Workshop Papers and Authors

Presiding: Jules Janick

What's Hot, What's Not: Introduction to the Workshop

Jules Janick
Department of Horticulture, Purdue University, West Lafayette, IN 47907-1165

Fashion refers to the current style of things and fads are styles that have a short life. A fad is a passing fashion. We are all familiar with the fashion industry in apparel where minor changes, e.g., skirt length, lapel width, or shoulder pad depth, quickly come and go but become of major importance for the clothing industry. The fashion in hair styles (from long hair to skin heads, straight to curls, natural to wigs) and facial hair (clean shaven, sideburns, mustaches, beards) alter and permutate over the years so that we can often date portraits from this feature alone. For many years, automobiles were sold on the basis of "styling" and its jargon has become part of our lexicography: rumble seat, streamlining, tail fins, coke-bottle look, hard top, vinyl roof, station wagon, sports van, and so forth. These many changes, although superficial and trivial, define our culture.

Are there fashions and fads in horticultural science? The answer, pure and simple, is yes. New technology engenders a tremendous flurry of activity. As claims mount and excitement increases there is a rush to jump on the bandwagon. In the beginning there is a heady feeling and it becomes easy to publish confirmatory results. Those in the field feel part of the competitive edge. Typically reality sets in as more is learned about the technology and its shortcomings and limitations become apparent. With the early disappointments there is often a decline in enthusiasm and at the end of the cycle the areas may become unfashionable, old hat, or even brain dead. Surprisingly some research areas become passé despite the fact that practical benefits may be increasing. A current example is trickle irrigation. The cycle may be very brief or it may reoccur for years with successive cycles of enthusiasm and disappointments. One interesting phenomenon in horticulture is the divergence of academic interest and industry interest. Many technological advances may lose their scientific interest but become a serious part of industrial research. Examples in horticulture include tissue-culture protocols and controlled-atmosphere storage. The objective of this workshop is to review areas of horticultural research in areas that at one time were considered very fashionable, and to compare claim with reality—in short, a reality check. What was hot, what's now hot, what's not. Finally, what can we learn from fads and fashions in research?

The first paper "Fruit Cultivars and Germplasm Evaluation" by Frank Dennis describes what was once the most fashionable and important research areas of pomology. The cultivar or variety is indeed the keystone of horticulture and all fruit industries depend on locating adapted and productive clones. Many fruit and nut crops, such as almond, date, kiwifruit, pistachio, pineapple, tart cherry, and wine grapes, are based on a relatively few clones, some centuries old. In the United States a number of fruit industries are based on a single clone: pistachio ('Kermen'), processing pear ('Bartlett'), pineapple ('Smooth Cayenne'), tart cherry ('Montmorency'), while the entire world kiwifruit industry is based on a single pistillate clone ('Hayward'). The discovery of this clone in New Zealand by a grower is one of the great unsung achievements. In North America, where apple orchards were started from seed, literally thousands of cultivars had to be sorted out to establish a modern industry, and the books describing them such as *The Apples of New York* (1905) by S.A. Beach and *Fruits of Ontario* (1907) have become classics. Despite its key role, cultivar testing soon came to be considered subprofessional, and today cultivar trials are not considered appropriate for our journals despite their critical importance to the industry. However, cultivar evaluation because of its importance continues as an essential component of improvement programs, and the evaluation of new clones and sports is a necessary technology for fruit growers everywhere.

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In the "The Colchicine Story," James Hancock reviews the rise and fall of colchicine as a research phenomenon in horticulture. During the 1940s and 1950s, the use of colchicine to double chromosome numbers was considered one of the potentially momentous achievements in genetics that could be expected to revolutionize plant breeding because a number of important crops were polyploid, whereas many wild species were diploid. The production of seedless watermelon by Kihara in the 1940s using crosses of colchicine-derived tetraploids with diploids was indeed an innovative achievement. It was widely predicted that the introduction of tetraploidy would not only lead directly to crop improvement but would be a bridge to introduce new genes from related diploid species. Colchicine has proven to be valuable for alloploid breeding, but the so-called raw tetraploids are of little direct value without additional breeding and selection. The colchicine story reinforces the concept that new breeding techniques are merely techniques and not an end in themselves. Despite continued use, the rise and fall of colchicine has become an example of a research fad in horticultural breeding.

"Commercial Micropropagation" by Sherry L. Kitto presents a reality check against the tremendous claims proposed for tissue culture from an industry with a meteoric rise but one that has experienced significant growing pains. Micropropagation still has problems competing with conventional plant propagation technologies. The present use of tissue culture for propagation is mainly confined to foliage and ornamental plants and to those plants, such as the peach rootstock GF 6776, which are difficult to propagate conventionally. In the ornamental Boston fern, tissue culture dominates the propagation system. The value of micropropagation has often hinged on its usefulness in multiplying disease-free plants, and tissue culture remains an essential component of genetic engineering, particularly gene transformation. However, some terrible mishaps have occurred due to somaclonal changes and mix-ups, which appear now to be due to incompetence or greed rather than to any inherent failure of the system. Although these errors have tarnished the image of commercial micropropagation, Kitto makes clear that this technology is here to stay. At the present time successful automation is under development in Japan and Israel in an attempt to make micropropagation more competitive. The industry continues to expand worldwide, but expectations have become much more realistic.

