PAM in Irrigation Water

Polyacrylamide (PAM) is a synthetic water-soluble polymer applied to irrigation water or into furrows prior to irrigation. PAM binds together soil particles suspended in water then settles them to the furrow or ditch bottom. Water-soluble polymers similar to PAM are commonly used in treatment of municipal water supplies, food packaging and as adhesives. Water-soluble polymers were first introduced as soil conditioners in the 1950's. In recent years, new formulations and application techniques have improved the effectiveness of PAM in irrigation water. PAM has been shown to reduce soil erosion by 90-95 percent and improve water infiltration rates by 20-60 percent, according to NRCS and university studies.

Advantages

- Relatively low cost per acre
- High reduction of irrigation-induced erosion and soil loss
- Ease of product application and integration into normal irrigation practices

Disadvantages

- Extra labor or equipment required for application
- Repeated applications can increase cost per acre
- May increase soil infiltration rates in certain soil types beyond need
- Applications must be repeated following cultivations, increasing the cost per acre.

NOTE

In field studies in western Stanislaus County, PAM reduced sediment concentrations in furrow irrigation drain water but was not effective in reducing chlorpyrifos (Lorsban, Lock-On, Govern) insecticide concentrations in PAM-treated drain water. The results suggest that most chlorpyrifos in drain water is not associated with sediment, so sediment reductions have little effect on chlorpyrifos concentrations.

Application Methods

Dry Granular PAM

Dry granular PAM is typically applied using an augured metering system into a supply canal before it hits the furrow, or applied directly in the furrow using what is known as the "patch method". Proper agitation is needed to properly dissolve PAM in the irrigation supply ditch. Lack of agitation results in globules forming and little reduction in furrow erosion. A drop structure in the irrigation ditch can provide turbulence and aid in dissolving granules. The "patch method" involves placing PAM at the head of the furrow; spreading it across 3-5 feet of the furrow to reduce the risk of the PAM becoming buried or washing down with little or no effect.

Liquid PAM

Liquid PAM can be metered and injected directly into an irrigation ditch, furrow, or pipeline. Emulsified PAM (special liquid PAM solutions) can be applied like the granular form into irrigation ditches or furrows using the patch method. Emulsified PAM doesn't require as vigorous mixing as granular but still needs adequate mixing for dissolving. Emulsified PAM is more voluminous than dry forms, but is easier to dissolve and is the only form of PAM to use in sprinklers due to reduced risk of clogging laterals.

Solid Blocks or Cubes

PAM blocks (or cubes) are typically placed in wire baskets in flowing ditches at turbulent points. The blocks slowly dissolve, releasing small amounts of PAM into the water. PAM blocks may not perform as well as liquid or granular PAM in furrow irrigation. PAM blocks have been useful for treating sediment ponds to accelerate water clarification and promote flocculation. PAM blocks can also be used to dose concentrated runoff areas on fields that otherwise cause uncontrolled erosion.

Check with your PAM supplier for application rates to match your soil type and irrigation system.

PAM IN IRRIGATION WATER Central Valley Installation and Maintenance Costs

Cost Estimates for PAM (2007)

Product and Equipment Costs for Dry PAM

Item	Costs per Unit	
	Low	High
Product cost per pound	$3.50	$4
Product cost per acre, per application	$0.875*	$4*
Total product costs per acre, per year	$2.63**	$24**
Application Equipment (Fishfeeder)	$ 300	$ 300

* At a low rate of ¼ lb per acre and a high rate of 1lb per acre
** When applied 3 and 6 times per year, respectively

Estimated Costs of Granular PAM in Irrigated Furrows

Item	Costs per Unit
Material per pound	$ 1.86
Labor per application, per acre*	$ 1.00
Total, per acre, per event	$ 2.86
Total cost, per acre, per year**	$30.74

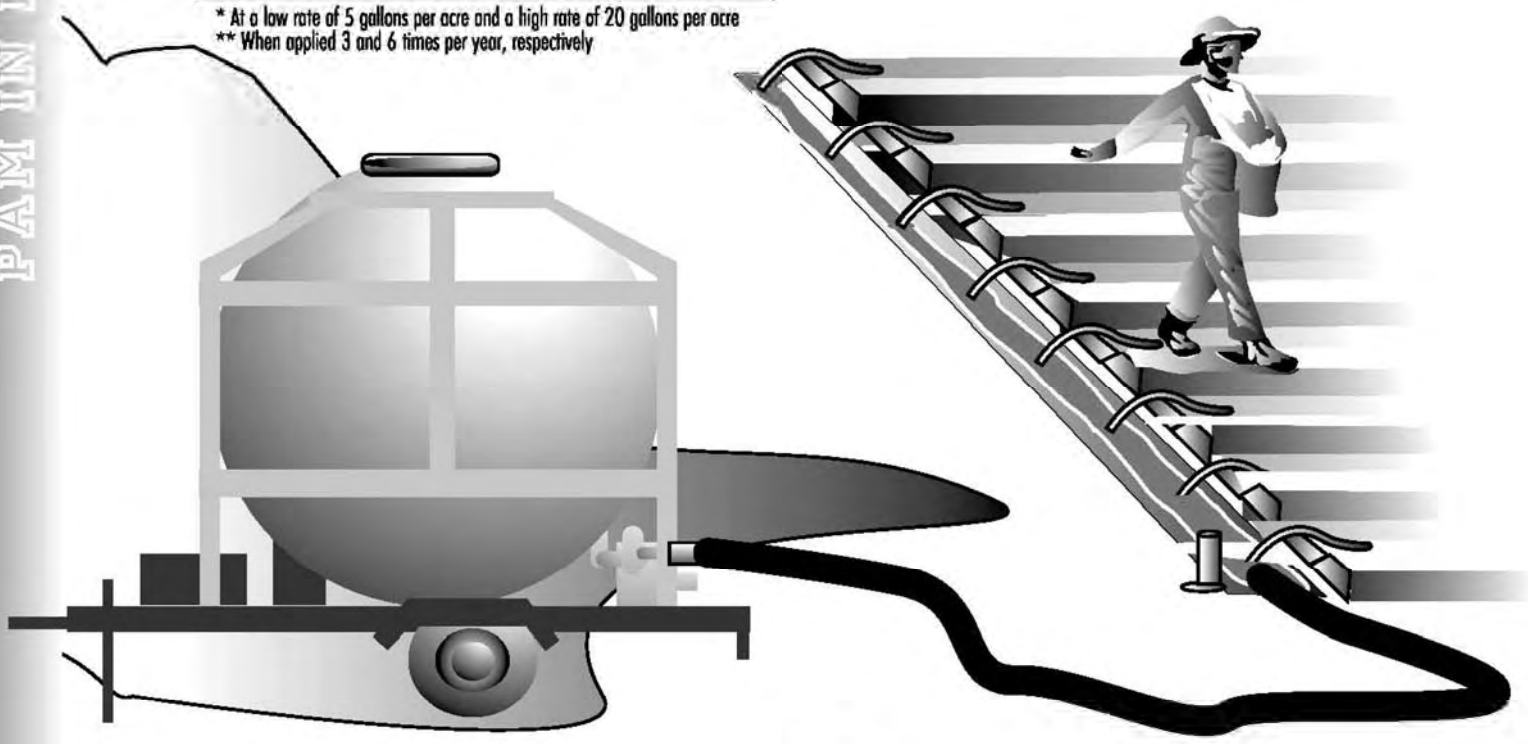
* Granular PAM (with an application rate of 1 lb/A)

** Applied at full rate for intitial irrigation and 3 irrigations following cultivation, then at half rate for 10 other irrigations (9lb/A, 14 events

Product and Equipment Costs for Liquid PAM

Item	Costs per Unit	
	Low	High
Product cost per gallon	$1.35	$1.35
Product cost per acre, per application	$6.75*	$13.50*
Total product costs per acre, per year	$ 20.25**	$81**

* At a low rate of 5 gallons per acre and a high rate of 20 gallons per acre
** When applied 3 and 6 times per year, respectively



BMP Handbook

Irrigation Scheduling

Irrigation scheduling is the process used by growers and irrigation managers to determine the correct frequency and duration of watering. Irrigation scheduling in simple terms is the knowledge of when to irrigate and how much irrigation water to apply. An effective irrigation schedule helps to maximize profits while minimizing water and energy use.

Weather-based irrigation scheduling can use either historical weather data, or "real-time" weather data. The former relies upon averages, while the latter tracks current conditions. Historical schedules work better with surface and impact sprinkler irrigation systems as high levels of soil moisture storage tend to buffer or smooth out daily differences in weather. Irrigation schedules using "real-time" weather data are recommended for all irrigation systems, but especially for drip/micro irrigation systems. These types of systems only water a portion of the potential root zone and therefore water storage is not as extensive as other types of irrigation.

One of the best ways to develop an irrigation schedule is through the Center for Irrigation Technology's "Wateright," available on-line at http://www.wateright.org. System specific information can be input (emitter numbers and spacing, flow rate, plant and row spacing, type of device, maturity of crop, etc.) and the program will do the calculations needed to develop the proper schedule.

In this booklet, five steps are described for the setup of an irrigation schedule:

1) Select an appropriate historical, and real-time, source for reference evapotranspiration (ET) rates and effective rain suitable to the area.
2) Select the appropriate crop coefficient data.
3) Select a soil texture and root zone depth appropriate for your area and crop.
4) Determine the management allowable depletion (MAD).
5) Select the appropriate irrigation efficiency.

Step 1: Select an appropriate historical, and real-time, source for reference evapotranspiration (ETo) rates and effective rain suitable to the area

The California Irrigation Management Information System (CIMIS) has an established network of weather stations throughout California that monitor real time weather conditions. You can access CIMIS at: http://wwwcimis.water.ca.gov/cimis/welcome.jsp. CIMIS calculates reference evapotranspiration or "ETo" for specific zones in California. Evapotranspiration is the combination of atmospheric evaporation and plant transpiration.

There are 4 CIMIS stations in the central San Joaquin Valley region: Station #92: Kesterson; Station #56: Los Banos; Station #148: Merced; and Station #161: Patterson. Although there is not a station in the center of the Orestimba Creek area, the most representative station appears to be Merced (station #148).

Step 2: Select the appropriate crop coefficient data

Reference ETo is usually determined by the amount of water used by a grass crop at the CIMIS station. Crop coefficients are used to determine water use for your specific crop in relation to its stage of growth. Early season crop coefficients are usually a small percentage of the reference ETo. Later in the season they can match or even exceed reference ETo.

Step 3: Select a soil texture and root zone depth appropriate for your area and crop

The Westside San Joaquin (northern region) watershed area generally consists of deep soils, with a range of soil textures from light to heavy. In some areas there are drainage impacted problems that may affect root zone growth. Your knowledge and experience with local crops and soil conditions will be a valuable tool in selecting a soil type and in determining an appropriate root zone for your particular crop.

In Table 1, rooting depth average, represents an average root zone in which 80% of the feeder roots would be contained

See www.curesworks.org for example irrigation scheduling templates. Three soil types were picked for each crop (with the exception of loamy sand for alfalfa, walnuts, and tomatoes, which are generally unsuitable crops for very light soils). These types of schedules can be developed at www.waterright.org.

Step 4: Determine the management allowable depletion (MAD)

Crops have varying ability to extract water from soil. As soils become drier, roots have to work harder to pull water out from soil pores. At a certain point, the plant begins to shut down and growth is slowed. Growers and irrigation system managers usually determine when to irrigate based upon the crop type and the soil's ability to give up its water. This term is commonly referred to as "management allowable depletion" or "MAD."

MAD is the percentage of the total available water which may be safely depleted before moisture stress occurs. Sand, for example, will be able to give up a higher percentage of its water before the plant experiences stress. Your specific soil type and crop will determine the MAD used for your irrigation schedule. Table 2 suggests average MAD percentages for specific crops.

