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INFLUENCE OF SUCROSE CONCENTRATION ON LONG-TERM SWEET POTATO CULTURES

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ABSTRACT: Virus-free sweet potato plants are being maintained in culture to supply clean plantlets to local growers. However, between requests for plant material a system was needed to control growth and increase the intervals between transfers. Long-term in vitro maintenance, on MS medium containing 0 to 12% sucrose, was used to evaluate shoot growth over time on four sweet potato cultivars. Sucrose levels above 6% were expected to impose an osmotic stress to suppress growth. However, sucrose levels from 2 to 12% had no influence on controlling in vitro growth and development over time. Having no sucrose in the medium resulted in minimal growth but was lethal to 50% or more of the cultures. The rate of root growth and leaf development was significantly reduced on sucrose levels from 0.1 to 0.3%. These low sucrose levels controlled the rate of growth and extended the interval between transfers from monthly, on 3% sucrose, to 8 to 12 months on 0.1 to 0.3% sucrose. Shoots actively grew when transferred back to a 3% sucrose medium. Low sucrose concentrations can be used to control growth of sweet potato and extend the intervals between transfers in vitro.

Keywords: in vitro, tissue culture, carbohydrate

INTRODUCTION

Tissue culture is now being used to maintain germplasm collections of disease-free sweet potatoes. However, one of the problems in tissue culture of sweet potato is that they require frequent maintenance, because of rapid growth. The frequent need for fresh medium takes time, supplies, and can be an increased cost to the lab. Research on cassava in vitro indicated that sucrose concentrations between 6 and 10% were able to reduce growth and development (Zimmerman et al., 2007) and extend the time between transfers. The objective of this study was to determine the influence of sucrose concentration in vitro on long-term sweet potato cultures in delaying the time between maintenance transfers.

MATERIALS AND METHODS

Virus-free sweet potato plants, obtained from the USDA Germplasm Repository, were grown and maintained in vitro. The four sweet potato cultivars used were 'Francia', 'Mojave', 'Papino' and 'Viola'. Single nodal cuttings from these plants were transferred to fresh Murashige & Skoog media (MS) (1962) containing 0, 3, 6, 9 and 12% sucrose with 0.8% agar. Shoots were grown in a 28° C growth room with a 16-hour photoperiod. Data on root and leaf development were collected twice weekly for 45 days. A second trial involved sucrose levels from 0, 0.1, 0.3 and 1% in MS medium gelled with agar after the higher sucrose levels did not retard the rate of sweet potato growth in vitro. Data was again collected twice weekly for 45 days and included number of leaves and roots for the lower sucrose trial. Data was analyzed with ANOVA and averages were plotted over time.

RESULTS AND DISCUSSION

We were trying to suppress sweet potato growth by increasing sucrose content as was possible with the work done on cassava (Zimmerman et al., 2007). However, increasing the sucrose content, which raises the osmotic potential of the medium, did not suppress growth in these sweet potato varieties. Leaf development over time was similar for all four varieties containing sucrose from 3 to 12% (Figure 1). Growing shoots without sucrose was lethal for 15 to 50% of the shoots. Those that survived without sucrose did have reduced shoot growth and root development. The high rate of shoot death with no sucrose makes it impractical to be used to suppress growth for long term in vitro maintenance. Root initiation and development at all sucrose levels was similar and the average after 45 days ranged from 5.2 to 5.9%. There was no significant difference between varieties or the media containing sucrose (Figure 2). It was concluded that sweet potatoes are not influenced by the osmotic potential of the medium with sucrose levels between 3% and 12% over 45 days of growth in vitro. Because the elevated sucrose levels did not suppress growth, a follow-up trial was conducted with lower sucrose levels.

In the second trial, the lower levels of sucrose were able to suppress shoot and leaf development. After 45 days in vitro, the size of the plant reflected the sucrose concentration it was grown in, with increasing sucrose levels resulting in more growth and development but at a slower rate than previously observed with high sucrose (Figure 3). At the lowest sucrose level of 0.1%, all explants survived. The rate of leaf development at 1% sucrose was similar to that obtained at the 3 to 12% levels (Figures 1 and 4). However, the rate of leaf development was reduced at sucrose levels below 1% (Figure 4), thus indicating a suppression in growth as was desired.