During World War II, hydroponics was used in a minor way as a means of growing vegetables on desolate Pacific atolls, and as a result of postwar hype in the press, hydroponics captured the imagination of the public as a revolutionary technology to grow plants. Yet the scientific basis for nutrient solutions go back to chemical and physiological studies on plant nutrition, particularly those of Theodore de Saussure (1767–1845), A.F. Wiegmann (1771–1853), and Justus van Liebig (1803–1873). Studies in sand culture at Purdue Univ. by R.B. and A.P. Withrow (1948) and at the Univ. of California by D.R. Hoagland and D.I. Arnon (1938) laid the basis for soilless culture of plants and a number of innovative techniques emerged, including liquid and matrix-based systems with solutions used only once or replenished and recycled. A number of specialized permutations of the system have been developed, such as roots grown on plastic channels (nutrient film technique) or sprayed with nutrient solution (aeroponics). Although hydroponics has not yet lived up to the wild claims of its proponents, the use of soilless culture has shown a consistent increase and is an essential part of controlled-environment agriculture. Hydroponic research continues for space flight travel. In "Hydroponics and Horticulture," Merle Jensen, one of the real advocates of controlled-environmental horticulture, and an enthusiastic advocate of the technology, makes the case that hydroponics has finally found its home in Arizona. Interestingly, hydroponics can be considered the exact opposite of organic culture.

Norman Looney chronicles the fantastic roller coaster ride of phytohormones in "Hormones and Horticulture." This field originated with the classic paper of Charles and Francis Darwin who discovered the evidence for chemical signals in plants using a few canary grass seedlings, a razor blade, a bit of tin foil, and a light source. Growth regulators became the hot topic in plant physiology from the 1930s to the 1980s and led directly to tremendous horticultural application, including selective herbicides; rooting promoters; fruit setters, growth promoters, ripeners, and thinners; and growth and abscission inhibitors. Growth regulator studies provided the basic technology for successful tissue culture. The ride has had its ups, downs, and swerves, and as a result many researches have experienced alternate feelings of elation with their success, and confusion and depression as the fear of pesticides and the charge of potential carcinogenesis changed public opinion about the value of their work. Yet research continues and with the new tools of molecular biology, the mode of action, often inferred but never proved, may finally be solved.

The origins of molecular biology are as old as the science of genetics. In 1866, the same year in which Mendel's paper on inheritance in the garden pea appeared, Haeckel published his conclusions that the cell nucleus was responsible for heredity. In the late 1860s, a young Swiss, Johann Fredrich Miescher, described a substance he called nuclein that was derived from pus scraped from surgical bandages and later found in fish sperm, and in 1889, his student, Richard Altmann, split nuclein into protein and a substance he named nucleic acid. The concept that DNA was the transformation principal in *Pneumococcus* was demonstrated by Oswald Avery, Colin McLeod, and Maclyn McCarty, and subsequent phage manipulations by Alfred Hershey and Martha Chase proved that DNA was indeed the genetic material. But it was the Watson and Crick paper on the structure of DNA that became the conventional baseline for the biotechnological revolution. This was followed by a race to unravel the genetic code. The discovery of restriction endonucleases in 1970 provided the ability to transfer gene sequences into plasmid vectors and thence across hitherto unbreachable barriers, and created the concept of genetic engineering.

At present, no area of biology is more fashionable, no field in horticulture is hotter. Expectations in both the academic and the financial sector have been enormous. But until 1966 the actual achievement in agriculture and horticulture had been modest indeed. Up to 1995 only the 'Flavr Savr™' tomato, a slow-ripening fruit due to the incorporation of an antisense gene, reached the marketplace, but the results were a commercial disappointment and the tomato is no longer being produced for the commercial market. Calgene was saved from bankruptcy by being bought out by Monsanto. However, in 1996 *Bt* maize and cotton and herbicide-resistant soybean were extensively planted and the results were very promising. Yet, a number of widely predicted changes, such as blue roses, have not happened. The reasons progress had been slower than expected were too much early hype, which created unrealistic expectations, and perhaps more important, a lack of appreciation for the complexities involved, such as the need for specific promoters, unavailability of really useful genes, technical difficulties of gene transformation, patent problems, and roadblocks because of a backlash encouraged by a new class of reforming Luddites.

W.R. Woodson in "Biotechnology and Horticulture" discusses recent developments in biotechnology that impinge on horticultural innovation. He makes a good case that progress has actually been much faster than could be reasonably predicted. Who could have anticipated a decade ago that transformation would become routine or that the genome of crop plants would be mapped? Other tremendous achievements that could revolutionize plant breeding include site directed mutations, gene evolution, complete genome mapping of crop plants, and selection of quantitative traits via molecular markers. It may be that the molecular revolution will have its greatest impact in understanding hitherto unexplainable horticultural processes such as flowering and juvenility. What is now clear is that progress in molecular biology in increasing at an exponential rate and horticulture may be among the greatest of beneficiaries. Clearly, to be involved in the significant horticultural research that lies ahead will be increasingly fashionable.

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