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DEFOLIATION CHALLENGES IN LATE-MATURING FIELDS

Bob Hutmacher, Steve Wright, Ron Vargas, Dan Munk

The following discussion is based on information from multi-year field research trials conducted by:

Steve Wright (UCCE-Tulare and Kings County), Bruce Roberts (CA State University Fresno, formerly UCCE-Kings County), Ron Vargas (UCCE-Madera and Merced Counties) in cooperation with Gerardo Banuelos (UCCE-Tulare Co.), Tome Martin-Duvall (UCCE-Madera Co.), Joe Padilla (formerly Kings Co.), cooperating chemical companies, and staff of the University of California West Side Research and Extension Center.

After a year routinely described as "difficult" and characterized by early cool temperatures, late plantings in many areas, and excessive heat during mid to late summer, it is good to see some fields working their way toward being wrapped up and done. University of California Cooperative Extension Farm Advisors have prepared some defoliation guidelines that describe general recommendations for several weather and crop condition scenarios, as well as multi-year results from harvest aid research trials done at the UC West Side Research and Extension Center. These recommendations can be reviewed by looking at "Defoliation Guidelines" available at the UC cotton web site: http://cottoninfo.ucdavis.edu

This year, however, defoliation and harvest preparation looks like it may be more difficult than usual in many vigorous, later-maturing fields. Many of these fields have

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PREVENTING STICKY COTTON— WHAT HAVE WE LEARNED ?

Larry Godfrey, Peter B. Goodell, Steve Wright, Bob Hutmacher

The 2001 California cotton crop was identified as having an abnormally high level of stickiness arising from insects and this created problems and concerns by processors. A unique set of conditions and circumstances contributed to this, but it was universally recognized that a repeat of this occurrence had to be avoided. An intensive education and awareness program was initiated during the 2002 growing season and the situation has been largely mitigated. The 2002 to 2004 crops were of high quality and honeydew-producing insects have been optimally managed. One outcome of this success has been an increased use of insecticides to effectively manage honeydew producing insects including cotton aphids and silverleaf whitefly. Insecticide applications have increased from 2.7 to 2.9 to 3.5 applications per cotton acre in 2001, 2002, and 2003, respectively (data from CA Dept. of Pesticide Regulation) with the majority directed against aphids and whiteflies.

The use of products such as endosulfan, Centric®, Knack®, and Courier® increased significantly from 2001 to 2002 and Assail® use increased dramatically from 2002 to 2003. In the short-term, this strategy has been very effective, but the long-term sustainability of this strategy is in question. Repeated applications of neonicotinoid products during a growing season increase the selection pressure and the chances for insecticide resistance development. Similarly, increased production costs

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Support for this publication is provided by California Cotton Growers through their Cotton Incorporated State Support Program.

Defoliation Challenges in Later-Maturing Fields

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similar characteristics in common:

- Most, but not all were planted later than normal, in late April through early May
- Plants in some of these fields have: (a) poor to only fair bottom and middle crops; and (c) low retention not only in first fruiting site positions, but also in later-developing second and third fruiting sites.
- Many fields have large plants, in part due to the lack of good early fruit set to help hold back vegetative growth, or due to persistant lygus populations. In addition higher plant populations were often used to deal with tough spring planting conditions.
- In many of these fields, the later-developing top crops are much better than on the bottom, representing a larger percentage of the total fruit on the plants – these top crops are hard to ignore since they represent a big portion of the plant's total yield potential in such fields.
- With all of the July and August heat, quite a few of these fields received a later-than-typical final irrigation, which should result in more late-season vegetative growth and many plants with green, turgid leaves as we approach October.

With more vigorous plants with a high proportion of later-maturing bolls, it may be desirable to consider different practices this year to improve chances for acceptable defoliation, desiccation, regrowth control, and to improve chances of opening later-maturing bolls. Continued higher than normal temperatures will help mature these bolls, but as usual, there is no "magic bullet" that will make all late bolls mature and open. Growers will need to look at the calendar, judge the likelihood that good weather will continue, and decide which bolls they really can afford to wait for. The weather service web site: http://www.wrh.noaa.gov/hnx/ can be consulted for short and longer-term rain and temperature forecasts (at website, click on "national" under forecasts, choose "long term forecasts", where several forecasts available).

Harvest Aid Considerations for Vigorous, Late-Maturing Fields in 2005.

