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Bob Hutmacher (Editor) Brian Marsh (Associate Editor)

FINAL INSECT MANAGEMENT DECISIONS FOR 2004: BRINGING IN A CLEAN CROP

Peter B. Goodell, *IPM Advisor, Statewide IPM Program;* **Larry D. Godfrey,** *Entomology Specialist, UC Davis;* **Bob Hutmacher,** *AgronomySpecialist, UC Davis and Shafter REC*

The 2004 cotton season has been exceptional in many respects. Ideal weather through the spring and summer ensured uniform stands, compact date of planting, vigorous early growth, and early and exceptional fruit retention. The lack of insect pressure in 2004 has also been a welcome relief to cotton growers. While the crop is progressing well and several weeks early in most locations, whitefly and aphid must still be in the forefront of PCAs and growers. During the past two seasons, growers in the San Joaquin Valley have taken seriously their responsibility and produced high quality, sticky-free cotton. With all the good news, PCAs and growers must still carefully watch the fields for the migration and buildup of whitefly and aphid during the critical period from first open boll to the last boll picked.

The Situation

The reports of whitefly populations in fields first appeared in mid-July in 2004. Though present in widely scattered locations, through early August, only limited treatments for whitefly were required. In general, most fields experience an adult population exceeding thresholds before nymphs trigger control measures.

Aphids have been present in cotton fields for most of the mid-season but their populations in many cases have not required treatment or have declines markedly without treatments in some locations. PCAs and growers watched

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HERBICIDE RESISTANCE MANAGEMENT CONSIDERATIONS

Ron Vargas, *UCCE Farm Advisor / County Director, Madera & Merced Counties;* **Steve Wright,** *UCCE Farm Advisor, Tulare County*

The use of herbicides in production systems have allowed growers to effectively and economically control weeds. Hard to control weeds, such as field bindweed and annual morningglory, can now be effectively managed in cropping systems. Selective herbicides have allowed the reduction, and in some cases, the elimination of hand weeding all together. Cultivation has been reduced in field and vegetable crops with movement toward reduced or minimum tillage systems. The new generation of herbicides are much more environmentally friendly, controlling weeds with only ounces of active ingredients per acre as opposed to pounds per acre required by some of the older herbicides. The introduction of herbicide tolerant crops has provided growers with an additional option for effective control. But, for herbicides to remain effective and to sustain their use, attention and consideration must be given to herbicide resistance.

Weed resistance to herbicides is not a new phenomenon (Table 1), but is somewhat less known and experienced than insecticide or fungicide resistance. The first report of herbicide resistance occurred in 1960 with the discovery of Triazine resistant common groundsel. Since that time 287 weed biotypes around the world have evolved resistance to herbicides. Both hairy fleabane and buckhorn plantain are resistant to glyphosate in South Africa. Hairy fleabane has become difficult to control with glyphosate in our California production systems, indicating

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

Final Insect Management Considerations—2004:

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the populations and reported that in most cases, the populations decreased or disappeared and are to be commended for "staring down" the threat and not over reacting with unnecessary pesticide applications..

The maturity of the cotton crop in the San Joaquin Valley is more uniform in 2004 than in many years due to the tight planting window in 2004. This should make pest management somewhat easier since fields are similar in their development and insecticide treatments somewhat synchronized compared to other years with much more broadly distributed planting dates and rates of development. . Harvest preparation and the harvest itself should occur within a smaller window than a year such as 2003, or many other years for that matter. This can help limit the amount of inter-field migration problems. Of course, most Pima fields will move toward maturity and readiness for harvest at a later date than most Acala fields, and could experience more extended periods of exposure to later migrations of both pests.

