Crop Load Management in Vermont Apple Orchards

Overview

Since orcharding developed from a sideline operation for diversified and subsistence farms in the early 1900's annual cropping and subsequent cash returns have been a primary consideration for apple growers. Left to their own devices, apple unthinned apple trees will tend to produce large crops of small fruit every other year at best, with excessive vegetative growth in the 'off' year. Management of the crop load produced by apple trees allows growers to accomplish many goals, including maintenance of annual yields with adequate return bloom the following year, production of larger, more marketable (and profitable) fruit, and maintenance of a good balance of vegetative to fruiting wood in the trees.

The fruiting cycle of an apple tree begins in June, when formation of fruit buds that will open the following year occurs. During this period, the tree must have adequate mineral nutrition, and not face excessive resource competition from an excessive load of developing fruit. Thus, thinning this year's crop affects not only the quality for the coming season, but for the following season as well.

Pollination

Before those fruit can be thinned, they must be 'set' from flowers that opened during the blossom period that typically comes in early to mid-May in Vermont. An apple blossom must be fertilized with pollen from another variety in order for the ovary to form and produce a fruit for that season. Unfertilized blossoms will drop from the tree soon after dropping their petals. Growers of single-variety blocks must ensure adequate cross-pollination by planting compatible varieties with overlapping bloom periods within close proximity to the main crop in the block. Planting diagrams that maximize the intended variety yet provide adequate cross-pollination potential have been developed (see the Cornell Cooperative Extension Service Information Bulletin 237 referenced above for more information). Multiple-variety orchards have fewer pollination problems due to the diversity of pollen sources provided to pollinating insects.

As soon as blossoms begin to open, growers introduce domestic honeybee hives to the planting. Generally speaking, a density of one hive per acre is ideal, often with four hives placed on a pallet and placed centrally to a four acre block. Honeybees are extremely effective pollinators when they fly, which tends to occur during warm (>65° F), sunny weather with little wind. If this ideal 'bee weather' is experienced during bloom, the bees may perform their job in a single day given adequate density in the orchard. If conditions during the bloom period are cold, cloudy, or windy, bees may need more time in the orchard, or alternative pollinators may be used. These include bumblebees and orchard mason bees, both of which are available commercially. It is important to keep pollinators in the block until all varieties have bloomed and had a chance to be pollinated. Early or late-blooming varieties may require additional 'bee-time' to ensure that pollination conditions are met.

Fertilization

Following pollination, which is simply the physical movement of viable pollen to a receptive stigma, fertilization must occur. In order for this to happen, the pollen grain must germinate and send a pollen tube down the stigma to a receptive ovary. Optimum conditions for fertilization are similar to that for bee flight, although this process may occur at slightly lower temperatures with pollen tube growth slowing greatly below 51° F. Growers can ensure better fertilization conditions by optimizing the mineral nutrient status of the trees, especially nitrogen and boron.

Fertilized ovules will now begin to grow seed tissue which produces hormones that allow individual fruitlets to better compete for mineral and other nutrient resources in the tree. Fruit which were adequately pollinated and fertilized, with at least six and up to ten seeds forming within them, will begin to 'set', and increase in size. Fruitlets that have set can be identified as early as one week after petal fall by the characteristic closing up of sepals. Fruits that will drop often can be further identified by a yellow or red color to the stem tissue. In the picture below note the bottom fruitlet with its sepals still open, compared to the closed sepals on the other fruit. Also notice the reddish-yellow stem of the upper right fruit, this will abscise soon.

Thinning

After putting much effort and a little worry into setting a crop of fruitlets, a grower now must consider how they will remove a substantial portion of the crop. In order to set a commercial crop of apples that will have adequate fruit size and ensure return bloom for the following year, a tree need only retain 10-20% of the potential fruits based on the original blossom density. Thinning is achieved by either chemically or manually removing fruitlets, with some growers using both tactics in a season. Thinning operations generally commence at petal fall or soon after, although some blossom thinners are available to growers. With chemical thinners, best response occurs when fruitlets from the king or central blossom are 10-12 mm in size, with a marked decrease in efficacy after reaching 20 mm. Developing thinning programs can be a complicated process, with many considerations including original blossom density, weather during and after bloom, pollinator activity, weather following thinner application, and varietal differences all interacting with one another. Increasingly growers will apply thinners at the petal fall stage and follow up if necessary at 10-12 mm fruit size. Application of two milder thinning treatments can result in a grower better able to adjust their program or plan around weather.

Plant growth regulators used in thinning programs include carbaryl insecticide, auxin hormones (napthalene acetic acid or napthalene acetimide), and cytokinin hormones (6-benzaldehyde). Organic growers sometimes use liquid lime sulfur and/or fish or mineral oil products labeled for fungicide and insecticide uses, respectively, that also exhibit some thinning effect when used at petal fall to 10-12 mm fruit size. Specific thinning programs should rely on grower experience and information from the latest New England Tree Fruit Management guide, available from the Cooperative Extension Service of each New England state.

In the photo below, the fruit cluster on the left was not chemically thinned. The single-fruit clusters in the photo on the right were from trees treated with carbaryl and 6-BA fourteen days prior.

Apple trees, both thinned and unthinned, will exhibit a 'June drop' roughly 4 weeks after petal fall. During this period, the tree will abscise naturally many fruit that did not compete for limited resources in the tree. Thinned trees will also shed their remaining uncompetitive fruit during this period. Growers should not be alarmed at seeing fruit on the ground at this time, but rather focus on the fruit remaining in the tree. A target on one fruit per blossom cluster on every other cluster born on the tree is considered a target for a good crop load.

Useful links:

- Pollination and Fruit Set of Fruit Crops - Cornell Cooperative Extension Service Information Bulletin 237
- Insect Pollination of Cultivated Crop Plants - 1976/2009 USDA ARS Bulletin
- Plant Growth Regulator Uses in Apples - A Guide to their use in Wisconsin

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