Table 1
Average Root Zone Depths by Crop (approximately 80% of active roots)

		Suggested Orestimba Root Zones
Alfalfa Hay (cut)	4 to 6	5
Almonds	2 to 5	4
Dry Beans	1 to 3	3
Tomatoes	2 to 4	3
Walnuts	5.5 to 8	5

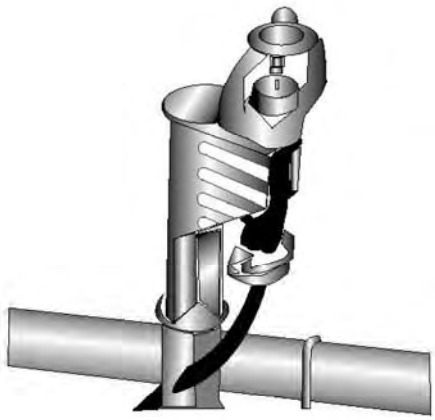
Table 2
Average Percentages of Management Allowable Depletions of Soil Moisture by Crop

		Suggested Orestimba
Alfalfa	50-55%	50
Deciduous fruit	50%	50
Beans	45%	45
Tomatoes	40%	40

Table 3
Practical potential irrigation efficiencies

Method		Irrigation Efficiency%	Suggested Orestimba
Sprinkler			
	Continuous Move	80-90	85
	Periodic-move	70-80	75
	Portable solid-set	70-80	75
Micro-irrigation			
	Drip, microsprinklers	80-90	85
Furrow		70-85	75-80 *
Border		70-85	75 *

* Assumes good management, and a tailwater recovery system that returns water to the same fields managed by that owner. In other words if the tailwater runs off the farmer's field and is no longer in his control, the IE no longer applies.



Step 5: Select the appropriate irrigation efficiency

Irrigation efficiency is usually defined as the amount of water used for the benefit of the crop divided by the gross amount applied. The "gross applied" portion relates to both the timing of the irrigation and how uniformly the water is applied. Irrigation systems that are engineered and managed properly have a high percentage of the applied water used to benefit the crop. While furrow and border (flood irrigation) systems can have good timing and fairly high uniformity, the efficiency of these systems are less than well designed drip/micro irrigation systems. Table 3 presents these efficiencies. If your system has an 85% efficiency you will need to apply enough water so that 85% of the amount applied meets your crop water needs.

References

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Hanson, B., L. Schwankl and A. Fulton. 1999. Scheduling Irrigations, When and How Much Water to Apply. Regents of the University of California, Division of Agriculture and Natural Resources. 202 p.

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NOTES

Irrigation Tailwater Return Systems

Tailwater return systems recover, control and reuse field-applied irrigation water or storm flows. Water flowing off the low end of a field is collected in a sump and reapplied on the same or adjacent fields by gravity flow or use of a booster pumps. Components of a tailwater return system: drainage ditches, water control structures, sediment basins, retention ponds (pits) and pumps with return piping that delivers runoff to the head of the field.

Advantages

- Eliminates agricultural drainage
- Eliminates sediment leaving field
- Conserves irrigation water
- Potentially recycles all tailwater
- Preserves downstream water quality
- Reduces weed seeds, insects in downsteam water supply
- Recirculates silt (deposits on field)
- Can eliminate need for additional management practices to meet off farm sediment standards
- Can reduce groundwater pumping costs
- Higher irrigation efficiency
- Return system may not reuse all tailwater; still potential increase in irrigation efficiency of 25-30%.
- Improved nutrient control/management

Disadvantages

- High cost to construct
- More management needed
- Potentially higher labor cost
- May increase salt deposition
- Takes land out of production
- May increase pumping costs
- Recirculates silt reducing soil intake rate

Installation/Maintenance Costs

Personalized estimates for tailwater return systems are available from the Stanislaus County Natural Resource Conservation Service (NRCS) office or a competent consultant with requisite design experience.

Booster pump, aluminum pipe, materials	$300-500/acre
Annual operation and maintenance cost range	$28-$60/acre

Tailwater Return Systems in the Orestimba Creek Area

In 2005, Summers Engineering of Hanford, California prepared a cost estimate for a grant proposal to design and install a tailwater return system in the Orestimba Creek drainage. The conceptual system would collect water from approximately 700 acres of irrigated alfalfa, walnut, and dry bean fields. The system was designed with a tailwater reservoir capable of collecting 600 acre-feet of runoff. Although the proposal was not funded, the estimate provided a baseline for what a similar system would cost (see below).

Cost for a Contractor Designed and Installed Tailwater Return System*

Item	*Costs*
Installation	
Design	$ 37,470
Construction	$280,500
Total cost	**$317,970**
Annual pumping costs	$ 6,000

*600 acre feet @$10/AF for electricity.

IRRIGATION TAILWATER RETURN SYSTEMS Central Valley Installation and Maintenance Costs

Wildlife-Friendly Tailwater Return Pond

In 2002, the Yolo County Resource Conservation District compiled a handbook containing practical information for farmers wishing to provide wildlife habitat on their land. Included in the handbook was a design for a tailwater pond and return system. Design costs include pond banks planted with native plants to improve water quality, habitat, and esthetics. Low and high cost estimates (1999 dollars), based on pond size, are shown below.

Cost Range for Tailwater Return System

Item	Cost	
Installation	Low (2,500yd^3)	High (7,500yd^3)
Pond	$3,730	$11,525
Return system	$9,850	$16,030
Vegetation establishment	$1,120	$ 2,840
Total	$14,700	$30,401
Annual Maintenance	$ 203	$ 618

Water Use Efficiency Tailwater Return Pond

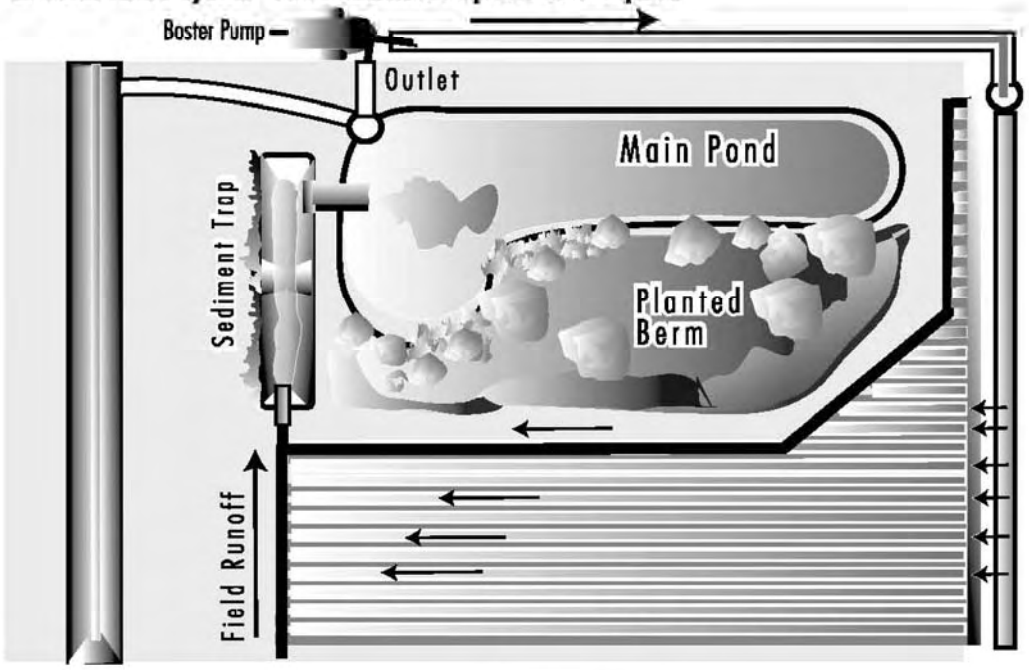
The Yolo County Resource Conservation District recently established five tailwater ponds in their area, all installed by local landowners. Costs depended on pond size, which ranged from 1.5 to 4 acre-ft capacity, pump size, type of return system and whether or not native vegetation was planted. (Yolo County Resource Conservation District. 2001. CALFED Water Use Efficiency Program Final Report. Yolo County RCD Pilot Program.)

Cost Range for Installation of Tailwater Return System

Item	Cost	
	Low (2,500yd^3)	High (7,500yd^3)
Pond and inlet/outlet structures	$ 4,000	$12,000
Return system with 1800' of pipe	$10,000	$16,000
Addition of native vegetation*	$ 1,000	$ 3,000

*Includes material, labor, and irrigation system

Tailwater return system with a sediment trap and habitat pond



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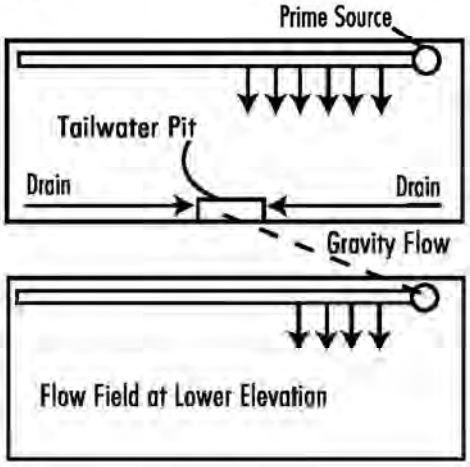
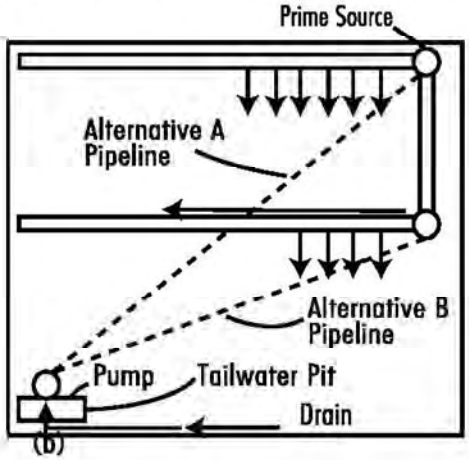
IRRIGATION TAILWATER RETURN SYSTEMS Central Valley Installation and Maintenance Costs

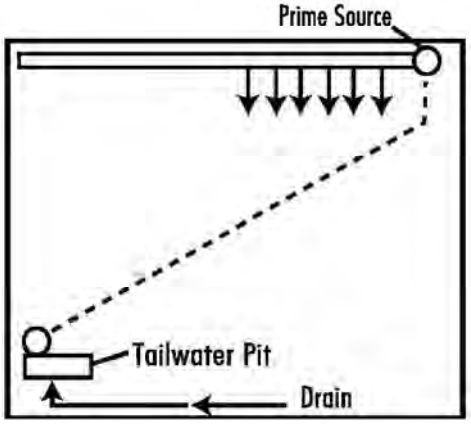
(a) sequential reuse to irrigate lower-lying lands



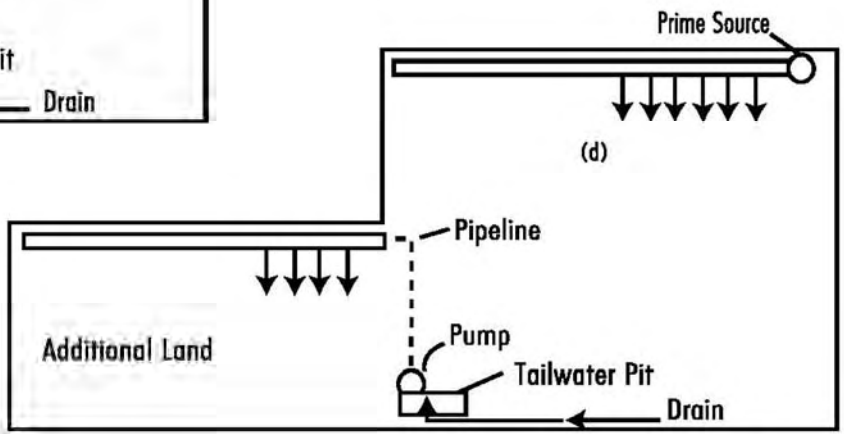
(c) return reuse system to the highest point in the same field



(b) alternative return reuse systems for sequential fields



(d) return reuse system to irrigate new additional lands



NOTES

Drip / Micro Sprinkler Irrigation Systems

Installation and Maintenance Costs

Drip/micro sprinkler systems use an engineered network of plastic components to precisely deliver water to each plant. Drip/micro sprinkler systems are designed so application rate is less than the soil infiltration rate, minimizing or eliminating irrigation water runoff. With drip/micro sprinklers, frequent irrigations of low volumes of water are applied to a portion of the available surface or subsurface area. The volume of soil wetted by drip/micro sprinkler systems varies from 10% to over 80% depending on crop type, soil type, cost of system, type of emitter, emitter flow rate, and other factors.

