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The Citrus Integrator: Integrating Insect and Disease Management

Decision models for integrated crop management range from the simplistic to the highly complex. Most useful models fall somewhere between the two extremes. The needs of teachers, researchers, and growers should also be met, so that continuity can be maintained from the classroom to the field. Unfortunately, the decision methods of many growers are unresponsive to process improvement, since there is no common language by which new technologies are easily integrated into commercial practice. If significant advances are to occur (e.g., expert systems development), then an integrated template must be developed. One such model—the Citrus Integrator—is a step in that direction.

Abbreviations Used in the Citrus Integrator

B	benomyl
C	copper
CRM	citrus rust mite
gs	greasy spot
M	surveyed mite density (mites per square centimeter)
T	average daily temperature (°F)

How to Use the Citrus Integrator

The Citrus Integrator (Plate 57) is a decision flowchart for integrating citrus insect and disease management. It consists of the Decision Guide, on the first page, and the Management Guide, on the second page. The upper half of the Decision Guide is the insect management model, and the lower half contains disease management information. The upper portion of the Management Guide outlines crop phenology and biological agents associated with changes in pest populations, and the lower portion details the integrated management timeline.

The Citrus Integrator is an effective teaching guide, but some field management details have necessarily been omitted because of space constraints. The model involves five major pests and diseases—citrus rust mite, greasy spot, melanose, Alternaria brown rot, and scab—because the management actions and materials used to control these problems overlap.

The use of the Citrus Integrator is best illustrated by example. Following the arrows and responding to the queries at each junction box in the Decision Guide will lead to a timeline in the Management Guide. The numbered steps in the Citrus Integrator are not followed in sequence; the numbers are given as positional references only. All pest management decisions involve market considerations, so it is appropriate to start with an economic evaluation.

Beginning at Step 1, suppose that economic factors have been evaluated and it is determined that a Valencia crop will be intended for the processed market. In Step 2, suppose that surveys have established that the citrus rust mite density is about three mites per square centimeter and that populations of other economically important insects are below damaging levels. Weather data suggest that average daily temperatures of about 76°F can be expected for the next several weeks. Referring to the middle of the three charts in Step 2, find the square at the intersection of 76 on the T axis and 3 on the M axis and, noting that the square is olive green, move down to the query box of the same color (Step 6). Since the crop is not intended for the fresh market, follow the No arrow left to the Spring/Summer query box (Step 5). Then track the Yes arrow down through the Processed option and then down to the June/July/August query box (Step 12). If the current date is in one of these months, follow the Yes arrow down and to the left, where Valencia is listed (Step 13). An evaluation of disease severity is made, based on disease history. If disease severity is moderate (Step 16), follow the arrow to the go-to box at the bottom of the page. This box refers to the integrated management protocol detailed in Timeline 32 on the following page of the flowchart. Since a specific treatment for rust mites was not diagnosed, Timeline 32 shows that these processed Valencia oranges need only a single copper spray to control greasy spot, applied in June to early July. If a miticide were required, however, the grower need only to refer to Timeline 40 to find a list of materials that could be included in the June treatment.

Other management scenarios are handled in similar fashion. For example, had the mite density or average daily temperature been much lower, the path would have tracked through the blue option in Step 5, resulting in a recommendation of no miticide. If it were April instead of June, the arrows would have led to the Natural Predators go-to box (Step 3). Over time, recogniz-

ing natural predators by name can help growers better judge when pesticide applications can be delayed or avoided.

The modular framework of the Citrus Integrator is readily modified and expandable as new technologies are developed. For example, the predictive model for postbloom fruit drop (Box 10.1) could reasonably be integrated into the path before the economic evaluation of Step 1. Similarly, an economic model could replace the Step 1 junction box, to be invoked whenever diagnostics are initiated. Neither addition would disrupt the flowchart logic.

Management cells are the boxes in the Management Guide defined by the intersection of a row and a column in the chart. They are related to crop phenology. For example, management cell 35-B describes the development and protection of the spring growth flush from greasy spot disease on fresh orange crops. Thus, in addition to helping growers understand how management decisions are interrelated, the Citrus Integrator can facilitate the development of expert systems for pest management.

Notes for the Example

Step 2. Other insects are surveyed on the basis of presence or absence; however, other rating systems may be used without disrupting the flowchart logic. The divisions between the colored areas in the charts in Step 2 may vary, depending on the geographical location.

