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Crop Notes

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In This Issue:

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ARRIVAL AT A PROBABLE CAUSE OF YELLOW STRAWBERRY PLANTS IN CASTROVILLE

Mark Bolda, UC Cooperative Extension, Santa Cruz County

Introduction: The issue of patches of yellow strawberry plants appearing in certain fields in the Castroville – Salinas production area is one for which an explanation has stymied us for years. The extraordinarily detailed study described below is a thorough attempt to understand this problem and offer solutions to it.
In this particular case the complaint we were invited to evaluate was composed of patches of yellow plants dispersed in patches of various sizes in the field (photo 1 below), and particularly pronounced on one side of the field. This area corresponds with a farm road from a previous artichoke plantation as well as being the end of the drip tapes installed by the strawberry grower. The bed tops tended to be dry and moisture has been adequate but not excessive, so the common thesis of excess water actually did not fit so well in this situation.
Materials and Methods: A total of four samples (two from an area of severe yellowing, and two from an area of apparently healthy green plants) were taken. Following the output example posted below (Figure 3), each sample consists of 10 zones of a bed, and each zone is tested for 14 parameters. At each soil sampling site, a representative plant sample was uprooted and taken away for analysis of tissue mineral concentration.

Results: The data in the Tables 1 and 2 below represent an average of the two samples taken for yellow and green plants. In order to better interpret the data, several zones have been grouped together. Zones 9 and 10 represent the surface of the bed, zones 1, 2 and 3 represent the soil straight underneath the drip tape, zone 8 the plant zone, zone 7 the root zone and zones 6, 5 and 4 being underneath the root zone 7.

Table 1: Evaluation of Zones 1- 6 of Bed in Yellow and Healthy Areas

Data (mg/Kg dw)	Zones 1,2 and 3		Zones 4,5 and 6	
	Yellow	Healthy	Yellow	Healthy
Moisture (%)	33.7	33.6	29.8	31.8
pH (units)	8.5	8.1	8.5	8.1
EC5 (umhos/cm)	269	267	381	355
Ammonia (NH3-N)	24	32	60	16
Nitrate (NO3)	204	49	443	94
Phosphate (PO4)	126	86	66	68
Potassium (K)	157	184	157	92
Calcium (Ca)	419	417	398	201
Magnesium (Mg)	169	375	174	130
Carbonate (CaCO3) %	2.3	1.8	2.7	1.7
Sulfate (SO4)	219	195	694	412
Sodium (Na)	454	417	578	426
Chloride (Cl)	175	184	181	242
Nitrite (NO2)	0	0	0	0

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Table 2: Evaluation of Zones 7-10 of Bed in Yellow and Healthy Areas

Data (mg/Kg dw)	Zone 7- Root Zone		Zone 8- Plant Zone		Zones 9 and 10	
	Yellow	Healthy	Yellow	Healthy	Yellow	Healthy
Moisture (%)	30.6	32.1	33	33.1	22.8	26.3
pH (units)	8.7	8.2	8.7	8.3	8.3	8.2
EC5 (umhos/cm)	305	389	258	374	938	546
Ammonia (NH3-N)	34	14	54	16	48	44
Nitrate (NO3)	314	30	199	25	968	452
Phosphate (PO4)	6.5	57	85	55	111	45
Potassium (K)	144	74	185	89	206	89
Calcium (Ca)	341	156	713	194	512	195
Magnesium (Mg)	140	83	383	127	384	104
Carbonate (CaCO3) %	2	1.3	2.0	1.9	2.0	1.9
Sulfate (SO4)	434	492	239	437	1216	622
Sodium (Na)	500	446	492	496	872	520
Chloride (Cl)	160	309	165	330	433	310
Nitrite (NO2)	0	0	0	0	0	0

Table 3: Comparison of Mineral Concentrations of Leaf Tissue for Green and Yellow Plants

Mineral	Yellow Plant	Green Plant
Total Nitrogen	2.4%	2.2%
Total Phosphorous	0.38%	0.44%
Potassium	1.1%	1.2%
Calcium	1.5%	1.3%
Magnesium	0.55%	0.38%
Total Sulfur	0.21%	0.18%
Copper	4.5 ppm	3.7 ppm
Zinc	23 ppm	18 ppm
Iron	515 ppm	365 ppm
Manganese	185 ppm	108 ppm
Boron	73 ppm	78 ppm
Molybdenum	1.1 ppm	1.9 ppm
Sodium	350 ppm	79 ppm
Chloride	4150 ppm	3000 ppm

The irrigation water has a role to play in this situation and as such we've had a look at that also. As is common in northern Monterey county, the farm gets its water as a mixture of recycled water blended with well or river water. A full report for an example of this blended irrigation water used on this farm is available from the Monterey Regional Water Pollution Control Agency at: http://www.mrwpca.org/recycling/chem2012_blended.php

In the sample taken of the blended recycled and river water mix, conductivity (EC) was 1.3 dS/m, sodium 118 ppm, chloride 160 ppm and adjusted SAR of 3.4 (sodium adsorption ratio, an index of sodium hazard adjusted for the amount of calcium in the irrigation water).

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Discussion and Solutions: The pH of the soil in the beds in all zones is quite high, which is not surprising because of the high percentage of carbonates (lime) throughout. One can also see accumulations of nitrates, phosphates and potassium are substantially higher in the areas of the yellow plants, which are quite likely due to their declining ability to take up the nutrients being continually applied as fertilizer. It is worth noting that nitrates in the high concentrations found in our soil tests can be toxic to plants, thus accelerating the decline of plants.
Nitrites, generated from ammonium in anaerobic conditions, are zero, indicating adequate aeration in the areas sampled in the bed.

In terms of the irrigation water, referring to the water quality guidelines for crops developed by UC Cooperative Extension, we find that the water used on this farm can be used with some restriction to irrigate crops moderately susceptible to salinity such as strawberry. In other words, this irrigation water isn't great but is OK.

It seems that the real culprits in this field are the accumulated amounts of chloride and sodium. Generally speaking, crops in our area perform best when the soil sodium levels are less than 250 ppm and soil chloride levels are less than 100 ppm.

Across all the soil samples the average amounts of sodium and chloride are above 250 ppm and 100 ppm respectively. High as they are, the concentrations of both ions do not vary greatly in the plant and root zones and the zones around them in either areas of green or yellow plants. There are, however, substantial differences in the concentrations of these ions at the crust (zones 9 and 10) between green and yellow plant areas. For example, on average soil from areas of yellow plants there is nearly a twofold accumulation of sodium in the crust of soil taken as well as a substantially higher amount of chloride over the soil sampled around green, healthy plants. This tells us that while these large amounts of sodium and chloride (also known as salts) are accumulating away from the plant via evaporation, and not leaching as one would normally expect. It would seem that the water is not draining away and rather evaporating out of the surface of the bed. It would be during this transition that the yellow plants are obtaining the fourfold accumulation of sodium and 40% increase in chlorides that we observe in the leaf tissue of yellow plants over that of green.

An important point at this stage to discuss would be how to return to better drainage and increase the ability to leach the salts away from the plant. Short of installing a system of subsurface drainage, there has been some anecdotal evidence of success in using a certain "Yeoman's plough" which is essentially a shank going some 16 inches deep into the soil next to the bed opening a deep cut in the soil improving aeration and water infiltration.   This has not been tested in replicated trials however, so I can't make a firm recommendation of this method at this time.

It is notable that the amount of lime ($CaCO_3$) in all the soil samples is high. This indicates that a lot of calcium coming into the soil from irrigation water is precipitating out and not as capable of sufficiently limiting the amount of exchangeable sodium. In turn the sodium hazard is high. This may also explain to some extent why areas quite close to one another respond differently, since in some areas (perhaps even quite close together) more calcium precipitates out than others.

Precipitation of calcium as lime means it is no longer exchangeable and therefore not as effectively mitigating the amount of exchangeable sodium. It is beneficial to raise the amount of exchangeable calcium in the soil water and one way to do that would be to acidify the irrigation water.   This would subsequently increase the amount of calcium available to reduce the sodium hazard (SAR) in the soil.
Finally, there are other useful steps which can be taken to reduce the amount of sodium and chloride being introduced into the field. For example, a grower experiencing a situation of high

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sodium and chloride should avoid using sodium nitrate or potassium chloride fertilizers.

Thank you to Frank Shields and Soil Control Lab for their generous assistance in this work. Thanks to other colleagues for their valuable insight and input which assisted me in the development of my conclusion.

This project was supported in part with funds provided by the California Strawberry Commission.

Picture of yellow strawberry plants in a Castroville field. Note washed out, almost bleached appearance of the leaves as well as the patchiness of distribution of these plants in the field itself.

Frank Shields of Soil Control Lab sampling soil and plants.

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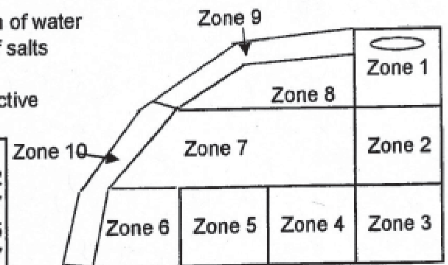
Account No.:
2060798 01 4004
Batch
Jun. - Jul. 2012 6
CODE:
Soil-bed
www.controllabs.com

Precision Agriculture Program: Potting Mix Profile
Date Collected: 28 Jun. 2012
Sample Identification: Castroville - Salinas field
Sample Id. Number: 1/1-2060798
Location (by GPS): West: North:

DATA (mg/Kg dw)	drip tape zone 1	zone 2	zone 3	zone 4	zone 5	zone 6	pri. roots zone 7	plant zone 8	crust zone 9	crust zone 10
Moisture (%)	35.4	34.8	32.9	34.9	33.9	30.3	31.7	33.1	26.7	24.6
pH (units)	7.8	8.2	8.2	8.2	8.1	8.0	8.1	8.4	8.0	7.8
EC5 (umhos/cm)	278	278	204	215	258	417	365	281	478	1063
Ammonia (NH3-N)	4.0	3.6	2.4	4.7	7.6	17	14	15	58	70
Nitrate (NO3)	8.4	10	5.7	5.7	4.1	2.7	3.3	3.6	0.9	1.5
Phosphate (PO4)	38	47	27	27	20	12	15	16	4.0	6.3
Potassium (K)	59	34	39	42	42	52	41	38	94	107
Calcium (Ca)	67	52	45	60	73	154	92	75	234	538
Magnesium (Mg)	50	42	34	30	40	80	50	50	125	254
Carbonate(CaCO3)%	2.4	2.1	1.9	2.3	2.3	2.3	3.2	2.4	2.4	2.3
Sulfate (SO4)	172	129	114	140	286	694	295	199	644	1900
Sodium (Na)	170	234	167	165	215	264	302	287	455	596
Chloride (Cl)	99	96	87	99	100	99	183	180	432	460
Nitrite (NO2)	0	0	0	0	0	0	0	0	0	0

COMMENT All work is done on a one to five water extract.
This test package determines the movement and accumulation of water soluble salts. It can show toxic zones from the accumulation of salts due to lack of water, water chemistry or nutrient placement. If done on a monthly basis problems can be predicted and corrective measures taken.



