YIELD AND YIELD COMPONENTS OF GREENHOUSE, FIELD AND SEED BED GROWN POTATO (*Solanum tuberosum* L.) PLANTLETS

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Abstract

The aim of the research was to determine field, greenhouse and seed bed performance of plantlets derived from in vitro propagated plantlets of three potato cultivars. Generally, higher values were obtained from the mid-early maturing cultivar Marabel, compare to other cultivars (early cultivar Velox and and mid-early cultivar Concorde) for tuber yield, tuber number and average tuber weight. For these yield components, in the field and seed bed plantlets were found lower values than greenhouse plantlets. The percentage of >4 g tuber weight was obtained for approximately 80 % in greenhouse and field plantlets and between 45 to 55 % in seed bed plantlets. These results indicated that greenhouse and seed bed potato plantlets can be used effectively to expand production of basic minituber seed stocks.

Keywords: *Solanum tuberosum* L., plantlet, tuber yield, minituber

Sera, Tarla ve Tohum Yatağı Koşullarında Büyütülen Patates (*Solanum tuberosum* L.) Fidelerinde Verim ve Verim Komponentlerinin Belirlenmesi

Özet

Bu araştırmanın amacı, üç patates çeşidine ait in vitro bitkilerden çoğaltılan fidelerin sera, tarla ve tohum yatağı performansını belirlemek olmuştur. Yumru verimi, yumru sayısı ve ortalama yumru ağırlığı bakımından orta erkenci Marabel çeşidinde, genel olarak diğer çeşitlere (erkenci Velox ve orta erkenci Concorde) göre daha yüksek değerler elde edilmiştir. Bu verim komponentleri bakımından tarladaki ve tohum yatağındaki fidelerde sera koşullarında büyütülen fidelere göre daha düşük değerler bulunmuştur. Sera ve tarla fidelerinde >4 g yumru yüzdesi yaklaşık % 80 ve tohum yatağında % 45 ile % 55 arasında saptanmıştır. Sonuç olarak, sera ve tohum yatağı patates fideleri temel mini yumru tohumluk stoklarının üretimi için etkili olarak kullanılabilir.

Anahtar Kelimeler: *Solanum tuberosum* L., Fide, Yumru Verimi, Mini Yumru.

1. Introduction

In many countries, healthy potato seed is produced by clonal selection, repeatedly propagating a sample tuber that often from one plant having the desired phenotype. A complate seed production programme consists of three categories: clonal selection in the first 1-4 years, basic seed in the next 1-3 years, and certified seed production in the final 1-3 years. The main disadvantages of a conventional seed potato programme are the low multiplication rate of field grown potato plants, resulting in a slow and inflexible system, and the increasing risk of catching viral, fungal or bacterial diseases with an increasing number of field multiplication. A reduction in the number of multiplication year requires a propagaule that can be produced in large numbers in protected environments in a short period (Lommen, 1995).

Many techniques have been developed during the last decades for producing potato plantlets in aseptic environments. The micropropagation of potato by in vitro culture of single node cuttings and other plant tissues are commonly used in the propagation of high genetic and disease-free seed tubers (high quality), germplasm exchange and conservation (Dodds et al., 1992; Gopal and Minocha, 1997; Naik et al., 1998). In vitro propagated potato plantlets are commonly used in potato seed production programmes for production of in vitro tubers, greenhouse production of minitubers, or field planting. The routine multiplication of in vitro plantlets, single node cuttings for example can be used to produce rooted plantlets in vitro during the rooting phase. These rooted plantlets are subsequently acclimatized ex vitro in a glasshouse to produce plantlets in the field to produce seed tubers or minitubers (Jones,

1988; Struik and Lommen 1990; 1999).

Minitubers are small seed potato tubers produced after acclimatization from plants propagated in vitro and planted at high density in the glasshouse in seed beds or in containers using different substrate mixtures. Minitubers can be produced throughout the year and are principally used for the production of pre-basic or basic seed by direct field planting (Lommen, 1999, Ritter et al., 2001). By using minitubers in a seed programme, the number of field multiplications can be reduced. This may increase the flexibility of seed prodduction, improve the health status of the ultimate commercial seed production and reduce the time for adequate volumes of seed from new cultivars to become available (Lommen and Struik, 1992; 1994). The aim of this study to compare yield and yield components of tissue culture derived some potato cultivars in greenhouse, seed bed and field conditions.

