Cooperative Extension • Monterey County

Crop Notes

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BI NAMED MONTEREY FARM ADVISOR

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LETTUCE VERTICILLIUM AND SPINACH SEED: RESEARCHING POSSIBLE CONNECTIONS

Steven Koike and Krishna Subbarao, University of California

Introduction: When it was recently discovered that spinach seed could carry viable colonies or propagules of the Verticillium wilt pathogen (*Verticillium dahliae*), speculation began to try to link contaminated spinach seed with the occurrence of Verticillium wilt of lettuce in California's central coast. It is important to emphasize that at this stage of our knowledge, such a link has not yet be demonstrated. The purpose of this article is to summarize pertinent aspects of Verticillium wilt as it occurs in lettuce and spinach, and to outline the research agenda that will help us better understand this important disease.

Summary of Verticillium wilt of lettuce: Verticillium wilt was first confirmed in California lettuce in 1995. The disease initially was detected in only a few fields in one area of the coast, but over the ensuing years has been found in widely separated areas. Still, the disease has been restricted to the coastal area, and no Verticillium wilt has been seen in lettuce grown in desert or San Joaquin Valley growing areas. There are two races of *V. dahliae* from lettuce, and both races can occur in the same lettuce field. Seed assay studies show that lettuce seed can carry viable *V. dahliae*. Limited seed surveys indicate fairly low (1 to 6%) rates of contamination. However, it is not yet clear if commercially planted lettuce seed is commonly infested.

Summary of Verticillium wilt of spinach: *Verticillium dahliae* also causes Verticillium wilt of spinach. However, this disease will normally not be seen in California because this fungus will cause visible symptoms on spinach only when plants have bolted and are producing seed. Therefore, this problem is only observed in spinach seed producing areas in the Pacific Northwest and Europe. In contrast to the lettuce seed situation, it is now documented that spinach seed can at

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times be commonly infested with *V. dahliae*. Infestation rates vary greatly from very low (1% or less of the seed) to high (greater than 40%) incidence.

Verticillium can be seedborne in both spinach and lettuce.

Unresolved research questions: It appears likely that infested spinach seed will have some role in *Verticillium* wilt as it occurs in lettuce. However, research documentation is required to prove this link. The following are some of the unresolved questions that must be answered.

1. Pathogen identification: Are spinach and lettuce *V. dahliae* isolates the exact same pathogen? Or are they genetically distinct from each other? How closely related are they? Research is already under way (Subbarao lab) to explore this aspect. In addition, other *Verticillium* species have been recovered from seed. Are any of these truly pathogenic on spinach or lettuce?

2. Host ranges: *Verticillium dahliae* isolates vary in the range of plant hosts they can infect. For example, *V. dahliae* from pepper generally attacks only pepper and will not cause disease on lettuce. The *V. dahliae* from lettuce will not cause disease on cauliflower. Therefore, to what degree will the *V. dahliae* from spinach infect lettuce plants? Preliminary inoculation studies indicate that some spinach isolates can infect lettuce. This aspect will need further defining.

Host ranges of various isolates will be important to document.

3. Multiple inoculum sources: While the aspect of spinach seed *V. dahliae* is being debated and researched, other potential sources of this pathogen need to be considered. Any particular field can be exposed to *V. dahliae* from the following: infested lettuce seed planted in the field; infested weed seeds that blow into the field; contaminated dirt and mud that fall off equipment and vehicles that enter the field; infested or infected plant materials such as strawberry transplants. The relative importance of these inoculum sources, in addition to contaminated spinach seed, require further evaluation.

4. Existing soil populations: While attention has focused recently on possible "new" sources of *V. dahliae*, populations of *V. dahliae* have been in coastal soils for a long time. This pathogen has been in some fields here long before the 1995 occurrence of Verticillium wilt of lettuce. The importance of these existing populations relative to new seedborne introductions requires further scrutiny. Could there be an over-emphasis on seedborne inoculum?

