THE CENTER FOR AGROECOLOGY & SUSTAINABLE FOOD SYSTEMS

# The Cultivar

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# BASIS Project Promotes Biological Management in Strawberries

Strawberry cropping has doubled on California's Central Coast in the last 15 years to over 11,000 acres, generating more than $400 million annually. Although lucrative, the crop is also costly to grow, and conventional management strategies require extensive inputs of synthetic chemical pesticides and fertilizers that can have negative environmental impacts.

To try and mitigate some of these impacts while offering growers alternatives, members of the Center for Agroecology & Sustainable Food Systems (the Center) and the US Department of Agriculture have initiated the Biological Agriculture Systems in Strawberries (BASIS) project. Modeled on other grower-researcher cooperative studies, BASIS teams farmers with research and extension personnel, pest control advisors, and resource conservation staff to develop farming strategies that maintain the economic bottom line while reducing agrochemical inputs.

"Our goal is to develop and make growers aware of the biological alternatives to some conventional growing techniques," says Carolee Bull, a USDA plant pathologist with the Salinas Agricultural Research Service who will serve as the research effort's principal investigator. "I'd like the BASIS program to provide the growers with a new tool bag full of biological tools to be used in conjunction with their current management tools," says Bull.

Conventional strawberry growers will lose a key disease and weed control input when production and use of methyl bromide, a class I ozone depleter, is phased out beginning in 2001, with cancellation scheduled for 2005. Methyl bromide, or a combination of methyl bromide and chloropicrin, are currently used as soil fumigants to control soil-borne diseases and weeds in conventional strawberry systems. Growers have also lost or are at risk of losing some traditional chemical controls for the major strawberry pests, two-spotted spider mite *(Tetranychus urticae)* and lygus bugs *(Lygus hesperus)*, due to regulatory issues, pest resistance, or review as part of the Food Quality Protection Act. Without these agrochemicals, strawberry growers will need alternative strategies to control weeds, pests, and diseases.

Also driving the need for lower-impact farming techniques is the expansion of strawberry acreage onto sandy, erodable soils located on steep slopes. The Natural Resources Conservation Service (NRCS) estimates that soil loss from some of this sloped ground can exceed 140 tons per acre in a wet year. Not only does the soil erode, but along with it come agricultural chemicals bound to soil particles. Wetlands and waterways throughout the Monterey Bay area, including Elkhorn Slough (see related story, page 4), carry multiple agricultural chemical loads from past and current uses, including DDT, toxiphene, chlordane,

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JON KERSEY

Amy Griggs (left) and Janet Bryer examine insects collected from a BASIS project strawberry field , located on Santa Cruz County's north coast.

endosulfan, dieldrin and aldrin.[1,2] Strawberry growers are under increasing pressure to curb erosion in order to protect the watershed from further chemical and soil contamination.

### BASIS Will Test Alternatives

The BASIS effort focuses on a team of both conventional and organic mentor growers using one or more management strategies to reduce agrochemical use, encourage beneficial insects, increase wildlife habitat, and improve erosion control on their farms. Working with these key growers, the BASIS research group plans to develop a "template" of alternative management strategies that can be copied by other growers in the region. "I'm really looking forward to working in this type of team system," says Bull. "If you have a scientist sitting in their office trying to figure out what to do, that information often won't be applied on a larger scale. Farmer input is the component that's traditionally been missing when we try and translate research findings to a field situation."

The strategies being tested include,

*Methyl bromide alternatives.* In place of methyl bromide fumigation for disease and weed control, the BASIS project will study the effectiveness of using 5-10 tons of finished compost added at planting, or an alternative fumigant (e.g., Telone/chloropicrin). Compost is known to boost soil microbial activity and diversity of beneficial microorganisms, which in turn suppress pathogens and pests more effectively. In addition, organically managed fields will incorporate mulched broccoli compost prior to planting. Broccoli contains naturally occurring chemicals that may help suppress pathogens and limit weed growth.

*Synthetic fertilizer alternatives.* Both conventional and organic growers will be encouraged to apply compost to increase both soil nutrient levels and the cation exchange capacity (a measure of the soil's ability to hold nutrients) of the sandy soils that make up much of the Central Coast's strawberry acreage. Quick-growing summer cover crops, e.g., buckwheat or mustard, will be used between strawberry production seasons when possible. For growers who can afford to take strawberry land out of production, cover crops will be planted in the fall. In continuously cropped systems, cover crops can be planted in furrow bottoms to increase levels of soil organic matter and nutrients.

Where fertilizers are applied, growers will be encouraged to analyze leaf tissues to make sure that the crop really needs the nutrients, and to apply the fertilizers in smaller, more frequent doses or as foliar sprays of kelp and micronutrients rather than as "top dressings" placed directly on the soil. These practices should reduce the amount of nitrate leaching into irrigation runoff and nearby waterways.

*Pesticide alternatives.* Pest control efforts will focus on two-spotted spider mites (TSSM) and lygus bugs. Populations of both pest and beneficial insects will be monitored and the results used along with degree-day calculations (which track TSSM and lygus egg-laying and hatching times), to time releases of predatory mites *(Phytoseiulus persimilis)* which feed on TSSM, and *Anaphes iole*, which parasitize lygus bugs. Growers will be encouraged to use supplemental biopesticides such as neem and pyrethrum rather than conventional pesticides to control significant pest outbreaks. Annual and perennial plantings of non-crop vegetation will also be used to trap lygus and promote populations of beneficial insects (see below).

*Herbicide alternatives.* Instead of fumigation with methyl bromide, BASIS plots will be tilled to prepare the planting beds, and the beds pre-irrigated. Once weeds have germinated for 10-14 days, the beds will be tilled to remove the weeds, and the process repeated. Other controls to be tested include incorporating broccoli residues, applying hot water (99°C) to kill shallow weed seeds and seedlings, and mulching with plastic (green, brown and black).

*Erosion control.* The Natural Resources Conservation Service recommends that growers align their furrow slopes in such as way as to reduce erosion in the furrow bottoms and distribute irrigation more efficiently. At BASIS sites, other erosion control measures will include establishing various grasses on field roads, in the ends of furrows, and on other bare soil around the plots. On field plot margins, growers will be encouraged to plant perennial grasses and shrubs to attract beneficial insects and further reduce runoff and erosion. Some growers will experiment with reshaping the raised beds to reduce soil loss during heavy rains.

### First Year of Three Year Project Underway

The BASIS project began last fall on eight farms in Salinas, Prunedale, Watsonville, Aromas, and Elkhorn Slough, and on Santa Cruz County's north coast. Due to the timing of funding, none of the growers has yet put in place the full range of alternative strategies, but each farm has begun one or more components that together will form an integrated management plan. At each site, both enrolled BASIS acreage and control plots farmed by the same grower will be monitored as a way of measuring the effects of BASIS practices. Researchers will compare yield, soil fertility, erosion control, and the size of beneficial and pest organism populations, including microorganisms, insects, mites, and weeds.

Center extension specialist Sean Swezey, post-graduate researcher Polly Goldman, and research assistants Janet Bryer and John Bailey began working with BASIS growers last fall to maintain or establish annual and perennial

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non-crop plantings on field margins. These "hedgerows" are used to trap lygus and attract populations of beneficial insects, as well as provide wildlife habitat. The Center research group monitors the annual and perennial plantings weekly for populations of both pest and beneficial insects. They also collect insect samples from the adjacent strawberry crops to see how the hedgerows affect pest and beneficial populations in the strawberry fields.

The annual trap crop planted in November 1998 includes one dormant and one semi-dormant variety of alfalfa *(Medicago sativa),* two radish varieties (daikon and the edible variety 'Cherry Belle'), and sweet alyssum ('Carpet of Snow' variety). Goldman notes that they are already seeing some effect on lygus populations. "At one study site, lygus moving into the fields from surrounding vegetation settled in the annual trap crop mix," she says. The grower sprayed the trap crop and has not seen lygus bugs in the adjacent strawberry planting; in contrast, lygus have been found on the same farm in strawberries that did not have an adjacent trap crop. "Even though he used a conventional pesticide to eliminate lygus from the trap crop, he did not have to spray the strawberry crop itself," notes Goldman.

