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Crop Notes

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ECOLOGICAL IMPACT ON SUSCEPTIBILITY OF WESTERN FLOWER THRIPS TO THE INSECTICIDE RADIANT IN STRAWBERRY PRODUCTION

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In the Central Coast area, strawberries are usually planted in late fall and terminated one year later after first-year production while some strawberries are kept in fields for second-year production. Weed species such as wild mustard and radish often grow near strawberry fields.

Western flower thrips, *Frankliniella occidentalis*, feed on many plant species. In the strawberry production system, their hosts include strawberries and nearby weeds. Their feeding on strawberries causes bronzing of the fruit surface, resulting in reduced fruit quality. Control of these pests has been largely dependent upon chemical insecticides. Among these insecticides, spinosad has been used most often. Dow AgroScience, the manufacturer of spinosad, has recently claimed wide-spread resistance of thrips to this insecticide class in Central Coast strawberries and modified the label for reduced applications to these strawberries. Here we report susceptibility of the thrips to Radiant, a second generation of spinosad, in a Central Coast ecosystem containing first-year strawberries, second-year strawberries and weed hosts.

Materials and Methods

A first-year strawberry field, a second-year field, and a nearby area with weed hosts (mainly wild mustard) near Meridian Road, Prunedale, were selected for the experiment. The first-year strawberries, second-year strawberries, and weeds were in close proximity. Western flower thrips with strawberry flowers from the first-year and second-year fields and the thrips with mustard flowers from the weed area were collected on July 22 and November 10, 2009. Collected samples were immediately shipped to the lab for bioassay experiments.

Strawberry seedlings were planted in pots filled with soil mixture in a greenhouse/shadehouse as a source for leaflets on which to conduct the bioassays. Plants used in the experiments were at the three-to six-trifoliate stages when leaflets were removed for the bioassays, and were never treated. Radiant (spinetoram) was diluted in distilled water and at least 6 concentrations were used to produce a range of 5-90% mortality. The most recently fully-expanded strawberry leaflets were dipped for 10 s in a solution containing a specific amount of Radiant. Control leaflets were dipped in distilled water only. After the leaf surface was dried, 25-35 adult thrips were transferred with an aspirator from the collected flowers to the upper surface of a treated leaflet encased in a Munger cell apparatus with a layer of wet paper facing the lower surface of the leaflet (Figure 1). After the initial exposure, adult mortality was determined at 24, 48 and 72 h. Thrips that were unable to walk at least a distance equivalent to their body length were considered dead.

The resulting data were corrected for control mortality and analyzed by probit analysis. LC_{50} and LC_{90} for spinetoram were determined for each 24 h interval (24, 48 and 72 h) after the treatment. Differences in LC_{50s} and LC_{90s} were considered not significant if their respective 95% CI overlapped.

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Results and Discussion

Across all hosts and sampling dates, our results indicate that toxicity of spinetoram to western flower thrips increased progressively from 24 to 72 h after the initial exposure (Table 1). However, Dow AgroScience used only the 24 h exposure results to identify resistance. Compared to those at 24 h post exposure, LC_{50s} at 72 h decreased 3 – 6.5 fold from the first-year strawberries, 3.0 – 3.5 fold from the second-year strawberries and 11.3 – 62.5 fold from the weeds, while the LC_{90s} declined 2.7 – 7.8 fold from the first-year strawberries, 2.6 – 5.2 fold from the second-year strawberries and 11 – 47 fold from the weeds.

Western flower thrips, *Frankliniella occidentalis*, feed on many plant species.

For the July 22 sampling date, LC_{50} at 48 h post-exposure from the second-year strawberries was 4.4-fold greater than that from the first-year strawberries and over 321-fold greater than that from the weeds (Table 1). For the November 10 sampling date, the LC_{50} from the second-year strawberries was similar to that for the first-year strawberries and 3.15-fold greater than that from the weeds (Table 1). Thrips in weeds were very susceptible (Table 1).

As the season progressed from July to November, there was a trend of increased tolerance/resistance of western flower thrips to spinetoram (Table 1). In comparison with those for the July 22 sampling date, LC_{50s} at 48 h post-exposure for the November 10 sampling date increased 4.8-fold from the first-year strawberries and 3.5-fold from the weeds. Increases from the second-year strawberries were not significant. Thrips in weeds were still susceptible. These results indicate that increased applications of spinosad increased the tolerance/resistance of thrips to this insecticide class.

Conclusion

In mid-season (July), western flower thrips in second-year strawberries were much more tolerant to Radiant than those in first-year strawberries, while those in first-year strawberries were much more tolerant than those in weeds. In late season (November), the tolerance/resistance levels in the first-year and second-year strawberries were similar but much greater than that in weeds. As the season progressed, there was a trend of increased tolerance/resistance. However, the tolerance/resistance levels were much less than Dow AgroScience claimed. Weed hosts provided a refuge for susceptible thrips that may help conserve spinosad insecticides.