Making Whitefly Treatment Decisions

Making treatment decisions late in the season can be complicated, especially in a year with cotton development spread out. Sampling using the existing guidelines (see www.uckac.edu/whitefly) is the first step. In most of the cases I have seen this year, the triggering factor tends to be adults but leaves should be inspected closely for immature insects. Take care to identify the whitefly as Silverleaf and not one of the other species that mcould 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:

1. Insect Growth Regulators (IGRs) to manage a population from increasing by stopping its development
2. Non-pyrethroid chemistry to manage adults, limit population establishment and protect open cotton. Products include organophosphates, carbamates and organochlorines.
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 targets, adults or immature whiteflies?
- Next, how long before defoliation?
- Is there open cotton (this might limit adulticide choices)
- How well (and quickly) does the field defoliate?

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

Insect Growth Regulators (IGRs).

These products are most useful in preventing whitefly populations from building within the field. The prevent development and emergence to adulthood and can sterilize the eggs when females feed on leaves. With both Courier and Knack, time is required for the population to cycle out. Depending on the situation, some adulticide might be warranted. Residual action can be expected for at least 21 days. If there is less than 21 days until defoliation, other conventional products could be utilized.

All Things in Moderation

Even with the pressure to produce high quality, non-sticky cotton, it is important to follow the basic tenets of IPM.

1. Visit and sample fields regularly.

2. Treat only when the pest populations exceed the action threshold.

3. Be realistic about yield potential and strive for the shortest season possible. Delaying harvest makes your fields available for aphid and whitefly migration late in the season.

4. Manage the crop to a successful termination. Take care with late irrigations; avoid situations that lead to re-growth 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 or aphid populations.

6. Practice good insecticide resistance by rotating compounds with differing modes of action.

7. Visit field between defoliation and harvest to ensure that aphid and silverleaf whitefly are not present in damaging numbers

8. Always read and follow label instructions

Final Insect Management Considerations—2004:
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Non-pyrethroid and combinations.

Useful during Situation II when an adult invasion is not overwhelming but gradual. Both Centric and Assail (chloronicotinyls or neonicotinoids) have shown promise in reducing adult populations prior to cutout. There is some concern about the efficacy of products that require translaminar action after leaves have begun to "*harden off*" In addition, these products may have already been used once and the concern for serious insecticide resistance management looms. Other choices are limited but include Lorsban combined with endosulfan (Thiodan/Thionex).

Pyrethroid combinations.

These are useful options when a large migrating adult population (Situation III) occurs, especially near defoliation. While knockdown is good, residual control is limited. When combined with an organophosphate, a synergism occurs that enhances control. This approach can be applied right at defoliation using DEF or using other defoliants when products such as Orthene or other organophosphate insecticides are included.

Aphid Management

The action threshold during late season after lint is exposed is 10 aphids/5th leaf. Managing aphids late season can be challenging when trying to rotate different insecticide chemistries. Dependence on a single mode of action, such as chloronicotinyls, may facilitate resistance development. Efficacy is important, since the threshold (10/5th leaf) is so low. Aphid populations at this part of the season tend to be rather persistent and do not fluctuate rapidly up or down as they do during the mid-season. Populations on severely cut-out and/or plants stressed by defoliants may occur on regrowth or green patches (such as near mid-ribs) on leaves. In addition to the chloronicotinyls, aphid control products include Lorsban, Dibrom (do not apply after open boll), Curacron, (do not apply after open boll), and Thiodan/Thionex.

Aphids and Whitefly

Making decisions when both pests are present requires evaluation of the most threatening insect. Combination treatments will likely be needed. Keep in mind that use of pyrethroid combinations for whitefly control will likely flare aphids, if present. If whitefly adults were of primary concern, Lorsban/Thiodan would also help reduce aphid. *NOTE: Any products that are mentioned, or indirectly implied in this document do not imply endorsement by the Univ. of California. Read and follow label directions.*

WATER STRESS VERSUS HEAT STRESS: How Do Symptoms Differ in Cotton?

