Fall webworms are the larvae of the moth, *Hyphantria cunea* (Drury). The larvae feed gregariously on foliage of many different host species from inside an unsightly web. The larvae are hairy and tan to brown in color. Pecan and other hardwoods are preferred host plants. Two to five generations occur each year. Two generations occur on pecan, one in May-June and another in July-August. Nursery trees are usually attacked in September-October. The larvae are heavily parasitized, but may completely defoliate small trees in a short time. Removal of the larvae in the web or by pruning is an alternative to control with insecticides.

The forest tent caterpillar is the larva of the moth, *Malacosoma disstria* Hubner, and is closely related to the eastern tent caterpillar. However, the forest tent caterpillar does not feed in a webbed tent. The larvae are black and somewhat hairy with a row of yellow and blue keyhole-shaped spots down the center of the back. Single larvae are often found in early spring feeding on the buds or new leaves of a variety of deciduous plant species which they may severely damage. Application of an insecticide at bud-break may be necessary to suppress the damage from this pest.

There are many gaps in our knowledge of these pests of ornamentals. Table 2 is an outline of the biological and operational information that are important from an entomologist’s point of view and lists the types of information that should be considered in making the best IPM decision. Many factors are related to characteristics of the pests and must be considered along with those operational factors that are controlled by the nurseryman. The relative importance allocated to each of the factors is for the judgment of the nurseryman. The table should help the decision maker to gather information in a systematic way and then to analyze the information within the constraints of his or her management objectives and the law. Many factors such as plant protection and quarantine laws, pesticide labels, etc., are beyond the control of the manager, e.g. fireant certification, and may override any other choices in the management plan. However, in 1991 these types of decisions by nurserymen from day to day are probably the exception rather than the rule. In the future it is probable that fewer tools and more outside regulations will affect IPM decisions. For this reason it is important that nurserymen constantly update their strategies and tactics. The environmentally-sound IPM approach will require much more intensive management of resources and information. Table 2 is a first step towards the organization of a variety of information into a quantitative, objective outline in which data can be collected, synthesized and applied for successful decisionmaking.

**Literature Cited**


**Additional index words.** leaf surface, stomata, Scanning electron microscopy, micropropagation.
Vitrification is a serious problem in tissue culture (Debergh et al., 1981; Ziv, 1991). Vitrified plants can not survive transplanting to soil which seriously restricts the use of long term propagation for industrial production (Navatel, 1982). Vitrification is also termed translucency, hyperhydration, hyperhydric transformation, glauciness, waterlogging, glassiness (Paques and Boxus, 1987). Several hypothesis were offered such as an increase in ammonium concentration, (Riffaud and Cornu, 1981; Vieitez et al., 1985), high concentrations of cytokinins (Debergh, 1983), calcium deficiency (Kreutmeier et al., 1984), and a superoptimal concentration of potassium (Quoirin and Lepoivre, 1977) have been suggested as causes of vitrification. We have observed that soybean shoots cultured in half strength Murashige and Skoog (1962) medium (MS) supplemented with additional potassium salt (KNO₃) formed translucent leaves while those cultured in the same medium without additional supplement were normal (Mohamed-Yasseen, unpublished). Addition of activated charcoal provokes vitrification in some plants (Densco, 1987; Mohamed-Yasseen, unpublished).

Debergh et al. (1981) and Debergh and Maene (1985) demonstrated that vitrification rate was always higher in liquid than in solid media, and it decreased as the relative humidity in tissue culture container was reduced. Increasing the water potential by reducing the concentration of gelling agent induced vitrification (Debergh, 1983; Zimmerman and Cobb, 1990). Leaves and chiefly stomata, are responsible for water regulation in plants through evaporation and transpiration. Observation of stomata in vitrified plants was needed to investigate for possible correlations between stomatal structure and vitrification. In this report, leaf surface of normal and vitrified plants were examined under scanning electron microscopy.