Verticillium is readily spread in contaminated dirt and mud.

5. Disease cycle: Research is needed to understand the disease cycle, or epidemiology, of this system. If seedborne *V. dahliae* is important, what level (infestation threshold) of contaminated seed is needed to cause field disease for lettuce? What is the fate of seedborne inoculum that is deposited in field soils? Does such inoculum readily survive, or does most of it not persist? Can inoculum that originated from seed be distinguished from pre-existing soilborne inoculum?

6. Disease control: Clearly, regardless of research findings, it will be desirable to eventually have spinach and lettuce seed that do not harbor *V. dahliae*. What seed production steps can be taken to reduce or eliminate contaminated seed? What accurate, standardized seed test will be used to detect *V. dahliae* in seed? What infestation thresholds will be appropriate? What seed treatments can be developed and implemented to deal with infested seed? Beyond these seed related issues, lettuce growers also will need to use resistant cultivars, as they are developed, and rotate with non-lettuce crops to reduce disease pressure, and reduce inter-field spread via contaminated dirt and mud.

Presently a team of researchers is investigating certain aspects of this issue. Growers, pest control advisors, members of the seed industry, and other industry persons are collaborating with researchers so that science-based information can be generated to address these concerns and to derive appropriate steps to manage the problem.

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What role does infested spinach seed have in field Verticillium problems?

CHILLING REQUIREMENTS IN CALIFORNIA STRAWBERRIES

By Mark Bolda, Farm Advisor

Cold conditioning, or chill requirement, is an essential part of growing and producing strawberries in California. The chilling requirement is defined as being the cumulative period, usually measured in number of hours below a certain temperature, which is needed to produce the internal changes in the strawberry plant that result in the normal sequence of growth following winter dormancy. In strawberries, hours accumulated of temperatures between 28 and 45 degrees Fahrenheit are considered to be effective and are counted as towards chill requirement.

A lack of supplemental chill will result in a plant which is less vigorous and with more tendency to fruit.

Chill requirement in strawberry is made up of two essential parts. One part is what the plant accumulates in the field before being harvested, and the other is accumulation of chill after harvest and the plant is in storage. There is a difference between the two. In-field chill takes place when the plant is still in the soil, out in the open and still has all its leaves. Supplemental chill takes place after harvest of the plant and occurs in a constant near freezing temperature, in the dark and the plant has none to very few leaves left.

Since the grower has little control over the accumulation of chill in the field, he or she should focus on the management of supplemental chill. Generally, growers should know that a high degree of supplemental chill in strawberry results in more vigor, meaning more vegetative growth, and less fruiting. A lack of supplemental chill will result in a plant which is less vigorous and with more tendency to fruit.

The catch is that growers need to strive to strike a balance between vigor and vegetative growth and fruiting. Too little vigor will result in a plant of reduced fitness which does not have a capacity to bear a great number of fruit, whereas a plant with large amounts of vegetative growth will

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have its fruiting ability compromised, since it is dedicating too many resources in the production of leaves, crowns and runners.

Additionally, accumulation of chill in the strawberry transplant makes it stronger and better able to survive the stress of harvest and subsequent transplant. Harvest of transplants means their leaves are cut off, they are ripped from the ground, tumbled in a drum and exposed to drying out in the open air. So, while in theory it is possible to grow good productive plants from transplants that are short of the recommended chill requirement, in practice, namely a commercial operation, plants lacking in supplemental chill requirement will not do well and some will probably not survive transplanting.

For University of California strawberry varieties, it is imperative that growers follow storage chill recommendations. These recommendations are based on years of research and should not be taken lightly.

Below are listed the storage chill recommendations for several popular UC varieties.

