University of California Cooperative Extension

Vegetable Notes

Fresno, Tulare and Kings Counties

EDITION #7: Onions & Garlic

December 2005

IN THIS ISSUE

SOURCES OF INFORMATION

Farm Advisors – Vegetable Crops
San Joaquin Valley

FRESNO
Shannon Mueller (559) 456-7261
Kurt Hembree (559) 456-7556

KERN
Joe Nuñez (661) 868-6222

MERCED & MADERA
Scott Stoddard (209) 385-7403

SAN JOAQUIN
Brenna Aegerter (209) 468-2085

STANISLAUS
Jan Mickler (209) 525-6800

TULARE & KINGS
Michelle Le Strange
(559) 685-3309, Ext. 220

Newsletter Editor
Michelle Le Strange
4437-B S. Laspina Street
Tulare, CA 93274
E-mail: mlestrange@ucdavis.edu

Vegetable Production Meeting
South San Joaquin Valley

UC West Side Research & Extension Center, Five Points
TUESDAY Morning - January 31, 2006

8:00am **Registration** – Coffee and refreshments

8:30 **Welcome** – *Michelle Le Strange and Shannon Mueller*

20 minute presentations by all speakers

Applying Kerb through Sprinklers for Lettuce Weed Control
Kurt Hembree, Farm Advisor, Fresno County

2005 Melon Evaluations for Yield and Quality
Shannon Mueller, Farm Advisor, Fresno County

Water Requirements of Bell Peppers
Jim Ayars, Agricultural Engineer, USDA, Parlier

Drip Irrigation Water Management in Processing Tomatoes
Don May, Farm Advisor Emeritus, Fresno County

Managing Calcium-related Disorders in High pH Soils
Tim Hartz, Vegetable Crops Specialist, UC Davis

10:20 **Refreshment Break**

Research Update on Preemergence Herbicides in Transplanted Peppers
Evaluating Extended Field Storage Varieties in Processing Tomatoes
Michelle Le Strange, Farm Advisor, Tulare & Kings Counties

Update on Tomato Vine Decline & Multiple Plants per Transplant Plug
Gene Miyao, Farm Advisor, Yolo, Solano, and Sacramento Cos.

Bacterial Diseases of Tomato
Mike Davis, Plant Pathology Specialist, UC Davis

Herbicide Drift Symptoms in Vegetables
Tom Lanini, Weed Science Specialist, UC Davis

General Discussion & Final Wrap Up

12:10pm **Adjourn** **2 hours DPR and CCA credit requested**

This meeting is open to any interested party. Meeting facility is handicap accessible.
For information call: Michelle Le Strange (559) 685-3303 or Shannon Mueller (559) 456-7261
or Chris Robles at UC WSREC (559) 884-2411

Response of Garlic and Onion to Irrigation Water

Blaine Hanson, Irrigation and Drainage Specialist, UC Davis
Don May, Farm Advisor Emeritus, and Ron Voss, Vegetable Crops Specialist Emeritus

GARLIC

Experimental Procedures

Several types of experiments were conducted on garlic response to irrigation at the University of California Westside Research and Extension Center over a four-year period. *The first experiment determined the effect of furrow irrigation frequency on garlic yield; the second on the effect of irrigation cutoff date on yield; and the third and fourth experiments investigated the response of garlic yield to various amounts of applied water on clay loam and sandy loam soil.* These latter experiments used a sprinkler line source to apply the water. A sprinkler line source consists of a single sprinkler line with a 15-ft sprinkler spacing. No overlap from an adjacent sprinkler line occurs, and thus the applied water varies with distance from the sprinkler line from a maximum amount near the line to no water applied beyond the wetted area of the sprinkler.

Results

The irrigation frequency experiment showed the highest yield for weekly furrow irrigations and a cutoff date of May 16. This yield was statistically different from the yields of the other treatments.

The cutoff date experiment revealed that irrigation cutoff dates of May 25 and June 4 reduced yield compared to cutoff dates of May 12 and May 19. Yield differences of the latter dates were significantly different from those of the earlier dates. The cutoff date had no effect on the percent soluble solids.

The sprinkler line source experiment in clay loam found no yield response to applied water (Fig. 1). Seasonal average amount of applied water with distance from the sprinkler line ranged from 12.8 to 13.3 inches next to the sprinkler line to 3.2 to 3.4 inches at 38 feet from the sprinkler line (the farthest distance of the yield measurements). Prior to 160 DAP (days after planting), little difference in canopy coverage was found at each distance. After 160 DAP, the canopy coverage continued to increase substantially with time except at the farthest distance where there was only a slight increase with time. Canopy coverage was similar for all amounts of applied water except at the farthest distance where the maximum canopy coverage was 57% compared to 73% to 78% at the shorter distances.

The sprinkler line source experiment in sandy loam showed decreasing garlic yield with decreasing applied water for amounts of water similar to that applied for the clay loam experiment (Fig. 1). No significant trend was found between soluble solids and applied water. Maximum values of canopy coverage were similar to those of the clay loam soil near the sprinkler line, but beyond 18 feet from the sprinkler, canopy coverage decreased with distance from the sprinkler line.

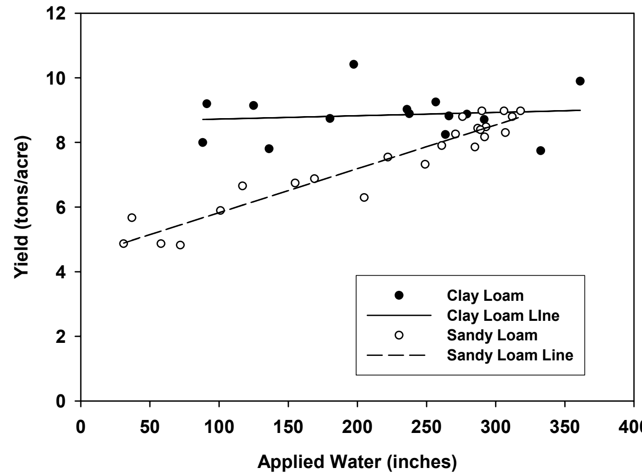


Fig. 1. Garlic yield versus applied water for clay loam and sandy loam soil using a line source sprinkler experiment.

Conclusions

The different yield responses between the clay loam and sandy loam soils are attributed to differences in soil moisture storage capacities between the two soils. For the clay loam, soil moisture use by the crop increased as applied water decreased. The average seasonal change in soil moisture content was 2.63 inches/foot at 38 feet from the sprinkler line, extracted down to a maximum depth of 5 to 6 feet. Thus, for this soil type, garlic was able to substitute stored soil moisture for irrigation water. However, the stored moisture of the sandy loam was much less for the sandy loam, and as a result there was little opportunity to substitute stored soil moisture for irrigation water. The average seasonal change in soil moisture content was 0.9 inches/foot of soil depth at 38 feet for the sandy loam.

ONION

Experimental Procedures

The first experiment (2002) investigated the response of processing and fresh-market onion to subsurface and surface drip irrigation on silty loam. High flow drip tape (0.45 gpm/100 feet) was used with an emitter spacing of 12 inches. Depth of the drip tape of the subsurface system was 8 to 9 inches. Both crops were planted on January 27, 2002 and harvested on September 4, 2002. The irrigation treatments consisted of water applications of 120%, 105%, 90%, 75%, and 60% of a baseline amount, estimated to be an amount equal to 100% of the crop evapotranspiration. Subsamples of the processing onions were obtained for quality analyses. Yields of the fresh market onions were separated into grades of colossal, jumbo, medium, and repack. Grade sizes were colossal (diameter greater than 3.5 inches); jumbo (between 3.0 and 3.5 in.); medium (between 1.6 and 3.0 in.); and repack (smaller than 1.6 in.).

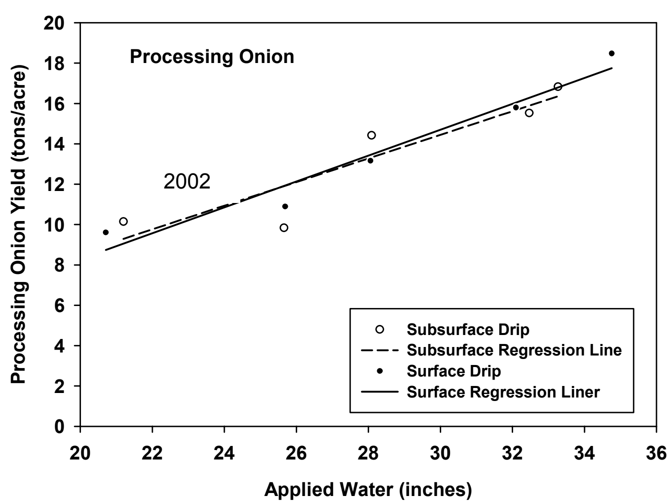
The second experiment (2005) consisted of applying water in amounts of 80, 100, 120, 140, and 160 % of an amount considered to equal 100% of the crop evapotranspiration (baseline amount). Surface drip irrigation with low flow drip tape was used on fresh market onions. In one of the treatments, two drip lines per bed was used. The distributions of soil water content and root density around the drip line was also determined.

A third experiment used a sprinkler line source in a clay loam soil. Processing and fresh market onions were grown.

Results

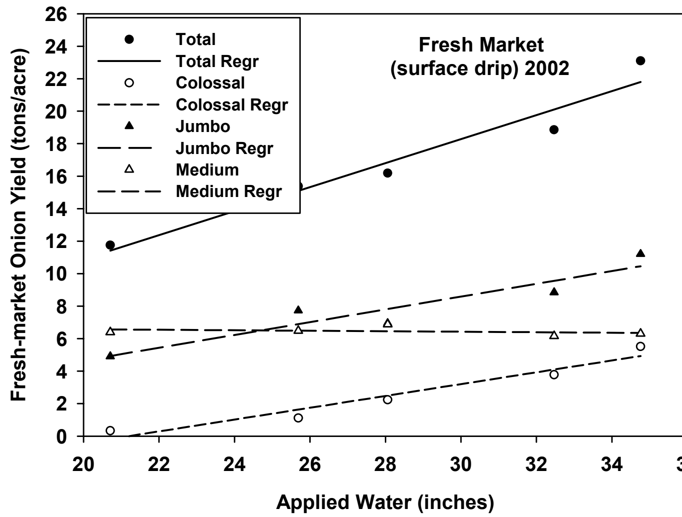
Results of the first drip experiment (2002) showed processing onion yield to increase with increasing applied water for both surface and subsurface drip irrigation (Fig. 2). The soluble solids decreased slightly as applied water decreased (data not shown). Yield differences between subsurface and surface drip irrigation were insignificant. For water applications greater than 100% of the baseline amount, yield continued to increase with applied water.

Fig. 2. Processing onion yield versus applied water for surface and subsurface drip irrigation.



Total fresh-market onion yield also increased with increasing amounts of applied water (Fig. 3). Both colossal and jumbo onion yields increased with increased applied water, while yield differences with applied water were insignificant for the medium and repack grades. Yield of the colossal grade was less than that of the jumbo grade.

Fig. 3. Fresh market yield versus applied water for surface drip irrigation.



Yield differences between subsurface and surface drip irrigation were insignificant. However, caution should be used in applying these results to other soil types, where horizontal water movement from the drip line is poor.

The sprinkler line source data showed both processing onion and fresh market onion yield to decrease with decreasing amounts of applied water in clay loam (data not shown). This is in contrast to the garlic data. Onions were unable to extract soil moisture at depths deeper than about 12 inches.

The 2005 drip experiment showed yield to increase with applied water up to 160% of the baseline amount, primarily due to a yield increase in the colossal size onions (data not shown). Two drip lines per bed had no effect on yield compared to one drip line. Most of the roots were limited to the top 6 inches of the soil profile, however, soil moisture extraction occurred at deeper depths.

Conclusions

Garlic is able to substitute soil moisture for irrigation water under deficit irrigation in clay loam by extracting soil moisture as deep as 5 to 6 feet. However, deficit irrigation of garlic in sandy loam reduces yield. Onion, however, cannot substitute soil moisture for irrigation water in clay loam, and thus, yield decreases with applied water.

The 2002 onion yield behavior with applied water indicates that yield would continue to increase with water applications exceeding 120% of the potential crop evapotranspiration. Little difference in onion yield was found between surface and subsurface drip irrigation. However, this behavior might not occur in soils with limited horizontal movement of water during drip irrigation. The 2005 data showed yield to increase up to amounts equal to 160% of the baseline. This suggests that the historical estimates of onion water use may be too low. This experiment will be repeated in 2006.

Weed Control Research Highlights in Onions and Garlic

Kurt Hembree, Richard Smith, and Grant Poole
Farm Advisors, Fresno, Monterey, and Los Angeles Counties

There have not been any new herbicides introduced in onions and garlic in California for a number of years. Weeds that continue to be difficult to control include mustards, shepherd's-purse, london rocket, nightshade, nutsedge, and field bindweed. In most cases, growers must rely on a series of herbicide treatments, from planting through lay-by, to provide adequate weed control. *Chart 1 lists currently registered herbicides in onions and garlic and their timing of application.*

Because onions and garlic are shallow-rooted, slow growing, and do not compete well with weeds, it is essential that weeds are controlled after planting for stand and yield. Unfortunately, herbicides registered between planting and the 2^{nd} true leaf stage are very limited. Many times, Goal applied alone or in combination with Buctril, can be injurious to onions. Additionally, multiple applications are usually needed for adequate weed control, from the 2^{nd} through the 5^{th} leaf stage. There is a need for herbicides that will effectively control weeds before the second leaf stage in onions. In garlic, Prowl and Goal are registered post-planting, preemergence and provide good annual weed control. Like in onions, Goal can cause crop injury and multiple applications are often needed. Field bindweed is also problematic in onions and garlic prior to harvest, and no herbicides are currently registered for its control.

Numerous studies were conducted in central and southern California during 2004 to evaluate various herbicides for weed control in onions and garlic. This report summarizes these studies conducted primarily in Fresno County (Kurt Hembree), Monterey County (Richard Smith), and in the high desert area of Los Angeles County (Grant Poole).

Onions

GoalTender 4F is a new formulation of Goal which has 44% more active ingredient (oxyfluorfen) than the 2XL formulation. GoalTender has less inert ingredients than the Goal 2XL formulation and has been shown to cause less crop injury in some field studies. Trials were conducted to see if GoalTender 4F could be applied to onions at the 1-leaf stage without injuring onions. Onions treated at the 1 leaf stage (½ to ¾ expanded) with GoalTender 4F were less injured than when treated with Goal 2XL at similar rates (Table 1). Rates of GoalTender 4F of 0.0625 to 0.1875 lb ai/acre (2 to 6 floz/acre product) resulted in slight onion injury, but was considered acceptable, when compared to the 2XL treatments (see pictures below).

Chart 1. Herbicides registered in onion and garlic in California in 2004

Trade name	Common name	Onion Timing*	Garlic Timing*
Vapam	Metam sodium	PP	PP
Prefar	Bensulide	PP, PPP	PP, PPP
Dacthal	DCPA	PPP at ≤ 14 weeks	PPP and 3-5 leaf banded
Prowl 3.3 or Prowl H$_2$0	Pendimethalin	2-6 leaf	PPP and 1-5 leaf
Goal 2XL / GoalTender 4F	Oxyfluorfen	2-4 leaf	PPP and >12" tall / ≥ 2 leaf
Buctril	Bromoxynil	2-5 leaf	>12" tall
Prism	Clethodim	≥ 1 leaf	≥ 1 leaf
Fusilade	Fluazifop	≥ 1 leaf	≥ 1 leaf
N-Phuric	Nitrogenous fertilizer	1 leaf	Not recommended
Poast	Sethoxydim	≥ 1 leaf	≥ 1 leaf

* PP = Preplant and PPP = Postplant preemergence

2 floz 4 floz 6 floz 8 floz 16 floz **4 floz 8 floz 12 floz 16 floz 32 floz**

Similarly, these rates did not result in reduced onion yields (Table 2). As a result of these and other studies, a registration for GoalTender 4F is being pursued in California in onions for treatment at the 1-leaf stage.

The preemergence herbicides registered after planting onions provide less than adequate weed control, can cause crop injury (particularly in sandy soils), or are often expensive. Chateau (flumioxazin) was recently registered in California in certain crops, including cotton and orchards and vineyards. Preliminary results in 2003 showed that Chateau could be applied to direct-seeded onions at ultra-low rates (1/8 to 1/4 oz/acre) following planting and provide at least two to three months of residual control of annual weeds, including london rocket, shepherd's-purse, chickweed, and nightshade. Prowl H_2O is a new formulation of Prowl that had not been evaluated in onions in California prior to 2004.

Studies were conducted in 2004 under various soil types to determine if Chateau and Prowl H_2O could provide adequate weed control without harming onion growth when applied following planting and sprinkler irrigated.

Chateau provided nearly 100% weed control in all sites, but onion stand was affected, based on soil type. In a Panoche clay soil (Fresno County), and in a Pico fine sandy loam (Monterey County) onion stand and growth was excellent (Tables 3 and 4), but in a sandy soil (Lancaster), stand loss was from 78 – 97% (Table 5). Prowl H_2O, applied at 1.2 and 1.8 pt/acre after planting and incorporated with sprinklers, resulted in a 25% stand loss. Similar rates of Prowl H_2O applied at the early flag or "loop" stage provided good weed control while only reducing onion growth by about 5 to 10% (Table 6). Additional work will be conducted to further investigate whether Chateau can be safely used under different soil types. The registrant of Prowl H_2O (BASF) is interested in pursuing a registration for this early onion timing once additional data is generated.

Table 1. Onion injury in Lancaster, CA, 2004

Treatment	Lb ai/A	Product/A	Injury – 7 days	Injury – 14 days	Growth – 25 days
1. GoalTender 4F	0.0625	2.0 floz	1.7	2.0	10.0
2. GoalTender 4F	0.125	4.0 floz	4.3	2.0	9.3
3. GoalTender 4F	0.1875	6.0 floz	5.7	3.7	8.7
4. GoalTender 4F	0.25	8.0 floz	6.3	5.0	6.8
5. Untreated	---	---	0.0	0.0	10.0
LSD @ p= 0.05			**1.55**	**1.05**	**1.13**

Table 2. Onion yield in Monterey County, 2004

Treatment	Lb ai/A	Product/A	Timing	No./plot	Lbs/plot	Lbs/bulb
1. Dacthal W75	8.0	10.0 lb	Preemergence	79.8	62.2	0.78
2. Goal 2XL*	0.25	16.0 floz	1 leaf	66.8	54.9	0.74
3. GoalTender 4F	0.125	4.0 floz	1 leaf	80.0	59.4	0.82
4. GoalTender 4F*	0.125	4.0 floz	1 leaf	77.8	63.3	0.81
5. GoalTender 4F	0.25	8.0 floz	1 leaf	78.3	63.1	0.81
6. GoalTender 4F*	0.25	8.0 floz	1 leaf	73.3	60.9	0.83
7. Goal 2XL*	0.25	16.0 floz	2 leaf	76.0	60.3	0.79
8. GoalTender 4F*	0.25	8.0 floz	2 leaf	76.3	61.2	0.80
9. Handweeded	---	---	---	79.0	57.8	0.73
LSD @ p= 0.05				**10.1**	**6.9**	**0.06**

Table 3. Onion stand and weed control on a Panoche clay loam soil in Fresno County, 2004

Treatment	Lb ai/A	Product/A	No. onion/10' bed	No. SP/5'	No. LR/5'
1. Chateau	0.004	1/8 oz	239	0.1	0.0
2. Chateau	0.008	1/4 oz	206	0.0	0.0
3. Dacthal	10.0	13.3 lb	235	185.6	35.8
LSD @ p=0.054			**15.8**	**5.0**	**2.4**

SP = Shepherd's-purse and LR = London rocket

Table 4. Onion stand, weed control, & yield on Pico fine sandy loam soil in Monterey County, 2004

Treatment	Lb ai/A	Product/A	Weeds/plot	Onion stand	Lbs/ plot
1. Dacthal	8.0	10.7 lb	8.5	144.3	62.2
2. Chateau	0.004	1/8 oz	2.3	155.0	60.5
3. Chateau	0.008	1/4 oz	1.2	152.7	60.9
4. Untreated	---	---	49.3	148.7	57.8
LSD @ p=0.054			9.2	16.9	6.9

Table 5. Onion stand and weed control on a sandy soil in Lancaster, 2004

Treatment	Lb ai/A	Product/A	Weed control	Onion stand	% Stand loss
1. Chateau	0.004	1/8 oz	96.7	91.7	78.3
2. Chateau	0.006	3/16 oz	100	51.3	91.7
3. Chateau	0.008	1/4 oz	100	25.3	97.7
4. Untreated	---	---	0.0	282.3	0.0
LSD @ p=0.054			35.2	70.5	31.6

Table 6. Onion stand and weed control on a sandy soil in Lancaster, 2004

Treatment	Lb ai/A	Product/A	Weed control	Onion stand	Onion vigor
1. Chateau	0.008	1/4 oz	93.0	187	4.7
2. Chateau	0.016	1/2 oz	100	92	2.0
3. Prowl H_2O	0.54	1.2 pt	93.0	327	8.7
4. Prowl H_2O	0.81	1.8 pt	99.0	335	9.3
5. Untreated	---	---	0.0	321	10.0
LSD @ p=0.054			5.81	75.6	2.20

Table 7. Yellow nutsedge control, onion injury, and growth in the Antelope Valley, 2004

Treatment	Lb ai/A	Product/A	Timing	Nutsedge control	Onion injury	Onion growth
1. Outlook	0.66	14 floz	2-leaf	63.3	3.0	9.0
2. Outlook Outlook	0.66 0.66	14 floz 14 floz	2-leaf 24 days later	83.3	3.0	9.0
3. Untreated	---	---	---	0.0	0.0	10.0
LSD @ p=0.054				25.6	n.s.	1.3

Yellow nutsedge is a major perennial weed in onions. Onions, because they are shallow rooted, slow growing. and have relatively poor canopy development, do not compete well with nutsedge. There are currently no herbicides registered in onions that effectively control nutsedge following planting. Trials were conducted in the Antelope Valley to see if (metolachlor) Dual Magnum or dimethenamid (Outlook) could control nutsedge, without injuring onions, if applied after the crop was emerged, but before the nutsedge was emerged.

Dual Magnum provided excellent nutsedge control (94-98%) when applied at the onion 2-leaf stage at rates of 1.3 and 1.6 pts/acre, respectively, but significantly injured onions. Onions treated at the 3rd and 4th true leaf stage were only slightly injured, but nutsedge was not effectively controlled, because they had already emerged by the time of treatment. Outlook applied at 14 floz/acre as a single or sequential application (2-leaf or 2-leaf plus 24 days later) only slightly injured onions and reduced growth, but was not significantly different from the untreated control plots (Table 7). The single application gave 63% control, while the sequential application gave 83% nutsedge control.

