Cooperative Extension • Monterey County

Crop Notes

November/December, 2006

In This Issue:

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IRRIGATION MANAGEMENT FOR OPTIMIZING RASPBERRY PRODUCTION

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Cathy Carlson, Staff Research Assistant

Introduction

Irrigation scheduling involves deciding when and how much to irrigate to optimize production and quality. Although numerous irrigation studies have been conducted to determine how to maximize production of commodities widely grown in California, such as cotton and tomatoes, fewer studies have been conducted for specialty crops, such as raspberries. However, as the acreage and the value of raspberries have increased on the central coast, the need for information on irrigation management has become more pressing. Anecdotal reports of water use from growers suggested that between 3 to 4 feet of water (3 to 4 acre-feet per acre) was necessary for maximizing fruit production during the growing season. Because of the scarcity and high cost of water at some locations on the central coast, improved water management could lower production costs. Additionally, better water management may reduce the risk of leaching soluble nutrients, such as nitrate, into ground water.

Weather-based estimations of crop water-use

Weather-based approaches to scheduling irrigations are used for many cultivated crops. Windspeed, air temperature, relative humidity, and solar radiation affect plant water-use, or more specifically the water lost by evaporation from the soil and by transpiration from the leaves of the crop. Using evapotranspiration (evaporation + transpiration) data from the California Irrigation Management Information System (CIMIS) it is possible to estimate the consumptive water use of a crop in units of inches or mm per day. CIMIS ET data is available from the Department of Water Resources website (www.cimis.water.ca.gov) for more than 120 locationos in California, and is generated by weather stations located on irrigated grass, which serves as a reference crop.

ET requirements of a specific crop can be estimated by multiplying reference ET data and the appropriate crop coefficient (Kc): $ET_{crop} = ET_{ref}\ Kc$

The value of Kc usually ranges from 0.1 to 1.1 and is closely related to the percentage of ground shaded by the canopy. Irrigation method and physiological stages, such as flowering and senescence are also factored into the crop coefficient. Because crop coefficients are not available for raspberries, estimates of canopy cover may serve as a close substitute for Kc values.

By irrigating just long enough to replace water lost by evapotranspiration it is possible to optimize irrigations for production and minimize percolation below the root zone. Also, it is possible to avoid under-irrigating during periods of high water consumption, which can result in stress and reduced growth.

Commercial Field Trials

In collaboration with commercial growers we conducted 9 irrigation trials in commercial fields to examine the effect of water management on plant growth and fruit production during the 2004 and 2005 seasons. Trials were conducted for 1st –year, fall and 2nd –year, spring-harvested crops and for crops grown under and without macro-tunnels (Table 1). All crops were planted from canes and established with overhead sprinkler. The crops were subsequently irrigated by surface drip with a tape discharge rate of 0.67 gal per minute per 100 ft. The same proprietary variety was planted at all sites.

Procedures

Crops were irrigated twice per week in the early spring and then 3 times per week in the late spring, summer and fall. Irrigation treatments consisted of 50%, 75%, 100%, and 125% of crop ET, and were replicated 4 times in each trial. Plots measured 1 bed width (88 inches) × 280 to 300 ft in length, depending on the field size. We used an infrared camera suspended from a pole to estimate canopy cover at various stages of development at each trial. Table 2. presents canopy cover values for a 1st-year, cane crop harvested in fall. For trials conducted in macro-

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WINTER COVER CROPS FOR REDUCING STORM RUN-OFF AND PROTECTING WATER QUALITY IN STRAWBERRIES

Michael Cahn, Irrigation and Water Resources Advisor
Mark Bolda, Strawberry and Caneberry Advisor
Richard Smith, Vegetable and Weed Advisor

Introduction

Winter-planted cover crops are increasingly used to reduce storm water run-off from agricultural lands and to prevent the migration of sediment, nutrients, and pesticides to surface water bodies. Cover crops can also protect ground water by trapping mobile nutrients such as nitrate before they can leach below the root zone.

One way that cover crops minimize storm run-off is by maintaining high soil infiltration rates. By extracting soil moisture, cover crops allow a greater portion of rainfall to infiltrate thereby reducing the portion available for run-off. Cover crops may also enhance infiltration by increasing macropore space in soil. Root exudates and other organic material from the cover crop aggregate soil particles and contribute to the large pores that allow water to rapidly infiltrate into the soil profile. Additionally, cover crops absorb energy from the rain drops which can break down soil aggregates and cause the formation of a crust that seals the soil surface. The thin crust can greatly impede infiltration and increase run-off.

Cover crops can also reduce suspended sediments and turbidity of storm-water run-off by slowing the movement of run-off. Fast flowing water has more energy to detach soil particles and keep sediments suspended than water flowing slowly. Also, slowing run-off permits time for water to infiltrate into the soil.

Despite the many benefits of winter cover crops, they must be compatible with grower practices, and not reduce yield or adversely affect the economics of the commodity being produced. This precaution especially applies to strawberries since they are grown during winter months and are of high value. Most strawberry producers who use cover crops plant the perimeter of fields and irrigation blocks to protect roadways from erosion. Planting cover crops in the furrows between beds would be a better strategy to maximize infiltration and reduce nutrient loss during storm events, but is not a common practice due to potential interference with the production of the spring crop.

Comparing cover crop strategies in strawberries

We conducted a replicated field trial during the 2005/06 winter to investigate if cover crops planted in furrow bottoms could reduce storm run-off and improve water quality in commercial, organic strawberry field. Cover crops were planted in the furrow bottoms for the entire length of the beds on November 11th, 2005. We compared a low stature cover crop (triticale), which was less likely to compete with the berry growth, with a fast growing barley variety. An unplanted control treatment was also included in the trial. The cover crop treatments were mowed once (Jan. 16th) to minimize competition with the strawberries. The unplanted control plots were hand weeded 3 times during the trial. The field was located near Moss Landing on the Elkhorn Ranch and had approximately a 2% fall. Plots consisted of 2, 48-inch wide beds of 312-foot length. Water from one furrow per plot was collected in a sump at the low end of the field. A marine bilge pump and a flow meter were used to measure the amount of collected runoff. Some of the water that was pumped was diverted through a narrow tube into a collection bucket for laboratory analysis.

Rainfall of individual storm events and cumulative rainfall for the season is shown in Figure 1. Most of the heavy storm events occurred during the end of December and early January, resulting in 8 inches of rainfall at the field trial site. The next series of rain events occurred in late February and early March.

