Cooperative Extension • Monterey County

Crop Notes

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In This Issue:

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SPINACH DOWNY MILDEW: PREPARING FOR ANOTHER SEASON

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Introduction: Downy mildew is the most widespread and destructive disease of spinach grown in California and Arizona. Growers, pest control advisors, and other field personnel are very familiar with this challenge. Early symptoms consist of light green, irregularly shaped lesions or blotches on cotyledons and true leaves. These lesions later enlarge and turn bright yellow. With time, the lesions can become tan and dry; however, if wet conditions are present the tissue can become soft and rotted. Examination of the underside of the leaf, opposite the yellow or tan area, usually reveals the purple growth of the pathogen. Such sporulation can at times occur on the top leaf surfaces. If disease development is extensive, leaves can appear curled and distorted. Because the leaf symptoms and the purple sporulation are so characteristic, field diagnosis is usually readily accomplished. Downy mildew is easily differentiated from other leaf spot diseases of spinach such as Stemphylium leaf spot, Cladosporium leaf spot, and anthracnose.

Pathogen: Downy mildew is caused by *Peronospora farinosa* f. sp. *spinaciae*, which belongs in the oomycete group of organisms. Older references name the pathogen as *P. effusa*. *Peronospora farinosa* f. sp. *spinaciae* is a complex pathogen and consists of multiple races. Races are identified by testing their virulence on differential sets of spinach cultivars having various resistance genes. By the end of 2011, thirteen races have been characterized (Table 1), with races 11, 12, and 13 being the most commonly found during the 2011 season. Previous research, as well as our recent inoculation experiments, indicate that the spinach downy mildew pathogen infects only spinach and does not cause disease on closely related plants such as beet, Swiss chard, and weeds in the Chenopodium plant family (nettleleaf goosefoot, lambsquarters).

Disease cycle. Like most downy mildews, this pathogen requires cool, wet conditions for infection and disease development. The heavy canopy of densely planted spinach retains much moisture and creates ideal conditions for infection and disease development. Spores are dispersed in the air from plant to plant and field to field by winds and to a lesser extent splashing water. If favorable temperatures and leaf wetness are present, downy mildew can progress rapidly and result in significant disease. Resilient oospores have been detected on spinach seed and presumably can occur in leaf tissue. However, the role of oospores in disease epidemiology in California is uncertain.

Control. Use resistant cultivars, as this ideally is the most effective means of controlling spinach downy mildew. Historically, however, single gene resistance has been relied on to breed resistant cultivars. So when new races of the pathogen develop, cultivars with this type of resistance are readily infected and new sources of resistance must be found. The rapid occurrence of multiple new races during the past few years is of great concern to the spinach industry. Seed treatments that include effective fungicides such as metalaxyl can provide protection for a number of days following emergence. Subsequently, foliar applications of preventative fungicides will be needed

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if the spinach cultivar is not resistant to the downy mildew race present in the area. Fungicides allowed for use on organic spinach have not been found to be consistently effective. Before using any fungicide, check product labels and consult with your local Agricultural Commissioner's Office for information on California fungicide registrations and allowable usage.

International discussions: Our research team, in particular Jim Correll, is remaining connected with the international groups that are also concerned with this disease. The International Working Group on Peronospora (IWGP) on spinach met on February 1, 2011 in Gouda, The Netherlands to discuss various aspects of downy mildew on spinach including the global distribution of races, the identification of new ("deviating") strains of the pathogen, and the genetics of resistance. The group meets annually to discuss recent developments of downy mildew in spinach and evaluate criteria for the naming of new races.

Table 1. Spinach downy mildew races and year of detection.*

Race	Year Detected
Race 1	1824
Race 2	1958
Race 3	1982
Race 4	1990
Race 5	1996
Race 6	1998
Race 7	2004
Race 8	2004
Race 9	2004
Race 10	2004
Race 11	2008
Race 12	2009
Race 13	2010
UA4410	2010
UA4711	2011

*UA4410 and UA4711 appear to be deviating strains and therefore are not yet officially numbered.

Downy mildew results in yellow and tan lesion on leaves, which results in significant loss of spianch quality.

MECHANICAL WEED CONTROL TOOLS FOR VEGETABLES

Richard Smith, University of California Cooperative Extension, Monterey County

The development of improved cultivation technology for row crop production has been an active area of research, and has made significant progress in recent years. Currently, standard cultivation removes weeds from the majority of the bed using sweeps, knives, coulters and blades. Typically a 4-inch wide band is left around the seedline. Weeds in the uncultivated band are typically removed by hand, and the density of weeds there, determines how laborious and costly hand weeding will be.

