THE FQPA AND NEW CHEMICALS

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The Food Quality Protection Act (FQPA) of 1996 put into motion one of the broadest and most comprehensive reviews of modern pesticide use enacted since FIFRA (the Federal Insecticide, Fungicide and Rodenticide Act) was passed in 1947. By rescinding the Delaney Clause of the 1958 Federal Food, Drug and Cosmetic Act, which barred processed food from containing even trace amounts of cancer-causing chemicals, this measure created a unified health standard for both raw and processed foods, with specific guidelines to protect children from pesticide hazards, by grouping together and evaluating all pesticides having common modes of action. Although this legislation sidestepped the prospect of outright cancellation of several key pesticides currently labeled for agricultural and non-agricultural use, its mandate to ultimately assess total cumulative risk in the population posed by similar active ingredients has instituted a review and reregistration process that has already made considerable progress towards an endpoint that will radically change the profile of pesticide programs currently used by fruit growers in the U.S. and worldwide.

The intended impacts of the FQPA are laudable and relatively straightforward - to restrict or cancel the use of harmful pesticides, and to increase reliance on the use of more reduced-risk materials. However, any sweeping reform brings with it also a number of unintended impacts. Some of the unintended impacts to be addressed here include: regulatory bottlenecks, a potential increase in pesticide resistance, a lack of effective alternative pest controls, greater economic hardship in the agricultural sector, difficulty in meeting market demands, and possible regional shifts in fruit production. These changes are realized not only by the people and businesses involved in the commercial end of the fruit industry, but also express themselves in the form of a greater burden on the elements of the public sector that are involved with the industry. One immediate outcome is an increased demand for research on and extension of new materials and techniques that would ostensibly serve as replacement technologies for the active ingredients expected to be lost in this process. Shifts are seen on both sides of the regulatory window, with a higher incidence of requests for Specific Emergency Exemptions -- state-initiated FIFRA Section 18's -- on the one hand, and more stringent pesticide use enforcement measures on the other. This generates a mostly desirable, if somewhat defensive, response in the form of heightened commodity group advocacy, and the establishment of more practical and realistic communication with the U.S. Environmental Protection Agency (EPA). Greater effort has been expended to provide regulators with better use and usage data, residue data, USDA-requested crop profiles and pest management strategic plans.

Predictably, this has led to a greater regulatory bottleneck at the EPA, which has always been inadequately staffed to meet its legislated mandates. For example, of the roughly 600 emergency exemptions submitted in 1998, 68% were issued, but 16% were pending at the end of the year, and another 11% were withdrawn by the states in view of failure of timely action on their request. Of the minor crop registration data packages submitted in 2000, 36% were delayed or rescheduled until at least the next year.

One intended impact of the FQPA is the progression of lost product uses in apples, a commodity that is a major risk driver because it constitutes a large part of the diets of infants and children. The first of these decisions came in 1999, when the use of methyl parathion was cancelled, and that of azinphosmethyl was restricted. Its tolerance was lowered, the maximum yearly use reduced, its pre-harvest interval (PHI) increased, and chemigation or application by air prohibited. In 2000, the use of chlorpyrifos in apples was restricted to the prebloom period, and a lowering of its tolerance is now likely. Also, the insecticide-acaricide Carzol was prohibited beyond the petal fall stage. An increase in the PHI of phosmet is anticipated, and

diazinon has already begun a phase-out of its interior residential uses, presaging an eventual withdrawl from minor crops like apples in the near future. One unintended consequence of this strategy may well be an increase in the development of pesticide resistance in the short term, as agriculturists rely to a greater extent on a narrower group of chemistries. For instance, products containing spinosad saw 164 new labeled uses in 2000. Some of the eliminated pesticides had been important resistance management tools in fruit programs; methyl parathion and chlorpyrifos were used commonly to control populations of codling moth resistant to azinphosmethyl in the western states.

