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Full Length Research Paper

Effect of pot size, planting date and genotype on mini-tuber production of Marfona potato cultivar

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This study was carried out to evaluate the effects of pot size, planting date and type of genotype on mini-tuber production of Marfona potato cultivar (*Solanum tuberosum* L.) in greenhouse conditions. Four genotypes (M-129, M-128P, M-127P and M-124P) originated from virus free sprouts and a genotype of the same cultivar (Marfona) originated from apical meristem, in 3 sizes of pot and 3 planting date were investigated. The results showed that using larger pots of 3-liter has no advantage and pots smaller than 2-liter is not suitable for mini-tuber production. Also, time of Nov 18 was the best of date for planting of potato in studied conditions and delay in date of planting reduced the mini-tuber production. The reduction in number of mini-tubers and growing period was greater for the genotype M-129 compared with the other potato genotypes. Furthermore, higher numbers of mini-tubers were produced by the M-127P and M-124P genotypes and M-127P had the highest total weight of mini-tubers. However the number of mini-tubers per plant was higher for genotypes originated from meristem culture than genotypes obtained from sprouts. It seems that genotypes originated from potato sprouts are not as efficient as the apical meristem ones. On the other hand, later genotype showed more homogenous in growth rate and phenotype.

Key words: *Solanum tuberosum,* pot size, planting date, mini-tuber.

INTRODUCTION

Producing mini-tubers from *in vitro* plantlets allows a faster multiplication rate in seed tuber production programs and reduces the number of field generations needed (Imma and Mingo-Castel, 2006). Mini-tubers can be obtained from high-density plantings in greenhouse beds after acclimatization in containers using different substrate mixtures (Imma and Mingo-Castel, 2006). Mini-tubers production is a speculative activity, which needs an important technical command, since mini-tubers have to be produced in a vegetative way (Ali et al., 1995). The mini-tubers must have a minimum of phytopathogenic infections and must be true-to-type. The difficulty lies in the fact that tubers naturally tend to accumulate and transmit viral, bacteriological and fungal diseases to the next generation, which weakens the plant production potential progressively. Degeneration of the seed tubers is reduced or prevented by regularly injecting new, disease-free plant material in the seed production system (Rolot and Seutin, 1999). The production of *in vitro* tubers or small grade tubers (5 - 10 mm diameter) produced in the laboratory under aseptic conditions is not difficult. The production of mini-tubers obtained by the culture of *in vitro* plantlets is the classical way to make a transfer from the *in vitro* to the *in vivo*. However, mini-tuber production has some disadvantages, associated with the high production costs and the larger sanitary risk (Rolot and Seutin, 1999). Their production needs an investment in green houses perfectly isolated to prevent the introduction of aphids carrying viruses. Moreover, depending on the variety and the plant density during subculturing, the number of mini-tubers produced by an *in vitro* plantlet or *in vitro* tuber is generally small. This places a serious constraint to the production costs; in addition the labour costs for mini-tuber production are high. This was meant not only to protect tubers from telluric infections but also to reduce the production costs by increasing the number of mini-tubers produced per unit area.

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The seed potato industry is based on production of early generations of disease-free potatoes (mini-tubers) under greenhouse conditions. Efforts to improve the cost efficiency of this greenhouse production hinge on increasing the number of usable tubers produced by each plant per unit of time (Bandara et al., 1998). Nowak et al. (1996) reported that the depth of the growing medium correlated positively with shoot dry weight, stolon weight, tuber number, and tuber weight in Shepody and Kennebec potato cultivars. Also, Bandara and Tanino (1995) indicated that Marfona potato cultivar grown in large pots (15 cm in diameter and 15 cm deep, equivalent 3 liter) produced larger mini-tuber and a higher number of tubers/plant than those produced in small pots (12.5 cm in diameter and 12 cm deep, equivalent 1.5 liter). Bandara et al. (1998) hypothesized that larger pots (>15 cm deep) may facilitate both above and below ground biomass production in potatoes, resulting in larger plants that in turn enhance plant growth regulation effects on tuberization. These effects may manifest themselves through improved uptake of foliar applied compounds and consequently produce a higher usable tuber number/ plant than those produced in smaller pots.

Several reports have indicated that planting date effects on the mini-tuber production (Bandara et al., 1998; Darabi, 2002; Iwama et al., 2005). The aim of this research work was to evaluate the effect of pot size, planting date and genotypes on mini-tuber production of Marfona potato cultivar.