Drip/micro sprinkler systems are custom designed and engineered. The system designer takes into consideration soil, crop water requirements, plant spacing, water source and quality, field shape, elevation changes, electrical or power supply availability and locations, cultivation and farming practices. Also considered is cost of plastic pipe and hardware, the quality of components (both initial, and long term), the owner's ability to manage and maintain a system effectively and the intended lifespan of the system.

A system application rate must be high enough to meet daily plant water requirements in an 18-hour (or less) period of run time (to take advantage of off-peak time-of-use energy rates). Orchard root diseases are minimized when run time is limited to 24 to 48 hours. Application rates of drip/micro systems vary from 0.02 in/hr to 0.10 in/hr.

Maintenance and Management

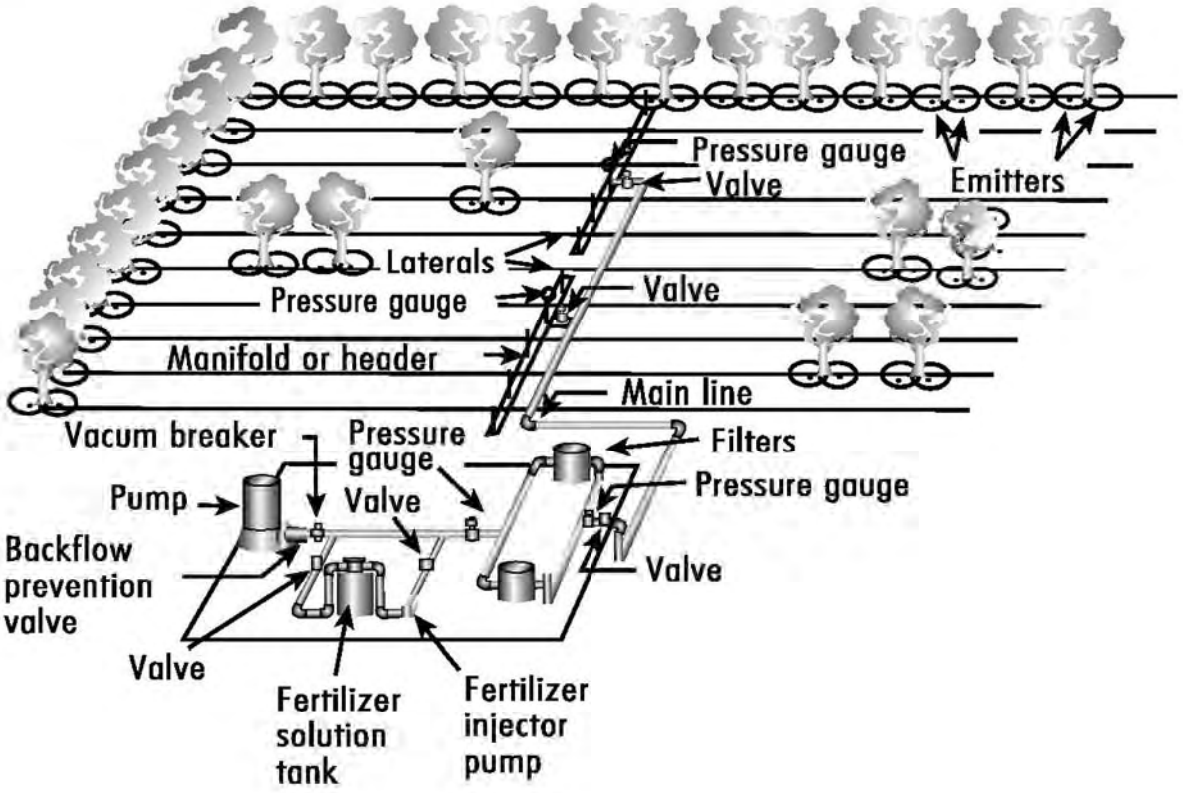
Drip/micro sprinkler systems are typically designed to achieve a system distribution uniformity (DU) of 85% to 95%. DU is a measure of how uniformly water is spread throughout a field. DU values decline with time due to clogging of emitters, emitter wear, increased pressure differences between emitters, and other factors. A drop in DU results in increased operating hours to accommodate the driest field areas. Increased operating time, assuming accurate irrigation scheduling, can result in over watering the wettest portions of a field. Deep percolation of excess water, and any nutrients, salts, or mobile components in the irrigation water, will degrade in transport, runoff to surface drains or leach to aquifers.

Costs for Grower/Contractor Installed Drip or Micro Irrigation System

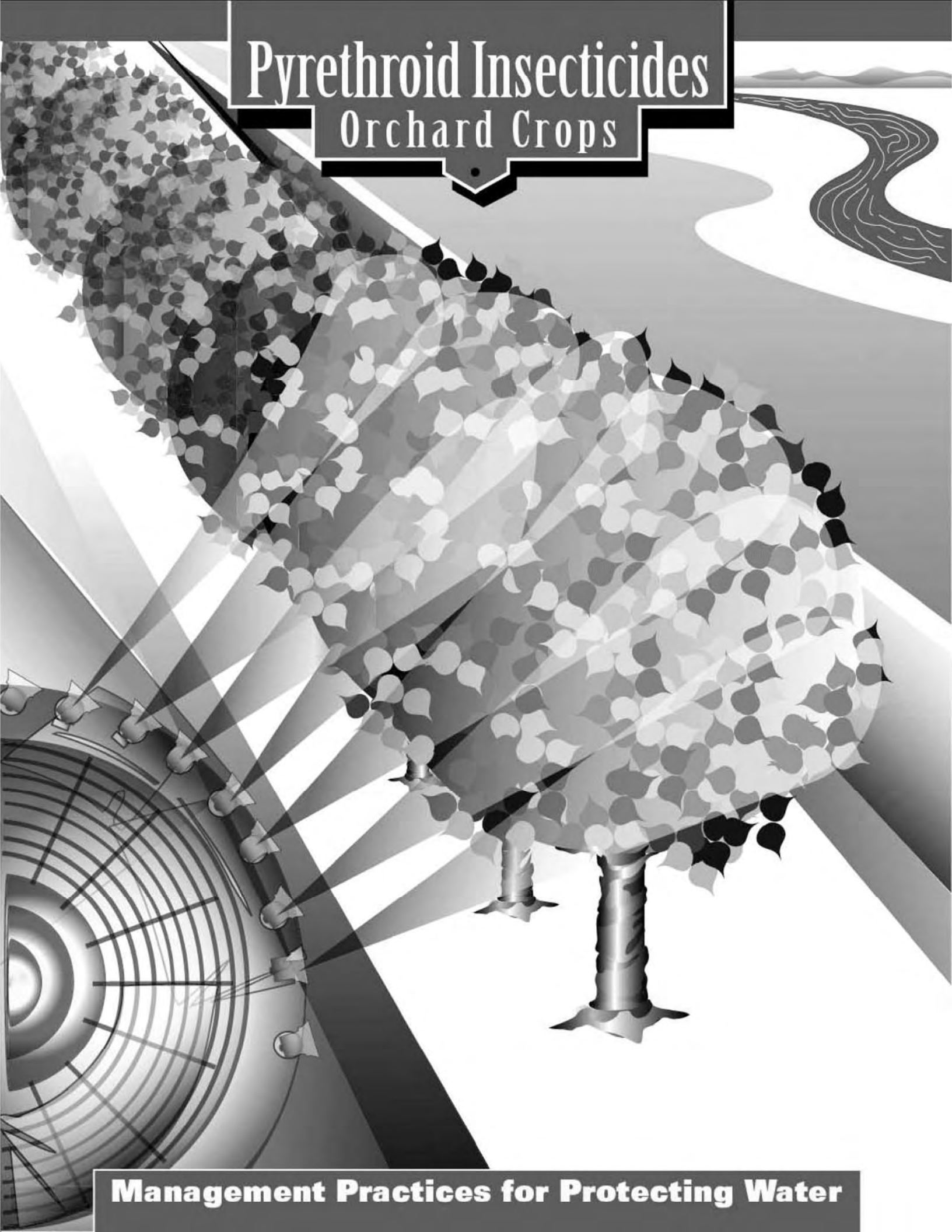
Item	Costs per Acre	
	Low	High
Installation and maintenance for the life of the system*	$800	$1,800

* Includes cost of new pump at $100/A

Typical Irrigation system layout (USDA-NRDA, 1997a; Turner, 1980)



Pyrethroid Insecticides
Orchard Crops



Management Practices for Protecting Water

Pyrethroid Insecticides Orchard Crops

Stewardship Practices for Protecting Water

Whenever pyrethroid insecticide applications are made near waterways and other sensitive sites, growers and applicators should be aware of the potential for drift or runoff to these areas. Pyrethroid insecticides adhere strongly to soil particles and therefore have the potential to be carried off-site by sediment runoff rather than moving dissolved in water. By taking a stewardship approach through use of sound Best Management Practices (BMPs), the potential for drift or runoff can be minimized.

Stewardship practices are aimed at minimizing off-site movement to waterways and sensitive sites. These practices along with product label directions can provide growers and applicators with the tools necessary to complete a successful spray application while minimizing potential off-site impacts.

Severe Consequences For Mistakes

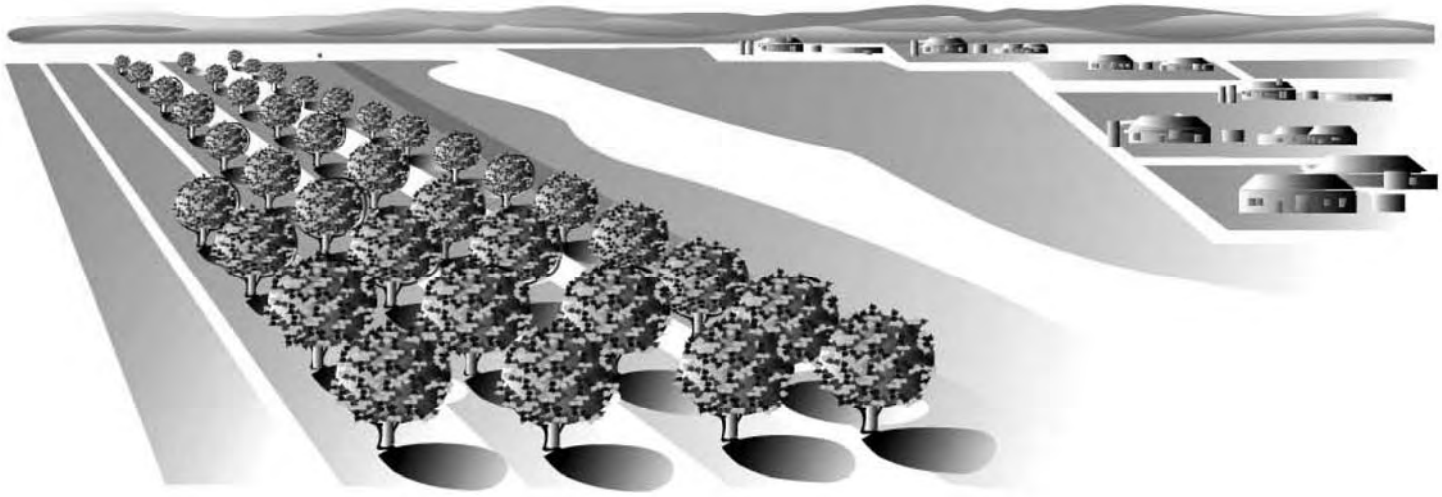
Consequences for application mistakes or ignoring good practices can have wide reaching impacts in the agricultural community. Product uses could be dramatically restricted or cancelled, hindering growers' ability to efficiently produce a profitable crop.

