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BIOTECHNOLOGY BASICS: SOME OF THE SCIENCE AND SOME OF THE ISSUES

Peggy Lemaux *(UCCE Biotechnology Specialist, UC Berkeley)*

Stories appear in newspapers and journals nearly daily about something new, what many call GMO's (genetically modified organisms) or GE (genetically engineered) crops. The means used to create GE crops is referred to as biotechnology or recombinant DNA (rDNA) technology. All these terms refer to the new ways used to modify the genetic makeup of crops and animals. What is a GMO or GE crop anyway? To answer this question and also to evaluate the risks and benefits of these products scientifically, it is helpful to improve your understanding of (1) how the genetic methods used to create these crops work; and (2) how these methods are different from or the same as the genetic methods used for thousands of years to change the crops we use for food, fiber and feed.

The uniqueness of the different varieties of any crop, such as cotton, with their identifiable growth habits and disease tolerance, for example, leads to distinguishable differences in varieties. That uniqueness is due in large part to the genetic information in the cells of the plant that determines its characteristics, such as branching patterns, maturity levels, and fiber quality. That information, contained in the millions of individual cells of the plants, is written in a chemical language, made up of chemical units, much like the letters that make up the text of this paper. That information is organized in paragraphs, which in genetic language are genes. The genes can be thought of as recipes, which dictate exactly how the

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CONDITIONAL WAIVERS FOR IRRIGATED LANDS: How Will the Landowner Be Affected?

Dan Munk *(UCCE—Fresno County),*
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Recent adoption of the Conditional Waiver of Waste Discharge Requirements for Drainage from Irrigated Lands (Conditional Waiver) has fundamentally changed the way surface water quality is viewed by the State and the way responsibility is assigned when surface water quality degradation occurs. The purpose of conditional waivers is to protect beneficial uses of state waters and to see that water quality objectives are met for California's waterways.

The Central Valley Regional Water Quality Control Board's (Regional Board) resolution requires irrigated landowners that have the potential for degrading surface water quality through intentional or unintentional discharges, to obtain a permit for such discharges or obtain a conditional waiver. Discharges could come in the form of tailwater runoff, stormwater runoff or from subsurface drainage systems whose waters then directly **or indirectly** impact state surface waters. The conditional waiver approach allows the grower to forego the individual waste discharge permit, commonly thought to be a more expensive and onerous process for most irrigated landowners.

The new regulation applies to small as well as large farming operations that would potentially drain into surface waters during irrigation drainage events or during storm water runoff periods including 100-year flood events. The regulations apply to land that is irrigated for the express purpose of producing crops. Many irrigation and

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organism grows, what it looks like and how it performs. If alphabetic letters were used to represent each chemical unit in the cotton plant, 400 books, each of 1000 pages, would be needed to hold all of the information for a particular cotton variety.

CLASSICAL AND MARKER-ASSISTED BREEDING

What if we wanted to create a new cotton variety with improved traits? If we used classical breeding methods, we would cross pollen (male cells) of one variety with eggs (female cells) of another variety and then look through the resulting plants to find a variety with the new trait we wanted. What happens with the genetic information in the cells when you do that? Are the two sets of books just combined, giving 800 books, so no information is lost? No, genetic rules say you can only end up with 400 books, so 50% of the information from each parent is lost. Breeders can't control which information or pages of the books are kept and which are lost; they can only observe the resulting plants and choose the ones that appear to have the characteristics they want. This is the method that was used to create most of the commercial varieties of crops available today.

Varieties used for crosses usually have numerous different characteristics and predicting exactly which traits the new varieties will have after crosses is difficult. New methods, based on recently discovered molecular information, are available to help breeders predict which plants from a cross have the characteristics they want – ones that they can't readily determine by just looking at the plants. This method is called marker-assisted breeding and involves the breeder looking for specific chemical language, also called a marker, in the genetic information of the plant and making sure that the specific language is in the plants they choose. It is like looking for a specific sentence in an electronic version of a book using the "Find" command in a word processing program. When breeders find the marker, the desired chemical sequence, in a particular plant, it is highly likely that the trait they want will also be present in that plant. This is like knowing you are close to your home because you see a particular building that you know is near your home.