The agrichemical industry has been responding in an effort to fill the void being created by the anticipated loss of most organophospate and carbamate uses in commodities like apples, but the process is slow and expensive, so a number of discontinuities are showing up between the product cancellations and their potential replacements. There is still a noticeable shortage of effective alternative controls for some pests; one assessment of current registrations shows only 8% of new pest control products to have activity against those insects falling outside of the traditional major categories of caterpillars and soft-bodied insects ' the beetles, bugs, and flies, which threaten to lead the next wave of "problem pests" in some fruit systems. A greater reliance on more reduced-risk materials can be seen as favorable by one measure. For example, spinosad, with an LD50 of greater than 5000 mg/kg, is typical of such products, and pheromone mating disruption is being evaluated on a wider scale than ever as a means of control. Over 125,000 acres in the U.S. were treated with pheromone for codling moth control last year, and new dispenser technologies are being developed, such as sprayable formulations, automated microsprayer systems, and paraffin-based liquids. However, control of internally feeding worms potentially still could be compromised, as mating disruption is not a stand-alone tactic, and efficacy of the new chemistries is not always equivalent to the OP standards.

As a result, fruit growers may increasingly find themselves having difficulty meeting market demands in the face of stringent market, phytosanitation and cosmetic standards that were formerly manageable with the availability of organophosphates. Internationally, a zero tolerance for apple maggot in some markets (e.g., Brazil) dictates a prophylactic spray program that has traditionally relied upon OP's. Even within the U.S., detection of a single plum curculio larva in loads from each of 12 farms resulted in the dumping of over a half million pounds of sweet cherries last year. Trends such as these could have the unintended consequence of regional shifts in the production of certain crops. For instance, OP's traditionally have been targeted against a suite of key pests in the eastern apple-producing states: plum curculio, codling moth, oriental fruit moth, lesser appleworm, European apple sawfly and apple maggot. Of these, only codling moth poses a significant threat in the western states, so it is not hard to imagine a production shift to this region in the event that effective and affordable alternatives to the traditional strategies do not become available.

Still, fruit growers have been fortunate in that a number of new products already have been developed and labeled for use, and others promise to be available soon. With the phasing out of products based on the older chemical classes such as the organochlorines, organophosphates, and carbamates, there has been a surge in the development of other classes of active ingredients since the mid-1990's. Among those actively being pursued are:

- Synthetic Pyrethroids (Asana, Ambush/Pounce, Danitol, Karate/Matador): Developed in the late 1970's, these generally have a longer residual than carbamates and OP's; they exhibit good contact activity and quick knockdown, but can be quite toxic to beneficials.
- Bacterially Produced Acaricides and Insecticides (B.t., Agri-Mek, SpinTor, Proclaim): Derived from bacteria in soil; diverse modes of action. Safe to humans, beneficials, and the environment; narrow spectrum of activity.
- Insect Growth Regulators (IGR's): This group is characterized by diverse chemistries and modes of action; they often have a narrow activity spectrum, and are generally safe to predators. Timing is critical to their effectiveness. Some of the different types of IGR's follow:

- Chitin Synthesis Inhibitors (CHI's; Dimilin, Cascade, Rimon): Members of this oldest group of IGR's disrupt the enzymes producing chitin in the insect cuticle. They have long residual activity, but unfortunately there is cross-resistance between the CHI's and OP's. They are regarded as safe to the environment, but are toxic to aquatic arthropods.
- Juvenile Hormone Analogs (JHA's; Comply, Esteem): Mimic natural insect juvenile hormones; often most effective upon lepidopterous pests. Application timing is very critical, and they may be slow acting.
- Molt Accelerating Compounds (MAC's; Confirm, Intrepid): First discovered in the 1980's; active mostly on lepidopterous larvae, and act by inducing a premature lethal molt in the insect, which leaves it unable to feed. Safe to the environment and beneficials; effective at low rates, and with long residual activity (20-28 days).

Some of these products have been available for several seasons so far, and we therefore have a reasonable idea of their strengths and weaknesses under representative growing conditions. However, others are so new that it will be some time before growers and the people who advise them are able to use them to their fullest advantage, both horticulturally and economically. Following are use profiles for some selected new chemicals, based on what has been observed in experimental and commercial settings where they have been applied (refer also to Table 1).

