Application of Genomic Technologies to Crop Plants: Opportunities and Challenges

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Enormous genomic resources have been developed for model plants such as Arabidopsis thaliana (L.) Heynh. and rice (Oryza sativa L.), including detailed genetic maps (Harushima et al., 1998), huge numbers of expressed sequence tags (ESTs) (Sasaki et al., 1994; Seki et al., 2002), deep-coverage large-insert [such as bacterial artificial chromosome (BAC)] libraries with extensive contig assemblies (Zhang et al., 1996; Mozo et al., 1998; Zhao et al., 2002), and both targeted and complete genome sequencing and annotation (Goff et al., 2002; Yu et al., 2002). These resources, coupled with the development of mutant stocks by knock-outs (Young et al., 2001) or targeted induced local lesions in genomes [TILLING (Till et al., 2003)], will allow for the efficient identification of gene(s) controlling phenotypes in model systems. However it is not clear how broadly applicable genetic associations revealed in model systems will be to economically important plants. Unquestionably, some genes identified in model plants will also condition economically important phenotypes in a crop plant. An example is the FLC locus that controls flowering in Arabidopsis (Michaels and Amasino, 1999) and in the closely related brassicas (Kole et al., 2001). Similar successes are readily communicated to the scientific community through publications; however, it will be difficult to publish, and therefore assess, the opposite scenario in which genes identified in model systems are not associated with similar traits in economically important plants. The purpose of this paper is to discuss some potential inconsistencies between model systems and economically important plants with onion (Allium cepa L.) as an example.

Recent studies have revealed that the Commelinaceae and Asparagales are two strongly supported monophyletic sister groups within the monocots (Chase et al., 1995; Chase et al., 2000; Fay et al., 2000). The Commelinoid monocots include the order Poales and possess the most economically important monocots, such as maize (Zea mays L.), rice, wheat (Triticum aestivum L.), etc. The Asparagales are the second most economically important monocot order and include important plants such as agave (Agave spp.), aloe (Aloe spp.), asparagus (Asparagus officinalis L.), chive (Allium schoenoprasum L.), garlic (Allium sativum L.), iris (Iris spp.), leek (Allium ampeloprasum L.), onion, orchid (Erycina spp.),...