The identification of specific markers breeders use is made possible because of the information made available through the science of genomics. What is genomics? One aspect of this science involves reading the chemical language for all of the information in a particular organism, which is called the genome. For cotton, this means reading the 1000 pages in each of the 400 books that contain the cotton plant's information. Reading the entire genome allows scientists to develop a genetic table of contents, or a road map, for the organism, so it is possible to locate specific information in the genome. Due to the efforts of a large number of researchers in recent years, there is enough information about the cotton genome that breeders have identified a significant number of markers that are beginning to help breeders with their efforts. This approach has the potential to speed up considerably the development of new varieties.

GENETIC ENGINEERING

Another way to use the new genetic tools is to move or modify specific genes to change a plant's characteristics through genetic engineering. In reading the entire genome it has been possible to identify a large number of genes and determine what characteristics of the plant they are responsible for. Once that information is known, it is possible to use chemical "scissors" to specifically cut out the gene, which is equivalent to a half-page of information in that previously discussed, "400-book" set of information. This entire process is like using a word processing program, first to find a particular sentence, and then to use the "cut" command to remove the sentence. Once removed, the gene can be reinserted back into the genome by chemical "pasting", again similar to pasting the removed text back into the same document or a new document. The tools and process of cutting and pasting the genetic information is referred to as recombinant DNA and the resulting organisms would be referred to as GE (genetically engineered), or as some prefer, GM (genetically modified).

But the gene is not what actually gives rise to the new characteristic. Genes code for proteins, which actually do most of the work in the cell. To ensure that the gene-encoded protein is made in the right tissue at the right time, genes have switches, or promoters, that tell the cell when and where to make the particular protein. Genes that are present in the genome have these switches, but sometimes they have been turned off or are turned on in the wrong parts of the plants. With genetic engineering different switches can be attached to genes that result in the protein being made at the right time and place. For example, if a gene is introduced to protect against a disease of the root, a promoter could be used to direct the protein to be made only in the root, not in the leaves or the seeds. In addition to the "on" switch, genes also have "off" switches, or terminators, that indicate where the information to make a certain protein ends.

Once the gene has been attached to the appropriate on and off switches, how is the gene put into the genome of the plant? There are two main ways scientists use. One uses a naturally occurring soil microbe capable of moving part of its DNA into a plant cell. Scientists can replace their DNA of interest and the bacterium will introduce that DNA into the plant cell. Once the DNA enters the cell from the microbe it becomes a part of the plant cell's genome. Scientists learned how to substitute their gene for the microbe's gene and in this way the gene of choice is moved into the plant cell's genome when the microbe introduces its DNA into the plant cell.

Another method to introduce genes involves physical force using what scientists call a "gene gun". This method uses tiny particles, about one-thirtieth the size of a cell that are coated with the DNA you want to introduce. The particles are projected at high speeds into the cell where the genetic information comes off the "bullet" and incorporates itself into the genome of the plant cell. The plant cell then multiplies and after thousands of cells are present they can be "coaxed" to re-form an entire plant, each cell of which has the new DNA in its genome.

COMPARING CLASSICAL BREEDING AND GENETIC ENGINEERING

Are classical breeding and genetic engineering the same or different? It depends on your point of view. Both methods use naturally occurring cellular machinery to move genes around and both cause genetic changes that can be passed on from generation to generation; in other words they are heritable. So in that sense they are the same. But there are also differences. In the case of classical breeding the changes occur inside the cell, while with genetic engineering scientists make the changes in the laboratory. Also during the breeding process, keeping a specific gene is a random process; a breeder can't specifically control which genes are in a particular plant after a cross, although marker-assisted breeding helps. With genetic engineering, scientists specifically choose genes they introduce into plants.

Perhaps the most fundamental difference between the two methods is that gene exchange through breeding takes place most often between closely related plant species, although gene exchange can occur at low frequencies across species barriers. For example, rye (*Secale*) was crossed with wheat (*Triticum*) to create *Triticale*, a crop species grown for animal feed in certain parts of the U.S. In contrast to the situation with classical breeding, the gene source used with genetic engineering can be the same plant, another plant or even a different type of organism, like a microbe or an animal. Why? It is because the same chemical language is used for the genetic information in all living things. And not only is the same chemical language used for the genes in all organisms, but humans and plants even share many of the same genes (percentage ranges from 40 to 60%).