While Dual Magnum provided excellent nutsedge control, having to delay treatment until onions are less likely to be injured (3rd to 4th leaf stage), would probably not be acceptable in cases where nutsedge emerged in fields earlier than this. Onions planted in the southern SJV in November and December would probably benefit from this treatment, since they should be at this stage of growth before nutsedge would be expected to emerge. Additional work needs to be conducted in the southern SJV to justify a possible regional registration. Although Outlook did not provide perfect nutsedge control, making two timely applications, beginning at the onion 2-leaf stage, may give growers a means of at least managing nutsedge in fields that are infested, without sacrificing yields.

Table 8. Garlic growth and yield in Fresno County in 2003

Treatment	Lb ai/ Acre	Product/ acre	Growth 45 days	Growth 60 days	Growth 90 days	Lbs/ 20' plot	Ton/ acre
1. Prowl Goal	0.83 0.125	32 floz 8 floz	10.0	10.0	10.0	24.2	3.95
2. Chateau	0.188	6.0 oz	10.0	9.9	10.0	28.30	4.62
3. Chateau	0.25	8.0 oz	9.9	9.8	10.0	30.17	4.93
4. Chateau	0.375	12.0 oz	9.6	9.5	9.9	29.09	4.76
5. Prowl Chateau	0.83 0.188	32.0 floz 6.0 oz	9.8	9.9	9.9	23.20	3.79
6. Prowl Chateau	0.83 0.25	32.0 floz 8.0 oz	9.7	9.8	9.9	25.87	4.22
7. Prowl Chateau	0.83 0.375	32.0 floz 12.0 oz	9.6	9.5	9.8	24.23	3.96
8. Untreated	---	---	9.9	8.8	7.0	15.93	2.60
LSD @p = 0.05			**0.22**	**0.55**	**0.70**	**8.15**	**1.33**

Garlic

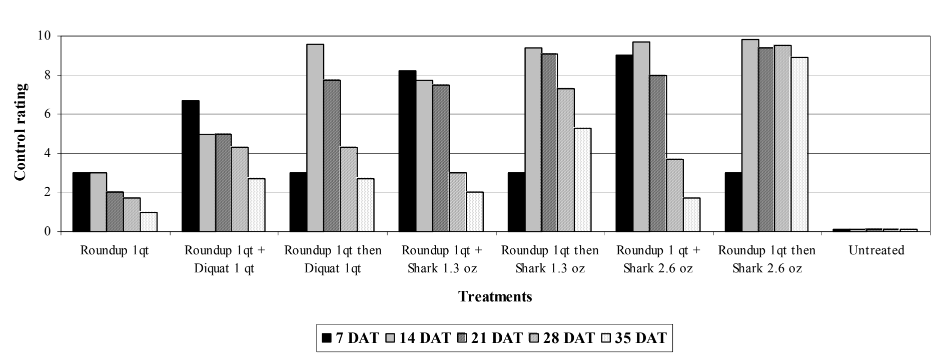
Like onions, garlic is not a very competitive crop early in the growing season. When garlic is about 12 to 16" tall, the plants have a well developed canopy and can compete better with weeds. For early-season weed control, growers typically use a combination of Prowl plus Goal after planting, followed by sprinkler irrigation for incorporation. In most cases this will give at least 2 to 3 months of good residual control. Timely cultivation is needed to aerate the soil and control escaped weeds. While this herbicide combination generally provides good winter weed control, it can cause some crop injury, particularly in cold, wet years. Additionally, a follow-up application of Goal and/or Buctril is usually required at row closure to control summer weeds like nightshade.

From 2000 to 2004, studies were conducted in western Fresno County to determine if Chateau could be applied post-planting, preemergence for weed control in garlic. Results commonly showed that Chateau, applied alone at 3 to 12 oz/acre or in combination with Prowl, gave equal or better weed control than the standard Goal plus Prowl treatment. Residual control was also excellent, depending on rate of Chateau used. In most cases, for every 2 oz of Chateau used, weed control could be expected to last at least 1-2 months. Twelve oz/acre generally gave season-long control. No injury or losses of crop growth or yield were seen in any of the studies (Table 8). The registrant (Valent) is currently pursuing a label for a 2-leaf timing and later treatment, with a post-planting, preemergence label to hopefully follow.

Field bindweed is a perennial, wiry weed that forms large mats on the soil surface, which can smother crops like garlic. In garlic, it is particularly problematic prior to harvest. Following the termination of irrigation water, garlic tops are allowed to dry to facilitate topping and digging of the garlic bulbs. The growth of field bindweed during this time increases the relative humidity of the crop canopy, which can increase drying time in the field. It also interferes with topping and digging by becoming entangled in harvest machinery, reducing harvest efficiency and increasing production costs. Several studies were conducted in western Fresno County since 2000 to evaluate the efficacy of foliar herbicides on field bindweed control prior to topping and harvesting garlic. Combinations of herbicides were applied to patches of field bindweed following irrigation cutoff, prior to topping garlic.

Roundup Ultra, applied over-the-top at 1 qt/acre, followed seven days later with a treatment of Shark at 2.6 oz/acre, provided >90% control for at least 35 days after treatment (Chart 2). In most cases, this would be adequate time to facilitate drying of garlic in the field for a timely harvest. As a result of this work, Roundup Ultra was labeled in California for field bindweed control prior to harvesting processing garlic. The registration of Shark for the second half of this treatment combination is expected following residue tolerance studies (currently in the IR-4 program).

Chart 2. Field bindweed control - 2002



Fungicides for Control of Downy Mildew and Purple Blotch of Onion

Jim Farrar, Department of Plant Science, California State University, Fresno

Downy mildew and purple blotch are two common fungal foliar blights of onions. Downy mildew is caused by *Peronospora destructor*, a cousin of the organisms that cause Phytophthora root rot and Pythium damping off. Purple blotch is caused by *Alternaria porri*. Purple blotch can not be distinguished from Stemphylium leaf blight in the field. The disease can be distinguished by the shape of the spores under the microscope. For this study, both purple blotch and Stemphylium leaf blight are considered together as purple blotch.

Symptoms of downy mildew begin as elongated slightly chlorotic areas of the older leaves. During foggy or rainy weather or after heavy morning dew the chlorotic areas may grayish purple fuzzy growth. This growth is the spore producing structures of the downy mildew fungus. The spores become airborne in air currents or if the relative humidity drops. The spores can spread to neighboring leaves and begin new infections.

Purple blotch symptoms often begin in tissue damaged by downy mildew infection or herbicide injury. The spots are smaller than downy mildew, may have a concentric oval appearance, and are often brown to purple. Older lesions may be covered with velvety, dark gray spores. These spores can also spread to neighboring plants and begin new infections.

An experiment to evaluate fungicides for control of downy mildew and purple blotch of onion was conducted in the University Agricultural Laboratory at California State University, Fresno. On 5 November 5, 2003, 'Stockton early red' onion transplants were sown four inches apart in four lines on 60-inch-wide beds. The soil type was Atwater loamy sand. The transplants were sprinkler irrigated to establish the stand. Later the field was converted to drip irrigation. Weeds were controlled by three applications of Goal 2XL at 0.5 pint/acre. The Goal applications caused some necrotic spots on the onion foliage. Each experimental plot consisted of one 20-ft-long bed. The experimental design was a randomized complete block with four replications per treatment. Fungicides were applied using a Solo backpack sprayer at 20 psi with a two nozzle wand with Lurmark 04F110 nozzles. Fungicides were applied in 67 gal water/acre. Applications were made on every seven days on February 6, February 13, February 20, February 27, March 5, March 12, March 19, March 30, April 9, April 16, and April 23. Severity of each disease was rated as the percent leaf area affected on 10 arbitrarily selected leaves per plot. On May 29, the center 10 ft of each plot was harvested and graded yields were recorded.

Downy mildew severity was high in April due to a cooler than normal spring. Purple blotch pressure was low throughout the season. Most purple blotch lesions were associated with either downy mildew lesions or necrotic spots caused by Goal herbicide damage. All fungicide treatments significantly reduced downy mildew on both rating dates and purple blotch on April 23 compared to the untreated check. Ridomil Gold/Bravo alternated with Acrobat plus maneb gave the best disease control in all evaluations, but was statistically equivalent to Amistar plus maneb, Switch plus maneb, and BAS 550 07F plus Penetrator. Disease control with BAS 550 07F was moderate when used alone but was better when tank mixed with either maneb or Penetrator. Harvest data was highly variable and there were no significant differences between treatments for either graded yield or total yield. No phytotoxicity was observed from any of the fungicide treatments.

Treatment, rate/A, (application times) [z]	Downy Mildew [y]		Purple Blotch [y]	
	Apr 23	May 7	Apr 23	May 7
Untreated Check	29.6 a	18.0 a	4.5 a	1.3
Ridomil Gold/Bravo, 2 lbs (1,2,5,6,9,10) alt w/ Acrobat 50WP, 6.4 oz + Maneb 75DF, 2 lb (3,4,7,8,11)	0.6 d	0.1 c	0 b	0.3
Amistar, 4 oz + Maneb 75DF, 2 lb (1-11)	2.1 cd	3.4 bc	0 b	0.3
Switch, 14 oz + Maneb 75DF, 2 lb (1-11)	9.0 bcd	5.1 bc	1.0 b	0.6
Bravo WeatherStik, 2 pt + Maneb 75DF, 2 lb (1-11)	11.5 bc	6.4 b	0.2 b	0.6
BAS 550 07F, 6.1 fl oz (1-11)	15.1 b	9.4 b	0.3 b	0.3
BAS 550 07F, 6.1 fl oz + Maneb 75DF, 2 lb (1-11)	5.6 bcd	6.8 b	0.2 b	1
BAS 550 07F, 6.1 fl oz + Penetrator, 2 pt (1-11).	4.6 cd	3.8 bc	0.3 b	0.3

[z] Applications: 1= 6 Feb; 2= 13 Feb; 3= 20 Feb; 4= 27 Feb; 5= 5 Mar; 6= 12 Mar; 7= 19 Mar; 8= 30 Mar; 9= 9 Apr; 10= 16 Apr; 11= 23 Apr

[y] Average percent leaf area diseased rated on 10 leaves per plot.

Leaf Blights of Onion

Joe Nuñez, Farm Advisor, Kern County

For several years the onion growers in the Antelope Valley region have been affected by a leaf blight of unknown origin. Although a bacterial disease had been suspected, the exact cause of the problem had not been determined. In 2001 a bacterium identified as a *Xanthomonas* species was isolated from the plants. Greenhouse tests proved that *Xanthomonas* was the cause of the leaf blight. **Prior to this, Xanthomonas leaf blight of onions had never been reported in California.**

Xanthomonas leaf blight has only been reported in a few places in the world, the first time in Hawaii in 1974. Since then, it has been found in Texas, Colorado, and a few other places outside of the USA. Because it is a relatively new disease of onions, very little is known about it. How it is introduced, spreads, and what can be done to control or manage is presently being investigated.

Symptoms of Xanthomonas Leaf Blight

Affected plants develop water-soaked lesions that appear first on the outer leaves before spreading onto the younger inner leaves. The elliptical lesions, which spread up and down the leaf blade, eventually become dry and papery as they age. In some fields, the majority of the plant canopy may be affected. In some fields, in the past two years well over half of the canopy collapsed. Although the lesions never spread into the bulbs, yields are apparently reduced since the bulbs are smaller than normal, presumably due to the loss of leaf area.

Bactericides seem to keep Xanthomonas leaf blight in check and it has not been noticed anywhere in California outside of the Antelope Valley.

In 2004, another bacterial leaf blight appeared in the Antelope Valley and Kern County almost simultaneously. The symptoms where very similar to Xanthomonas leaf blight just described, but the difference was that the young inner leafs became bright yellow and had definite bacterial oozing. Microscopic examination revealed that the inside of the young leafs were filled with bacteria.

UC Davis and Colorado State University both identified the bacterium as *Pantoea agglomerans* (formally named *Erwinia herbicola*). This bacteria has been reported in the literature as a relatively minor disease of onion that occasionally causes considerable damage under the correct conditions.

The common link between the field in Kern County and the field in the Antelope Valley was a particular seed lot. At this time it is believed that an infested seed lot with *Pantoea agglomerans* was planted, and favorable conditions allowed it to infect those plants and spread to other adjacent varieties. This was likely an isolated incident that hopefully will not occur again.

Although most of the onion bacterial problems seen in California cause bulb rots, occasionally we can see bacterial diseases that only cause leaf blights. Knowing the cause of a disease is always important so that the correct steps can then be taken to correct the problem.

Another "new" leaf blight disease of onions to be aware of is Iris Yellow Spot Virus (IYSV). IYSV is an emerging disease of onions in the Western US. Ten years ago it was common in many onion seed fields in parts of the Western US. However in 2001 the virus appeared in commercial bulb fields in Washington, Idaho, Utah, Oregon, and Colorado. There already have been reports of it being in California in seed and commercial bulb fields.

Symptoms of Iris Yellow Spot Virus are eyespot to diamond shaped yellow or straw colored lesions on the seed stalk or leaves. Infected leaves will fall over later in the season and dry out. Infected plants are very susceptible to environmental stress such as heat, drought, or poor nutrition. Although the plants aren't killed by IYSV, bulb size is reduced because of the loss of green leaf tissue.

IYSV is vectored by the onion thrips (*Thrips tabaci*) but hasn't been shown to be vectored by the Western Flower Trips (*Frankliniella occidentalis*). IYSV is classified as a Tospovirus related to Tomato Spotted Wilt Virus and Impatiens Necrotic Spot Virus. Like all plant viruses, once a plant is infected with IYSV there is no cure. However, IYSV infection does not mean plant death. There are steps that can be taken to reduce the impact of IYSV.

1. Maintain optimum growing conditions (fertility and irrigation) to allow onion plants to grow and produce sizable onions.
2. Remove volunteer onions which can be a source of IYSV.
3. Take steps to reduce thrips populations.
4. Examine nearby crops such as small grains and dry beans because as they dry down, thrips often leave in masses to greener crops such as onions.

Garlic White Rot Trial - Progress Report

Shannon Mueller[1], Kurt Hembree[1], and Mike Davis[2]
[1]UC Cooperative Extension, Fresno County and [2]Department of Plant Pathology, UC Davis

Introduction

White Rot is a growing problem in garlic and onion producing areas throughout the world. In the San Joaquin Valley, there are over 82 infected fields affecting more than 12,662 acres. The disease is caused by a fungus, *Sclerotium cepivorum,* which only attacks alliums (onion and garlic). It is a significant threat to production areas because the reproductive structures of the fungus (sclerotia) remain viable in the soil for decades once a field is infected, even in the absence of a host.

Sclerotia are very small, the size of a poppy seed, and can be easily spread with infested seed cloves and/or plant material, soil or debris on farm equipment, water, and movement of people and/or animals. Germination of sclerotia is stimulated by organic sulfur compounds emitted from the roots of growing garlic or onion plants. When the sclerotia invade the host plant, the bulb rots and the plants die. Biostimulants, such as diallyl disulfide (DADS) and garlic powder, have been shown to effectively reduce sclerotia populations in the soil (>90%), achieving disease control similar to methyl bromide fumigation, but as soon as a susceptible crop is planted, the disease quickly reaches economically damaging levels.

Currently registered fungicides applied at planting in the fall do not have adequate residual activity to prevent the disease when sclerotia become infective in the spring.

Materials and Methods

A trial was designed to evaluate the efficacy of fungicides applied as seed treatments, in furrow applications, and foliar applications in controlling white rot in garlic. The trial was conducted in a commercial field on the West Side of Fresno County where high levels of the disease were identified several years ago.