Zone 7 (additional tests)		
Size %:	Gravel (greater than #10)	0.2
	Medium Sand (#40 to #10)	1.7
	Fine Sand (#200 to #40)	10.5
	Silt & Clay (Less than #200)	87.7
Shrinkage:	Shrinkage Ratio (g/cc dry wt.)	1.8
	Shrinkage Limit (SL) % water	21

Field Information:

Rows per Bed	2	Mulch	plastic	Weeds	none
Plants per Acre	13939	Color	black/silv	Cracks	none
Row Cycles (")	54	Cover	full	Fungus	none

Plant Problems
yellow extreme / turning brown and dying. In sections f the field.

o = no problem
\+ = potential problem
++ = problem

INTERPRETATION	zone 1	zone 2	zone 3	zone 4	zone 5	zone 6	zone 7	zone 8	zone 9	zone 10
pH	+	+	+	+	+	+	+	+	+	+
Total Nitrogen	o	o	o	o	o	o	o	o	o	o
Carbonates	o	o	o	o	o	o	o	o	o	o
EC5	o	o	o	o	o	+	o	o	+	++
Sodium (Na)	+	++	+	+	++	++	++	++	++	++
Chloride (Cl)	+	+	+	+	+	+	++	++	++	++
Nitrite (NO2)	o	o	o	o	o	o	o	o	o	o
SAR	+	++	+	+	++	+	++	++	++	++
Ca/Mg ratio	o	o	o	o	o	o	o	o	o	o

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Photo 3: Soil evaluation courtesy of Soil Control Lab. The diagram to the center right is a cross section of half a bed, divided into 10 parts.

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IN-SEASON SOIL NITRATE TESTING EXPLAINED

Tim Hartz, UC Davis and Richard Smith, Monterey County UCCE

The recent adoption of the new ‘Ag Order’ by the Central Coast Region Water Quality Control Board has increased interest in management practices that can help growers reduce nitrogen fertilization. In-season soil nitrate testing is one such practice; we have conducted dozens of field trials showing that testing soil for residual nitrate-nitrogen (NO_3-N) prior to sidedressing or fertigation can reliably identify fields in which N application can be reduced or postponed. UC has promoted a value of 20 parts per million (PPM) residual soil NO_3-N in the root zone of vegetable crops as the action threshold. Above that level no N fertilization is required *at that time*; below that threshold, some application may be appropriate. In our contacts with growers and consultants it is clear that there are a number of questions about how to safely and efficiently use in-season soil nitrate testing. Here are answers to some questions that we have been asked repeatedly.

1. Does the 20 PPM NO3-N threshold work for all crops?

This threshold is broadly applicable across a range of common vegetable crops. That is because 20 PPM represents enough N to supply crop N uptake requirements for an extended period of time. If you take a sample of the top 12 inches of soil, that sample will represent approximately 4,000,000 lb of soil per acre; if that soil has a NO_3-N concentration of 20 PPM, then the soil contains about 80 lb NO_3-N per acre. Cool season vegetable crops have a characteristic N uptake pattern. During the first half of the growing season plants take up N slowly, typically no more than 1-2lb N/acre/day. Therefore, when a soil nitrate test is taken prior to first sidedressing, a 20 PPM NO3-N value means that crop N uptake can be easily met for at least 2-3 weeks just from residual soil nitrate. From midseason until harvest, crop N uptake is much faster, 3-4 lb N/acre/day for lettuce and up to perhaps 5-6 lb N/acre/day for celery and brassica crops. A soil test taken at midseason would indicate that sufficient N is available for a couple of weeks.*The 20 PPM threshold does not apply to strawberries, which have a low N uptake rate, and can thrive with a lower level of available soil N. Also, spinach presents special challenges, which we will address in a subsequent article.*

2. Does a 20 PPM NO_3-N test result mean the same thing in all fields?

Two field characteristics should be considered when evaluating an in-season soil NO_3-N test result. First, what is the nitrogen supplying power of the soil? In general, soil with higher organic matter content, or in which a large amount of vegetable crop residue has recently been incorporated, will supply more nitrogen over time, thereby reducing the rate at which the current crop will deplete the residual soil NO_3-N. A soil with > 2% organic matter will mineralize more crop-available N than a soil with < 1%; a field in which the prior crop was spring mix will mineralize less N than a field in which the prior crop was broccoli (which leaves vastly more crop residue than spring mix). The other major factor is irrigation. A heavy textured soil being drip irrigated is likely to have much less leaching than a sandy soil being sprinkler irrigated. Where heavy leaching is experienced, the soil nitrate test would have to be repeated to ensure accuracy.

3. Do I need to maintain at least 20 PPM NO_3-N in soil throughout the growth cycle for crops to grow at a peak rate?

Absolutely not. The whole point of the test is to determine whether there is enough available soil N to carry the crop for an extended period of time. Vegetable crops can grow at peak rates until soil NO_3-N concentration is depleted to a much lower level. In evaluating the soil NO_3-N concentration at harvest in the many lettuce fertilization trials we have run, high yields were often achieved with N treatments in which soil NO_3-N ended up between 5-10 PPM at harvest. This is an important point, because if fields are managed to maintain at least 20 PPM

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NO_3-N right up to harvest, then a large amount of soil nitrate will be available to be leached by the germination water of the following crop, or by winter rainfall.

4. If my residual soil NO_3-N is below 20 PPM, does that mean I should apply my full N sidedress rate?

For maximum efficiency of fertilizer N recovery by the crop, it makes more sense to scale your application depending on the soil value. As previously explained, a foot of soil weights about 4,000,000 lb/acre, so each PPM NO_3-N on a soil test represents about 4 lb N/acre. In theory, you could tailor your N application rates exactly using this relationship. However, it is more realistic to use a system in which you apply a half rate if the soil test is between 10-20 PPM, and a full rate if the test is less than 10 PPM.

5. How do I collect a sample that is representative of the root zone?

This can be a complicated topic. When sampling is performed at an early growth stage, before a sidedress or fertigation has been done, sampling in the plant row will generally do a good job. However, once an N application has been made, the soil nitrate is not uniformly distributed throughout the bed, and your sampling technique must attempt to represent the overall condition. Because different growers use different configurations of knives on sidedress rigs, and have different combinations of bed width/number of plant rows/number of drip tapes, there is no sampling protocol that works for everyone. Obviously, zones of recent banded application need to be avoided and, in the case of drip irrigation, areas of the bed that remain too dry for root activity should be avoided as well.

6. How often should soil NO_3-N sampling be done?

From the standpoint of achieving maximum N efficiency, the answer is as often as necessary to ensure that unnecessary N fertilization is minimized. For lettuce, a system of soil sampling prior to the first sidedress or fertigation, and a second test 2-3 weeks later, would provide sufficient information with which to efficiently schedule N applications throughout the season. Longer season crops like celery or cauliflower may require up to 3 samplings to inform fertilization decisions. As a practical matter, soil sampling prior to the first in-season N application offers the greatest potential for reducing fertilization rates, and increasing N efficiency. While repeat samplings can be beneficial, the logistics of sampling multiple times per crop, and responding to those results, can be challenging. Particularly for growers who have no experience with in-season soil sampling, we recommend beginning with only an early season sample. Once that practice has been integrated into your management routine, in-season sampling can be expanded.

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STEMPHYLIUM LEAF SPOT: NEW DISEASE ON PARSLEY

Steven Koike
Plant Pathology Farm Advisor

Parsley is the familiar leafy plant in the Apiaceae that is grown both as a fresh market vegetable, herb, and garnish and as a dehydrated product for various culinary uses. California is the number one producer of parsley in the USA with approximately 2600 acres in 2010, representing approximately half of the country's parsley. Monterey and Ventura counties together grow 49% of California's parsley; in 2010 the value of parsley in these two counties was valued at $13.5 million. Because this is a leafy vegetable commodity, markets require that the foliage be of very high quality and have few defects.

From 2009 through 2011, unfamiliar foliar symptoms were observed on commercial parsley grown in Ventura County. Initial symptoms were leaf spots less than 1/4 inch in diameter,

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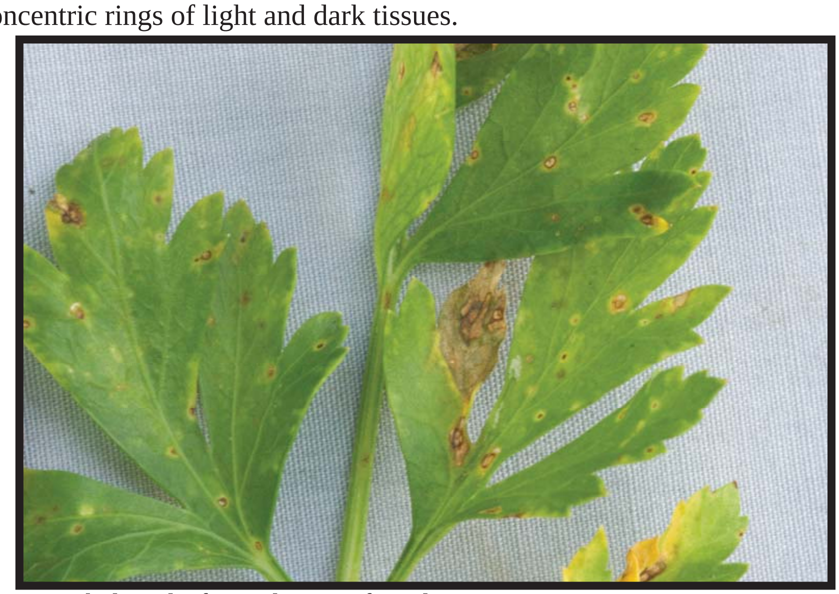
circular to oval in shape, and yellow in color. As disease progressed the spots enlarged slightly, retained the circular to oval shape, and turned tan to light brown in color with yellow borders. In some cases leaf spots exhibited a ring spot appearance due to alternating lighter and darker colored tissue. When the disease was severe the leaf spots grew together and the leaves became prematurely yellow and senescent, eventually drying up and resulting in leaf dieback. Fungal growth and structures were not observed in the spots. Leaf petioles were also diseased and had narrow, elongated, brown lesions. Spots occurred mostly, but not exclusively, on older foliage. When the parsley was harvested, the remaining lower older leaves still attached to the plants often exhibited the most severe symptoms; the disease also re-appeared on the subsequent re-growth following a harvest.