WHAT'S OUT THERE?

So how many crops we grow and foods we eat are genetically modified? It depends on your definition. If you mean in how many crops have genetic changes occurred – even at the hands of humans - the answer would be all, including those grown under organic certification. Take for example corn whose ancient relative looked little like modern corn. Its seeds were small, in drastically reduced numbers and nearly impossible to crack with your teeth.

If you mean how many different plants that are commercially available have been changed by the genetic engineering methods described here, the number would be very small. While many processed foods, except those labeled 100% organic, may contain a GE ingredient, they come from a small number of large acreage GE crops, corn, soybean, cotton and canola. In 2004, for example, 85% of soybean acreage, 76% of cotton, and 45% of corn was GE; in 2002 54% of canola acreage was GE. Because oil, *e.g.*, cottonseed, corn and canola, and meal, *e.g.*, corn, soy and cottonseed, from these crops is in many foods, the percentage of processed foods with one of these ingredients is high, by some estimates 75% of processed foods. GE rice and alfalfa are also being tested in relatively large-scale plantings in the U.S. to study performance and assess impacts prior to commercial production.

Other smaller acreage crops have been genetically engineered, but are only grown in small-scale field tests (most > 20 acres). What kinds of small acreage crops were grown commercially? In early 1990's, several fruit and vegetable products were commercially grown and entered U.S. (and some European) markets, FlavrSavr™ tomato, NewLeaf™ potato, high solids tomato, and Freedom™ squash; most have since been taken off the market. The only whole GE fruits or vegetables commercially available currently are papaya and some types of squash, both engineered very successfully for improved viral resistance, and sweet corn, for corn ear worm protection.

What GE plants are being developed and tested in labs and small-scale field trials? Examples include:

- Mold-resistant strawberries
- Nematode-resistant tomatoes
- Grapes with resistance to Pierce's Disease and downy mildew
- Peppers resistant to bacterial diseases
- Blight resistant potatoes
- Types of pines with white pine blister rust resistance
- Plants with altered omega-3, omega-6 oils
- Frost-tolerant food crops

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- Food crops with elevated folate levels
- Blue, long-lived roses
- Reductions in allergens in foods and pollen

WHAT ISSUES CONCERN THE PUBLIC?

While much media attention focuses on safety questions related to GE foods, when asked to identify food safety concerns, few (1 to 2%) U.S. consumers list "altered or engineered food" as a concern. Certainly there have been a number of food and environmental safety issues raised regarding GE crops and foods. These issues must be carefully addressed. But efforts to resolve them should be proportional to the risk and should not overshadow finding solutions that are more relevant to solving the real issues being raised.

What are some food safety issues related to GE crops? One, often-stated issue is that the GE foods we eat today have not been tested for food safety. It is not true that they are not tested, but it is true that companies conduct this testing prior to commercialization, as occurs with drugs in the pharmaceutical industry, and that the testing is voluntary. The data from these tests are then reviewed by federal agencies like the FDA and the EPA, which can require further testing. While this part of the process is voluntary, the companies have the most to lose if a problem occurs - as happened with Starlink™ corn (see below), which cost the company ~$2 billion. What kinds of tests are carried out on the GE foods? Nutrient equivalence testing is done to show that, for example, all vitamins, minerals, proteins, carbohydrates and fats are the same for GE and conventional food. Animal testing for toxicity and sometimes allergenicity is also done.

Do GE foods cause allergies? One example raised is Starlink corn; products containing this GE variety were removed from the market in 2000. This was because Starlink corn had an introduced gene encoding a modified protein that protected it from insect damage. Based on examination of safety data by federal agencies, the corn was permitted to be commercially grown for animal feed, but until further testing and assessment was done, not for human consumption because it might cause human allergies. But the corn ended up in the food supply and some individuals claimed they suffered allergic reactions to the corn. Subsequent tests of these individuals and the food they claimed caused the problem indicated the problems were unrelated to Starlink. But importantly this problem raised the issue of crop segregation. It has caused federal agencies to take a closer look at and change some of their policies.