Technology for mechanical cultivation of the seedline falls into two categories: 1) blind and 2) computer assisted cultivators. Implements used for blind cultivation are not guided by a person or machine. They are designed to be able to hit crop plants without significant damage, but yet remove young weed seedlings. Examples of this type of technology include 1) finger weeders, 2) torsion weeders and 3) various spring tine weeders (Photos 1-3). Finger and torsion weeders are useful in row crop scenarios and are designed for use on transplanted vegetables or large seeded vegetables such as bean and corn. Spring tine weeders are mostly used in field crops such as small grains. These devices are designed to take advantage of a size differential between the transplanted crop and newly emerged weeds. Cultivation is often done 1-2 weeks following transplanting. In our studies, these weeders supplement the action of standard cultivation and have the ability to reduce the time it takes to subsequently hand weed vegetables (Table 1).

Camera and computer assisted weeders have the ability to detect and distinguish crop plants in the seedline. An image of the seed row is captured by the camera and is then analyzed by the computer, which determines the location of crop plants in the seedline. Current technology uses the difference in size and color between the crop and the weeds, to distinguish the crop from weeds. These mechanical weed control machines were designed primarily for use on transplanted crops because the crop plants are initially larger than the weeds. Once the machine recognizes the crop plants it activates a weed removal implement. The implements that have been proposed or that are used by commercial units include swinging, spinning, or opening and closing blades, or other techniques such as flaming and the use of timed chemical sprays. The key for success is for the machine to take out as many weeds in the seedline as possible while not damaging crop plants. Currently, there are two notable computer-assisted mechanical weed control machines either on the market or close to being commercialized for row crop production.

In 2009 and 2010 we evaluated a commercially available unit, the Tillet Weeder, which is fabricated in England (Garford Corp, http://garford.com/). This computer-assisted mechanical weed machine uses a spinning round-blade with a notch cut out of one side. The blade travels in the seed line removing weeds, but when it encounters a crop plant, it spins around it by placing the plant in the notch (Photos 4 & 5). We evaluated the efficacy of this machine for weed control, crop safety and impact on hand weeding in trials on leafy green vegetables as compared to standard cultivation with knives and sweeps. In one trial with transplanted radicchio, the Tillet removed 64% of the weeds in the seed line and reduced subsequent hand-weeding time by 3.7 hours per acre (Table 2). The mechanical action of the Tillet in this trial did not reduce the stand or the yield of radicchio in this trial. In a subsequent trial in direct-seeded lettuce the Tillet was used to both thin and weed direct seeded lettuce. It reduced weed densities by 79% and hand-thinning times by 51% compared to the standard cultivation (Table 3); in this trial there was no significant differences in the yield of lettuce, but there were fewer plants per acre and a trend that indicated lower yield; this finding emphasized the need for great care in using this type of machine to minimize the impact of the blades cutting below the soil surface and damaging the roots of young crop seedlings.

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In May, 2011 we held a field day demonstrating a prototype of an automated weeder/thinner that is soon to be commercially available. The machine was developed by the University of Arizona and Mule Deer Automation (New Mexico). Instead of using a blade to remove weeds as in the Tillet cultivator, this machine sprays a chemical in a band application to remove unwanted plants. Various chemicals can be used in this machine such as acid or salt-based fertilizers (e.g., phosphoric acid or ammonium nitrate [see Photo 6]) or herbicides such as paraquat or pelargonic acid (Scythe®); organic herbicides can also be used. We are hoping to be able to test this machine in the Salinas Valley this coming growing season.

Other technology that is being deployed include alternative detection systems such as the use of lasers or x-rays to detect the stem of crops such as tomatoes which then activates a weed removal blade. The development of plant maps by use of real time kinematic (RTK) global positioning systems (GPS) is being used in field crops. This technology allows for closer and more precise guidance of standard cultivators. This technology has not been applied to vegetable production to any extent in our area, but is being researched as a technique to someday guide in-seedline cultivators.

Technology will continue to develop and improve in the coming years. Computer-assisted mechanical weed control machines can provide an alternative option for weed control in vegetable crop production. These technologies do not entirely replace the need for hand labor, but they can make subsequent hand weeding operations less costly and more efficient.



Photos 1-3. Blind cultivation weeders: Finger weeders on left, torsion weeders in middle and spring tine weeder on right.