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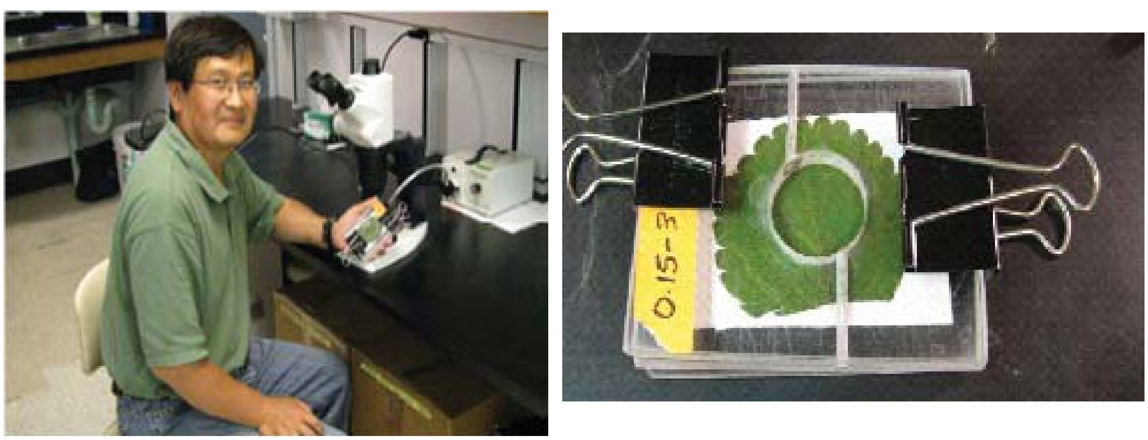

Figure 1. Dr. Yi Yu, a visiting professor from China, was checking the mortality of thrips during a bioassay experiment.

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Table 1. Susceptibility of the western flower thrips from first-year and second-year strawberry fields and weeds to spinetoram.

Sampling site	Sampling date	n	Exposure duration (h)	Slope ± SE	LC_{50}, µg ai/ml (95% CI)	LC_{90}, µg ai/ml (95% CI)
1st year strawberries	Jul. 22	1662	24	0.819 ± 0.052	130.213 (94.669—171.333)	4776.857 (2965.443—9083.167)
			48	0.940 ± 0.063	65.027 (43.892—88.748)	1500.844 (1046.703—2409.082)
			72	0.869 ± 0.064	20.630 (12.406—30.475)	614.826 (449.724—903.709)
	Nov. 10	968	24	1.885 ± 0.187	526.037 (413.586—636.796)	2516.137 (2018.516—3375.430)
			48	1.852 ± 0.200	311.456 (218.226—402.846)	1532.127 (1197.634—2136.959)
			72	1.716 ± 0.212	169.856 (100.933—239.553)	948.617 (717.342—1369.820)
2nd year strawberries	Jul. 22	1216	24	1.048 ± 0.063	434.192 (344.679—548.389)	7252.679 (4649.337—13085.200)
			48	1.506 ± 0.127	285.259 (211.132—358.411)	2023.474 (1440.796—3416.110)
			72	1.293 ± 0.099	142.097 (103.668—182.241)	1391.802 (1039.537—2053.747)
	Nov. 10	1137	24	1.751 ± 0.161	581.380 (465.822—700.084)	3135.748 (2465.477—4310.795)
			48	1.497 ± 0.153	321.556 (230.851—415.635)	2307.226 (1752.461—3325.371)
			72	1.625 ± 0.182	197.989 (129.418—268.645)	1217.457 (921.850—1758.907)
Weeds	Jul. 22	1104	24	0.762 ± 0.038	3.430 (2.162—5.419)	164.762 (85.179—382.556)
			48	0.707 ± 0.041	0.887 (0.559—1.364)	57.544 (31.093—125.917)
			72	0.770 ± 0.050	0.329 (0.173—0.567)	15.140 (7.373—41.601)
	Nov. 10	1133	24	0.593 ± 0.077	25.057 (4.041—68.464)	3620.815 (1748.922— 11373.395)
			48	0.565 ± 0.053	3.153 (0.341— 12.496)	583.664 (215.121— 1732.059)
			72	0.566 ± 0.047	0.421 (0.107—1.207)	77.494 (34.868— 175.015)

94 µg ai/ml = a spray volume of 100 gallons per acre at full label rate of Radiant (10 oz/acre)

187 µg ai/ml = a spray volume of 50 gallons per acre at full label rate of Radiant (10 oz/acre)

BACTERIAL LEAF SPOT OF PARSLEY: CHARACTERIZATION OF A NEW DISEASE

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Symptoms on parsley: First seen in California in 2002 and continuing through 2010, a previously undescribed leaf spot disease has been affecting parsley throughout central coast California and particularly in Monterey County. Symptoms consist of small leaf spots that are usually less than ¼ inch in diameter. Spots are noticeably and consistently angular in shape, with the margins of the spot restricted by leaf veins. The color of the leaf spots can vary from light tan to brown to dark brown (Figs. 1 and 2). These leaf spots penetrate the entire leaf, so that the spots will be visible from both the top and bottom sides of the infected tissue (in contrast to chemical damage or abrasion in which the symptom is usually only seen from the top side of the leaf). Spots rarely merged and coalesced but in severe cases the large number of spots resulted in blight-like symptoms.