MATERIAL AND METHODS

The experiment was conducted during 2006 - 2007 under greenhouse conditions. Virus free clones of potato cultivar Marfona originated from apical meristem and potato tuber sprouts were used in this experiment. There were different genotypes (M-129, M-128P, M-127P and M-124P) originated from sprouts which were provided the Agriculture Biotechnology Research Institute of Iran (ABRII) and one genotype of the same cultivar regenerated from callus tissue of apical meristem culture.

The selected genotypes were propagated through nodal cutting in aseptic conditions and kept in growth chamber at 24°C ±3, light intensity 55.6 µmol m^{-2} s^{-1} with a period of 16 h light and 8 h dark. The 4 weeks-old plantlets obtained from each single nodal cutting of the clones were planted in clay pots (one seedling per pot) with different sizes (1.5, 2.0, 3.8 liter) filled with Methylbromide fumigated sterilized soil (two parts sandy loam, one part decayed compost) at the three planting dates on Nov 18 (83.3 µmol m^{-2} s^{-1} with period 13 h Dark : 11 h Light), Dec 16 (64.8 µmol m^{-2} s^{-1} with period 15 h Dark : 9 h Light) and Feb 26 (46.3 µmol m^{-2} s^{-1} with period 13 h Dark : 11 h Light).

The laminate plastic glasses placed up side down on the pleated seedling to perform hardening for two weeks. The plantlets were grown under greenhouse condition at 23 ± 2°C/16 ± 2°C (day/night temperatures) under sunlight.

The plants were irrigated as required to maintain adequate moisture levels. The pots were fertilized monthly with a 250-ppm solution of 20:20:20 (N:P:K) commencing the 2nd week of planting. Total number and total weight of mini-tubers per pot were determined at 120 days after planting.

Analysis of variance (ANOVA) was performed separately for genotypes and pot size and planting date in a randomized complete block design. The means were compared using a Duncan test, whenever the *F*-tests for treatments were significant at $p < 0.05$.

RESULTS AND DISCUSSION

The effect of pot size on the mini-tuber production

The results showed that the effect of pot size on the number and total weight of mini-tuber per pot was significant at the 1 percent level (data not shown). Mean comparison among the number of mini-tuber indicated that size of large pot (3.8 liter) had significantly higher number of mini-tubers and total weight per pot than medium (2.0 liter) and small (1.5 liter) pots sizes (Figure 1). Bandara et al. (1998) reported that the plant growing and number of mini-tuber in large pots (3.0 liter) produced longer haulms than those growing and number of mini-tuber in small pot (1.5 liter). Therefore, our results showed trends similar to those of Bandara et al. (1998). Although large pot (3.8 liter) has about twice volume of medium (2.0 liter) pot, number and total weight of mini-tuber in 3.8 pots was not twice of 2 liter medium pot. So, it seems that using large pots over 3.8-liter had no more advantage for both type of the genotypes in mini-tuber production and using small pots lower than 2-liter was not suitable for mini-tuber production in greenhouse condition as well.

The effect of planting date on the mini-tuber production

The results showed that the effect of planting date on number of mini-tuber and total weight per pot was in potato cv Marfona significant at the 1 percent level (data not shown). Mean comparison among number of mini-tuber indicated that planting date in November of 2006 significantly produced higher number of mini-tubers and total weight per pot than planting date in December 2006 and February of 2007 (Figure 2). Opoku-Ameyaw and Harris (2001) reported that under field conditions the last planting time often resulted in a reduction in number of tubers. Also, Opoku-Ameyaw and Harris (2001) indicated that total mini-tuber yield of potato cv Cara was significantly greater from the first planting date than those from subsequent planting dates. Opoku-Ameyaw and Harris (2001) indicated that the total amounts of radiation during growing season on the plants growth and tuber yield were affected.

However, it seems that early planting could increase tuber yield if amount of radiation for growth to be sufficient and clearly the trends are too imprecise to forecast planting dates with confidence, but earlier planting dates are likely to be justified as time progresses. It is however, unlikely that radiation receipts will change-indeed, if the forecasts are for weather winters, it is possible that radiation receipts may be reduced if cloudiness increases in the period September to February. On the other hand,