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Despite the many benefits of winter cover crops, they must be compatible with grower practices, and not reduce yield or adversely affect the economics of the commodity being produced.

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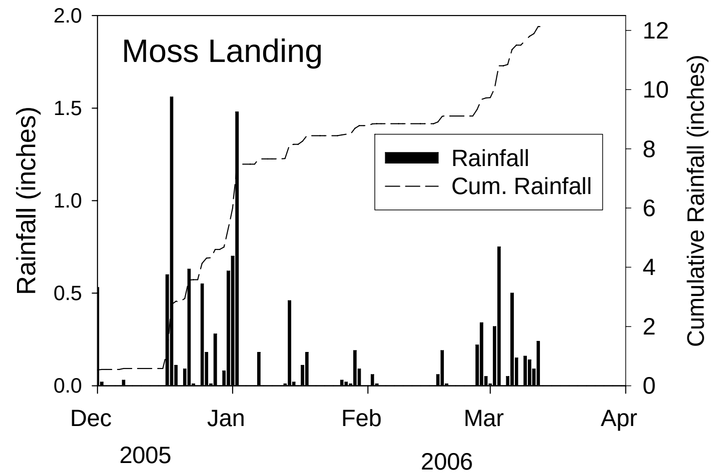

Figure 1. Rainfall amounts from individual storm events and total precipitation for the winter measured at the field trial site near Moss Landing.

Planting cover crops in the furrows between beds would be a better strategy to maximize infiltration and reduce nutrient loss during storm events, but is not a common practice due to potential interference with the production of the spring crop.

Runoff collected from the plots during the late December storm events (Dec 22 – Jan 3) was analyzed for sediments, nutrients, and dissolved salts. Total run-off during this period was similar among all treatments (Table 1). The cover crops may not have reduced run-off because the ground was saturated at the beginning of the sampling period. More than 2 inches of rainfall occurred 3 days prior to collecting the first set of run-off samples. Also an impervious clay layer several feet below the soil surface may have prevented rainfall from infiltrating once the soil was saturated.

Data showing that run-off measured from the plots was slightly greater (0.5 inches) than the cumulative rainfall (4.6 inches) in late December would also suggest that the field was poorly drained. In late February and March, when evapotranspiration was higher and rainfall was less intense, the amount of run-off from all treatments was less than rainfall. Although cumulative run-off in early March was approximately a half inch less in the cover cropped plots compared to the unplanted plots, the differences among treatments were not statistically significant (data not presented).

Despite minimal effects on the amount of run-off, barley and triticale cover crops, planted in the furrow bottoms significantly improved the quality of the runoff (Table 1). Turbidity and suspended sediments were reduced by as much as 70% compared to the unplanted control. Total phosphorus and total nitrogen, which includes the organic fractions of these nutrients was reduce by 40% and 47% respectively in the cover crop treatments relative to the unplanted control treatment (Table 1). Soluble nutrients, such as ortho-phosphate and nitrate, and salts were not different among treatments.

Using triticale, a low stature cover crop, improved water quality as much as barley, which tends to have a tall stature.

Using triticale, a low stature cover crop, improved water quality as much as barley, which tends to have a tall stature. A low-growing cover crop would reduce the mowing needed during the winter and minimize competition with the strawberries. In this study, a hoeing in mid December which disturbed the soil may have contributed to the high suspended sediments in the control plots. Except for early winter, cultivation of the furrows is often not possible in organic strawberry production due to wet conditions.

Summary

Cover crops planted in the furrow bottoms in strawberries reduced sediment and turbidity in the run-off by as much 70% and reduced total P and total N by more than 40%. Soluble P and nitrate levels in the runoff were not reduced by using cover crops. Run-off amounts were similar in cover crop and unplanted areas, most likely because of inadequate drainage caused by a clay layer a few feet below the soil surface. Providing adequate drainage, either through deep tillage or tile drainage, appears to be prerequisite for cover crops to reduce run-off on poorly drained soils.

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Cover Crop Treatment	Cumulative Runoff[Z]	Electrical Conductivity	pH	NO3-N	Total N	Total P	Ortho-P	Total Suspended Sediments	Turbidity
	inches	dS/m		---------- ppm ----------					NTU[Y]
Control	5.42	0.47	7.21	11.49	3.86	1.42	0.56	659	909
Triticale	5.07	0.55	7.41	11.77	2.05	0.89	0.56	222	320
Barley	5.26	0.59	7.45	10.84	2.04	0.80	0.50	205	266
	NS[X]	NS	***	NS	***	***	NS	***	***

[X] NS = not statistically signficant, *** = staticsally significant at the 0.001 confidence level
[Y] low NTU (Nephelometric Turbidity Units) indicate less turbidity
[Z] runoff was collected from 12/22/05 to 01/03/06

Table 1. Comparison of storm run-off collected from cover crop furrow treatments in organic strawberries. Values are averages of analyses from 6 storm events.

Despite minimal effects on the amount of run-off, barley and triticale cover crops, planted in the furrow bottoms significantly improved the quality of the runoff (Table 1).

USE OF ROOT DIPS FOR STRAWBERRIES

Mark Bolda, Strawberries and Caneberries

An option for the management of *Colletotrichum* anthracnose and *Phytopthora* root rot disease in strawberry is to immerse transplants in water and fungicide solutions prior to planting. These methods are commonly referred as root dips, and the following article is a brief discussion of the options currently available to growers.

Colletotrichum:

In warm wet weather, *Colletotrichum acutatum* can cause plant dieback after transplant, reduction of plant productivity and fruit lesions. Strawberry nurseries work hard to keep the strawberry transplants they sell to growers clean of *Colletotrichum* anthracnose disease. The fungicides Abound and Quadris (both azoxystrobin) have been shown to suppress anthracnose in strawberries, and transplants should be planted immediately after dipping. Abound is fully labeled for both dipping and foliar applications. Quadris can also be used for dipping, but requires a supplemental label, as strawberry uses are no longer on the regular (Section 3) label. Since Abound and Quadris both have great affinity for soil, it is recommended that transplants be washed prior to dipping and fungicide solution should be changed often. Plant crowns should be left in the mixture for 2 to 5 minutes. The fungicides Switch and Pristine are currently registered for use as foliar applications for anthracnose control but not for dips.

In organic production systems, the only method currently recommended is to wash strawberry transplants with water prior to transplanting, as recent research indicates that *Colletotrichum* spores are removed with washing. Hot water dips are not recommended in any case, as they can be damaging to the plant. Growers of organic strawberries should also take care to purchase plants which are clean of anthracnose.