Currently the most important foliar disease of parsley is Septoria blight caused by the fungus *Septoria petroselini*. In most cases Septoria blight and bacterial leaf spot will be readily differentiated from each other. While both diseases result in angular-shaped, tan to brown spots, bacterial leaf spot will not have any fungal fruiting bodies in the lesions. However, Septoria blight lesions will almost always contain distinctive, tiny, black fruiting bodies called pycnidia (Fig. 3).

Pathogen identification: Our research team has documented that bacteria in the *Pseudomonas syringae* group are responsible for bacterial leaf spot of parsley. However, we discovered that the cause (etiology) of this disease is complex and is due to two distinctive pathogens. We completed a series of biochemical, physiological, and host range tests as well as extensive examination of pathogen DNA. These findings indicate that parsley bacterial leaf spot is caused by both *Pseudomonas syringae pv. apii* (also the pathogen causing bacterial leaf spot of celery) and *Pseudomonas syringae* pv. *coriandricola* (known as the pathogen causing bacterial leaf spot of cilantro). It is interesting that in most cases a parsley field was affected by either one or the other pathovar (pv.); in only a few cases were both pathovars found in the same planting. Therefore, this parsley disease is caused by two familiar pathogens that cause leaf spots on closely related species (celery, cilantro) in the Apiaceae plant family. The technical publication on these findings is available via the internet (see below for further information).

Of further interest are the experimental findings that these two pathovars are not restricted to a particular Apiaceae host plant. Parsley strains of pvs. *apii* and *coriandricola* both infected parsley, celery, and cilantro. Celery strains of pv. *apii* caused leaf spots on parsley, celery, and cilantro. Finally, cilantro strains of pv. *coriandricola* likewise caused disease on the same three crop species. Therefore, these two P. *syringae* pathovars from Apiaceae hosts are not restricted to the original host but can cross-infect other Apiaceae crops. This cross-infectivity could have important implications for growers and pest control advisors. For example, if bacterial leaf spot develops in a cilantro field, it would be possible for the pathogen to be splashed onto an adjacent celery or parsley crop and initiate disease in those plantings.

***Pseudomonas syringae* pathovars:** There are many pathovars (pvs.) that cause plant diseases and which are placed in the *Pseudomonas syringae* species. The pathovar system was designed to try and organize these many pathogens that look virtually identical in

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culture, test similarly in biochemical and physiological tests, but infect different plants and have distinct host ranges (Table 1). For example, the P. *syringae* that causes bacterial leaf spot of spinach (pv. *spinaciae*) will not infect tomato, and the pathovar that causes leaf spots on cauliflower (pv. *maculicola*) will not cause spots on leek. Generally, molecular analyses that examine the DNA of these pathovars are unable to consistently distinguish between them. However, in our parsley study we successfully used a molecular technique (multilocus sequence typing, or MLST) to differentiate pv. *apii* from pv. *coriandricola* and from all other pathovars of *P. syringae*.

Managing parsley bacterial leaf spot: Controlling this leaf spot disease of parsley will be similar to steps used to manage the celery and cilantro problems. (1) The initial source of inoculum for this parsley disease is not yet known. However, since *P. syringae* pv. *apii* and *P. syringae* pv. *coriandricola* are seedborne on celery and cilantro seed, respectively, contaminated parsley seed is a suspect source of the pathogen. Therefore, the use of pathogen-free seed or seed treatments may be appropriate. (2) All three of these diseases depend on splashing water to disperse the bacteria and create favorable conditions for infection and disease development. Therefore, avoiding the use of overhead sprinkler irrigation is advisable where possible. (3) Crop rotation with non-Apiaceae plants may be very important since these pathogens cross-infect other crops within this plant family. (4) It is likely that diseased crop residues may still harbor viable bacteria, so back-to-back plantings of parsley, celery, and cilantro should be delayed until crop residues have dissipated. *P. syringae* pathovars are not soil inhabitants, so once the host tissue has decayed rotted away, the pathovars do not survive in the soil for long periods of time. (5) Highly effective pesticides are not available for these bacterial leaf spot problems. While copper-based fungicides may afford some protection, these products are generally not sufficient to provide the high quality produce demanded by the market.

Search for samples: Our research team is investigating a possible new bacterial disease on fennel, as well. Because of these developments on commercially grown plants in the Apiaceae, we are seeking additional samples of foliar problems from any member of the Apiaceae crop group: celery, cilantro, dill, fennel, parsley, and others. Further clarification of the relationship between these various bacterial pathogens, determination of which hosts are susceptible to which pathogen, and other aspects may assist industry in managing these diseases.