Hedgerows of perennial plants can serve as long-lasting habitat for beneficial insects. The perennial hedgerows in the BASIS study feature native species, including yarrow *(Achillea millefolium),* which in earlier studies has successfully attracted large numbers of beneficial species; the buckwheats *Eriogonum latifolium* and *E. giganteum*; 'Blue Blossom' ceanothus, *Ceanothus thrysiflorus,* and Monterey ceanothus*, C. cuneatus* var. *rigidis*; coffeeberry, *Rhamnus californica*; California sagebrush, *Artemesia californica;* elderberry, *Sambucus mexicana;* and at the coastal sites, gum plant, *Grindelia stricta;* lizard tail, *Eriophyllum staechadifolium;* and black sage, *Salvia mellifera.*

Based on their experiences from the past several years, when they had difficulty establishing perennial hedgerows in the fall and winter due to weed competition, the researchers delayed planting any new perennial borders until this spring. Once the growers had installed drip irrigation to get the new plantings established, Goldman, Bryer and Bailey mulched the perennials with several layers of newspaper and a thick layer of wood chips to reduce weed growth.

### BASIS Group Recruiting More Growers

BASIS has already generated interest amongst Central Coast strawberry growers, especially conventional growers who are putting a few acres into organic production for the first time. Bull hopes that as BASIS begins to generate information, more growers will make their farms available for study. "We're very excited about the project and have hit the ground running with our first plots," says Bull. "We're hoping that in the next two years the number of growers involved will expand."

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## From the Director

Over the past few months, it has been my pleasure to see a number of individuals associated with the Center for Agroecology & Sustainable Food Systems (the Center) receive well-deserved recognition for their contributions to sustainable agriculture and environmental action. Dr. Sean Swezey (the Center's Farm Extension Specialist) was recently appointed Director of the University of California's system-wide Sustainable Agriculture Research and Education Program (UC SAREP). We congratulate Sean on this appointment, and while this means he will be spending less time at CASFS, it represents an excellent opportunity to build stronger collaborative links between the Center and UC SAREP (more on page 8).

Also, at the 1999 Ecological Farming Conference, longtime Center staff member Orin Martin was awarded the prestigious "Steward of Sustainable Agriculture" award by the Committee for Sustainable Agriculture, for his 22 years of teaching and community service in organic gardening. Congratulations, Orin, on a well-deserved award that recognizes your ability to inspire others through teaching (for more on Orin's award, see page 10).

Finally, in May I had the opportunity to represent the Center and the UC Santa Cruz campus at a dinner in San Francisco organized by the California League of Conservation Voters, honoring Alfred E. Heller for a his lifetime of work in support of the environment. Alf, and others in the Heller family, have been major supporters of agroecological research and education activities at UCSC, including lobbying for UC support to the Center, creating the endowed chair in agroecology held by Professor Steve Gliessman, and providing major support for the Center's Farm Extension program. Indeed, in the few minutes that Alf had to speak at the dinner, he opened by challenging the environmental and conservation movements to "not let agriculture be defined by agribusiness and technologists," but rather to support and work with groups such as the Center to build sustainable agricultural systems. We congratulate Alf on this award, and thank him for his continued vision and support of the Center.

Alf's message to environmental and conservation groups is timely, since it is apparent that many private foundations which have supported sustainable agriculture and food systems work in the past are no longer willing to do so. The reasons for this shift are unclear, but further indicate it is imperative that we build new partnerships that effectively link goals of building sustainable agriculture and food systems with other societal goals such as conservation of biodiversity, preservation of open space, and community health. As you can see, such links are already being made in much of the work described in this issue of *The Cultivar,* notably the work underway in Elkhorn Slough, and the BASIS project.

Projects which consider the health of the entire ecosystem, including social aspects of sustainable agriculture, will continue to drive the Center's work. In the next issue we will highlight some of the social issues questions which have been raised as the organic agriculture movement enters the mainstream, and what this may mean for the movement's future.

*– Dr. Carol Shennan*

In addition to the cooperating growers, the BASIS team includes faculty and staff from the Center for Agroecology & Sustainable Food Systems, as well as personnel from UC Cooperative Extension, USDA's Natural Resources Conservation Service, Community Alliance with Family Farmers, the Monterey and Santa Cruz County Resource Conservation Districts, and independent pest control advisors and strawberry industry representatives. BASIS is funded by a Biologically Integrated Farming Systems (BIFS) grant from the UC Sustainable Agriculture Research and Education Program.

Research findings from the BASIS project will be shared through a series of breakfast meeting, field days, and publications. The first meeting will take place at the Elkhorn Native Plant Nursery on June 24, 1999, from 8 am - 10:30 am as part of the Lighthouse Farm Network series (see below for directions). Sean Swezey and Polly Goldman will present research results from their strawberry farmscaping studies and will introduce the BASIS project. For more information on the BASIS project or to find out about enrolling acreage in the study, contact Carolee Bull at 831/755-2889.

*- Martha Brown*
*- Polly Goldman*

*The Elkhorn Native Plant Nursery is located off Highway 1 at the north end of Moss Landing. Turn east directly across from the Beacon Station and Army surplus store at Struve Rd. The nursery is located one mile straight ahead through the strawberry fields. A tour of one of the Castroville-area BASIS farms will also take place. For details, contact Reggie Knox at 831/457-1007; sponsored by the Community Alliance with Family Farmers.*

[1]Kleinfelder, Inc., 1993. Elkhorn Slough 205(j) Uplands Water Quality Management Plan. Prepared for the Association of Monterey Bay Area Governments (AMBAG).

[2]Mischke, T., K. Brunetti, V. Acosta, D. Weaver, and M. Brown. 1985. Agricultural Sources of DDT residues in California's environment. California Department of food and Agriculture, Environmental Hazards Assessment Program. Sacramento, CA.

# Buffer Strips Help Protect Watershed's Health

Daniel Mountjoy picks up a chunk of dirt from the ground at the bottom edge of a strawberry field. "See the layer of fine sediment on top of the sand?" says Mountjoy, a watershed specialist with the National Resource Conservation Service. Had it not been for patches of grass planted alongside the steep road and a catch basin at the field edge bottom, this fertile soil would have washed into the Elkhorn Slough estuary, a critical wildlife habitat that is part of the National Estuarine Research Reserve system. Not only would the soil particles and humus be carried away, but also the pesticides and fertilizers used to grow strawberries on this highly erodable soil.

Like many wetlands and waterways, the species-rich Elkhorn Slough is vulnerable to runoff and erosion from nearby agricultural operations. One quarter of the uplands surrounding the estuary is in agricultural production, and many crops grow on sloping fields with up to 25% grades. Rainfall generates surface runoff which transports the sandy topsoil from the productive land into the slough. According to Mark Silberstein, director of the Elkhorn Slough Foundation, water quality in the watershed has been deteriorating steadily over the last 25 years, mainly because it is the sink for excess fertilizers. The main crops grown adjacent to Elkhorn Slough are strawberries and flowers, crops with exacting cosmetic demands that require high inputs of nutrients and pesticides.

Fortunately, help is on the way. On the East Coast, narrow strips of grass or trees planted between agricultural land and waterways, called vegetated buffer strips (VBS), are used successfully to trap sediment and filter nutrients from farm field runoff. Much of the Chesapeake Bay – the nation's largest estuary – is now bordered by trees and meadows, thanks to efforts to improve the bay's water quality and protect its diverse wildlife.

Because the buffer zones were so successful at improving water quality, the National Resource Conservation Service launched a nationwide buffer promotion project in 1997. Vice-President Al Gore praised the initiative as the way to "achieve the additional water quality gains we seek." The initiative's goal is to line two million miles of important watersheds and rivers with conservation buffers by 2002.

### Azevedo Ranch Study Tests VBS

In California, the use of buffer strips as water filters and sediment traps is in its infancy. One of the first VBS studies on the West Coast, conducted at the Azevedo Ranch adjacent to Elkhorn Slough, was recently completed. From 1995 to 1998, UC Santa Cruz Environmental Studies graduate students Marc Los Huertos and Felicia Rein studied whether buffer strips can prevent erosion and nutrient pollution in a Mediterranean climate with seasonal rains. California's heavy, seasonal rainfall makes erosion control difficult, and unlike comparable studies on the East Coast, Los Huertos and Rein depended on natural rainfall rather than simulated rainfall to evaluate sediment and nutrient transport.

The researchers prepared three replicates of three different treatments on a south-facing slope, which stretches 40 meters from the edge of the row crop fields toward the slough. For the first time on the West Coast, they used native perennial bunchgrasses *(Nassella pulchra, Bromus carinatus* and *Deschampsia caespitosa)* for one of the VBS treatments. Local botanists helped determine the mix of grasses, which were grown from seed collected in the watershed to maintain the local gene pool. Using native plants in the strips also restores habitat while eliminating the problem of introducing species which may disrupt native vegetation communities.

