Using Growing Degree Days for Alfalfa Production

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The use of growing degree-days (GDD) in conjunction with field scouting for pests can result in better management of alfalfa and more profit for producers. They help determine when to apply pesticides for the best control of pests and when to harvest the first cutting of alfalfa for the highest quality hay.

What are growing degree-days?

Growing degree-days (GDD) is a measure of the amount of heat needed for plants, insects, and microorganisms to grow and develop. If a plant or insect is too cold, it cannot grow. However, at some minimum temperature, growth begins. The warmer the plant or insect is, the faster it grows up to a maximum temperature when growth stops. Growth and development rates of plants, insects, or microorganisms are assumed to be roughly linear between the minimum and maximum threshold temperatures. Temperatures above the threshold maximum may cause it to stop growth and development or that the rate of change remains constant.

For each day that the average temperature is one degree above the minimum temperature, one degree day accumulates. Degree-days (24-hour period) provide an estimate of the growth stage of a plant, insect, or microorganism based on temperature measurements. The warmer the weather, the faster degree-days accumulate until the maximum threshold temperature is reached. GDD start to accumulate on the biofix (beginning) date of January 1 each year.

For example, the minimum threshold temperature for alfalfa growth is 42°F and the maximum threshold temperature for alfalfa is 110°F. If the day's high and low were 93°F and 51°F respectively, then the average daily temperature of 72°F for the day would result in an accumulation of 30 GDD (72°F - 42°F = 30 GDD). If the average temperatures were to go below 42°F threshold or above 110°F threshold, no GDD would accumulate. The average daily temperature is calculated by adding the days high and low together and dividing the result by two; then to get degree-days subtract the minimum developmental threshold temperature (Sakamoto, Gifford, and Koh, 1977).

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GDD_{42} = \left\{\frac{\text{daily max. temperature} + \text{daily min. temperature}}{2}\right\} - \text{base temperature}_{42}
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GDD_{42} = \left\{(93 + 51) \div 2\right\} - 42 = 30 \text{ GDD}
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How are GDD used to manage pests and produce high quality hay?

Lygus peak hatch (when the first 3rd instar appears) normally occurs at approximately 250 GDD (Champlain and Butler, 1967). Producers can monitor GDD and scout for lygus as GDD approach 250. For those trying to produce dairy quality hay, timing of harvest is critical. Dairy quality hay is usually considered to be 40% or less NDF (neutral detergent fiber or fiber content). If hay is harvested at approximately 600 to 700 GDD then NDF is usually 40% or less which is "dairy quality hay" (Cherney and Sulc, 1997; Hay & Forage Grower, 1988)). The relative small range in timing for insect control and hay quality can be predicted more effectively with GDD. GDD accumulate each day, thus effective pest control and hay quality determination are best accomplished with regular monitoring of accumulated GDD.

Timing the insecticide application is critical in Lygus control

When insecticides are applied either too early or too late, optimal control is not achieved. Early applications miss the insects, they have not hatched, and most insecticides do not harm the eggs. If applications are applied too late, much of the damage to the crop has already been done. Furthermore, mature insects (later instars of Lygus) are more difficult to control than immature insects.

Peak hatch occurs in Lygus around 250 GDD. However eggs may begin hatching around 160 GDD. At 250 GDD many Lygus are present in the first to third instar stages of development. It is important to use field scouting along with GDD, to know when it is best to treat. However in most cases, the optimal time to treat for lygus is 250 GDD. Chart 1 shows the accumulated GDD for Lygus in late May of 1999 for Humboldt and Pershing Counties.

Chart 1
Lygus populations and GDD affect timing of control

Chart 1 is an example of GDD accumulated for Lygus in 1999. Keep in mind that GDD varies from year to year. On May 25, 1999 the GDD for Lygus in Lovelock Upper Valley, Lovelock Lower Valley, Orovada and Silver State Valley were 296, 284, 227, and 226 respectively. Therefore, based upon accumulated GDD, growers in the Lovelock area should have already scouted and sprayed as necessary, or be in the process. Growers in the Orovada and Silver State Valley region should have begun closely scouting fields and spraying as needed as GDD approached 250, which occurred within the next few days. Remember that field scouting is critical when trying to determine if insects are present in sufficient quantities to warrant economical treatment and in determining the proper timing of insecticides.

Using GDD for Optimal Timing of Harvest for First Cutting Hay

Over the last two years the difference in the price of dairy quality hay and poorer "cow hay" has often been more than $50 / ton. The stage of plant maturity at harvest has a bigger impact on hay quality than any other factor. Therefore, proper timing of harvest is critical in achieving dairy quality hay. As mentioned earlier, to achieve high quality hay on the first cutting, harvest should occur around 700 GDD (Cherney and Sulc, 1997). Chart 2 shows the GDD for alfalfa hay in late May for Humboldt and Pershing Counties.

Chart 2

Chart 2 is an example of GDD accumulated for alfalfa hay in 1999. On May 25, the GDD for alfalfa hay in Lovelock Upper Valley, Lovelock Lower Valley, Orovada and Silver State Valley were 741, 720, 589 and 571 respectively. Therefore, based upon GDD, growers in the Lovelock region should have begun cutting in Lovelock. Growers in the Orovada and Silver State Valley region should have begun to closely monitor their fields for maturity and begun cutting as GDD approached 700 if the production of dairy quality hay was a goal.
Visual appraisal may be misleading

To achieve dairy quality hay, first cutting must be cut in the vegetative stage. If you can look across a field and see bloom, the hay is past dairy quality (most likely it is around 50% bloom). If you pick 10 stems and one of the ten has ANY bloom, the field is in 10% bloom and may be past past dairy quality stage.

Conclusion

GDD is another management tool available to producers. While it can be a very useful tool in achieving optimal insect control and when trying to produce dairy quality hay, growers should realize that it is not a cure-all. GDD requires a higher level of management skills. Growers need to carefully monitor their fields and apply insecticides accordingly. If dairy quality hay is a goal, growers should monitor GDD in order to cut at the most opportune time that will result in the highest quality.

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References:


