University of California Cooperative Extension

Vegetable Notes

Tulare and Kings Counties

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Open for Business *(but it's not Business as Usual)*

UCCE Fresno County Vegetable Crops Research & Education Program

Shannon Mueller, Agronomy Farm Advisor, Fresno County
Jeanette Sutherlin, County Director, Fresno County

Vegetable crops rank in the top 10 leading crops in Fresno County with a total gross return of $865,452,000 (2002 Fresno County Crop and Livestock Report). UC Cooperative Extension has always maintained an active research and education program to support a wide variety of commercial vegetable crops in Fresno County. Farm Advisor Don May spent 36 years on the West Side developing information for area growers. Following his retirement, Jesús Valencia transferred to Fresno County from Stanislaus County in 2000 to continue activities with processing tomatoes, melons, and other vegetable crops.

With the recent resignation of Jesús Valencia, UCCE Fresno County has developed a plan to maintain a research and education program serving local clientele. The current University of California budget situation prevents us from opening this farm advisor position for immediate academic recruitment. However, authorization has been granted to begin a search for a staff research associate (SRA) to continue vegetable crops research programs under the direction of Agronomy Farm Advisor, Shannon Mueller. The position vacancy announcement and application for the SRA position are available at *cefresno.ucdavis.edu*.

Michelle Le Strange, Farm Advisor in Tulare and Kings Counties, will also work with the SRA to coordinate research and education activities for processing tomatoes. Shannon Mueller will coordinate activities for melons (specifically cantaloupe and watermelons), onions, and garlic. This year we plan to focus on variety evaluations and a limited number of pest and/or disease management studies, but will expand the program as opportunities present themselves.

Industry support of the vegetable crops program has always been strong. We appreciate your continued support of ongoing research and would like to discuss research needs and accommodate specific interests when possible. More importantly, we encourage your assistance as we begin the search for a Staff Research Associate. If you are interested in the SRA position, or know of someone looking for an exciting opportunity in the vegetable crop industry, check the Fresno county website, or call Shannon for more information.

If you have any questions, concerns, or comments, please call Shannon Mueller at 559-456-7261 or Michelle Le Strange at 559-685-3309, Ext. 220.

Recent Disease Developments in Lettuce

Steven T. Koike, Farm Advisor, Monterey County

A number of recent disease developments have occurred on lettuce grown in California. Growers, PCAs, and other field personnel will need to be able to recognize some new diseases that have been detected and documented on the crop. Other, more familiar and established diseases have undergone changes in either the pathogen or distribution of the problem; again, the industry should keep informed on such changes because new information might influence disease management decisions.

New disease of romaine

Phoma basal rot was first reported as a problem on lettuce production in the United Kingdom in the early 1990s. More recently (since 1999), this disease has caused significant losses in some romaine fields in coastal California. Above ground symptoms are similar to those caused by lettuce drop and gray mold diseases and consist of wilting and yellowing of lower leaves, one-sided growth of plants, overall stunting, and eventual plant collapse. However, in contrast to these other crown rots, there is no visible fungal growth at the crowns of infected plants. Rather, Phoma basal rot causes distinct, dark brown to black, sunken cavities to develop at the crown and upper tap root tissues. Lesions can extend deep into the crowns and roots, resulting in extensive weakening of the plant structure; such plants can easily be broken off at the ground level. In greenhouse grown lettuce in Europe this disease also causes circular, dark gray to black leaf spots that can expand up to 1 inch in diameter, though such spots have not yet been observed in California.

The causal agent of Phoma basal rot is *Phoma exigua*, a soilborne fungus. Most lettuce types show some susceptibility, though romaine cultivars are the most sensitive to damage. Because this is a new disease in California, limited information is available regarding control measures. Avoid growing romaine in fields having a history of the disease. Preliminary field trials indicate some currently unregistered fungicides can provide good control.

Lettuce dieback disease in Huron

Lettuce dieback, a recently described soilborne virus disease, was first documented in coastal California and later in Arizona. However, the disease has now been confirmed in the Huron area. The pathogen was initially identified as *Tomato bushy stunt virus* (TBSV). This virus causes severe stunting of lettuce with mature, diseased plants failing to develop past the 8 to 10 leaf stage. Extensive chlorosis develops on the outermost leaves while younger, inner leaves often remain dark green in color, but may become rough and leathery in texture. The yellow outer leaves usually develop necrotic (dead, brown) spots that expand into extensive areas of dead tissue. Romaine cultivars consistently show the most serious symptoms, several leaf and butterhead lettuce cultivars are also susceptible, but commercial iceberg cultivars remain symptomless.

Symptoms may vary due to age of plants when infected, time of year, environmental conditions, and cultivar involved. Molecular analysis indicates that the TBSV-like viruses isolated from California lettuce are substantially different from other strains of TBSV. Because of these genetic differences, a new name has been given to the lettuce dieback pathogen: *Lettuce necrotic stunt virus* (LNSV). LNSV (and also TBSV) is unusual in that it has no known invertebrate (insect or nematode) or fungus vector to carry it to its plant host. Rather, the virus resides in soil and water, and is spread by river water, irrigation runoff, flood waters, and infested soil. This characteristic is consistent with the occurrence of the disease in the Salinas Valley, as most affected fields are near the Salinas River or have been flooded in the past few years. At least one field became infested when silt from an adjacent ditch was dredged up and spread onto the field.

To manage lettuce dieback, crop rotations should be arranged so that romaine and other susceptible cultivars are not planted in infested fields having a history of the problem. Resistant cultivars will likely be the best method of managing the disease, and promising sources of resistance have been identified. New resistant romaine cultivars should soon be available.

Fusarium wilt now on the coast

The first report indicating that lettuce was susceptible to Fusarium wilt was made in 1960 in Japan. The disease was later found in the USA in the early 1990s (Huron area in California) and late 1990s (Arizona), and most recently was reported in Europe (Italy) in 2002. However, in 2002 we found Fusarium wilt for the first time in coastal lettuce. The disease occurred only in limited areas in one field, but in those areas approximately 35 to 50% of the lettuce was unharvestable. Fusarium wilt causes vascular tissues to turn red or brown. In older plants, leaves turn yellow, wilt, and become necrotic. The taproot may develop a hollow cavity. Plants are usually stunted and may fail to form heads. Fusarium wilt symptoms can sometimes resemble those caused by ammonium toxicity and

Verticillium wilt, though Verticillium tends to cause vascular discoloration that is blacker.

The cause of Fusarium wilt of lettuce is *Fusarium oxysporum* f. sp. *lactucae*. The pathogen morphology and colony characteristics are similar to other *F. oxysporum* fungi. Inoculation experiments indicate that the fungus appears to be host specific to lettuce, and that lettuce is not susceptible to other *forma speciales* of the *F. oxysporum* group. Currently, three races of this pathogen (1, 2, and 3) are known to exist.

Changes in downy mildew

Downy mildew, caused by *Bremia lactucae*, is a familiar disease that has been affecting lettuce for many years and is the most important foliar problem on this crop. Downy mildew results in light green to yellow angular lesions on the leaves. White fluffy growth of the pathogen develops primarily on the under sides of these spots. With time the lesions turn brown and dry up. Older leaves usually exhibit symptoms first; such leaves that have lesions and are in contact with the soil can become soft and rotted due to secondary decay organisms. On rare occasions the pathogen can cause systemic infections that result in dark discoloration and streaking of internal vascular and pith tissues.

Bremia lactucae is well known for its ability to change. Shortly after the fungicide Ridomil was registered and used regularly on lettuce, strains developed insensitivity to the product and were no longer controlled by the chemical. Recently, strains in coastal California have been found to be insensitive to the fungicide Aliette. Laboratory experiments indicate that variation exists in the degree of insensitivity. Some isolates will continue to grow and sporulate on lettuce treated with twice the labeled field rate (10 lb/acre) for Aliette, while others show intermediate levels of such insensitivity. Yet other isolates remain sensitive to the product. Field personnel should note if downy mildew disease continues to be serious despite timely Aliette applications. Such a development might indicate the presence of insensitive strains.