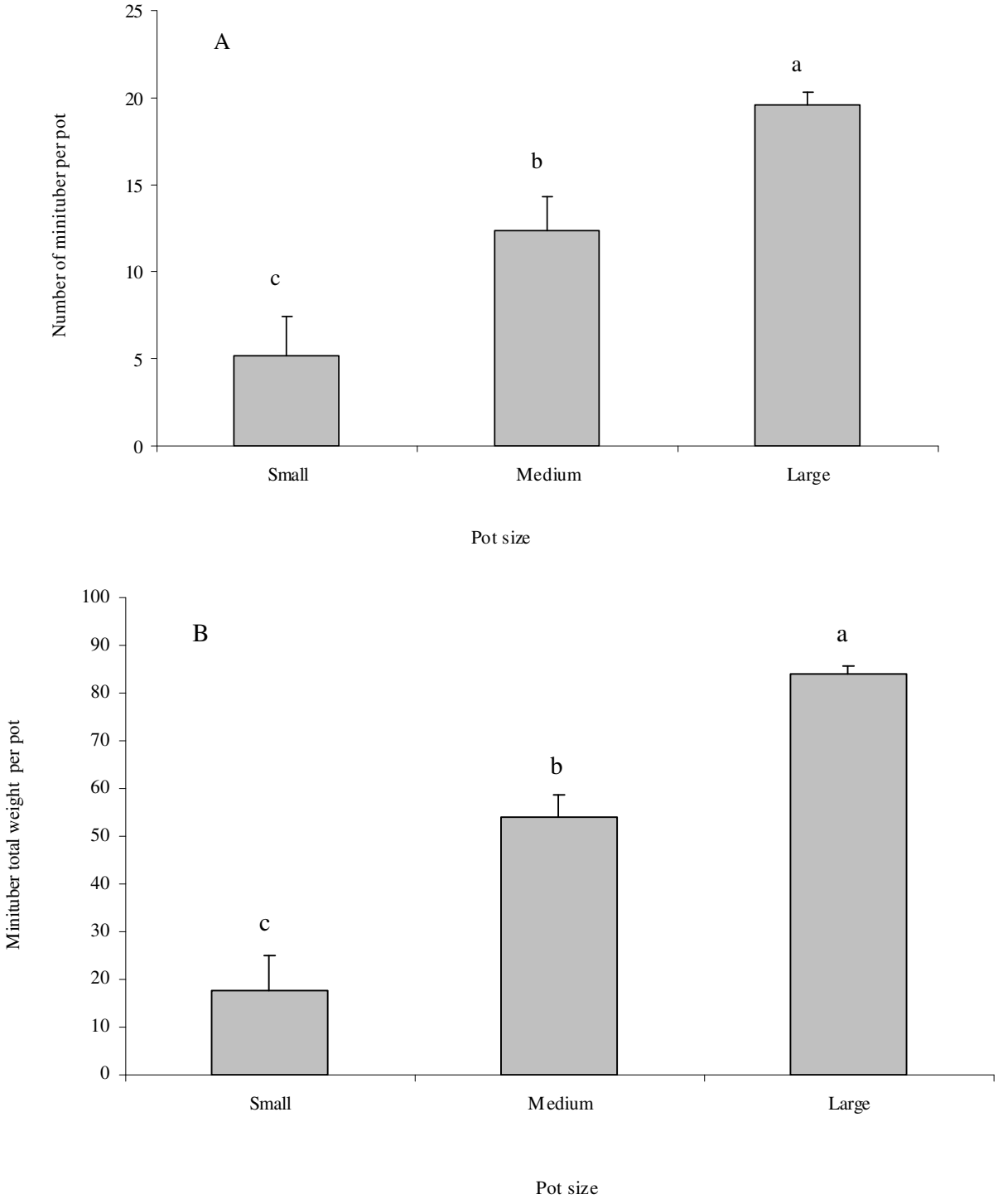

Figure 1. Effect of pot size on the number of mini-tubers (A) and total weight of mini-tubers (B) in potato cv Marfona.

Hammes and Nel (1975) suggested that tuberization in potatoes is controlled by a balance between endogenous gibberellic acids and a tuber-forming stimulus. Among the plant growth regulators that have been used to study the potato tuberization phenomenon, GA_3 has been reported to have a consistent delaying or inhibiting effect on potato tuberization (Jackson and Prat, 1996). Furthermore, Tiz and Ziger (2002) reported that the high periodic light radiation decreased amount of endogenous giberlic acids. Therefore, it is possible that the total amount of radiation sunlight at the planting date of Nov 18 can reduce amount of endogenous gibberellic acids and so,