The cause of this leaf spot disease is the fungus *Stemphylium vesicarium*. This is the first time parsley has been documented to be a host to this fungus. *S. vesicarium* is known as a leaf pathogen of other crops such as garlic, leek, onion, asparagus, and alfalfa. Experiments indicated that *S. vesicarium* isolates from parsley could also cause small leaf spots on celery and carrot. Seed assays demonstrated that this pathogen can be found on parsley seed; therefore, initial disease outbreaks may be due to seedborne inoculum. Because all parsley is irrigated with overhead sprinkler systems, a low level of infested seed could result in problems due to the favorable environment resulting from high density parsley plantings and splashing irrigation water.

While Septoria late blight is typically the most destructive disease of parsley in California, the addition of Stemphylium leaf spot adds yet another challenge that California growers must deal with while producing large volumes of high quality, defect-free parsley. Presently Stemphylium leaf spot is not widespread and management practices are not yet required.

Stemphylium leaf spot is not the only new foliar problem that has been recently documented in the state. A new bacterial leaf spot disease caused by two different pathovars of *Pseudomonas syringae* (pvs. *apii* and *coriandricola*) was found in commercial fields (see Crop Notes issue May/June 2012). Growers and field personnel must now therefore distinguish between four foliar diseases of parsley. Powdery mildew can be readily identified because of the white, powdery mycelium on leaves. Septoria late blight is distinctive because of the spherical, brown to black fungal structures (pycnidia) that form in the angular leaf spots. Bacterial leaf spot causes angular, tan to brown leaf spots that lack any mycelial growth or fungal structures. Stemphylium leaf spot also lacks fungal structures in the spots but is characterized by oval to round spots that often contain concentric rings of light and dark tissues.



Stemphylium leaf spot disease of parsley.

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Stemphylium leaf spot disease of parsley.

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LEACHING FRACTION EFFECTS ON SALT MANAGEMENT AND NITRATE LOSSES IN COMMERCIAL LETTUCE PRODUCTION

Michael Cahn, Irrigation and Water Resources Advisor
Barry Farrara, and Tom Lockhart, Staff Research Assistants

The Salinas Valley is fortunate to have an ample supply of ground water available for irrigating crops, but as water is applied to fields, it may be adding something that can be detrimental to crop production: salt. Of course, all salts to some degree are needed for plant nutrition, especially calcium, magnesium, potassium, and sulfate, but too much of any salt can slow plant growth. The main effect of excessive salt in soil is that plants have difficulty extracting moisture; growth slows, and yields decrease. In addition, a high concentration of some ions such as sodium and chloride can cause toxicity when absorbed into plant cells.

Previous research has demonstrated that salinity levels greater than 1 deciSiemen per meter (dS/m) in irrigation water can significantly affect yields of lettuce and other leafy greens. Similarly, when soil salinity levels build up to values greater than 2.5 dS/m, yield of lettuce is impacted. A common practice to minimize salt effects on crop growth is to leach the soil profile so that salts move below the root zone. This practice is traditionally done during pre-irrigation and during germination, when more water is applied than is lost by evaporation from the soil surface.

Because many growers have transitioned from using overhead sprinklers to using surface drip for production of lettuce, less leaching may occur during the post-thinning stage of the crop. This is because less water may be applied under drip compared to sprinklers, and because drip tape is positioned to distribute moisture between the rows of plants, forcing salts to accumulate in the plant rows. Applying extra water during the drip phase of the crop to minimize salt accumulation in the root zone could lead to a significant loss of nitrate-N during the period when the crop has the greatest nitrogen demand. In this situation, a higher N fertilizer rate may be needed to compensate for N losses associated with applying extra water for salt control.

To understand the balance between N fertilizer requirement and leaching fraction during

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the drip phase of lettuce production, we conducted replicated irrigation trials in commercial fields. Trials were designed to investigate if leaching in the early stages of the crop, such as before planting and during stand establishment was sufficient to sustain production through the remaining crop cycle, and to determine if extra N fertilizer is needed when a leaching fraction is applied during the drip phase of the crop. Irrigation treatments of 100% and 150% of crop evapotranspiration (ET) were imposed after thinning in drip-irrigated lettuce fields to create leaching fractions of 0% and 50% (Table 1). High and low rates of nitrogen fertilizer (Table 2) were applied to the irrigation treatments to determine if additional N fertilizer was needed to sustain production under higher leaching fractions.

We conducted trials in regions representing different growing environments and water sources. Trial 1 was conducted in north- Monterey County and was planted with iceberg lettuce on 40-inch wide beds on June 14, 2011. Trial 2 was conducted in south Monterey county and seeded with romaine lettuce on 80-inch wide beds on August 10, 2011. Salinity of the irrigation water averaged 1.2 and 0.9 dS/m at Trials 1 and 2 respectively. A blend of recycled, ground, and surfaced water was used to irrigate Trial 1 and only ground water was used for irrigating Trial 2. Salinity levels in the soil profile were evaluated before pre-plant irrigation, after emergence, and at crop maturity. Irrigations were scheduled following the growers' standard practices. Pre-plant, germination, and post thinning applied water volumes were measured using flow meters (Table 1). Fertilizer N rates differed by more than 50 lbs N/acre between the high and low N treatments at each trial site during the drip phase of the crop (Table 2). Soil nitrate, crop N uptake, and concentration of salts and nitrate in leachate were monitored during the crop cycle. Suction lysimeter tubes were used to collect leachate during each drip irrigation event. Marketable yield, biomass, and total N uptake were evaluated at crop maturity.

Results

Leaching fraction and N management effects on yield Leaching fraction had varying effects on yield for the 2 field trials. The irrigation treatments had no effect on yield (Table 3) at the north county trial (Trial 1) ; however, biomass and marketable yields were lower than the industry average at this trial and crop ET was also low. At the south county trial (Trial 2), marketable and biomass yields were highest under the 150% crop ET treatment (Table 4). Increasing the fertilizer N rate during the drip phase of the crop did not increase yields at either trial, and caused a slight but statistically significant marketable yield loss at Trial 2 (Table 4), where soil NO3-N concentrations were greater than 40 ppm in the 100% ET, high N treatment.

Irrigation treatment effects on soil salinity Salinity levels of the soil profile after harvest were highest under the 100% ET treatment for both trials (Figs. 1 and 2).). Soil salinity levels increased with depth, demonstrating that salts were leached from the surface during the drip phase of the crop (Figs. 1 and 2). The lowest salinity levels at the 1 foot depth were measured under the 150% ET treatment at both trials. Bulk salinity (EC), calcium, sodium, and chloride levels in the 0 to 3 foot depths were statistically lowest in the 150% ET treatment at harvest (data not presented).

Salinity effects on lettuce production. The buildup of soil salinity appeared to impact lettuce yield at Trial 2 (south county trial). Yields were lowest for the 100% ET treatment where soil salinity levels at the 0 to 1 foot depth were greater than 2.5 dS/m (Fig. 2). In contrast, at the north county trial, where yield was not affected by the irrigation treatments, soil salinity was less than 2.5 dS/m at the 1 foot depth for all treatments.

Irrigation treatment effects on leaching of nitrate and salts A leaching fraction greater than 150% of crop ET during the drip phase of the lettuce crops increased estimated losses of salt

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and nitrate-N compared to the 100% of crop ET treatment at both trials (Figs. 3-6). Nitrate-N losses were estimated to range from 10 to 40 lbs/acre and 40 to 100 lbs/acre for Trials 1 and 2, respectively. The highest N losses due to leaching occurred in the 150% ET, high N treatment for both trials (Figs. 3 and 4). Additionally, residual nitrate concentrations in the soil profile after harvest were lowest under the 150% ET treatment at both trials, presumably due to the effect of leaching (Figs. 7 and 8). However, in neither trial were soil nitrate levels at levels (< 20 ppm NO3-N) that would be expected to cause yield loss. The total salt estimated to have been leached ranged from 100 to 400 lb/acre and 400 to 1600 lb/acre at Trials 1 and 2, respectively (Figs. 5 and 6). The greatest amount of salt was leached under the 150% ET treatments for both trials. Also, salinity concentration measured in the upper 2 feet of the soil profile was lowest in the 150% ET treatment at both trials after harvest (Figs. 9 and 10), indicating that without a substantial leaching fraction soil salinity levels increased significantly.

Conclusions

The results of these field trials demonstrated that applying a 50% leaching fraction (150% of crop ET) reduced salt accumulation in the soil profile and increased yield during the drip phase of lettuce production under conditions where soil or water salinity was moderately high. Extra water applied to leach salts also resulted in an increased loss of nitrate-N from the soil profile. Additional fertilizer N to compensate for leaching of nitrate-N was not necessary to maintain yields, presumably because nitrate levels were substantially above 20 ppm nitrate-N in the top foot of soil. The results also demonstrated that the best strategy to manage salts in soils with high salinity and minimize associated nitrate leaching is to use a leaching fraction of approximately 50% and maintain nitrate-N levels above 20 ppm in the top 1 foot layer of soil. The quick nitrate test is a useful tool for growers to assess whether additional fertilizer N is required to maintain an adequate level of mineral N in the soil.

Acknowledgements
We thank the California Leafy Green Research Board for funding this project and grower cooperators for donating their time and resources.

Table 1. Summary of irrigation water volumes applied at 2011 lettuce trials. Trial 1 was conducted in north county and Trial 2 was conducted in South County.

	Applied Water		
Treatment	sprinkler	drip	total
	------- inches -------		
North County Trial			
Grower standard	5.3	4.2	9.5
100% ET	5.3	3.1	8.4
150% ET	5.3	4.5	9.7
South County Trial			
Grower standard	8.4	5.3	13.7
100% ET	8.4	4.7	13.0
150% ET	8.4	6.6	15.0

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Table 2. Summary of fertilizer N applied at 2011 lettuce trials.