Materials and Methods

Leaves of normal and vitrified microplants were excised from cultures of carnation (Dianthus chinensis L.), soybean (Glycine max L. Merr), and chicory witloof (Cichorium

Figure 1. Stomata of normal soybean leaf. 

Figure 2. Abnormal stomata observed in vitrified leaves. (A) Closed stomata in soybean leaf. (B) distorted stomata in chicory witloof. (C) occluded stomata in carnation leaf.
intybus L.). Shoot tips of carnation were surface sterilized with 70% ethanol for one minute, 0.3% (v/v) NaClO for ten minutes, rinsed three times in sterile distilled water. Carnation shoot tips were then cultured in Murashige and Skoog (1962) medium (MS) supplemented with 30 g/l sucrose, 8 g/l (Bacto-agar, Difco), 30 g/l sucrose, 0.15 uM thidiazuron, and 0.05 uM α-naphthaleneacetic acid. The pH of all media were adjusted to 5.7 after adding growth regulators with 1N KOH. Growth regulators were added before autoclaving. Soybean and chicory witloof microplants were regenerated from cotyledonary nodes and leaf discs respectively. Methodology of regeneration and culture conditions for soybean and chicory witloof were already described (Mohamed-Yasseen and Splittstoesser, 1990, 1991a). All cultures were incubated in a growth room providing 18 h photoperiod (cool white fluorescent light, 40 μmol·m⁻²·s⁻¹) and 28°C. Leaves from vitrified and normal shoots from carnation, soybean and witloof chicory were fixed in 4% glutaraldehyde, and prepared for scanning electron microscopy (SEM) observation by conventional methods and examined using a JEOL U3 SEM, (Mohamed-Yasseen and Splittstoesser, 1990b). In some instances, samples were cryofixed in propane pre-cooled by liquid nitrogen, and observed using an AMRAY 1000A SEM (Mohamed-Yasseen and Splittstoesser, 1990c).

**Results and Discussion**

Leaf surfaces of vitrified shoots were anatomically different from normal leaves. Normal leaves have open stomata (Fig. 1). Closed (Fig. 2A), distorted (Fig. 2B), and occluded stomata (Fig. 2C), were observed in vitrified leaves. Vitrified leaves had fewer stomata per unit area than non-vitrified leaves. Epidermal cells in vitrified leaves were elongated and leaves were wrinkled. Stomata of vitrified leaves were recessed or elevated which may be caused by wrinkled leaf surface. Vitrified soybean leaves had more epicuticular waxes than normal leaves (Fig. 2A). However, no difference in epicuticular waxes were noted between normal and vitrified leaves of carnation or witloof chicory. Closed and abnormal stomata in vitrified microplants were noted in carnation (Diathus caryophllus) and melon (Weker and Lesham, 1987; Lesham et al., 1988). However, there is no available information on the relationship between abnormal leaf surface, notably stomata, and vitrification and processes which cause a decrease in water loss or increased water uptake, induce vitrification (Ziv, 1991). Removal of leaves from microplants was reported to cause vitrification, and was not related to ethylene production (De Proft et al., 1987). Similar results were observed in some Allium spp. when injuring stem base of seedlings to increase water uptake together with decreasing water loss by removal of a portion of their leaves. Moreover, excessive injury of explants during surface sterilization by NaClO with detergent also induce vitrification (Mohamed-Yasseen, unpublished). Leaves of normal microplants have open stomata which were shown to be functioning (Shackel et al., 1990). In this report, closed, and distorted stomata, fewer number of stomata, and wrinkled leaves were observed in vitrified leaves of carnation, soybean and witloof chicory. Vitrified leaves of Zinnia elegans, and Solanum nigrum showed similar results (Mohamed-Yasseen and Splittstoesser, 1992). It is possible that vitrification is associated with abnormal structure of stomata and leaf surface, such modification are supposed to cause leaves to be inefficient in water regulation, mainly through transpiration, which lead to water accumulation in leaves lacunae, causing vitrification disorder.

**Literature Cited**


