Captan is a cornerstone fungicide for apples because it is very effective against apple scab and also controls summer fruit rots. Captan has long been noted for its ability to prevent scab on fruit even when scab control on leaves is less than perfect. In fungicide tests in replicated plots where we purposely used lower than recommended rates, Captan 50W at 3 lb/A has usually provided better control of apple scab than mancozeb fungicides applied at the same rate.

Fungi do not become resistant to captan because it blocks multiple biochemical pathways (i.e., it is a multi-site inhibitor). Resistance to captan can occur only if fungi develop simultaneous mutations for all of the blocked pathways, something that has not happened in the 60 years since captan was introduced.

Captan kills spores that it contacts, whereas many of our newer fungicides kill fungi or arrest fungal growth only after germ tubes emerge from the spores. As a result, when captan is applied in combinations with other fungicides in protectant sprays, captan usually does 90 to 99% of the work by killing spores on contact, thereby reducing selection pressure for fungicide resistance to the other product in the tank mix. We use tank mixes with other fungicides (dodine, benzimidazoles, DMIs, strobilurins, SDHIs) to expand the spectrum of disease control and/or to control/suppress the small amount of scab that may have escaped control from the last spray. Captan does not control powdery mildew or rust diseases, so tank mixes are needed to control those diseases even when captan alone might suffice for controlling apple scab.

Unfortunately, captan also has a dark side: it is toxic to plant cells if it penetrates into leaf or fruit tissue. Spray oil and other spray adjuvants that act as penetrants allow captan to move through the protective wax cuticle on leaf surfaces. When that occurs, we see captan-induced leaf spotting, usually on the two or three leaves on each terminal that were just unfolding at the time trees were sprayed. It takes time for cuticular waxes to develop on new leaves, so young unfolding leaves are the most susceptible to spray injury. The leaf cells directly killed or injured by captan provide entry sites for other leaf spotting fungi such as Phomopsis, Alternaria, and Botryosphaeria than can enlarge the spots. It may take five or 10 days for the injury to become visible, and by that time the injured leaves may be 5 or 6 nodes below the growing point on terminal shoots.

the three weeks after petal fall because during that time period terminal shoots are growing very rapidly (i.e., producing lots of new leaves), and spray mixtures used at petal fall and in first and second cover sprays commonly include insecticides, growth regulators, foliar nutrients, and spray adjuvants. Captan applied alone almost never causes leaf spotting on apples. Rather, it is the other products in the tank that sometimes enhance captan uptake and trigger the resultant
phytotoxicity. Increasing the number of products that are included in a tank mixture increases the probabilities that the mixture will enhance captan absorption and result in injury to leaves.

Early last week, we became aware that, under some conditions, spray mixtures that included Fontelis and captan were triggering unacceptable levels of leaf spotting or leaf edge burn. Because orchards showing injury were always treated with spray mixtures that included more than just Fontelis and captan, we lack definitive proof that Fontelis was the key contributing factor. However, the other products in these spray mixtures had previously been combined with captan without causing noticeable injury. In Quebec, Vincent Philion noted severe damage on Spartan apple trees sprayed with a tank mix of Fontelis-captan-urea under slow drying conditions. Urea in that mix may have exacerbated the captan damage, although urea-captan combinations have been used without incident in the past.

Following is a summary of our observations on injury associated with Fontelis-captan mixtures based on contributions from Vincent Philion in Quebec and crop consultants Jeff Alicandro and Jim Eve in Wayne County, New York:

1. Thousands of acres of apples have been treated with Fontelis-plus-captan combinations, and damage has been noted on only a very, very small percentage of the treated acreage.
2. Factors that seemed to increase the probability of injury were applications made under slow drying conditions (e.g., spraying at night) and applications that were made with low volumes of water (i.e., <100 gal/A).
3. Damage is primarily on leaves and is usually limited to a few leaves per terminal. In some cases, only occasional terminals show damage and the injury is very minor.
4. Cultivars vary in their susceptibility to damage, with the greatest damage being reported on Braeburn, Spartan (Acey Mac), Red Delicious, Empire, Gala, and Mutsu.
5. The unusually hot weather that prevailed throughout much of the northeast during the last few days of May might have contributed to the problem by favoring rapid terminal growth and/or by making trees more susceptible to damage via some other mechanism.

Although DuPont, the manufacturer of Fontelis, had run extensive trials to test the safety of Fontelis-captan mixtures, it is impossible to duplicate all of the tank mixtures that apple growers will ultimately use. Nor can test conditions ever duplicate all of the environmental factors that prevail during applications after products are commercialized. Thus, the discovery of occasional problems with Fontelis-captan mixtures is one of those unfortunate but perhaps unpredictable events that can occur in the process of commercializing a new product. Fontelis will remain an important apple fungicide for controlling scab and rust, especially during the time period when it can be combined with mancozeb.

It is important to note that some pathogens cause leaf spotting that is very similar to leaf spotting caused by captan injury. Rust-induced leaf spotting occurs when cedar apple rust spores germinate on apple cultivars that are resistant to rust (Fig. 4). The invading rust fungus soon dies due to the host incompatibility reaction, but the cells killed or damaged by the germinating rust spores provide entry points for leaf spotting fungi. Rust-induced leaf spotting can be differentiated from leaf spotting due to phytotoxicity by the fact that rust-affected leaves usually
show some bright yellow-orange pinpoint spots either at the center of lesions or at other locations on the leaves where the rust spots were not followed by secondary pathogens. Frog-eye leaf spot caused by Botryosphaeria obtusa can also cause severe leaf spotting, but distribution of this disease is very uneven within trees, with most infections occurring below over-wintering fruitlet mummies that supplied the inoculum.

Finally, pesticides other than captan can also cause leaf spotting and/or leaf burn. Sulfur and liquid-lime sulfur can cause damage when applied ahead of hot weather and/or if mixed with or applied close to oil sprays. Last year, Topguard fungicide caused a leaf-edge burn when applied to Cortland trees in my test plots that had recently been treated with streptomycin plus Regulaid. Topguard injury has reportedly been observed on Braeburn when sprays were applied with enough water to allow droplets to accumulate on leaf edges.

Defining the exact cause of phytotoxicity on apple leaves is often difficult. However, we know that special cautions are required when applying captan because it has a demonstrated record of causing phytotoxicity to leaves if oils, adjuvants, or carriers in other pesticides enable captan to penetrate into leaves.