Seed treatments and in furrow treatments were applied at planting on 11/19/03. Garlic variety *California Early* was planted by hand and Prowl and Goal were applied for weed control. Plots were sprinkler irrigated throughout the season.

Disease development is favored by cool, moist soil conditions, typical of springtime weather patterns in the central San Joaquin Valley. Foliar fungicide treatments began as soon as soil temperatures reached the optimum level for infection. This was determined using weather records from the West Side Research and Extension Center in Five Points, CA (**Figure 1**). Sclerotia germinate between 59-64 °F and the range for infection is 50-75 °F, with optimum soil temperature between 60-65 °F. When temperatures rise above 78°F, disease is inhibited.

Irrigation was terminated at the grower's discretion, using typical commercial standards. The field was topped and sprinkler irrigated to facilitate harvest. Plots were harvested with a commercial harvester.

Results

Disease Evaluations (Figure 2)

In the spring, disease ratings were made using a scale from 0 to 10 where 0 = No visible symptoms of disease, all plants healthy and green and 10 = All plants dead. Plots were rated six times during the season. Early in the season, symptoms were evident on the lower leaves. Lower leaves were yellow, wilting, and some had died. Diseased bulbs showed black rot with white mycelium and black sclerotia. There were statistically significant differences in the diseases scores for the various treatments. The untreated control, and foliar applications of Switch, Pristine, or Botran, and soil applied Rovral treatments all had the highest disease scores. Folicur, as a seed treatment or soil applied, and soil applied Switch and Botran were equivalent, and significantly lower than the other treatments. There was a fairly clear separation throughout the evaluation period between the foliar treatments and the soil/seed treatments.

Treatment	Rate	Application Method
1. **Planted,** Untreated control	---	---
2. **Folicur** *(Bayer)*	0.4 oz ai/cwt	Seed treatment
3. **Folicur** *(Bayer)*	2 lb product /A	In furrow
4. **Switch** *(Syngenta)*	14 oz product/A	In furrow
5. **Switch** (Syngenta)	14 oz/A/application	Foliar
6. **Pristine** *(BASF)*	18.5 oz/A/application	Foliar
7. **Botran** *(Gowan)*	102 oz/A	In furrow
8. **Botran** *(Gowan)*	50 oz/A/application	Foliar
9. **Rovral** *(standard)*	4 lbs/A	In furrow
10. **Unplanted,** Untreated Control	---	---

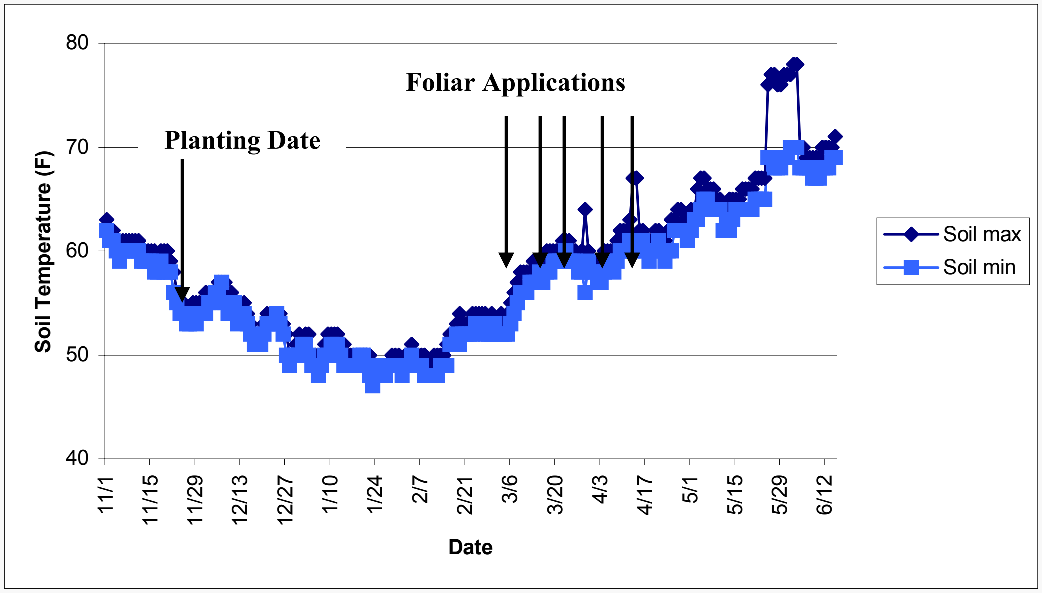


Fig 1. **Maximum and Minimum Soil Temperatures Recorded at UC WSREC, 2003/2004.**

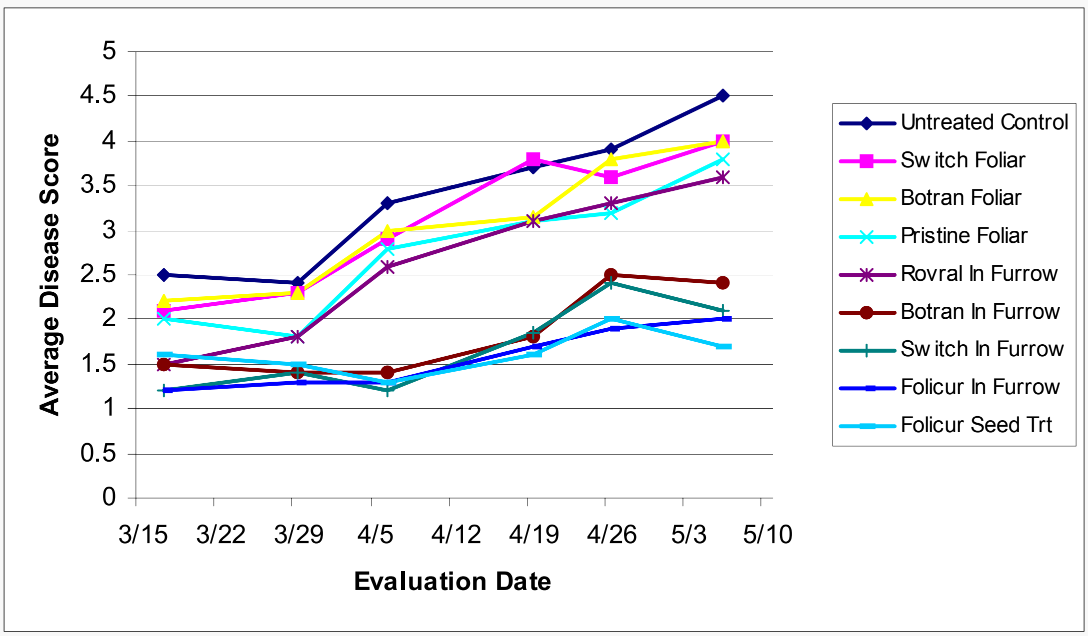


Fig 2. Average Disease Scores During Rating Period. Garlic White Rot Trial, 2004.
0 = No visible disease symptoms and 10 = All plants dead.

Yield (Table 1)

There were highly significant yield differences in this trial. Relative to the untreated control, white rot symptoms were reduced and yields were increased by fungicide applications. The highest yields were recorded where either a seed treatment or soil application of Folicur, Switch, or Botran was made prior to planting. Foliar treatments using Switch, Pristine, or Botran did not provide any yield benefit. Rovral, which has been the standard treatment, was better than nothing, but seed treatment and other soil-applied materials were significantly better. Yield trends correlated very well with the disease ratings recorded during the season. Plots with the highest disease ratings yielded the least.

Table 1. Average Yields (Dry Tons/Acre) and Final Disease Scores Garlic White Rot Trial, West Side of Fresno County, 2004.