Los Huertos and Rein compared this native mix with a second treatment of non-native annual barley (*Hordeum vulgare*). Farmers commonly use barley as a fast-growing and cheap erosion control and cover crop, and while it is recommended on the East Coast, it is not native to California. However, because it doesn't aggressively reseed,

annual barley may be useful for short-term erosion control without posing long-term threats to native plant communities. The third treatment was left unseeded as a control, and the control plots were soon covered with fireweed and other perennial and annual weeds.

### VBS Make Effective Sediment Traps

Rein, who investigated the hydrology of the buffer strips as well as conducting an erosion study, wanted to find out if the strips would trap sediment and prevent erosion, and evaluated the minimum strip width needed for effective erosion control.

She found that all three buffer strip treatments were effective, trapping a mean of 67% of the sediments suspended in surface runoff. The amount of sediment trapped and the formation of erosion gullies largely depended on the density of the plant cover in the VBS; the denser the cover, the more sediment it trapped. The majority of sediment washing off the farm field was caught within the first ten meters of the buffer strip.

Although the buffer strips all trapped sediments, there were differences in the amount of cover generated. The annual barley thrived in the first year, but failed to reseed well in the second year, which made it less effective as a buffer after the first growing season. The perennials needed six months to establish themselves, but formed a dense cover by the end of the first year. Rein's data suggest that, once established, perennials effectively trapped sediments running off the fields during heavy rains, and prevented further erosion gullies. Rein started a second study in September 1997 to investigate whether the optimal erosion control would be a mix of annual and perennial species.

She is still analyzing the study's results, but based on preliminary findings Rein recommends a mix of an annual species with native perennials to retain sediment the first season a VBS is established. "The non-aggressive annual, for example a barley (*Hordeum* sp.), will provide a fast-growing cover the first year, and allow the perennials to take over for several years more, depending on the species composition," she says. Rein also recommends that growers avoid farming the edges of the watershed or slopes with grades

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Felicia Rein (right) measures an erosion gully formed by runoff in a VBS study plot above Elkhorn Slough.

steeper than 15%. "Farming these sites is only marginally profitable for the farmer and it's damaging to the soil and the watershed," she says.

Stopping sediment runoff not only helps limit erosion, it reduces the release of toxins bound to soil particles. For example, although DDT was banned in 1975, it remains in the watershed's soil all around Elkhorn Slough. This includes Azevedo Ranch, where measurements have detected lingering DDT, says Rein. Heavy rain can mobilize sediment and transport this toxic pesticide and other residues into the watershed, where it poses risks to wildlife and human health. "DDT continues to be a threat in the watershed, so erosion control is a primary need. And buffer strips help," Rein says.

### Nitrogen Continues to Escape

While the buffer strips helped control erosion and trap sediment, they failed to serve as a sink for excess nitrogen from fertilizers, at least during part of the year. In the same three treatments, Los Huertos measured nitrate concentrations in subterranean water, the soil, and plant biomass. The good news is that the grasses and soil microbes accumulated nitrogen from rain and irrigation runoff in their biomass during the growing season. The bad news is that they released the accumulated nitrogen in the summer and fall. Most above-ground plant biomass and soil microbes die during the dry season, releasing nitrogen back into the soil system, and the first rains carry away this excess nitrogen and deposit it in the slough. This was true for all treatments, and Los Huertos concludes that the buffer strips are not robust enough to trap nitrogen. "Although they removed nitrogen during a portion of the growing season, they weren't effective year-round," says Los Huertos. Rein is still analyzing samples of nitrogen pools from surface runoff and groundwater.

Los Huertos's results suggest that vegetated buffer strips cannot solve the problem of nitrogen run-off into the watershed in this climate. Instead, he recommends that growers should manage nitrogen differently, noting that much more nitrogen is used on fields than is needed for optimal growth. "Reduce the [amount of] nitrogen until you see a reduction in crop response," he says. According to Los Huertos, another option that needs to be explored would be to provide the nitrogen to the plant in a different form, for example as compost. The organic matter stores the nitrogen longer and

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makes it available to the plant as needed.

Los Huertos believes that the focus needs to shift from yield maximization to nitrogen optimization practices to lessen the nitrate pollution of the watershed without decreasing yields. "By the very nature of agriculture we're going to lose nitrogen to water or as a gas; what we're trying to do is maximize yield while minimizing nitrogen losses. We also need to include a 'downstream' component in crop trials, so that water quality as well as crop yields are analyzed."

**Erosion Control's Costs and Benefits**

Even though the grass buffers failed to remove excess nitrogen from water moving through the soil, sediment retention alone goes a long way toward improving water quality. Pesticides and other toxins often adhere to soil particles, washing into the slough along with sediment. Anything that can be done to reduce erosion will make a difference to the watershed's health.

Daniel Mountjoy, the NRCS representative in the Elkhorn Slough watershed, drives around in his dirt-spattered green pick-up truck, trying to help farmers reduce or eliminate erosion on their land. Grassed roads, the right furrow angles, underground outlets, sediment and water basins, reinforced stream banks, grazing rotation and fencing of pastures are all means to keep the soil and its contents where it belongs – on the farm.

Most growers understand the importance of controlling erosion. "I don't want to lose my topsoil into the ocean," says Mike Oliver, who farms in the Elkhorn Slough watershed. With the help of grants, including one from California State University Monterey Bay's Watershed Institute, he planted grass on the steep slopes of his farm and installed underground pipes, which drain the water into catch basins. The basins stop the water flow, so the sediment can settle to the ground. These efforts made all the difference during last year's record-setting El Niño rains, keeping most of the soil on Oliver's farm.

"It's worth doing it," says Oliver. "It takes financial assistance initially, but eventually it will pay for itself." He invested $15,000 in the first year, and it now costs $5,000 - $7,000 annually to control erosion on his 300-acre farm. For the most part Oliver did not have to take land out of production. "You can't farm in the [soggy] low spots anyway," he says.

Some growers try to maximize production by farming to the edge of waterways, with no barrier between the fields and water to slow runoff and trap sediment. On these locations, the intermittently flooded, marginal land should be taken out of production and replaced with buffer strips, says Rein. For the farmer, this can mean an economic loss.

Yet based on an economic analysis, Rein has concluded that the money saved in erosion repair would compensate production losses. Few people attempt this type of cost-benefit analysis of conservation efforts, because it is often hard to assess the gains to the natural resource in dollar values. Using the Azevedo site as a model, Rein listed the lost production and buffer establishment on the cost side of the equation. Prevention of cropland erosion, sediment deposition on county roads, and elimination of crop border herbicides were counted as gains. Under the bottom line she counted a profit of approximately $1,500 in the first year after installing vegetated buffer strips. In addition, benefits from damage avoided to the entire watershed were approximately $4.5 million. "It's a long-term sustainable practice," says Rein.

Rein's findings may not apply in every case. According to Mountjoy, Rein assumes that the land used for buffer strips would be marginal, yielding lower economic benefits. Farmers may want reimbursement for direct costs, and may not be satisfied with indirect gains. Although taxpayers in general gain when public road repairs and river and harbor dredging can be avoided, farmers may not see this as a direct benefit. Also, loss of wildlife and natural habitat affects society as a whole, a cost which is difficult to account for in a cost-benefit analysis. If the benefit to the grower is not clear, alternative compensation may be necessary.

Environmental protection must bring a real-life profit for the farmer, for example a sum paid for land taken out of production, rent reduction or a tax break. Nobody can force growers to pay for something that benefits the general public. But in this watershed with its steep slopes and easily eroded soils, buffers are a simple solution that make sense economically and ecologically, argues Rein. "I prefer the incentive-based approach, where society shares the cost with the grower, since we all benefit from this practice," she says.

Growers who rent land have less incentive to invest in erosion control efforts. But Oliver argues that tenants can save money by controlling erosion, even on rented land. "If you're only on a ranch for four years, it's worth the effort," he says. The NRCS subsidizes erosion control through the "environmental quality incentives program," which pays for 75% of set-up costs. The Conservation Reserve Program (CRP) of the USDA, established in 1985, gives landowners annual rental payments for the land, cost-share assistance and incentives in return for establishing conservation practices. Under the CRP, 230,000 miles of buffer zones have so far been restored, reducing soil erosion by 93%. A stunning 5 million acres were signed up for the CRP by March 1999.

Los Huertos, Rein, Mountjoy and others working in the Elkhorn Slough watershed hope that the VBS study will help convince growers and others that environmental resources and the growers' bottom line can both benefit from erosion control efforts.

*– Beate Kittl*
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# Research Updates

❒ The impending phase-out of the soil fumigant methyl bromide has triggered interest in identifying strawberry varieties that perform well in organic management systems. This winter, plant pathologist Carolee Bull of the US Department of Agriculture received a grant from California's Department of Pesticide Regulation to conduct strawberry variety trials in four organic fields representing different soil and climatic conditions in Monterey and Santa Cruz counties.

