Effect of Leaves on Microtubers Produced from Potato Single-Node Cuttings In Vitro

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ABSTRACT

Microtubers are used to propagate, to store, and to transport potato clones. Culturing single-node explants from potato plantlets in vitro without subtending leaves was reported to result in plantlets with lower vigor and a higher coefficient of variation. The effect on microtuber production in vitro of leaf area and the presence or absence of leaves on potato single-node cuttings was investigated as an extension of the above study. Stock plantlets of potato cvs Atlantic, Kennebec, Russet Burbank, and Shepody were cultured under a 16-h photoperiod. Single-node cuttings were excised and grown in a high-sucrose tuberization medium in darkness. Leaf area did not affect the frequency, size, or weight of microtubers of cvs Katahdin and Russet Burbank. The absence of leaves reduced microtuber diameter for Russet Burbank; whereas Atlantic, Kennebec, and Shepody were unaffected. Mean fresh weight of microtubers was reduced when leaves were removed for all cvs except Atlantic. No effect of the removal of the leaf was observed for mean dry weights of microtubers from all cvs, although microtubers from single-node cuttings without leaves accumulated significantly more percent dry matter than those with leaves. Rapid multiplication facilities may therefore wish to consider conserving resources such as media, vessels, and growth room space by culturing explants without leaves for the production of microtubers.

INTRODUCTION

Productivity of potato rapid multiplication cultures is strongly influenced by the leaf subtending the single-node cuttings used as explants (Seabrook and Douglass 1994). Remov-
ing the leaves from the explants can permit the inoculation of cultures at increased densities thus saving both labor and resource costs. However, potato plantlet cultures are severely affected by the removal of the leaf, and produce cultures with shorter plantlets, smaller leaf area, lower fresh weights, and increased coefficients of variation (Seabrook and Douglass 1994).

Microtubers are an efficient way to propagate and to store valuable potato nuclear stock (Donnelly et al. 2003; Estrada et al. 1986; Tovar et al. 1985). When germplasm is stored as microtubers, labor and space costs are minimized, and fewer transfers of tissues are required (Seabrook et al. 1993). Shipping potato germplasm is more efficient if microtubers are used because they do not dry out as readily as plantlet cultures and withstand handling more easily than plantlets (Seabrook and Coleman 1988).

One of the barriers to the efficient production and utilization of microtubers is the small size of the resultant propagules (Seabrook et al. 1993; Xu et al. 1998b). Large microtubers (>0.04 g) are easier to handle, are less subject to excessive shrinkage in cold storage, have shorter dormancy, and exhibit greater survival when planted out directly in the field (Leclerc et al. 1994, 1995). Although large microtubers can be obtained by culturing whole plantlets or cuttings comprised of several nodes on a semi-solid medium, this takes more resources in terms of cultured plant tissues, media, and glassware. Larger microtubers can be produced by growing potato plantlets in liquid culture (Leclerc et al. 1994). However, microtubers from liquid cultures do not store well and tend to be very soft, with open lenticels that become the site of entry for microorganisms causing rot. Single-node cuttings excised from potato plantlets in vitro consist of a section of stem with a node subtended by a simple leaf. Generally, a single bud is situated in the axil of the leaf in vitro grown single-node cuttings, although occasionally there is a central large bud with a smaller bud on either side (Seabrook et al. 1993). When potato single-node cuttings are grown in semi-solid media, the leaf has usually senesced by the time a microtuber is formed.

No reports have been found outlining the influence of the leaf on a single-node cutting upon the yield of microtubers. In view of the depletion of the leaf when microtubers are formed, it is possible that its size and vigor influences the size of the microtuber. As the influence of the leaf on the productivity and vigor of rapid multiplication cultures had been established (Seabrook and Douglass 1994), it was of interest to determine if the leaf affects the size of microtubers. From the perspective of rapid multiplication facilities, it is important to know if resources could be saved by culturing single-node explants without leaves. Thus, the influence of the leaf of in vitro single-node cuttings on microtuberization was investigated.

MATERIALS AND METHODS

In Vitro Culture of Stock Plantlets

Potato plantlets of cvs Atlantic, Katahdin, Kennebec, Russet Burbank, and Shepody were cultured from single-node cuttings excised and transferred every 4 wk to fresh culture medium lacking growth regulators (Seabrook and Douglass 1994).

All stock cultures were maintained in a growth room at a temperature of 19 C ± 1.0 and illuminated with Cool-white (F96T12, HO) and Grolux (Sylvania F96T12, VHO) fluorescent lamps (1:1) to provide an irradiance of 22 watts m⁻² and a photoperiod of 16 h (long day).

Production of Microtubers

Single-node cuttings with and without leaves were grown in a medium with increased sucrose (9%) to promote the formation of microtubers (Seabrook et al. 1993). Injury to the single-node cuttings during excision and transfer to fresh medium was carefully avoided in case the close proximity of wound tissue influenced microtuberization. Cuttings used for the “leaf-off” treatment had the leaf removed just prior to inoculation of the culture. Media was autoclaved at 121 C. All microtuberization cultures were incubated in darkness at 19 C ±1.0 in a plant tissue culture growth room.

Experiment #1 tested the effect of leaf area on microtuberization of single-node cuttings. Three leaf areas were tested for Katahdin (0.5-1.0, 1.0-2.0, >2.0 cm² with 45 explants per leaf area category), and Russet Burbank (1.0-2.0, >2.0 cm² with 53 explants per leaf area category) with 75 mL of semi-solid tuberization medium dispensed into Magenta 7 vessels (Magenta Corp., Sigma-Aldrich Canada Ltd., Oakville, ON, Canada).

Experiment #2 determined the effect of the presence or absence of the leaf subtending the axillary bud of single-node cuttings on subsequent microtuberization. Ten mL of semi-solid tuberization medium was dispensed into 25 X 150 mm test tubes and capped with Kaput closures (Belco Glass Inc., P.O. Box B, 340, Edrudo Road, Vineland, NJ, 08360, USA).