Root growth and development was reduced at all the low sucrose concentrations with averages between 1.6 and 3.2 for 0% and 1%, respectively (Figure 5). The low sucrose levels were able to suppress root initiation and root growth. The average rooting for the 0.1 to 1% range of sucrose concentration was between the 0% to 3% rate previously observed in the high sucrose study (Figure 5).

CONCLUSION

Sucrose levels between 3% to 12% had no influence in suppressing growth due to increased osmotic potential, and plants grew similarly at these levels for the four sweet potato varieties whereas 0% sucrose was lethal to 15 to 50% of the explants. However, using a sucrose concentration in the media at 0.1% to 0.3% significantly reduced the rate of leaf and root growth yet sustained the plants. For long-term sweet potato in vitro maintenance, a sucrose level between 0.1% and 0.3% is recommended.

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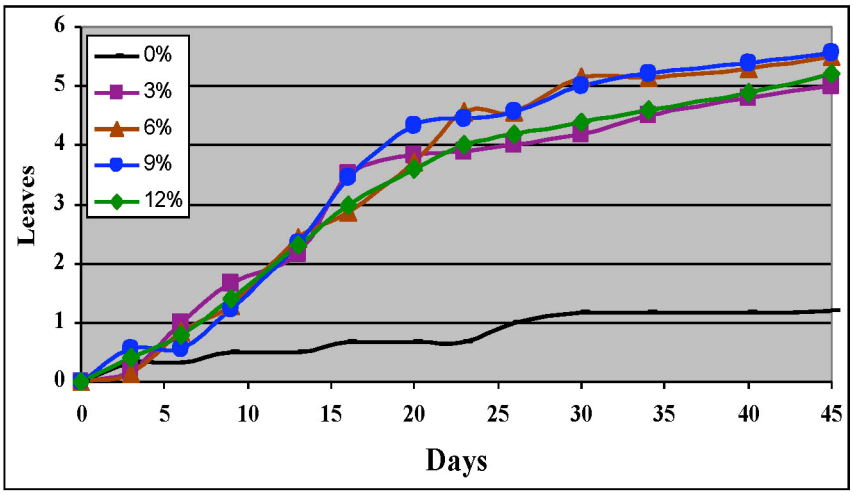

Figure 1. Average leaf development of four sweet potato varieties grown in vitro on 0 to 12% sucrose over 45 days.

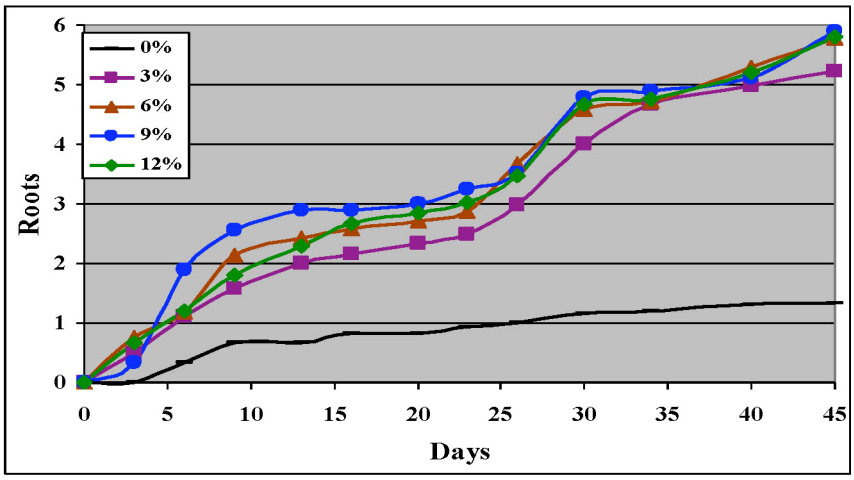

Figure 2. Average root development of four sweet potato varieties grown in vitro on 0 to 12% sucrose over 45 days.

