The University of Rhode Island Ornamental Breeding Program©

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The selection of superior ornamental plants combined with effective marketing strategies and production methods drives much of the economic growth in the nursery industry. The majority of newly introduced ornamental plants derive from chance discoveries of unique seedlings or branch mutations in nurseries, arboreta, and botanical gardens. There are, however, many public and private ornamental breeding programs both in the U.S.A. and abroad developing new plants using traditional methods and biotechnology to target specific traits. Unfortunately, lack of genetic variability for a particular trait in many important woody ornamentals is a significant impediment to plant improvement using traditional breeding methods. No amount of crossing alone will introduce or enhance a desirable trait, whether physiological or aesthetic, if the genetic potential does not exist in a population. In nature, living organisms "overcome" genetic shortcoming by tolerating mutations that may bring about genetic changes leading to novel traits. Natural genetic mutations and genome reorganization are primary survival mechanisms, allowing plants to adapt to their changing environment over time. Plant breeders have been taking advantage of this knowledge for many years by inducing mutations in agronomic and horticultural plants (Ahloowalia and Maluszynski, 2001).

Current ornamental breeding efforts at the University of Rhode Island are focused on developing protocols for ethylmethanesulphonate (EMS) mutagenesis of seeds and tissue cultures of several woody plants. Two outcomes are expected: (1) individual seedlings and plantlets stably expressing novel characteristics will be selected as potential cultivars, and (2) breeding populations exhibiting a range of novel traits will be developed for use in future breeding efforts. Mutagenesis of the multicellular plant seed results in first generation plants that are genetic mosaics, and observed traits may be chimeral. In addition, most mutations are recessive and will not be revealed in the first generation. Self-compatible plants can be self-pollinated, and a portion of the existing mutations will be revealed in the resulting progeny. Further rounds of self-pollination would reveal additional mutation-induced traits. For outcrossing species, plants can be selected as potential cultivars if an observed novel trait is stable and can be maintained by asexual propagation. Additional selection among outcrossing plants can be made in subsequent generations following either controlled or open pollination. Also in outcrossing or self-incomplatilbe plants, isolating half-sib populations can greatly increase the odds of acquiring progeny having recessive mutant genes in the homozygous state.

The preferred chemical mutagen for seeds is EMS and has also been used for inducing mutations in plant tissue cultures (Koornneef, 2002; Latado et al., 2004; Omar et al., 1989). Ethylmethanesulphonate results in mainly transitional point mutations occurring randomly in each exposed genome. The use of in vitro methods is of particular interest because of its potential for overcoming the problem of genetic mosaicism. Both approaches have proven valuable, but require different approaches for generating non-chimeric plants. Ethylmethanesulphonate acts randomly within treated tissues, and results are dependent on time of exposure, EMS concentration, and the genome size of the target plants. The optimum concentration and timing of EMS treatments for an ornamental plant of interest can be estimated based on published reports or protocols for EMS mutagenesis of other plants and conducting relatively simple multifactor experiments (Alcantara et al., 1996; Penmetsa and Cook, 2000).

Multigenic traits tend to show the highest mutation-induced variability since there are more potential "targets" for mutation than traits controlled by a one or only a few genes (Koornneef, 2002). For instance, variegated mutants often result from induced mutations since many different genes control chlorophyll synthesis and degradation processes. Chlorophyll mutants can often be identified soon after germination following the emergence of the first true leaves. Other traits require longer evaluation periods such as flower color mutations. Natural and induced mutations have already contributed greatly to the improvement of fruit, vegetable, and agronomic and ornamental crops and have great potential for contributing new many more plants for the horticulture industry and novel germplasm for ornamental plant breeders.

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