Is the issue of food allergies limited only to the new GE foods? Let's look at the non-GE kiwi fruit, first introduced into the U.S. in the 1970's. At that time it was not known to be a food allergen. Today it is known that some individuals develop allergies to the fruit. In fact some people have cross allergies between kiwi and latex rubber and don't know it. This is a situation that can result in severe anaphylaxis, and in some cases death. So non-GE foods can unexpectedly cause allergies as well, leading one to consider whether we should have done decades of testing, and what kind of testing, on kiwi to predict this problem before introducing it into the U.S. food supply – a process some are suggesting for GE foods. A difficult question.

OTHER ISSUES TO CONSIDER

Movement of Genes into Wild Relatives. Could gene passage from GE crops to weed species lead to a "superweed", one that doesn't respond to herbicides? Certainly gene passage from plant to plant will occur. In the U.S., major crops like soy, corn and cotton don't have wild relatives, but other crops like canola, sugarbeet, sunflower, rice and oats do have wild relatives and in some cases these relatives are control problems.

So is it possible that a gene could escape into wild relatives? Yes, it is likely. Could this be a problem? It depends on the trait that the gene is responsible for. To examine this issue, let's look at rice. Rice can cross with a plant called red rice, which can contaminate and reduce the value of cultivated rice. The movement of genes for Vitamin A enhancement, for example, from cultivated GE rice to wild rice would have little environmental effect. On the other hand, movement of genes conferring herbicide tolerance would eliminate the opportunity to control red rice with the specific herbicide for which the herbicide-resistant GE rice was developed. It would not create a "superweed", one that doesn't respond to all herbicides, but it would require farmers to return to control practices used before introduction of GE varieties. We do need to be mindful of the consequences on the environment of what we do.

What about movement of genes in areas of plant diversity? Again, the impact should be judged on a case-by-case basis, depending on the gene considered for introduction. Particularly in areas of high plant cultural diversity, crops with certain traits, engineered or classically bred, should not be released or the plants should be modified to prevent passage of the trait to wild relatives. An example of genes escaping in an area of cultural diversity was raised by a report that Bt genes escaped into landraces of corn in Mexico, an area of cultural diversity for this important crop.

Movement of Engineered Genes into Organic Crops. Another possible impact of gene movement from GE crops involves the passage of genes to organically grown crops. In the U.S. federal policy developed by organic farmers themselves states that GE crops cannot be designated as "organic". Therefore, although genes have moved from conventional crops to organic crops for years, movement of engineered genes from conventionally grown plants to organic plants can cause problems for organic farmers.

One relevant question in this regard is whether organic farmers will lose their certification if pollen from GE crops drifts onto organic plants and cross-pollinates. The National Organic Program regulations speak to the issue of "GMO contamination" of organic crops by genetic drift. "This regulation prohibits the use of excluded methods [which include GMOs] in organic operations. The presence of a detectable residue of a product of excluded methods alone does not necessarily constitute a violation of this regulation. As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods, as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation."

However, if a certifying agent suspects that an organic product came into contact with prohibited substances or were produced using excluded methods, the agent can call for testing, which under certain conditions could result in the product not being considered "organic" (according to National Organic Standards, subpart G, Administrative, sections 205.670 205.671). So, if GE cotton were grown near organically grown cotton, could this cause a problem? It is possible for the pollen (male cells) to flow from plant to plant and fertilize the eggs (female cells) of another plant, because of bees and sometimes wind, but, according to the Organic Supervisor for the California Department of Food and Agriculture, Ray Green, if this occurs by accident, the grower will not lose his organic certification and can likely sell his product as organic.

Creation of Weeds Resistant to Herbicides. Certainly it is true that increased plantings of herbicide-resistant GE crops has increased the use of specific herbicides which the GE crops are engineered to resist. In general these herbicides have been more environmentally friendly in many ways, but there also remains the possibility that overuse of single pesticides could lead to, and already has led to, the development of herbicide resistant weeds. Was this surprising? Perhaps to some, but history has shown that overuse of a particular herbicide can render a new chemical or technology useless. Will this situation create an ecological disaster? Not likely. Other perhaps less environmentally friendly herbicides can be used, but it will be a problem for companies developing the crops and farmers using them.

For more information and scientific references, visit the Biotechnology Information and Scientific Database sections of the ANR biotechnology workgroup website: http://ucbiotech.org or consider looking at information in some other websites / information sources mentioned below.