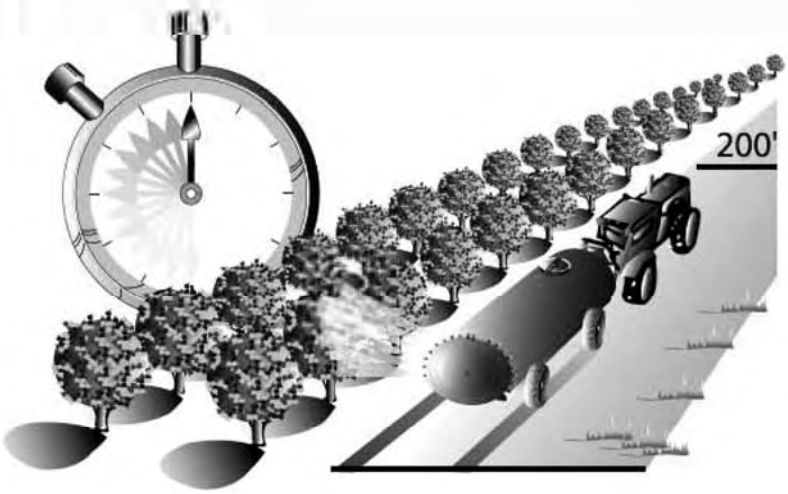
Each individual who handles or uses pesticides has the responsibility to take the proper precautions. Adhering to proper stewardship practices is good for the entire agricultural community!

Evaluate Sensitive Sites

Evaluate the surrounding area to determine if waterways or other sensitive sites (schools, day-care centers and urban/commercial areas) are in close proximity or are connected via ditches to the application area. Check with your County Agricultural Commissioner for product-specific restrictions in your area.

Follow all Integrated Pest Management (IPM) practices prior to any pyrethroid insecticide application. Visit the University of California IPM website (http://www.ipm.ucdavis.edu) for information on IPM practices for your specific crop.





Adopt On-site Practices to Reduce Runoff

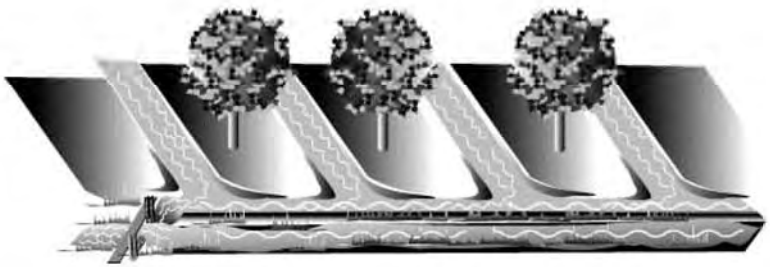
On-site practices are approaches for managing soil, water, pesticides and nutrients for sustainable agricultural production while minimizing environmental impacts.

The goal is to:

A Reduce or eliminate sediment movement off the orchard site.

B Reduce or eliminate flows of runoff water carrying dissolved pesticides and nutrients.

See the CURES booklet, Orchard Practices for Protecting Surface Water (http://www.curesworks.org/publications/orchPrac.asp)



These practices include but are not limited to:

1. Having dense, well-established orchard floor vegetation during dormant season reduces runoff of farm inputs and sediment in several ways:

- Reduction in runoff volume through increased water infiltration.
- Reduction in sediment generation caused by rainfall impact on bare ground.
- Reduction in pesticide mass carried by sediment.
- Faster breakdown of pesticides on vegetation than soil.
- Slows water movement and reduces sediment carried in surface flows.
- Adsorption of pesticides to plant surfaces.

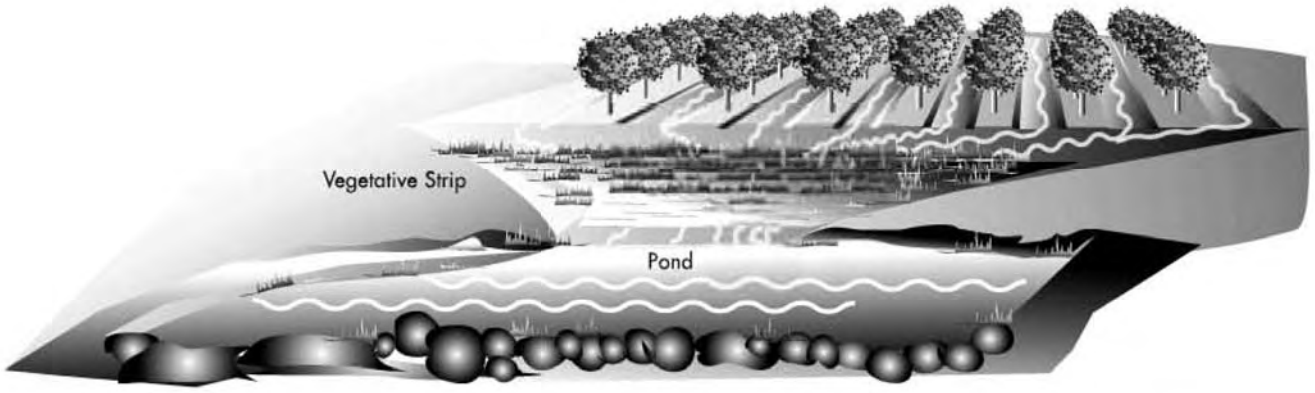
2. Managing runoff water to minimize or eliminate the impact of off-site movement of sediment using:

- Sediment basins
- Tailwater return systems
- Riser boards or dirt banks that retain winter rain runoff (after dormant sprays are applied) for a period of time to allow sediment to settle out.

3. Vegetative buffers, vegetative filter strips and vegetative barriers:

- Reduce sediment transport out of orchards.
- Trap pesticides to allow for degradation

4. Use vegetated ditches and holding ponds to enhance reduction of residues in tailwaters and to slow flow (thus reducing sediment transport potential)



Before You Start Spraying

Any field treated with a pyrethroid by ground or aerial equipment should be evaluated and supervised prior to, during and after the application. This requires the person on-site to have a thorough understanding of the field being sprayed, the expected weather conditions and the location of sensitive sites and waterways in the vicinity of the treated field. The individual responsible for the application must be aware of:

- Wind conditions (speed and direction - current and forecast) and whether rainfall is forecast for the next 48 hours.
- Air temperature (current and forecast).
- Presence/absence of a temperature inversion layer.
- Presence/absence of waterways and sensitive sites in the area, especially downwind of the application site or connected to the site by drainage ditches, canals or sloughs.
- The application equipment setup and calibration; proper use of any drift-reducing application equipment.
- All chemicals and rates used to complete the application.

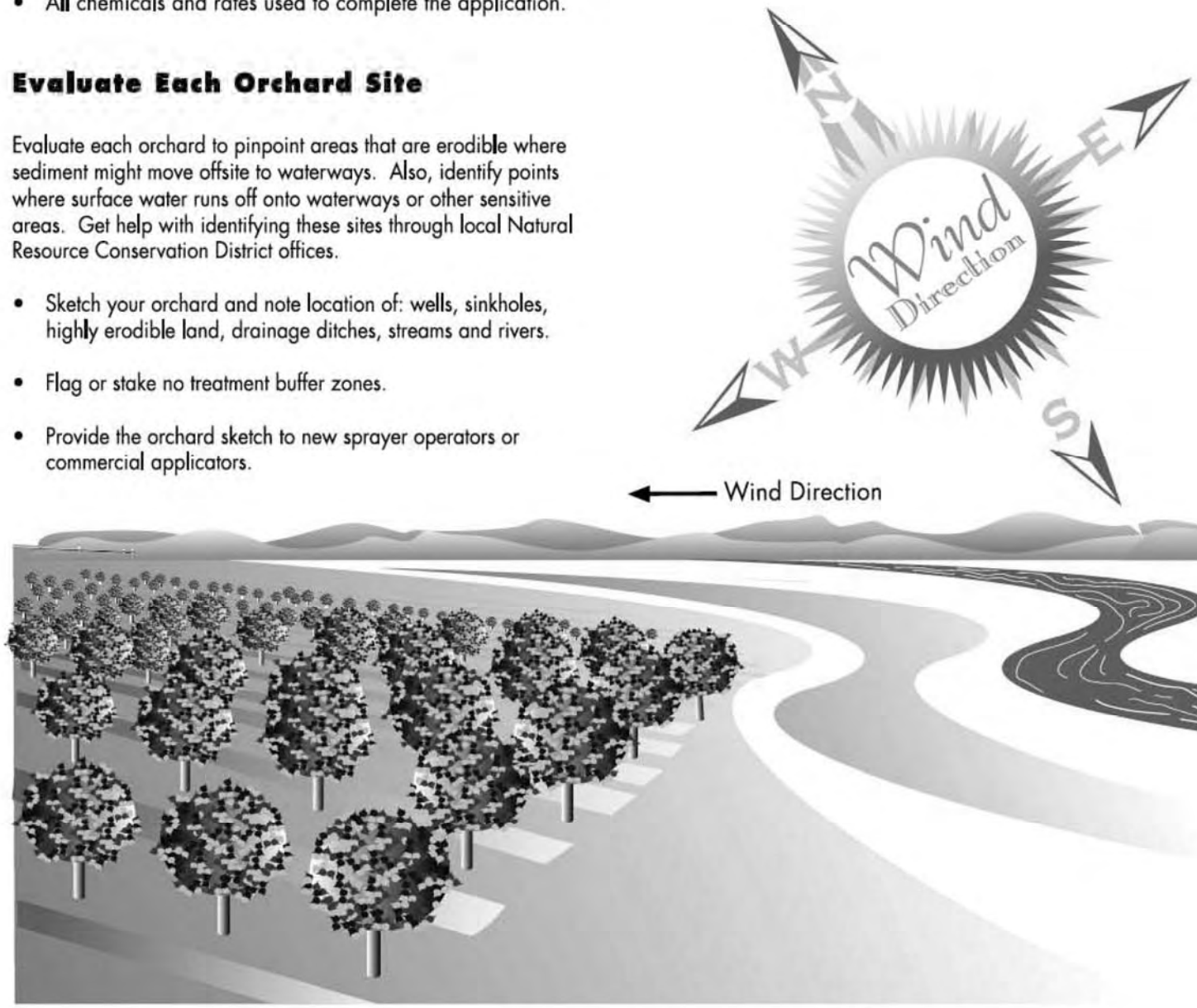
Evaluate Each Orchard Site

Evaluate each orchard to pinpoint areas that are erodible where sediment might move offsite to waterways. Also, identify points where surface water runs off onto waterways or other sensitive areas. Get help with identifying these sites through local Natural Resource Conservation District offices.

- Sketch your orchard and note location of: wells, sinkholes, highly erodible land, drainage ditches, streams and rivers.
- Flag or stake no treatment buffer zones.
- Provide the orchard sketch to new sprayer operators or commercial applicators.

Monitor Weather Conditions

1. Always monitor and record weather conditions prior to, during and after an application.
2. Check with the County Agricultural Commissioner about application restrictions in adverse or questionable weather conditions.
3. If other approaches have not provided sufficient information concerning weather conditions, create a smoke column to determine wind direction and the presence or absence of an inversion layer (check with the county agricultural commissioner for agricultural burning restrictions).



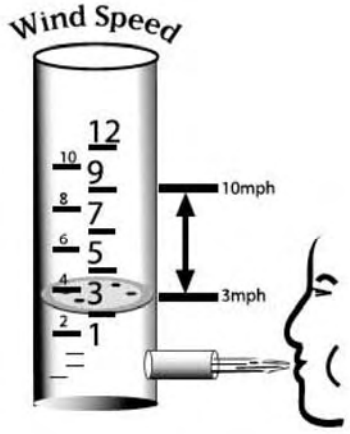
Record Application Conditions

Should a pyrethroid application result in a complaint, the best way to resolve the conflict is with accurate and complete records of the application conditions. Recording a few simple facts could prove valuable in the event of an incident or complaint.

1. Compile and maintain a summary report on weather conditions prior to, during and after the application. Also note changes in conditions when stopping to refill or adjust equipment.

2. Consider using a proven and accurate hand-held wind speed and temperature indicator to record on-site field conditions. Be sure to note wind direction.

3. Local weather services, Internet services (government and private providers) and weather stations at local airports can be sources of current and forecasted weather information.