Bob Hutmacher, *Agronomy Specialist, UC Davis Plant Science Dept. & Shafter REC*

After a June and July with relatively moderate temperatures, air temperatures of 105 to 110 F that occurred in the San Joaquin Valley in early August this year raised some of the usual comments about potential for heat stress damage. It might be worth a review of some of the characteristics and differences between high temperature injury versus water stress injury.

Particularly during late boll-filling, average retention of 1st and 2nd position upper-canopy squares/blooms typically declines to 25 to 35 percent or less, with many squares and even several day old bolls dropping off plants even when soil water and nutrient status are fairly good. Squares and small bolls (> 3-4 days old) lost primarily due to carbohydrate and/or nutrient stress will usually turn yellow and abscise. Squares and small bolls lost primarily due to moderate to severe water stress (enough to cause significant mid-day leaf wilt) usually show rapid yellowing, then with more severe stress a brown color in the bracts and floral tissue. Many squares and small bolls will be abscised if the stress develops gradually and without concomitant high air temperatures, allowing formation of an abscission layer at the base of the peduncle (small stem holding the square). Squares and small bolls on plants that develop water stress rapidly (due to hot, windy conditions, limited root system, low soil water content) will routinely have squares, small bolls that turn brown and "stick" on the plant. This stress is too quick and severe to allow an abscission layer to fully develop (a weak area in the stem that can detach) before localized tissue around the fruiting site dies.

High temperature injury to squares and young bolls has been shown in past research in Texas, Arizona and California to be related to reduced pollen viability when daytime air temperatures exceed about 107 to 110 F (may differ with variety and other weather conditions) or when nighttime air temperatures exceed about 85 F. The worst impacts on pollen viability seem to occur in squares of the age of 2 to 3 weeks prior to bloom, with lesser impacts on older or younger squares. Even if temperatures don't hit these extreme levels, some square and particularly young boll losses can occur and be related to high temperatures. The most likely reason for these boll losses will be temporary reductions in carbohydrate supplies (due to lower photosynthetic rates with high day temperatures and elevated respiration rates with high night temperatures). You can't prevent high air temperatures, but you might be able to lessen impacts on yields. Hotter leaves with less evaporative cooling increases temperatures within the whole plant canopy. Avoiding moderate water stress with more frequent irrigations during very hot weather can in part reduce negative impacts of hot weather on fruit retention as long as irrigations are managed to reduce problems with soil aeration. Waterlogged soils in combination with high temperatures and high humidity can actually reduce the ability of the plant to cool itself, resulting in much hotter than desired temperatures in the plant canopy. Try to reduce the duration of waterlogging in these situations.

Herbicide Resistance Management:
(continued from page 1)

possible development of resistance. Reports of poor or ineffective control of lambsquarter in our Roundup Ready cotton systems have surfaced in the last two years. And just recently, Roundup resistance horseweed (marestail) has been confirmed in the eastern U.S.

In California the greatest herbicide resistance problems have occurred in aquatic weeds in rice production in the Sacramento Valley. Many of these weeds species have been selected for resistance to the sulfonylurea herbicide bensulfuron (Londax). Rigid ryegrass (Lolium rigidum) has exhibited resistance to glyphosate (Roundup) in northern California. Although there are few cases of resistance in California there are many herbicides in use that have selected resistance in many weed species throughout the U.S. With the use of Staple in cotton, Shadeout in tomatoes, Upbeat in sugarbeets, Londax in rice, Pursuit in alfalfa and Assert in wheat, all herbicides that lead to rapid selection for resistant weeds, it is probable that the number of cases in California will increase. In addition the availability of Roundup Ready cotton and corn, BXN (bromoxynil tolerant) cotton and the soon to be released, Roundup Ready alfalfa, may promote the sole reliance on one particular herbicide that will increase the selection pressure on weeds for resistance.