Center director Carol Shennan and farm manager Jim Leap will conduct part of the trial at the Center's on-campus farm, which was selected as a study site because of its long history of organic management. The trial's main objectives include determining which strawberry varieties will generate the highest yields in organic production systems, and the effect of mycorrhizal inoculants (beneficial root fungi) on yield and plant disease.

In October of 1999, Leap will plant 4 replicates each of 10 strawberry varieties on a 1/3 acre site, and will manage the planting with organic fertility inputs and alternative pest control measures (e.g., release of beneficial insects, insectary hedgerows). Center staff will collect data on yields from each variety through the 1999-2000 crop season.

❒ Phillip Fujiyoshi, a graduate student in professor Steve Gliessman's agroecology group, recently completed his PhD studies through UCSC's Biology Department. Working at the Center's on-campus Farm, Fujiyoshi examined the mechanisms of weed suppression by squash *(Cucurbita* spp.*)* intercropped in corn (*Zea mays* L.). The following summary of Fujiyoshi's study is based on his dissertation abstract; the full dissertaion text is available at the web site http://www.agroecology.org/people/phillip/dissertation.htm.

Fujiyoshi writes, "Ecologically based methods of weed management are needed to reduce the environmental harm caused by herbicides and cultivation. The traditional practice of interplanting squash into corn provides agroecologists with a source of ideas from which to develop techniques for weed management in diverse systems."

Fujiyoshi found that interplanted squash suppressed weed growth in a region (temperate zone) different from the Central and South American settings where this system is normally used. He also tested the hypotheses that light competition and allelopathy are responsible for the weed suppression. Fujiyoshi writes, "Trials of interplanted squash density demonstrated squash's ability to suppress temperate zone weeds, notably the dominant species of the system [amaranth, *Amaranthus retroflexus*] as well as a rhizomed perennial species [field bindweed, *Convolvulus arvensis*] that resists mechanical cultivation. Low-density squash reduced weed biomass with no loss of corn yield under conditions of plentiful moisture, while higher densities of squash were detrimental to both weeds and corn, as was a gap in irrigation."

To test the factors involved in limiting weed growth, a field experiment compared the level of weed suppression from the shade of an artificial canopy with the suppression generated by the whole squash plant. Light interception was initially higher in the corn-squash intercrop, but it was surpassed by the corn monocrop with the artificial canopy. Weed biomass was correlated with light levels across all treatments, but the data suggest that an additional factor, such as allelopathy, contributes to weed suppression. Laboratory and greenhouse experiments confirmed that compounds which would normally be released from squash roots under natural conditions exhibited allelopathic activity.

Based on his study, Fujiyoshi concludes, "Guidelines for weed management using squash interplanted in corn include avoiding too high a density of squash and providing plentiful moisture. Recommendations for future study include a more thorough light-monitoring regime for comparing an artificial canopy with a natural one, studying the interactions of corn and squash varieties with a history of interplanting versus those normally monocropped, and identification of squash allelochemicals and their testing on weed species in soil."

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Phil Fujiyoshi examines a plot of squash plants in his intercropping study at the Center's on-campus Farm research fields.

❒ Artichoke plume moth *(Platyptilia carduidactyla)* is the predominant pest of artichokes in the Central Coast area of Calfiornia. The larvae of the artichoke plume moth (APM) is highly destructive and often difficult to control in many fields. Increased resistance to organophosphate insecticides, rising costs of synthetic pyrethroid substitutes, and regulatory pressures limiting the use of presently registered or new material for APM control have stimulated interest among conventional artichoke growers to seek more sustainable alternatives.

In March 1998, the Center's farm extension specialist Sean Swezey organized a grower-researcher "biorational" program for artichoke pests (BIORAPP) which includes a management team of growers, Center and artichoke industry researchers, and local agricultural professionals. The effort is funded by the Organic Farming Research Foundation and the UC Sustainable Agriculture Research and Education Program. Results of the BIORAPP program are shared through weekly updates and biennial field meetings, organized in conjunction with the Community Alliance with Family Farmers.

The BIORAPP program consists of intensive weather monitoring and arthropod monitoring, pheromone applications, locally reared natural enemy release, and cultural controls of the artichoke plume moth. Four growers, with sites located at the old Ft. Ord base in Monterey County and on the coast north of Santa Cruz, are currently participating in the program. Two of these use organic pest control methods and two use more conventional methods, but all have agreed not to spray insecticides in fields designated as biorational unless APM infestation exceeds 10% of the artichoke buds sampled.

A native egg parasitoid, *Trichogramma thalense*, is mass reared in the Center's insectary and released weekly into these selected artichoke fields during the summer and early fall growing season. APM flight, larval incidence, and bud damage are being monitored in both the experimental and untreated (control) plots.

As of December 1998, bud infestion in the BIORAPP fields was at or below 4%, an acceptable level of damage potential. Monitoring has continued through the spring, and Center staff will begin to release *T. thalense* again in early June, after the artichoke plants have been cut back. Past experience has shown that the wasps are more effective if released before APM pressure begins to build. Further data will be presented in the next issue of *The Cultivar* and at future BIORAPP field days, hosted by the Community Alliance with Family Farmers. For information on upcoming field days, contact Reggie Knox at 831/457-1007.

❒ The USDA-ARS in Salinas CA is seeking an Agricultural Science Research Technician (Plants) to help conduct research on organic production of small fruits and vegetables. A background in field research, data analysis, and organic production is essential. Highly motivated individuals with the ability to work in an independent fashion are encouraged to apply. U.S. citizenship is required. For more information, please contact Dr. Carolee T. Bull, USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905. Phone 831/755-2889. For general information and application forms, contact Ms. Elsa Chavez at 831/755-2800. Applications must be postmarked by July 19, 1999. USDA-ARS is an equal opportunity provider and employer.

# *Center Notes*

❒ Sean Swezey, the Center's associate director and head of the Farm Extension Program, has been named the new director of the systemwide UC Sustainable Agriculture Research and Extension Program (UC SAREP). According to Henry J. Vaux, Jr., Associate Vice President of the UC Division of Agriculture and Natural Resources, "Swezey emerged from a prolonged search for a new SAREP director as the top candidate. We are extremely fortunate to have identified a person of his experience to lead SAREP into the 21st century. He is an accomplished field researcher and has developed a reputation as a consensus builder among the major commodity growers on the Central Coast." At present, UC SAREP's headquarters will remain at their present UC Davis location.

Says Swezey of his new SAREP role, "Every grower in California is deeply concerned about issues of sustainability. Under my leadership SAREP will develop programs that serve the great breadth and diversity found in California agriculture. Our first job is to

## *Organic Research at USDA/ARS Site*

At the USDA/Agricultural Research Service site in Salinas, California, we have approximately 17 acres of certified organic research and production land (certified by the California Certified Organic Farmers). I have developed a small research program in the area of organic strawberry and vegetable production. The research we are conducting is being supported this year by funds provided by ARS. It is unknown at this time if funds will be available to continue this research in subsequent years. However, we will be hiring an organic farm manager to help manage this piece of land.

We are also looking for organic farmers who would like to serve on a liason committee to provide recommendations for the establishment of good organic management practices for research plots. The Salinas location is recruiting organic farmers to serve on the Salinas Organic Research Liason Committee. The Liason committee's role is to provide recommendations for the establishment of good organic management practices for research plots. For an application please contact Ms. Elsa Chavez (831)755-2800 or for more information contact Dr. Carolee Bull (831)755-2889.

The Salinas location is dedicated to having this research plot remain certified organic. It is our hope that permanent funds will become available to develop an organic research center in Salinas. In addition to the ARS funded project, I am currently involved in another organic research project funded by the California Department of Pesticide Regulation (see item in Research Updates, page 7).

*– Dr. Carolee Bull*

JON KERSEY

New SAREP director Sean Swezey examines a codling moth trap at a Central Coast apple orchard.

help growers develop innovative and sustainable practices." Along with his new SAREP duties, Swezey will continue to serve part-time as the Center's farm extension specialist, coordinating research projects on the Central Coast and in the northern San Joaquin Valley, as well as teaching for UCSC's Environmental Studies Board.

❒ The Packard Foundation has awarded a one-year, $200,000 grant to the Life Lab Science Program to support development of Life Lab's "Growing Classroom" as a model school garden learning center for California. The new project will be developed on an acre of land just inside the entrance gate to the Center's Farm on the UCSC campus. Funds from the grant will help support planning and development of the garden's infrastructure and construction of some of its initial components.