Grower Responsibilities with Aerial Applicators

When hiring a commercial aerial applicator to apply a pyrethroid insecticide, the grower is responsible for ensuring that the following steps are followed:

1. Positively identify and confirm the targeted pest(s) before ordering the application.

2. Make sure the product is labeled for the targeted pest(s).

3. Hire only responsible, reputable applicators.

4. Confirm that the aerial applicator has a written recommendation from the Pest Control Advisor (PCA).

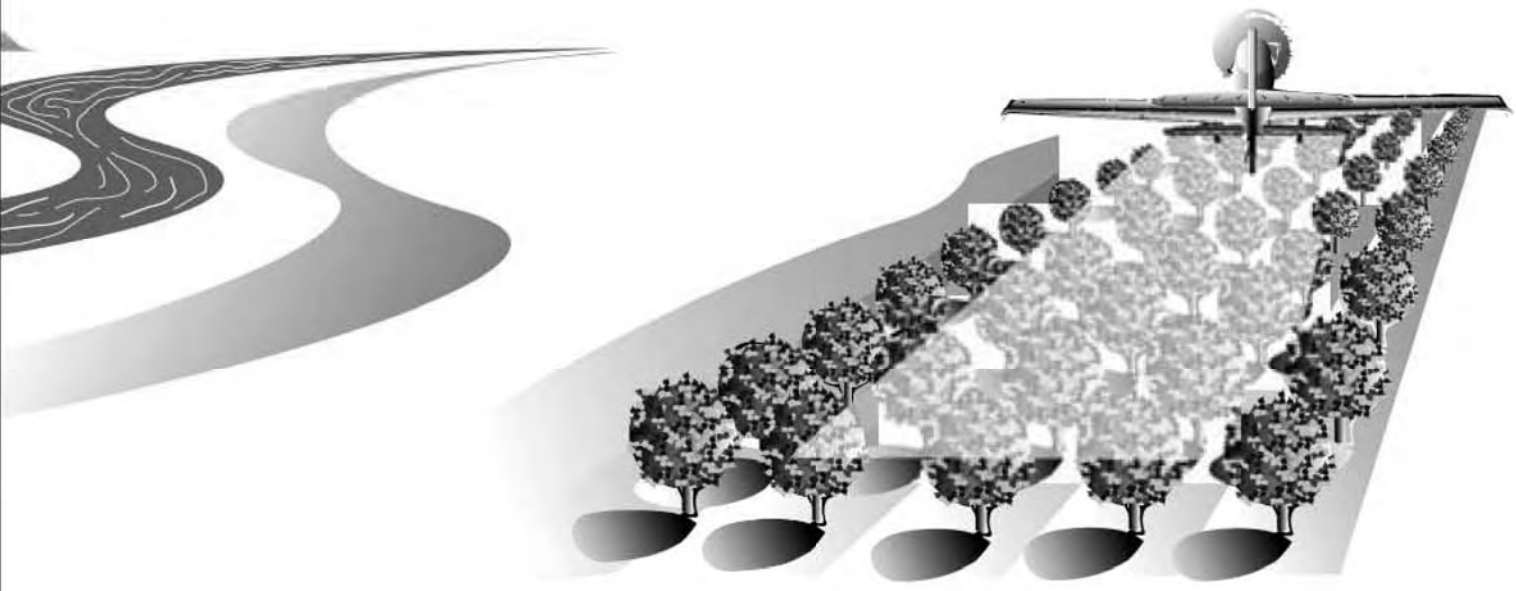
5. Positively identify the proper site for application. Use GPS coordinates if applicator has this capability. Provide the applicator with a sketch of your orchard layout.

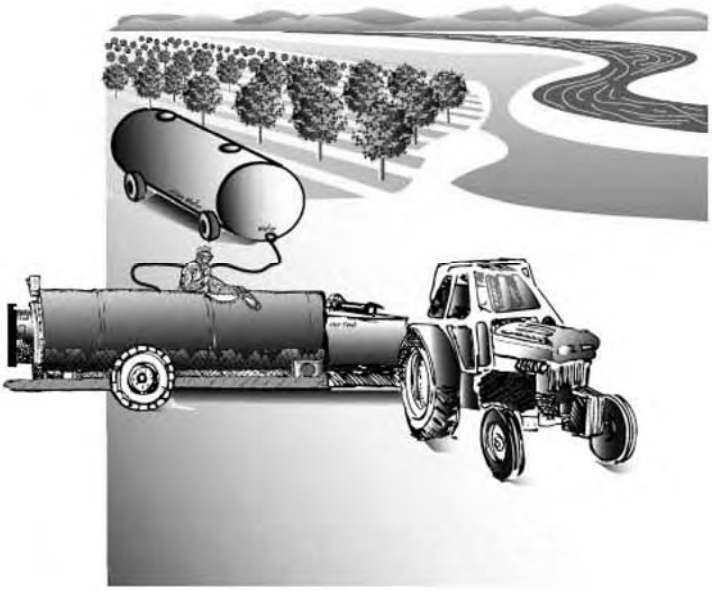
6. Check to ensure weather conditions are appropriate for aerial applications by reviewing the 1-6 hour forecast prior to initiating treatments.

7. Don't pressure applicators to make treatments when conditions are marginal. This can jeopardize their licenses as well as the industry image.

8. Make sure aerial treatments are applied properly, avoiding direct overspray or off-site movement toward waterways and other sensitive sites.

9. Growers should consider Chemical Drift Insurance Coverage as an addition to a Comprehensive General Liability Insurance Policy.





Follow Proper Mixing and Loading Practices

1. Do not leave sprayer unattended while filling.
2. Partially fill tank (usually 1/3 to 1/2 full of water) prior to the addition of chemicals.
3. Make sure that the sprayer has sufficient agitation (mechanical or bypass) to keep chemical mixed. With bypass agitation, be sure to check if agitation will be sufficient when sprayer is actually spraying.
4. Make sure sprayer agitation system is running while mixing and loading pesticides.
5. Do not overfill tank. Spills can wash away to sensitive areas. Use air gap to prevent tank overfilling.
6. Use backflow valve on the fill tube.
7. Use a closed chemical transfer system whenever possible.
8. Open paper chemical packages with scissors or knife, rather than tearing.
9. Immediately triple rinse containers. Pour rinsate into tank prior to filling.
10. For returnable bulk containers, check with supplier for rinsing instructions.
11. Apply rinse water back to treated field. Never just drain out.
12. Check with county for proper disposal methods for empty pesticide containers.

Properly Calibrate Sprayer

- Calibrate equipment prior to each application.
- Use spray nozzles adjusted for tree canopy. Set nozzle pattern to match tree height and shape. Reduce the size of lower nozzles when lower canopy is thin or non-existent.
- Periodically check sprayer coverage by placing water-sensitive paper in a few areas of the tree canopy. Compare patterns to check uniformity.

Carefully Select Mixing and Loading Site

- If possible, use a concrete or asphalt pad that drains to a central sump. Otherwise, vary the location of mixing and loading site to prevent accumulation of accidentally spilled spray materials.
- Take precautions to ensure there is at least 100 feet between a mixing/loading area and any wells or ditches, canals or streams that feed into nearby rivers.
- Mix and load on a site not prone to runoff and where soil can be disked after mixing/loading is completed. Do not mix or load on hard-packed roads that could drain or run off into nearby areas or waterways.

Sprayer Set Up And Good Application Techniques

- Know the droplet spectrum of each nozzle (available from nozzle distributors).
- Use nozzles with volume median diameter (VMD) appropriate to the insecticide being applied (check with County Agricultural Commissioner for local requirements).
- Replace worn nozzles when necessary with newer, more effective nozzles.
- Use nozzles that provide adequate coverage at the largest possible droplet size and the recommended droplet size spectrum to reduce drift while maintaining efficacy.
- Consider spray controllers that adjust nozzle output based on ground speed. Be sure to understand the limitations of the controller and select the proper nozzle for use with the speed range you expect. Do not allow the pressure to get too low as to cause streaking or too high as to cause excessive fine droplets.

General Stewardship Recommendations

This publication outlines stewardship practice recommendations useful during the handling and application of pyrethroid insecticides. These recommendations are intended as guidance on good stewardship measures useful for both ground and aerial applications, especially near sensitive sites (see more details on these and other practices on following pages). Stewardship practices recommended for California conditions include:

1. Applicator must be aware of and comply with county permit conditions and restrictions.

2. Avoid applications just prior to a rainfall event or irrigation to minimize the potential for runoff. Check weather forecasts. These have improved in recent years with several companies offering predictions of upcoming rain events. (www.fieldwise.com and www.foxweather.com).

3. Applications should be made only if wind is blowing at least 3 mph away from nearby waterways or other sensitive sites.

4. Avoid spraying when wind is blowing toward nearby waterways or sensitive sites.

5. Avoid aerial spraying when wind speed is less than 2 mph or greater than 7 mph.

6. Avoid ground applications when wind speed is greater than 10 mph.

7. Also use a registered, proven drift-control agent and/or proven drift-reducing application equipment. Check the pyrethroid label and with your farm-input supplier's representative for the appropriate drift-control agent.

8. Choose the lowest chemical rate that provides efficacy when applied through your equipment.

9. Check for compatibility of products used in tank mixes. Follow chemical label recommendations on testing for compatibility.

10. Maintain an adequate buffer zone (untreated area from sprayed crop to sensitive area) to protect waterways and sensitive sites. Check with the product label and county agricultural commissioner for specific requirements.

11. Always shut off nozzles when making row turns.

12. Shut off outward facing nozzles when spraying the outside row, directing spray inward only.

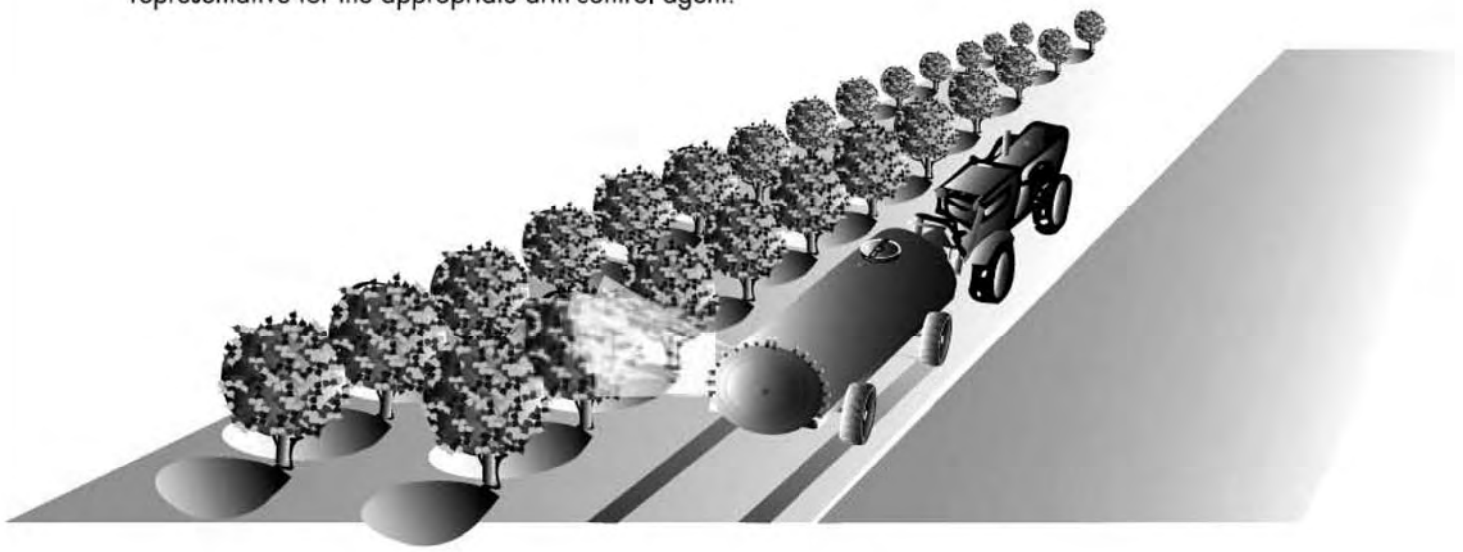
13. Start spraying only when nozzles are adjacent to the first trees in the row.

14. Make sure applicator always has any required county permit(s) on hand during treatments.

15. Attend annual pesticide training for growers and/or applicators. Check with your local agricultural commissioner or farm advisor for dates.