Definition of Resistance

"Herbicide resistance" is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. In contrast, "herbicide tolerance" can be defined as the inherent ability of a plant to survive and reproduce with a herbicide treatment at a normal use rate. In a plant, resistance may be naturally-occurring or induced by such techniques as genetic engineering. Resistance may occur in plants by random and infrequent mutations; no evidence has been presented to demonstrate herbicide-induced mutation. Through selection, where the herbicide is the selection pressure, susceptible plants are killed while herbicide resistant plants survive to reproduce without competition from susceptible plants.

Factors Leading to the Development of Herbicide Resistance

Most weed species contain a tremendous amount of genetic variation that allows them to survive under a variety of environmental conditions. The development of a herbicide-resistant weed species is brought about through selection pressure imposed by the repeated, often nearly continuous use of a herbicide. Long residual preemergence herbicides or repeated application of postemergence herbicides will further increase selection pressure.

Factors that can lead to or accelerate the development of herbicide resistance include weed characteristics, chemical properties and cultural practices.

Weed characteristics conducive to rapid development of resistance to a particular herbicide include:

1. Annual growth habit.
2. High seed production.
3. Relatively rapid turnover of the seed bank due to high percentage of seed germination each year (i.e., little seed dormancy).
4. Several reproductive generations per growing season.
5. Extreme susceptibility to a particular herbicide.
6. High frequency of resistant gene(s), (e.g. *Lolium rigidum*).

Herbicide characteristics which lead to rapid development of herbicide resistance in weed biotypes include:

1. A single site of action for the herbicide material
2. Broad spectrum control.
3. Long residual activity in the soil

Cultural practices can also increase the selective pressure for the development of herbicide resistant biotypes. In general, complete reliance on herbicides for weed control can greatly enhance the occurrence of herbicide resistant weeds. Other factors include:

1. Shift away from multi crop rotations towards mono cropping (orchard and vineyard systems).
2. Reduced or no till productions systems.
3. Continuous or repeated use of a single herbicide or several herbicides that have the same mode of action (transgenic herbicide tolerant crops).
4. High and/or low herbicide use rate relative to the amount needed for weed control.

Resistant Management—Getting Started

The first step to preventing herbicide resistance is early detection. Scout fields and be on the lookout for patterns that would indicate resistance. Whole fields infested with weeds or strips of weeds do not typically indicate resistance. Patterns of resistance include:

- patches where specific weed species are dominant in fields
- patches of dense populations with lesser populations radiating out from the central, higher weed density patch
- escapes scattered in no particular pattern throughout the field.

Herbicide Resistance Management: *(continued from page 4)*

Table 1. Most common genera of weeds found to have developed resistance to specific herbicides. List shows number of separate instances of resistant weed species confirmed (by Worldwide count versus counts done in California).

Genus	**Common Name**	**Number of documented cases of herbicide resistance**	
		Worldwide	**In California**
Amaranthus	Pigweed	42	0
Chenopodium	Lambsquarters	25	0
Conyza	Fleabane or horseweed	22	0
Lolium	Ryegrass	21	2
Setaria	Foxtail	17	0
Avena	Wild Oat	15	1
Echinochloa	Barnyardgrass or watergrass	15	3
Alopecurus	Blackgrass	13	0
Senecio	Groundsel	12	1
Polygonum	Knotweed or smartweed	12	0
Solanum	Nightshade	11	0

How to Prevent or Delay Herbicide Resistance
Weed management strategies that discourage evolution of herbicide resistance should include:

- Herbicide rotation
- Crop rotation
  - Plant crop with different season of growth
  - Plant crop for which different registered herbicides can be used
  - Plant crop for which suitable alternative weed control practices exist
- Monitor after Herbicide Application
  - Check for weedy patches in fields in patterns consistent with herbicide application problems
  - Hand-weed patches of weeds present in patterns consistent with herbicide application problems
- Non-Chemical Weed Control Techniques
  - Cultivate
  - Hand Weed—a 90 percent or greater rate of weed removal reduces the chances that a herbicide resistant plant will produce seed
  - Mulch with both synthetic and organic materials
  - Soil solarization
- Use Short-Residual Herbicides
- Use Certified Seed to Reduce Weed Seed Load
- Clean equipment used in the field that could be contaminated with weed seed or otherwise introduce weed species to fields
  - Use power washer or compressed air to help remove weed seed and weed plant parts