Phytopthora:

Root rot caused by several species of *Phytopthora* is unfortunately a common problem in California strawberry production fields. While field drainage and soil fumigation are vital in management of this disease, root dipping can be a way to further avoid problems in susceptible strawberry varieties and when field history and conditions appear to favor the disease. Dipping strawberry transplants in Aliette (fosetyl aluminum) or phosphorous acids prior to transplant has been shown to reduce *Phytopthora* root diseases. It should be noted that Aliette and the phosphorous acids are compatible with dips using Abound or Quadris for control of *Colletotrichum.*

Phosphorous acids are normally sold as fertilizers. Growers should be certain that they are purchasing products containing phosphorous acid, as opposed to phosphoric acid which does not exhibit the same capability of limiting Phytopthora. Additionally, all products sold as nutrient solutions must state the phosphorous content in terms of phosphoric acid equivalents, even if they only contain phosphorous acid. Products such as Phosgard, Nutriphyte and Fosphite all contain phosphorous acid.

There currently is no fungicide registered nor is there a phosphorous acid corollary for use in organic systems. Growers of organic strawberries concerned about Phytopthora should be certain to obtain clean plant stock and purchase less susceptible varieties such as Albion or Seascape.

There are several fungicides mentioned in this article. Before using any of these products, check with your local Agricultural Commissioner's Office and consult product labels for current status of product registration, restrictions, and use information.
Those growers who have further questions concerning root dips or other issues in caneberries and strawberries are urged to contact Mark Bolda at the UC Cooperative Extension office in Watsonville.

In warm wet weather, *Colletotrichum acutatum* can cause plant dieback after transplant, reduction of plant productivity and fruit lesions.

Phosphorous acids are normally sold as fertilizers. Growers should be certain that they are purchasing products containing phosphorous acid, as opposed to phosphoric acid which does not exhibit the same capability of limiting Phytopthora.

UNIVERSITY of CALIFORNIA

Agriculture & Natural Resources

Cooperative Extension • Monterey County

University of California Cooperative Extension, Monterey County and USDA

2007 Irrigation and Nutrient Management Meeting and Cover Crop and Water Quality Field Day

Tuesday, February 20

7:45 a.m. to 3:00 p.m.

RAIN OR SHINE

Irrigation and Nutrient Management Meeting: Monterey County Agricultural Center, 1432 Abbott Street, Salinas

7:45	**Registration and Refreshments**
8:00	***Drip Germination of Lettuce*** Mike Cahn, Irrigation Farm Advisor, Monterey County
8:30	***Release of Nitrogen from Compost & Cover Crops and Their Impact on Broccoli Fertility*** Joji Muramoto, Research Scientist, UCSC Richard Smith, Vegetable Crop and Weed Science Farm Advisor, Monterey County
9:00	***Phosphorus Transformation in Soil*** Husein Ajwa, Extension Specialist in Soil and Water Management, UC, Davis
9:30	***Tipburn in lettuce: nutritional and varietal studies*** Tim Hartz, Extension Vegetable Specialist, UC, Davis
10:00	Break
10:30	***Water Quality Effects on Food Safety in Vegetable Production*** Trevor Suslow, Extension Specialist in Microbial Food Safety, UC, Davis
11:00	***Pyrethroid Runoff Issues in the Salinas Valley*** Don Weston, Professor of Integrative Biology, UC, Berkeley
11:30	***Impact of Cover Crops: Results from a Long-Term Study*** Eric Brennan, USDA Organic Program, Salinas Vegetable Research Station

Cultural Practice Demonstration and Discussion on How to Control Storm Water Runoff and Sediment Loss
USDA Spence Vegetable Research Station, 1572 Old Stage Road

12:30	***Lunch –Equipment Yard*** Pizza lunch provided by CAFF
1:15	***Field Demonstration and Discussion*** ***Identifying Storm Runoff Control Practices for the Salinas Valley:*** ***Cover Crops, Furrow Dike, Hedge Rows, Filter Strips, Vegetated Roads, Sediment Traps and Basins*** Mike Cahn, Mark Bolda and Richard Smith, University of California Cooperative Extension; Sam Earnshaw, Community Alliance with Family Farmers; and NRCS, TBA
2:30	***Conclusion***

- **Sponsors:** University of California Cooperative Extension; United States Department of Agriculture (USDA); Community Alliance with Family Farmers (CAFF); and Agriculture and Land-Based Training Association (ALBA)
- **Continuing Education, Certified Crop Advisor and Water Quality Credits have been requested**
- **For more information call Michael Cahn 759-7377 or Richard Smith 759-7357**

Post Workshop Tour
Tembladero Wetlands Demonstration Site
3:30 to 5:00 Call Sam Earnshaw 831-722-5556

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University of California and U.S. Department of Agriculture cooperating.

EVALUATION OF PRACTICES FOR CONTROLLING STORM RUN-OFF FROM VEGETABLE FIELDS

Michael Cahn, Irrigation and Water Resources Advisor
Richard Smith, Vegetable and Weed Science Advisor
Arnett Young, Monterey County Research Assistant

Introduction

Winter storm run-off from agricultural lands can transport sediments, nutrients and pesticides into nearby surface water. Because of the need to plant early in the year, when soils are often saturated, growers are challenged to implement management strategies that will reduce storm run-off and not interfere with early season production. Winter cover crops can often reduce storm run-off and improve soil structure but they can slow down planting operations in the early spring. The large amount of biomass produced by winter cover crops may require multiple tillage operations to fully incorporate material before bed shaping.

The purpose of this project was to evaluate alternative strategies to planting full cover crops, which might control storm run-off with less risk of slowing down early spring tillage operations. One strategy we examined was to pass over listed beds in the late fall with a tillage implement, called a furrow dike, which mounds soil at regular intervals in the furrows so that run-off is retained, allowing more time for water to infiltrate. We also evaluated planting a low statured triticale variety (Trios 102) in the furrow bottoms; Trios was selected because it produces less biomass and would minimize residue which may interfere with bed shaping in the early spring (runoff evaluations of this treatment were terminated on February 22 in order to evaluate incorporation methods). Additionally we evaluated applications of a granular polymer (polyacrylamide) that was applied before storm events at rates ranging between 1.7 and 3.3 lb/acre (Table 1). Polyacrylamide (PAM) was applied by hand to the upper 200 feet of the field. Finally, we evaluated the combined practices of diking and planting a low stature cover crop in the furrows. These 4 alternative practices were compared with a full-cover cover crop (Merced Rye) planted in late November (standard cover crop) and to listed beds without any vegetation or other management practice to reduce run-off (untreated control).