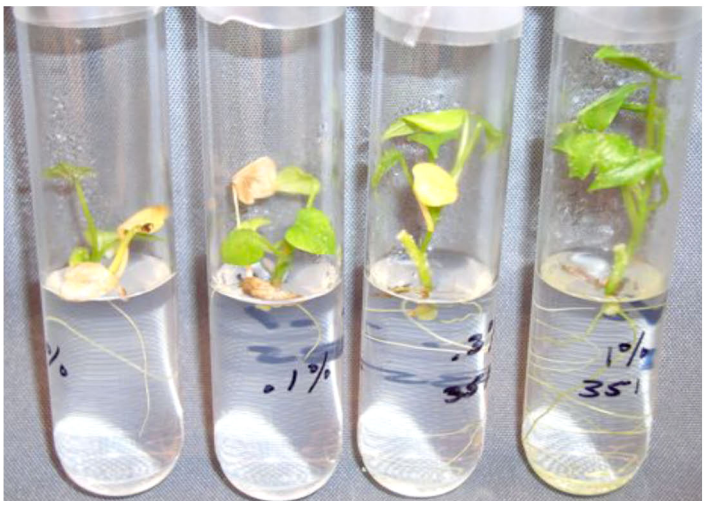

Figure 3. Growth of 'Mojave' sweet potato grown on 0% (left) to 1% (right) sucrose after 45 days in vitro.

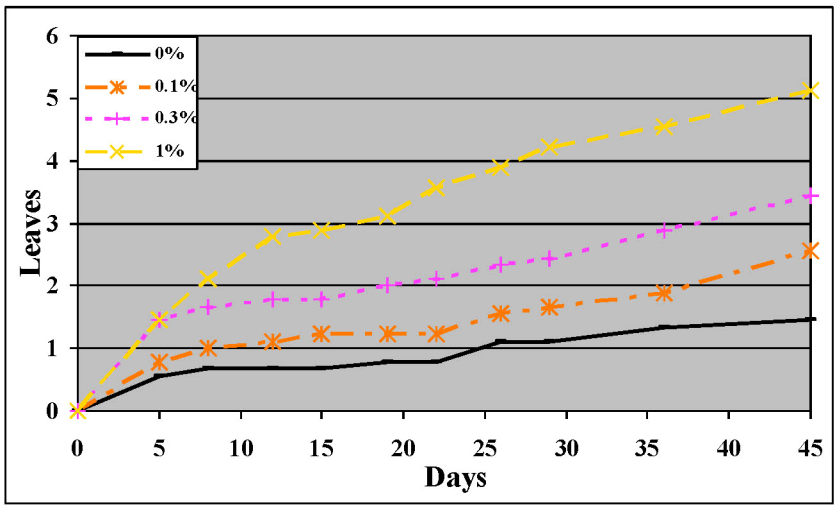

Figure 4. Average leaf development of four sweet potato varieties grown in vitro on 0 to 1% sucrose over 45 days.

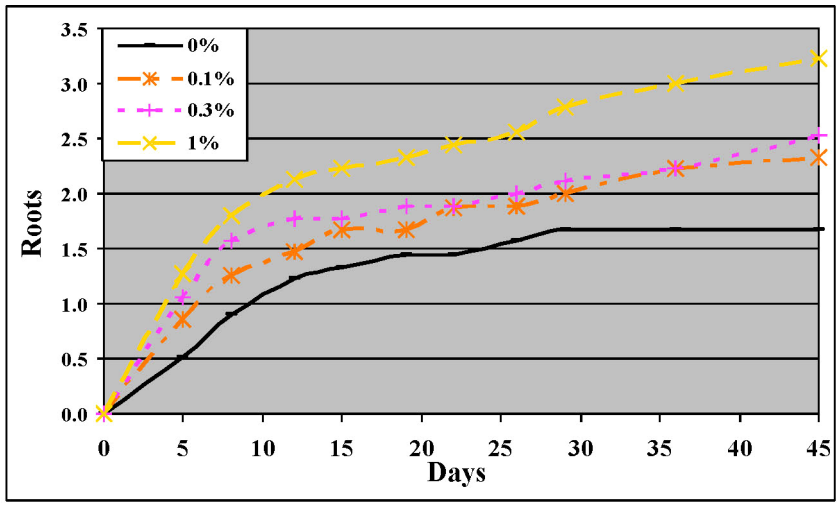

Figure 5. Average root development of four sweet potato varieties grown in vitro on 0 to 1% sucrose over 45 days.