Variety	**Type**	**Supplemental chilling**
Albion	Day neutral	10-18 days
Aromas	Day neutral	10-21 days
Camarosa	Short day	0-7 days
Chandler	Short day	< 7 days
Diamante	Day neutral	10-21 days
San Andreas	Day neutral	10-18 days
Portola	Day neutral	10-18 days

From UC publication 3351 "Integrated Pest Management in Strawberries"

Finally, growers should know that to a small extent, plant vigor stemming from an excess or lack of supplemental chill requirement can be controlled by early season flower management. Removing flowers early in the season, such as in January on the Central Coast, allows the plant to continue to develop vegetatively, and would make up for a small deficiency in chill. Removing flowers later or not removing them at all slows the plant vegetative growth and would put the brakes on, so to speak, on a plant with an excess of chill requirement.

Finally, growers should know that to a small extent, plant vigor stemming from an excess or lack of supplemental chill requirement can be controlled by early season flower management.

FREEZE INJURY IN STRAWBERRY TRANSPLANTS

Mark Bolda, Farm Advisor

There has been recently a spate of questions about freeze injury in strawberry transplants, so this is a topic which merits some discussion.

The freeze damage seen in transplants has been in the crown. The crown of strawberry (which is actually a shortened stem) is composed of several parts. The central part of the crown is called the pith and is made up of parenchyma cells. In plants, parenchyma cells serve to fill up the space

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The central part of the crown is called the pith and is made up of parenchyma cells.

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between more specialized cells. Surrounding the pith are several more layers, in order from inside to out: the vascular layer containing the important food and water conducting elements, a cortical layer made up of yet more parenchyma cells and finally the epidermis on the very outside.

Any injury to the vascular layer will represent loss of later plant growth, since the food and water conducting elements located in this layer have been damaged or destroyed.

The pith is most sensitive to frost damage. The damage is caused by the formation of ice crystals in the parenchyma cells and the affected area of the pith, which is normally white, turns brown. Generally, lesser freezing injury is represented by a browning of a portion of the pith and, according to the literature, growers should expect to see little if any effect on the later growth of the plant. However, with greater injury, the pith takes on a deeper shade of brown and the surrounding vascular layer turns brown or even black. Any injury to the vascular layer will represent loss of later plant growth, since the food and water conducting elements located in this layer have been damaged or destroyed.

As a reference to the above and more detailed information, readers are encouraged to read the section on crowns found about a quarter of the way down in the following document provided by the National Agriculture Library of the USDA.

http://www.nal.usda.gov/pgdic/Strawberry/book/bok9teen.htm

NUTSEDGE CONTROL IN ONIONS

Richard Smith and Miriam Silva Ruiz, Farm Advisor and Research Assistant,
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These trials showed that burning nutsedge back with an acid based fertilizer such as 7-7-0-7 allowed the subsequent application of Outlook to effectively inhibit nutsedge regrowth for about two months.

Summary: Yellow nutsedge is a serious weed in onion production. It cannot be effectively removed by hand or cultivation and has the potential to devastate the yield of onions. Both Outlook and Dual Magnum are registered for use on onions to control yellow nutsedge. Neither of these materials have postemergence activity on onions, and in most years the nutsedge will be emerged prior to the allowed timing of these materials (2nd – 4th true leaf stage). These trials showed that burning nutsedge back with an acid based fertilizer such as 7-7-0-7 allowed the subsequent application of Outlook to effectively inhibit nutsedge regrowth for about two months. The control provided by Outlook and Dual Mangum helped to safeguard the yield of onions which otherwise was greatly reduced by competition by nutsedge. There is some indication that the use of the acid fertilizer may slightly reduce the yield of onions, but the damage caused by uncontrolled nutsedge was far greater. Outlook reduced the number and size of nutsedge tubers in treated plots and may help reduce nutsedge pressure in subsequent crops.