The best samples will consist of diseased plants collected from several different locations of a field. If possible, four or five different sampling locations per field will give us a better chance of understanding the disease dynamics for these leaf spot problems. Send samples to the UC Cooperative Extension diagnostic laboratory in Salinas: 1432 Abbott Street, Salinas CA, 93901 (phone 831-759-7550), attention Steven Koike.

The reference below is available as a free download at http://apsjournals.apsnet.org/doi/abs/10.1094/PHYTO-11-10-0318

Bull, C. T., Clarke, C. R., Cai, R., Vinatzer, B. A., Jardini, T. M., Koike, S. T. 2011. Multilocus sequence typing of *Pseudomonas syringae sensu lato* confirms previously described genomospecies and permits rapid identification of P. *syringae* pv. *coriandricola* and P. *syringae* pv. *apii* causing bacterial leaf spot on parsley. Phytopathology DOI: 10.1094/PHYTO-11-10-0318.

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Table 1. Selected plant hosts infected by *Pseudomonas syringae* pathovars (pv.)

Host	Pathogen
Bean	*Pseudomonas syringae* pv. *phaseolicola*
Beat/chard	*Pseudomonas syringae* pv. *aptata*
Celery	*Pseudomonas syringae* pv. *apii*
Cilantro	*Pseudomonas syringae* pv. *coriandricola*
Crucifers	*Pseudomonas syringae* pv. *maculicola*
Cucurbits	*Pseudomonas syringae* pv. *lachrymans*
Leek	*Pseudomonas syringae* pv. *porri*
Spinach	*Pseudomonas syringae* pv. *spinaciae*
Tomato	*Pseudomonas syringae* pv. *tomato*
Parsley	*Pseudomonas syringae* pv. *apii* and *Pseudomonas syringae* pv. *coriandricola*

Fig. 1. Bacterial leaf spot of parsley.

Fig. 2. Bacterial leaf spot of parsley.

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Fig. 3. Septoria blight of parsley, showing small black fruiting bodies of the fungus.

SPINACH WEED CONTROL: WHERE WE HAVE BEEN AND WHERE WE ARE NOW

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Spinach is produced on high density 80-inch wide beds that are mechanically harvested. Therefore, weed-free spinach is essential.

Weed control is a critical part of spinach production. This is particularly true now that much of the spinach is produced on high density 80-inch wide beds that are mechanically harvested. Therefore, weed-free spinach is essential. High density plantings of spinach cannot be cultivated, and the only non-chemical options that are available to growers are cultural practices such as the use of preirrigation followed by shallow cultivation to kill a flush of weeds, crop rotations, field selection, and field sanitation practices that minimize weed seed production. These practices can be very useful in reducing weed populations to manageable levels in production fields.

Herbicides provide further weed control in conventionally produced fields that help to make subsequent hand weeding operations more efficient and economical. The situation with herbicides registered for use on spinach has been a bit of a roller coaster ride over the past several years:

The requirement for a 12 month interval to pass between Dual use and lettuce planting is also a problem in the Salinas Valley where lettuce is the dominant crop.

A number of years ago a key highly effective preemergent herbicide, Antor, was removed from the market. Efforts to register Dual Magnum were initiated in the mid-1990s and in 2008, it was finally registered under a 24c registration. However, the registration has the following restrictions: 1) a 50 day preharvest interval (PHI) and 2) a 12 month plant back restriction to lettuce. Given that the majority of the spinach acreage is clipped baby and teenage types (grown for the bagged spinach market) which mature in 25-35 days during the summer production season, the 50 day PHI, is too long. There are efforts to reduce the PHI of Dual Magnum on spinach, and we will have to see how successful these efforts will be. Presently the requirement for a 12 month interval to pass between Dual use and lettuce planting is also a problem in the Salinas Valley where lettuce is the dominant crop.

Several years ago, Helm Agro Chemical Corporation took over production of RoNeet. In 2008 they announced that they were suspending production of RoNeet. Fortunately, within a year, RoNeet was returned to the market and it continues as the key preemergence herbicide for use on spinach.

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Other weed control options for use on spinach include the broadleaf postemergence herbicide Spin-aid. However, its use is restricted to freezer spinach production which has more days to harvest than clipped spinach. Blading Vapam or Kpam at 3 inches below the crop surface is done by some spinach growers. This technique provides useful weed control, but its use is limited by the additional cost, buffer zone issues, and the additional days needed to wait before the crop can be planted.

Finding new potential herbicides for use on spinach has been very difficult because spinach is very sensitive to most preemergence materials. Recently, we have been examining the use of Lorox which has been shown to have some safety on spinach, but the safety varies by soil type and soil characteristics.

As a result of all of these challenges, we thought it useful to explore ways to try to work with the Dual Magnum PHI in order to expand the weed control options available to growers on the Central Coast. An initial study conducted in 2009 in which we applied Dual Magnum to shaped 80-inch beds 3 weeks prior to plating. Results indicated that rates of Dual Magnum greater than 0.5 pint/A were needed to get good weed control (Table 1). In 2010, we followed up on this work and examined Dual Magnum applications made 14-day preplant and at-planting. It also provided an opportunity to observe the loss of weed control by Dual Magnum if left on the soil surface for 14 days prior to planting.

