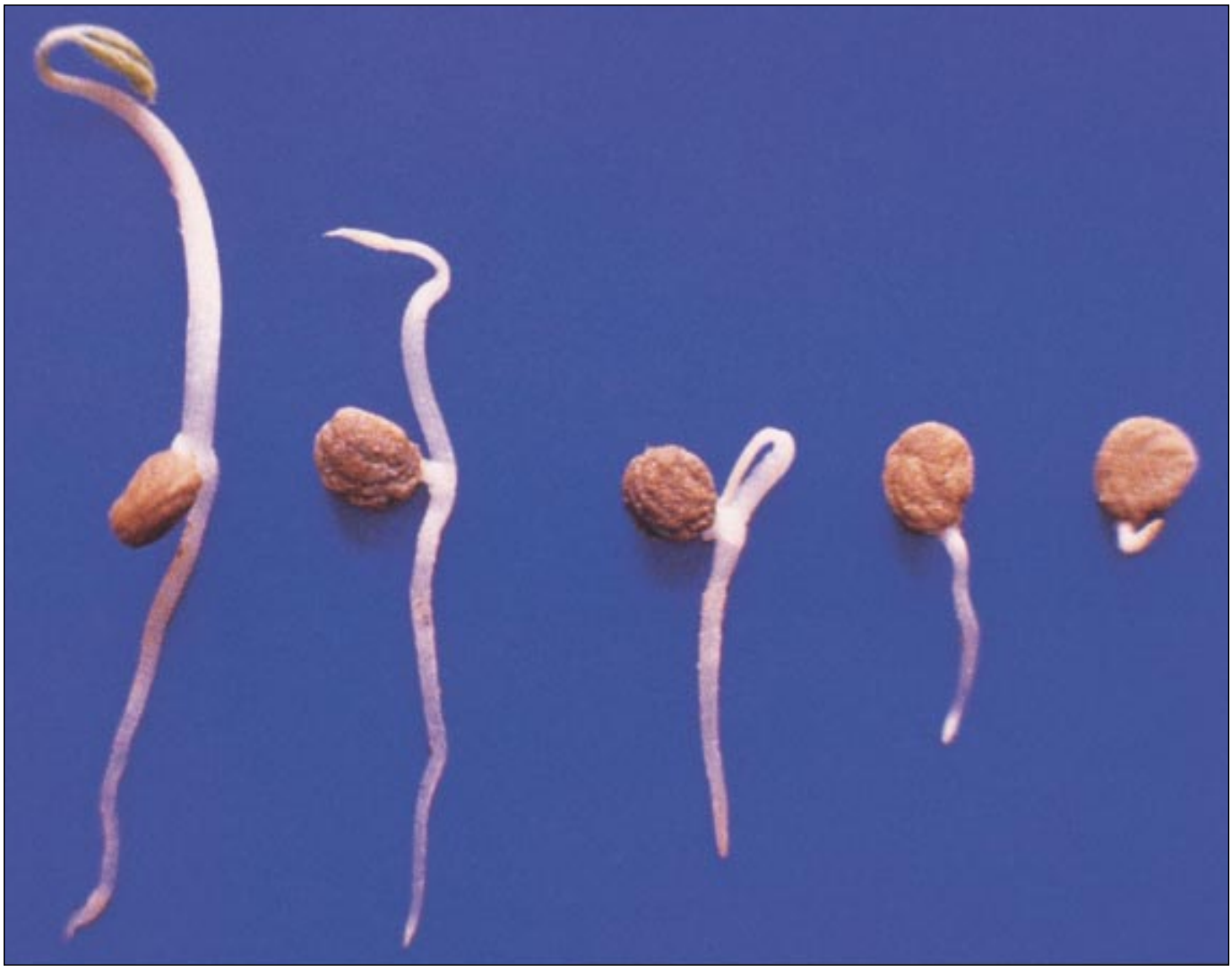

Photo by Thomas SC Li

Figure 1 • *Germinating American ginseng seeds.*

Stratification *of* American Ginseng Seeds—Problems and Solutions

THOMAS SC LI

ABSTRACT

Germination of American ginseng was 80% after treating moist seeds 3.5 mo at 15 °C (59 °F) followed by 9 mo at 1 to 2 °C (34 to 36 °F) in the laboratory. The warm treatment promoted the embryo to grow to a mature size while the cold treatment broke endogenous dormancy. Controlled stratification of seeds in the laboratory avoids many of the problems associated with the traditional method of stratifying seeds outdoors in sand beds.