Strategy One: Several UCCE field studies conducted during the 1990's demonstrated a benefit in defoliation and boll opening by applying a pre-treatment of 4-6 oz of Ginstar at 6 nodes above cracked boll (NACB) followed by later treatments (at about 3-4 NACB) of: (1) Ginstar at 8 oz; or (2) Ginstar in combination with a boll opener material (such as Prep, Cotton Quick, Finish or others); or (3) Def/Folex plus a boll opener. In order to avoid freezing leaves on plants, Ginstar rates should be adjusted if major changes in air temperatures occur at application or are anticipated in the days following application. In many cases in both Acala and Pima, a final application of sodium chlorate and Paraquat, Shark, or ET will also be useful in desiccating remaining leaves and improving opening of last-remaining bolls. Shark or ET applications will also help dry remaining broadleaf weeds.

Strategy Two: Another approach for vigorous, late-maturing cotton fields, particularly when there are concerns that the fields are just not making progress in opening up bolls, involves use of glyphosate as a pre-treatment in non "RR" varieties. UCCE studies done on Acala varieties during the 1990's looked at several timings for these pre-treatment glyphosate applications. The treatment combinations in these studies consisted of glyphosate pre-treatments at the equivalent of 1 lb.ai/acre rates tested at timings of 8, 9 or 10 nodes above cracked boll, followed 7-10 days later by standard defoliation treatments involving Def/Folex or Ginstar with or without boll openers. Results showed some advantages in earlier opening of later-developing bolls with the glyphosate pre-treatments. However, care should be exercised to make sure of the average NACB status of the field and relative percentages of the total field at various stages of maturity.

Glyphosate should not be applied before about 8 NACB for these pre-treatments in Acala varieties, since research showed yield losses of 5 to 12% with earlier applications at 10 NACB. UCCE field research on responses of Pima to glyphosate as a first treatment is very limited, and has not been clearly proven to improve boll opening and yield with late-maturing, vigorous Pima cotton.

Strategy Three: Another approach is to closely pay attention to the calendar, the weather, and consider how much risk you want to take in choosing a final harvest date. Consider these steps:

1. Keep an eye on predicted trends in the weather.
2. Consider your own experience with how many days of harvest will likely be needed from harvest of your first field to the last field.
3. Decide what you think is the last harvest date you consider to be an acceptable risk.
4. Count back about 21 days from those desired harvest dates, and start with your defoliation program on those dates no matter what maturity stage (what NACB) the crop is in.

Defoliation Challenges in Later-Maturing Fields
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Many CA growers are familiar with data sets from Acala and Upland cotton defoliation trials done by Tom Kerby and Kater Hake in the 1980's and 1990's which suggest that, on the average, defoliations initiated at 8 NACB would result in yield losses of about 5% when compared with initiation at 4 NACB, while those initiated at 6 NACB would reduce yields 2 to 3%. However, those same studies acknowledged that when a very large percentage of the total crop consists of bolls on the upper 6 to 9 fruiting branches, losses from early defoliant applications can be substantially more (over 10%). Particularly under circumstances of mostly a mid-canopy and top-crop, the closer you can get to 4 to 6 NACB prior to first defoliant application, the lower the yield loss.

In areas with lingering concerns regarding silverleaf whitefly populations: Fortunately whitefly populations have been low in August, however, if you are still dealing with late-season whitefly populations at the time of first harvest aid application, it may be worthwhile to consider results from several research trials conducted in Arizona and California. These field trials suggest that there is a synergistic response (better whitefly control) when pyrethroid insecticides are combined with a first defoliant treatment that is an organophosphate defoliant (Def/Folex).

Harvest Aid Management Publication Available!

"*Harvest Aid Materials and Practices for California Cotton—A Study Guide for Agricultural Consultants and Pest Control Advisers*" by R.B. Hutmacher, R.N. Vargas, S.D. Wright, and B.A. Roberts (UC Publication # 4043) - 2003

This publication from the University of CA-ANR is now available by: (1) contacting your county UCCE office; or (2) by contacting Univ. CA Communications Services at their web site: http://anrcatalog.ucdavis.edu

Preventing Sticky Cotton – What Have We Learned?
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and regulatory scrutiny are other potential drawbacks of this strategy.