Treatment	Yield (T/A)	Disease Score[1] from 5/6/04
Folicur *(in furrow)*	8.4 a	1.7 d
Folicur *(seed treatment)*	8.4 a	2.0 cd
Switch *(in furrow)*	7.7 ab	2.4 cd
Botran *(in furrow)*	7.2 ab	2.1 cd
Rovral *(in furrow)*	5.9 cd	3.6 ab
Switch *(foliar)*	5.4 de	3.8 ab
Pristine *(foliar)*	5.3 de	4.0 a
Botran *(foliar)*	5.1 de	4.5 a
Planted, Untreated Control	4.5 e	4.0 a
Unplanted, Untreated Control	---	---
P-Value	**0.0000**	**0.0000**
LSD (0.05)	*1.198*	*0.961*
C.V (%)	*12.75*	*24.16*

[1]Disease Score: 0 = No visible symptoms of disease, all plants healthy and green
10 = All plants dead

Conclusions

It is clear that a multi-layered approach will be required to minimize the impact of white rot on garlic production. Use of biostimulants has proven to reduce sclerotia populations in infected fields. Combining this strategy with seed treatments or soil-applied fungicides at planting may help maintain this disease at manageable levels. Alternative approaches also need to be considered, such as soil solarization, flooding, deep cultivation, metam sodium or batan applications, or injection of fungicides through the drip system.

As evidenced by the rapid increase in the number of infected fields each year, this disease spreads quickly. Preventing infection of clean fields is crucial. Along with research efforts, a targeted educational program needs to be implemented. Anyone entering an infected field, no matter what the current crop is, must understand the risk of contamination as they move themselves or equipment to other sites.

WHITE ROT – The Curse of the Alliums*

Distribution

- USA: California, Oregon, Nevada, New York
- Canada, Mexico
- Europe, United Kingdom
- Asia, Africa
- Central & South America
- Australia & New Zealand

Methods of Spread

- Infected soil on equipment
- Seed
- Animals
- Other Plant material

Research Efforts

- Biostimulants: Garlic Powder & DADS
- Chemical control
  - Seed Treatment
  - In-furrow application
  - Methyl bromide spot treatment
  - Metam sodium spot treatment
- Soil solarization
- Flooding

Possible Treatment Regime

- Year 1 – White Rot Identified
- Spot treat with metam sodium or equivalent
- In following crop rogue all volunteer garlic
- Prior to planting 3rd crop, apply garlic powder or AlliUP
- Prior to planting 4th crop, apply garlic powder or AlliUP
- Rotate back to onions or garlic and apply in-furrow application of Folicur or Switch

Summary of White Rot Strikes 1994-2004

Year	Fields with White Rot	Acres
1994	4	640
1995	5	960
1996	3	520
1997	0	0
1998	0	0
1999	12	1,775
2000	5	800
2001	8	1,462
2002	14	2,047
2003	19	2,825
2004	11	1,669
Totals	**82**	**12,662.92**

*Compiled by Bob Ehn, CA Garlic and Onion Research Program

Garlic Germplasm Collection:
Dry matter, Alliin and Thiosulfinate Contents of Accessions

Marita Cantwell, Gyunghoon Hong, and Ron Voss
Mann Lab, Dept of Plant Sciences, UC Davis

Garlic is approximately 40% dry weight with the major complex carbohydrate being fructan with a small portion of free sugars. Garlic flavor is due to the formation of organosulfur compounds when the main odorless precursor, alliin (s-allyl cysteine sulfoxide), is converted by the enzyme alliinase. The main compound formed by this reaction is a thiosulfinate, allicin, and this is responsible for the characteristic odor and flavor of fresh garlic. Allicin comprises about 80% of total thiosulfinates. Alliin is also the precursor of the compounds responsible for the health benefits of garlic. We measure alliin concentrations by HPLC and thiosulfinates by a spectrophotometric method. Garlic cultivar as well as growing conditions can impact the compositional quality of the garlic cloves.

During the past several years we have been evaluating the composition quality of a USDA Garlic Germplasm Collection comprising more than 200 accessions from 38 countries. The collection has been planted at Westside Research and Education Center and in 2000, 2001, 2002 and 2003 we evaluated 89, 57, 44, and 39 accessions, respectively. In 2004 we evaluated almost the entire collection. Examples of the variation in dry matter, alliin, and total thiosulfinate contents are shown in **Figures 1, 2** and **3**. For reference, the % dry weight of CA Early and CA Late cultivars was 39.2 and 40.2%. The alliin concentration of CA Early is consistently lower than that of CA Late and in 2004 those values were 17.9 and 20.6 mg/g DW. Of the 186 accessions studied in 2004, there were about 40 accessions with higher dry weight and alliin contents than CA Late garlic, whereas more than half of the accessions had higher thiosulfinate concentrations. The 2004 compositional data will be included in the GRIN (USDA ARS 'Germplasm Resources Information Network'; http://www.ars-grin.gov/) database for this USDA collection.

In 2002 we planted 40 accessions at two UC Research & Education Centers (BAREC in San Jose and West Side at Five Points). The average % dry weight of BAREC-grown garlic was 38.2% while that of Westside-grown garlic was 39.8% (only 4% higher). However, the alliin concentrations varied considerably between the 2 locations, with concentrations averaging 26% higher in the Westside garlic (20 mg/g DW) than in the BAREC-grown garlic. Alliin concentrations in both locations ranged from 6 to 29 mg/g DW. The average alliin concentrations of CA Early and CA Late cultivars were 19 and 22 mg.g DW in 2002.

Fig. 1: Variation in **dry weight** of 186 accessions.

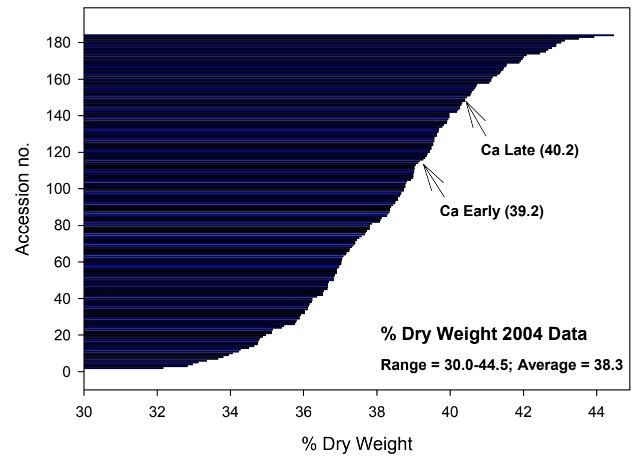


Fig. 2: Variation in **alliin** content of 186 accessions.

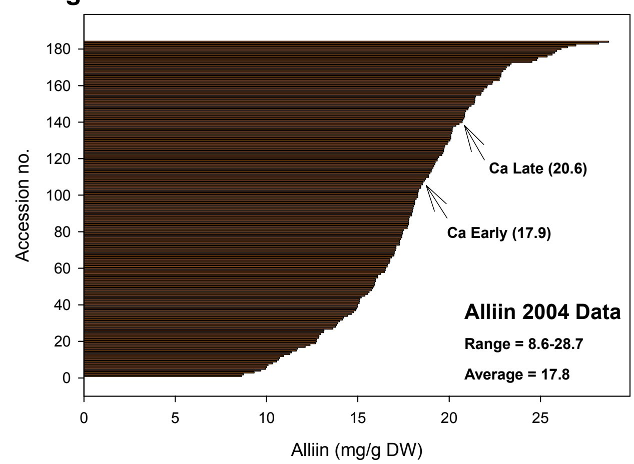
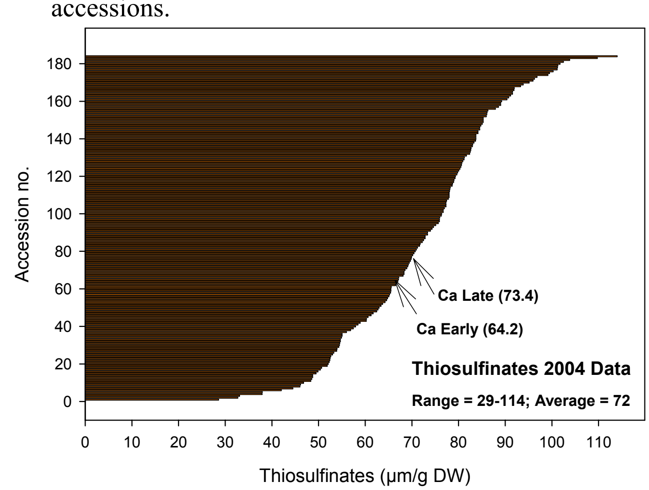


Fig. 3: Variation in **thiosulfinate** content of 186 accessions.