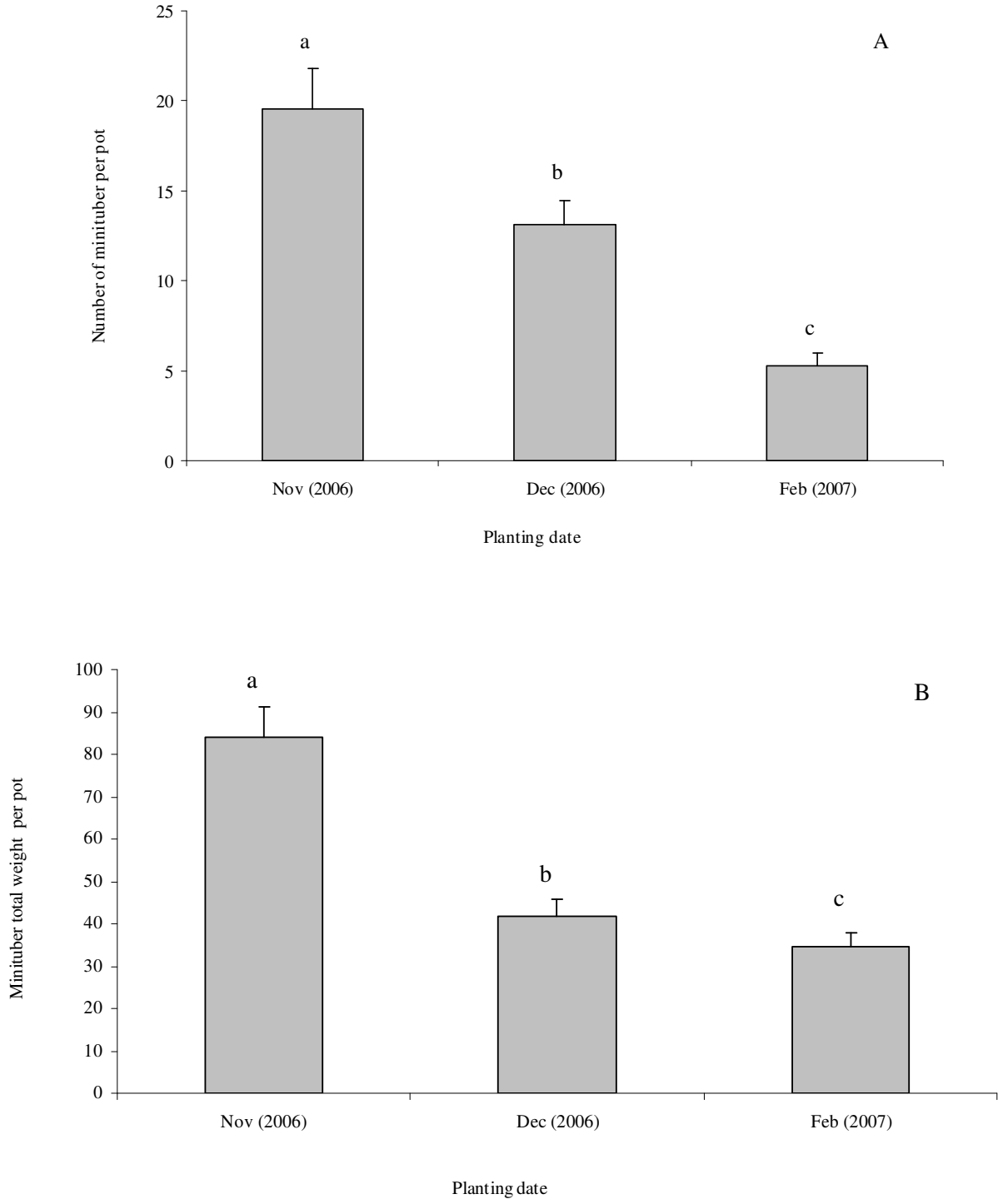

Figure 2. Effect of planting date on the number of mini-tubers (A) and total weight of mini-tubers (B) in potato cv Marfona.

number of mini-tuber was increased. Because, period and intensity of light in day at the planting date of Nov 18 was more than other planting dates.