Treatment	Applied N fertilizer pre-drip	drip	total
	------- lbs N/acre -------		
North County Trial			
Grower standard	100	64	164
Low N	100	0	100
High N	100	80	180
South County Trial			
Grower standard	134	20	154
Low N	134	19	153
High N	134	71	205

Table 3. Irrigation and nitrogen management treatment effects on iceberg yield at Trial 1 (North County)

Treatment	Plant weight	Trimmed Plant weight	Trim/bulk ratio	Biomass Yield	Marketable yield	Dry mater content	Nitrogen content of dry tissue	Crop N uptake	
	lb/plant			tons/acre		%		lb N/acre	lb N/1000 plants
Grower Standard	1.57	0.71	0.43	22.90	10.45	4.63	3.96	82.00	2.82
100% ET low N	1.52	0.70	0.44	22.35	10.38	4.23	3.97	72.80	2.49
150% ET low N	1.54	0.70	0.43	22.58	10.22	4.30	3.80	72.03	2.47
100% ET High N	1.54	0.67	0.42	22.48	9.74	4.34	4.06	76.88	2.64
150% ET High N	1.56	0.69	0.42	22.05	9.83	4.84	3.94	83.23	2.94
$LSD_{0.05}$ [z]	NS	NS	NS	NS	NS	NS	NS	NS	NS
Irrigation Treatment									
100% ET	1.53	0.68	0.43	22.41	10.06	4.28	4.01	74.84	2.57
150% ET	1.55	0.69	0.43	22.31	10.02	4.57	3.87	77.63	2.70
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS	NS
N fertilizer Treatment									
Low N	1.53	0.70	0.43	22.46	10.30	4.26	3.88	72.41	2.48
High N	1.55	0.68	0.42	22.26	9.79	4.59	4.00	80.05	2.79
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	0.11	NS	NS

[z]Fisher's protected least significant difference, multi-comparison test at $p < 0.05$ level

NS means are not statistically different at the $p < 0.05$ level

Table 4. Irrigation and nitrogen management treatment effects on romaine yield at Trial 2 (South County)

Treatment	Plant weight	Trimmed Plant weight	Trim/bulk ratio	Biomass Yield	Marketable yield	Dry mater content	Nitrogen content of dry tissue	Crop N uptake	
	lb/plant			tons/acre		%		lb N/acre	lb N/1000 plants
Grower Standard	1.77	1.61	0.91	31.3	28.4	4.70	4.18	122.3	3.46
100% ET low N	1.60	1.47	0.92	28.8	26.3	5.28	3.99	119.4	3.32
150% ET low N	1.77	1.62	0.92	32.1	29.4	4.57	4.22	122.7	3.39
100% ET High N	1.52	1.38	0.91	27.6	24.9	5.10	4.14	115.9	3.20
150% ET High N	1.75	1.60	0.91	32.2	29.4	4.79	4.26	131.0	3.57
$LSD_{0.05}$ [z]	0.08	0.08	NS	1.2	1.1	0.40	NS	7.9	NS
Irrigation Treatment									
100% ET	1.56	1.42	0.91	28.2	25.6	5.19	4.07	117.7	3.26
150% ET	1.76	1.61	0.91	32.2	29.4	4.68	4.24	126.9	3.48
$LSD_{0.05}$	0.14	0.11	NS	1.6	1.3	0.37	NS	8.0	NS
N fertilizer Treatment									
Low N	1.69	1.54	0.92	30.5	27.8	4.92	4.10	121.1	3.35
High N	1.64	1.49	0.91	29.9	27.2	4.94	4.20	123.5	3.38
$LSD_{0.05}$	NS	0.05	NS	NS	0.5	NS	NS	NS	NS

[z]Fisher's protected least significant difference, multi-comparison test at $p < 0.05$ level

NS means are not statistically different at the $p < 0.05$ level

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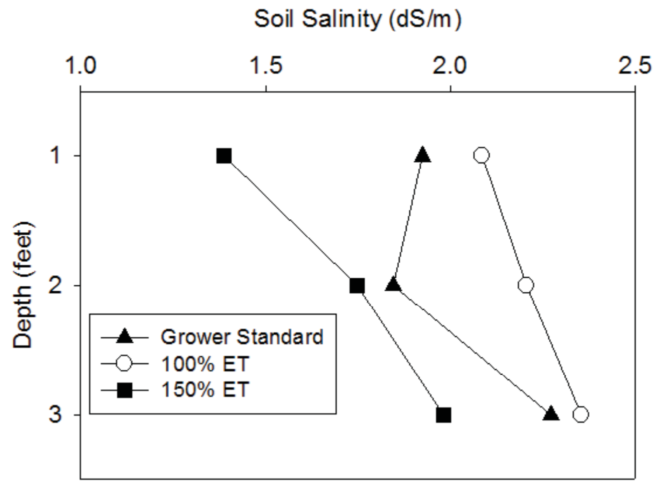

Figure 1. Irrigation treatment effects on soil salinity measured after harvest in iceberg (north county trial [1]). Means for the 100% and 150% ET treatments represent the average of the high and low N treatments.

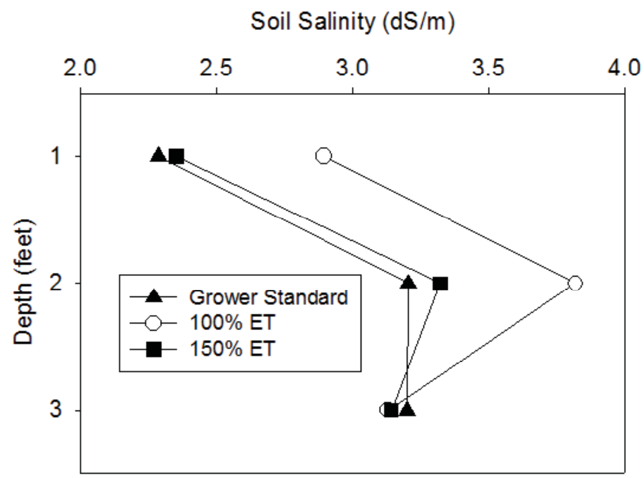

Figure 2. Irrigation treatment effects on soil salinity measured after harvest in iceberg (south county trial [2]). Means for the 100% and 150% ET treatments represent the average of the high and low N treatments.

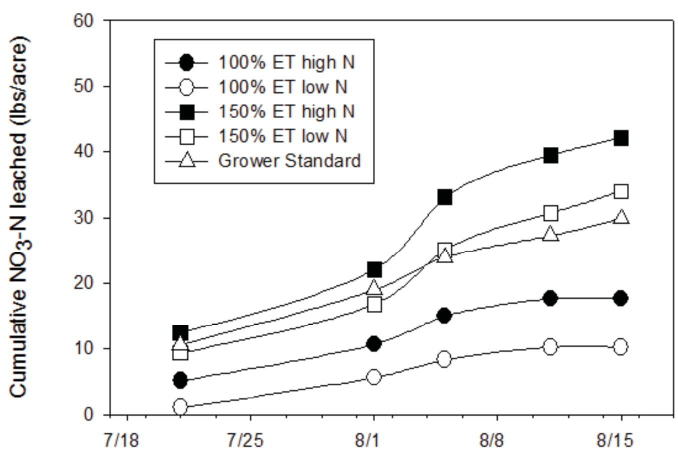

Figure 3. Water and N fertilizer treatment effects on cumulative nitrate leached in iceberg lettuce, post thinning (north county trial [1]).

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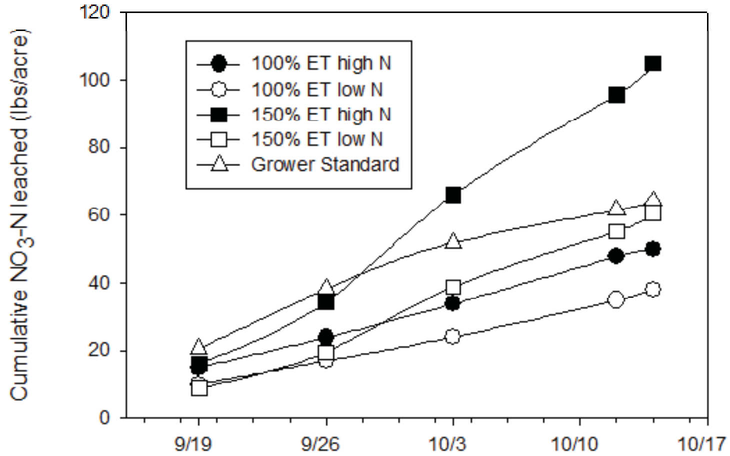

Figure 4. Water and N fertilizer treatment effects on cumulative nitrate leached in romaine lettuce, post thinning (south county trial [2]).

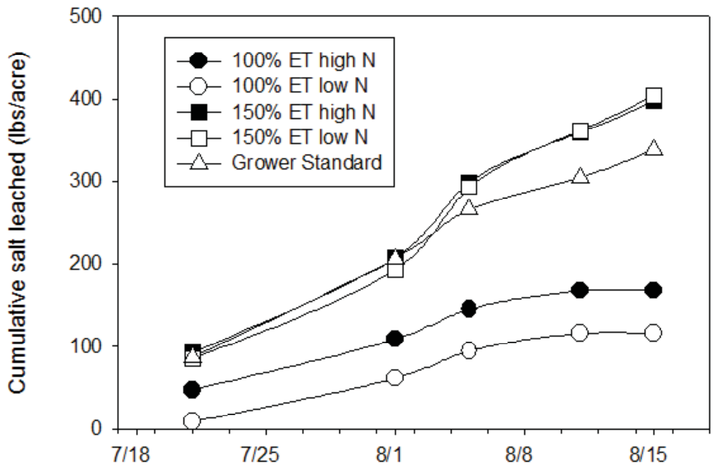

Figure 5. Water and N fertilizer treatment effects on cumulative salt leached in iceberg lettuce crop, post thinning (north county trial [1]).

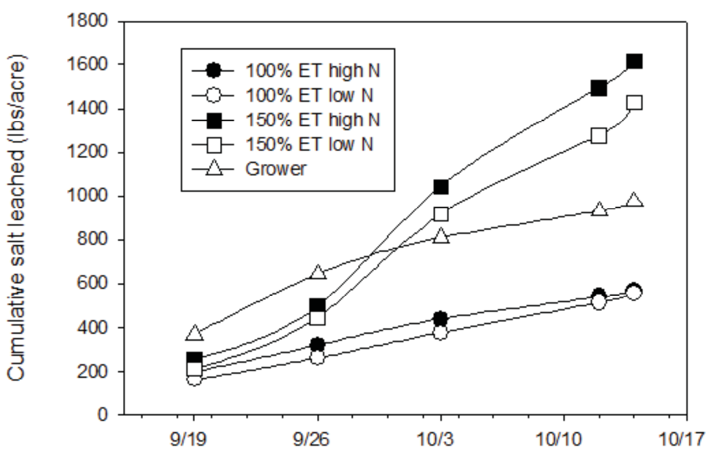

Figure 6. Water and N fertilizer treatment effects on cumulative salt leached in romaine lettuce, post thinning (south county trial [2]).