ACTARA (thiamethoxam)
Company: Syngenta (Novartis)
Classification: A thianicotinyl (neonicotinoid). Related to Provado.
Mode of Action: Systemic insecticide with both contact and ingestion activity. Toxic to bees, slight toxicity to most beneficials, nontoxic to predatory mites.
Targeted Pests: Aphids, plum curculio, European apple sawfly, leafhoppers, mealybugs
Observations: Rapid uptake of residue from leaf surface into plant tissues. Some activity on mirids (tarnished plant bug, mullein plant bug), little on leps.

AGRI-MEK (avermectin)
Company: Syngenta (Novartis)
Source: Produced by a soil bacterium, Streptomyces avermitilis.
Mode of Action: Stops muscle movement and paralyzes pests. Both movement and feeding are inhibited and pest dies.
Pest Activity: Pear psylla, mites, leafminers, leafhoppers.
Observations: Penetrates the plant cuticle (translaminar). Long residual activity and control effectiveness. Most effective when applied in the early season before leaves harden off.

AVAUNT (indoxacarb)
Company: DuPont
Classification: Oxadiazine, a new chemical class.
Mode of Action: Stomach and contact poison. Slight toxicity to beneficials and bees.
Targeted Pests: Plum curculio, apple maggot, leafhoppers, codling moth, oriental fruit moth.
Observations: Cross-resistance with OP's suspected in leafrollers; not active on scales or aphids; possible negative effect on Stethorus punctum.

CALYPSO (thiacloprid)
Company: Bayer
Classification: chloronicotinyl (neonicotinoid), same class as Provado.
Mode of Action: Contact and stomach activity. Minimal effect on beneficials and bees.

Targeted Pests: Plum curculio, codling moth, oriental fruit moth, leafminers, leafhoppers, apple maggot, sucking insects.
Observations: Some systemic activity in plant tissue. Not active on woolly apple aphid; registration not expected before 2002.

COMPLY (fenoxycarb)
Company: Syngenta (Novartis)
Classification: IGR, juvenile hormone analog.
Mode of Action: Intereferes with the molt of larvae to pupal stage. Also, sterilizes eggs, and may prevent adults from entering diapause.
Pest Activity: Pear psylla, leafrollers, leafminers.
Observations: Acts slowly against lepidopterous larvae. Material may be translaminar in leaves. Most effective in the early part of the season. Registration in U.S. questionable.

CONFIRM (tebufenozide)
Company: Rohm and Haas
Classification: Molt accelerating compound
Mode of Action: Initiates premature molting of lepidopterous larvae. Initially, causes larvae to stop feeding then die from starvation. Primarily active through ingestion.
Targeted Pests: Leafrollers, codling moth.
Observations: Most effective timing coincides with egg hatch. Long residual activity (14 ' 21 days). Safe to beneficials.

DANITOL (fenpropathrin)
Company: Valent Biosciences
Classification: Synthetic pyrethroid
Mode of Action: Contact activity. Toxic to many beneficial species.
Targeted Pests: Leafminers, leafhoppers, leafrollers, tarnished plant bug, aphids, plum curculio, internal leps, apple maggot, European red mite.

ESTEEEM (pyriproxyfen)
Company: Valent Biosciences
Classification: IGR, juvenile hormone analog.
Mode of Action: Taken up by insect cuticle, interferes with molting and egg hatch and development. Safe to most beneficials and bees.
Targeted Pests: San Jose scale, pear psylla.

INTREPID (methoxyfenozide)
Company: Rohm & Haas
Classification: A molt accelerating compound. Related to Confirm.
Mode of Action: Initiates premature molting of lepidopterous larvae. Initially, causes larvae to stop feeding then die from starvation. Primarily active through ingestion.
Targeted Pests: Leafrollers, codling moth, oriental fruit moth.