Web Links Suggested by Peggy G. Lemaux and Alison Van Eenennaam *(UCCE Biotechnology Specialists) - UC Berkeley and UC Davis respectively)*

General Biotechnology Information

http://ucbiotech.org 130 issues/responses relating to agriculture, biotechnology, linked to scientific literature, talks and PowerPoint presentations. (NOTE: consider starting with this site, as it has links to websites below that are shown with an asterisk "*" – check "LINKS" section at this site

http://www.isb.vt.edu/cfdocs/indexlinks.cfm Extensive list of available ag biotech websites

* pewagbiotech.org A fact sheet, entitled, Chronicles and Catalogues: State and Federal Legislative Activity Relating to Agricultural Biotechnology

*http://www.colostate.edu/programs/lifesciences/TransgenicCrops/ General information plus a Q&A from Colorado State University

* http://www.nbiap.vt.edu/ Information Systems for Biotechnology is a monthly newsletter with the latest findings in ag biotech; moderately technical

* http://www.nysaes.cornell.edu/comm/gmo/ Informative brochure:Agricultural Biotechnology:Informing the Dialogue

Issues and Risks of Biotech Crops

* http://www.colostate.edu/programs/lifesciences/TransgenicCrops/risks.html Issues and risks of ag biotech products

Papers on gene flow in plants:
http://www.plantphysiol.org/cgi/reprint/125/4/1543.pdf
http://www.plantphysiol.org/cgi/reprint/132/4/177o.pdf
http://www.riskassess.org/index.cfm
http://www.isb.vt.edu/2002menu/regulatory_information.cfm Field test information and charts on biotech crops in U.S. and foreign countries

Regulatory/Safety Information

* http://www.whybiotech.com/index.asp?id=2837 Council of Biotechnology Information (industry consortium) A comprehensive article that lists every biotech agricultural product that has been approved in North America.

* ICGEB database on biosafety studies: Extensive bibliography of biosafety references from the International Centre for Genetic Engineering and Biotechnology

Free CD, Essential Biosafety through AgBios, Canada providing scientific and regulatory information for genetically modified and other novel crops and foods. Includes database of safety information on all GM plant products with regulatory approval Contains detailed information on how it was produced and what concerns were addressed during environmental and food safety risk assessments. View CD's contents at <http://www.essentialbiosafety.info>

*http://www.ams.usda/gov/nop/NOP/Guidance%20Statements/ScopeGuidance041304.pdf National Organic Program Guidance Statement on USDA rules for what types of products may carry USDA organic program seal

* US Dept. of State Factsheets (December, 2002) - *note again that asterisk (*) means that the following are available at the UC Biotech Workgroup website at:* ***http://ucbiotech.org***
"Agricultural Development and Trade Issues for Bio-Engineered Crops in U.S. Food Aid Donations"
"Environmental Considerations for Bio-Engineered Crops in US Food Aid donations"
"Food Safety Assessments for Bio-Engineered Crops in U.S. Food Aid Donations"

http://www.cast-science.org/cast/src/cast_top.htm
Ecological Impact Assessment of products of ag biotech by Council for Agricultural Science and Technology

Economics

*http://www.technology.gov/reports/Biotechnology/CD120a_0310.pdf U.S. Dept. of Commerce Report on the Use of Biotechnology in U.S. Industry; First comprehensive federal survey and data analysis of biotechnology in U.S.

*http://www.ers.usda.gov/publications/tb1906/ Report on market benefits from adopting biotech crops

Broader Perspectives / Other Perspectives

http://www/foei.org/gmo/index.html Perspectives of Friends of the Earth on genetic engineering and GMO's

http://www.greenpeace.org/ and
http://ge.greenpeace.org/homepage/ Visions and perspectives of Greenpeace on genetic engineering

http://www.i-sis.org.uk/isisnews/sis17.php Newsletter of Institute of Science in Society which opposes genetic engineering

Animal Biotechnology

* The National Academies Report on animal biotechnology released on August 20, 2002 by the National Academies of Science, titled "Animal Biotechnology: Science Based Concerns"

http://www.animalbiotechnology.org

http://animal science.ucdavis.edu/animalbiotech

http://www.agbiotechnet.com Commercial site for information on animal biotechnology issues

Miscellaneous

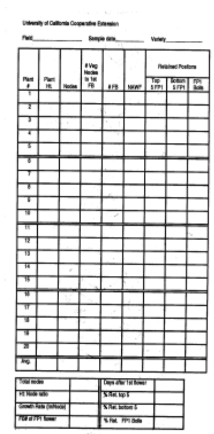
http://www4.ncsu.edu/unity/users/g/glcomsto/www/homepage.html Bioethics website of Professor Gary L. Comstock at North Carolina State University.