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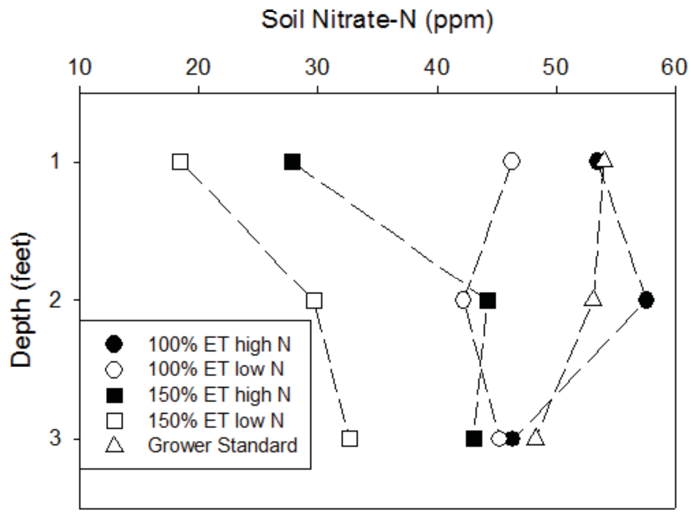

Figure 7. Water and N fertilizer treatment effects on soil nitrate distribution after harvest of iceberg lettuce (north county trial [1]).

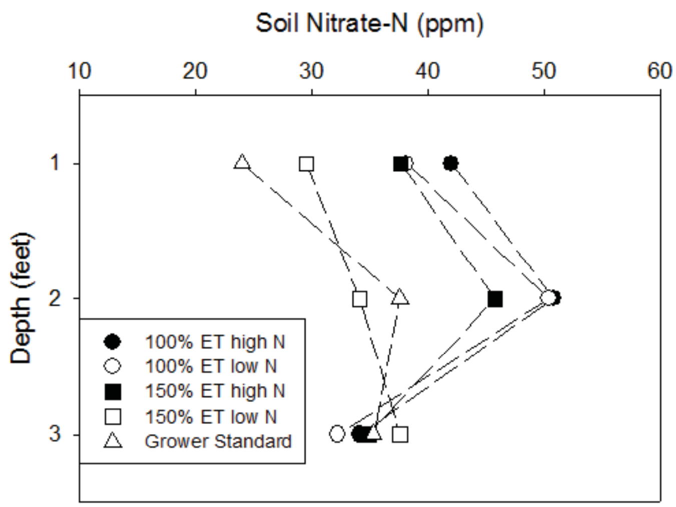

Figure 8. Water and N fertilizer treatment effects on soil nitrate distribution after harvest of romaine lettuce (south county trial [2]).

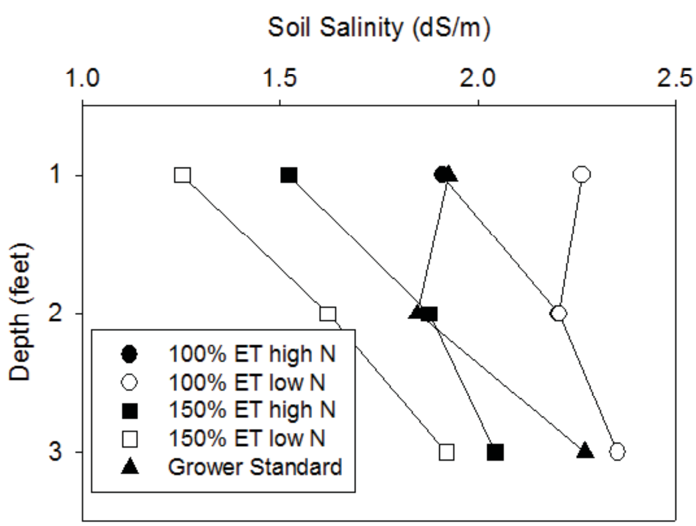

Figure 9. Irrigation and N fertilizer treatment effects on soil salinity measured after harvest in iceberg (north county trial [1]).

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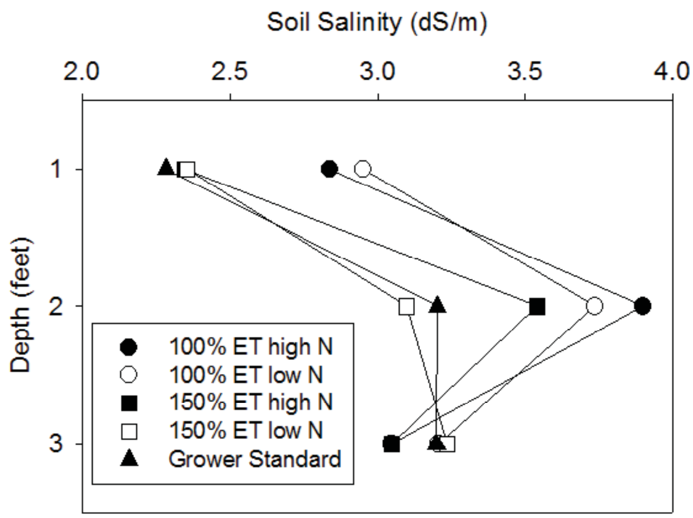

Figure 10. Irrigation and N fertilizer treatment effects on soil salinity measured after harvest in romaine (south county trial [2]).

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RACE PFS: 14—ANOTHER NEW RACE OF THE SPINACH DOWNY MILDEW PATHOGEN

Jim Correll, University of Arkansas
Steven Koike, University of California Cooperative Extension

Along with researchers in Europe, we report here another new race, the 14th, of the downy mildew pathogen (*Peronospora farinosa* f. sp. *spinaciae*) of spinach. First identified in November 2010 from spinach in Ventura County, California, this race breaks the resistance of several important cultivars. The isolate was initially designated as UA4410 and was characterized with a standard set of differential varieties. Isolates with the same disease reaction as UA4410 were subsequently found in locations throughout California and Arizona in 2011 and 2012. This race has not been reported in Europe. After careful evaluation of the significance of this development to the spinach industry, the International Working Group on Peronospora (IWGP) has designated this isolate as race Pfs: 14. Isolate UA4410 will be the type isolate (or official isolate) of Pfs: 14. The IWGP is located in The Netherlands and is administered by Plantum NL.

Race Pfs: 14 poses a threat to the spinach industry because it is particularly well-adapted to modern hybrids with resistance to races 1-13. Similar developments have taken place when races Pfs: 5 (1996), Pfs: 6 (1998), Pfs: 7 (1999), Pfs: 8 and 10 (2004), Pfs: 11 (2008), Pfs: 12 (2009), and Pfs: 13 (2011) were identified and named. The occurrence of Pfs: 14 will encourage development and eventual use of Pfs: 1-14 resistant spinach cultivars.

A collaboration of researchers with the IWGP, University of Arkansas (Correll), and University of California (Koike) is monitoring the development of new races of spinach downy mildew on a global scale by continuously collecting and testing suspected new isolates. Collected field samples are tested for race identification using a fixed, standardized host differential set of varieties that contains the full range of available resistances. New race designations will be mutually agreed upon by this collaboration based on persistence of the race over several years, occurrence in a wide area, and significant economic impact. In this way it is hoped that research

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findings and conclusions will be agreed upon and better communicated between the researchers, seed industry, spinach growers, and other interested parties.

For California and Arizona, the Correll-Koike team will continue to receive and test spinach downy mildew samples for growers, pest control advisors, and seed companies. Industry is encouraged to continue to submit downy mildew outbreak samples to Correll-Koike, as such samples facilitate the discovery of additional new races. The Correll-Koike research is made possible by support from the California Leafy Greens Research Board and by active participation from the agricultural industries in California and Arizona.

The IWGP consists of spinach seed companies (Pop Vriend, Monsanto, Rijk Zwaan, Nunhems, Takii, Sakata, Bejo, Enza, Syngenta, Vilmorin, and Advanseed) and Naktuinbouw (the Inspection Service for Horticulture in The Netherlands), and is supported by researchers at the University of Arkansas and the University of California Cooperative Extension (Monterey County) in the USA. Researchers all over the world are invited to join the IWGP initiative and use the common host differential set to identify new isolates.

For more information on this subject you can contact Steven Koike (stkoike@ucdavis.edu), Jim Correll (jcorrell@uark.edu), Diederik Smilde (d.smilde@naktuinbouw.nl), or IWGP chairperson Jan de Visser (JandeVisser@popvriendseeds.nl).

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PYTHIUM ROOT ROT OF LETTUCE

Steven Koike, University of California Cooperative Extension
Frank Martin, USDA-ARS Salinas

Pythium species are well known plant pathogens that affect dozens of crops and cause a diverse range of diseases such as seed decay, seedling damping-off (both before and after seedling emergence from soil), rot of feeder roots of established plants, bottom rot of leaves in contact with soil, and rot of fruit in contact with soil. *Pythium* species are soil inhabitants and exist and thrive in most agricultural soils for extended periods of time. In any particular field, many different species may be present, with some of these species being non-pathogenic to crops. *Pythium* is favored by wet soil conditions and ample soil water levels. Taxonomically, *Pythium* belongs in the Oomycete group of organisms. While they may look and behave like fungi, evolutionarily Oomycetes are more closely related to algae.

Prior to 2011, lettuce grown in coastal California counties was not known to be subject to diseases caused by *Pythium* species. In particular, damping-off diseases of young lettuce seedlings, to date, are not seen. However, in 2011 mature romaine plants in the Salinas Valley were observed to be affected by a root rot disease. Examination of plants, testing for pathogens, and subsequent investigation found this lettuce to be infected with Pythium root rot caused by *Pythium uncinulatum*.

Symptoms of this disease became most apparent after thinning when plants were at the rosette stage. Affected plants were smaller and stunted. As disease progressed, outer leaves became yellow and eventually wilted. By harvest time, diseased plants were noticeably smaller and most outer leaves were yellow with some brown necrotic spots. The feeder roots of the plants were rotted and brown to gray in color. The taproot could also have some brown discoloration on the surface but did not have internal, central discoloration as seen in vascular wilt diseases.

