Cooperative Extension | University of California | Santa Barbara/Ventura Counties

UCCE & DPR Sponsored

California Department of Pesticide Regulation

Lompoc
Ornamentals & Row Crop
Pest Management
Project

No. 12
Summary Issue

University of California Cooperative Extension

624 W. Foster Road, Suite A
Santa Maria, CA 93455

IPM Information Series

January, 1998

Information Series
Summary Issue
By Phil A. Phillips

In this issue of our Lompoc Project "Information Series", we want to summarize some of the key points regarding IPM in row crops grown in coastal California. In previous issues we have covered a broad range of topics from irrigation management to the impact of micro-climate on disease development.

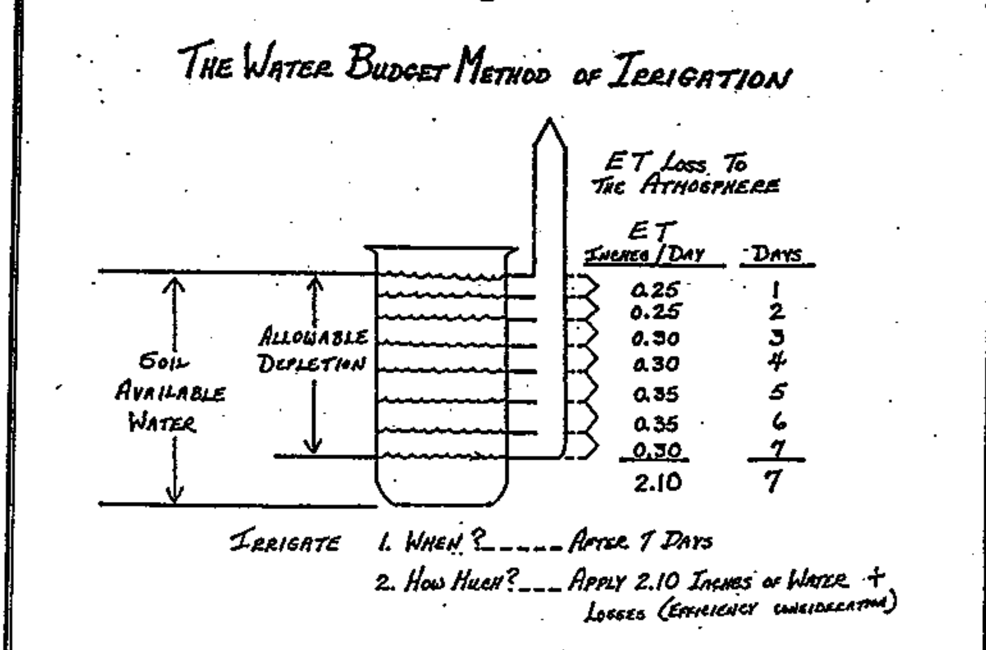
IPM principles :

A healthy plant is the baseline defense against insects, mites, nematodes, and pathogens. We have previously discussed how irrigation management is a very important component of maintaining plant health (Information Series #1, July '97). No matter what system is used for monitoring soil water depletion, it is imperative that water losses from plant uptake, soil surface evaporation and percolation be continually measured and accounted for in order to properly determine the need for subsequent irrigations. Irrigation scheduling based solely on the calendar is insufficient and will likely lead to plant stress and subsequent loss of inherent plant resistance to pest attack with the end result being less net profit to the grower (see Fig.1).

When pesticide intervention is necessary, the use of selective as opposed to the more traditional broad-spectrum pesticides is a very important part of any IPM program. Classes of pesticides such as the botanicals, soaps and oils, *Bacillus* products (BT's), and the newer generation fermentation byproducts are generally considered selective and more environmentally benign than the organophosphate, carbamate, and pyrethroid classes of pesticides. The more selective pesticides can be used with less concern for disruption of secondary pests such as aphids, whiteflies, leafminers, and mites than when the more broad-spectrum pesticides are used. This is primarily because beneficial predators and parasites which keep secondary pests under control are conserved with the use of selective pesticides. Additionally, with the use of many of the insecticides within the broad-spectrum classes of pesticides there can occur the phenomenon known as hormolygosis. With hormolygosis, the pesticide treated plant responds as if it has been wounded by producing more free amino-acids in cell sap. This in turn provides the herbivorous pests with a more nutritious food source which allows them to potentially produce more and stronger progeny. The net result is a more prolific pest population than prior to the pesticide application. Many of the problems associated with the use of broad-spectrum pesticides can be overcome when these materials are used as spot treatments of relatively small delineated areas. This allows reservoirs of undisturbed beneficials to remain around the treated area. The use of these same materials formulated as a bait rather than a spray tends to serve the same purpose by exposing to the toxicant only those target organisms which are attracted to the bait.