NEW IDEAS IN COTTON PLANT MAPPING SOFTWARE

Brian Marsh *(UCCE Kern County and UC Shafter REC);* **Bob Hutmacher** *(UC Davis Plant Science Dept. and UC Shafter REC)*

During the 1980's, University of California Cooperative Extension Specialists and Advisors developed a method of Acala cotton plant mapping and data interpretation to aid decision making for management decisions regarding the application of plant growth regulators and pesticides.

Data collected included plant height, number of vegetative nodes, number of fruiting nodes, number of 1st position bolls retained at the bottom five and top five fruiting nodes, and nodes above white flower (NAWF). Calculated values include height-to-node ratio (HNR), growth rate (GR, for multiple sampling dates) and date of 1st flower. Planting date and row spacing are also used in the calculations. Data was collected from numerous multi-year studies without major yield limiting factors, with data collected from all though the San Joaquin Valley. This data was compiled and analyzed to establish index growth curves for Height:Node Ratios, Growth Rates and NAWF for SJ-2 Acala cotton under high yield conditions. A data recording method was developed using paper cards, which have been used "as is" or after modification by various users over the years.



Plant measurements were hand written on the card then totaled, averaged and calculations made. On a separate card the calculated values could be marked on a graph that also had graphs of the index growth curves. An additional table had data on top-5 retention threshold values that should be maintained for good yields based on bottom-5 retention. Growers and consultants could then use the data and graphs to help determine how any parti cular field was doing in comparison to expected (index) growth responses in high-

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NEW PLANT MAPPING SOFTWARE

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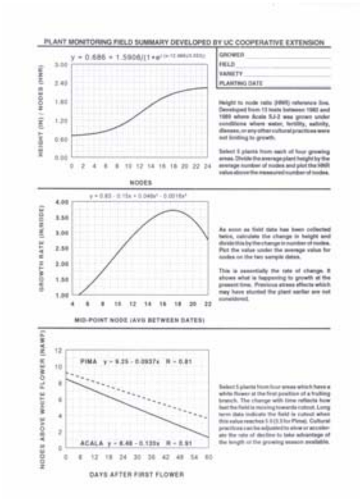
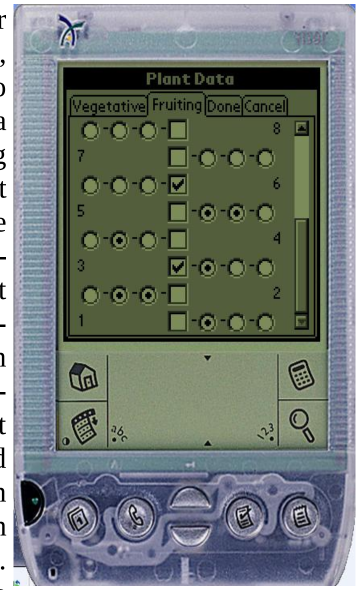


yielding SJ-2 fields, using the information further to assist in developing appropriate management decisions.

During the 1990's a computer program was developed for Lotus 123 that ran on a Hewlett Packard Palmtop PC. Data was entered directly on the Palmtop PC and the above mentioned growth calculations were made automatically. Index values in percent were calculated relative to the SJ-2 established growth curves. A growth regulator rate recommendation was also calculated along with an expected yield response. Changes in computer technology over the years have resulted in the HP Palmtop PC computers and Lotus 123 programs largely being unsupported and obsolete.

Recently, new programs with mapping capabilities have been developed to operate on some of today's handheld devices, utilizing more recently-developed operating systems. A brief description of the approach used and basics of operation will now be given. We hope some continuing and former users of the HP Palmtop programs will try early, test versions of the new programs and help in their evaluation and updating.