KEY WORDS: *Panax quinquefolium*, after-ripening, dormancy, embryo, Araliaceae

NOMENCLATURE: USDA NRCS (2001)

American ginseng (*Panax quinquefolium* L. [Araliaceae]) is propagated by seeds. Many factors affect ginseng seed germination including stratification period (Li 1995), seeding time and depth (Liu 1988), temperature (Bae 1978), and spacing (Park 1987). Traditionally in North America, ginseng seeds are harvested in late August or early September and immediately stratified in a sand box buried outdoors (Proctor and Louttit 1995). Embryos in newly harvested ginseng seeds are not fully developed and have an average length of 0.5 mm (0.02 in)(Hovius 1996). Stoltz and Snyder (1985) indicated that ginseng seed germination is a two-stage process. During the first stratification period under warm temperatures of 15 to 20 °C (59 to 68 °F) (Jo and others 1988), cotyledons, hypocotyls, radicles, and epicotyls become visible and the embryos continue to develop and reach a length of 3 to 3.5 mm (0.12 to 0.14 in) (Yu and Kim 1992). Seeds with fully developed embryos need a second stratification period at a cold temperature of 1 to 2 °C (34 to 36 °F) to overcome endogenous dormancy (Proctor and Bailey 1987). Both the warm and cold stratification may take up to 18 to 22 mo (Xiao and others 1987). During this two-stage stratification, seeds are very vulnerable; without proper or suitable environmental conditions seeds will either rot, fail, or be slow to germinate. Uncontrolled fluctuating temperature and moisture levels, and the presence of pathogenic organisms in the seed box cause seeds to sprout prematurely, rot, dry out, or be delayed in germination by up to 2 y after seeding, with severely reduced germination rates (Li 1995). Stratifying seeds in a controlled environment is a potentially reliable method of reducing or eliminating these serious problems. In an indoor controlled environment, ginseng growers should be able to maintain a disease-free environment and provide ideal temperatures and moisture levels for seeds to stratify as well as to monitor seed conditions.

Based on earlier research (Li and others 2000), the following experimental technique worked well for stratifying American ginseng seeds in the laboratory. Seeds were harvested from 4-y-old plants in a commercial ginseng field, de-pulped, cleaned, and soaked in a 1% formalin solution for 10 min, and then mixed with pasteurized sand in a 1:2 (v:v) ratio. The sand was moistened with 500 to 600 ml (17 to 20 oz) of 1% formalin and additional sterile distilled water was added to provide a 10% (w:w) moisture level. Sand and seed (2 kg [4.5 lb]) mixtures were placed in 11.3-l (3-gal) plastic containers with removable covers. Several holes had been drilled for drainage and a 2 cm (0.8 in) layer of gravel had been placed at the bottom. The containers were placed in temperature controlled chambers in the dark and subjected to a warm temperature regime (15 °C [59 °F]) for 3.5 mo followed by a 9-mo cold temperature regime (1 to 2 °C [34 to 36 °F]). We found that varying the warm temperature and the length of cold stratification affected germination (Table 1; Li and others [2000]) so propagators may wish to experiment with their particular seed sources.

Stratification of ginseng seeds under a controlled environment indoors is a relatively new experimental procedure not yet fully evaluated or accepted for American ginseng, however, this method shows significant improvement for ginseng stratification, as it shortens

TABLE 1

Effects of the length of the cold stratification period after 3.5 mo of warm stratification on the germination percentage of American ginseng seeds [b]

Warm stratification temperature °C (°F)	Months of cold stratification at 1 to 2 °C (34 to 36 °F)	Germination (%)
15 (59)	5	20 a [a]
	7	47 b
	9	80 c
20 (68)	5	2 a
	7	18 b
	9	60 c

[a] Values with a common letter in each column for each warm stratification temperature are not significantly different ($P = 0.05$) according to Duncan's New Multiple Range Test.

[b] Modified from Li and others (2000).

the time required for stratification and increases percentage of germination. I believe that the length of warm and cold periods during stratification is an important factor for ginseng seed germination. More importantly, seed stratification carried out in a controlled environment indoors can shorten the length of seed stratification, increase percentage of germination, and avoid hazards experienced outdoors such as pathogens and fluctuation of temperature and moisture levels.

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