Introduction: Onions are particularly susceptible to weed pressure because they have slow seedling development and they do not form a competitive canopy later in the growth cycle. In conventional systems growers rely upon a preemergence herbicide to reduce weed pressure during the seedling stage and upon postemergence applications to kill escaped weeds and to apply a preemergence material to inhibit weed emergence later in the growth cycle. In 2007 and 2008 several new registrations of herbicides or modified labeled uses were granted:

- Goal Tender for use at the 1st true leaf stage (prior label use stated 2nd true leaf stage)
- Prowl H2O for use at the loop stage (prior label use stated 2nd to 9th true leaf stage)
- Nortron for preemergence and postemergence use (growth stage not specified)

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- Outlook for use against yellow nutsedge at the 2nd true leaf stage
- Dual Magnum for use against yellow nutsedge at the 4th true leaf stage

These registrations have greatly improved weed control programs in onions by giving growers increased herbicide choices and increased flexibility regarding when during the crop cycle they can be used.

Outlook was registered in 2007 prior to the onion growing season and growers used this material during both the 2007 and 2008 growing seasons. Dual Magnum was registered at the end of the growing season in 2008 and growers have not yet been able to use it along the coast. Outlook is registered for use at the 2nd true leaf stage and Dual Magnum at the 4th true leaf stage. Yellow nutsedge (*Cyperus esculentus*) is a warm season weed that emerges when soil temperatures warm in the late spring. In 2006 the weather was wet and cool. In a trial conducted in 2006, both Outlook and Dual Magnum were applied at the 2nd true leaf stage (May 8) and there was little emergence of yellow nutsedge at that time. Both materials had reduced nutsedge emergence at the weed evaluation conducted 76 days after planting. A small number of nutsedge plants broke through at the 120 days after planting weed evaluation, but in general both materials provided excellent control of yellow nutsedge and good safety to the onions. However, in the 2007 trial the spring weather was dry and warm and by the 2nd true leaf stage on April 11 there was significant emergence of well developed nutsedge plants. Outlook is not effective against established nutsedge plants. As a result, this research project was initiated to evaluate burning nutsedge back with an acid fertilizer (7-7-0-7) and then applying Outlook. This research report discusses the results of trials conducted in 2007 and 2008.

METHODS

Two field trials were conducted in Monterey County: Trial No. 1: This trial was established with a cooperating grower south of King City. The soil at the site was Metz complex loamy sand. Each plot was one 40 inch bed wide by 25 feet long; the plots were arranged in a randomized complete block design with four replications. The field variety was 'Tamara' and was planted on March 4, 2007. Prior to the establishment of the trial, the field had been treated with Dacthal post plant preemergence and Goal Tender at the first true leaf stage; both of these materials had no impact on the nutsedge population. First true leaf applications were made on April 4 and second true leaf on April 11. The acid based fertilizer 7-7-0-7 and Outlook was applied at the first and second true leaf stages (see Tables for application rates and timing). Irrigation was applied on the first or second day following the Outlook applications to incorporate the material into the soil. Evaluations of the number of nutlets in the soil of each treatment were conducted by collecting roughly 8,000 – 10,000 cm3 of soil on September 27. The soil was sieved to remove all nutlets in the soil which were then counted and weighed. The number of nutlets in each sample was converted to nutlets per 1,000 cm3. Yield evaluations were conducted on September 27 by harvesting all bulbs in an eight foot long strip in the middle of each plot and counting and weighing bulbs. Trial No. 2: This trial was conducted with a cooperating grower west of San Ardo. The soil type at the site was Pico fine sandy loam. Each plot was one 40-inch bed wide by 30 feet long and replicated four times in a randomized complete block design. The field variety was planted to a proprietary dehydration variety from ConAgra on March 10. Prior to the establishment of the trial, the field had been treated with Dacthal post plant preemergence and Goal Tender at the first true leaf stage; both of these materials had no impact on the nutsedge population. The first true leaf applications were made on April 10 and the second true leaf on April 21. The acid based fertilizer 7-7-0-7 and Outlook were applied at the first and second true leaf stages (see Tables for application rates and timing). Irrigation was applied on the first or second

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Onions are particularly susceptible to weed pressure because they have slow seedling development and they do not form a competitive canopy later in the growth cycle.