University of California and USDA-ARS personnel (Research Entomologists Michael McGuire and Jay Bancroft) responded to the sticky cotton issue with an increased research effort on late-season aphids and whiteflies supported by Cotton Incorporated State funds. Studies are ongoing, but a significant effort was made in 2002-04. This research is particularly challenging because insect populations are often clumped on only a few leaves per plant (or on re-growth) and therefore the sticky cotton may also be in hot spots within the field and among a plant's bolls.

Stickiness on cotton lint can be difficult to measure accurately and repeatedly and the threshold level of allowable stickiness varies. In our studies, we targeted 15 sticky spots with the high-speed thermodectector (H2SD) method as a level indicating moderate stickiness. All our studies were done with Acala cotton; this level of 15 sticky spots would most likely not be acceptable for most uses of Pima lint.

What has been learned in this research?

Many of the findings can be summarized as follows:

- management of whiteflies and aphids has some similarities but unfortunately management of these two related insects usually occurs independently while in reality, techniques to control one pest may promote levels of the other
- trying to manage a mixed population of aphids and whiteflies is very difficult
- cotton lint that would be considered sticky can develop from low levels of cotton aphids
- cotton lint can go from non-sticky to sticky in a short period (~1 week)
- cotton lint can become sticky at any point from boll opening until harvest – defoliation does not stop the threat of sticky cotton
- the addition of an insecticide with the harvest aid application generally reduced the amount of stickiness, but did not completely eliminate the threat
- selection of harvest aids including ripening agents and defoliants is important in effectively and quickly removing green leaves from the plants.

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Preventing Sticky Cotton – What Have We Learned?

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Late-Season Cotton Aphids and Stickiness

Trials conducted at Shafter REC in Kern County in 2002-04 examined late-season aphid numbers and Acala cotton lint stickiness. Upon the start of boll opening, insecticide applications were started at weekly intervals; some insecticides were intended to control the aphids and other treatments were designed to flare levels of aphids. As many as 26 treatments (insecticides / timings / number of applications) were used during 2004. The goal was to manipulate the number of aphids and timing of aphid control through the time of defoliation. Aphid levels were recorded weekly from the fifth MSN leaf. Cotton was hand-harvested, ginned and lint stickiness determined with the thermodetector method.

Populations varied yearly in terms of numbers of aphids and timing of the infestation relative to boll opening (Table 1). In 2003, the year with the highest level of stickiness, a low-moderate whitefly infestation also occurred and may have contributed to the stickiness (whiteflies were effectively controlled the other years). In 2002 and 2004, "clean" cotton was produced with one application of Assail; in 2003, two applications of Assail were required. Also in 2003, Assail applied with the harvest aids resulted in very sticky cotton as this timing was too late to prevent stickiness. The stickiest cotton produced occurred with relatively low aphid populations that averaged 1.9 (2004) to 7.3 (2003) aphids per leaf (all aphids, adults and immatures, were counted with the aid of a microscope). Therefore, very significant levels of honeydew and lint stickiness can occur with relatively low levels of aphids. Maintaining aphid levels at 5 aphids per leaf or less should provide adequate protection of Acala cotton quality in the absence of whitefly infestation.

Lint Stickiness Can Develop Quickly and at Any Time before Harvest

In studies conducted in 2004 (Figure 1), cotton was hand-harvested and lint stickiness was sampled repeatedly at the time of harvest aid application, 2 weeks later and 3 weeks after harvest aid application (day of cotton harvest). Stickiness increased from 6 sticky spots to 37 sticky spots over this initial 2-week period in plots with no applications (harvest aid or insecticides). The aphid population over the 2-week period started at 1.3 aphids per leaf and increased to 2.6 and 7.6 aphids per leaf at 1 week, and 2 weeks later, respectively. This shows how quickly lint can go from non-sticky to very sticky.

The application of only a harvest aid (several different ones were tested and all generally were effective in preparing the crop for harvest) reduced the stickiness by about 25% compared with areas where no harvest aids were applied. The addition of an insecticide to the harvest aid resulted in an additional 25% reduction in stickiness; however, under the conditions of this study, the lint was still marginally sticky with only the one insecticide application.