The field trial was conducted at the USDA Spence research farm, near Salinas CA, and the soil type was a Chualar sandy loam. Plots measured 588 ft ´ 3, 40-inch wide beds. The field was listed November, 10 2005 and cover crops were planted Nov 14. The cover crops were germinated from rain fall in late November and early December. Treatments were replicated 4 times in the field following a randomized complete block design.

Summary of Results:

Because rain events in the early winter did not cause run-off at the trial site, overhead sprinklers were used to saturate the soil profile and to induce run-off. The first 5 run-off events were caused by overhead sprinklers and the subsequent 5 run-off events in late winter and early spring were from storms. The amounts of water applied by sprinkler events and precipitation measured from rain storms are presented in Table 1.

The cumulative amounts of run-off measured from plots during sprinkler and rain events are presented in Table 2. In general strategies that relied on vegetation significantly reduced run-off. Almost no run-off was measured from the full-cover Merced rye treatment. The cover crop planted in the furrow bottoms also greatly reduce run-off. The other practices (diked furrow bottom, dike furrows + cover crop, and PAM) did not reduce run-off from sprinkler events. Though, these 3 treatments had less run-off then the untreated control during rain events, the difference were not statistically significant.

The standard cover crop, furrow-planted cover crop, and PAM treatments reduced suspended sediment and turbidity in run-off induced by sprinklers (Table 3). The furrow-diked treatments did not achieve much reduction if any, in suspended sediments and turbidity. Total phosphorus concentration was not significantly reduced by any of the treatments; however, total nitrogen was reduced in the standard cover crop and furrow-bottom cover crop treatments. Sediment and nutrient concentrations in rain induce run-off were not significantly different among the control, PAM, and diked furrow treatments (Table 4). No water ran off the standard cover crop treatment during this rain event.

Conclusions:

Winter cover crops, planted in beds and furrows, or only planted in furrow bottoms, significantly reduce run-off and the concentration of sediments in run-off. By planting in the furrow bottoms with a low growing crop, such as triticale, it should be possible to minimize interference from residue during bed shaping. The diked, furrow bottom treatments did not reduce run-off. Because the furrows were not chiseled in the fall, the diking implement, may have compacted the furrow bottoms, thereby reducing infiltration. We will reevaluate the diking implement after chiseling the furrows during the second year of the trial. Granular PAM reduced sediment loss in sprinkler induced run-off but not under storm induced run-off. Possibly the rate of PAM, which was reduced to 1.7 lb/acre was too low to reduce sediment loss in the February rain event. Nevertheless, applying PAM to

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Winter storm run-off from agricultural lands can transport sediments, nutrients and pesticides into nearby surface water.

Winter cover crops can often reduce storm run-off and improve soil structure but they can slow down planting operations in the early spring.

The purpose of this project was to evaluate alternative strategies to planting full cover crops, which might control storm run-off with less risk of slowing down early spring tillage operations.

Just Published. . .

October 12, 2006

The following new ANR publications are now available from Communication Services:

California Dairies: Protecting Water Quality
Patricia L. Ristow, G. Stuart Pettygrove, Deanne M. Meyer, Davis Lewis, Nyles Peterson, Janet C. Broome

This handy guide is a primer for consultants, local agencies, and lending institutions that summarizes practical approaches and technologies that have been implemented by progressive dairy producers to protect surface and groundwater quality.

Since each dairy is different, practices must be tailored to each situation. This guide discusses three types of dairies – dairies with irrigated cropland, dairies with non-irrigated pasture and hay fields, and dairies with limited cropland – and outlines a variety of management measures for each. It also summarizes four critical components that progressive dairy producers have successfully implemented to protect water quality. 16 pp. 21630 $10.00

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IMPROVEMENT OF YIELD IN RED RASPBERRY WITH OPTIMIZED CANE PRUNING AND FERTILITY MANAGEMENT

Mark Bolda, UCCE Farm Advisor

Introduction

It is standard practice for raspberry growers of some floricane fruiting (spring bearing) varieties to remove the first flush of vegetative canes in the spring in order to allow the fruiting canes of the plant to produce more fruit. This removal of vegetative cane to improve fruit yield is supported by the scientific literature, which finds that vegetative cane growth competes with fruiting cane for resources in red raspberry.

The second flush of vegetative cane after the first is normally maintained for the fruit production of the fall as well as a crop in the following year. As with the first flush of vegetative canes, the growth of these vegetative canes competes with the spring crop for nutrients. Normally this second flush of vegetative canes are not pruned, however, because their removal is thought to cause too much delay in production of these future fruiting canes, and would result in canes which are small and less fruitful for the second crop in the fall.

However, the gain in yield from removal of the second flush of vegetative cane can be quite substantial; my own work has shown a 40% increase in yield in raspberry cane that is allowed to fruit in the absence of vegetative cane. The issue to be addressed is to work out a way to remove this second flush of vegetative cane to gain a maximum in yield of the first crop in the spring, yet grow substantial enough cane to yield a normal crop in the fall.

In this trial it is hypothesized that growers, through a modification in fertility practices, can remove the second flush of vegetative canes, thereby maintaining a near maximum of fruit in the spring, without a loss in productivity of the second crop later in fall.

Materials and Methods

A test plot consisting of 4 treatments of four replicates each was set up in a well functioning raspberry farming operation. Rates of applied nitrogen consisted of a grower standard of 90 lbs, and a grower standard with an additional 8 lbs nitrogen added, targeted to times that the vegetative cane is more disposed to take it up, mainly in June and July after harvest of the first crop is complete and the vegetative canes are being grown for the second crop. Fertilizer was applied as per grower procedure, i.e. as a side-dress in the early spring, and later as a drip tape applied liquid supplement.

First flush of vegetative primocane was removed by the grower February 22, 2005, and the second flush was removed by the researcher in designated treatments on April 11, 2005.

Measurement of fruit yield was done by an established procedure for yield evaluation.

It is standard practice for raspberry growers of some floricane fruiting (spring bearing) varieties to remove the first flush of vegetative canes in the spring in order to allow the fruiting canes of the plant to produce more fruit.

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To measure growth of cane, cane height was measured once in the fall and cane diameter was measured twice on June 24 and October 22, 2005.

Tissue Sampling: Carbohydrate partitioning was evaluated to determine resource allocation of canes in the various fertilizer and pruning treatments once during the growing season. Carbohydrate analysis samples were taken on August 2, 2006 by removing sections of cane from 0.9 m to 1.2 m from each treatment replicate.