With selective pesticides, the nature of the selectivity is often not so much toxicological as it is lack of residual toxicity. Since many of the selective pesticides only kill the target organism for a short period of time, timing the application of these products is generally crucial to their success. In order to determine the most appropriate time for pesticide application or for the release of beneficial organisms, it is necessary to carefully monitor both the pest and appropriate beneficial species.

Fig. 1.



At several Lompoc Project meetings and field days as well as in this "Information Series" we have discussed the use of various monitoring techniques including pheromone traps, sticky traps, timed searches, beating trays and replicated observations. With very minimal time expenditure it is possible to produce a very clear picture as to the status of any particular pest at any particular time by using one or more of these techniques. The success of any monitoring system is predicated on the consistency of the monitoring technique used and the frequency of its use. For instance, in monitoring for a diamondback moth larval hatch early in a crop of broccoli or stock (fresh cut flower), it is important to search either the same number of plants each time or to search for the same length of time (timed-search) at each location in the field during an inspection so that the information gathered is not only comparable from location to location within the same field, but is also comparable between fields or for the same field over several inspection dates. It is only in this way that an accurate assessment of the current population and its increase or decrease over time can be made. This sort of consistent , quality information is invaluable when an assessment of a recent pesticide treatment's efficacy is desired.

Although the short term nature of row crops relative to permanent cropping systems such as tree crops (or even strawberries) often doesn't allow sufficient time for many beneficial species to build their populations in response to pest buildup, their are in fact quite a few opportunities for the grower or PCA to take advantage of biological control in row crops. Leafminers, for instance, are generally under excellent biological control until they are released from their parasites by the application of organophosphate, carbamate, or pyrethriod insecticides. The parasite *Diglyphus begini,* one of several leafminer parasites, can average 75% leafminer parasitism several weeks after transplanting when selective products such as the BT's and avermectin are used as opposed to the carbamate methomyl and the pyrethriods. Beet armyworm can be heavily parasitized by *Hyposoter exiguae* in host crops where the more environmentally benign pesticides are used. Trichogramma parasites which attack the egg stage of many lepidopterous pests such as cabbage looper and corn earworm are extremely sensitive to the broader-spectrum pesticides. In fact, most of the parasitic hymenoptera (small stingless wasps) such as these are easily decimated by even the slightest pesticide drift from one field to another adjacent field down wind. In order for growers to optimize the free biological control offered up by the myriad of beneficials which attack row crop pest insects and mites, it is best that large areas of several hundred acres or more be under a biologically intensive IPM program in which every effort is made to use only selective pesticides or broad-spectrum pesticides in bait form in combination with other control tactics such as cultural controls..

Cultural control methods include manipulations of management operations such as the time of planting or irrigation scheduling. For example, in a previous issue of "Information Series" on the seedcorn maggot (#3, March/April '97), we discussed the importance of delaying the spring planting of direct-seeded crops into fields containing large amounts of undecomposed organic residue from a previous winter crop to avoid serious crop loss from resident maggot populations. It is also recommended to use an additional cultural technique, that of dragging a chain directly over the seed row and behind the planting shank so as to cover the freshly exposed moist organic odors emanating from the soil and prevent adult seedcorn maggot flies from homing in and laying their eggs directly into the new seed row.