The downy mildew pathogen is also noted for its diverse genetic strains, or pathotypes, in California. During any one season, a series of *B. lactucae* pathotypes may exist in all lettuce producing regions. Coastal field surveys dating back to 1982 illustrate that the downy mildew population is a quite dynamic ion response to the deployment of resistant lettuce cultivars (see table below for data since 1995). In the mid- to late-1990s pathotype CA V was prevalent with pathotypes IIA, IIB, III, and IV being a part of the population. However, by the 2000s, the prominent pathotypes were CA VI and VII, with CA V perhaps declining and the other pathotypes not being detected.

Novels are the downy mildew pathogens that are genetically distinct from the designated, numbered pathotypes. Novels are isolates that usually are infrequently encountered and may be transient and not survive for more than a few seasons. If a particular novel becomes established in the population, that strain is assigned a pathotype number.

Growers should be aware of the diversity of *B. lactucae* and remember that cultivars will vary in their resistance to pathotypes and novels in California. *(Steve Koike thanks Richard Michelmore and Oswaldo Ochoa for their help with this article.)*

Diversity of lettuce downy mildew in coastal California[1]

Percentages per year of California pathotypes

Year[2]	IIA	IIB	III	IV	V	VI	VII	Novels[3]
1995	5	15	6	15	26	0	0	33
1996	1	4	3	14	29	0	0	49
1997	0	5	0	0	51	0	0	44
1998	1	0	0	0	49	0	0	50
2001	0	0	0	0	17	29	29	25
2002	0	0	0	0	0	22	39	39

[1] Table adapted from R. W. Michelmore, Lettuce Board Annual Reports. Note that these numbers are based on samples, so that the diversity of all populations in the state may or may not be represented by these research statistics.

[2] The 1995 to 1997 data are based on systematic sampling. The 1998 to 2002 data are derived from samples submitted by growers and advisors. The 2001 and 2002 collections comprise significantly fewer samples than in previous years.

[3] Novels are virulence phenotypes that are distinct from the accepted pathotype categories, usually are not found in great numbers, and have not yet been assigned to a pathotype designation.

Efficacy of Fungicides for Control of Downy Mildew of Lettuce, 2003

James Farrar, Plant Science Dept, CSU Fresno & Jesús Valencia

Field Trial: An evaluation of fungicides for control of downy mildew of lettuce was conducted at the University of California Westside Research Station near Five Points, California. On December 3, 2002 'Blanco' iceberg lettuce seed was sown in two lines per 40-inch bed on Panoche clay loam soil. Each plot consisted of one bed, 30-feet long. Experimental design was a randomized complete block with four replications per treatment. The experiment was sprinkler irrigated to establish the stand and furrow irrigated thereafter.

Treatments: Plots were treated every 7 days starting on January 21 and continuing until March 6. Fungicides were applied using a Maruyama MS068 motorized backpack sprayer with a single nozzle wand. Disease severity was rated as the percentage of leaf area diseased on 10 arbitrarily selected whole plants per plot. Plots were harvested on April 10 and number of marketable (harvested) heads, total weight of marketable heads, number of undersized (cull) heads, and total weight of undersized heads was recorded.

Table of Results

	Average % Diseased [y]		Harvest weight	Cull weight
Fungicide and (rate/A)[z]	**Mar 27**	**Apr 3**	**(lbs)**	**(lbs)**
Untreated check	9.3	19.3	32.1	33.5
Quadris 15 fl.oz.	1.7	22.1	55.3	19.8
Acrobat 50WP (0.4 lb) + **Maneb** 75DF (2 lb)	1.2	15.9	60.5	30.5
Acrobat 50WP (0.4 lb) + **Aliette** 80WDG (5lb) **alt w/** **Acrobat** 50WP (0.4 lb) + **Maneb** 75DF (2 lb)	0.6	4.3	67.5	19.8
Cabrio (1lb)	1.4	20.0	54.6	28.6
Cabrio (1lb) **alt w/** **Acrobat** 50WP (0.4 lb) + **Maneb** 75DF (2 lb)	1.2	9.25	67.6	27.4
LSD (P=0.05)[x]	**2.3**	**11.77**	**18.7**	**9.2**

[z] alt w/ = alternate with
[y] Percent leaf area diseased rated on whole plant basis for 10 plants per plot.
[x] Analysis of variance followed by Fisher's protected least significant difference (LSD) was calculated.

Summary: Evaluations in February and early March indicated that all fungicide treatments resulted in equivalent disease control and significantly reduced disease compared to the untreated check. Therefore, the last fungicide applications were on March 6 and disease evaluations were continued weekly in order to examine the longevity of control. There were no significant differences between fungicide treatments until March 27.

In general, alternating fungicides between applications resulted in longer lasting disease control and the greatest weight of marketable heads. The extended disease control of alternated applications may give growers greater flexibility in harvest date scheduling and will guard against resistance development in the pathogen. No phytotoxicity was observed from any of the fungicide treatments.

EBDC Fungicide CORRECTION & CLARIFICATION

In the April 2003 newsletter there was an article entitled "Developing an Anti-resistance Strategy Against Fungal Pests by Understanding Fungicide Classes and Modes of Action." The article emphasis was on tomatoes, but the anti-resistance strategies apply to many crops. One of the recommendations suggested for delaying pest resistance was the use of tank mixes to control a single pest.

Several points should be made for clarification purposes: In general, a broad-spectrum fungicide is tank mixed with a systemic fungicide for the control of tomato fungal pests. Two of the most important multi-site inhibitors used in tomato production are mancozeb and maneb. These compounds belong to the ethylenebisdithiocarbamate (EBDC) chemical class. The EBDCs are known carcinogens and air contaminants.

Review of the EBDCs is underway and their eligibility for re-registration will be determined in the near future. The loss of the EBDCs is being predicted by many. This is based on the regulatory actions taken on other, already reviewed, toxic compounds and the strong encouragement by regulatory agencies for reduced-risk pesticide research and development.

When asked about the future status of the EBDCs, CDPR would not speculate. However, Mike Lees, a representative of Dow AgroSciences, states that, according to their federal regulatory manager, mancozeb will not be lost and there will be no major changes in its registration. Let's hope this is true for the other EBDCs as well.

Jan Mickler, Farm Advisor, Stanislaus County

Comparison of Fungicides for Control of Downy and Powdery Mildew on Iceberg Lettuce, 2003

Tom Turini, Farm Advisor, Imperial County

Diseases that attack leaves can cause economic losses to lettuce crops throughout California. Powdery and downy mildew can be found on lettuce throughout California. However, the frequency and severity of economic damage caused by each of these diseases differs between production areas.

Powdery mildew, caused by *Erysiphe cichoracearum*, may appear in lettuce fields throughout California, but it is generally more damaging in the desert than in the costal production areas or in the Central Valley. A white, ashy, superficial growth on the upper and lower leaf surfaces characterize this disease. It tends to be more severe on plants as they near maturity. Powdery mildew spores (conidia) are borne in un-branched chains. The spores can be carried long distances on air currents. Temperatures between 65^{o} and 77^{o}F are optimum for spore germination. Humidity over 85 % is required for infection, fungal growth and sporulation.

Downy mildew of lettuce, caused by *Bremia lactucae*, can be devastating when weather conditions favor disease development. This disease is characterized by angular yellow areas that are bound by veins appear on upper leaf surfaces, the corresponding lower leaf surface may be covered with white downy fungal growth. Under a 10x hand lens, it is apparent that the white growth consists of branched structures (sporangiophores), which are diagnostic for downy mildew. Sporulation is favored by daily highs between 50 and 77 ^{o}F, while light is low, and humidity is near 100%. When night temperatures are over 60 ^{o}F, sporulation is rare.