Yellow nutsedge (*Cyperus esculentus*) is a warm season weed that emerges when soil temperatures warm in the late spring. In most years nutsedge will be emerged prior to the allowed timing of use Outlook or Dual Magnum

Outlook is not effective against established nutsedge plants. As a result, this research project was initiated to evaluate burning nutsedge back with an acid fertilizer (7-7-0-7) and then applying Outlook.

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day following the Outlook applications to incorporate the material into the soil. Evaluations of the number of nutlets in the soil of each treatment were conducted by collecting roughly 8,000 – 10,000 cm3 of soil on September 19. The soil was sieved to remove all nutlets in the soil which were then counted and weighed. The number of nutlets in each sample was converted to nutlets per 1,000 cm3. Yield evaluations were conducted on September 19 by harvesting all bulbs in an eight foot long strip in the middle of each plot and counting and weighing bulbs. **Details for both trials**: All materials were applied with a CO2 backpack sprayer with two passes of a one nozzle wand with an 8008E tip at 30 psi applying the equivalent of 72 gallons per acre.

There were significantly fewer nutsedge and lower weight of nutsedge nutlets in the soil in the Outlook treated plots

RESULTS

Trial No. 1: The trial site was heavily infested with yellow nutsedge. The nutsedge was emerged by the time the onions were at the first and second true leaf stage. Given that Outlook is a post emergence material, it was thought that if the nutsedge was burned back with an acid based fertilizer (e.g. 7-7-0-7) then Outlook could inhibit the emergence of new leaves of nutsedge. Weed pressure was so extreme in the trial that weed control ratings were used to evaluate treatments rather than weed counts. First true leaf applications of Outlook gave better weed control than second true leaf applications on the April 23 and May 4 evaluation dates, but by June 1 all Outlook treatments had similar weed control ratings (Table 1). All Outlook treatments had greatly improved weed control than the untreated control. However, on the August 9 evaluation date the nutsedge began to resprout and weed control began to breakdown. There was no significant phytotoxicity in any of the treatments. There were significantly fewer nutsedge and lower weight of nutsedge nutlets in the soil in the Outlook treated plots (Table 2). There is a trend that indicates that the 14 oz/A application had fewer nutsedge in the soil than the two sequential applications of 7.0 oz/A. Yields of all Outlook treatments were improved over the untreated (Table 2). However, yields were less than observed in an adjacent trial in a part of the field with little nutsedge pressure (data not shown), which may indicate that there was a yield reduction which may have been due to the following factors: 1) nutsedge pressure; 2) phytotoxicity from 7-7-0-7 applications; or 3) a combination of these factors.

The untreated plots had no marketable yield.

Trial No. 2: This trial was conducted in a field with an extremely high nutsedge population. Nutsedge was emerged and well established by the first and second true leaf stages. Early applications of the acid fertilizer 7-7-0-7 in combination with 7.0 or 14.0 oz/A of Outlook provided the better nutsedge control for two months after application than applications made at the 2nd true leaf stage (Table 3). By July 29 the level of control provided by Outlook was breaking down and the nutsedge was resprouting and all treatments declined in efficacy. One treatment included Goal Tender at the first true leaf stage and this treatment also provided excellent weed control but was the most phytotoxic treatment on most evaluation dates (Table 3). The stand of onions in this trial was impacted by the high nutsedge population early in the growth cycle and the yield evaluations are a bit difficult to interpret due to variability in the data. In general it appears that the 1st true leaf applications of Outlook at 14.0 oz/A had lower yield than the 7.0 followed by 7.0 oz/A treatment. The untreated plots had no marketable yield. The variety used in this trial was less vigorous than varieties used for fresh market and the regrowth of nutsedge was higher in the part of the field with this variety than in an adjacent planting of a more vigorous fresh market type of onion.

ACKNOWLEDGEMENTS

We would like to thank the cooperating growers: Rio Farms and Christensen and Giannini Farms for their cooperation in conducting the field trials and staff research associate Salvador Montes.