Onion and Garlic Thrips

(from UC IPM Pest Management Guidelines)
Onion thrips: *Thrips tabaci*
Western flower thrips: *Frankliniella occidental*

DAMAGE

Thrips are the most common and serious insect pest of onions, and are found wherever onions are grown in California. High populations of thrips can reduce both yield and keeping quality of onions. Thrips are most damaging when they feed during the early bulbing stage of plant development. Scarring of leaves is a serious problem on green onions. When foliage is severely damaged, the entire field takes on a silvery appearance.

Thrips have rasping-sucking mouthparts and feed by rasping the surface of the leaves and sucking up the liberated plant fluid. They feed under the leaf folds and in the protected inner leaves near the bulb. When population levels are high, thrips can also be found feeding on exposed leaf surfaces. Both adults and nymphs cause damage.

DESCRIPTION OF Thrips

Thrips are very small, slender insects that are best seen with a hand lens: mature onion thrips are about 0.05 inch long and flower thrips are slightly larger at 0.06 inch long. The most distinctive characteristic of thrips are two pairs of wings that are fringed with long hairs. Adults are pale yellow to light brown in color. The immature stages have the same body shape as adults but are lighter in color and are wingless. Western flower thrips adults have red-colored pigment in their eyes; onion thrips eyes are gray.

Both onion thrips and western flower thrips have a very extensive range of hosts, including cereals and broadleaved crops. Both species attack onions, but onion thrips are believed to be more prevalent and injurious. They also can be a problem on garlic, but generally are not as serious a pest as they are on onion. Onion thrips thrive in hot, dry conditions and are usually more damaging in areas where these climatic conditions prevail for most of the production season.

MANAGEMENT

Biological Control: Natural enemies, including predaceous mites, minute pirate bugs, and lacewings, are often found feeding on thrips. These beneficials are very susceptible to insecticide sprays, however, and may not be important in fields where insecticides have been used.

Cultural Control: Avoid planting onions near grain fields, if possible, because thrips numbers often build up in cereals in spring. Overhead irrigation and rainfall provide some suppression of thrips populations, but treatments are often still necessary.

Monitoring and Management Decisions: Although thrips feeding during the early bulbing stage is the most damaging to yields, thrips must be controlled before onions reach this stage so that populations do not exceed levels that can be adequately controlled. Onions can tolerate higher thrips populations closer to harvest; however, in the case of hand-topped onions, thrips can be extremely annoying to harvest crews and treatment closer to harvest may be desirable. Consult IPM website for threshold levels for various crops.

CA Garlic & Onion Industry Issues

Bob Ehn, CA Garlic and Onion Research Program

1. WHITE ROT Marketing Order

A. Marketing Order – Purpose

- To organize onion & garlic growers to develop a white rot management program
- To conduct long and short term research in white rot management
- To develop a white rot Master Plan to prevent further spread of disease
- To initiate other research programs as problems are presented
- To maintain CA position as leader in Allium production

B. Marketing Order – Membership

- All fresh, dehydrated and processed garlic
- All processed onions
- All seed onion and garlic growers
- Areas include Southern desert, San Joaquin Valley and Tulelake production regions

C. Marketing Order – Funding

- Generated by mandatory assessments
- Assessment rate based upon lbs harvested

D. Marketing Order – Board of Directors

- Research Advisory Board consists of 12 members, alternates, and ex-officio members
- Six (6) are Processors, Dehydrators
- Six (6) are growers
- Grower representatives come from all affected areas

2. Additional Research Programs

A. Garlic Rust

B. Bulb Mites

C. Herbicides for bindweed and nutsedge

D. Downy mildew

E. Bacterial soft rots

SOURCES OF INFORMATION – ONIONS and GARLIC

PUBLICATIONS FROM UC

Many items are available at no cost from local UCCE offices or the World Wide Web.

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

UC IPM (homepage)
www.ipm.ucdavis.edu

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

UC Postharvest Technology:
http://postharvest.ucdavis.edu
(be sure to browse the Produce Facts)

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

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

Download these items from the UC VRIC, ANR, or Postharvest websites

Dehydrator Bulb Onion Production in California
ANR Publication 7239
Available in Spanish**:** Producción de cebollas para deshidratado en California

Fresh-Market Bulb Onion Production in California
ANR Publication 7242
Available in Spanish: Producción de cebolla para el Mercado fresco en California

Green Onion Production in California
ANR Publication 7243
Available in Spanish: Producción de cebolla verde en California

Onion Seed Production in California
ANR Publication 8008
Available in Spanish: Producción de semilla de cebolla en California

Onion Nutrient Guidelines
Leaf Analysis Guide for Diagnosing Crop Nutrient Status and Soil Analysis Guide for Diagnosing Available Nutrient Status

Green Bunching Onion Postharvest Recommendations
Postharvest Research and Information Center

Dry Onion Postharvest Recommendations
Post harvest Reach and Information Center

Garlic Postharvest Recommendations
Postharvest Research and Information Center

Growing Garlic in California at VRIC website

INDUSTRY ORGANIZATIONS

CA Garlic and Onion Research Advisory Board
1629 Pollasky, Clovis, CA 93612
Telephone: (559) 297-9322

CA League of Food Processors
www.clfp.com
Represents and promotes processors in CA

CA Onion & Garlic Processors Handlers

Christopher Ranch, 305 Bloomfield, Gilroy
Con Agra Food Ingredients, 9301 Lacey, Hanford
DeFrancesco & Sons, P.O. Box 605, Firebaugh
Harris Fresh, P.O. Box 497, Coalinga
Sensient Dehydrated Flavors Co., P.O. Box 279, Cressey
Sequoia Packing, 500 Enterprise Parkway, Coalinga
The Garlic Co., 18602 Zerker Rd, Bakersfield
Tulelake Growers Association, Tulelake

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

PESTICIDE LABELS

CDMS – Ag Chemical Information Services
http://www.cdms.net/pfa/LUpdate.Msg.asp
GREENBOOK – http//www.greenbook.net/

MARKET NEWS

http://www.produceforsale.com/producemarkets.htm

The Vegetable Notes Newsletter is available ONLINE.

To download this or previous editions go to
Tulare County: http://cetulare.ucdavis.edu/Vegetable Crops/
We welcome your comments. Send to newsletter editor:
mlestrange@ucdavis.edu

Other UCCE county websites in the SJV:
Fresno County: http://cefresno.ucdavis.edu
Kern County: http://cekern.ucdavis.edu
Kings County: http://cekings.ucdavis.edu
Merced County: http://cemerced.ucdavis.edu
San Joaquin County: http://cesanjoaquin.ucdavis.edu
Stanislaus County: http://cestanislaus.ucdavis.edu

Vegetable Notes

UCCE Tulare & Kings and Fresno Counties

Michelle Le Strange and Shannon Mueller, Farm Advisors

Newsletter Volume 1, Issue #7:

Onions and Garlic
in the San Joaquin Valley

Vegetable Production Meeting - UC WSREC
January 31, 2006

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University of California
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Tulare, CA 93274

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