Photos 4 & 5. The Tillet Weeder is a commercially available mechanical weed control machine that uses computer technology and a spinning blade to remove weeds. On left: The disc-shaped cultivation blades are lifted up so you can observe the notched cut-out that allows the blade to spin around crop plants. On the right: Thinning lettuce.

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Photo 6. Lettuce thinned and weeded with the University of Arizona/Mule Deer Automation prototype. The unwanted plants were treated with ammonium nitrate (AN20) fertilizer (in dark gray rectangular areas) and will die in a matter of days.

Table 1. 2010 finger weeder trial. Weed removal by cultivation treatments, weeding time and yield evaluation (count of heads remaining in field after harvest operation)

Cultivation treatment	Percent weeds removed by cultivation treatments						Weeding time	Unharvested heads
	Purslane	Night-shade	Shepherd's Purse	Malva	Sow thistle	Total weeds	hr/A	heads/A
Standard	49	50	72	50	70	48	8.7	6,802
Standard + Finger weeder	59	33	99	87	80	81	4.5	9,440
Pr>Treat	0.826	NA	0.015	0.368	0.272	0.024	0.270	0.097
Pr>Block	0.814	NA	0.630	0.500	0.249	0.953	0.390	0.177
$LSD_{0.05}$	NS	NA	14	NS	NS	26	NS	NS

Table 2. 2009. Effect of the Tillet Weeder on weed control, hand-weeding time and crop yield in transplanted radicchio. Weed counts pre- and post- cultivation were made in the seed line only - standard cultivation did not remove weeds in the seed line.

Treatment	Pre-cult weed counts Aug 5 Plants/plot	Post-cult weed counts Aug 7 Plants/plot	percent weed control	Hand weeding Aug 7 hrs/A	Hand weeding Aug 14 hrs/A	Total weeding time hrs/A	Stand count Aug 7 plant/A	Stand count Oct 7 plant/A	Yield mean head Oct 7 lbs/head	Yield total weight Oct 7 tons/A
Standard	40.3	NA	NA	8.4	6.9	15.3	31,245	29,628	0.84	12.4
Tillet	47.6	16.9	64	5.9	5.7	11.6	30,721	29,119	0.88	12.7
LSD 0.05	NS	NA	NA	0.7	0.8	1.3	NS	NS	NS	NS

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Table 3. 2010. Effect of Tillet Weeder on thinning of lettuce and weed removal and yield of direct seeded lettuce

Cultivation Treatment	June 14	June 15			June 14	June 15		August 5	
	Prethin lettuce stand count plants/A	Post Tillet[1] lettuce stand plants/A	Post hand thin[2] lettuce stand plants/A	Hand Thinning[3] time hr/A	Prethin[4] weed count weeds/A	Post thin[4] Tillet weed count weeds/A	Percent weed removal	Crop biomass tons/A	Mean head weight lbs
Standard	115,473	NA	30,642	13.2	1243	---	---	28	1.81
Tillet	118,580	39,374	27,143	6.4	948	196	79	24	1.78
Pr>F treat	0.063	NA	0.077	0.002	0.464	---	---	0.079	0.688
Pr>F block	0.131	NA	0.364	0.171	0.865	---	---	0.9	0.900
LSD 0.05	NS	NA	NS	1.9	NS	---	---	NS	NS

1 – Stand count following the Tillet machine only; 2 – Stand count following the Tillet and hand thinning; 3 – hand thinning time comparison of stand with and without Tillet prethinning; 4 – Weed counts in the seedline only before and after the Tillet a pass of the Tillet machine.

For further information on automated cultivators for vegetable crops:

Blind Cultivators

- Buddingh Weeder Co. (finger weeder and others) http://www.buddinghweeder.com/
- Einboch (spring tine weeder) http://www.einboeck.at/index.php?lang=en
- Frato Machine Import (torsion weeder) http://www.frato.nl/UK/torsiewieder-UK.htm
- Kovar (spring tine weeder) http://www.kovarsales.com/weederharrow.html
- Kress Company (finger weeder) http://www.kress-landtechnik.de/
- Red Dragon (flame weeder) http://www.flameengineering.com/Agricultural_Flamers.html

Computer Assisted Cultivators

- Garford Agricultural Equipment http://www.garford.com/index.html
- Frank Poulsen Engineering http://www.visionweeding.com/Products/Intra%20Row%20Weeding/ROBOVATOR.htm
- Ramsey Highlander http://www.ramsayhighlander.com/products/spinach-spring/spinach.htm
- University of Arizona (Mark Siemens) http://extension.arizona.edu/programs/specialty-crops-mechanization
- University of California, Davis (David Slaughter) http://bae.engineering.ucdavis.edu/pages/faculty/slaughter.html and http://baesil.engineering.ucdavis.edu/BAESIL/AutoWeedControl.html (videos of the implement)

UC Cooperative Extension-Santa Clara, San Benito & Monterey Counties

2012 Pepper Production Meeting

Wednesday, March 14, 2012

8:00 a.m. - 12:15 p.m.