Fungicide Field Study: Fungicide efficacy against downy and powdery mildew on lettuce was compared in a study conducted at the University of California Desert Research and Extension Center on a Meloland clay loam. Beds were spaced 40 in. center to center. On 20 November 2002, 'Coyote' iceberg lettuce was sown in two seed lines per bed and irrigated. Plants were thinned to 12 in. between plants. The experimental design was a randomized complete block with five replications. Each fungicide, was applied over 25 feet of two beds. Plots were separated by two untreated planted rows. On 16 February, 2 and 13 March, materials were applied in 30 gallons of water per acre with a CO_2 pressurized backpack sprayer at 30 psi. A 2-nozzle spray boom was used with Teejet 8002 flat fan nozzles spaced 20-inches apart.

On 20 March, the number of downy mildew lesions per plant on each of 10 plants per plot was recorded. On 28 March, powdery mildew severity was rated on a scale of 1-5. **Results are presented in Table 1.**

Downy mildew disease pressure was high and few materials held the disease below a level that would have caused economic damage. Maneb 75DF and treatments containing Maneb 75DF and Cabrio EG tank mixed with Acrobat 50WP provided good control.

Powdery mildew severity levels were sufficient for treatment differences to be obvious. Under the conditions of this study, Microthiol Special 80W with or without Maneb 75DF, Quitec, BAS 516, Cabrio EC with or without Acrobat 50WP and Flint 50WDG provided excellent control of powdery mildew.

The fungicides that are effective against one of these pathogens typically have little effect on the other. Therefore, the ability to distinguish downy and powdery mildew is critical for anyone who is recommending treatment for these diseases. The most reliable method of distinguishing the two is by examining the spores. Powdery mildew spores are borne in un-branched chains while downy mildew spores are borne on branched structures.

Table 1. Fungicide activity against downy mildew on 'Coyote' iceberg lettuce at Holtville, CA.

Treatment	Rate/A	Downy mildew (lesions/plant)[w]	Powdery mildew (rating)[x]
Untreated		67.2 ab[y]	2.9 a
Curzate 60DF + **Maneb** 75DF	5.0 oz + 2.0 lb[z]	3.5 d	1.7 bc
Maneb 75DF	2.0 lb	5.7 d	2.5 ab
Curzate 60DF + **Maneb** 75DF	5.0 oz + 1.5 lb	9.0 d	2.7 a
Maneb 75DF + **Microthiol Special** 80W	1.5 lb + 6 lbs	10.8 d	0.0 d
Cabrio EG + **Acrobat** 50 WP	16.0 oz + 6.4 oz	14.7 d	0.1 d
Quadris 2.08F	15.4 oz	41.2 c	1.0 c
Cabrio EG	16.0 oz	54.6 b	0.1 d
DPX-KP481 50WG	8.0 oz	65.8 ab	2.3 ab
Microthiol Special 80W	6 lbs	65.8 ab	0.0 d
Curzate 60DF	5.0 oz	66.8 ab	2.6 a
Quintec (250g/L)	4.0 fl oz	69.9 ab	0.0 d
BAS 516	(1.45 lb)	71.4 ab	0.0 d
Quintec (250g/L)	6.0 fl oz	77.9 a	0.0 d
Flint 50WDG	1.5 oz	77.9 a	0.1 d
DPX-KP481 50WG	12.0 oz	78.0 a	1.4 c

[w] On 20 March, the number of downy mildew lesions per plant on each of 10 plants per plot were recorded.
[x] On 28 March, powdery mildew severity was rated according to the following scale on each of 10 plants per plot: 1 = no powdery mildew observed; 2 = powdery mildew on lower wrapper leaves only; 3 = powdery mildew on upper wrapper leaves; 4 = powdery mildew on cap leaf; 5 = extensive powdery mildew on the entire plant.
[y] Within the same column, means followed by the same letter do not differ significantly as determined by Student-Newman-Keul's Multiple Range Test ($P \leq 0.05$).
[z] Materials separated by a "+" were tank mixed.

Sampling for Garden Symphylans in Vegetable Crops

Bill Chaney, Farm Advisor, Monterey County

In recent cropping seasons, very small soil pests, called garden symphylans, have caused increasing concern for some vegetable producers. These tiny white pests have been making stand establishment difficult in lettuce, pepper, spinach and some other direct seeded and transplanted crops. Garden symphylans (also called garden centipedes, or simply symphylans) are not insects; they are in their own arthropod class, Symphyla. When full grown they are not more than 0.5 inch long, have 15 body segments and 11 to 12 pairs of legs. They are slender, elongated, and white with prominent antennae and move quite quickly when disturbed.

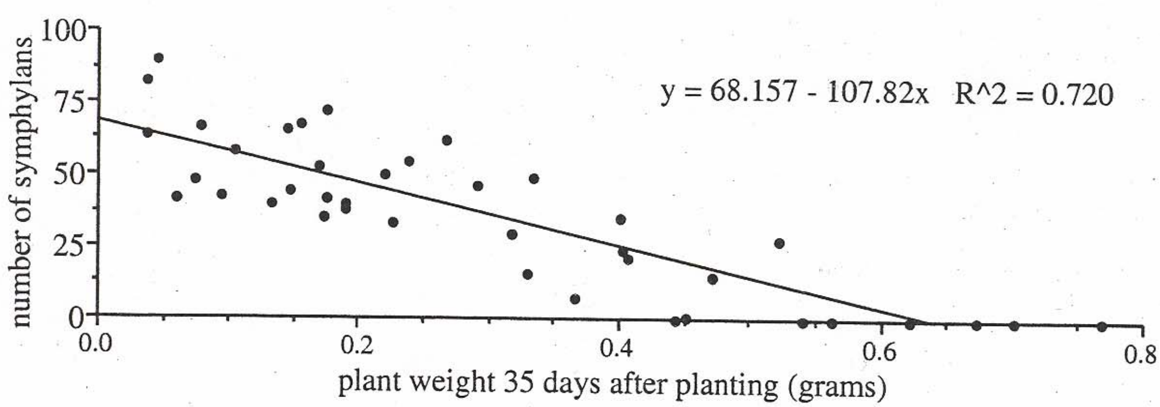
Lifecycle: Symphylans are long lived; some adults may live several years. The adult females lay eggs in the soil that hatch into immature versions of adult symphylans, but with fewer segments and legs. These early instar symphylans can easily be confused with some white springtails, which also damage seedlings. They move long distances in the soil, yet cannot tunnel through the soil, but must rely on existing soil pores. The primary food of symphylans is decaying organic matter, but they will actively feed on root hairs when available. Ideal soils for symphylans are those with good soil structure and high organic matter content, the same characteristics most growers strive for in their fields.

Plant Damage: Symphylans may damage sprouting seeds, seedlings before or after emergence, or even older plants. They feed primarily on root hairs and rootlets and their ability to injure the crop decreases as plants get larger, however, their pitting of older roots may provide entryways for pathogens. They sometimes stunt transplants by feeding on new roots as they attempt to grow out of the transplant plug. There is a normal cyclic nature to symphylan populations during the year, with active feeding phases and less active phases when populations appear low and apparently are deeper in the soil profile. There may be a difference in the amount of damage seen in affected areas of the field from crop to crop due to these population changes, but once a problem is seen in an area of a field, it tends to reoccur over many years.

Control Options: Management of symphlans has been difficult at best and largely depended on the use of soil insecticides. As the available soil insecticide registrations are diminishing, symphylans are becoming an increasing problem. Infested soil can be treated with insecticides, but their effect is limited because of the symphylan's ability to migrate through the soil. Insecticides may help in giving the plants a chance to establish in a protected zone. Careful soil tillage and moisture management may help reduce damage. Numerous naturally occurring organisms prey on symphylans in the field including true centipedes, predatory mites, predaceous ground beetles, and various fungi; however, little is known about their effect on symphylans populations.

Sampling with Potato Bait: Sampling for symphylans is difficult and visible detection of any symphylans often indicates a population large enough to cause economic damage. We have been utilizing a sampling plan modified from one developed by researchers at Oregon State and it has proven very efficient and relatively easy. It involves using thick slices of raw potato placed on the soil surface at the level at which moisture is clearly visible in the soil. Care must be taken in removing dry soil from the surface not to disturb the pores in the moist soil to prevent symphylans from reaching the bait. A technique of gently raking the dry soil away with a lettuce knife, rather than slicing into the soil with a knife or spade will be more effective. Then cover the bait with a solid plastic dome to protect the bait from drying out while it is allowed to attract symphylans. This plastic dome or cap must be large enough not to cause excessive heating of the area or to accumulate excess condensation. We use 6 inch round by 6 inch high white plastic "pots" with no drainage holes. PCA's and growers can use this technique and may find large plastic or Styrofoam cups easier to acquire. Researchers at OSU used 4-inch white PVC caps. The bait is left in place for 24 to 36 hours then when the cap is removed, the symphylans can be counted when the potato slice is picked up, both on the potato and on the soil surface. Count the soil surface first as the symphylans there will quickly hide.

Stand losses: We have done several studies on the correlation of symphylans counts to damage to seedlings. The graph shows the results of one such study. These data were generated by taking plant samples from the two plants on either side of a symphylan bait station and regressing the weights on the numbers on symphylans. As you can see from the graph, when symphylan counts approach 75 per potato slice, you can expect complete stand losses. This is consistent with our observations in the field, and significant stand loss will occur at much lower symphylan populations. We are also examining various control options and hope to report this winter on which may be most effective for growers and PCA's to test next year.



Evaluation of Insecticides During 2002 for Cabbage Looper Control in Cauliflower

Eric T. Natwick, Farm Advisor, Imperial County

The experiment was conducted in a 1.5-acre block of cauliflower. Plots measured 50 ft x 13.33 ft on 4-beds per plot. The experiment consisted of 13 treatments in a randomized complete block design with 4 replicates. Treatments were applied on 14, 24 October, and 14 November with a Lee Spider Spray Trac operated at 35 PSI delivering 53 gpa using 3 TJ-60 11003VS nozzles per bed. Cabbage looper larvae were counted on 20 plants in each plot on 15, 22, 28 October, 4, 12, 18, 25 November, 2, 9 December 2002.

Seasonal cabbage looper means for all of the insecticide treatments were lower (P=0.05) than the seasonal mean for the check (8.6) (Table 1). Capture 2 EC at 5.12 fl oz per had the lowest seasonal cabbage looper mean (0.5) followed by Avaunt 30 WG at 3.5 dry oz/acre (0.9), and Avaunt 30 WG at 2.5 dry oz/acre (1.1) and Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre (1.1).

There were no differences in cabbage looper numbers one day after the first treatment, but all treatments except S1812 35 WP at 6.86 dry oz/acre and Avaunt 30 WG at 3.5 dry oz/acre had means lower than the check 8 days after the first treatment. Capture 2 EC at 5.12 fl oz per acre had the fewest cabbage looper larvae /twenty plants (0.8) 8 days after the first treatment followed by Lorsban 75 WG at 21.33 dry oz/acre (1.3) and Success 2 SC at 4.0 fl oz/acre (1.5) compared to the check (6.0).

Four days after the second treatments were applied only S1812 35 WP at 6.86 dry oz/acre and Dipel at 8.0 dry oz/acre had means that were not significantly lower than the check. Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre and Avuant 30 WG at 3.5 dry oz/acre had the fewest cabbage looper larvae (0.3) followed by Avaunt 30 WG at 2.5 dry oz/acre (0.5), Confirm 2F at 8.0 fl oz/ acre (8.0), and Capture 2EC at 5.12 fl oz/acre (1.0) compared to the check (7.5) four days after the second treatment.

Eleven days after the second treatment the check mean was 19 cabbage loopers /twenty plants which was greater than all the insecticide treatments. Capture 2 EC at 5.12 fl oz/acre had the fewest cabbage looper larvae (0.3) followed by Avaunt 30 WG at 3.5 dry oz/acre (1.0), Avaunt 30 WG at 2.5 dry oz/acre (2.0), and Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre (2.0) eleven days after the second treatment.

Nineteen days after the second treatment the check mean was 10 cabbage loopers /twenty plants which was significantly greater than all the insecticide treatments except S1812 35 WP at 6.86 dry oz/acre with 7.5 looper larvae. Capture 2 EC at 5.12 fl oz per acre (1.3) and Avaunt 30 WG at 2.5 dry oz/acre (1.3) had the fewest cabbage looper larvae followed by Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre (1.5), and Avaunt 30 WG at 3.5 dry oz/acre (1.8) nineteen days after the second treatment.

Four days after the third treatments were applied insecticide treatments had means that were not lower than the check. Avaunt 30 WG at 3.5 dry oz/acre had the fewest cabbage looper larvae (0) followed by Capture 2EC at 5.12 fl oz per acre (0.8), and Avaunt 30 WG at 2.5 dry oz/acre and Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre (1.0) compared to the check (9.0) four days after the second treatment.

Eleven days after the third treatment the check mean was 10.8 cabbage loopers /twenty plants which was greater than all the insecticide treatments. Capture 2 EC at 5.12 fl oz per, Avaunt 30 WG at 3.5 dry oz/acre, and Avaunt 30 WG at 2.5 dry oz/acre had the fewest cabbage looper larvae (0) followed by, and Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre (0.3) eleven days after the second treatment.

Eighteen days after the third treatment the check mean was 6.5 cabbage loopers /twenty plants which was greater than all the insecticide treatments except S1812 35 WP at 6.86 dry oz/acre. Avaunt 30 WG at 3.5 dry oz/acre and Confirm 2F at 8.0 fl oz/acre had the fewest cabbage looper larvae (0) followed by Capture 2 EC at 5.12 fl oz per (0.3) and Warrior T at 3.8 fl oz/acre plus Lannate L at 64.0 fl oz/acre (1.0) eighteen days after the second treatment.

Twenty-five days after the third treatment the check mean was 8.0 cabbage loopers /twenty plants which was greater than all the insecticide treatments. Avaunt 30 WG at 3.5 dry oz/acre, Confirm 2F at 8.0 fl oz/acre and Capture 2 EC at 5.12 fl oz per had the fewest cabbage looper larvae (0) followed by Avaunt 30 WG at 2.5 dry oz/acre (0.3) twenty five days after the second treatment.

Table 1. Mean Numbers[z] of Cabbage Looper Larvae per Twenty Cauliflower Plant Following Various Insecticide Treatments, Brawley, CA 2002.