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Affected plants could not be harvested.

Pythium uncinulatum, like most *Pythium* species, produces swimming spores (zoospores) that are released and move within the water film in the soil. Water flow from irrigation, flooding, and movement of soil via tractors and equipment can spread this pathogen. In addition to zoospores, the pathogen also produces a sexual spore (oospore) that is encased within a spiny outer covering (oogonium). It is the oospore that allows the pathogen to survive in the soil in the absence of susceptible plants.

In the Salinas Valley this disease does not appear to be widespread and is currently of minimal importance; only two fields in this valley have been confirmed to have this problem. However, notify the UC Cooperative Extension lab in Salinas if you see possible cases of this disease. *Pythium uncinulatum* on lettuce has also been reported in California's Coachella Valley, Yuma Arizona, The Netherlands, and Japan.

Photos 1A and B. Lettuce infected with *Pythium uncinulatum* can be stunted with yellowed lower leaves.

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Photos 2A and B. *Pythium uncinulatum* infects the feeder roots of lettuce

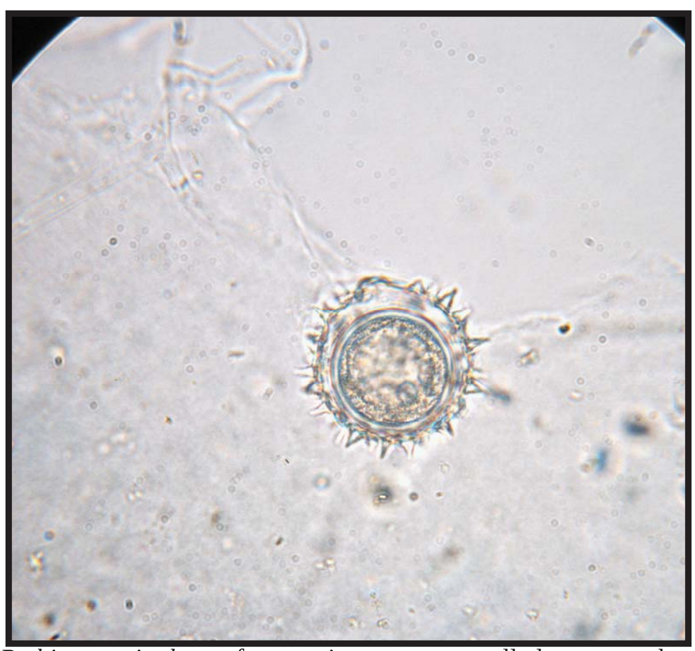

Photo 3. *Pythium uncinulatum* forms spiny structures called oospores that survive in the soil.

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ETgage® CAN PROVIDE ACCURATE ESTIMATES OF REFERENCE EVAPOTRANSPIRATION

Michael Cahn, Irrigation and Water Resources Advisor
Barry Farrara, Staff Research Associate

Introduction

Evapotranspiration (ET) data can be used to estimate water use of most horticultural crops. Reference ET is the volume of water transpired and evaporated by a reference crop, usually grass or alfalfa, which provide a consistent canopy covering 100% of the ground. ET data are usually expressed in inches or millimeters of water lost by the crop. A crop coefficient (Kc) is used to convert ET of the reference crop to the ET of the crop of interest:

ETcrop = ETref × Kc

Kc changes as the crop develops and is usually based on the percentage of ground shaded by the leaves of the crop. Previous articles we have written explained how to access reference ET data from the California Irrigation and Information System (CIMIS) website (Salinas Valley Agriulture Blog: May 21, 2010; June 24, 2010). The CIMIS website (wwwcimis.water.ca.gov) provides free access to the weather data including, reference ET, for most of the agricultural regions of California.

Although more than 120 CIMIS weather stations are located throughout California, growers sometimes find that the closest station does not accurately reflect the weather conditions of their farm. On the central coast, air temperature, relative humidity, and wind speed can vary over short distances depending on the surrounding terrain or distance from the ocean. In addition, fog patterns, common along the central coast, can vary across distances as short as 1 or 2 miles, and can affect the solar radiation measurement, one of the most important factors in calculating reference ET. To account for the spatial variation in climate, *spatial reference ET* estimates are also available from the CIMIS website. *Spatial ET* uses a combination of satellite and weather station data to estimate reference ET at a 1.6 mile scale.

While spatial ET estimates can be an improvement over conventional estimates of ET provided by CIMIS weather stations, many growers are still interested to measure ET directly at their farms. Several companies sell weather stations that can be set up to measure ET, but they must be sited correctly and maintained to provide accurate data. The staff at the California Department of Water Resources checks the quality of CIMIS ET data on a daily schedule, and maintains and assures the accuracy of instruments on the CIMIS weather stations.

Atmometers are another method used to estimate reference ET. Fabric on top of the atmometer is exposed to the air, and is moistened from below by a wick submerged in a water reservoir. As water evaporates from the surface material, water is wicked up to the fabric, and the water level in the reservoir drops. ET is estimated from the volume of water lost from the reservoir. A commercially available and easy to use atmometer is the *ETgage®* (Fig. 1). It can be read manually or interfaced with a datalogger so that daily ET values can be recorded. For more information about the ETgage, refer to the company's website (www.etgage.com).

Evaluation of the ET gage

We evaluated the accuracy of the ETgage to estimate reference ET in Santa Clara County during the 2011 season using the #30 green fabric covering. Other coverings (#54) are available for use with corn and other agronomic crops. One ETgage was located at the edge of a fresh market tomato field, 0.5 miles from Gilroy CIMIS station #211. Another ETgage was located approximately 17 miles from CIMIS station #211 at the edge of a turf grass field northwest of Morgan Hill. We compared readings from the ETgage with ET estimates from the Gilroy CIMIS station and spatial CIMIS for each of the test sites.

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Results

Daily estimates of reference ET by the ET gage, CIMIS station, and spatial CIMIS are presented in Figures 2 and 5 for the two test locations. All three methods of estimating reference ET produced similar values at the fresh market tomato site near the Gilroy CIMIS station (Fig. 2). The ET gage values fluctuated more than spatial CIMIS and CIMIS station values between periods of high and low ET. When ET increased, ET gage values tended to be higher than the CIMIS station values, and when ET decreased, ET gage values were generally lower than the CIMIS station values (Fig. 2). However, cumulative ET for all three methods of estimating ET produced similar totals during a 3 month period (Fig. 3). Total ET measured by the ET gage was 0.1 % less the total ET estimated by the CIMIS station, and the total for spatial cimis ET was 5% less than the total ET estimated by the CIMIS station.

Reference ET values recorded by the ET gage corresponded more closely with spatial CIMIS values than with the Gilroy CIMIS station values at the turf grass site (Fig. 4). Both the ETgage and spatial CIMIS had lower ET values than the Gilroy CIMIS station. Also, cumulative reference ET values estimated by spatial CIMIS and the ET gage were nearly identical (Fig. 5), and totaled 16% lower than the Gilroy CIMIS station. Since air temperature is generally higher in Gilroy than northern Morgan Hill, lower ET values would be expected for the ET gage and spatial CIMIS estimates.

Conclusions

Our initial tests demonstrated that the ETgage provided accurate estimates of reference ET. However, the ET values must still be adjusted with a crop coefficient (Kc) to estimate the ET of a crop other than alfalfa or grass. Also, the ETgage needs to be sited correctly to provide accurate data. Locating it near a building, tree, or in a parking lot will affect the ETgage readings. The instructions also recommend positioning the top of the ETgage higher than 39 inches above the ground and at least a foot above the crop canopy. For our tests, we located the instrument in a field unobstructed by structures and beside a crop. It would be best to locate the ETgage near well watered grass or pasture if possible. We also found that the ETgage required some maintenance. The reservoir needed to be refilled periodically with distilled water, and the green material covering the top of the ETgage would sometimes come loose or become dusty. Finally, the ETgage required a person to collect readings on regular schedule or periodically download the datalogger.

Figure 1. ETgage® mounted on a post adjacent to a lettuce field. Photo by M. Cahn.

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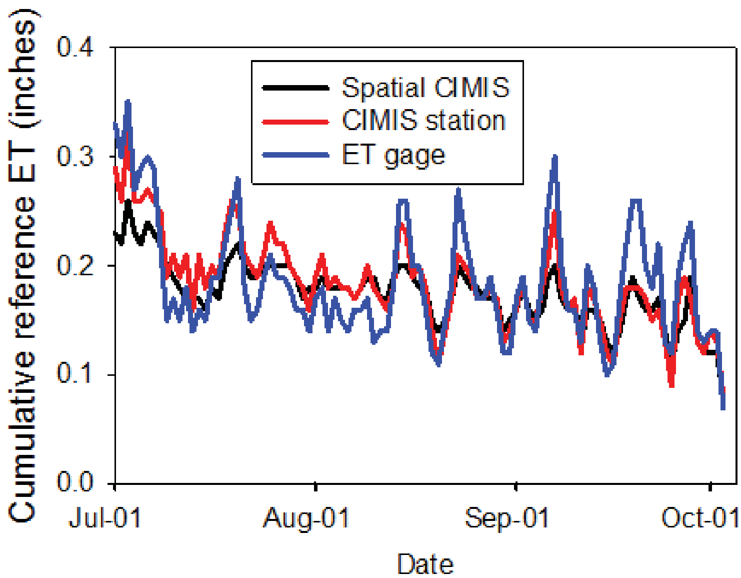

Figure 2. Comparison of daily reference ET values for spatial CIMIS, Gilroy CIMIS station and an ETgage in Gilroy during July-Sept, 2011.

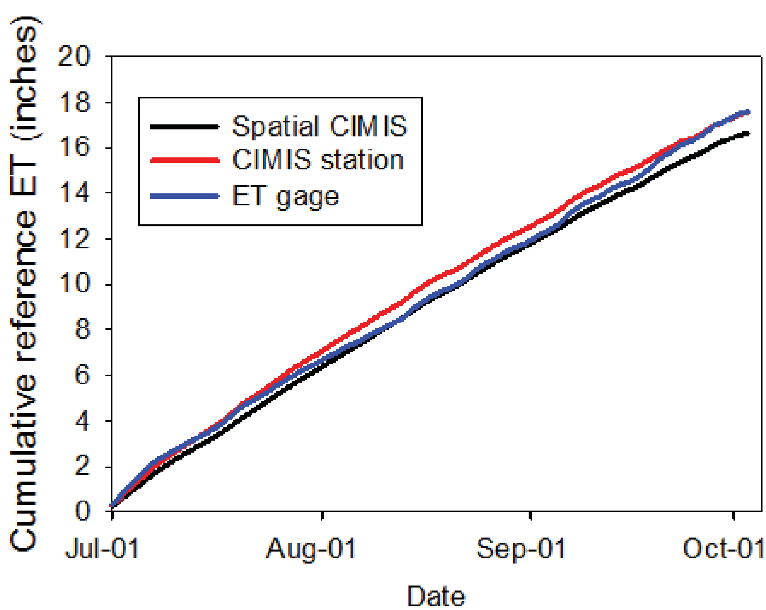

Figure 3. Cumulative reference ET for spatial CIMIS, Gilroy CIMIS station, and ETgage in Gilroy during July – Sept, 2011.