Applications of Dual Magnum applied 14 days before planting did provide a measure of weed control, but it is clearly a less desirable method of providing weed control for spinach than at-planting applications.

The trial was conducted in San Ardo. Preplant applications were applied to shaped beds on September 1. The materials remained on the bedtop until planting on September 14. The at-planting treatments were applied immediately following planting on September 15. All treatments were incorporated into the soil with the germination water on September 15. None of the treatments injured spinach except for Dual Magnum at 1.0 pint/A applied preplant and Lorox at 0.6 lb/A (Table 2). All materials reduced total weeds over the untreated control, and Lorox at 0.6 lb/A provided complete weed control. Dual Magnum applied 14 days prior to planting had more weeds than the at-planting applications at the same rate. The untreated control, 14-day preplant applications of Dual Magnum at 0.3, 0.5 and 0.75 pint/A, at planting applications of Dual Magnum at 0.3 and 0.5 pint/A and RoNeet at 1.25 pint/A all had yields >8.0 tons/A. The 1.0 pint/A rate of Dual Magnum applied preplant did not provide further weed control than the 0.75 pint/A rate and had a lower yield. In general, applying Dual Magnum 14 days preplant reduced weed control by this material over at-planting applications. Lorox at 0.4 lbs was safer on spinach than the 0.6 lb/A rate and provided good weed control in this trial.

Summary: The results indicate that there is a significant reduction in weed control in the Dual Magnum treatments that sat on the soil surface 14 days prior to planting. Applications of Dual Magnum applied 14 days before planting did provide a measure of weed control, but it is clearly a less desirable method of providing weed control for spinach than at-planting applications.

Table 1. 2009. Evaluation of Dual Magnum applied three weeks prior to planting to comply with the 50 day preharvest interval. Weed counts taken on August 6 - sixteen days after planting.

Treatment	Material Per Acre	Llbs a.i./A	Purslane	Malva	Other Weeds	Total Weeds	Phyto
Dual Magnum	0.50 pint	0.48	41.3	0.8	1.3	43.3	0.0
Dual Magnum	0.75 pint	0.72	4.0	1.8	2.3	8.0	0.8
Dual Magnum	1.00 pint	0.96	1.0	2.8	4.3	8.0	1.3
Untreated	----	----	3.0	11.8	21.8	36.5	0.0
Pr>Treat			<0.001	<0.001	<0.001	0.002	0.005
LSD 0.05			16.4	3.7	5.7	17.0	0.7

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Table 2. 2010. Weeds counts (per 25 ft^2) and phytotoxicity ratings on September 30

Treatments	a.i. lbs/A	Material/A	Application Timing	Phyto[1]	Malva	Purslane	Other Weeds	Grass[2]	Total Weeds	Yield T/A
Untreated	---	---	---	0.0	5.5	4.2	1.9	1.1	12.6	8.5
Dual Magnum	0.3	0.31 pint	14 days preplant	0.3	3.6	2.0	0.6	0.0	6.2	8.6
Dual Magnum	0.3	0.31 pint	At planting	0.0	2.9	0.4	0.0	0.0	3.3	9.1
Dual Magnum	0.5	0.52 pint	14 days preplant	0.3	3.9	3.7	0.3	0.0	7.9	8.7
Dual Magnum	0.5	0.52 pint	At planting	0.3	1.7	0.4	0.0	0.0	2.2	8.5
Dual Magnum	0.75	0.78 pint	14 days preplant	1.3	3.0	1.3	0.6	0.0	4.9	8.0
Dual Magnum	0.75	0.78 pint	At planting	1.3	1.7	0.1	0.3	0.0	2.2	7.7
Dual Magnum	1.00	1.05 pint	14 days preplant	3.0	4.0	0.6	0.7	0.0	5.3	7.3
Lorox 50W	0.2	0.4 lb	At planting	2.0	0.9	0.4	0.3	0.1	1.7	7.8
Lorox 50W	0.3	0.6 lb	At planting	6.3	0.0	0.0	0.0	0.0	0.0	5.3
RoNeet 6E	0.93	1.25 pt	At planting	0.0	2.2	1.0	0.6	0.1	3.9	9.8
			Pr>Treat	<0.001	0.007	0.013	0.003	<0.001	<0.001	0.005
			Pr>Block	0.041	0.186	0.453	0.269	0.735	0.741	0.577
			$LSD_{0.05}$	0.9	2.4	2.4	0.8	0.2	3.6	1.7

1 – Scale: 0=no crop damage to 10= crop dead; 2 – barnyard grass and lovegrass

PRODUCTION ON 80-INCH BEDS IMPACTS LETTUCE DROP DISEASE

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Lettuce drop: Lettuce drop is one of the most important and persistent diseases of lettuce and is well known to growers and pest control advisors who deal with this leafy green commodity. The pathogen is soilborne and survives in the ground as hard, black, resilient survival structures called sclerotia. Infection and disease development result in a soft, watery rot that will cause the plant to collapse and be unharvestable (Photo 1). Lettuce drop is caused by two distinct species of *Sclerotinia*, each having a different way of attacking the crop.