In disease management it is often important to manipulate irrigation practices to mitigate severe disease pressure. For instance, many fungal pathogens require water on the plant surface before they can infect healthy plant tissue. Botrytis grey mold is a good example of this. By scheduling irrigation runs, especially overhead sprinklers, during the night, when plant surfaces are likely to be wet anyway, and shutting them off early in the morning, plant surfaces are permitted to dry off during the day and are thus subject to a shorter period of wetness than if they had been irrigated during the daylight hours. Since disease severity or pressure is often worse with longer periods of plant surface wetness (leaf wetness), this sort of irrigation management can reduce disease pressure considerably. Merely shifting from sprinkler to drip or from surface drip to subsurface drip can significantly reduce periods of leaf wetness and thereby reduce disease pressure.

Know your enemy :

We have examined the importance of knowing the basic biology and behavior of the pest organism(s) you are trying to control in previous issues of this publication and at Lompoc Project seminars. Without this information it is impossible to formulate a successful IPM program for a given crop/field situation. Each species of insect, mite, nematode, weed, and pathogen has unique biological parameters for its growth and development. Knowing these specific requirements along with specific behavioral attributes permits the development of a customized IPM program for each situation. For example, knowing that the fungus *Septoria apiicola*, the causal agent of late blight in celery, has a lower developmental temperature of 55 degrees F allows us to lessen fungicide application during cold storm periods. Most insects have lower developmental temperatures around 50 degrees F. Many of the newer, more selective pesticides have activity against one or more, but not necessarily all, of the target pests in the field. For this reason alone it is imperative to know the exact identification of the organism you are attempting to control. Most pests have some point in their life cycle which is more susceptible to a specific control tactic that other stages. These points of susceptibility often differ from species to species, making correct identification essential for successful control.

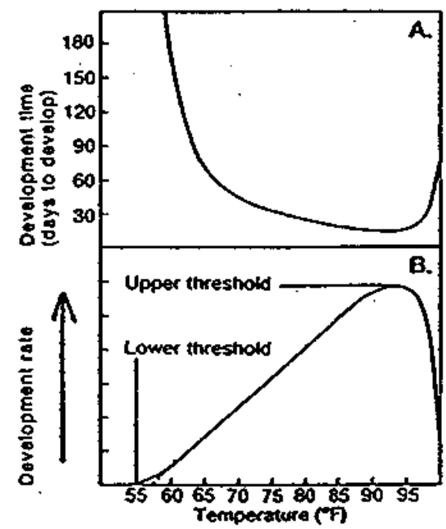


Fig. 2. An organism develops more quickly as temperatures increase up to a point, after which development slows. From Wilson and Barnett (1983).

What drives organisms? :

In the first issue of this publication we examined the concept of physiological time. This is basically the developmental time of an organism as determined by the ambient weather conditions within which it finds itself. The primary driving force is temperature, which determines the rate of the biochemical reactions which have to take place within the organism in order for it to develop. As noted above, all organisms have some lower threshold temperature below which their development ceases or is so slow as to be insignificant. Additionally, there is some thermal maximum at which development ceases and/or death occurs (see Fig.2). Thus it follows that, in general, the more heat an organism is subjected to (below the thermal maximum), the more rapidly that organism will grow (see Fig. 3, an example from cotton pest research). It is for this reason that most insect pests are most abundant in the late spring and summer months as opposed to the winter. They are simply able to cycle through more generations per unit of calendar time(eg. per month)(see Fig.4). It is for this reason that insect development is better measured in units called degree-days rather than calendar days. Degree-days are simply a measure of the amount of heat to which the organism has been subjected. Since this measure of heat is the product of temperature and time, it is independent of the calendar. For example, the diamondback moth requires about 518 degree-days to complete one full generation with a lower developmental threshold of 45 degrees F while the beet armyworm requires a similar 520 degree-days but has a much higher "lower threshold" of 55 degrees F. Thus, under cooler coastal conditions, the diamondback moth can cycle through more generations per unit of calendar time than the beet armyworm because it can utilize the heat available at lower temperatures. Along the coast the diamondback moth can cycle through two or more generations for every generation of beet armyworm.