Results were tested statistically using a multiple comparison procedure (Least Significant Difference at the 95 percent level of significance) to determine whether the means of counts and percentages per treatment were significantly higher or lower from the other treatments.

Results and Discussion: Refer to the tables below for statistical analysis of results.

Pruning of canes a second time, while resulting in less fruit in the fall, did not affect total yield, nor did it have a positive effect on spring fruit yield. The use of extra fertilizer also did not result in significant gains in yield, whether or not the canes were pruned a second time.

With one exception, pruning a second time resulted in shorter, thinner canes, whether or not extra fertilizer was used. Starch content of canes did not vary by fertilizer or pruning treatment.

Normally this second flush of vegetative canes are not pruned, however, because their removal is thought to cause too much delay in production of these future fruiting canes, and would result in canes which are small and less fruitful for the second crop in the fall.

All Plots [1]

Treatment	Yield, Spring	Yield, Fall	Yield, Total	Cane Height	Cane Diameter	Cane Diameter	Starch Content
Unpruned	2348.7 a	224.7 a	2573.5 a	6.09 a	78.50 a	76.67 a	9.11 a
Pruned	2727.6 a	79.5 b	2807.1 a	5.34 b	68.06 b	70.83 b	8.38 a

All Plots [1]

Treatment	Yield, Spring	Yield, Fall	Yield, Total	Cane Height	Cane Diameter	Cane Diameter	Starch Content
Grower Standard Fertilizer	2727.6 a	145.4 a	2873.0 a	5.78 a	74.88 a	73.50 a	8.39 a
Grower Standard Fertilizer + Extra	2348.7 a	161.9 a	2510.7 a	5.65 a	71.69 a	74.00 a	9.09 a

Pruning of canes a second time, while resulting in less fruit in the fall, did not affect total yield, nor did it have a positive effect on spring fruit yield.

Unfertilized Plots [1]

Treatment	Yield, Spring	Yield, Fall	Yield, Total	Cane Height	Cane Diameter	Cane Diameter	Starch Content
Unpruned	2814.7 a	218.0 a	3032.6 a	6.04 a	80.75 a	78.34 a	9.18 a
Pruned	2640.5 a	72.7 b	2713.3 a	5.25 b	69.00 a	68.67 b	9.03 a

Fertilized Plots [1]

Treatment	Yield, Spring	Yield, Fall	Yield, Total	Cane Height	Cane Diameter	Cane Diameter	Starch Content
Unpruned	2222.4 a	237.5 a	2459.9 a	6.11 a	76.25 a	75.00 a	8.70 a
Pruned	2475.1 a	86.3 b	2561.4 a	5.46 b	67.13 b	73.00 a	7.78 a

[1] Treatments followed by the same letter have no statistically significant differences.

The author thanks José Espindola for his contribution and participation in this trial.

RESEARCH AND INFORMATION CENTERS (RICs)

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Weed Research and Information Center
Joe DiTomaso, Director — Gale Perez, Program Rep.
wric.ucdavis.edu

Cornucopia of Online Tools

Each center's Web site offers free unique tools that apply breakthrough research information to real-world situations.

The **Agronomy** RIC offers an interactive plot plan creator that generates forage plot plans based on specific data input. Go to http://alfalfa.ucdavis.edu and click on Plot Plan Creator.

Fruit trees need enough hours of cold temperatures for flower and leaf buds to develop normally. The **Fruit and Nut** RIC's Web site calculates cumulative chilling hours at http://fruitsandnuts.ucdavis.edu/weather. Growers and industry members can track chilling hours, decide on orchard management practices and estimate crop load.

The Web site of the **Environmental Horticulture** RIC provides a comprehensive index on California turf grass at http://ohric.ucdavis.edu/newsltr/ctc/ctcv_index.htm.

The **Postharvest** RIC offers recommendations for the handling of almost 150 commodities. Maturity and quality indices, recommendations on temperature and relative humidity control, and responses to controlled atmospheres are all at http://postharvest.ucdavis.edu/Produce/Producefacts.

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The **Vegetable** RIC provides information in English and Spanish on 32 vegetable crops for growers and home gardeners at http://vric.ucdavis.edu/veginfo/veginfor.htm.

The **Weed** RIC offers an interactive comprehensive chart of weeds and their susceptibility to various herbicides at http://wric.ucdavis.edu/information/weedchart.html.

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the head of the field may not be a satisfactory strategy for controlling storm run-off since the practice did not reduce run-off and was difficult to decide which storm events would require an application of the polymer.

Table 1. Water applied to field trial by overhead sprinklers and rain events.

Date	Precipitation	PAM application
	inches	lb/acre
	----overhead sprinklers --	
2/8/2006	1.89	3.3
2/10/2006	1.16	3.3
2/14/2006	1.23	3.3
2/17/2006	0.63	0.0
2/21/2006	0.79	1.7
	----- rainfall -----	
2/27/2006	0.54	1.7
3/3/2006	0.61	0.0
3/6/2006	0.38	1.7
3/10/2006	0.46	0.0
3/13/2006	0.42	0.0

Table 2. Cumulative sprinkler and rainfall induced run-off expressed in gallons per plot and percentage of applied water (rainfall).

	------------------ Cumulative Run-off -----------------------			
Treatment	Sprinkler induced[x]		Rainfall induced[y]	
	gallons	% of applied	gallons	% of rainfall
Untreated Control	674	5.9	1490	31.0
Standard Cover Crop	19	0.2	21	0.4
PAM[z]	976	8.6	1102	22.9
Furrow Dike	812	7.1	651	13.5
Furrow Dike +Cover	788	6.9	959	20.0
Cover Crop Furrow	191	1.7	--	--
CV (%)	55	55	70	70
$LSD_{0.05}$	475	4.2	914	19.0

[x] 5.7 inches applied between 2/8/06 and 2/21/06
[y] 2.4 inches measured between 2/27/06 and 3/13/06
[z] Total of 11.6 lb/acre applied before 4 irrigations between 2/8/06 and 2/21/06 and 3.33 lb/acre applied before 2 rain events between 2/27/06 and 3/13/06

The cumulative amounts of run-off measured from plots during sprinkler and rain events are presented in Table 2. In general, strategies that relied on vegetation significantly reduced run-off.

Table 3. Average sediment and nutrient concentrations in sprinkler induced run-off.