Two Sclerotinia species: *Sclerotinia minor* produces small (less than 1/8 inch wide) sclerotia, does not have a spore stage in nature, and can only infect lettuce when sclerotia in the soil germinate and directly infect crowns and taproots. *Sclerotinia sclerotiorum* can also directly infect lettuce from soilborne sclerotia. However, for this species a more important means of infection takes place above ground. Sclerotia near the surface of the soil can grow small mushroom-like structures (apothecia) that later produce ascospores. These spores fly in the air, can land on leaves of the lettuce plant, and cause above ground decay of the plant (called by some growers "aerial Sclerotinia"). In the coastal California agricultural region, *S. minor* is the most significant and important species on lettuce, even though *S. sclerotiorum* is also present and occasionally is found on lettuce. In contrast, in the San Joaquin Valley and desert county regions, *S. sclerotiorum* is much more prevalent on lettuce and *S. minor* is rarely found.

Changing to 80-inch beds: In recent years, the vegetable industry began to grow lettuce on wider beds to increase the number of plants per unit area and hence maximize yields relative to per acre costs. Rather than the traditional 40-inch center-to-center bed configuration with two rows of lettuce per bed top, lettuce is now commonly grown on 80-inch center-to-center wide beds with five, six, or more lettuce rows per bed top (Photo 2). Researchers wondered if this change in growing practices would have an impact on lettuce drop problems and if this would influence which *Sclerotinia* species would be found in coastal plantings. To investigate these possibilities, we conducted a multi-year field study in the Salinas Valley.

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Field experiments: Two sets of replicated field plots were set aside for these experiments. At both locations, the fields were prepared for lettuce production using standard commercial practices, with half of the plots at each site shaped into 40-inch beds and the remaining half fashioned into 80-inch beds. Lettuce was planted in 2 rows per 40-inch bed and in 5 rows per 80-inch bed. Subsequently, at one location the field was inoculated with sclerotia of *S. minor* while the second location received sclerotia from *S. sclerotiorum*. Different soil moisture levels were also incorporated into the experiments with high (watered twice a week), moderate (watered once a week) and low (watered once every two weeks) irrigation rates used for all combinations of bed width and *Sclerotinia* species (Table 1).

Impact of 80-inch beds: Lettuce drop disease caused by *S. minor* was significantly higher in the 80-inch beds (designated as W for "wide beds") compared to the 40-inch plantings (designated as N for "narrow beds") (Fig. 1). The wetter environment created by higher moisture levels also resulted in increased lettuce drop, with highest disease incidence occurring in plots that were watered twice a week (Fig. 1).

Results were similar for lettuce drop disease caused by *S. sclerotiorum*. Disease incidence was significantly higher in the 80-inch beds (W) compared to the 40-inch plantings (N) (Fig. 2). Highest disease incidence also occurred in plots that were watered twice a week (Fig. 2). All diseased plants in these plots were affected by airborne ascospores as evidenced by the above-ground leaf symptoms. In addition, field environments created by the experimental design had significant effects on the production of ascospore-producing apothecia fruiting bodies. The number of apothecia per square area was greatest in the 80-inch bed configurations and in plots receiving twice-a-week irrigations (Fig. 3).

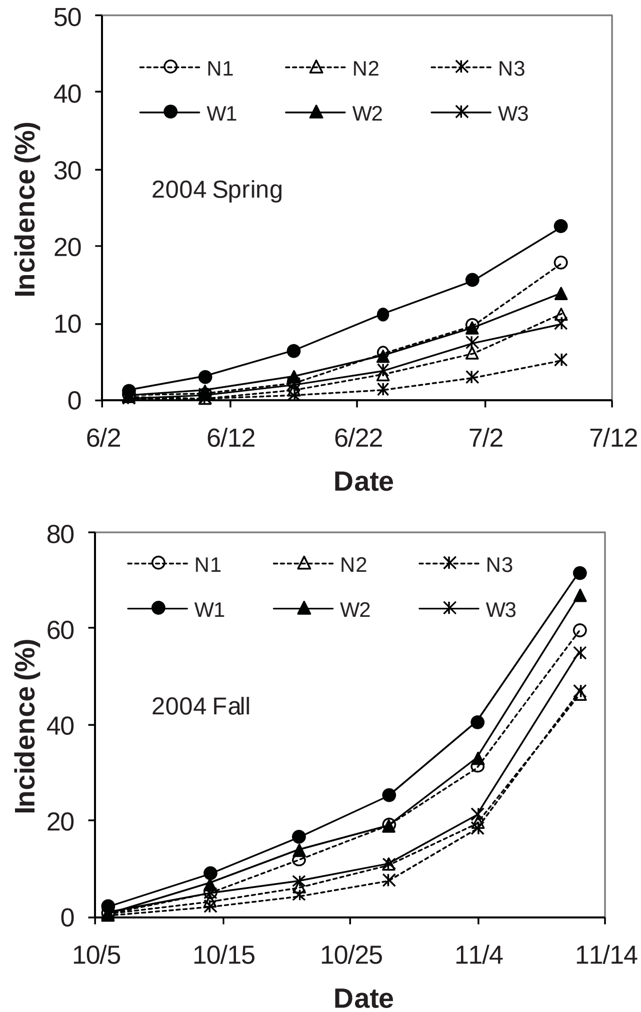
Conclusions and implications: Based on these studies, it appears that industry adoption of wider bed configurations in lettuce production could lead to increased incidence and yield loss from *S. minor* due to the higher soil moisture levels and slower drainage of water that occurs in the middle of 80-inch beds. An additional possibility is the rise of *S. sclerotiorum* as an increasingly important pathogen that could contribute to lettuce drop in coastal regions. Wider beds create protected, moist environments that enable apothecia and ascospores to be more readily produced. In seasons to come we may see increased lettuce drop on the coast caused by *S. sclerotiorum*.