16. Adopt on-site practices to reduce runoff (see page 6).

See your county guidelines for product-specific restrictions and recommendations



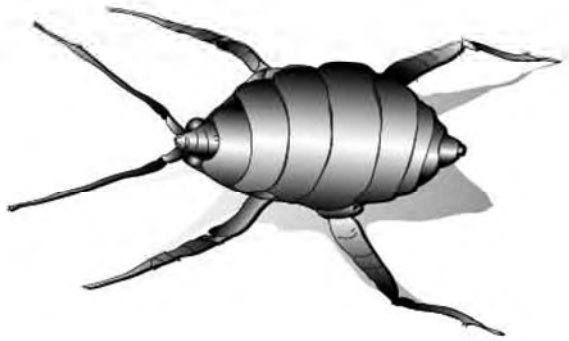
Follow Integrated Pest Management (IPM) Approaches

The University of California Cooperative Extension has developed IPM guide books for a number of orchard crops that detail numerous pest management options. Commodity organizations also can provide current information on IPM. Basic principles of an IPM approach include:

1. Thoroughly scouting an orchard to monitor and assess the pest situation.

2. Consider all reasonable options to mitigate a pest problem when making decisions concerning pest management.

3. Rotate chemical classes to avoid pest resistance.



Developed with support from:

Bayer CropScience

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Cures

Coalition for Urban/Rural Environmental Stewardship

www.curesworks.org

Application Equipment **Checklist**

Before filling the tank, adding pesticides and beginning an application, closely perform a visual inspection of the equipment. Always wear personal protective equipment when checking application machinery.

Check and Make Sure:

- ☐ Hose connections are sealed and tightened.
- ☐ Regulator connections are sealed and tightened.
- ☐ Sight gauges are clear and working.
- ☐ Clean filters and screens on a daily basis.
- ☐ Fix leaking gaskets immediately.
- ☐ Pressure gauges are located at the proper points with proper scales and are sealed and working.
- ☐ All nozzles and metering devices are of correct size, sealed and unobstructed.
- ☐ All sprayer shields are in place (where appropriate).
- ☐ Tank drain plug is in place.
- ☐ There is no damage to hoses or piping.

Diazinon
Insecticides
Management Practices for Protecting
Surface Water During Dormant Orchard Applications

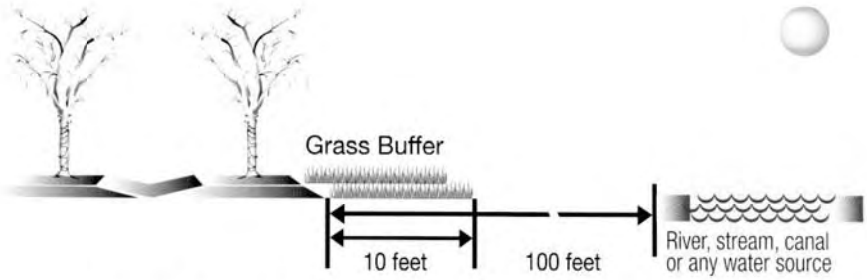
Diazinon Dormant Season Best Management Practices

Diazinon insecticides have been the standard practice for years to protect orchard crops from numerous overwintering pests. However, periods of heavy rainfall soon after dormant spray applications can potentially transport diazinon off-site to nearby streams and rivers, posing a risk to aquatic organisms. Water quality monitoring performed throughout Central Valley waterways after winter storm events has detected diazinon at levels that exceed state standards.

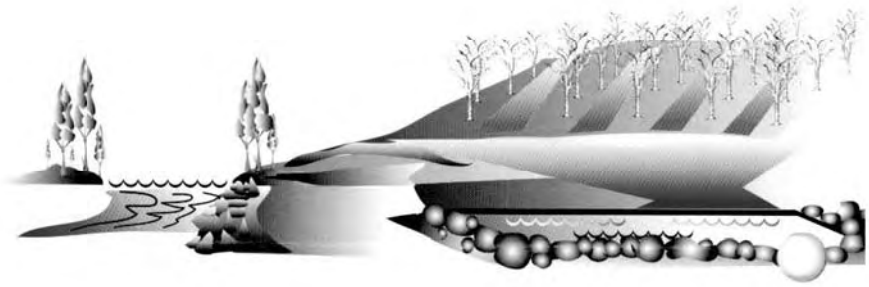
In an effort to protect aquatic species and mitigate offsite movement, diazinon registrants have developed a series of management practices for use during dormant spray season applications. The practices outlined in this publication are intended for use in counties and portions of counties located in the Sacramento and San Joaquin valleys below 1,000 feet elevation.

In addition to the practices illustrated in this publication, the following restrictions also apply:

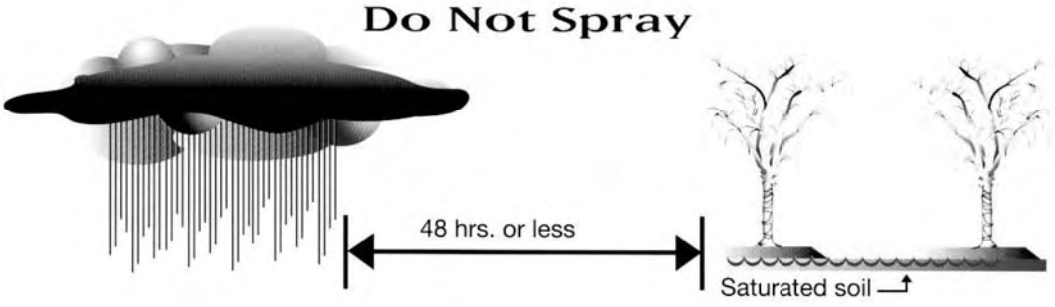
- Dormant applications on orchard crops are restricted to ground application equipment only.
- Spray must not be directed higher than the tree canopy and spray must be directed away from sensitive aquatic sites.



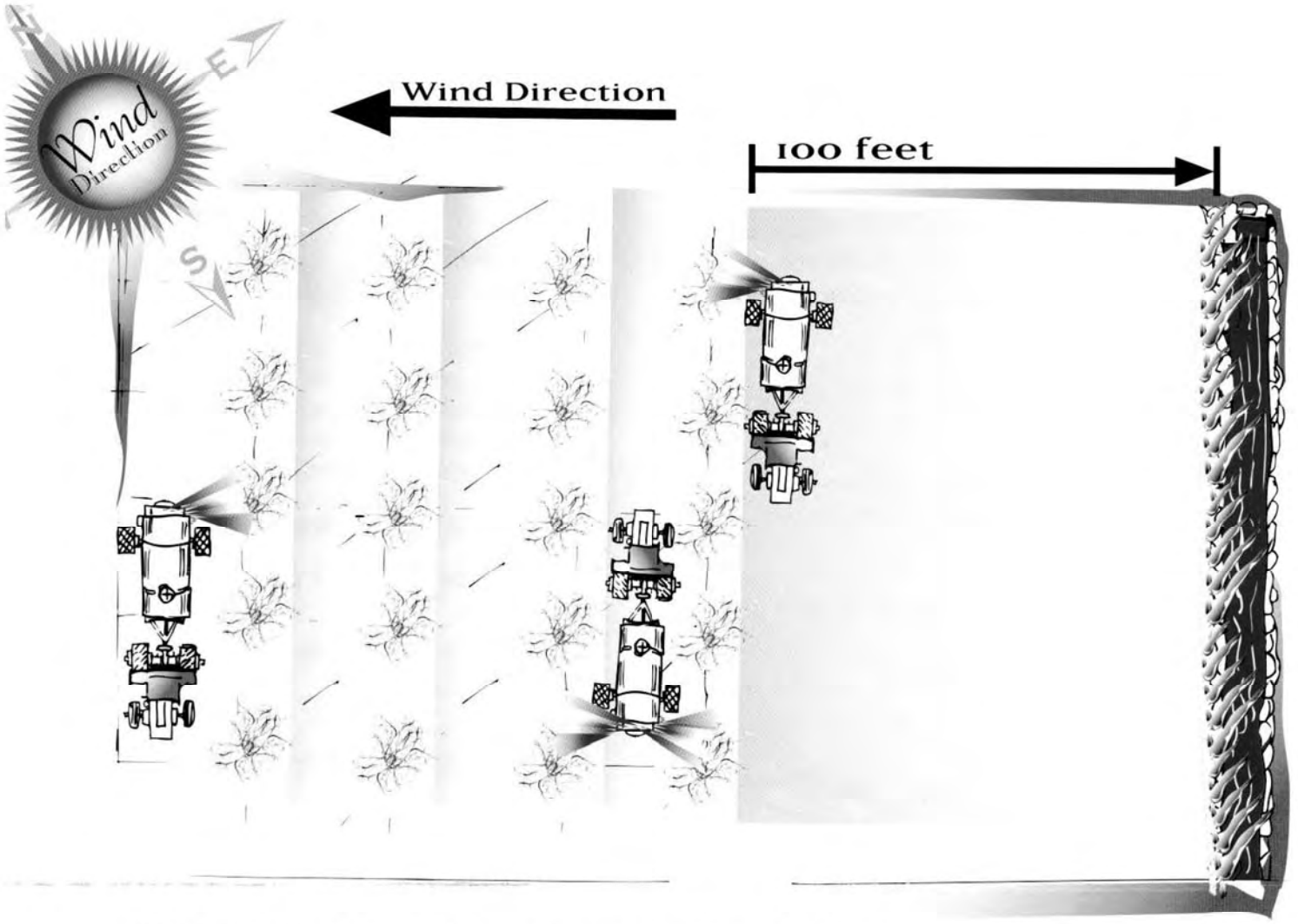
Maintain a vegetative buffer strip a minimum of 10 feet wide from the edge of a field that is adjacent to and within 100 feet of sensitive aquatic sites.



Do not apply within 100 feet upslope of "sensitive aquatic sites" such as any irrigation ditch, drainage canal or body of water that may drain into a river or tributary unless a suitable method is used to contain or divert runoff waters. Waters that are contained or diverted must be held for a minimum of 72 hours before release into a sensitive aquatic site.

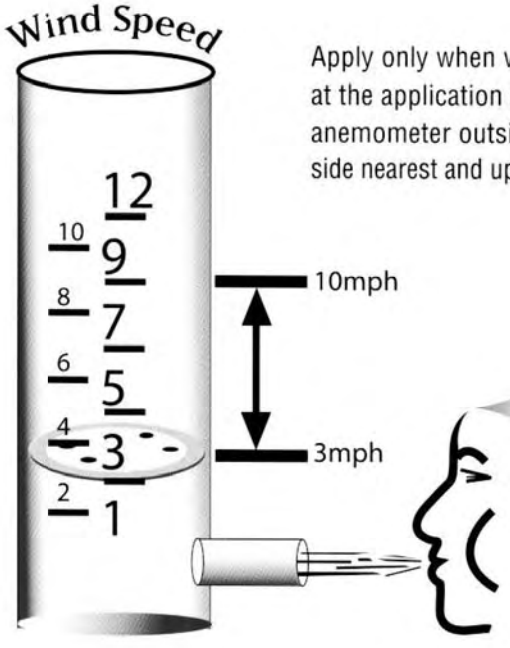


Do not apply diazinon to orchards when soil moisture is at field capacity, and/or when a storm event likely to produce runoff from treated orchard is forecasted by the National Weather Service to occur within 48 hours following an application.



When sensitive aquatic sites are downwind from orchards, spray the first three rows nearest the sensitive aquatic sites only when the wind is blowing away from the sites. The row at the edge of the field next to sensitive aquatic sites must be sprayed with the outside nozzles turned off.

Make dormant applications only when insect scouting information or the recommendation of a Pest Control Advisor indicate treatment is required. (See UC IPM Guidelines for San Jose Scale in stone fruits and almonds and aphids in stone fruits. Use the prune dormant spur sampling program to determine need for a dormant treatment in that crop).