Life Lab's Growing Classroom will serve families and student groups from throughout the region who visit the Center's Farm by providing a place to explore and actively participate in the garden habitats that will be created as part of the facility. The garden will include native plants, sensory awareness gardens, a bird-watching station, and garden beds where visiting kids, parents, and teachers can plant and harvest crops.

The garden will also serve as a statewide demonstration site for teachers and administrators interested in starting their own school gardens. By providing a model of different planting strategies, compost and irrigation systems, tool care and storage, and other garden components, the Growing Classroom will help educators generate ideas for outdoor classrooms at sites throughout California.

Center staff are working with Life Lab members to help plan and implement the new garden. Long-term plans call for integrating the garden into the Center's Kids Tour program, and involving students in the Apprenticeship in Ecological Horticulture in site development and maintenance.

❒ This summer, the Center's *Apprenticeship in Ecological Horticulture* staff will begin a curriculum development project that will result next year in a training manual encompassing the basic skills and concepts taught in the six-month Apprenticeship training course. Initiated in 1967, the Apprenticeship provides a blend of classroom and hands-on training to 35 participants each year at the Center's Farm & Garden facilities on the UCSC campus. With demand for this type of practical training on the rise, Center staff recognized the need for a training manual that other groups might use in developing their own programs.

The project's primary objective is to formalize the existing course curriculum and synthesize perspectives and training materials from other organic educators into a concise training manual. The manual will be made available to other organizations and individuals involved in sustainable agriculture education, urban gardening, organic farm internships, overseas food projects, and other training programs. "Not only will it increase the effectiveness of the existing Apprenticeship course, the manual will also serve as the basis for short courses and other new training programs at the Center," says Apprenticeship coordinator Ann Lindsey.

This training manual is the first stage of a larger multi-year curriculum development project at the Center. "We hope that the training manual will become a template that other individuals and groups can use to develop new skills-based training programs in organic production," says Lindsey. By providing an accessible manual for broad distribution, the Center hopes to increase the number of individuals trained in the essential skills and concepts of successful organic farming and gardening.

The Organic Farming Research Foundation and the Mary A. Crocker trust have provided grants to help launch the curriculum project. Our thanks to both organizations for their support of this new effort to make the Center's training curriculum available to a wider audience.

❒ Christof Bernau has been hired to fill the Center's Apprenticeship training staff position, and will also manage the raised bed garden area of the UCSC Farm. Bernau was a student in the Apprenticeship in Ecological Horticulture in 1994 , and supervised the propagation facilities at the Center's Farm & Alan Chadwick Garden for several years before going east to manage the Canterbury Shaker Village's demonstration farm in New Hampshire. He brings to the position an enthusiasm for teaching, a broad knowledge of horticulture with special strength in propagation, and a particular love of California native plants. Bernau's plans include expanding the collection of California natives and shade plants for future plant sales and for use at the Farm & Garden.

❒ The Center offers a six-month training course in organic gardening and farming called the Apprenticeship in Ecological Horticulture. The course, based at the Center's on-campus Farm & Alan Chadwick Garden, emphasizes hands-on learning, working side-by-side with instructors, and classes in organic horticultural methods. Cultural requirements for vegetable, herb, flower, and fruit cultivars are covered, including the specifics of soil preparation, composting, sowing, cultivation, propagation, irrigation, and pest and disease control. Marketing efforts include an on-site Community Supported Agriculture (CSA) project. This is a full-time program involving strenuous field and garden work five days a week. There are several full and

*continued on next page*

partial tuition waivers available for minorities and for economically disadvantaged individuals. Tuition for the 2000 program is $3,000 with additional costs for books, tools, and food. Dates for the program are April 10, 2000 - October 13, 2000. Application deadlines are November 1, 1999 (US and Canadian citizens); September 1, 1999 (international applicants). Potential applicants are encouraged to visit the Center. Orientation sessions and tours take place at the Farm on Thursdays at 11:30, June-November.

For an informational brochure and application, please write, call, or visit our Web site:

Apprenticeship Information
CASFS
UC Santa Cruz
1156 High St.
Santa Cruz, CA 95064
831/459-2321; 831/459-2799 (fax)
http://zzyx.ucsc.edu/casfs

❒ Many thanks to those of you who responded to our recent Reader Survey. We are compiling your suggestions for article topics and your rankings of the newsletter's most useful sections, and will use your feedback to help guide development of *The Cultivar.* Please keep us informed of any address changes.

## Orin Martin Receives Steward of Sustainable Agriculture Award

MARTHA BROWN

Orin Martin accepts his SUSTI award at the 1999 Ecological Farming Conference at Asilomar, California

Orin Martin, manager of the Center's Alan Chadwick Garden, was recognized for more than two decades of service to organic gardening when he received a Steward of Sustainable Agriculture ("SUSTI") award at the 1999 Ecological Farming Conference at the Asilomar Conference Center in January.

According to the Committee for Sustainable Agriculture, which organizes the conference and awards program, "Susties honor those special people who have been actively and critically involved in Sustainable Agriculture. These Stewards of Sustainable Agriculture have demonstrated their long-term, significant contributions to the well-being of agriculture and the planet..." Past SUSTI winners include the Lundberg Family, Wes Jackson, Robert Rodale, Helga and Bill Olkowski of the Bio-Integral Resource Center, and Bill Mollison.

Martin is a fixture of the organic gardening scene in Santa Cruz and a respected teacher of his craft. After finishing a one-year apprenticeship at the UCSC Farm & Garden in 1974-1975, he coordinated the Santa Cruz County Community Gardens Program for two years, overseeing 12 gardens and advising more than 400 community gardeners. In 1977 he took up his current position at UCSC, where he manages the Center's Alan Chadwick Garden and instruct students in the six-month Apprenticeship in Ecological Horticulture training program.

In more than twenty years of teaching and gardening, Martin has directly touched the lives of hundreds of students and has influenced thousands more as the result of his students' efforts. He combines vast knowledge about all aspects of organic food and ornamental plant production with a keen dedication to "apprenticeship-style" teaching, where students learn in a hands-on setting, working side-by-side with their instructors. He has inspired apprentices to pass on what they learn in programs ranging from school and community gardens to international development efforts. Besides his work with 35-40 apprentices each year, Martin also advises dozens of UCSC undergraduate students, providing them with gardening experiences to complement their classwork.

Martin views gardens and gardening as more than a way to grow food and flowers – he sees them as a vehicle for social change. SUSTI award winner Cathrine Sneed, who founded the renowned San Francisco County Jail gardening project, credits Martin with sparking her own passion for gardening and for getting her to see the difference it can make in people's lives. Hers is just one of countless "gardening ambassadorships" Martin has launched.

# Resources

❒ ***Field and Laboratory Investigations in Agroecology,*** by Stephen R. Gliessman, serves as a companion manual to Gliessman's textbook, ***Agroecology: Ecological Processes in Sustainable Agriculture.*** The field and laboratory manual provides instructions for hands-on investigations in five categories: environmental factors, population dynamics in crop systems, interspecific interactions in crop systems, farm and field systems, and food systems. For example, the farm and field systems' section offers exercises to investigate the effects of a weedy border on insect populations, map agroecosystem biodiversity, examine overyielding in an intercrop system, and analyze the effects of trees in an agroecosystem. These investigations can be adapted to different climates, seasons, facilities, and available time.

Both the lab manual ($24.95) and textbook ($49.95) are available from Lewis Publishers and can be ordered by phone, email, or on-line. Contact Lewis Publishers, 2000 NW Corporate Blvd., Boca Raton, FL 33431-9868, orders@crcpress.com, http://www.crcpress.com, 1-800-272-7737 (phone), 1-800-374-3401 (fax) or 1-561-994-0555 (phone, outside the USA), or 1-561-998-9114 (fax). In Europe, the Middle East, Africa and Asia, contact Springer-Verlag, PO Box 14 02 01, D-14302, Berlin, Germany, orders@springer.de, (49) 30/8 27 87-3 73 (phone), (44) 30/8 27 87-3 01 (fax).

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# *Study Compares Nitrate Levels in Organic and Conventional Crops*

Farmers face a tricky balancing act when it comes to using nitrogen: too little, and plants won't thrive; too much, and the excess can end up polluting groundwater, drinking water, and wildlife habitat. Nitrogen runoff can trigger algae blooms which choke waterways and starve fish and other aquatic species of oxygen.