2. Materials and Methods

In vitro plantlets of *Solanum tuberosum* L. cultivars Concorde (mid early), Marabel (mid-early) and Velox (early) were multiplied routinely by subculturing single node cuttings every 3 weeks. Single node cuttings were propagated in Murashige and Skoog (1962)'s MS basal medium with 3 % sucrose and 0.7 % agar (Sigma type A) in petri dishes (25x100mm). Cultures were placed in tissue culture growth room at 16 hour photoperiod and 25±1 ^{o}C temperature regime for 3 weeks. Three week-old plantlets (4-6 cm long) were transplanted in a controlled growth room into a sterile mixture of peat moss and perlite (2:1 by volume) in pots. The plantlets were irrigated lightly with tap water until they were rooted one week and then they were transplanted to polyethylene bags (sizes 10 x 10 x 15 cm) in greenhouse and grown for 10 days.

The greenhouse plantlets were grown in polyethylene bags (sizes 20 x 30 x 45 cm) in a mixture of peat moss and soil (1:1 by volume). The plantlets were developed in polyethylene bags until they were harvested. The experiment were carried out during two spring (March–June 2001 and April–July 2002) and two autumn (October 2001–January 2002 and November 2002–February 2003) season in greenhouse conditions. Seed bed plantlets were grown in pots one week and they were transfered from pots to seed bed. The plantlets (planted at 150 plantlets m^{-2}) were carried out during one autumn (October 2001–January 2002) and one spring (April–July 2002) season in seed beds (in greenhouse) in a mixture of peat moss and soil (1:1 by volume). Seed bed transplant experiments were laid out in a completely randomised block desing with three replications. The field plantlets were planted within the rows 30 cm and between the rows 70 cm wide. Fertilizer was broadcasted at 6 kg N da^{-1}, 4 kg P_2O_5 da^{-1} and 8 kg K_2O da^{-1}. Disease control and irrigation were carried out according to practice. The experiment were carried out during two spring season (March–June 2001 and April–July 2002) in the experimental field at Akdeniz University Faculty of Agriculture.

Greenhouse and field grown potato plantlets were laid out in a completely randomised block design with three replications. 10 plantlets from each cultivar were transplanted in polyethylene bags in each replication in greenhouse experiment and 10 plantlets from each cultivar were planted in two rows in each replication in field experiment. Tuber yield (g fresh per plant, as a minituber yield), tuber number (per plant, as a minituber number), average tuber weight (g fresh per tuber, as a average minituber weight) and percentage of tubers sizes were measured on greenhouse, seed bed and field plantlets . All data combined over years and seasons were subjected to analysis of variance (Freed et al., 1989) and average values were evaluated as a figure using Microsoft Excel Office Programme.

3. Results and Discussion

The analyses of variance for the tuber yield, tuber number and average tuber weights are shown in Table 1. There were statistically significant differences amongst the cultivars with respect to tuber yield, tuber number and average tuber weight for

greenhouse, field and seed bed plantlets. In general, the mean values for tuber characters in greenhouse grown plantlets were higher than those obtained from field and seed bed plantlets (Figure 1). The highest values were obtained from the mid-early maturing cultivar of Marabel in tuber characters in greenhouse, field and seed plantlets (except average tuber weight in seed bed tranplants). This is agreement with results of Lommen (1999) who reported that in transplanted crops, tuber yield from early cultivars could be extremely low when compared to late cultivars, due to a low radiation intercept by the crop's canopy.