PROCLAIM (emamectin benzoate)
Company: Syngenta (Novartis)
Classification: An avermectin, related to Agri-Mek.
Mode of Action: Mostly ingestion activity, some contact efficacy. Safe to most beneficials; toxic to bees on contact, virtually safe when dried.
Targeted Pests: Lepidoptera, such as leafrollers and leafminers.
Observations: Needs adjuvant (e.g., horticultural mineral oil, Dyne-Amic).

PROVADO (imidacloprid)
Company: Bayer Corp.
Classification: A chloronicotinyl. A neonicotinoid, related to nicotine.
Mode of Action: Exhibits both systemic and contact activity against sucking insects. Safe to beneficials.
Targeted Pests: Aphids, leafminers, leafhoppers.
Observations: Some systemic activity in plant tissue.

SPINTOR (spinosad)
Company: Dow AgroSciences
Source: Naturally derived from a soil bacterium, Saccharopolyspora spinosa.
Mode of Action: Contact and stomach poison, acts on insect nervous system. Treated insects stop feeding and quickly become paralyzed.
Pest Activity: Lepidopterous larvae (leafrollers, leafminers), apple maggot
Observations: Activity often enhanced by addition of an adjuvant.

SURROUND (kaolin clay)
Company: Engelhard
Classification: Naturally occurring clay mineral.
Mode of Action: Particle film forms a physical barrier/deterrent to pest feeding, ovipositing, landing.
Targeted Pests: Plum curculio, leafhoppers, apple maggot, internal leps.
Observations: Not active on aphids, scales. May negatively impact hymenopterous parasitoids and generalist predators such as spiders.

Despite the considerable efficacy against most fruit pests represented in these materials, the ultimate determinants of each of their roles in the industry will be the diversity of growing conditions (climate, site, variety), pest pressures (together with pesticide use history, resistance, etc.), market demands, economics, and user sophistication to be found throughout the fruit industry. An admittedly nearsighted assessment of one potential scenario could easily lead to predictions of increased economic hardship associated with these new tools. A likely increase in pest control expenses is suggested by the 16-40% increased cost of new products, the greater number of applications often needed, their more information-intensive use patterns, and a consequently more complex production system; all this is set against a backdrop of negative economic growth in the agricultural sector over the past few decades. The business of growing fruit, never an easy job, will continue to require its members to diligently plan, experiment, prioritize, and constantly re-evaluate their methods in order to stay on the practical and profitable side of this challenging occupation.

Table 1. Activity profiles of new pesticide products being registered and currently available.			
Product Name (common name)	**Targeted Pests**	**Some activity**	**Little activity; Negative effects**
Actara (thiamethoxam)	Aphids, plum curculio, leafhoppers, European apple sawfly, mealybugs	Leafminers, plant bugs, apple maggot	Leps (codling moth, oriental fruit moth, leafrollers) San Jose scale
Avaunt (indoxacarb)	Plum curculio, apple maggot, European apple sawfly, leafhoppers	Leps (codling moth, oriental fruit moth, leafminers)	OBLR (cross-resistance with OP's?) Spirea aphid, San Jose scale; Harmful to *Stethorus*
Calypso (thiacloprid)	Plum curculio, codling moth, oriental fruit moth, leafminers, leafhoppers, apple maggot, aphids		San Jose scale
Confirm (tebufenozide)	Tufted apple budmoth, redbanded leafroller	Obliquebanded leafroller	Codling moth, oriental fruit moth
Danitol (fenpropathrin)	Leafminers, leafhoppers, leafrollers plant bugs, aphids, plum curculio, leps, apple maggot, mites		Harmful to most beneficial insects and mites
Esteem (pyriproxyfen)	San Jose scale, leafminers	Pear psylla	
Intrepid (methoxyfenozide)	Leafrollers, codling moth, oriental fruit moth	Leafminers	
Proclaim (emamectin benzoate)	Obliquebanded leafroller, leafminers	Leps (codling moth, oriental fruit moth)	
Surround (kaolin clay)	Plum curculio, apple maggot, leafhoppers, pear psylla	Leps (codling moth, oriental fruit moth, leafminers)	Aphids, scales; may suppress hymenop, parasitoids, spiders.