How to Manage Herbicide-Resistant Weeds.
To keep herbicide-resistant weeds under control, incorporate the following into your management plans:

- Herbicide Rotation
  - Go to www.wric.ucdavis.edu to guide you to information on herbicide rotation decisions
  - Look at Table 2 in this article for “Herbicides Registered for Cotton”
- Fallow Mechanical Tillage Practices
- Use of Close Cultivation Practices Where Possible
- Use of Hand Weeding to Remove Weeds Within Crop Seed Row
  - Monitor weeding crew to insure that 90 percent or more of within-row weeds are removed
- Prevent Weed Seed Spread Through the Use of Clean Field Equipment
  - If any of your fields have history of herbicide-resistant weeds, work those fields last in your use of farm equipment
  - Use power washer or compressed air to clean equipment and remove weed seeds
- Monitor Initial Evolution of Herbicide Resistance by Patterns of Weed Escapes Typical of Resistant Plants
  - Watch for Weed Escapes that appear in same places in back-to-back crops
  - Watch for weed patches that do not have regular patterns more indicative of application problems
- Aggressively control weeds suspected of resistance before they can produce seed

Herbicide Resistance Management: *(continued from page 5)*

If you suspect weed resistance where herbicide applications have failed to control weeds, to further confirm check the following: 1) only one weed species has escaped, 2) sprayer calibration, 3) were weather conditions favorable for herbicide performance, 4) confirm by respraying and, 5) report problem to local UCCE Farm Advisor. The potential for herbicide resistance should receive serious and thoughtful attention. As weed management systems change with new herbicides and herbicide resistant crops are introduced, resistant management must be an integral part of the production system. If selection pressure is maintained through the continuous use of the same herbicide, herbicide resistance will soon render it ineffective.

For more information go the University of California Weed Research and Information Center web site at www.wric.ucdavis.edu.

References

1. Prather, T., Ditomaso, J., and Holt, Jodie. Herbicide Resistance: Definition and Management Strategies. ANR Publication 8012.
2. International Survey of Herbicide Resistant Weeds. www.weedscienc.org/in/asp.
3. Weed Science Society of America. www.wssa.net
4. WSSA.2002. Herbicide Handbook, Eighth Edition.

Table 2. Herbicides Registered for Cotton Production (*including classification by mode of action and group assigned by the WSSA (Weed Science Society of America).*

Chemical Name	Trade Name	Mode of Action	WSSA Group
metham	Vapam	Fumigant	27
MSMA	MSMA	Organoarsenical	17
trifluralin	Treflan/Trifluralin	Mitotic Inhibitor	3
pendimethalin	Prowl	Mitotic Inhibitor	3
promoetryn	Caparol	Photosynthesis Inhibitor	5
diuron	Karmex/Diuron	Photosynthesis Inhibitor	7
glyphosate	Roundup Ultra Max Touchdown IQ	Amino Acid Synthesis Inhibitor	9
pyrithiobac	Staple	Amino Acid Synthesis Inhibitor	2
metalachlor	Dual	Shoot and Root Inhibitor	15
paraquat	Gramoxone Max	Cell Membrane Disrupter	22
oxyfluorfen	Goal	Diphenylethers	14
flumioxazin	Valor	N. phenylphthalimide	14
bromoxynil	Buctril	Uracials	6
fluzaifop-p-butyl	Fusilade	Lipid Biosynthesis Inhibitor	1
sethoxydim	Poast	Lipid Biosynthesis Inhibitor	1
clethodim	Prism	Lipid Biosynthesis Inhibitor	1

Use of trade names does not constitute an endorsement by the University of California. Read and follow all labels before use.

