Slaney, respectively).

The interaction mean comparison of the pre-sprouting and cultivars treatments showed that the most amount of flowering time, plant height, number of the tubers and tuber yield related to the P_2C_1 and P_2C_2 , P_4C_2 , P_4C_1 and P_4C_2, P_1C_2, respectively. For the specific weight property there was not significant difference between the pre-sprouting and cultivars treatment interaction. The less value of the treatments mean comparison interaction included the P_3C_1 and P_1C_1 for the flowering time, plant height and tuber number and tuber yield (Table 3).

The pre-sprouted treatments had higher yield in compare to the control for all pre-sprouting periods although the differences were not significant for every periods. The interactions between pre-sprouting treatments and cultivars can be explained by the fact that the process of physiological old age is very dependent on cultivar, as several properties are dependent on cultivar (Hagman, 2012).

Table 3. The interaction mean comparison of pre-sprouting and cultivars treatments results of the studied properties

	Flowering time (day)	Plant height (cm)	Number of tubers	Tuber yield (kg/de)	Specific weight (gr/cm^3)
P_1C_1	44.833 d	36.645 c	5.810 d	1352.129 f	1.071 a
P_1C_2	46.208 b	41.153 ab	7.010 bc	1972.888 a	1.073 a
P_2C_1	46.750 a	39.675 b	6.678 c	1739.600 d	1.068 a
P_2C_2	46.792 a	39.059 bc	6.932 c	1681.775 e	1.072 a
P_3C_1	44.792 d	39.703 b	7.304 b	1773.542 c	1.073 a
P_3C_2	45.833 c	39.966 b	7.018 bc	1831.946 b	1.074 a
P_4C_1	45.792 c	39.788 b	7.751 a	1861.642 b	1.073 a
P_4C_2	46.000 b	41.440 a	7.911 a	1798.067 c	1.074 a

The non similar letters at each column have significant difference at 5% probability level.

The tubers number increasing per plant as a result of pre-sprouting was perceived with individual cultivars. The yield determination 82 or 83 days after planting, indicated significant raising of yield of the pre-sprouted potatoes. The positive effect of pre-sprouting on yield at an early planting date, being frequently used in agricultural practice for early potatoes, shows to exist with main crop potatoes. The effect of pre-sprouting on the tuber size distribution could have been determined by the extention reduction in the tubers number per plant and by the occurrence of diseases and pests (Karalus and Rauber, 1997). Pre-sprouting period nearby to standard practice amended growth and yield significantly. pre-sprouting caused to increase tuber numbers and decreased tuber weights and by this result, changed the yields proportion in different size classes considerably. The different pre-sprouting regimes can affect on the several growth and yield factors, especially early plant development, number of stems, number of tubers per plant and mean tuber weight (Johansen and Molteberg, 2012). The main stem number per plant consistently increased by pre-sprouting during the studied years. The main stem highest number per plant was achieved at 15 February and 1 March plantings in 2001 and 15 February in 2002. The effects of pre-sprouting and planting date on plant height were inconsistent between years. Pre-sprouted seeds gave shorter plants in 2001 and taller plants in 2002. The highest plant height was achieved at 15 January planting and plant height significantly reduced by delaying of planting. In contrary to this case, plant height enhanced by delaying of planting in 2002 (Caliskan *et al.*, 2012).

CONCLUSIONS

We finally conclude that pre-sprouting has an important effect on the yield and potato morphology properties. Also, Slaney cultivar was the best cultivar for the studied properties under experimental climate and pre-sprouting treatments.

Also, for the tuber number property there was regular trend between the pre-sprouting treatments, while this trend was irregular for the other studied properties. Binella cultivar included the most amounts for the flowering time property while for the other properties Slaney cultivar had the most value. So according to the study aim for different positions can be selected Binella or Slaney cultivar as this study results. Plant height, tuber number and specific weight showed the most value under the control condition of pre-sprouting and Slaney cultivars in compare to the other interaction treatments.

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