Abstract

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Seed orchards are the major tool for deploying the improvement generated by breeding programs and assuring the consistent supply of genetically improved seed. Attainment of genetic gain and monitoring of gene diversity through selection and breeding were studied considering the factors: selection intensity; genetic value; coancestry; fertility variation; and pollen contamination. The optimum goal of a seed orchard is achieved when the orchard population is under an idealized situation, i.e., panmixis, equal gamete contributions from all parental genotypes, non-relatedness and no pollen contamination. In practice, however, due to relatedness among parents, variation in clonal fertility and ramet number, and gene migration from outside, the realized genetic gain and gene diversity deviate from the expectation. In the present study, the genetic value of seed orchard crops (genetic gain, G) could be increased by selective harvest, genetic thinning and/or both. Status number (N_S) was used to monitor the loss of gene diversity in the process of forest tree domestication, and calculated to be reasonably high in most seed orchards. Fertility of parents was estimated based on the assessment of flowering or seed production, which was shown to be under strong genetic control. Variation in fertility among orchard parents was a general feature and reduced the predicted gene diversity of the orchard crop. Fertility variation among parents could be described by the sibling coefficient (Ψ). Ψ was estimated to be 2 (CV= 100% for fertility). In calculating Ψ, it was possible to consider, besides fertility variation, the phenotypic correlation between maternal and paternal fertilities, and pollen contamination. Status number was increased by controlling parental fertility, e.g., equal seed harvest, mixing seed in equal proportions and balancing parental contribution. By equalizing female fertility among over-represented parents, it was possible to effect a favorable tradeoff between gene diversity and seed production. If the status number of orchard crop is not large enough, loss of gene diversity, random drift in gene frequency and potential inbreeding problems could occur in subsequent generations. Genetic loss or erosion did not seem to be alarming during the domestication of forest trees, because a large number of parents are commonly used in first-generation seed orchards. An understanding of reproductive processes and monitoring of the impacts of the management practices are essential to maximize genetic gain and to maintain sustainable gene diversity in seed orchard programs.

Key words: status number, effective population size, group coancestry, inbreeding, fertility variation, ramet variation, gene migration, sibling coefficient