The effect of genotypes on the mini-tuber production

The results showed that the effect of genotypes obtained

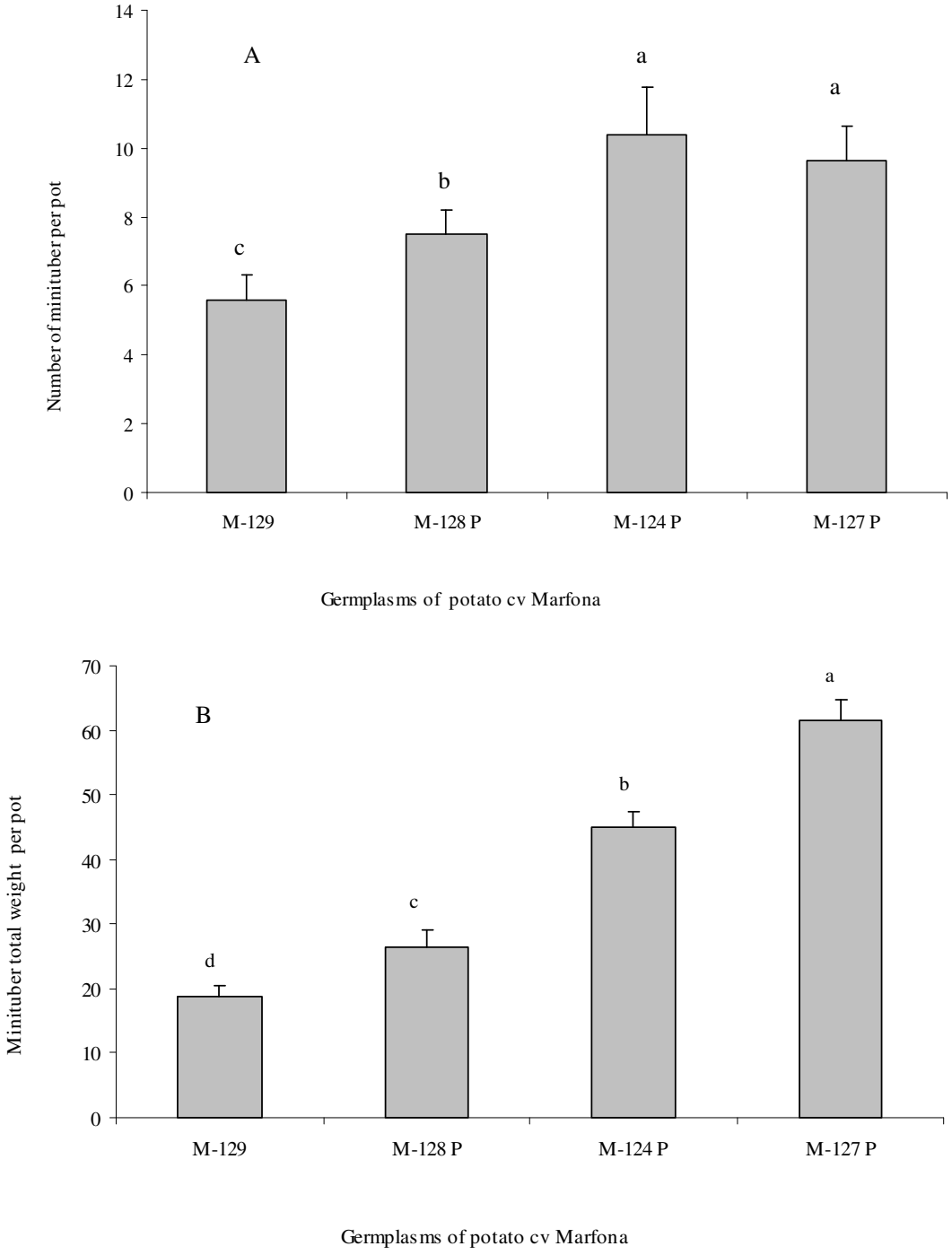

Figure 3. Effect of genotype on the number of mini-tubers (A) and total weight of mini-tubers (B) in potato cv Marfona.

from different origins on the number and total weight of mini-tubers per pot was significant at the 1 percent level (data not shown). Mean comparison among the number of mini-tuber indicated that genotype of M-124 P and M-129 had the highest and lowest number of mini-tubers per pot, respectively (Figure 3). However, number of mini-tuber per pot for apical meristem originated genotypes was higher than sprouts ones (data not shown). Mean comparison among of total weight per pot in potato cv Marfona indicates that genotype of M-127 P and M-129 had the highest and the lowest total weight per pot, respectively (Figure 3). It could be concluded that vigo-

rousness of different clones obtained from different callus tissue might have different potential in mini-tuberization.

Conclusion

On the base of the results obtained, it seems that the size of pot could affect the mini-tuber production and using clay pot about 2-3-liter could be suitable for maximum mini-tuber production. Also, planting date could significantly affect the mini-tuber production. The highest number and total weight of mini-tubers was obtained during a period of 4-month after planting date (Nov 18) with the average of 19.58 tubers and a mean tuber weight of 83.92 g. The genotype M-127P produced the highest number of mini-tubers per plant however was not as many as the meristem culture originated clones. Therefore it seems that the type of genotype can affect the mini-tuber production.

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