* *Same color and WSSA group letter indicates same mode-of-action.*

Ron Vargas (UCCE Madera/Merced Counties); Steve Wright (UCCE Tulare and Kings Counties)

DEFOLIATING THE 2004 SAN JOAQUIN VALLEY COTTON CROP

Ron Vargas, *UCCE Farm Advisor, Madera & Merced Counties;* **Steve Wright,** *UCCE Farm Advisor, Tulare County;* **Bob Hutmacher,** *Agronomy Specialist, UC Davis and Shafter REC*

The 2004 cotton season is looking more and more like it will be an exceptional year for earliness and record high yields, and good potential for excellent quality lint if favorable weather conditions continue during September and into October. Good to even excellent weather conditions during planting, mild spring and summer growing conditions (for the most part), and generally very low incidence of damaging insect pressure have resulted in most fields reaching an early, strong vegetative cutout with excellent fruit retention.

In general, most harvest aids work best, often even at lower labeled rates, in fields with a more uniform distribution of bolls throughout the fruiting branches, strong vegetative cutout, and little late season vegetative growth. The easiest fields to defoliate effectively, simply, and at lower costs are those with a uniform boll set, a definite cutout, and soil water and soil nitrogen that have been drawn down significantly during the post-cutout period. Under these conditions, plant growth rates have slowed, boll maturity has progressed well, and plant hormonal balance has shifted to favor the development of leaf abscission.

As the 2004 season nears completion, most of the fields we have visited fit the crop descriptions just discussed. The major exceptions may be in fields where additional nitrogen fertilizer and water were applied later in the growing season in attempts to delay cutout and provide for additional growth and fruiting site production. Defoliation in these fields would be expected to be significantly later, and may in fact be problematic if the plants continue to produce new vegetative growth and flowers throughout August and into September.

For the well-prepared, cutout, early fields represented across much of the SJV as we head into September:

1. Lower rates of most defoliants should be effective; in addition, under expected warmer conditions with earlier harvests, lower rates will also help reduce "freezing" or "sticking" leaves on plants
2. Earlier harvests during good weather should make it easier to schedule harvests within a proper time frame after harvest aid applications; less regrowth is expected when defoliation is quicker, effective and less time passes between defoliation and harvest
3. Harvest aid materials that tend to provide good defoliation in well-prepared Acala fields without rank growth (such as Ginstar, Def or Folex) should give effective defoliation with a single application.
4. Pretreatment or growth regulator harvest aid materials (such as Ethephon) that improve boll opening may be less critical in the conditions described for most fields in 2004. However, tank mixes that include ethephon will be useful in areas where late-season aphid or whitefly infestations may be a problem, as these mixes can help provide faster leaf drop.
5. If a second treatment is needed, harvest aid chemicals that provide more of a contact-burn type of damage (such as sodium chlorate, paraquat (Gramoxone), and carfentrazone (Shark) applied alone or in combination) can be more effective.

Most importantly, <u>defoliation decisions need to be made on a field-by-field basis</u> in order to do the best job and make the fewest mistakes that could end up costing you at the level of yield, crop quality, or harvest aid efficacy. In general, apply defoliants when about 95 percent of the green bolls you intend to harvest are mature, or when about 60 to 65 percent of the expected harvestable bolls have cracked open. This timing will usually correspond to about 4 nodes above cracked boll (4 NACB) in Acala and about 3 NACB in Pima varieties. Use the "sharp knife" technique to assess boll maturity. If defoliants are applied too early, there is a possibility of compromising both yield and some aspects of fiber quality.

- All of these concepts and terms are reviewed in the "*Harvest Aid Management Guidelines*" available on the University of CA Cotton web site at:
  http://cottoninfo.ucdavis.edu
- In addition, at the same web site you can review or print out a copy of <u>Volume 68 (Sept. 2003) of the *CA Cotton Review* newsletter</u>, which has extensive comments on characteristics of specific chemicals and relative performance of a range of materials in UCCE harvest aid trials in recent years.