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Table 1. Trial No. 1. Weed ratings1 and phytotoxicity ratings on April 23, May 4, June 1 and August 9, 2007

No.	Treatment	Material/A	a.i./A lbs	Application Timing	Nutsedge				Phytotoxicity			
					4/23	5/4	6/1	8/9	4/23	5/4	6/1	8/9
1	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 1 t. leaf Post 1 t. leaf 14 days later	5.8	7.8	8.3	3.5	0.2	0.0	0.0	0.0
2	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 1 t. leaf Post 1 t. leaf	6.7	8.0	8.6	3.5	0.3	0.0	0.0	0.0
3	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 2 t. leaf Post 2 t. leaf 14 days later	2.3	4.2	8.1	3.1	0.0	0.0	0.0	0.0
4	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 2 t. leaf Post 2 t. leaf	2.8	5.3	8.0	3.3	0.0	0.0	0.0	0.0
5	Untreated	----	----	----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LSD (0.05)	----	----	----	0.9	1.1	0.6	0.6	n.s.	n.s.	n.s.	n.s.

1 – Scale: 0 = no weed control to 10 complete weed control.

Table 2. Trial No. 1. Yellow nutsedge nutlet counts in soil and onion yield evaluations on September 27, 2007

No.	Treatment	Material/A	a.i./A lbs	Application Timing	Nutlets/ 1000 cm^3 soil	Nutlets Wt (gr)/ 1000 cm^3 soil	Nutlets Mean wt (gr)	Onion Yield Tons/A	Onion Yield Bulbs/A	Onion Mean wt/head
1	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 1 t. leaf Post 1 t. leaf 14 days later	103.6 a	7.52 a	0.072	46.5	97,206	0.78
2	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 1 t. leaf Post 1 t. leaf	61.8 a	5.28 a	0.079	47.2	89,854	0.86
3	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 2 t. leaf Post 2 t. leaf 14 days later	116.8 a	7.51 a	0.076	45.7	88,220	0.84
4	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 2 t. leaf Post 2 t. leaf	98.2 a	6.21 a	0.070	46.3	90,181	0.84
5	Untreated	----	----	----	290.6 b	25.45 b	0.093	34.7	97,533	0.58
	LSD (0.05)	----	----	----	123.8	8.90	n.s.	9.9	n.s.	0.14

1 – Scale: 0 = no weed control to 10 complete weed control.

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Table 3. Trial No. 2: Nutsedge weed rating1 (upper number in each cell) and Phytotoxicity ratings2 (lower number in each cell – shaded grey) on six dates in 2008.

Treatment	Material /A	Timing	April 25	April 29	May 8	May 14	June 5	July 29
7-7-0-7 Outlook 7-7-0-7 Outlook	60 gal 7 oz 30 gal 7 oz	1st true leaf 1st true leaf 2nd true leaf 2nd true leaf	7.0	7.5	7.0	6.6	7.8	4.5
			3.2	2.7	1.2	2.0	1.5	3.0
7-7-0-7 Outlook 7-7-0-7	60 gal 14 oz 30 gal	1st true leaf 1st true leaf 2nd true leaf	8.0	8.5	8.5	8.3	9.1	5.0
			3.7	3.7	3.0	3.5	4.2	2.8
7-7-0-7 Outlook	60 gal 7 oz	2nd true leaf 2nd true leaf	3.7	6.2	4.7	5.0	4.2	3.8
			2.5	2.0	1.0	1.5	2.0	2.3
7-7-0-7 Outlook	60 gal 14 oz	2nd true leaf 2nd true leaf	5.0	6.5	5.5	5.0	6.5	3.5
			3.2	2.0	0.7	1.7	1.7	2.5
7-7-0-7 Outlook Goal Tender	60 gal 14 oz 8 oz	1st true leaf 1st true leaf 1st true leaf	7.8	8.2	8.7	8.0	8.3	5.8
			4.2	4.2	3.0	4.2	3.5	4.0
Untreated	----	----	0.0	0.0	0.0	0.0	0.0	0.0
Pr>F Weed Rating			<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD 0.05 Weed Rating			1.5	0.7	1.3	1.3	1.6	1.6
Pr>F Phytoxicity			<0.0001	<0.0001	<0.0001	<0.0001	0.0004	0.0009
LSD Phytoxicity			0.6	1.1	0.6	1.2	1.5	1.4