Treatment	oz/acre	15 Oct	22 Oct	28 Oct	4 Nov	12 Nov	18 Nov	25 Nov	2 Dec	9 Dec	Mean
Check	--------	0.5 a	6.0 a	7.5 a	19.0 a	10.0 a	9.0 a	10.8 a	6.5 ab	8.0 a	8.6 a
S1812 35 WP	6.86 dry	2.5 a	4.0 abc	5.8 ab	7.8 b	7.5 ab	4.3 b	6.3 b	9.8 a	4.5 b	5.8 b
S1813 35 WP + DiPel	6.86 dry + 8.0 dry	0.8 a	3.5 bcd	4.8 bc	5.8 bcd	4.8 c	3.3 bc	2.0 cde	2.5 bcd	1.0 cd	3.1 cde
DiPel	8.0 dry	0.8 a	2.3 bcde	5.0 abc	7.0 bc	5.5 bc	2.8 bcd	4.5 bc	6.0 ab	3.5 bc	4.1 c
Avaunt 30 WG	2.5 dry	0.5 a	3.3 bcd	0.5 d	2.0 cde	1.3 e	1.0 cd	0.0 e	1.0 cd	0.3 d	1.1 fg
Avaunt 30 WG	3.5 dry	1.0 a	4.3 ab	0.3 d	1.0 de	1.8 de	0.0 d	0.0 e	0.0 d	0.0 d	0.9 g
Confirm 2 F	8.0 fl	1.5 a	1.8 cde	0.8 d	3.8 bcde	4.0 cd	2.0 bcd	2.5 cde	0.0 d	0.0 d	1.8 efg
Proclaim 5 SG	2.4 dry	1.3 a	3.3 bcd	1.3 d	7.5 b	5.3 bc	2.8 bcd	2.3 cde	4.0 bcd	1.8 cd	3.3 cd
Success 2 SC	4.0 fl	2.0 a	1.5 de	1.8 d	4.5 bcde	4.8 c	3.0 bc	1.5 de	1.5 cd	1.5 cd	2.4 def
Warrior T + Lannate L	3.8 fl + 64.0 fl	0.5 a	2.3 bcde	0.3 d	2.0 cde	1.5 de	1.0 cd	0.3 de	1.0 cd	1.0 cd	1.1 fg
Capture 2 EC	5.12 fl	0.0 a	0.8 e	1.0 d	0.3 e	1.3 e	0.8 cd	0.0 e	0.3 d	0.0 d	0.5 g
Lorsban 75 WG	10.67 dry	1.3 a	2.3 bcde	2.5 cd	7.5 b	4.8 c	1.8 bcd	1.5 de	4.8 bc	2.5 bcd	3.2 cd
Lorsban 75 WG	21.33 dry	2.5 a	1.3 de	1.8 d	5.3 bcde	3.0 cde	4.0 b	2.8 cd	1.8 cd	1.3 cd	2.6 de

[Z] Means within columns followed by the same letter are not significantly different by ANOVA and LSD (P# 0.05).

Broccoli Weed Control Studies

Kurt Hembree, Michelle Le Strange, and Neil Va
Farm Advisor- Fresno County, Farm Advisor - Tulare & Kings Counties, and
Research Assistant - Fresno County

Two field trials were conducted in 2002 at the West Side Research & Extension Center in western Fresno County to compare pre- and post-emergence herbicides for weed control and tolerance of direct-seeded broccoli. In the first trial, two formulations of Goal (2XL and 4F) were compared as post-planting, pre-emergence or post-emergence directed treatments. In the second trial, Valor 50WG, Spartan 75DF, and Goal 2XL and 4F were compared when applied as post-emergence directed treatments.

For both trials, the field was sprinkler irrigated to develop the stand and incorporate pre-emergence treatments, after which the field received furrow irrigation. Shepherd's-purse and London rocket were the primary weeds present in the field. Although the broccoli plots were harvested past its maturity, yields were determined by counting and weighing the number of heads per 10 foot of plot row.

Results - Trial #1: Dacthal applied at a standard rate of 14 lb/A gave the best weed control (95%) and did not affect stand development (table 1). Reducing the Dacthal rate to 7 lb/A resulted in poor weed control. Although preemergence treatments of Goal 2XL (8oz/A) and Goal 4F (4oz/A) gave nearly 100% weed control during the season, they resulted in a 40% loss of broccoli stand, and injury and reduced growth of surviving plants. Goal 4F applied at 2 to 16 oz/A post-emergence directed gave 99% control of the weeds, while only slightly injuring broccoli plants.

Over-all growth of the broccoli did not seem to be affected from the post-emergence directed treatments of Goal 4F, except at the highest rate (16 oz/A) (table 2). Broccoli yields were highest in plots treated with Dacthal pre-emergence or Goal 4F post-emergence directed (table 2). Although untreated plots yielded the same number of broccoli heads, average head weight was reduced by 50%.

Table 1. Trial #1: Stand Counts and Weed Control in Broccoli

Treatment	Rate/A	Timing	Stand counts 1/13/03 Broccoli #	SP #	LR #	Weed control SP 2/6/03	SP 3/18/03	LR 2/6/03	LR 3/18/03
Dacthal W75	14.0 lb	Pre-B	43.0 a	1.5 c	1.3 c	9.4 bc	9.4 c	9.6 b	9.7 b
Dacthal W75	7.0 lb	Pre B	41.0 a	16.0 b	4.3 b	8.9 d	9.1 d	9.3 c	9.3 c
Dacthal W75+	7.0 lb	Pre-B	27.5 b	0.0 c	0.0 c	10.0 a	10.0 a	10.0 a	10.0 a
Goal 4F	4.0 oz	Pre-B							
Goal 4F	4.0 oz	Pre-B	25.5 b	0.0 c	0.0 c	9.9 a	9.9 ab	9.9 a	9.9 a
Goal 2XL	8.0 oz	Pre-B	25.3 b	0.0 c	0.0 c	9.9 a	9.9 a	9.9 a	10.0 a
Goal 4F	2.0 oz	Post-D	42.5 a	18.8 a	8.8 a	9.2 c	9.7 b	9.5 bc	9.7 b
Goal 4F	4.0 oz	Post-D	42.3 a	15.8 a	10.0 a	9.5 b	9.9 ab	9.6 b	9.9 a
Goal 4F	8.0 oz	Post-D	42.3 a	19.8 a	9.8 a	9.3 bc	9.9 ab	9.6 b	10.0 a
Goal 4F	16.0 oz	Post-D	41.3 a	17.3 ab	10.5 a	9.4 bc	10.0 a	9.6 b	10.0 a
Untreated	----		44.0 a	18.3 ab	8.5 a	0.0 e	0.0 e	0.0 d	0.0 d
	P = 0.05	CV:	8.68%	14.91%	26.58%	1.87%	1.29%	1.68%	1.37%
		LSD:	5.2	2.6	2.3	0.2	0.2	0.2	0.2

Pre-B = post-plant and pre-emergence broadcast
Post-D = post-emergence and directed with shielded spray
SP = Shepherd's-purse and LR = London rocket
Weed control based on a 0 to 10 scale; 0 = no control and 10 = perfect control
Stand counts were collected from a 10 ft. x 6 ft. area

Table 2. Trial #1: Broccoli Growth, Injury and Yield

Treatment	Rate/A	Timing	Broccoli Growth: Growth 1/13/03	Growth 2/6/03	Growth 3/18/03	Broccoli Injury: Injury 1/13/03	Injury 2/6/03	Injury 3/18/03	Yield per 10' of row: No. heads	Lbs.	Lbs./head
Dacthal W75	14.0 lb	Pre-B	9.4 b	10.0 a	10.0 a	0.0 c	0.0 c	0.0	27.3 a	24.17 ab	0.89 b
Dacthal W75	7.0 lb	Pre B	9.0 c	9.9 a	10.0 a	0.0 c	0.0 c	0.0	28.5 a	21.06 bc	0.82 b
Dacthal W75+	7.0 lb	Pre-B	4.4 d	7.1 c	8.3 c	3.8 b	0.0 c	0.0	22.3 b	27.82 a	1.25 a
Goal 4F	4.0 oz	Pre B									
Goal 4F	4.0 oz	Pre-B	4.0 e	7.3 c	8.6 c	4.1 b	0.0 c	0.0	23.5 b	27.06 a	1.17 a
Goal 2XL	8.0 oz	Pre-B	4.0 e	7.0 c	8.4 c	5.3 a	0.0 c	0.0	20.3 b	24.28 ab	1.22 a
Goal 4F	2.0 oz	Post-D	10.0 a	9.9 a	10.0 a	0.0 c	2.3 B	0.0	29.3 a	27.47 a	0.89 b
Goal 4F	4.0 oz	Post-D	10.0 a	10.0 a	9.8 a	0.0 c	2.0 b	0.0	27.8 a	26.21 ab	0.94 b
Goal 4F	8.0 oz	Post-D	10.0 a	10.0 a	9.9 a	0.0 c	2.3 b	0.0	30.5 a	28.53 a	0.93 b
Goal 4F	16.0 oz	Post-D	10.0 a	10.0 a	9.3 b	0.0 c	3.0 a	0.0	30.5 a	29.22 a	0.96 b
Untreated	----		10.0 a	9.1 b	7.6 d	0.0 c	0.0 c	0.0	29.3 a	17.01 c	0.59 c
	P= 0.05	CV:	2.77%	3.57%	2.83%	21.34%	23.96%	0.00%	8.36%	13.77%	11.62%
		LSD:	0.4	0.5	0.4	0.5	0.4	n.s.	3.60	5.57	0.18