Nitrogen – or more specifically, nitrate, one form of nitrogen which plants absorb and store in leaf and stem tissues – can also pose human health risks. In the body, nitrate is metabolized to nitrite, a compound which at high levels can trigger "blue baby" syndrome (methaemoglobineamia) in infants and can combine with various amines to create potential carcinogens (*N*-nitroso compounds). Groundwater is the most common source of nitrate problems. Wells are commonly tested and consumers warned to avoid water high in nitrates. Recognizing the potential health hazards of nitrates in food, the European Community (EC) has also set upper limits for nitrate in a variety of vegetable crops. So far, the US has not established such standards, but US farmers dealing with EC nations must adhere to nitrate-level regulations.

Joji Muramoto, a research associate at the Center for Agroecology & Sustainable Food Systems, is interested in the ways that farming practices and nitrogen sources affect nitrate levels in leafy vegetables. With a grant from the Organic Farming Research Foundation, Muramoto examined the range of nitrate content in lettuce and spinach sold as organically grown and conventionally grown in Santa Cruz County; evaluated the relative safety of these vegetables based on the maximum limits for nitrate specified by European Commission Regulation (EC) No. 194/97; and examined the relationship between organic fertilizing practices and nitrate content in leafy vegetables on several certified organic farms and conventional farms located on California's central coast.

Ideally, a cropping system would produce an optimum yield of vegetables containing low foliar nitrate levels; identifying farming practices which strike that balance is one of the goals of Muramoto's work. Studies in Europe have shown that organically grown crops have lower nitrate levels than those grown with conventional fertilizers. However, overfertilization with any input, including those approved for organic systems, can lead to high nitrate levels in crops and groundwater.

### Market Surveys Reveal Range of Nitrate Levels

Muramoto purchased three brands (five samples per brand) of organically grown lettuce (Romaine and iceberg) and spinach from farmers market and natural foods stores during January and February of 1998, and again in August and September. He bought three brands (five samples per brand) of conventionally grown lettuce and spinach from standard supermarkets during the same time period.

Muramoto also traced the origin of each sample by calling growers or distributors, and discovered that all of the winter-purchased crops originated in southern California, Yuma, Arizona, or Mexicali, Mexico. In summer, all of the organic crops and most of the conventional crops were grown on the Central Coast.

Regardless of season or management system, none of the lettuces sampled exceeded the maximum level of nitrate content established by the European Commission (EC). In contrast, 29% of all spinach samples contained nitrate levels which exceeded the maximum EC standards (summer, 2500 mg/kg; winter, 3000 mg/kg on a fresh weight basis). In particular, 83% of conventional summer-grown spinach and 33% of organic summer-grown spinach contained nitrate over the maximum levels.

Muramoto believes that the significantly higher levels of nitrate seen in conventionally grown spinach (an average of 2540 $NO_3$ mg/kg fresh weight for conventional versus 1800 mg/kg for organic) may have stemmed from differences in nitrogen fertilizer applications. However, some of the organic samples also showed levels of nitrate above those accepted by the EC, indicating that organically acceptable nitrogen inputs and practices can also lead to high nitrate levels in crops.

### Fertilizer and Soil Types Affect Nitrate Levels

To try and link farming practices and fertilizer inputs to nitrate levels found in lettuce and spinach, Muramoto conducted farmer interviews and analyzed soil, water and crop samples at three organic farms, one conventional farm, and one farm with both organic and conventional fields. All the farms are located in Monterey and Santa Cruz counties. Farm surveys were conducted in September and October of 1998, when lettuce or spinach was within a day or two of harvest.

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Table 1. Fertility practices and nitrate content in spinach at four organic fields.

| Fertility practices | Compost 5 tons/acre | Compost 5-7 tons/acre | Compost 5 tons/acre | Meat & bone meal 150 lbs/acre |
|---|---|---|---|---|
| preplant – sidedress (a) or top dress (b) | | | Bird guano 300 lbs (b) Foliar feeding(b) | Seabird guano 150 lbs/acre (a) |
| Total N application rate (lbs/acre) | 110 | 90 -120 | 120 | 26* |
| $NO_3$ (whole plant) mg/kg fresh weight | 1300 | 470 | 2200 | 2700 |

*the grower was cutting back N fertilizers due to high nitrogen in the soil earlier in the year

## *For the Farmer & Gardener*

# *Asian Greens Offer Tasty, Easy-to-Grow Source of Nutrition*

The Mustard/Cole family contains approximately 380 genera and 3,000 species of annual and perennial herbaceous plants. While members of the family have a cosmopolitan distribution, there are significant concentrations in the Mediterranean zones of the world as well as in southwest and central Asia. [Note: While the updated family name has been changes from Cruciferae to Brassicaceae, I prefer the old (Linnaeus) family name (Cruciferae), as it is visually descriptive of the cross-like, four-petaled flowers of most species.]

In addition to the many valuable ornamentals in this family (Alyssum, Arabis, Aubrieta, Dentaria, Erysimum, Hesperis, Iberis, Lunaria, Mathiola), the Cruciferae yield up some economically important and nutritionally valuable vegetable and oil crops. Undoubtedly, the genus Brassica is the largest natural grouping of these vegetable crops, and *Brassica oleracea* contains many significant sub groups (see below).

*Brassica oleracea acephala* (headless) – kale, collards
*B. o. botrytis* – cauliflower
*B. o. capitata* (head) – cabbage
*B. o. gemmifera* – brussel sprouts
*B. o. gongylodes* – kohlrabi
*B. o. italica* (branched) – broccoli

*Brassica rapa* (the turnip) and its sub groups are the nomenclatural home to many mild and slightly pungent Asian greens. These crops are among the most versatile yet under-appreciated and unsung leafy vegetables. They offer nutritious dark greens high in vitamins A and C, calcium, potassium, phosphorous, and iron. Leafy Asians can be included in salad mixes, where – along with their nutritional bonanza – they add a piquant, distinctive taste to mild lettuce-based salads. At mid maturity (3-6" leaf size) they contribute to stir fry dishes. And at full maturity, they offer an amazing amount of high-nutrition biomass. They are all fast maturing, at 30-80 days following transplant. Some examples: Mizuna Mustard – 3 to 4 full size plants can weigh 1 pound in 50 to 60 days; Napa Cabbages – 1 head can weigh up to 8-10 pounds in 60-80 days.

### Cultural Requirements

The Asian greens described in this article are biennial and annual plants. They are particularly sensitive to alternating warm-cool-warm weather patterns, especially in conjunction with the lengthening days of spring ( >13-14 hours), which together induce bolting (a gardener's term for premature flowering and running to seed). As little as 10 days of cold weather with a good portion of the 24 hour cycle below 50-55ºF, followed by a warm period, will truncate the vegetative cycle of the plant and essentially cause crop failure.

There are two principal strategies to avert bolting: 1) pay attention to varietal descriptions for early spring bolt-resistant varieties; 2) delay sowings until early summer (June and July), with harvest coming in late summer-fall (a touch of frost on mature Asian greens increases sugar concentrations and reduces sulfur compounds, resulting in rich sweet flavors).

The Asian greens described here have an optimum germination temperature range of 60º - 85º (3 to 5 days) and are cool season crops, preferring to grow in a temperature range of 55º-75ºF. Seeds will remain viable for 3-5 years.

Plants perform best if transplanted from speedling or plug trays as they have a primary tap root and weak, restricted fibrous roots. A seedling that is easily handled can be raised in 30-40 days and maturation takes place within 30-80 days after transplanting (depending on the species and variety).

Because the Brassicas have been bred to be out of balance (all top, very little root system), they respond to high nitrogen inputs and frequent, shallow waterings. As the heading Chinese cabbages approach maturity, they require a good dry down between irrigations to avoid a bacterial soft rot that rots the head from the inside out. Liberal spacing (15"-18") between plants contributes to better air circulation at the base of the plants, lessening bottom rot.

While Asian greens are versatile in terms of soil textural class, they grow optimally on rich loams high in organic matter. Because these crops grow and mature so rapidly, growers should amend the soil with a fully mature, particulate compost with quickly available nutrients (especially nitrogen and potassium; potassium contributes to the leaves' structural support and speeds maturation).

### Drum-Headed Chinese Cabbages

*Brassica rapa* (turnip genus) *pekinensis*

Common names – Chinese Cabbage, Napa Cabbage, Bok Choy, Wong Bok, Pe Tsai

Types/Forms – squat barrel, loose headed, long cylindrical (torpedo shaped)

Heading Chinese cabbages or Wong Bok cabbages have been in cultivation for over 2,500 years. They are thought to be a natural cross between the non-heading Pak Choi of southern China and a wild northern turnip. As such, they are not as heat tolerant as Pak Choi.