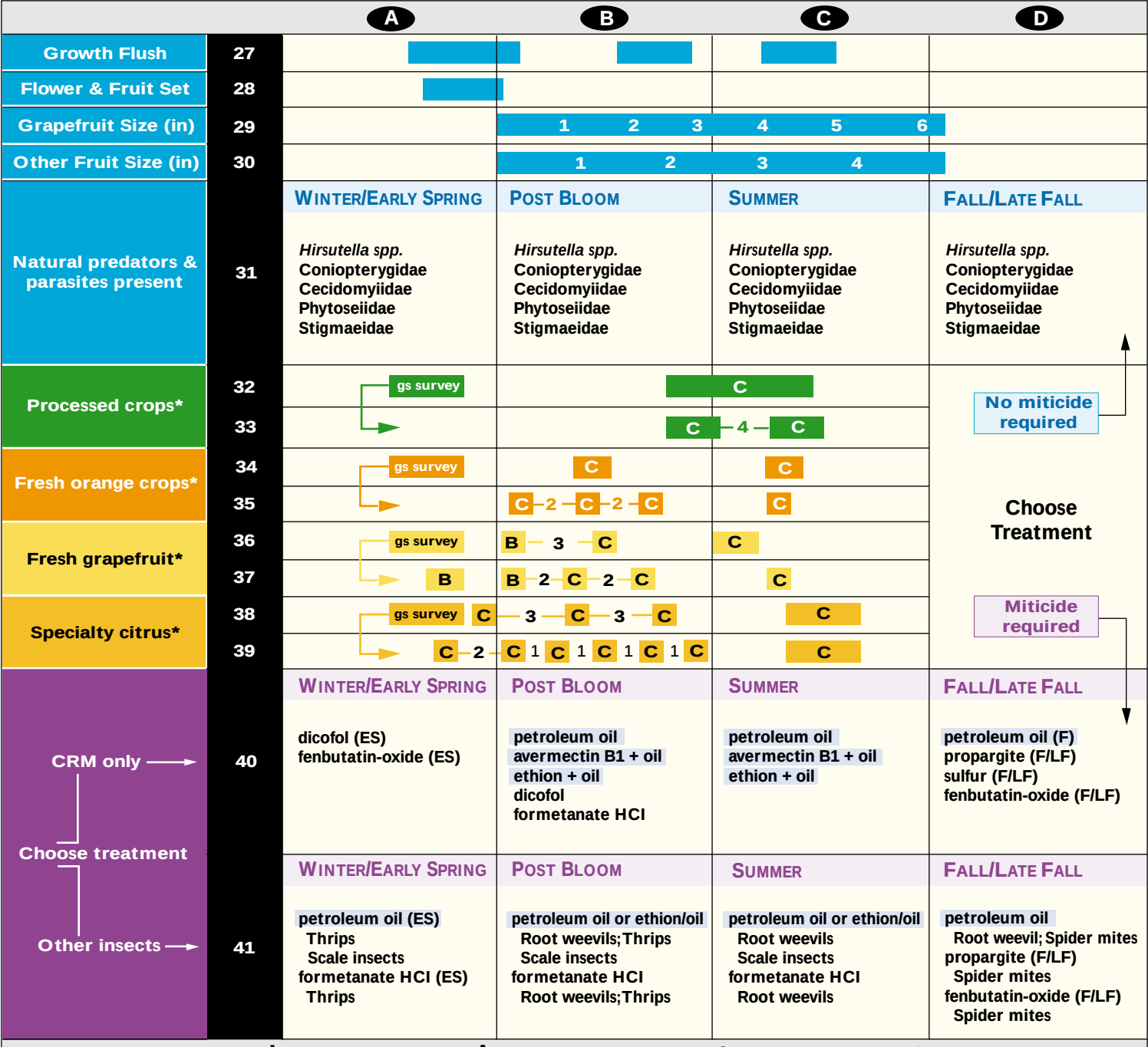
Step 15. Disease severity is estimated from foliar symptoms and winter inoculum surveys.

Timeline 31. Predators and parasites may vary from country to country.

Timeline 32. Processed Valencia, Murcott, tangerine, and tangerine hybrids are usually in this group.

Timeline 33. Processed grapefruit, Hamlin and Pineapple oranges, and tangelos are usually in this group.

Timeline 36. The numbers between the time bars represent the number of weeks between treatments.



TREATMENT NOTES:

* Numbers between time bars represent the number of weeks between treatments.

1 - 30: See supplementary text for notes on steps 1 to 30.

31: Specific genera of predators and parasites vary from one geographical area to another. Others not listed here may also occur.

32: Processed Valencia, murcott, tangerine and tangerine hybrids will occur most often in this group.

33: Processed grapefruit, Hamlin, pineapple and tangelos will occur most often in this group.

34: Spray approximately May 1, then later in summer for greasy spot control.

35: Alternative: benomyl at petal fall for scab, which will also control melanose, then copper at 2 to 3 wk. intervals.

36: Benomyl, carbamate or copper after petal fall with copper (4 to 6 lb. ai per acre) as the second application.

37: Benomyl or carbamate at 25% to 50% spring flush expansion. Alternate benomyl, carbamate or copper at early postbloom.

38: Spray at petal fall followed by 2 subsequent monthly applications. Specialty varieties not scab-susceptible may be treated using this program (e.g., 'Fall-Glo').

39: Spray at 25% to 50% spring flush expansion, after petal fall, then every 1.5 to 3 weeks depending on rain & disease severity.

40: Choose materials from this row if rust mites are the only problem insects. Blue highlighted materials may be mixed with copper.

41: Choose materials from this row if there are insects other than rust mites present at damaging levels.

THE CITRUS INTEGRATOR™