Pre-B = post-plant and pre-emergence broadcast
Post-D = post-emergence and directed with shielded spray
Growth based on a 0 to 10 scale of plants present; 0 = no growth and 10 = completely healthy
Injury based on a 0 to 10 scale of plants present; 0 = no visible injury and 10 = all plants were killed

Results - Trial #2: Control of shepherd's-purse and London rocket was equally effective where Goal 4F (2 to 4 oz/A), Goal 2XL (8 oz/A) Valor 50WG (1.5 oz/A), or Spartan 75DF (2 to 8 oz/A) were applied post-emergence directed at the broccoli 4-leaf stage (table 3). Goal 4F applied at 1 oz/A gave slightly reduced weed control and a non-ionic surfactant had to be added to the Valor treatment to be effective. Broccoli growth was significantly reduced where Valor was used with a surfactant or when Spartan was used at rates above 4 oz/A (table 4). All treated plots showed some degree of crop injury initially, however symptoms were not visible about 45 days after treatment. The highest yields were in plots treated with the two Goal formulations at all rates tested and where Spartan was used at 2 or 4 oz/A (table 4). Like in the first trial, untreated plots yielded smaller broccoli heads.

Summary: Although both formulations of Goal tested provided excellent pre-emergence weed control following planting, they caused a significant loss of both stand and yield. Only Dacthal applied pre-emergence at 14 lb/A gave acceptable weed control without reducing yields. However, effective weed control was achieved when Goal was applied as a post-emergence directed and shielded spray. Application rates of Goal 4F at 2 to 8 oz/A (0.0625 to 0.5 lb ai/A) were equally effective as Goal 2XL at similar rates. Spartan also provided excellent weed control at rates of 2 and 4 oz/A. Rates higher than this caused increased crop injury and a reduction in over-all growth and yield. While Valor provided effective weed control at a rate of 1.5 oz/A, it resulted in crop injury and a significant loss of crop growth and yield.

Table 3. Trial #2: Weed Control in Broccoli

Treatment	Rate/A	Timing	SP 2/6/03	SP 2/19/03	SP 3/18/03	LR 2/6/03	LR 2/19/03	LR 3/18/03
Valor 50WG	1.5 oz	Post-D	9.5 b	9.4 c	9.8 ab	9.1 d	8.3 d	5.0 c
Valor 50WG+	1.5 oz	Post-D	10.0 a	10.0 a	10.0 a	10.0 a	9.9 a	9.9 a
Activator 90	0.25% v/v							
Spartan 75DF	2.0 oz	Post-D	9.4 bc	9.2 d	9.9 ab	9.6 c	9.5 c	9.8 ab
Spartan 75DF	4.0 oz	Post-D	9.8 a	9.9 ab	9.9 ab	9.8 b	9.8 ab	9.7 ab
Spartan 75DF	8.0 oz	Post-D	9.9 a	9.9 ab	10.0 a	9.9 ab	9.9 a	10.0 a
Goal 4F	1.0 oz	Post-D	9.1 d	9.5 c	9.7 b	9.2 d	9.7 b	9.4 b
Goal 4F	2.0 oz	Post-D	9.2 cd	9.8 b	9.9 ab	9.5 c	9.9 a	9.8 ab
Goal 4F	4.0 oz	Post-D	9.4 bc	9.9 ab	10.0 a	9.8 b	9.9 a	9.9 a
Goal 2XL	8.0 oz	Post-D	9.5 b	9.8 b	9.9 ab	9.8 b	9.9 a	9.9 a
Untreated	----	----	0.0 e	0.0 e	0.0 c	0.0 e	0.0 e	0.0 d
	P = 0.05	CV:	168%	0.95%	1.48%	1.38%	1.33%	3.56%
		LSD:	0.2	0.1	0.2	0.2	0.2	0.5

Pre-B = post-plant and pre-emergence broadcast0.2
Post-D = post-emergence and directed with shielded spray
Weed control based on a 0 to 10 scale; 0 = no control and 10 = perfect control
SP = Shepherd's-purse and LR = London rocket

Table 4. Trial #2: Broccoli Growth, Injury and Yield

			Broccoli Growth			Broccoli Injury			Yield per 10' of row 4/29/03		
Treatment	Rate/A	Timing	2/6/03	2/19/03	3/18/03	2/6/03	2/19/03	3/18/03	No. heads	Lbs.	Lbs./ head
Valor 50WG	1.5 oz	Post-D	8.4 bc	8.5 b	9.1 b	3.5 c	1.5 cd	0.0	22.5 bc	17.50 c	0.77 ab
Valor 50WG+	1.5 oz	Post-D	1.5 e	2.8 d	4.3 d	9.0 a	5.0 a	0.0	22.3 c	9.70 d	0.44 c
Activator 90	0.25% v/v										
Spartan 75DF	2.0 oz	Post-D	9.0 b	9.5 a	9.4 ab	2.3 d	1.3 cd	0.0	29.5 a	25.35 ab	0.87 a
Spartan 75DF	4.0 oz	Post-D	8.1 c	9.7 a	10.0 a	3.3 c	2.0 bc	0.0	27.0 ab	21.36 bc	0.79 ab
Spartan 75DF	8.0 oz	Post-D	5.5 d	5.3 c	4.8 d	4.3 b	2.5 b	0.0	21.0 c	16.82 c	0.79 ab
Goal 4F	1.0 oz	Post-D	10.0 a	9.9 a	10.0 a	1.3 e	0.3 ef	0.0	29.0 a	23.87 ab	0.83 a
Goal 4F	2.0 oz	Post-D	9.7 a	9.9 a	10.0 a	1.3 e	0.5 ef	0.0	31.0 a	28.44 a	0.94 a
Goal 4F	4.0 oz	Post-D	9.7 a	9.8 a	10.0 a	2.0 de	0.8 de	0.0	31.3 a	26.71 ab	0.86 a
Goal 2XL	8.0 oz	Post-D	10.0 a	9.9 a	9.9 a	1.5 e	0.3 ef	0.0	31.3 a	27.76 a	0.87 a
Untreated	----	----	9.8 a	9.5 a	7.9 c	0.0 f	0.0 f	0.0	30.8 a	17.36 c	0.58 bc
	P= 0.05	CV:	4.89%	4.91%	4.58%	16.23%	33.11%	0.00%	10.41%	18.46%	19.05%
		LSD:	0.6	0.7	0.6	0.7	0.7	n.s.	4.6	6.34	0.24

Pre-B = post-plant and pre-emergence broadcast
Post-D = post-emergence and directed with shielded spray
Growth based on a 0 to 10 scale of plants present; 0 = no growth and 10 = completely healthy
Injury based on a 0 to 10 scale of plants present; 0 = no visible injury and 10 = all plants were killed

Soil Characteristics: 1945 versus 2001

Herman Meister, Farm Advisor, Imperial County

When we think about the important role that soil plays in the production of food and fiber for the world's population, we realize that it is an irreplaceable resource that must be protected. Soil is the medium that supports plant growth and the source of most plant nutrients. Soil water and the soil atmosphere bathe the roots and keep the above-ground plant healthy and growing. A healthy soil environment is in everyone's interest.