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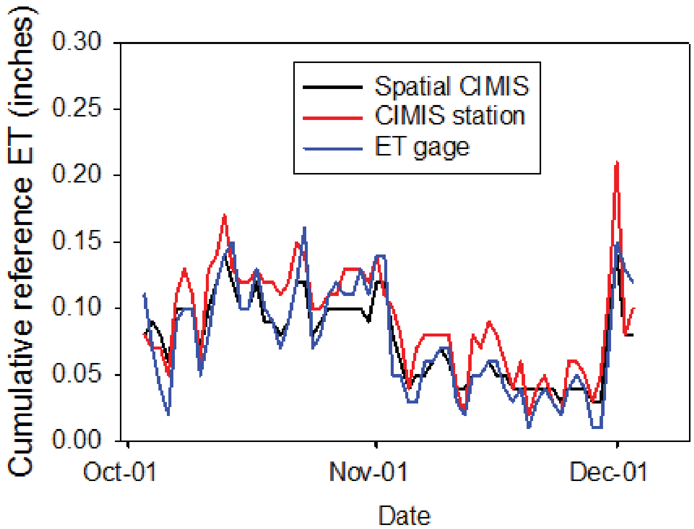

Figure 4. Comparison of daily reference ET values for spatial CIMIS, Gilroy CIMIS station and the ETgage north of Morgan Hill during Oct-Dec, 2011.

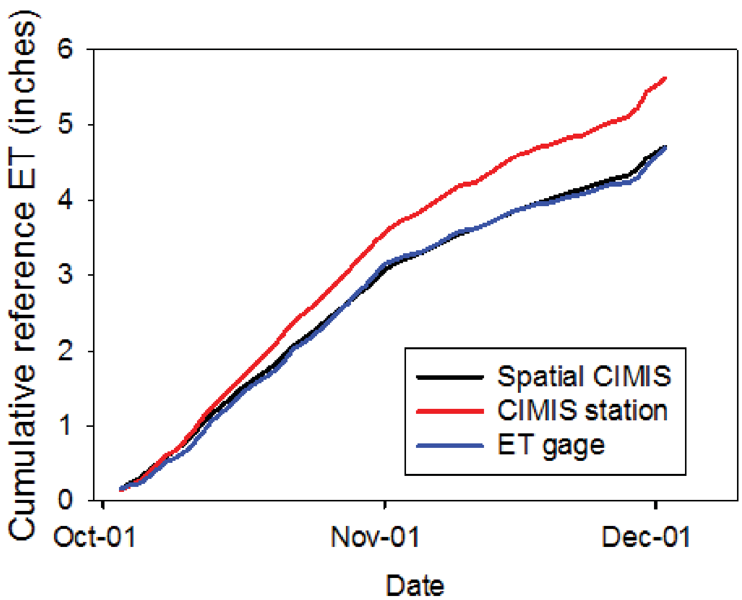

Figure 5. Cumulative reference ET for spatial CIMIS, Gilroy CIMIS station, and ETgage north of Morgan Hill during Oct-Dec, 2011.

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Bagrada bug has now been found in the Santa Maria Valley and there is a strong possibility that it will find its way the Salinas Valley sometime soon. It will be a troublesome insect issue for all Brassica crops as well as peppers. It will be able to establish populations in the many mustard family weeds that occupy areas throughout our valley. These locations will provide a source for infestations of this insect. The following article was written by John Palumbo with the University of Arizona and provides practical information on the means that growers and PCA's in the desert are using to control this insect. We will be filling our entomology position in December and will have a good resource person to help us deal with this and other insect issues in the Salinas Valley.

Richard Smith.

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Impact of the Bagrada Bug on Desert Cole Crops: A Survey of PCA/Growers in 2010 and 2011

John C. Palumbo, Yuma Agricultural Center

The Bagrada bug, *Bagrada hilaris,* became a major pest of cole crops in the fall on 2010. Widespread infestations were reported throughout the desert growing areas in September and October where stand losses and yield/quality reductions to broccoli, cauliflower, cabbage and other *Brassica* crops were considered economically significant in some growing areas. In an attempt to document the impact of these outbreaks on desert production, we surveyed Growers/PCAs from Yuma and Imperial Valley in 2010 and 2011 to estimate the severity of Bagrada bug infestations on direct-seeded and transplanted cole crops. PCAs and growers were anonymously asked to estimate the acreage where *Bagrada* populations were present, and of those acres, what percentage required insecticide treatments and how often. In addition, they were asked to estimate, on average, percent stand losses and plant injury caused by *Bagrada* infestations. Finally, PCAs and growers were asked to list the insecticide products they found to be effective in controlling Bagrada adults when applied as either chemigations or foliar sprays. A copy of the survey questionnaire is found in the Appendix of this report. A total of 17 questionnaires were completed by Growers/PCAs in 2010 representing a total of 9310 acres of direct seeded crops (e.g., broccoli) and 4610 acres of transplanted crops (e.g., cauliflower) crops. In the 2011 survey at total of 13 questionnaires were completed representing 6210 acres of direct seeded crops and 3450 acres of transplanted crops. One additional source of information used in this report was insecticide use data for Brassica crops in Arizona developed from the 1080 database maintained by the University of Arizona, Pest Management Center. Total acreage of *Brassica* crops (broccoli, cabbages, cauliflower and kale) treated with several active ingredients From Aug through October in 2009, 2010 and 2011 were summarized from 1080's submitted to the AZ Department of Agriculture.

Summary

<u>Direct-seeded Crops:</u>

Based on PCA estimates, Bagrada bugs were present on fewer acres in 2011, and the percentage of acres treated for *Bagrada* was down slightly compared to 2010. This is consistent with the later arrival of adults into the Yuma and Imperial Valleys in 2011. Averaged across both years, PCAs / growers reported treating direct-seeded crops for Bagrada bugs on a higher percentage of acres than where they reported that Bagrada bugs were present (Table 1). This is not surprising given the preventative nature of controlling *Bagrada* infestations necessary to reduce stand losses This is likely reflected as well by the large number of acres chemigated (74.5%) on an average of 1.6 times. However, once sprinkler pipe was removed from the field, the survey suggests that management for *Bagrada* remained intensive where 88.5 % of the reported acres were sprayed an average of 2.3 times. When the number of chemigations and foliar sprays are combined over both years, almost 4 insecticides applications were made to control this pest.

Consequently, *Bagrada* infestations at stand establishment were estimated to cause, on average, 4.4% stand loss where in some cases losses exceeded 20% (Table 2). Stand losses to *Bagrada* were lower in 2011. Feeding injury, defined as the plants with multiple heads, forked terminals, and/or blind terminals resulting from Bagrada feeding, was also higher in 2010 on direst-seeded crops compared to this year. On average, PCAs / growers estimated that Bagrada bugs caused feeding injury to plants in 6.1% of the acreage they managed, even with the intensive insecticide spraying. In some cases, this injury was estimated to exceed 50%. These reported losses are consistent with losses measured in trials conducted at the Yuma Ag Center in 2010.

Transplanted Crops: In contrast, growers/PCAs reported treating a smaller percentage of transplanted acres for Bagrada than direct-seeded crops. Fewer acres were chemigated (66.3%) and slightly fewer times (1.4) (Table 1). Once sprinkler irrigation pipe was removed from the field, the survey suggests that management for *Bagrada* was also less intensive where about 83.2% of the acres were sprayed an average of 2 times. Averaged across both years, growers/PCAs treated for Bagrada on transplants 3.3 times Relative to direct-seeded crops, stand losses were lower in transplanted crops. On average Bagrada infestations were estimated to cause 2.3% stand loss, and losses did not exceed 10% (Table 2). The lower % stand losses in transplanted crops suggests that newly transplanted crops are more better able to withstand feeding without injury during stand establishment. Similarly, on average, grower/PCAs estimated that Bagrada bugs caused feeding injury to plants in > 4% of the acreage they managed and in some cases, this injury was estimated to exceed 20%. This suggests to some extent that feeding injury occurring in cole crops may be more important on very young seedlings (i.e., cotyledon-1 leaf plants).

Effective Insecticides:

Grower/PCAs reported using pyrethroids almost exclusively to control Bagrada bugs through chemigation (Figure 1). Among the insecticide active ingredients (AI) reported as effective, bifenthrin (Brigade, Sniper, Hero and Discipline) was the most commonly reported, followed by lambda-cyhalothrin (Warrior II, Lambda-Cy) and zeta-cypermethrin (Mustang, Hero). Several other other pyrethroids were reported as being effective, but used by relatively fewer PCAs. One PCA reported using Alias in 2010. In general, comments provided on the survey suggested that pyrethroid chemigations appeared to provide effective knockdown control of adults, but re-application was often necessary after 2-3 days.

In contrast a much broader array of AIs were reported for use against *Bagrada* when applied as foliar sprays (Figure 2). The pyrethroids were the most commonly reported AIs used for effective *Bagrada* adult control with foliar spray applications. Bifenthrin was the to be most commonly used AI, followed by lambda cyhalothin, zeta-cypermethrin, and esfenvaluate. Among the alternative chemistries used, dinotefurnon, methomyl and chlorpyrifos were reported to be effective against Bagrada adults by several PCAs, and a number of neonicotinoids, and pyrethroids were reported less frequently. These results are consistent with efficacy trials conducted at Yuma Ag Center where products that have contact activity (i.e., Pyrethroids, OP/Carbamates) have provided the most effective control against Bagrada adults on both direct-seeded and transplanted cole crops.