Gilroy Grange Hall (8191 Swanston Lane)

7:45 **Registration**

8:15 **Welcome & Introductions** – *Kevin O'Day, Santa Clara County Ag Commissioner*

8:25 **Recycling Plastic and Drip Tape—a Growers View-Update**
Aziz Baameur, Small Farms/Specialty Crops Advisor, Santa Clara County

9:45 **Thrips as Virus Vectors- Update**
Steve Koike, Entomology Farm Advisor, Monterey County

9:15 **Fertility Projects in Pepper Crops- Update**
Aziz Baameur, Small Farms/Specialty Crops Advisor, Santa Clara County

9:40 **New Layby Weed Control Strategies**
Richard Smith, Vegetable Crop and Weed Science Farm Advisor, Monterey County

10:10 **Break**

10:30 **Powdery Mildew Biology- Update**
Steve Koike, Plant Pathology Farm Advisor, Monterey County

11:00 **Irrigation Evaluations of Santa Clara County Pepper Production.**
Michael Cahn, Irrigation and Water Resources Farm Advisor, Monterey County

11:25 **Metam Label Regulation update**
Kristian Barbau- Santa Clara County Ag. Commissioner's Office

11:55 **General Discussion**

12:20 **Adjourn.**

2 continuing education credits have been requested-more information at the door

To register please call Gretchen at 408-282-3111

Please call ahead for special accommodations.
For more information call *Aziz Baameur 408-282-3127* or *Richard Smith 831-759-7357*
For Spanish translation, call *Maria de la Fuente*, Farm Advisor San Benito County *831-637-5346*

Cosponsors: ❖ **Farm Bureau** ❖ **Agricultural Commissioner's Office** ❖ **California Pepper Commission**

2012 Reunión de Productores de Chile

Miércoles, Marzo 14, 2012

8:00 a.m. - 12:15 mediodía

Gilroy Grange Hall (8191 Swanston Lane)

7:45 Registro

8:15 Bienvenida & Introducción – *Kevin O'Day, Comisionado de Agricultura, Condado de Santa Clara*

8:25 Reciclaje de Plástico y Cintillas de Irrigación— Reporte de los productores
Aziz Baameur, UCCE Condado de Santa Clara, Asesor de Granjas Pequeñas.

9:45 Actualización sobre Thrips como Vectores de Virus
Steve Koike, UCCE Condado de Monterey, Asesor Agrícola de Fitopatología.

9:15 Actualización de proyectos de Fertilización en Cultivos de Chile
Aziz Baameur, *UCCE Condado de Santa Clara, Asesor de Granjas Pequeñas.*

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9:40 Nuevas Estrategias de Control de Malezas antes del cierre del dosel/follaje ("*Layby*")
Richard Smith, UCCE Condados de Monterey, Asesor Agrícola de Cultivos Vegetales, Nutrición Vegetal, y Ciencias de la Maleza.

10:10 Receso

10:30 Actualización sobre la Biología de la Cenicilla Polvorienta
Steve Koike, UCCE Condado de Monterey, Asesor Agrícola de Fitopatología.

11:00 Evaluaciones de Irrigación de la Producción de Chile en el Condado de Santa Clara
Michael Cahn, UCCE Condado de Monterey, Asesor Agrícola de Riego y Recursos de Agua.

11:30 Actualización de la Etiqueta de Metam-Sodio
Kristian Barbau- Biólogo de la Oficina del Comisionado de Agricultura del Condado de Santa Clara.

11:50 Discusión General

12:15 Clausura

Créditos de Educación Continua.

Para inscriberse, , llame al 831-637-5346 x 13

Por favor llámenos si necesita acomodo especial, o mayor información:
Aziz Baameur 408-282-3127* o *Richard Smith 831-759-7357

Para traducción al Español contacte a *Maria de la Fuente*,
UCCE Condado de San Benito, Asesora Agrícola *831-637-5346 x 13*

Co-Patrocinadores: ❖ Farm Bureau ❖ La oficina del Comisionado de Agricultura ❖ California Pepper Commission