Treatment	Total Suspended Solids	Turbidity	Total P	Total Kjeldahl N
	mg/L	NTU[x]	------- mg/L	---------
Untreated Control	463	910	1.3	2.4
Standard Cover Crop	75	52	1.4	1.2
PAM[y]	116	119	0.9	2.9
Furrow Dike	448	1025	1.4	2.2
Furrow Dike +Cover	310	753	1.2	1.9
Cover Crop Furrow	189	460	1.3	1.4
CV (%)	21.6	28.1	9.5	16.7
F-test	0.003	0.011	0.110	0.008

[x.] low NTU (Nephelometric Turbidity Units) indicate less turbidity
[y.] Total of 11.6 lb/acre applied before 4 irrigations between 2/8/06 and 2/21/06 and 3.33 lb/acre applied before 2 rain events between 2/27/06 and 3/13/06

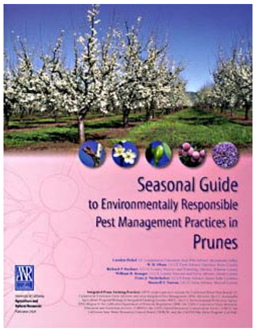
The standard cover crop, furrow-planted cover crop, and PAM treatments reduced suspended sediment and turbidity in run-off induced by sprinklers (Table 3).

Treatment	Total Suspended Solids	Turbidity	Total P	Total Kjeldahl N
	mg/L	NTU[x]	------- mg/L	---------
Untreated Control	1046	3577	2.7	5.5
Standard Cover Crop	--	--	--	--
PAM[y]	1007	2113	2.5	5.2
Furrow Dike	1450	4290	3.5	6.3
Furrow Dike + Cover	705	2393	2.6	3.7
Cover Crop Furrow	--	--	--	--
CV (%)	52.2	41.6	25.1	27.2
F-test	NS[z]	NS	NS	NS

[x.] low NTU (Nephelometric Turbidity Units) indicate less turbidity
[y.] 1.65 lb/acre applied before a 0.54 inch rain event on 2/27/06
[z.] NS = not statistically significant

Winter cover crops, planted in beds and furrows, or only planted in furrow bottoms, significantly reduce run-off and the concentration of sediments in run-off.

Just Published. . .(Cont'd from page 7)



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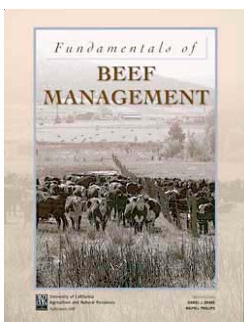

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SYRPHID FLIES SUPPRESS LETTUCE APHID IN ORGANIC ROMAINE

Hugh Smith and William Chaney

The lettuce aphid (Nasonovia ribisnigri) became established in California in 1998 and has become the most important insect pest of lettuce in California's Central Coast region. The lettuce aphid builds up in the innermost leaves of the lettuce plant, contaminating areas that cannot be treated easily with insecticides. This contamination makes lettuce unmarketable. In addition to the lettuce aphid, foxglove aphid, green peach aphid and potato aphid are pests of Central Coast lettuce.

The lettuce aphid (Nasonovia ribisnigri).

A syrphid fly adult feeding on fennel pollen.

The lettuce aphid builds up in the innermost leaves of the lettuce plant, contaminating areas that cannot be treated easily with insecticides.

Conventional lettuce growers use frequent scouting and application of organophosphate, neonicitinoid, and other insecticides to treat lettuce aphid when it first appears in the crop. Organic lettuce producers on California's Central Coast rely on naturally-occurring predators to clean up aphid infestations before harvest. The most important predators of aphids in lettuce in the Central Coast region are syrphid flies, also called hover flies. Syrphid fly adults feed on nectar and pollen from flowers. The female flies then seek out plants with aphids on them to lay their eggs. The small green larvae that hatch from the eggs are specialists in eating aphids. Many organic lettuce producers intercrop lettuce with quick-flowering annuals or "insectary crops" to provide floral resources to syrphid adults with the intention of increasing egg-laying by syrphids in nearby lettuce. Sweet alyssum and a "good bug blend" are the most commonly used insectaries on the Central Coast.

In 2005, Bill Chaney, UCCE entomology farm advisor for Monterey County, and Hugh Smith, a university entomologist, carried out a six month survey of the syrphids attacking aphids in organically grown romaine in and around the Salinas Valley. The purpose of the survey was to determine which syrphid species are most important in cleaning up infested lettuce before harvest, and to get a better understanding of how this natural control system works. From March through September of 2005, romaine was collected from 14 ranches near Aromas, Gilroy, Hollister, Salinas, Greenfield and San Ardo. At five of these ranches, romaine was collected 3-5 times during the development of the crop, so that the syrphid complex could be studied as the aphid infestation increased. For each sample date, 20 romaine heads were collected. During the survey period well over a thousand heads of romaine were examined for aphids and syrphids.

Results

Chaney and Smith found that at least 12 different species of syrphid fly attack aphids in organic romaine in the Salinas Valley area. Four species were common, and seem to be primarily responsible for suppressing aphids. They are assisted by three less common syrphid species. The five additional syrphid species found in the survey were rare. Syrphids are also attacked by natural enemies: five percent of the syrphid larvae collected were found to be parasitized by parasitic wasps.

The most important predators of aphids in lettuce in the Central Coast region are syrphid flies, also called hover flies.

Differences in syrphid behavior were revealed that may help explain why this group of syrphids is so successful in suppressing aphids. Two of the most common species of syrphid (Toxomerus marginatus and Sphaerophoria sulphuripes) were often collected from romaine plants that had few or no aphids, as well as moderately and highly infested romaine. The tendency of females of these species to lay eggs on lettuce where aphid numbers are very low may prevent lettuce aphid from becoming established in some fields.

The purpose of the survey was to determine which syrphid species are most important in cleaning up infested lettuce before harvest, and to get a better understanding of how this natural control system works.

The second most commonly collected syrphid species, Platycheirus stegnus, was only reared in substantial numbers from romaine that was highly infested with aphids. The female of this species exhibited unusual egg-laying behavior, laying eggs in clusters of parallel eggs. All other syrphid females found in the survey lay eggs singly, or occasionally in groups of 2-3. P. stegnus may be adapted to respond to highly infested plants. The differences in behavior observed among three of the most common species of syrphid attacking lettuce aphid indicates that members of the complex may take advantage of different levels of aphid infestation.

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Differences in syrphid behavior were revealed that may help explain why this group of syrphids is so successful in suppressing aphids.