The new program utilizes touch screen technology and a graphic interface for data input. Data entry can be made on any handheld running Palm OS version 4.0 or lower. Other programs are available for Palm CE. Data is stored on the desktop in Microsoft Access, while Microsoft Excel is used to generate reports. After installing the software and the handheld is initialized, a prompt will ask that the grower name and field be entered, either on the desktop or handheld.



In the field, once the grower name and field are selected, the user has the option to enter plant data, insect data or add comments. Selecting plant data, the first input screen is displayed on the handheld. The screen displays a spot to enter plant height and a graphic representation of a cotton main stem. Plant height is entered by touching the height square with the stylus and entering the height either on the pop-up keyboard or on the number writing space. Touch "DONE" and the vegetative screen returns. The upper-most vegetative node is recorded by touching the corresponding node number.

Touch the "Fruiting" tab to display the next data input screen. A graphic representing the main stem fruiting nodes and branches will be displayed. Retained boll data is recorded by touching each corresponding button. Data can be recorded for 1st, 2nd, and 3rd position bolls on fruiting branches. Only 1st position bolls are used in the current Acala growth index calculations.

Next, touch the buttons that correspond to the node with the upper most 1st position white flower and the upper most node on the main stem. When both are checked, "white flower" and "terminal" appear on the screen at the checked nodes. The input data can easily be reviewed by scrolling up or down. When ready to continue, click the "Done" tab. A new window will open. Click "Yes" to add data for additional plants or "No" when complete data entry for that field. Reports are in the same general format as the program "CottonPro" which has been available through the IPM web site for several years. This new program will provide an alternative to writing down data on cards or use of older palmtop computers, and should speed up data entry for in-season plant mapping.

Copies of this program can be obtained from the UCCE Kern County Office. <u>Contact Brian Marsh at 661-868-6210 or by email at bhmarsh@ucdavis.edu.</u>

** mention of trade names in this article does not imply endorsement by the University of CA*

CONDITIONAL WAIVERS

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water districts believe this applies to most, or all, of the irrigated acreage in the Central Valley.

The conditional waiver can then be seen as a way to maintain compliance with the State and to "cover" the landowner, should any incidental or accidental discharges occur into surface waters. This does not however excuse the landowner from their responsibility in the event a harmful discharge does occur to a local watershed. Surface waters of the state include natural waterways such as streams, lakes and ponds, in addition to irrigation ditches and canals, or temporary steams flowing into larger water bodies.

Obtaining and maintaining a waiver does require considerable monitoring, reporting and oftentimes modification of existing management practices to comply with the state waiver requirements. But with the recent formation of coalition (or watershed) groups, coalition staff members can handle most of the compliance requirements for the region/watershed identified by the group. This takes a huge responsibility off the individual grower and this, combined with the fact that costs for monitoring and reporting are shared over a large acreage, is the primary reason for their popularity.

The waivers and permit each are intended to minimize or eliminate water quality degradation in state water bodies. They require that landowners adopt best management practices on their acreage to minimize the potential for discharging specific pollutants identified as harmful to the surface water body. The California Water code defines waste as including materials such as pesticides, fertilizers, soil, salts, and naturally occurring trace elements.

Options for Compliance

Once you have determined that you are a discharger, or potential discharger, there are 3 options for complying with the State, however not all require you to physically obtain the waiver. One may file with the Board for the waiver as an individual discharger. The second and most common method, as discussed above, is to join a coalition of other landowners within your watershed. The third and least popular method is to apply for a waste discharge permit, a lengthy process that many industrial and municipal dischargers currently use.

Regardless of the option used for compliance, documents must be filed with the board that include the nature of irrigation and drainage activities, topography and land use maps of the farmed and un-farmed land owned. In addition, details regarding the potential or actual occurrences of drainage water leaving the site, whether the discharges are related to irrigation events, storm events or other unintentional discharges that could potentially occur. The documentation described is intended to serve as both a survey of current watershed resources but also as an implementation plan that includes methods of minimizing potential breaches in water quality standards intended for the local waterways.

Detailed information about the Monitoring and Reporting Program, Order number R5-2003-0826 for coalition groups are described on the regional boards website referenced at the end of this article. This 28 page document outlines the needs for reporting and monitoring the local watershed. This site also outlines information for individual dischargers who elect not to join a coalition.

Which Compliance Option Have You Selected?