While field and seed bed plantlets produced approximately 2 to 5 tubers per plant, greenhouse plantlets produced more tuber (3 to 8) than field and seed bed plantlets (Figure 1). Average tuber weight and tuber number were determined as different depending on the production technique (Lommen and Struik, 1992; 1995). Kaur et al., (2000) found that the tuber numbers of various potato cultivars were between 6.2 to 7.9 in plantlets grown in polyethylene bags. Lommen and Struik (1992) were reported that tuber yield was 16.9 g to 23.0 g and tuber number 8.0 to 8.8 in two potato cultivars in glasshouse (200 transplant m^{-2}). At the same plant density, tuber number was changed 1.85 to 2.52 and average tuber weight 9.8 to 10.9 in glasshouse conditions (Grigoriadau and Leventakis, 1999). Vosatka and Gryndler (2000) were reported that tuber yield was 22.95-31.23 g, tuber number 6.39-9.7 and average tuber weight 3.36-3.63 g in potato plantlets grown glasshouse conditions. Pruski et al., (2003) were reported that tuber yield was 53.35-169.35 g and tuber number 2.22-3.95 in three potato cultivars in seed bed (9x9 cm spacing). These results are consistent with our findings.

The analyses of variance for the percentage tubers <4 g, 4-8 g and > 8g are shown in Table 1. There were statistically significant differences among the cultivars with respect to these characters except for <4 g tuber percentage in field plantlets. Generally, for <4 g tuber percentage higher values were obtained for early cultivar of Velox, which had the lowest percentage of tubers >8 g in all potato plantlets. Mid-early maturing cultivar Marabel showed the highest values for the percentage of of tubers >8 g (Figure 1). The percentage of >4 g tuber weight was obtained for approximately 80 % in greenhouse and field plantlets. Because of higher plant densities in seed bed plantlets (150 transplant m^{-2}), the percentage of <4 g tuber weight was higher than greenhouse and field plantlets. These minitubers (>4 g) seem suitable for large scale use in a seed production programme. Micropropagated plants produced minitubers in greenhouse and field conditions between 9-15 mm and 5-25 mm diameter, respectively (Ahloowia, 1994).

The performance of potato plantlets varied between years, planting seasons, growing conditions, plant densities and potato cultivars. The overall results clearly indicated that especially greenhouse and

Table 1. Summary of Variance Analysis for Yield Components Examined in Greenhouse, Field and Seed Bed Plantlets of Three Potato Cultivars.

	Mean squares					
	TY (g)	TN	ATW (g)	<4 g TP (%)	4-8 g TP (%)	>8 g TP (%)
G^+ Season	26547.76**	30.32**	299.30**	602.75**	2620.84**	4996.23**
Cultivar	11800.78**	67.15**	14.60**	301.33*	641.27**	1600.98**
Interaction	4710.36**	11.66**	9.76ns	150.24ns	506.39**	888.32**
F^+ Season	127.30 ns	0.92 ns	28.88 ns	765.97 ns	44.33 ns	445.31 ns
Cultivar	721.28**	6.79**	11.652*	274.52ns	395.10*	1303.33*
Interaction	51.90 ns	0.05 ns	1.11 ns	109.39 ns	153.62 ns	118.40 ns
SB^+ Season	151.59*	4.68*	2.55*	364.42*	8.43ns	485.98*
Cultivar	47.62**	4.51**	0.87**	419.12**	151.81*	141.55**
Interaction	26.26**	0.70**	0.69**	358.31*	204.93*	376.79**

*, ** Indicates significance at P<0.05 and P<0.01, respectively. ns: non significant,
G^+:greenhouse, F^+: field, SB^+: seed bed, TY: tuber yield, TN: tuber number, ATW: average tuber weight, <4g TP: percentage of tubers <4 g, 4-8 g TP: percentage of tubers 4-8 g, >8 g TP: percentage of tubers >8 g.