Table 1. Field treatments comparing *Sclerotinia* species, bed configuration, and irrigation frequency

Sclerotinia pathogen	Bed configuration	Irrigation frequency
S. minor	40-inch	twice a week once a week once every two weeks
S. minor	80-inch	twice a week once a week once every two weeks
S. sclerotiorum	40-inch	twice a week once a week once every two weeks
S. sclerotiorum	80-inch	twice a week once a week once every two weeks

(Cont'd from page 10)

Fig. 1. Incidence (percent disease) of lettuce drop caused by *Sclerotinia minor* for spring and fall crops grown on 40-inch or 80-inch beds.

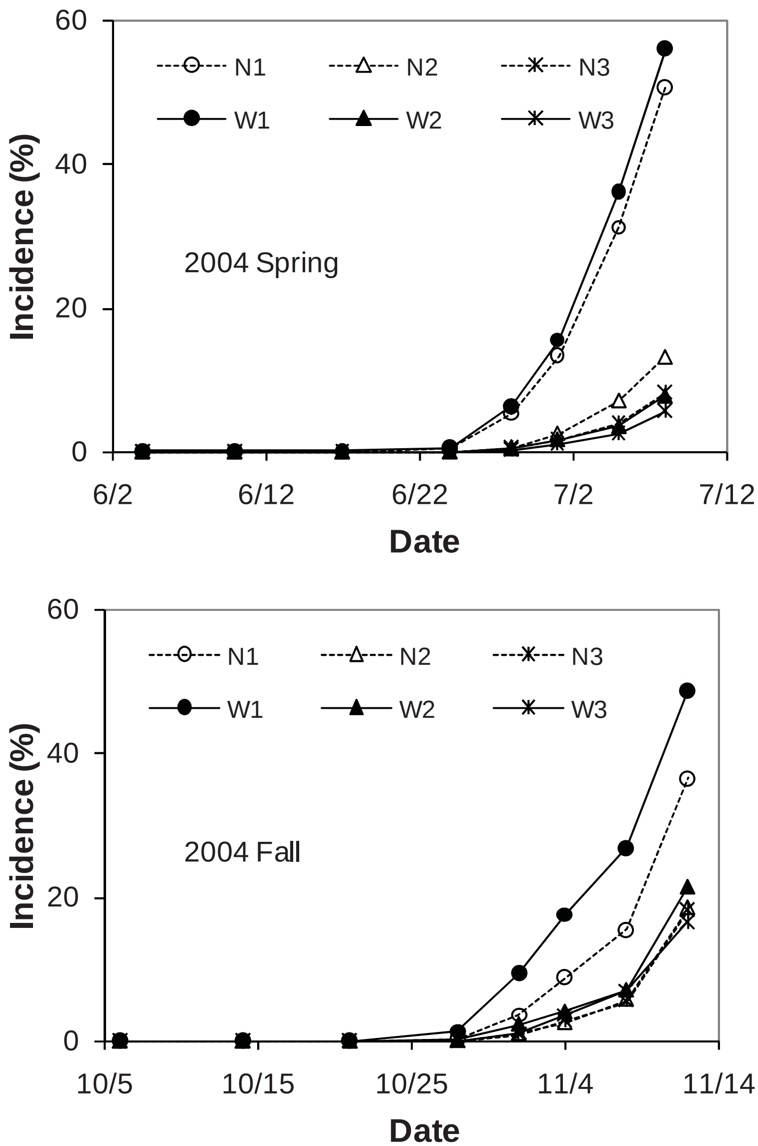


N = narrow beds (40-inch)
W = wide beds (80-inch)
1 = plots watered twice a week (high soil moisture)
2 = plots watered once a week (moderate soil moisture)
3 = plots watered once every two weeks (low soil moisture)

(Cont'd to page 12)

(Cont'd from page 11)

Fig. 2. Incidence (percent disease) of lettuce drop caused by *Sclerotinia sclerotiorum* for spring and fall crops grown on 40-inch or 80-inch beds.