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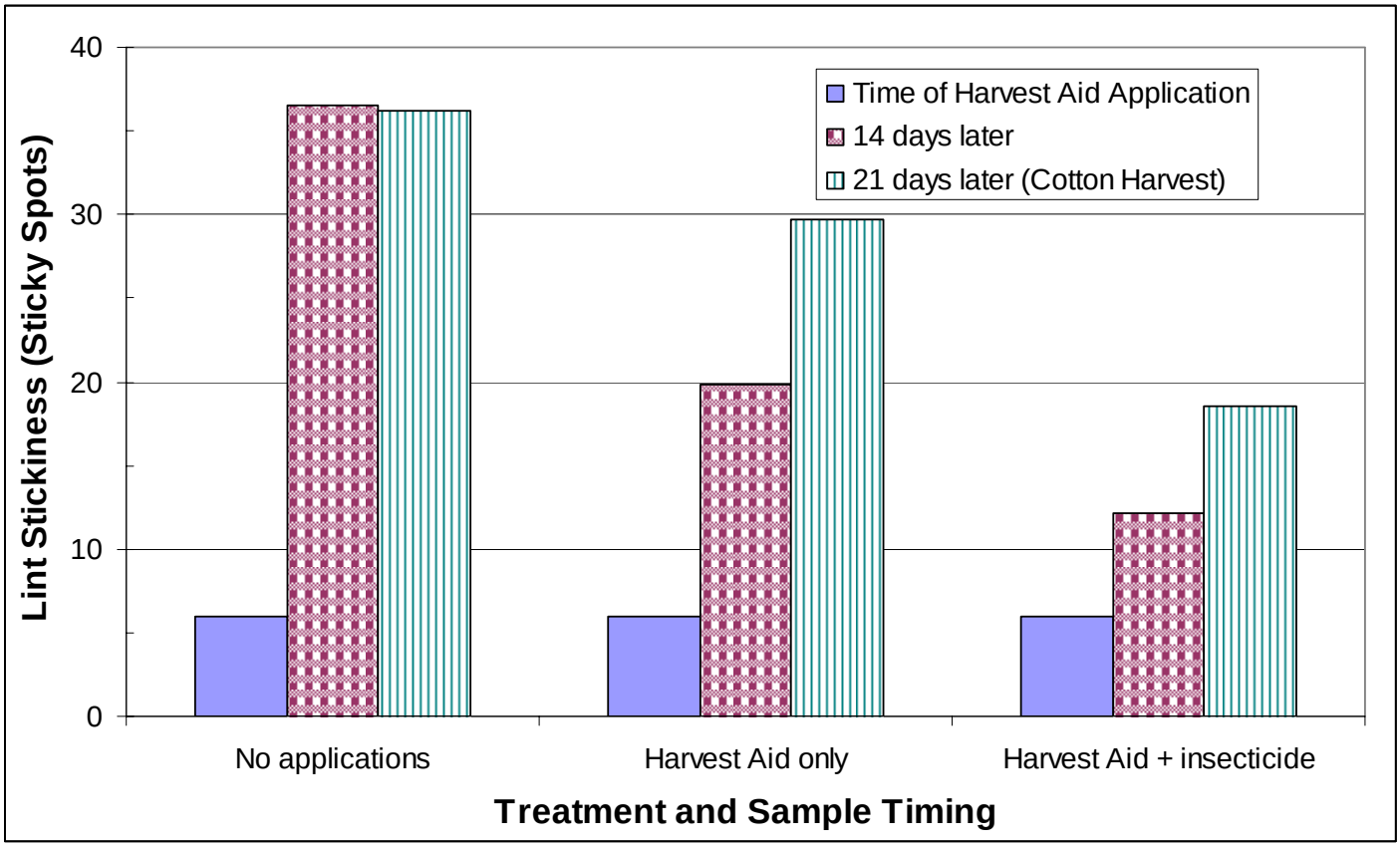
Table 1. Sticky levels on cotton lint (number of sticky spots determined by High Speed Stickiness Detector). Trials conducted in Kern County at Shafter REC.