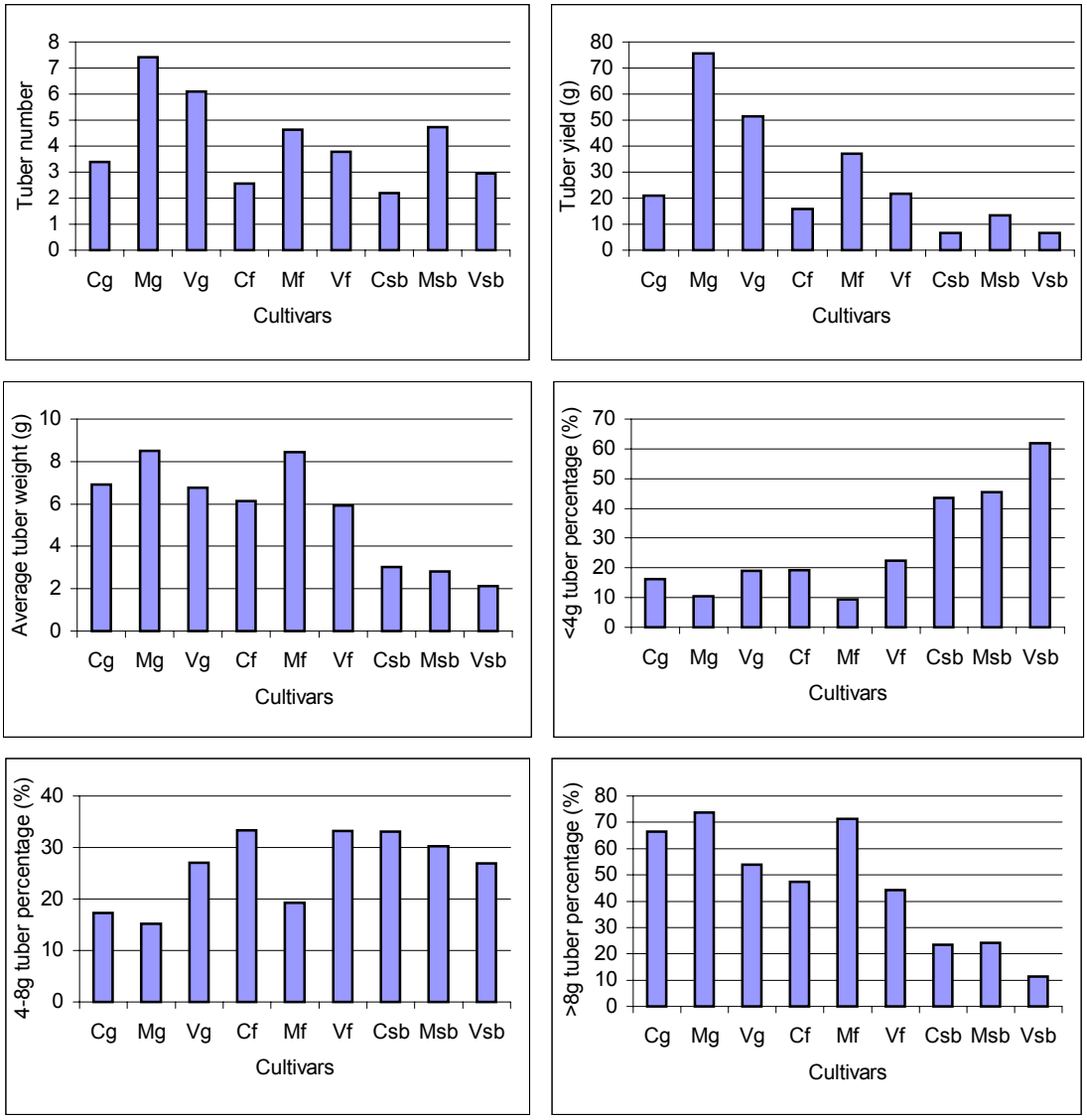

Figure 1. Tuber Yield, Tuber Number, Average Tuber Weight and The Percentage of Tuber Sizes (<4 g, 4-8 g and >8 g) of Greenhouse, Field and Seed Bed Potato Plantlets (g: greenhouse, f: field, sb: seed bed, C: Concorde, M: Marabel, V: Velox).

seed bed produced plantlets derived from micropropagated plantlets can be used effectively to increase good quality minituber production of potato and minitubers seem suitable for large scale use in a seed production programme. Application of minitubers in seed production programmes, however, will only be successful if tuber yield progeny tubers that are economically and/or in quality superior to tubers by existing technologies.

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