1 – Rating: 0 = no weed control to 10 = total weed control; 2 – Scale: 0 = no crop damage to 10 = crop dead

Table 4. Trial No. 2: Yield evaluation on September 19, 2008.

Treatment	Material/A	Timing	Marketable			Culls			Total		
			1000's/A	T/A	Mean lbs	1000's/A	T/A	Mean lbs	1000's/A	T/A	Mean lbs
7-7-0-7 Outlook 7-7-0-7 Outlook	60 gal 7 oz 30 gal 7 oz	1st true leaf 1st true leaf 2nd true leaf 2nd true leaf	128.7	14.4	0.22	10.8	0.1	0.04	139.5	14.6	0.21
7-7-0-7 Outlook 7-7-0-7	60 gal 14 oz 30 gal	1st true leaf 1st true leaf 2nd true leaf	84.9	11.2	0.28	9.1	0.3	0.05	94.0	11.6	0.26
7-7-0-7 Outlook	60 gal 7 oz	2nd true leaf 2nd true leaf	110.1	9.4	0.17	36.8	0.8	0.05	147.0	10.3	0.15
7-7-0-7 Outlook	60 gal 14 oz	2nd true leaf 2nd true leaf	143.1	16.2	0.23	18.6	0.5	0.05	161.8	16.7	0.21
7-7-0-7 Outlook Goal Tender	60 gal 14 oz 8 oz	1st true leaf 1st true leaf 1st true leaf	102.5	11.8	0.23	14.1	0.4	0.05	116.6	12.1	0.21
Untreated	----	----	0.0	0.0	0.0	1.0	0.1	0.01	1.0	0.1	0.01
Pr>F			<0.0001	<0.0001	<0.0001	0.0870	0.0488	0.0228	<0.0001	<0.0001	<0.0001
LSD 0.05			33.0	3.5	0.06	23.7	0.5	0.03	48.7	3.5	0.06

UPDATE ON *IMPATIENS NECROTIC* SPOT VIRUS IN LETTUCE

Steven Koike, Richard Smith, and Tom Turini, UC Cooperative Extension;
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Introduction. For the last three seasons (2006 through 2008), coastal lettuce has been affected by the *Impatiens necrotic spot virus* (abbreviated INSV). INSV was not previously known to infect lettuce, but we now know this virus can cause damage to iceberg, romaine, leaf, and butterhead lettuce. The disease has been found in scattered parts of Monterey, Santa Cruz, and San Benito counties. INSV is vectored by the thrips insect, can infect a wide range of plants, and is not known to be a seedborne virus. While *Tomato spotted wilt virus*, another thrips-vectored virus, has been found in the San Joaquin Valley, INSV has not been found in lettuce in that inland area. Supported by the lettuce industry, we have been conducting research on various aspects of this disease outbreak.

INSV has been causing significant damage to lettuce for two seasons.

Virus strain? Because of this unexpected development, researchers wondered if perhaps this disease was due to a new or different strain of INSV. However, comparisons of the genetic sequences of INSV isolates from lettuce with those from the more typical ornamental hosts have revealed that these isolates are essentially identical. Thus, it appears that the INSV outbreak in lettuce is not due to the evolution or introduction of a new form of the virus that specifically infects lettuce.