The fleshy, succulent, overlapping leaves of this vegetable form a tight, dense head, and make it look a bit like a Romaine lettuce on steroids. The outer leaves vary in color from light to mid green and tend to be tough and hairy (especially when young). The inner leaves are blanched, and thus extremely tender and succulent. These leaves exhibit a prominent network of blanched white veins radiating out

*continued on next page*

from the base of the petiole*, giving it the appearance of a walnut shell.

The taste of Wong Bok's leaves offer a double dividend; the leaf blade has a light, peppery taste often associated with Brassicas and their sulfur compounds, while the petiole is the essence of sweet and juicy, with a measure of crunch thrown in. Wong Bok can be shredded into green salads (adding a distinctive flavor), marinated raw, lightly steamed, or added at the tail end of a stir fry.

With all the Chinese cabbages, breeding and particularly hybrids have resulted in substantial improvements in terms of uniform and rapid head formation, density, taste, disease resistance, resistance to bolting (open pollinated varieties have almost no bolt resistance), and interesting variations in color and form.

**the petiole is a leaf stalk that connects the leaf blade to the stem or branch*

### *Types of Chinese Cabbages*

#### Traditional Types

The traditional (Napa type) short, squat-barreled varieties feature broad, dense heads reaching 3-8 pounds and 12-18 inches tall. Like their European counterparts, Napa can be refrigerated for up to eight weeks (32º-40ºF, 90% relative humidity). A Napa cabbage can yield considerably more weight and nutrition in about the same time from transplanting (50-60 days) as it takes to produce a head of Romaine lettuce.

Napa Cabbage, Wong Bok

© Pat Latas

*Early Season Varieties*
(note that # days=days from transplant to maturation)

- Nerva (50 days) – an extra-early hybrid for spring crops. Bolt-resistant, 10"-12" tall heads weigh 3-4 pounds. Light, succulent texture.
- Summer Top (43-50 days) – remarkably early but not particularly bolt resistant. Large, dense heads with deep green outer leaves.
- Blues (50 days) – one of the most bolt-resistant varieties. 3-5 pound heads are mild, juicy and sweet.
- Kasumi (60-65 days) – the most bolt-resistant variety to date, features short (10" wide, 12" tall), 5-8 pound heads.

*Mid - Main Season Varieties*

- China Pride (65-80 days) – good bolt resistance, excellent head uniformity. 4-5 pound heads with sweet taste.
- Orange Queen (80 days) – similar in appearance to Kasumi, but has distinctive, orange-colored interior leaves. More nutritional than any other variety, but it is bolt prone.

#### Loose-Headed Types

- Lettucey type (45 days) – taller and more open topped (much like a Romaine lettuce) than the Napa varieties. 12"-15" tall heads weight 2-3 pounds; the leaves have a distinctive, light-green, savoyed or ruffled look.

#### Long, Cylindrical or Michihli Types

This type of Chinese cabbage features tall, narrow, torpedo-shaped (18" x 8") heads that are slow to mature. Because they are bolt prone, they perform better in late summer - fall and are somewhat sweeter than Napa types.

- Michihli (78 days) – the standard open-pollinated variety. Somewhat bolt prone.
- Jade Pagoda (70 days) – 16" x 6" heads, medium green leaves with a distinctively white mid rib and beautiful yellow-creamy hearts.
- Monument (80 days) – 20" tall heads with the best bolt resistance of any cylindrical type and uniform heading and size.

Pak Choi

© Pat Latas

#### Loose-Headed Chinese Cabbages

*Brassica rapa chinensis*
Common names – Pak Choi, Pac Choi

Pak Choi originated in the warmer, more humid areas of southern China. It is older than the heading Chinese cabbages and much more heat tolerant. Pak Choi is a non-heading Chinese cabbage with dark green, slightly savoyed (ruffled) leaves and white veins. The most distinctive feature of Pak Choi is its exaggerated white petiole; the petiole is sweet and juicy, while the leaves have a peppery taste with more bite than Napa leaves.

Pak Choi can be harvested all at once or leaf by leaf over a period of months. It is not as bolt prone as Napa cabbages. While there are many varieties of the Napa types, Pak Choi offers limited varietal selections.

- Pak Choi (Chinese Pak Choi; 40-50 days) – 16"-20" tall with pale green leaves, slightly more spicy than other varieties.
- Joi Choi (50 days) – a shorter, broader Pak Choi with extremely dark savoyed leaves and a thicker, almost pure white petiole. Features vigorous, fast growth – far superior to other varieties.
- Ching-Chiang (40 days) – an early dwarf Pak Choi tolerant to heat, rain and cold.
- Mei Quin (45 days) – a true baby Pak Choi. Crisp, sweet, 6" vase-shaped plant with white-green coloration to the petiole.
- Shanghai Pak Choi – similar to Mei Quin but with a lime-green petiole.

*continued on next page*

© Pat Latas

Mei Quin
(baby Pak Choi)

**Rosette Pak Choi**

*Brassica rapa rosularis (narinosa)*
Common Names – Tatsoi, Tah Tsai, Spinach Mustard

Tatsoi is one of the most cold tolerant Asian greens (15º-20ºF). It grows in a rosette form 6"-10" across. While it is tolerant of cold (even light snow), it deteriorates in prolonged wet weather. The leaves are spoon-shaped, dark green, and waxy, with a short (1"-4") green petiole on the leaf stalk. Baby size Tatsoi has become a foundation ingredient for mesclin salad mixes because of its mild, sweet flavor. At maturation, the leaf stalk and blade can reach 10" long. Occasionally, Tah Tsai features a white petiole.

**Mustards (Hot and Sweet)**

*Brassica juncea* (no sub groups)
Common Names – Red Leaf Mustard, Mustard Cabbage
Varieties – Osaka Purple and Giant Red

Giant Red and Osaka Purple mustards originated in the mountainous regions of Central Asia and are among the most valued vegetables in China, Japan, and Southeast Asia. Their spicy, Dijon mustard flavor and pungency actually decrease (slightly) with age. Small, tender leaves (1"-3") can be used whole in salad mixes, slightly larger leaves (3"-6") can be used in stir fry dishes, and mature leaves can achieve 3' x 10" and are best steamed (cooking tones down the peppery flavor). Unlike the Chinese cabbages and Tatsoi, the mustards can tolerate heat and humidity. Nutritionally, the mustards are a valuable source of phosphorous, calcium, iron, potassium, and vitamins A and C.

*Brassica rapa nipposinica (japonica)*
Common Name – Mizuna Mustard
Varieties – Kyona, Tokyo, Sakata

Mizuna (pronounced meezuna) features upright growth and tolerates both heat and cold. This mustard has pencil-thin white stalks and deeply cut-serrated, light green leaves. Its best quality is that it is mild flavored (even innocuous) and can be used as mustard at almost any stage.

**Flowering Broccolis**

*Brassica rapa* and *B. oleracea alboglabra*
Common Names – Choy Sum, Gai Lon, Hon Tsai Tai

This distinctive group of Asian greens presents both the cook and the market gardener with a unique opportunity to broaden their edible vegetable horizons. Basically, the Choy Sum types are small plants that quickly (40-50 days) send up a thick, succulent flower stalk topped with delicate, yellow, four-petaled flowers. The edible flower stalk can be steamed lightly so as to preserve both flavor and texture or stir fried whole or chopped, and combines well with glazes and sauces. The Choy Sums are best sown in mid spring - mid summer to reduce the incidence of premature bolting.

- Bouquet Choy Sum (45 days) – slightly savoyed, spinach-like leaves send up a thick flower stalk. Mild mustard taste.
- Gai Lon (50 days) – this variety is a cut above all other Choy Sum types. A variation on the European broccoli, it originated in the Mediterranean Basin. Gai Lon is more robust than other flowering broccolis, growing to 15"-18", with a thicker stem of pale blue green.
- HonTsai Tai (the name means red vegetable) – this Choy Sum has a purple hue to the green leaves, with bright purple veins, a purple stalk, and yellow flowers.
- Autumn Poem (35 days) – similar to HonTsai Tai except it is bigger, green, sweeter in taste and offers repeat harvests.

*– Orin Martin*

***References***

*Oriental Vegetables: The Complete Guide for Garden and Kitchen,* by Joy Larkcom. Tokyo, New York: Kodansha International, 1991.

*World Vegetables,* by Mas Yamaguchi. Van Nostrand Reinhold, 1983.