Many people have attempted to define soil quality by measuring various soil characteristics and relating these to different management practices, such as productivity, environmental quality, or plant disease. But *soil quality means different things to different people, depending on its intended use.* For example, farmers generally want a soil that supports ideal crop growth year after year with a minimum of inputs. Highway construction engineers look for very different soil properties for building roads.

Farmers realize that balanced crop fertilization increases yields and farm profitability. At the same time, enhanced crop productivity increases the amount of organic matter that can be returned to the soil. Organic matter positively influences soil properties like structure, tilth, bulk density, and irrigation infiltration rates.

1945 to 2001: A recently published article from the University of California reported on changes in soil quality that have occurred in the last 45 to 55 years (Declerck, Singer and Lindert. 2003). *Soil samples collected primarily in 1945 were compared with samples collected at the same locations in 2001.* These 125 sampling locations represented four major land uses throughout the state: tree crops (25 sites), row crops (44 sites), rangeland (48 sites), and vineyards (8 sites). Although these sites represent only a proportion of California agriculture, analysis of these historic samples provides an insight into changes in soil quality that have occurred throughout the state.

Soil pH: The average *soil pH in 1945 was 6.9 compared to 7.1 in 2001.* This slight increase in pH is well within the acceptable range for plant growth and indicates no extreme changes towards acidification or alkalization as a result of production practices.

Soil Salinity: The average *soil salinity at the 125 sites significantly decreased during the 56-yr period from 0.85% dS/m in 1945 to 0.44 dS/m in 2001*. The largest decrease in salinity occurred in soil used for row crops. This 48% average decrease in soil salinity likely reflects an improvement in irrigation management practices and reflects an improvement in soil quality.

Soil Phosphorus: Concentrations of plant-available P (sodium-bicarbonate extractable) increased approx-imately 20% during this period, with significant increases occurring in land used for tree crops, row crops, and vineyards. *The average P concentration in 1945 was 72 ppm and is now 85 ppm.* The improved fertility status that has occurred will enhance the inherent productivity of the soil and increase the amount of crop residue that can subsequently be returned to improve the soil.

Soil Nitrogen and Carbon: The amount of total *nitrogen and carbon significantly increased between 1945 and 2001 – reflecting an accumulation of soil organic matter.* Average soil nitrogen concentrations increased from 0.09% to 0.29% and soil carbon increased from 1.06 to 1.34% between 1945 and 2001. These changes in soil organic matter are typically reflected in better aggregate stability and water infiltration.

Soil Texture: The clay content of the samples consistently increased from an average of 10% to 13% for the period between 1945 and 2001. *This increase in clay content may be a sign of accelerated soil erosion, which would have a negative impact on soil quality*. While this increase in clay content is not great, erosion of topsoil can have very negative effects on crop production and water quality. Efforts to minimize soil loss should always be part of a farm management plan.

Impact? *These results indicate that soil quality has generally been maintained or improved over the last 50 to 60 years of intensive management and cropping. It also shows that continued efforts must be made to minimize soil erosion. The documented improvements in soil chemical properties and fertility reflect the stewardship of farmers and industry, UCCE education programs, and the NRCS.*

Efforts to maintain high yields and soil quality are essential for long-term sustainability. Careful management and utilization of modern technology will accomplish this. The technology available in 2003 is beyond the wildest dreams of the farmers in 1945. For instance, the use of satellite-aided precision agricultural tools, computer-controlled water management, improved soil-testing techniques, rapid assessment of plant tissue samples… all can aid in protecting the quality of the precious soil resource and the environment.

Condensed from "California Soil Quality: a Closer Look" California Agriculture, April-June 2003. Also excerpts from the "News and Views", June 2003.

Calcium in Plants

Warren Bendixen, Farm Advisor, Santa Barbara County

Plants have a high calcium requirement. Calcium is important in the formation of cell walls in plants, forming a calcium pectinate. It also enhances pollen germination and growth.

Calcium content in plants ranges from 0.20 to 5.00 percent of the dry weight in leaf tissue with sufficiency values from 0.30 - 3.00 percent in leaf tissue of most crops.

Calcium in plants seems to exist in a fine balance with magnesium, potassium and boron. An upset in this balance will disturb the plant functions.

A high magnesium level reduces the plant's absorption of calcium and potassium. Magnesium excess is indicated when the exchangeable magnesium is more than 40-60 percent of the cation exchange capacity.

The relationship between calcium and potassium is well known. The ratio of calcium to nitrogen in fruit crops and a similar ratio between calcium and boron may be related to quality. Ammonium nutrition can create a calcium deficiency by reducing calcium uptake.

Excessive calcium in the soil can produce a deficiency of magnesium or potassium, depending on their concentration.

Calcium deficiency produces several characteristic symptoms. It is responsible for "tip burn," hardening of fruit, root tip stunting, and growing point damage in strawberries, black heart of celery, brown head in broccoli, and blossom end rot in tomatoes and peppers. Calcium-deficient strawberries show a dense cover of seeds with smaller fruit size.

Calcium deficiency is also associated with water balance in plants. Higher than normal temperatures that cause higher plant transpiration or foggy, overcast days with lower than normal transpiration can cause calcium deficiency in strawberries and vegetables.

Since calcium is an immobile element in the plant, deficiencies occur at the growing terminals. The conductive tissue at the base of the plant will decay, resulting in the reduction of the uptake of water, wilting in high temperatures, and a reduction in essential element uptake.

Calcium deficiencies are corrected by adding gypsum, limestone, calcium nitrate or superphosphate.

Impact of Delays to Cool on Shelf-life of Broccoli

Marita Cantwell, Postharvest Specialist, Vegetable Crops Dept, UC Davis

Very rapid quality and biochemical changes occur within a few hours of harvest in most fresh produce. Although our general recommendation is *"cool as soon as possible",* we lack specific data for different products.

Broccoli is a very perishable vegetable. Currently it is field-packed and in most cases, cooled by liquid icing. Delays of several hours may occur but liquid-ice cooling ensures ice around the broccoli during most of the transport and distribution period, and probably mitigates any detrimental effect delays to cool might have. However, if we are interested in handling broccoli without ice and cool by forced air or hydrocooling, delays to cool may be expected to have more impact on shelf-life.

Postharvest Experiments: We ran 2 delay to cool tests on broccoli (cv. Marathon) in the Salinas Valley in 2001. In the first test, the broccoli was cut, placed in plastic trays that were stacked inside a van in the field and during transport to the lab. Temperature was monitored and averaged 20°C (68°F), and the broccoli lost an average of 0.4% weight per hour. After specific periods, *the broccoli was air or hydrocooled*, and then placed in polybags in coolers with gel ice packs.

Hydrocooling involved immersion in a slurry of water and ice for 20 minutes, and for air cooling, the broccoli was placed in perforated polyethylene bags inside a large cooler in the field (temp=0-5°C) or inside a cold room at the lab. Weight loss during air cooling was negligible but hydrocooled broccoli has a 4-6% increase in weight in the first test and a 5-10% increase in the 2nd test.

After all samples were cooled, the individual heads were tagged and placed on trays inside perforated polybags at 7.5°C (45°F). The basis for determination of shelf-life was number of days to show any yellow beads or florets.

The second test was done on broccoli harvested from the same field, but it was *only hydrocooled.* Average pulp temperature was 25°C (77°F), and average weight loss in the 2nd test was 0.6% per hour.