Harvest Aid Management Publication Now 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

SQUARE AND EARLY FIBER DEVELOPMENT

Bob Hutmacher, *Agronomy Specialist, UC Davis Plant Sci. Dept. & Shafter REC*

In order to begin to understand the impacts of water, nutrient or temperature stresses on fruit retention, yield or fiber quality, it is useful to consider the timing involved in the stages of fruit production and the patterns of fruiting site development as cotton plants age. We tend to think of and describe cotton as a plant that transforms from an essentially vegetative plant to one that is also reproductive, and may even think of this as a "transition" that occurs during a fairly narrow time frame. In fact, it is better to understand that the very early stages of floral development start very close to the time that the first couple of true leaves are expanding on the plant. The rate at which additional potential flower sites are produced depends on genetic, nutritional and other environmental factors which influence continued vegetative growth and the production of new main stem nodes and extension of fruiting branches.

The first 3 to 5 or more main stem nodes produced on commercial cotton varieties tend to be vegetative, and do not generally produce fruiting branches. Flower buds and potentially fruit can develop at many growing points (meristems) on cotton plants. These fruiting meristems are produced at main stem nodes, usually starting at the 5th main stem node or higher (varies with variety and environmental conditions). Commercial varieties of cotton typically exert what is called "apical dominance". This refers to the fact that the upper growing point on the main stem, or terminal, acts as a vegetative meristem, producing hormones that generally prevent or reduce chances that other vegetative meristems will develop (in this case, preventing or reducing the number of vegetative branches). This also explains the fact that any significant damage to the terminal often results in increased development of vegetative meristems (more vegetative branches). This ability to push additional vegetative branches after damage to the terminal gives the cotton plant a mechanism for recovery of fruit production ability, albeit with later-maturing fruit on the vegetative branches.

Meristems that produce fruiting branches differ markedly from those producing vegetative branches in that: (1) they are not as impacted by hormonal control from the main stem terminal; and (2) they produce internodes that terminate in parts of a flower. The fruiting branch meristems produce structures in a certain order that helps explain why the branches look the way they do. First produced on the fruiting branch is the "subtending leaf" that will be adjacent to the site of the developing square. Next are the bracts which will be the outer part of the square and eventually will encircle the developing boll. Next are the flower parts (sepals, petals, anthers) and carpel walls (locks on the bolls). For the fruiting branch to continue to grow to produce a second position fruit (2nd fruit out from the main stem), another meristem located outside of the bracts of the first position fruit must also be "activated" and begin to grow. Nutrient or carbohydrate limitations, related to environemental stresses or other factors can impact continued development of fruiting branches beyond the first, second or third fruiting positions on the branch.

A basic time line for square development illustrates how much happens in development prior to bloom and relative sensitivity of some growth stages to various stresses:

Days Prior to Bloom	Range of Size Of Square	Developmental Stage and Sensitivity to Stresses
32 to 40	< 0.1 mm	Square initiated at about 40 days, bracts start to develop, lock # can be reduced by carbohydrate or temp stress
21 to 24	1 to 2 mm (some call "pin head" square)	Seed # determined, which carbohydrate stress can reduce
18 to 21	3 to 4 mm (some call "match head"	Pollen cells divide, pollen viability affected by high temperature stress
3 to 5	12 to 16 mm	Fibers begin to form
0 (bloom)	Open flower	Pollen released, fiber elongation rapid; ovules fertilized within first day