Insecticide Usage – 1080 database:

Results from the 1080 database shows that reported insecticde usage on Arizona cole crops is consistent with the information provided by PCAs in the surveys. Based on the usage data, the pyrethroids were treated on a higher number of acres than any other chemical class. Among the pyrethroids, bifenthrin was treated on more acres than any other pyrethroids. The neonicotinoids (dinotefuron) and organophosphates (chlorpyrifos) was the next most commonly used chemical classes used to treat broccoli. The 1080 data also shows that in 2009 only 22,392 acres of cole crops were treated from Aug-Oct in Arizona. However, since the outbreaks of the Bagrada bug in 2010, insecticide usage on cole crops acreage has increased by almost 2 fold. This is largely due to the increased use of pyrethroids, wheras OP/carbamate usage has remains about the same. It should be noted that the sharp increase in dinotefuron usage is likely due to whitefly management as well.

Table 1. Impact of Bagrada bug on desert cole crops based on chemical control.

	Direct-seeded			Transplanted		
Chemical Control for *Bagrada*	**2010**	**2011**	***Avg.***	**2010**	**2011**	***Avg.***
% acres where *Bagrada* present	95.8	87.6	*91.7*	94.4	87.0	*90.7*
% acres treated with insecticide	95.8	91.3	*93.6*	88.3	84.3	*86.3*
% acres chemigated	73.8	75.2	*74.5*	60.6	72.0	*66.3*
Avg. no. of chemigations applied	1.6	1.6	*1.6*	1.4	1.3	*1.4*
% acres sprayed with insecticide	90.0	87.0	*88.5*	85.6	80.8	*83.2*
Avg. no. of sprays applied	2.7	1.8	*2.3*	2.1	1.8	*2.0*
Total no. insecticide applications	4.3	3.4	*3.9*	3.5	3.1	*3.3*

Table 2. Impact of Bagrada bug on desert cole crops based on feeding injury.

	Direct-seeded			Transplanted		
Impact of Bagrada on Crops	**2010**	**2011**	***Avg.***	**2010**	**2011**	***Avg.***
Avg. % stand loss due to Bagrada	6.3	2.5	*4.4*	3.1	1.5	*2.3*
Worst case (% stand loss)	18.7	17.4	*18.1*	6.8	6.3	*6.6*
Avg. % plant injury to Bagrada	8.0	4.2	*6.1*	4.6	3.9	*4.3*
Worst case (% plant injury)	18.1	11.1	*14.6*	9.8	11.0	*10.4*

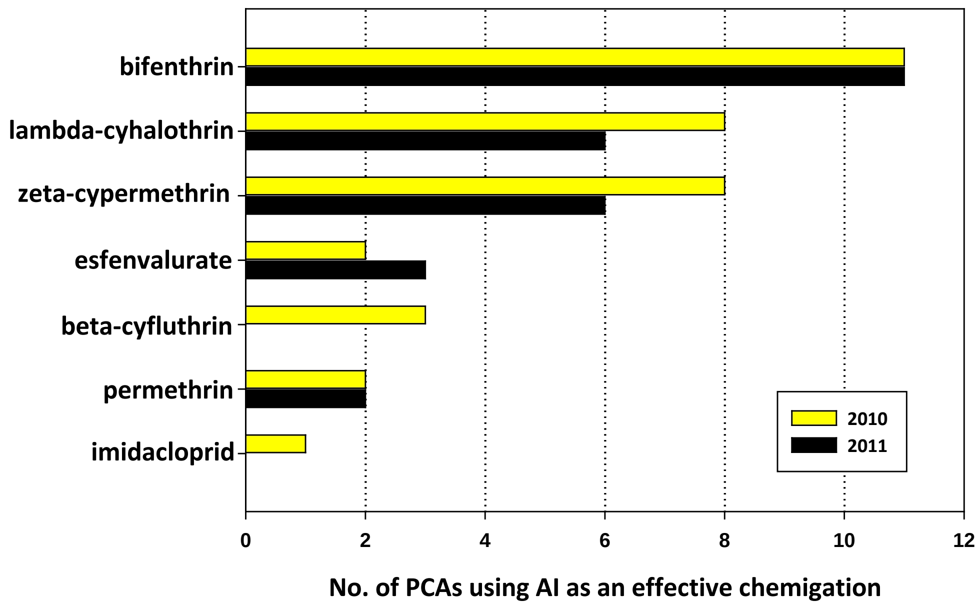

Figure 1. Insecticide AIs reported as effective against *Bagrada* bug adult infestations when applied as chemigations on cole crops in Yuma and Imperial Valley in 2010-2011.

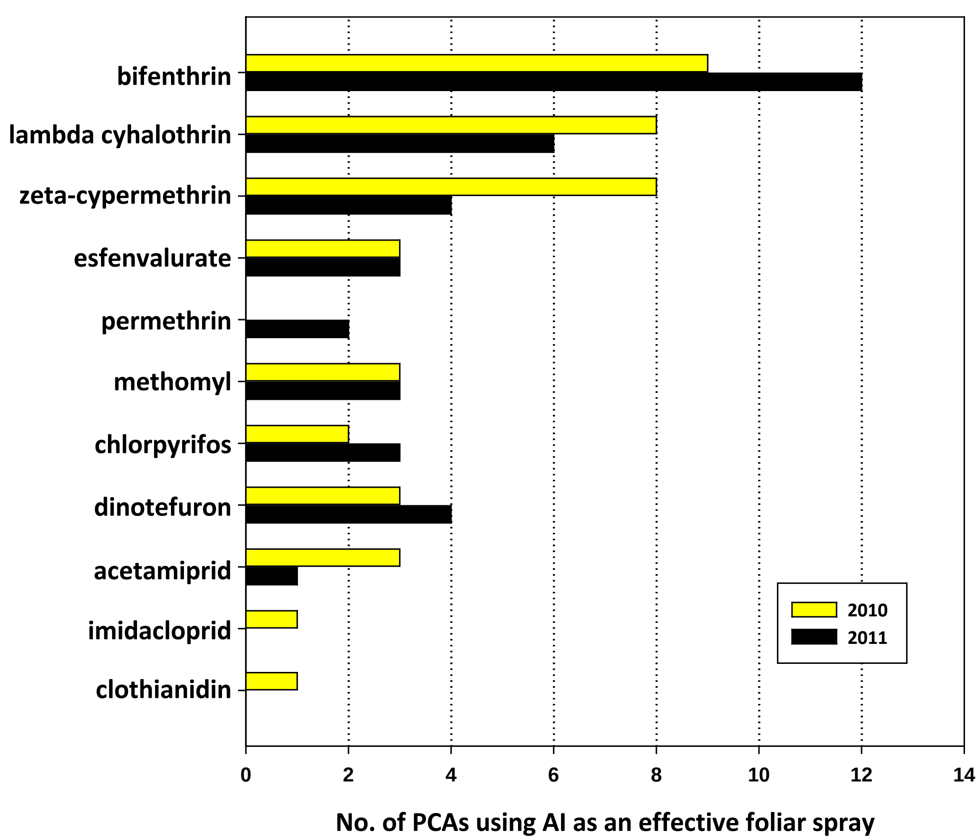

Figure 2. Insecticide AI s reported as effective against *Bagrada* bug adult infestations when applied as foliar sprays on cole crops in Yuma and Imperial Valley in 2010-2011.

Table 3. Insecticide use by active ingredient (AI) on *Brassica* crops grown in Arizona during Aug – Oct in 2009, 2010, and 2011. *Source: Arizona Pest Management Center 1080 database.*

	Treated acres		
Active Ingrediant	**2009**	**2010**	**2011**
Pyrethroids			
bifenthrin	7,026.9	16,235.7	13,465.2
zeta-cypermethrin	5,204.1	10,272.7	5,084.4
esfenvalerate	3,909.7	4,492.2	6,608.5
lambda-cyhalothrin	2,618.2	2,480.7	6,617.0
permethrin	145.2	2,128.9	860.1
cypermethrin	200.4	604.5	1,504.2
cyfluthrin	524.5	521.0	375.7
beta-cyfluthrin	102.8	228.0	186.9
fenpropathrin	0.0	24.5	182.4
Total	***19,731.8***	***36,988.2***	***34,884.4***
OP/Carbamates			
methomyl	379.5	339.4	530.3
chlorpyrifos	1,801.7	2,207.4	1,986.1
Total	***2,181.2***	***2,546.8***	***2,516.4***
Neonicotinoids			
acetamiprid	42.4	971.9	505.3
dinotefuran	436.6	1,687.5	3,857.4
Total	***479.0***	***2,659.4***	***4,362.7***
Total Treated Acres	***22,392.1***	***42,194.4***	***41,763.5***

Appendix

2010-2011 Bagrada Bug Survey

		***Brasscia* / Cole Crops**	
		Direct-seeded *(e.g. Broccoli)*	**Transplanted** *(e.g. cauliflower)*
1	**Number of acres scouted in Fall 2010** *(August thru November)*		
2	**% Acres where Bagrada bugs were present** *(August thru November)*		
3	**% Acres Treated for Bagrada bugs** *(August thru November)*		
4	**% Acres Chemigated for Bagrada bugs** *(August thru November)*		
5	**Avg. No. of Chemigations applied**		
6	**% Acres sprayed (air or ground) for Bagrada bugs**		
7	**Avg. No. of Sprays applied**		
8	**Avg. % stand loss due to Bagrada bugs**		
9	**Worst case (% stand loss)**		
10	**Avg. % plant injury due to Bagrada bugs** *(multiple heads/forked terminals/ blind plants)*		
11	**Worst case (% plant injury)** *(multiple heads/forked terminals/ blind plants)*		

12 **Which insecticides did you find to be most effective?**
Please list as many as you like, include tank-mixtures when appropriate.

Chemigation: ______________________________

Foliar sprays: ______________________________

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University of California Cooperative Extension
Monterey County

2012 Plant Disease Seminar: First Announcement

Tuesday, November 6, 2012
8:00 a.m. to 12:00 p.m.

****County of Monterey Agricultural Center****
Conference Room
1432 Abbott Street, Salinas, California

This seminar will focus on a broad range of topics dealing with plant pathology and pest management. Topics will include updates on plant disease and pest developments in coastal California, research findings on plant diseases, and current issues affecting growers, pest control advisors, and other agricultural professionals.

Registration/sign in is from 8:00 to 8:30. There is no fee for this meeting. Continuing education credits will be requested. Please call ahead (at least 24 hours) for arrangements for special needs; every effort will be made to accommodate full participation. For more information, contact Steven Koike (831-759-7350; 1432 Abbott Street, Salinas, California 93901).

Requirement from California DPR: Bring your license or certificate card to the meeting for verification when signing in for continuing education units.

An afternoon session, held in this same conference room, will be hosted by CAPCA, Monterey Bay Chapter.