Thrips vector? Worldwide, INSV is vectored only by thrips, and is apparently only vectored by one species, the western flower thrips (WFT) (*Frankliniella occidentalis*). We intensely sampled lettuce plants to determine if different thrips species might be implicated in this California outbreak. However, the vast majority (95 to 98%) of thrips collected from lettuce were WFT. We confirmed, therefore, that the INSV outbreaks are associated with WFT populations. During our sampling of lettuce, we found that thrips numbers were very high, with some counts exceeding 600 thrips per 5 plant sample. These high populations may be driving the INSV outbreaks and could account for crop loss from INSV.

Source of INSV? INSV is unlikely to be seedborne in lettuce, and distribution of diseased lettuce plants in a field indicates introduction of the virus from external sources. We therefore searched for reservoir sources of INSV by conducting a survey of weeds and other plants in the vicinity of INSV outbreaks. While we occasionally found a few weed species that tested positive for INSV, our surveys failed to identify a reservoir host that could be considered a source of INSV for lettuce. We do not yet know, therefore, where the virus is coming from.

High thrips popultations may be driving these outbreaks.

Outlook? Additional research will hopefully identify the source of the INSV problem for lettuce. In the meantime, continued, elevated thrips populations will make INSV outbreaks very likely. Keep in mind that symptoms caused by INSV may resemble symptoms of lettuce dieback disease (caused by *Lettuce necrotic stunt virus* and *Tomato bushy stunt virus*). In late 2008, a few lettuce plants were found to be infected with *Lettuce mosaic virus*; even this virus caused symptoms that could be confused with INSV symptoms. Contact UC Cooperative Extension for assistance in identifying these virus problems.

INSV is vectored by thrips and can cause significant damage to lettuce.

UNIVERSITY of CALIFORNIA
Agriculture & Natural Resources
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University of California Cooperative Extension, Monterey County

2009 Irrigation and Nutrient Management Meeting and Cover Crop and Water Quality Field Day

Tuesday, February 24

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	***Water Management of Lettuce: Field Scale Studies*** Mike Cahn, Irrigation and water resources Farm Advisor, Monterey County
8:30	***Nitrogen Management of Lettuce: Field Scale Studies*** Richard Smith, Vegetable Crop and Weed Science Farm Advisor, Monterey County
9:00	***Nitrogen Management Project at Dole Fresh Vegetables Corporation*** Jim Wilkinson, Ag Manager, Dole Corp and Tim Hartz, Extension Vegetable Specialist, UC, Davis
9:30	***Using Vegetation and Polymers for Controlling Nutrient, Sediment, and Bacteria in Irrigation Run-off*** Mike Cahn, Irrigation and water resources Farm Advisor, Monterey County
10:00	***Practical Examples of Vegetative Strip Plantings on the Central Coast*** Sam Earnshaw, Community Alliance with Family Farmers
10:15	***Break***
10:30	***Nitrogen Availability from Organic Fertilizers*** Tim Hartz, Extension Vegetable Specialist, UC, Davis
11:00	***Field Evaluations of Liquid Organic Fertilizers on Strawberries*** Mark Gaskell, Farm Advisor, Santa Barbara County
11:30	***Monterey County Water Concerns: Update on Groundwater Status and Salinas Valley Water Project*** Robert Johnson, Monterey County Water Resources Agency
12:00	***Conclusion and travel to lunch and field demonstration site***

Vegetable Furrow Bottom Cover Crop Field Trial Demonstration
Sea Mist Farms – off Espinosa Road (Between Hwy 101 and Castroville)

12:45	***Lunch – on Site*** Pizza lunch
1:30	***Field Demonstration and Discussion*** ***Discussion of the Impact of Low-Residue Cover Crops on Winter Fallow Beds on Runoff and Water Quality*** Mike Cahn and Richard Smith, University of California Cooperative Extension;
2:30	***Conclusion***

* **Sponsors:** University of California Cooperative Extension; Resource Conservation District (RCD); Community Alliance with Family Farmers (CAFF)
* **Continuing Education, Certified Crop Advisor and Water Quality Credits have been requested**
* **For more information call Richard Smith 759-7357 or Michael Cahn 759-7377**

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