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The five repeatedly sampled sites included a range of aphid infestation levels from negligible to moderate and high. Three different syrphid species were present in the negligibly-infested fields, and 4-7 species were present in the moderately and highly infested sites. For example, average numbers of aphids, syrphid eggs, and syrphid larvae per romaine plant were very low on an organic ranch near San Ardo (Fig 1). On each collection date, the primary syrphids attacking aphids in this field were T. marginatus and S. sulphuripes, which are active at low aphid densities (Fig 1b). In a highly-infested field near Aromas, average aphid numbers per plant were around 50 three weeks prior to harvest (Fig. 2a). This number dropped to the low single digits by harvest time. The primary syrphid reared from this field was P. stegnus, but six other species of syrphid were present (Fig 2b).

This survey confirmed that there are several syrphid species involved in suppressing lettuce aphid and other aphid pests of organic lettuce to below economically-significant levels on California's Central Coast. T. marginatus, P. stegnus, and S. sulphuripes are three of the most important syrphid predators of aphids in organic romaine on the Central Coast, but in most commercial fields that were studied, aphid suppression required contributions from combinations of these species as well as rarer species.

This survey confirmed that there are several syrphid species involved in suppressing lettuce aphid and other aphid pests of organic lettuce to below economically-significant levels on California's Central Coast.

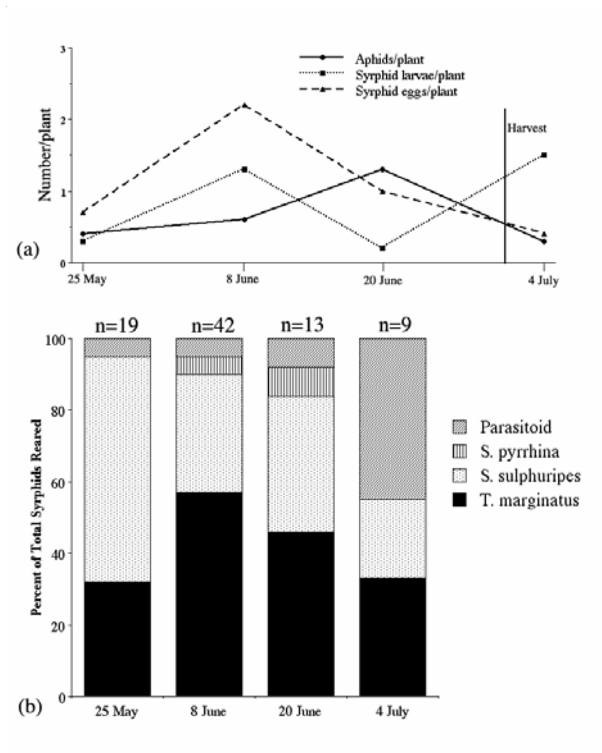

Fig. 1. Aphid and syrphid populations at a low aphid density site (San Ardo). (a) Average per plant densities of aphids, syrphid eggs, and syrphid larvae. (b) Syrphid species composition and percent parasitism of reared syrphids from each sample date.

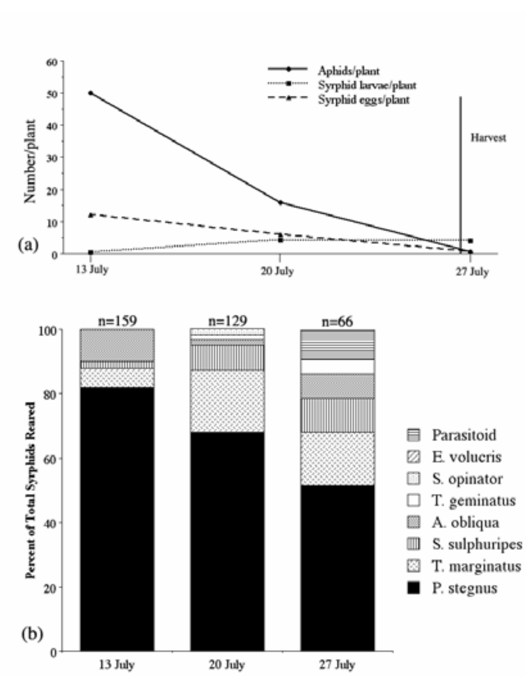

Fig. 2. Aphid and syrphid populations at a high aphid density site (Aromas). (a) Average per plant densities of aphids, syrphid eggs, and syrphid larvae. (b) Syrphid species composition and percent parasitism of reared syrphids from each sample date.

(Cont'd from page 1)

tunnels crop ET was reduced by 20% to account for shading by the plastic cover. Flowmeters were used to monitor the amount of water applied to each treatment. An example of the cumulative water applied during the season for trial 5 is presented in Figure 1. Soil moisture was monitored at depths of 1, 2, and 3 feet in 2 replications of each irrigation treatment for each trial using granular matrix (watermark ™) blocks. Carton yield was measured by the cooperating growers. Effects of irrigation treatment on plant height, cane diameter, and number of laterals was measured in selected trials.

Results

Estimated water-use (~17 inches) was highest for fall-harvested crops, which were grown from December through October in 2004. The second-year spring crop in 2005 had the lowest water-use (~8.5 inches) due to late rains which delayed the need to irrigate in the early spring. For all crops the consumptive water use was estimated to be substantially less than the 3 to 4 feet of water normally applied for commercial production.

Soil moisture monitoring was used to cross-check crop ET estimates. Cutting back irrigation in the 50% and 75% ET treatments reduced soil moisture to greater than 30 centibars in the 1 and 2 foot depths (data not presented). Conversely, soil moisture was maintained between 10 and 30 centibars in the 100% and 125% ET treatments, demonstrating that the crop was adequately irrigated to maintain the soil near field capacity.

Yield results of all trials are presented in Figures 2-4. Irrigation treatments had minimal effects on carton yield for Trials 1-3, which were 2nd year spring crops that were established under well-watered, unstressed conditions during the preceding year (Figure 2). Only the 50% ET treatment significantly reduced yield in trial 3. These results demonstrate how the irrigation management of the prior year can carry over into the second year of production. In contrast, yields of trials 5-7 were significantly affected by irrigating less than the crop ET requirement in the 1st and 2nd seasons (Figures 3 and 4). In general, reducing the irrigated amount to 50% of crop ET reduced production while irrigating at 100% of crop ET maximized production. The effect of irrigation on production was more dramatic in the first season than the second, presumably because a portion of the water demands were met by rainfall during the second-year, spring crop. The main effects of irrigation on quality were a reduction in fruit size in the 50% ET treatment (data not presented).