	Cleanest cotton				**Stickiest Cotton**			
	Application Timing	**Peak aphid Population**	**Avg. aphid population**	**Lint Quality**	**Application Timing**	**Peak aphid population**	**Avg. aphid population**	**Lint Quality**
2002	Assail @ 4 weeks before defoliation	4.7 aphids per leaf	2.4 aphids per leaf	2.3 sticky spots	Warrior @ 4 weeks before defoliation	14 aphids per leaf	6.4 aphids per leaf	17.1 sticky spots
2003	Assail @ 4 & 2 weeks before defoliation	4.9 aphids per leaf	2.0 aphids per leaf	23.9 sticky spots	Assail@ defoliation	22.3 aphids per leaf	7.3 aphids per leaf	49.8 sticky spots
2004	Assail @ 3 weeks before defoliation	2.9 aphids per leaf	0.5 aphids per leaf	12.9 sticky spots	Warrior @ 2 weeks before defoliation	6 aphids per leaf	1.9 aphids per leaf	33.8 sticky spots

Figure 1. Influence of time and insect control on the buildup of honeydew on cotton lint.



Making Whitefly Treatment Decisions

Making treatment decisions late in the season can be complicated. Sampling using the existing guidelines (http://www.ipm.ucdavis.edu/PMG/selectnewpest.cotton.html and www.uckac.edu/whitefly) is the first step. Take care to identify the whitefly as Silverleaf and not one of the other species that could be present (see www.uckac.edu/whitefly for identification tips). Decisions should be based on population demographics and crop development.

If control is required, there are three main approaches:

- Situation 1. Insect Growth Regulators (IGRs) to manage a population from increasing by stopping its development; usually a mid-season to late season.
- Situation 2. Non-pyrethroid chemistry to manage adults, limit population establishment and protect open cotton. Products include organophosphates, carbamates and organochlorines, usually late season before crop termination.
- Situation 3. Pyrethroid combinations to knockdown adults and limit honeydew secretion just prior to defoliation.

Several steps are required to formulate a control strategy:

- First, what is the target, adults or immature whiteflies or both?
- Next, how long before defoliation and estimated date of harvest?
- Is there open cotton(this might limit product choices)
- How well (and quickly) does the field defoliate? Green leaves left on the plant for 2 to 3 weeks can be enough time for another generation to develop and allow time for stickiness to occur.

These questions will direct you toward one of the approaches listed above. See UC Pest Management Guidelines for Cotton for details (www.ipm.ucdavis.edu).

Our field trials in Tulare County over the past three years have focused on the third situation, pyrethroid combinations. These are useful when a large migrating adult population occurs near defoliation and quick knockdown is required. We evaluated defoliant and insecticide combinations to control whiteflies and prevent sticky cotton. These studies were designed to identify a best approach in defoliation and insect control as well as evaluate the use of organophosphate defoliants (DEF in these trials) as a synergist for whitefly control (see Table 2 for limited sticky spot results from those trials) Experiences

from southern California provided evidence that combining pyrethroid insecticides and organophosphate chemistry has improve the efficacy and slowed development of resistance to pyrethroids. In brief, each year had differing levels of whitefly pressure from very high (2003) to very low (2004) with 2002 being a moderate population. The numbers of sticky spots at defoliation at each site and year (shown as "pretreatment" levels in table 2) were 3.7 and 7.4 in 2002, 9.3 in 2003 and 5.2 in 2004. In 3 of the 4 trials, lowest sticky spot counts (less than 10 sticky spots) were achieved when DEF®/Prep® and Danitol®/Orthene® were used.

Of the 36 combinations (defoliants, insecticides and years), moderately sticky cotton (<15 sticky spots) was achieved 13 times with the highest success rate (6/8 occurrences) with DEF/Prep (with or without insecticides). No other treatment achieved this level (<15) except in 2004 where even defoliants alone produced acceptable cotton. The following observations were noted:

- Individual situations require individual solutions (one size does not fit all);
- Under light but treatable populations, good defoliation may only be needed, insecticide adds little to the solution (2004 data);
- Under moderate pressure, DEF and pyrethroids (Danitol) were important in preventing sticky cotton (compared to the untreated check) and performed better than non-organophosphate based defoliants) (2002 data);
- Under heavy pressure, OP defoliants and pyrethroids help reduce sticky cotton but do not eliminate problem (2003 data); a case of too little too late.

Table 2. Sticky spot counts on cotton lint (# sticky spots by High Speed Stickiness Detector) under varying defoliants, harvest aids and insecticides (Danitol and Orthene) treatments. Trials conducted in Tulare County.