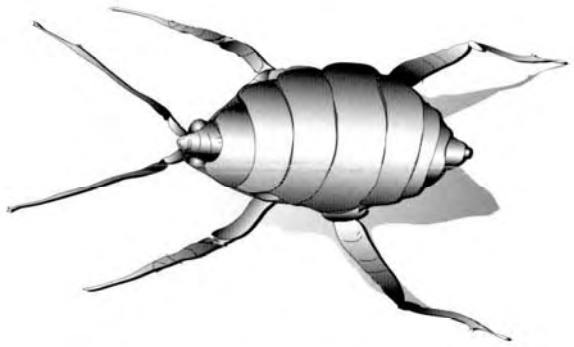


Apply only when wind speed is 3-10 mph at the application site as measured by an anemometer outside of the orchard on the side nearest and upwind from a sensitive site.

Follow Integrated Pest Management (IPM) Approaches

The University of California Cooperative Extension has developed IPM guide books for a number of orchard crops that detail numerous pest management options. Commodity organizations also can provide current information on IPM. Basic principles of an IPM approach include:

1. Thoroughly scouting an orchard to monitor and assess the pest situation.
2. Consider all reasonable options to mitigate a pest problem when making decisions concerning pest management.
3. Rotate chemical classes to avoid the build-up of pest resistance.



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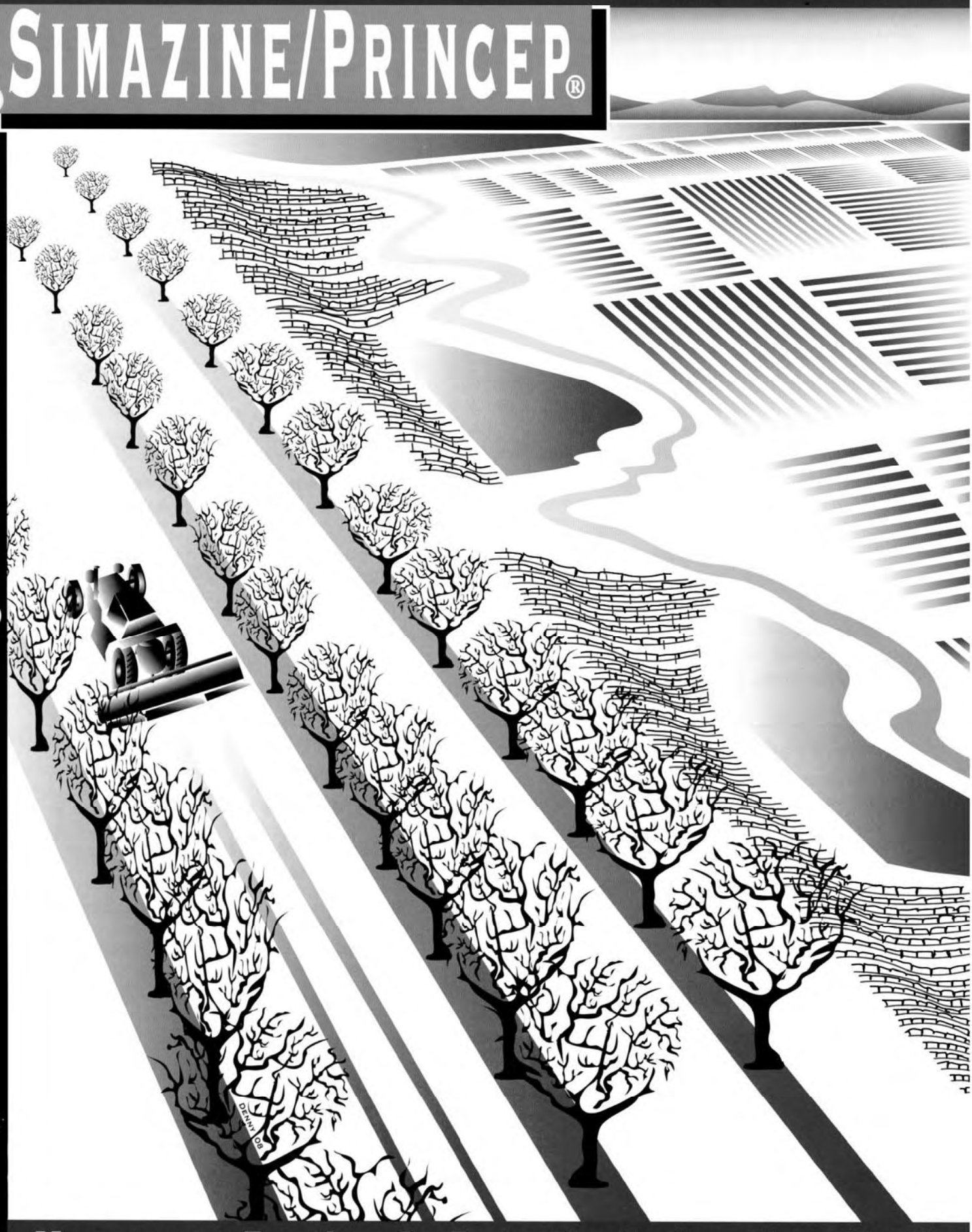
Application Equipment **Checklist**

Before filling the tank, adding pesticides and beginning an application, closely perform a visual inspection of the equipment. Always wear personal protective equipment when checking application machinery.

Check and Make Sure:

- ☐ Hose connections are sealed and tightened.
- ☐ Regulator connections are sealed and tightened.
- ☐ Sight gauges are clear and working.
- ☐ Clean filters and screens on a daily basis.
- ☐ Fix leaking gaskets immediately.
- ☐ Pressure gauges are located at the proper points with proper scales and are sealed and working.
- ☐ All nozzles and metering devices are of correct size, sealed and unobstructed.
- ☐ All sprayer shields are in place (where appropriate).
- ☐ Tank drain plug is in place.
- ☐ There is no damage to hoses or piping.

SIMAZINE/PRINCEP®



Management Practices for Protecting Surface Water Quality

SIMAZINE/PRINCEP®

Water Quality Stewardship

Watershed and water quality management continue to be priorities throughout the United States. Agriculture's role in developing and implementing stewardship practices that minimize runoff of sediment, nutrients and pesticides is an important component of effective watershed management programs. This guide provides useful, common sense techniques called Best Management Practices (BMPs) to help you enhance the effectiveness of your efforts to protect water quality.

Preemergence herbicides are important tools for the efficient production of fruit, nuts and grapes in California. Preemergent herbicides such as simazine (Princep), are usually surface-applied to orchards and vineyards and commonly incorporated into the soil matrix by irrigation or natural rainfall for activation. Whenever applications of simazine or other pesticides are made near waterways or other vulnerable areas, applicators should be aware of the potential for spray drift or runoff. Therefore, measures should be employed to minimize its offsite movement to areas where control is not intended.

Each individual who handles or uses any pesticides has the responsibility to take the appropriate precautions. Adhering to proper stewardship practices is good for the entire agricultural community and the environment.

Three Good Reasons to Use BMPs

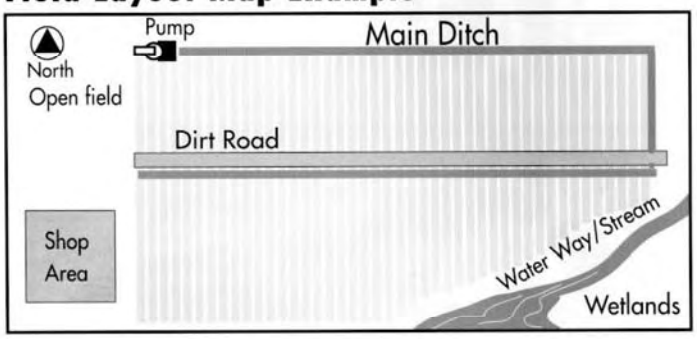
- It's the responsible thing to do.
- BMPs are both environmentally and economically beneficial.
- Voluntary water protection practices could lessen the need for mandatory government programs in the future.

General Best Management Practices

Field Evaluation

Review your orchards and vineyards for physical characteristics that can influence movement of pesticides and fertilizers. Pay particular attention to locations of surface water features (lakes, streams, etc.), shallow groundwater, sinkholes, abandoned wells, soil type and the relationship of field locations to residential areas and water supplies. Conduct your own field evaluation following the Site Evaluation Checklist (see back page) and use the information to develop a BMP plan that will work best for you.

Field Layout Map Example



Factors You Should Consider

Applicators must be aware of and comply with any county permit conditions and restrictions on simazine. Make sure the applicator always has any required county permit(s) and a Material Safety Data Sheet (MSDS) on hand during applications. Be aware that application conditions and restrictions can be periodically modified. Check with your County Agricultural Commissioner for details on updates or new regulations.

For more information on California restrictions and recommendations visit: http://www.cdpr.ca.gov/docs/emon/ehap.htm

To further reduce the risk of herbicides moving offsite to waterways, you should always follow the product label concerning:

- **Product Rates**
- **Application Timing**
- **Product Placement and Setbacks**
- **Chemical and Soil Properties**
- **Irrigation Management Strategies**
- **Mixing and Loading Practices**
- **Container Handling**
- **Equipment Cleaning and Maintenance**

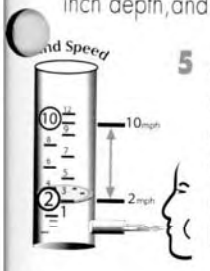
Application Considerations for Simazine

1. Do not apply within 66 feet of points where surface water enters an intermittent or perennial stream and river. Do not apply within 200 feet of the edge of a lake or reservoir.

2. When applied to highly erodible land, maintain a 66-foot buffer of vegetative cover from any point where runoff enters a waterway.

3. Do not apply prior to rain events when the forecast calls for significant precipition in the treatment area. Check weather forecast services or website forecasts such as **www.fieldwise.com** & **www.foxweather.com** Plan for an interval of 48 hours or more between applications and forecasted rainfall.

4 For late fall applications when using irrigation for incorporation, apply only enough irrigation to incorporate the product to a 1-2 inch depth, and never irrigate to runoff conditions.



5 Avoid spraying when winds exceed 10 mph, or the air is completely calm. Start spraying only when nozzles are adjacent to the first vines or trees. Maintain a nozzle pressure range recommended by the manufacturer (typically 40 psi) to avoid non-uniform droplets.

6 To optimize application efficiency, a sprayer should be calibrated regularly. Check nozzles regularly and replace at least annually.

7 Always shut off nozzles at row ends.

8 Use the lowest boom height that provides uniform coverage.

9 Precision Applications: Use appropriate nozzles and drift reducing agents for your situation. Use nozzles that provide adequate coverage with the largest possible droplet size and the recommended droplet size spectrum to reduce drift while maintaining coverage. Target the spray swath at the base of orchard or vineyard row (shielded low volume sprayers).

Irrigation Management Strategies

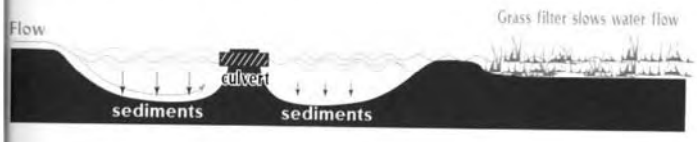
1 Do not allow irrigation drainage water to leave a treated site shortly after an application of simazine.

2 Fix leaky irrigation systems and drainage problems which may contribute to irrigation runoff into waterways.

3 In flood irrigated orchards, use return systems that re-circulate runoff water or a storage and reuse system.

4 Precision irrigation can reduce the amount of drainage water leaving a field. Examples of these irrigation practices include:

- Monitor soil moisture levels and schedule irrigations according to crop requirements rather than the calendar.
- Use microsprinklers or drip irrigation to reduce the amount of tailwater runoff.



Field Site Practices to Reduce Runoff

1 Sediment control basins can be built to: trap sediment and pesticides adsorbed to soil particles; reduce and manage onsite and downstream runoff; and divert the flow of dissolved nutrients and pesticides. Sediment basins also improve the ability to farm sloping land, reducing gully erosion as well as improving downstream water quality.

2 Cover crops planted in the vineyard or orchard row can help prevent runoff and sediment transport during high rainfall. Growing cover crops or adding soil amendments can aid in improving soil permeability and reduce runoff. If a site is prone to runoff, design a drainage system to minimize offsite movement of silt, pesticides and fertilizers.