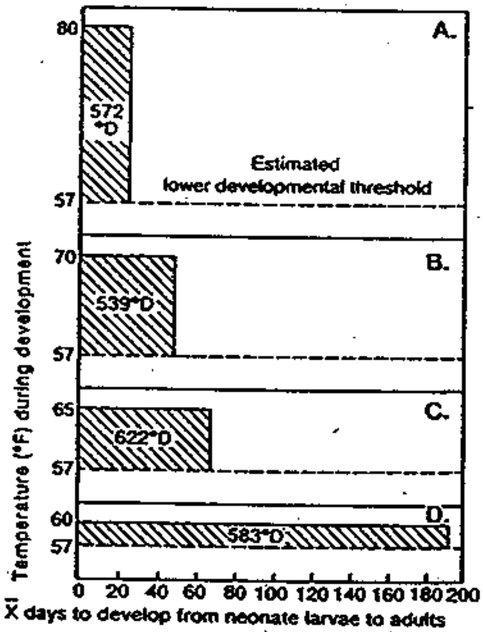


Fig. 3. Heat accumulation, or degree-days (°D), for cotton bollworm remains about the same, even though development time differs at different temperatures. From Wilson and Barnett (1983).

Pathogens are also dependent upon temperature for their development. However, many pathogens also require various conditions of humidity or of leaf wetness in order to infect plants and cause disease. For example, in a previous issue of this publication (#6, June '97) we discussed the Septoria late blight model which can be used to determine the need for fungicide sprays. This model is based on the biological requirements of average temperatures above 55 degrees F during periods of sustained leaf wetness. The warmer the temperature and the longer the period of leaf wetness each day, the more disease development can take place given the presence of the pathogen (see Fig.5).

A similar, although more complicated, situation exists with downy mildew of lettuce. Downy mildew conidia require free water on the leaf surface for germination and infection, while actual sporulation (spore production) only requires high relative humidity. Colonization by this pathogen requires temperatures at or above 70 degrees F. This is a considerably higher heat requirement than the septoria pathogen of celery discussed above.

Fig.4. Degree-days
Organisms with a lower developmental threshold temperature accumulate more heat units each day than those with a higher threshold.

Daily Degree-days Given The Day's Max. & Min. Temperature

Minimum temperature	50	55	60	65	70	75	80	85	90	95	100	105	110
						Maximum temperature							
						Threshold = 40°F							
75						35	37.5	40	42.5	45	47.5	50	52.5
70					30	32.5	35	37.5	40	42.5	45	47.5	50
65				25	27.5	30	32.5	35	37.5	40	42.5	45	47.5
60			20	22.5	25	27.5	30	32.5	35	37.5	40	42.5	45
55		15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	40	42.5
50	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5	40
45	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35	37.5
40	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35
						Threshold = 50°F							
	50	55	60	65	70	75	80	85	90	95	100	105	110
75						25	27.5	30	32.5	35	37.5	40	42.5
70					20	22.5	25	27.5	30	32.5	35	37.5	40
65				15	17.5	20	22.5	25	27.5	30	32.5	35	37.5
60			10	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35
55		5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30	32.5
50	0	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	27.5	30
						Threshold = 60°F							
	50	55	60	65	70	75	80	85	90	95	100	105	110
75						15	17.5	20	22.5	25	27.5	30	32.5
70					10	12.5	15	17.5	20	22.5	25	27.5	30
65				5	7.5	10	12.5	15	17.5	20	22.5	25	27.5
60			0	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25

Fig.5. Septoria Late Blight of Celery

Disease severity values (DSV's) as a function of leaf wetness period and average air temperature during the wetness period.

	Leaf-wetting time (hr) required to produce daily disease severity values of:					
Mean Temp (C)	DS V's					
	0	1	2	3	4	
13-17	0-6	7-15	16-20	21+		WET HOURS
18-20	0-3	4-8	9-15	16-22	23+	
21-25	0-2	3-5	6-12	13-20	21+	
26-29	0-3	4-8	9-15	16-22	23+	

Madden, L., S.P. Pennypacker, and A.A. MacNab. Phytopathology 68:1354-1358.

Summary:

Sound IPM programs that maximize returns to the grower are based on knowledge. Calendar scheduled pesticide applications are no longer sufficient to maximize grower profits. Information about the stage of crop growth, predicted weather, current and recent air and soil temperatures, leaf wetness events, relative humidity, and of course, the presence of pest organisms in the soil or on the crop is constantly needed to make informed decisions within a successful IPM program.