***Seed Sources***

Johnny's Selected Seeds
Foss Hill Rd.
Albion, ME 04910
207/437-9294 www.johnnyseeds.com

Shepherd's Garden Seeds
30 Irene St.
Torrington, CT 06790
860/482-3638 www.shepherdseeds.com

Territorial Seed Company
PO Box 157
Cottage Grove, OR 97424
541/942-9547

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**Resources** *(from page 10)*

❒ ***Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide*** (2nd Edition), by Mary Louise Flint, offers home gardeners and small-scale farmers practical advice on controlling a wide variety of pests with alternative pest management practices. The new edition has been completely reviewed and substantially revised since it was first published in 1990. "It is my hope that the revised version *of Pests of the Garden and Small Farm* will provide gardeners with much of the information necessary to reduce reliance on chemical pesticides well into the next century," says Flint, a UC Cooperative Extension entomologist.

The latest edition of the guide includes new management practices for dozens of pests with much more emphasis on biological control agents, use of highly selective insecticidal oils, and cultural practices such as solarization, disease suppressive composts and mulches. Other features include managing and preventing weed problems, diagnosing and preventing plant diseases, and taking advantage of beneficial organisms in the garden or farm.

***Pests of the Garden and Small Farm*** (DANR Publication #3332) is available for $35.00 from the University of California, DANR Communications Services-Publications at 6701 San Pablo Ave., Oakland, CA 94608-1239, and from many county offices of UC Cooperative Extension. Phone orders can be placed by calling 800/994-8849 or 510/642-2431. Send email inquiries to danrcs@ucdavis.edu.

❒ ***Educational and Training Opportunities in Sustainable Agriculture (11th edition),*** compiled by Jane Potter Gates and volunteers, lists institutions, organizations and farms that offer classes, internships, workshops, and resources on sustainable agriculture. Listings range from university credential programs to hands-on training courses to on-farm apprenticeships throughout the U.S. and Canada, and include a number of international programs. Updated annually, this 60-page directory is available free; changes and additions will be added throughout the year to the Web version of the publication. To order, contact the Alternative Farming Systems Information Center, National Agricultural Library (Rm. 304), 10301 Baltimore Ave., Beltsville, MD 20705-2351, 301/504-6559 (phone), 301/504-6409 (fax), afsic@nal.usda.gov. The web site address is http://www.nal.usda.gov/afsic.

# Events

❒ **Strawberry Farmscaping Research Results and Tour** will take place Thursday, June 24, from 8 am-10:30 am at the Elkhorn Native Plant Nursery near Moss Landing, California. Sponsored by the Community Alliance with Family Farmers' Lighthouse Farm Network, the meeting will include a description of the new BASIS project (see cover story, this issue) as well as a report on results from the past two years of research on the effects of strawberry farmscaping. See page 4 for directions to the nursery. For more information, contact Reggie Knox at 831/457-1007.

❒ **Herbs for the Home Gardener,** a workshop on medicinal and culinary herbs, will take place on Saturday, July 10, from 11 am - 3 pm. Local herb expert Darren Huckle will offer advice on how to choose, grow, and use herbs from your backyard gardener. $20 for members of the Friends of the UCSC Farm & Garden; $25 for non-members. Call John Fisher at 831/459-3248 or send email to johnfish@cats.ucsc.edu for details on registration and directions to the workshop site.

❒ **Ecological Processes in Agricultural Landscapes,** a symposium coordinated by Center faculty affiliate Steve Gliessman and Center research associate Erle Ellis, will take place on Tuesday, August 10, 1999 as part of the Ecological Society of America's annual meeting in Spokane, Washington. Speakers will present research approaches that demonstrate how ecological processes support agroecosystem services; whether the sustainability of specific practices, inputs, and management decisions is a function of ecological processes; and ways ecologists can become more involved in managing agricultural landscapes and their interface with natural ecosystems. For more information on the symposium, see the web site http://www.agroecology.org/conferences/esa99.html.

❒ **Apples for the Home Garden and Small Orchard,** a free workshop on apple growing, will take place on Saturday, September 11 from 10 am to 12 noon at the Alan Chadwick Garden at UC Santa Cruz. Apple tree expert Orin Martin will offer advice on which apple varieties and rootstocks are best suited to the home garden or small orchard. If the crop is timely, a tasting will be included. Call 831/459-3240 for more information or directions.

❒ **The UCSC Farm & Garden's Fall Plant Sale** will take Friday, September 17 from 12 noon - 6 pm, and Saturday, September 18 from 10 am - 2 pm in the Barn Theater Parking Lot at UC Santa Cruz. The region's best-suited varieties of organically grown winter vegetables and perennial landscape plants will be available to help extend your gardening season. Proceeds benefit the Apprenticeship in Ecological Horticulture. Call 831/459-3240 for more information or directions.

❒ **Preparing the Winter Garden,** a hands-on gardening workshop, will take place Saturday, September 18, from 12 noon - 3 pm at the Farm on the UC Santa Cruz campus. Learn how to prepare your garden beds for the winter season and get the most out of your fall-planted crops. $5 for members of the Friends of the Farm & Garden; $10 for non-members, payable the day of the workshop. Call 831/459-3240 for more information or directions.

❒ **The Harvest Festival** will take place on Saturday, October 9, from 11 am to 5 pm at the Farm on the UC Santa Cruz campus. This annual celebration features live music, food, workshops, children's activities, hayrides, Farm tours, and much more. Free for members of the Friends of the Farm & Garden and kids 12 and under; $3 for non-members. Call 831/459-3240 for more information or directions.

❒ **The 10-Year Reunion of the 1989 Apprenticeship Class** will take place Saturday, October 9, 1999, in conjunction with the Harvest Festival at the UCSC Farm. We'll meet at the Farm Center steps at 12 noon for a Farm walk together and at 4 pm for dinner. Also welcome are 1988 second-year apprentices and apprentices from the class of 1990. If you're interested in attending, please contact Eric Johnson, 1111 Maxwell Ave., #211, Boulder, CO 80304, 303/443-4112.

❒ **The 1999 Small Farm Conference** will take place Sunday through Tuesday, November 7-9, 1999 at the Radisson Hotel Berkeley Marina in Berkeley, California. The theme of the 1999 conference is "Cultivating the Farm – City Connection." On Sunday there will be short courses, tours and an evening tasting event. Short course topics include "Value Added Farm Products," "Sustainable Agriculture Education for Educators and Activists," "Ideas for Beginning Farmers," and "Advanced CSA Management." Themes for the Monday and Tuesday workshops include "Sustainable Agriculture Practices," "Specialty Crops and Products," "Policy Issues," "Farmers Markets," "Alternative Marketing," "Successful Farm to City Models," and "Agriculture and Food Education."

The Center for Agroecology & Sustainable Food Systems is cosponsoring the Small Farm Conference with the Center for Urban Education on Sustainable Education, California Federation of Certified Farmers Markets, Community Alliance With Family Farmers, Golden Gate Farmers Market Association, UC Cooperative Extension - Alameda and Contra Costa Counties, Farm Service Agency of USDA, and the Ecology Center of Berkeley. For registration information, contact Kinene Barzin at 510/588-5444 or kbarzin@compuserv.com.

**Nitrate Study** *(from page 11)*

Several interesting results emerged from the field surveys. Despite differences in soil type (sandy soil in the conventional field; loam soil in the organic field), nitrate content in Romaine lettuce from the paired fields was not significantly different, and agreed with the trend and levels of nitrate content in lettuces found in the market survey. The grower applied readily available organic fertilizers (meat + bone meal and guano) as a sidedressing rather than compost to the organic field. In this case, these fertilizers might generate the comparable nitrate content seen in the organic and conventional lettuce samples.

In the survey of organically managed spinach fields, crops treated with guano contained considerably higher nitrate levels than crops grown in fields where compost, applied at a rate of 5-7 tons/acre, was the only fertilizer used (see Table 1, page 11). However, the survey also revealed that not only the kind of organic fertilizers applied, but also soil characteristics, can affect nitrate levels in plants. Although spinach grown using guano tended to contain higher levels of nitrate than spinach grown using compost, this was not always the case. Spinach grown on sandy soils treated with guano showed the lowest nitrate concentration among all organic spinach.

"Further research is needed to determine the actual factors involved," says Muramoto, "but it is obvious that differences in soil texture may affect nitrate availability in soils, and hence, nitrate content in plants. In other words, growing crops such as spinach may require higher levels of readily available nitrogen on fields with sandy soil than on loam or clay fields." However, Muramoto cautions that growers should apply readily available fertilizers carefully in order to avoid nitrate accumulation in soils and plants.

Muramoto's findings have implications for all growers interested in controlling nitrate levels in their crops. Based on this study, compost-based fertility management appears to offer a way to limit nitrate accumulation in spinach in organic systems. Judicious application of all nitrogen sources – especially readily available nitrogen fertilizers such as guano and Chilean nitrate – combined with soil tests to determine current nitrate levels also appear to be important factors in reducing nitrate levels to a healthy level.

*– Martha Brown*

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