3 Vegetative filter strips placed between fields and water bodies provide localized erosion/runoff protection (*i.e.* grassed roadways or areas of vegetation). Depending upon the site, a full border around a field may not be necessary for mitigating impacts to surface water. Filter strips could be planted at field ends or along other sensitive zones.

Application Stewardship

1 Evaluate each field to identify areas where sediment or surface water runoff might move offsite to waterways or other vulnerable areas.

2 Develop a field layout map and note the location of wells, sinkholes, highly erodible land, drainage ditches, streams and rivers.

3 Provide the field layout map to all sprayer operators or commercial applicators.

4 Document application date/timing and keep a historical record on hand.

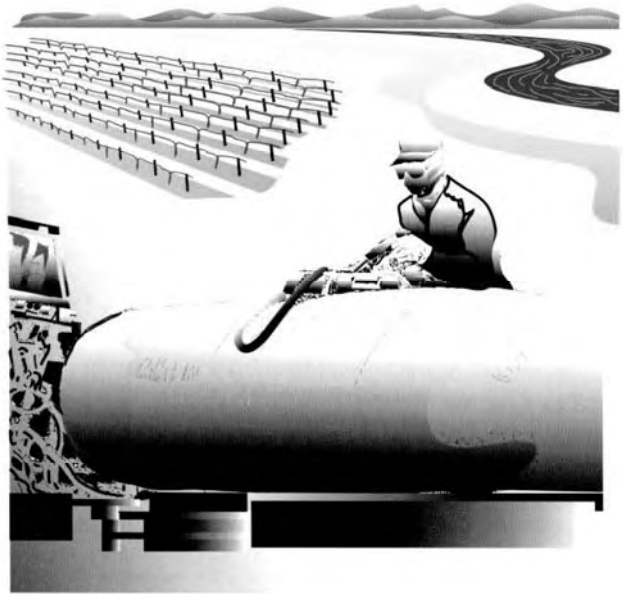
5 Be a responsible operator. The individual responsible for the application must be aware of:

- Wind condition (speed and direction) and whether rainfall is forecasted or an irrigation will occur within the next 48 hours.
- Presence/absence of waterways and vulnerable sites in the area, especially downwind of the application site or connected to the site by drainage ditches, canals or sloughs.
- The application equipment set up and calibration; proper use of any drift-reducing application equipment such as hooded sprayers.
- Always wear the required personal protective equipment when mixing, loading and applying chemicals (check the label for guidance).
- Proper record keeping of all applications as part of the field history.

Holding Ponds

Follow Proper Mixing and Loading Practices

1. Do not mix or load within 50 feet of any stream, river, or edge of a lake or reservoir.
2. Do not leave a sprayer unattended while filling.
3. Fill tank (1/4 full of water) prior to the addition of chemicals.
4. Do not overfill the tank: spills can wash away to vulnerable sites. Use an air gap to prevent tank overfilling.
5. Use a backflow valve on the fill tube.
6. Open paper chemical packages with scissors or a knife, rather than tearing.
7. Immediately triple rinse containers. Pour rinseate back into the tank prior to filling.
8. Apply rinse water back to the treated field. Never just drain out.
9. Never leave pesticides in a spray rig overnight.
10. Check with the county for proper disposal methods for empty plastic containers.



Site Evaluation Checklist

Before Spraying...

- ☐ Evaluate each field to pinpoint areas that are erodible where sediment might move offsite to waterways.
- ☐ Identify points where surface water runs off into waterways or other vulnerable areas. Get help with identifying these sites through local Natural Resource Conservation Service (NRCS) offices.
- ☐ Develop a field layout map and note the location of wells, sinkholes, highly erodible land, drainage ditches, streams and rivers.
- ☐ Flag or stake no treatment buffer zones.
- ☐ Provide the field layout map to all sprayer operators, commercial applicators, Pest Control Advisors or anyone involved with pest management decisions.

Additional reference information for California growers is available at:
http://www.cdpr.ca.gov/docs/emon/ehap.htm

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Stewardship of Lorsban-4E/Lorsban 15G Insecticides (Chlorpyrifos) to Avoid Water Quality Issues

Chlorpyrifos Residues Detected in Local Waterways

Water testing conducted in recent months by Central Valley water quality coalitions and other monitoring conducted in some coastal counties has detected residues of chlorpyrifos – the active ingredient in Lorsban®-4E and Lorsban 15G insecticides – in several waterways where farm runoff is common.

Q How has this happened?

A Residues of chlorpyrifos have been entering surface water through three potential routes following treatment of grapes (and other crops):

- Irrigation tail water runoff
- Spray drift into waterways that border fields
- Storm water runoff after fields have been treated with an insecticide

Q What does this mean to grape growers and/or PCAs?

A Lorsban-4E and Lorsban 15G provide effective and economical control of grape and vine mealybugs and several species of ants. University research has shown the post-harvest application of Lorsban-4E to be the most effective and economical method of controlling vine mealybug.

Without appropriate mitigation efforts by the registrants and users, detections of chlorpyrifos residues could result in serious regulatory restrictions and threaten the future use of an important insect management tool in grapes and other crops in certain areas of California.

Dow AgroSciences
Lorsban®-4E
Insecticide

Dow AgroSciences
Lorsban® 15G
Granular Insecticide

Q What has Dow AgroSciences done?

A New label changes have been implemented for Lorsban-4E and Lorsban 15G, including:

- A restriction statement: "To avoid contamination of irrigation tail waters, do not flood irrigate within 24 hours following a soil surface or foliar application."
- Addition of spray drift management guidelines. See labels for more details, including guidelines regarding wind speed, temperatures and inversion effects.
- Addition of buffer zones when chlorpyrifos applications are made adjacent to permanent bodies of water or other sensitive aquatic areas (50 feet for airblast applications). See labels for more details.

It's Not Just Chlorpyrifos

While water testing has indicated the presence of chlorpyrifos, be aware that ANY pesticide used on crops could potentially be transported into waterways through these routes and detected in monitoring. To date, more than a dozen insecticides and herbicides have been detected in California surface waters. If appropriate preventative actions are not taken, ANY pesticide or nutrient could potentially reach waterways, thus threatening future use of those important farm inputs.

Call to Action

Dow AgroSciences is committed to the long-term defense and stewardship of chlorpyrifos products; however, Dow AgroSciences cannot do it alone. Growers and PCAs also need to take immediate action to preserve the use of this important insect management tool. Simply switching insect control products is not a long-term or short-term solution, as waterways will continue being monitored for many farm inputs.

The CA Dept. of Pesticide Regulation has recently placed all pyrethroids under re-evaluation due to detection of these products in sediments of surface waters. Other products may follow the same path if detected in the waters of state at levels toxic to some sensitive indicator species.

Best Management Practices (BMPs)

The following BMPs can be implemented to help protect farms and valuable farm inputs.

Field Site BMPs

- Vegetative ditches, barriers, filter strips around field perimeters to reduce sediment movement, increase filtration of sediments and farm chemicals potentially present in the water, and reduce overall volume of runoff.
- Holding ponds (sediment basins) to capture runoff water and settle out sediments or allow breakdown of farm chemicals before they reach the waters of state.
- Tail water return systems for reuse of excess irrigation water.
- Irrigation management to reduce the amount of runoff at the end of each field.

Spray Drift Management & Other Application BMPs

- Be aware of sensitive sites and waterways that are near the vineyard being sprayed.
- Avoid spraying directly into or toward a ditch carrying water out of the vineyard.
- Turn off outside nozzles when treating the outer 3 rows of vines adjacent to waterways.
- Know the current weather conditions (rain, wind speed and direction) and avoid making an application if conditions favor off-site movement of the pesticide.
- Be aware of the weather forecast and consider its impact to an application.
- Use drift control agents and/or drift-reducing application equipment.
- Properly dispose the spray equipment rinsate. Do not dump any rinsate or unused spray mix into the ditches, roads or other sensitive areas. All the excess spray mix and rinsates must be disposed of properly or sprayed in the vineyard.
- Follow all recommendations made in the product label regarding management of off-site drift and contamination of tail water.

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For additional information, contact UC Extension or the Coalition for Urban/Rural Environmental Stewardship (www.curesworks.org).

Dow AgroSciences

Always read and follow label directions.
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Stewardship of Lorsban-4E Insecticide (Chlorpyrifos) to Avoid Water Quality Issues

Chlorpyrifos Residues Detected in Local Waterways

Water testing conducted in recent months by Central Valley water quality coalitions has detected residues of chlorpyrifos — the active ingredient in Lorsban®-4E insecticide — in several waterways where farm runoff is common.

Q A How has this happened?

Residues of chlorpyrifos appear to have been entering surface water through three potential routes following treatment of tree nuts (and other crops):

- Irrigation tail water runoff
- Spray drift into waterways that border orchards
- Storm water runoff after orchards have been treated with an insecticide

Q A What does this mean to tree nut growers and/or PCAs?

Lorsban-4E provides effective and economical control of several key pests of trees, including codling moth, walnut aphid, navel orangeworm, peach twig borer, walnut and San Jose scales, and several ant species. University research and grower practices over the last two decades have shown that Lorsban-4E is a very important tool for insect control in tree nuts in California.

Detections of chlorpyrifos residues may result in serious regulatory restrictions. The restrictions could threaten the future use of an important insect management tool in tree nuts and other crops in certain areas of California.

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Q A What has Dow AgroSciences done?

New label changes have been implemented for Lorsban-4E, including:

- A restriction statement: "To avoid contamination of irrigation tail waters, do not flood irrigate within 24 hours following a soil surface or foliar application."
- Addition of spray drift management guidelines. See labels for more details, including guidelines regarding wind speed, temperatures and inversion effects.
- Addition of buffer zones when chlorpyrifos applications are made adjacent to permanent bodies of water or other sensitive aquatic areas (50 feet for airblast and 150 feet for aerial applications). See label for more details.
- Reduction in the total amount of chlorpyrifos applied to tree nuts per season.

It's Not Just Chlorpyrifos

While water testing has indicated the presence of chlorpyrifos, be aware that ANY pesticide used on crops could potentially be transported into waterways through these routes and detected in monitoring. To date, more than a dozen insecticides and herbicides have been detected in California surface waters. If appropriate preventative actions are not taken, ANY pesticide or nutrient could potentially reach waterways, thus threatening future use of those important farm inputs.

Call to Action

Dow AgroSciences is committed to the long-term defense and stewardship of chlorpyrifos products; however, Dow AgroSciences cannot do it alone. Growers and PCAs also need to take immediate action to preserve the use of this important insect management tool. Simply switching insect control products is not a long-term or short-term solution, as waterways will continue being monitored for many farm inputs.

The CA Dept. of Pesticide Regulation has recently placed all pyrethroids under re-evaluation due to detection of these products in sediments of surface waters. Other products may follow the same path if detected in the waters of state at levels toxic to some sensitive indicator species.

Best Management Practices (BMPs)

The following BMPs can be implemented to help protect farms and valuable farm inputs.

Field Site BMPs

- Vegetative ditches, barriers, filter strips around field perimeters to reduce sediment movement, increase filtration of sediments and farm chemicals potentially present in the water, and reduce overall volume of runoff.
- Holding ponds (sediment basins) to capture runoff water and settle out sediments or allow breakdown of farm chemicals before they reach the waters of state.
- Tail water return systems for reuse of excess irrigation water.
- Irrigation management to reduce the amount of runoff at the end of each field.

Spray Drift Management & Other Application BMPs

- Be aware of sensitive sites and waterways that are near the orchard being sprayed.
- Avoid spraying directly into or toward a ditch carrying water out of the orchard.
- Turn off outside nozzles when treating the outer 3 rows of trees adjacent to waterways.
- Know the current weather conditions (rain, wind speed and direction) and avoid making an application if conditions favor off-site movement of the pesticide.
- Be aware of the weather forecast and consider its impact to an application.
- Use drift control agents and/or drift-reducing application equipment.
- Properly dispose the spray equipment rinsate. Do not dump any rinsate or unused spray mix into the ditches, roads or other sensitive areas. All the excess spray mix and rinsates must be disposed of properly or sprayed in the orchard.
- Follow all recommendations made in the product label regarding management of off-site drift and contamination of tail water.

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For additional information, contact UC Extension or the Coalition for Urban/Rural Environmental Stewardship (www.curesworks.org).

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