Certain plant parts and certain developmental stages are more sensitive than others to physiologic problems or environmental stresses. In most research studies, the growing points, or meristems, have been found to actually be quite stress-hardy, surviving many adverse conditions. Locks per boll (or locule #) can be strongly influenced by plant carbohydrate production and to some extent nutrient availability. As squares develop, they transition from receiving most carbohydrates from bracts (young squares) to nearby leaves (older squares), and this can effect sensitivity to short-term reductions in photosynthate production or to damage to subtending leaves. High temperature sensitive stages of pollen formation occur about 18-20 days or so prior to bloom, so damage from high temperatures is most evident about 2 to 3 weeks after those temperatures are experienced. Fiber elongation starts in earnest at bloom, and progresses rapidly after pollination. If pollination does not occur, fiber elongation will cease early and unfertilized ovules will be present as motes. Developing seeds produce hormones that help promote nutrient and carbohydrate movement to the bolls, but the number of seeds per boll can be impacted by high temperature or water stress. A future issue will cover some sensitive development stages later during boll growth.

ANNOUNCEMENTS and MEETING DATES:

FIELD DAYS:

- **September 16 (Thursday)** - *UC WEST SIDE REC COTTON FIELD DAY (Location: UC West Side REC,, Oakland Avenue at Lassen Avenue, about 6 miles south of Five Points, CA on Lassen Avenue. For more information: call Dan Munk at (559) 456-7561.*
- **September 21 (Tuesday)** - *UC SHAFTER REC COTTON FIELD DAY (includes UC & USDA-ARS researchers and exhibits (Location: UC Shafter REC, 17053 N. Shafter Avenue, Shafter, CA (2 miles north of Hwy 43 on Shafter Avenue); Registration: Starts at 8:30 AM. For more information call Freddie Swing at (661) 746-8038) or Brian Marsh (661) 868-6210.*

HARVEST SAFETY MEETINGS:

- **September 10 (Friday)** - COTTON HARVEST SAFETY PROGRAM (MADERA & MERCED COUNTIES) - programs in English & Spanish. *Location: Minturn Coop Gin. Time: 7:30AM Registration, concludes with lunch at noon. Reservations (RSVP) required, call (559) 675-7879, Ext. 201 or (209) 385-7403*
- **September 15 (Wednesday)** - COTTON HARVEST SAFETY PROGRAM (KINGS & TULARE COUNTIES) - programs in English & Spanish. *Location: Mid Valley Gin, 21978 Road 36, 3/4 mi south of Kansas Ave., Tulare. Time: 8:30AM Registration, concludes with lunch at noon. Reservations (RSVP) required, call (559) 732-8301 (Tulare Farm Bureau) OR (559) 685-3303 (Tulare Co. UC Coop. Extension).—call no later than Sept. 10*

Western U.S. Conservation Tillage Conference and Equipment Demonstrations

Two-Day Program brought to you with the support of:

The University of CA, USDA-NRCS, Monsanto Corp., Evangelho Seed Co., John Deere, Pioneer Equipment, Westside School District, Syngenta Corp., CA Assoc. Resource Conservation Districts, Yetter Manufacturing, CA Tomato Research Inst., CA Tomato Commission

Dates : Wed., Sept 8 (7AM to 5 PM) & Thur., Sept 9 (7AM to 1 PM) 2-day program !
Location : UC West Side Research & Extension Ctr., 17353 W. Oakland Avenue, Five Points, CA
Lunch : Provided both days to registered attendees

- *Talks by researchers, growers and companies from California, Arizona, Oregon, other states*
- *Conservation Tillage equipment demos both days*
- *Grower panel discussions & Tours to Farm Sites using Alternative Tillage equipment*

For more information : go online, read or print out brochure at: **http://groups.ucanr.org/ucct**

To Register : (NOTE: $10.00 registration fee will be requested to help cover expenses)
(1) print out registration page of brochure on website, follow instructions and FAX as directed; OR
(2) Fill out following information and FAX to: Diana Nix, UC Kearney Ag Ctr. FAX: (559) 646-6593

Name ___________________________ Organization _____________________________
Address (street) ________________________ City _____________________________
State ___________________ Zip __________
Phone ___________________________ E-mail address __________________________

* 10 PCA and CCA credits applied for