Figure 1 shows that delays to cool at 20°C (68°F) did not affect shelf-life until 6 hours or more (Fig 1A. Test #1). There was not a significant difference in shelf-life between the air-cooled and the hydrocooled broccoli and the data were combined in Figure 1. However, since the hydrocooled broccoli absorbed some water (4-6% fresh weight), there were differences in head firmness at the end of shelf-life. At 25°C (77°F), a significant loss in shelf-life occurred after a 3 hours delay to cool (Fig 1B. Test #2). We could expect that if the broccoli were held at 15°C (59°F) after harvest, we would not be able to observe a difference in shelf-life until after a delay to cool of 9-12 hours.

Although shelf-life was measured at 7.5°C, the trend in loss of shelf-life with increased delays to cool would remain at lower storage temperatures. **Figure 2** shows expected shelf-life of broccoli at different temperatures. The broccoli cultivars Marathon and Legacy have relatively long shelf-lives. If shorter shelf-life cultivars were used, the impact of delays to cool would likely be greater.

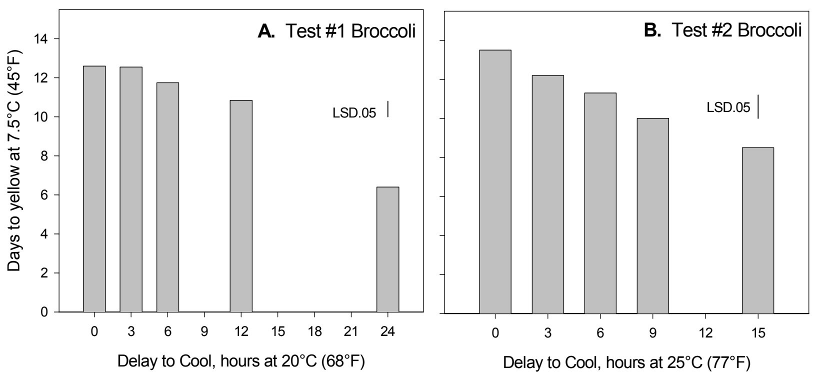


Figure 1. Shelf-life (days to show first yellow beads) of Broccoli in relation to delays to cool at two temperatures (20°C, Fig 1A and 25°C, Fig 1B). In Test #1, heads were hydrocooled and air-cooled; in Test #2, heads were hydro-cooled.

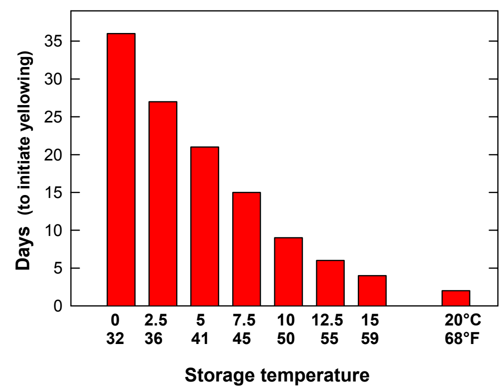


Figure 2. Shelf-life of broccoli (cv. Legacy) stored in humidified air at different temperatures.

TMDLs – A New Approach to Water Quality Regulation

Bo Cutter, Water Resource Management Specialist, UC Riverside

The Total Maximum Daily Load (TMDL) term refers to a regulatory program, numeric water quality standards, the process to set those standards, and a new approach to regulating water-quality. The TMDL approach is different from past water-quality regulation because it focuses on improving the quality of a water body rather than limiting the concentration of pollutants coming out of the end of a pipe. Furthermore, the TMDL approach is designed to limit pollution from both point and non-point pollution sources. Finally, the TMDL program's goal of improving the quality of water bodies necessitates a watershed-wide pollution- reduction strategy.

The TMDL program has its roots in the Clean Water Act (1972); which directs states to identify polluted water bodies and take action to eliminate pollution. However, for the first two decades following passage of the legislation, Federal and State Governments used the National Pollutant Discharge Elimination System (NPDES) permit system to reduce pollution from large point sources such as public wastewater plants. This approach has largely succeeded in identifying low-cost pollution reduction technologies and mandating that point sources install these technologies. However, despite this success, in California many water bodies remain polluted; 80-85% of river miles and 63% of lake acreage suffer significant impairment (EPA 2002). The key unaddressed problems are non-point agricultural and urban runoffs. The EPA began to address non-point water pollution and contaminated water bodies in the early 90s through the TMDL program.

SOURCES OF INFORMATION

PUBLICATIONS from UC

Many items are available at no cost from local UCCE offices or UC websites. Free online publications from UC IPM are available through either the IPM or ANR catalog websites. Vegetable Production pamphlets are available through UC VRIC or ANR catalog websites.

IPM Cole Crops & Lettuce Manual, #3307
IPM Cole Crops Pest Management Guidelines
IPM Lettuce Pest Management Guidelines

Broccoli Crop Production in CA, #7211
Cabbage Production in CA, #7208
Cauliflower Production in CA, #7219
Iceburg Lettuce Production in CA, #7215
Leaf Lettuce Production in CA, #7216
Spinach Production in CA, #7212

Key Points of Control & Management of Microbial Food Safety: Info for Growers, Packers, & Handlers of Fresh-Consumed Horticultural Products, #8102

UC Websites

UC Vegetable Research & Information Center –
(UC VRIC) www.vric.ucdavis.edu

UC Weed Research & Information Center
(UC WRIC) www.wric.ucdavis.edu

UC Integrated Pest Management
(UC IPM) www.ipm.ucdavis.edu

UC Post Harvest Technology
http://postharvest.ucdavis.edu

UC Ag Economics: Cost of Production Guidelines
http://coststudies.ucdavis.edu or (530) 752-1515

UC Ag & Natural Resources Catalog
http://anrcatalog.ucdavis.edu

WEATHER & IRRIGATION

CIMIS - CA Irrigation Management & Info System
CA Dept Water Resources - www.cimis.water.ca.gov
UC IPM - Weather, day degree modeling and CIMIS
www.ipm.ucdavis.edu/WEATHER/weather1.html

GOVERNMENT

CDFA - www.cdfa.ca.gov
CDPR - www.cdpr.ca.gov
CA AG Statistics Services - http://www.nass.usda.gov/ca
Curly Top Virus Control Program - (559) 445-5472

FARM WATER QUALITY PLANNING SERIES http://waterquality.ucanr.org

The following reference sheets were developed for growers of irrigated crops who are interested in implementing water quality protection practices. The short course series teaches the basic concepts of watersheds, nonpoint source pollution, and self assessment and evaluation techniques.

Introduction

Water Quality Planning Short Course Objectives

Recommended Practices

- Practices for Reducing Nonpoint Source Pollution from Irrigated Agriculture
- Nutrient Management Goals and Recommended Practices for Vegetables
- Sediment Management Goals and Recommended Practices for Strawberries

Goals, Resources Inventory, Mapping

- Identifying Your Farm Water Quality Goals
- Guide to Resource Management Records for Farms
- Legal Descriptions of Property
- Farm Maps
- Developing a Farm Map

Water Quality Legislation

- Water Pollution Control Legislation
- Ground Water Protection Areas and Wellhead Protection Draft Regulations
- Self-determined Compliance

Management of Nonpoint Source Pollution

- Nonpoint Sources of Pollution in Irrigated Agriculture
- Developing a Nonpoint Source Pollution Evaluation Program
- Nutrient Management in Cool-Season Vegetables
- Irrigation Water Salinity and Crop Production

Watersheds

- Watershed Function
- Watershed Response to Storm Events

Groundwater

- Basic Concepts of Groundwater Hydrology
- Groundwater Quality and Groundwater Pollution
- Water Well Design and Construction
- Groundwater Sampling and Monitoring

Vegetable Notes

UCCE Tulare and Kings Counties

Vegetable Notes Newsletter Edition #4:

Cole Crops & Lettuce

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