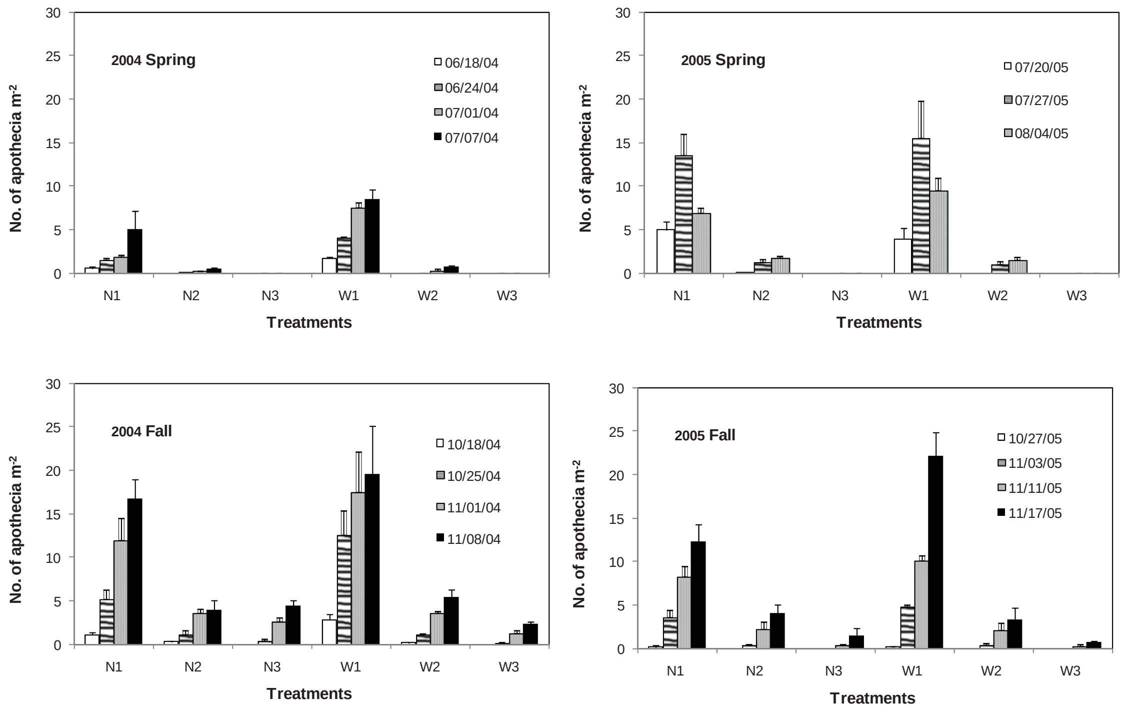


N = narrow beds (40-inch)
W = wide beds (80-inch)
1 = plots watered twice a week (high soil moisture)
2 = plots watered once a week (moderate soil moisture)
3 = plots watered once every two weeks (low soil moisture)

(Cont'd to page 13)

(Cont'd from page 13)

Fig. 3. Comparative numbers of apothecia produced by *Sclerotinia sclerotiorum* in 40-inch or 80-inch beds of lettuce.



N = narrow beds (40-inch)
W = wide beds (80-inch)
1 = plots watered twice a week (high soil moisture)
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3 = plots watered once every two weeks (low soil moisture)

All figures are from the following technical publication:
Wu, B. M., Koike, S. T., and Subbarao, K. V. 2011. Impact of consumer-driven changes to crop production practices on lettuce drop caused by Sclerotinia sclerotiorum and S. minor. Phytopathology 101:340-348.

Photo 1: Sclerotinia lettuce drop causes plants to collapse and be unharvestable.

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Photo 2: The industry now commonly uses 80-inch wide beds that result in more plants per acre.

University of California
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University of California Cooperative Extension

Automated Lettuce Thinner Field Demonstration

Thursday, May 26
9:00 to 11:00 a.m.
USDA Spence Research Station
1572 Old Stage Road (follow signs once on the ranch)

Topics:

- An automated lettuce thinner and weeder developed by the University of Arizona will be demonstrated on planted lettuce
- The machine uses a spray based system for thinning and weeding
- It can be used in both conventional and organic production systems
- There will be ample opportunity to watch the machine work and discuss it with the development engineers

Presenters

- Mark Siemens, Agricultural Engineer, University of Arizona
- Ryan Herbon, Agricultural Engineer, Mule Deer Automation, New Mexico
- Steve Fennimore, Extension Vegetable Weed Control Specialist, UC Davis
- Richard Smith, Vegetable Crop and Weed Science Farm Advisor, Monterey County

2.0 Continuing Education Credits have been approved
No registration fee
Refreshments will be served.
For more information call Richard at 759-7357.