2002—Trial Site A– Tulare Co.				**2002—Trial Site B—Tulare Co.**		
Pretreatment = 3.7 sticky spots	Insecticide Applied ?			**Pretreaatment = 7.4 sticky spots**	Insecticide Applied ?	
	NO	YES			NO	YES
Ginstar	21.5	40.4		**Ginstar**	23.0	24.5
Ginstar + Prep	16.2	19.4		**Ginstar + Prep**	27.3	19.8
DEF + Prep	10.3	4.6		**DEF + Prep**	13.5	5.4
Defol + Gramoxone	27.5	11.4		**Defol + Gramoxone**	16.8	19.2

2003—Tulare County				**2004—Tulare County**		
Pretreatment = 9.3 sticky spots	Insecticide Applied ?			**Pretreatment = 5.2 sticky spots**	Insecticide Applied ?	
	NO	YES			NO	YES
Ginstar	34.8	23.6		**Ginstar**	6.5	4.5
Ginstar + Prep	36.4	21.2		**Ginstar + Prep**	4.8	5.8
DEF + Prep	21.9	22.9		**DEF + Prep**	5.8	3.3
Defol + Gramoxone	32.3	39.7		**Defol + Gramoxone**	12.0	13.3

Managing Both Aphids and Whiteflies

Late-season control of aphids and whiteflies can be challenging. Factors contributing to the challenge include:

- the large cotton canopy
- underleaf location of these pests
- poorer coverage from aerial application than from ground application, and
- hardening-off of cotton leaves which reduces translaminar movement of insecticides.

Label restrictions prohibiting applications after boll opening and pre-harvest intervals may sometimes limit product availability. Management of mixed populations of aphids and whiteflies can be particularly difficult.

Whiteflies may be under control during the mid-season period with Insect Growth Regulators (IGRs), for instance, but waves of migrating whitefly adults can quickly infest cotton fields. Late season (stage III) control of whiteflies often involves a pyrethroid + organophosphate mixture (Danitol® + Orthene®). Even at this point in the season, the application of a pyrethroid can greatly increase levels of aphids.

In the presence of aphid, Lorsban® (1B) or endosulfan (2A) would also enhance the synergism of the pyrethroids against whiteflies and still have efficacy against aphids, the consequences of using this combination must be considered carefully. Assail® (4A) is another option for late-season control (well before defoliation, see Table 1) of both aphids and whiteflies; however, the rate for whitefly control is higher than that for aphids. If other applications have been made during the season of neonicotinoid-containing products (4A modes of action) such as Assail, Centric®, Leverage®, Provadao®, resistance management principles would suggest rotating to other classes of chemistry.

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Disclaimer: To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned. Always read and follow the label.

Preventing Sticky Cotton :

Summary of an Approach to Consider

All Things in Moderation

Even with the importance of producing high quality, non-sticky cotton, it is important to follow basic tenets of Integrated Pest Management:

1. Visit and sample fields regularly.
2. Treat only when the population exceeds the action threshold.
3. Be realistic about yield potential and strive for the shortest season possible. Delaying harvest makes fields available for aphid and whitefly migration late season.
4. Manage the crop to a successful termination. Take care with late irrigations; avoid situations that lead to regrowth before and after defoliation.
5. Use defoliants appropriate to your situation to minimize the length of time that lint is exposed to green leaves. If required, treat the fields to reduce adult whitefly and/or aphid populations.
6. Practice good insecticide resistance by rotating compounds with differing modes of action (see http://cottoninfo.ucdavis.edu for details).
7. Visit the field between defoliation and harvest to ensure that aphid and whitefly are not present in damaging numbers.
8. Always read and follow labels.

DAN MUNK

Sabbatical Leave

UCCE Fresno County Cotton, Water & Soils Farm Advisor Dan Munk will be taking sabbatical leave from his regular duties starting October 1, 2005 and continuing through Sept. 30, 2006. Dan will be busy writing up research and extension projects, conducting research during a stay in Australia, and with several training activities.

Other advisors who have agreed to support clientele information needs during Dan's leave include:

- **Kurt Hembree (UCCE Weed Control Advisor, Fresno Co.)**
- **Rich Coviello (UCCE Entomology Advisor, Fresno Co.)**

Both can be reached at the UCCE Fresno Co. office at (559) 456-7285.

- **Steve Wright (UCCE Cotton Advisor, Tulare and Kings Co.)**
- **Ron Vargas (UCCE Cotton Advisor, Madera and Merced Co.)**

Their phone numbers are on the address page of this newsletter.

We wish Dan well and hope he has a good and productive sabbatical !