Irrigation treatments also affected the plant growth in trials 5-7. Cutting back on irrigations (< 100% crop ET) reduced plant height (Table 3), and cane diameter (Table 4), but did not affect the number of lateral branches on the main cane (Table 5). Plant height and cane diameter were similar for the 100% and 125% ET treatments.

Conclusions

Using a weather-based approach to scheduling irrigations can help growers estimate water needs of raspberries so that production can be maximized without over-applying water. The results of trials conducted during the 2004 and 2005 seasons demonstrated that irrigating 2 to 3 times per week at 100% of estimated crop ET maximized production. This approach to irrigation scheduling also reduces the risk of over-irrigating which can leach mobile nutrients such as nitrate below the rooting depth of the crop. Estimates of canopy cover were useful for calculating crop ET from CIMIS reference ET data. Additionally, monitoring of soil moisture provided a useful cross-check of ET based scheduling of irrigations. The combined approach of weather and soil-based scheduling of irrigations appears to be a practical method for growers to achieve optimal use of water in raspberries.

Table 1. Summary of irrigation trials

Trial	Macro-tunnel	Harvest	Crop	Year
1	Yes	Spring	2nd	2004
2	No	Spring	2nd	2004
3	No	Spring	2nd	2004
5	No	Fall	1st	2004
6	No	Fall	1st	2004
7	Yes	Fall	1st	2004
5	Yes	Spring	2nd	2005
6	No	Spring	2nd	2005
7	Yes	Spring	2nd	2005

Table 2. Average canopy cover for first-year cane raspberries (Trials 5-7).

Fall Crop, 1st Year Canes	
Days after Leaf-Bud Break[1]	**% Canopy Cover**
67	**12**
77	**16**
87	**22**
97	**30**
107	**38**
117	**48**
127	**58**
137	**67**
147	**75**
157	**82**
167	**87**

1. Leaf-bud break was estimated to occur feb. 15th, for a dec. 5th planting date.

(Cont'd to page 15)

Because of the scarcity and high cost of water at some locations on the central coast, improved water management could lower production costs.

By irrigating just long enough to replace water lost by evapotranspiration it is possible to optimize irrigations for production and minimize percolation below the root zone.

Acknowledgements
We thank Manuel Mercado and Frank Estrada for their cooperation in conducting the field trials.

For all crops the consumptive water use was estimated to be substantially less than the 3 to 4 feet of water normally applied for commercial production.

The results of trials conducted during the 2004 and 2005 seasons demonstrated that irrigating 2 to 3 times per week at 100% of estimated crop ET maximized production.

The combined approach of weather and soil-based scheduling of irrigations appears to be a practical method for growers to achieve optimal use of water in raspberries.

(Cont'd from page 14)

Table 3. Effect of irrigation management on plant height. 2nd –year spring crop.

	Plant height			
ETc Treatment	Trial 5	Trial 6	Trial 7	Overall
	feet			
50%	4.67	5.02	4.33	4.67
75%	5.12	5.00	4.46	4.87
100%	5.23	5.17	4.66	5.02
125%	5.30	5.25	4.67	5.08
CV (%)	6.3	7.3	7.6	7.1
LSD $_{0.05}$	0.13	NS	NS	0.14

Table 4. Effect of irrigation management on cane diameter. 2nd –year, spring crop.

	Cane Diameter			
ETc Treatment	Trial 5	Trial 6	Trial 7	Overall
	mm			
50%	100	107	100	102
75%	102	110	105	106
100%	105	116	113	111
125%	112	110	113	111
CV (%)	20.7	13.2	15.6	16.9
LSD $_{0.05}$	NS	NS	8.9	7.8

Table 5. Effect of irrigation management on number of lateral branches on main cane. 2nd –year, spring crop.

	Lateral Number			
ETc Treatment	Trial 5	Trial 6	Trial 7	Overall
	#/cane			
50%	5.8	6.5	5.2	5.9
75%	4.4	6.3	6.3	5.6
100%	5.3	5.9	7.0	6.0
125%	5.0	6.2	5.9	5.7
CV (%)	46.4	36.0	36.2	39.4
LSD $_{0.05}$	NS	NS	NS	NS

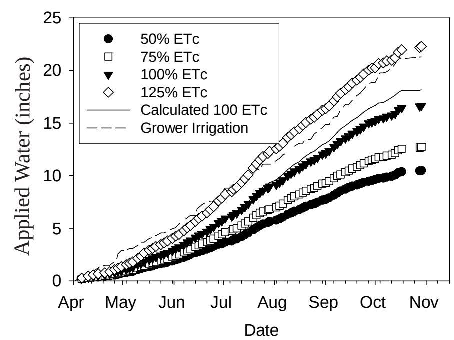

Figure 1. Cumulative applied water for 50% - 125% ETc treatments and grower treatment for trial 5, 1st -year fall crop.

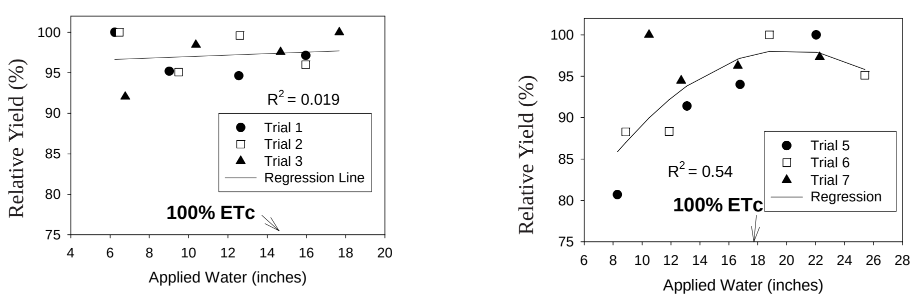

Figure 2. Relative yield response to applied water for 2nd -year spring crops and 1st year fall crops in 2004.

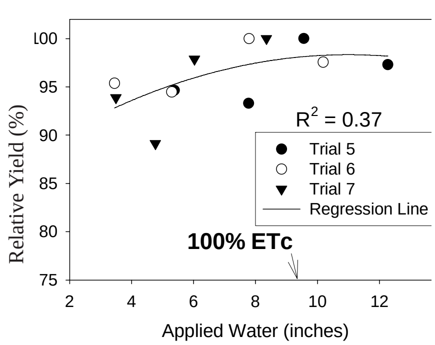

Figure 3. Relative yield response to applied water for 2nd -year spring crops in 2005.

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MONTEREY COUNTY

Crop Notes

November/December, 2006

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