By submitting a report of waste discharge, you have decided to forego joining a coalition or securing an individual waiver and have accepted the Boards waste discharge requirements. Some individual waivers will be sought and can be obtained for agricultural operations in addition to conducting and reporting water monitoring on potentially affected waters.

Watershed groups or "coalitions" are the most popular and cost effective way to obtain a conditional waiver. In this case the watershed program coordinator is the responsible party for providing information to the board regarding land/management practices, characterization of local water bodies impacted, and an approved monitoring program for all potentially affected waterways. If or when the local water body is found to be out of compliance with respect to water quality objectives, the waiver adopted by the coalition will include a schedule of compliance by the board and a timeline is established for improving the quality of the impacted water body.

Progress Expectations and Enrollment

On November 1, 2003 coalition or individual discharger reports were due to the regional board that included a general report of the location and setting as well as a notice of intent to obtain a conditional waiver. On April 1, 2004 individual and watershed groups were to have submitted a watershed and farm evaluation report in addition to a monitoring and evaluation report. These reports contain a detailed description of the watershed geography, cropping patterns and landscape being affected as well as a comprehensive assessment of the hydrology of the irrigated landscape. Information including a water resources inventory and a description of specific farm irrigation and water transfer practices is required.

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CONDITIONAL WAIVERS

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April 1, 2004 was also a date for individual dischargers to file a plan of action for their respective geographies.

While November 1, 2003 has passed, the Regional Board recognizes that many growers have never heard of the regulatory program and is encouraging growers to make a good faith effort to assess their properties runoff potential and take the appropriate action when they hear about the program. As of July 1, 2004 each coalition is expected to implement a monitoring plan that has been approved by the regional board. The monitoring program includes a sampling of water quality characteristics including temperature, flow, pH, coliform bacteria and toxicity testing to sensitive aquatic species. Eventually, monitoring requirements will also include nutrient and pesticide testing.

Contacting Local Coalitions

The coalition group philosophy is strength in numbers and therefore all groups are actively supporting affected growers within their area of influence. Some coalitions are absorbing the program costs by reapportioning staff time and resources from related activities, while others are charging a nominal fee based on affected acreage. Registration involves contacting the local watershed coalition leader and filing intent to be part of the watershed coalition. There are some details that the coalition will need to properly document a landowner's affected acreage. The board requires that a list of participating growers and their contact information be compiled by the watershed leader and only released to the board in the event of a failure to comply in the event water quality objectives are not being met.

ADDITIONAL RESOURCES AVAILABLE:

<u>Central Valley Regional Water Quality Control Board Website:</u>

www.swrcb.ca.gov/rwqcb5/programs/irrigated_lands/index.html

<u>South San Joaquin Valley Water Quality Coalition</u> (includes Kings, Kaweah, Tule and Kern River Watersheds).
Coordinators: David Orth / Mike Mendes.
Contact Number: (559) 237-5567

<u>Westlands Water District (Coalition),</u>
Contact: Thaddeus Bettner
Contact Number: (559) 241-6215

<u>Westside San Joaquin River Coalition.</u>
Coordinator: Joseph McGahan
Contact Number: (209) 826-9696

Reminders:

- Please check out the UC cotton web site (**http://cottoninfo.ucdavis.edu**) for variety trial yield and quality information - results of 2004 variety trials should be analyzed and ready for posting on the website by early to mid-January. The **<u>yield</u>** data will be summarized in January and February paper copies of the CA Cotton Review Newsletter mailed to you each year, but the web site will also have: (a) fiber quality (HVI) summaries for all trials; (b) access to yield and quality data from trials in other recent years. This will be the site for the most complete data sets we can provide.

Upcoming Items — Future Issues *(two next issues planned for January, 2005 and February, 2005 - planned issue date for specific articles shown in parentheses)*

- UCCE Variety Trial Yield Results (January 2005 issue)
  - Approved Acala Variety trials
  - CA Upland Advanced Strains trials
  - Pima Variety trials
- San Joaquin Valley Cotton Board Trials—Yield Results (January or February, 2005 issue)
  - Pima and Acala Approved Variety trials
- Summary of Seed Treatment Trial Results (January 2005 issue)
- Update on Verticillium Wilt recommendations based on 2004 observations (January or February)
- Update on Fusarium screening trials (January or February 2005 issue)