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Agriculture and Natural Resources

Central Coast Agriculture Highlights

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Strawberry plant nutrient sufficiency levels revised

Mark Bolda, UC Santa Cruz, Tom Bottoms and Tim Hartz, UC Davis

It has been more than 30 years since UC published strawberry leaf nutrient diagnostic guidelines (Publication 4098, 'Strawberry deficiency symptoms: a visual and plant analysis guide to fertilization', released in 1980). In the years since that publication, varieties, production practices and yield expectations have changed considerably. In 2010 we began a project, funded by the California Strawberry Commission, to reevaluate leaf and petiole nutrient sufficiency ranges for day-neutral strawberries. With the cooperation of many berry growers in the Watsonville-Salinas and Santa Maria areas we collected leaf and petiole samples from more than 50 'Albion' fields over the past two production seasons. In each field samples were collected 5 times over the production season, from early spring through September, to document the nutrient concentration trends from pre-fruiting to post-peak production. Leaf samples were analyzed for total concentration of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), manganese (Mn), iron (Fe) and copper (Cu). Petioles were analyzed for NO_3-N, PO_4-P and K concentration.

After the season cooperating growers provided yield information, which allowed us to categorize the fields as being 'high yield' or low yield'. We then applied a process called DRIS (Diagnosis and Recommendation Integrated System) to mathematically evaluate the difference in nutrient concentrations as well as nutrient ratios between high yield and low yield fields. This process allowed us to identify which of the high yield fields were ideally balanced nutritionally. From this group of nutritionally balanced, high yield fields we were able to calculate a DRIS sufficiency range for each nutrient at each growth stage.

Figure 1 shows that leaf N, P and K concentrations were highest before harvest began (stage 1, which was late February in Santa Maria and late March in Watsonville-Salinas), and declined to a reasonably stable level throughout the main harvest period (stages 3-5, May-July in Santa Maria, June-August in Watsonville-Salinas). The decline in leaf macronutrient concentrations during the peak harvest period was expected; it happens in many fruiting crops because the leaves rapidly translocate nutrients to the developing fruit. By contrast, micronutrient concentrations either increased from early vegetative growth to the main harvest period [as was the case for boron (B), Ca, and Fe], or remained reasonably stable over the entire season (all other micronutrients). The vertical bars on each data point on Fig. 1 indicate the range of values typical of nutritionally balanced, high yield fields at each growth stage. These are the DRIS sufficiency ranges; leaf nutrient concentrations within these ranges can safely be assumed to be adequate for high yield production.

Table 1 lists the DRIS leaf nutrient sufficiency ranges for pre-harvest and main harvest growth stages. For the sake of comparison, both the sufficiency ranges given in UC Publication 4098 and the current University of Florida guidelines have been included. Although for most nutrients the ranges match pretty well, for others there are substantial differences. Where the DRIS sufficiency range is substantially higher than the other sources (Ca, Mn, and Fe, for example) it is because those nutrients are in such abundant supply in our coastal soils that plant uptake is far in excess of actual plant requirement; for those nutrients a lab test result marginally below the DRIS range would not be a matter of concern.

For several nutrients (N, Zn and Cu) the DRIS sufficiency range fell below the other recommendations. We are confident that the DRIS ranges represent nutrient sufficiency because they were determined by measuring the levels common in high yield fields. The field survey approach used in this project ensured that a wide range of field conditions and grower practices were included, so the results are broadly representative of the coastal industry. Also, for all three nutrients the average leaf concentrations of the high yield and low yield groups were essentially equal, suggesting that availability of these nutrients did not limit yields.

Fig. 2 shows the trends in petiole concentrations over the season. Petiole NO_3-N was so highly variable as to be nearly worthless as a diagnostic technique. During peak fruit harvest (our sampling dates 3 and 4) petiole NO_3-N in high yield fields varied from < 200 PPM to 2,600 PPM. While we believe that leaf total N is a more reliable measurement, this study suggests that maintaining petiole NO_3-N > 1,000 PPM pre-harvest, and > 400 PPM during peak harvest, is adequate to maintain high productivity. Given the high variability of petiole NO_3-N it is possible that concentrations < 400 PPM would be adequate during the summer.

Petiole PO_4-P and K were less variable than petiole NO_3-N. Maintaining PO_4-P > 1,200 PPM throughout the season should ensure P sufficiency. Given the high soil P availability in most coastal soils rotated with vegetable crops, this level is probably much higher than the 'critical value'. Maintaining petiole K > 2.5% preharvest, and > 1.5% during peak

Table 1. Comparison of DRIS leaf nutrient sufficiency ranges with prior UC recommendations, and current University of Florida guidelines.

Growth stage	Nutrient	Nutrient sufficiency ranges: DRIS	UC Pub. 4098	University of Florida
Pre-harvest	% N	3.1 - 3.8		3.0 - 3.5
	% P	0.50 - 0.90		0.20 - 0.40
	% K	1.8 - 2.2		1.5 - 2.5
	% Ca	0.6 - 1.3		0.4 - 1.5
	% Mg	0.33 - 0.45		0.25 - 0.50
	% S	0.19 - 0.23		0.25 - 0.80
	PPM B	31 - 46		20 - 40
	PPM Zn	13 - 28		20 - 40
	PPM Mn	75 - 600		30 - 100
	PPM Fe	70 - 140		50 - 100
	PPM Cu	3.3 - 5.8		5 - 10
Main harvest	% N	2.4 - 3.0	> 3.0	2.8 - 3.0
	% P	0.30 - 0.40	0.15 - 1.30	0.20 - 0.40
	% K	1.3 - 1.8	1.0 - 6.0	1.1 - 2.5
	% Ca	1.0 - 2.2	0.4 - 2.7	0.4 - 1.5
	% Mg	0.28 - 0.42	0.3 - 0.7	0.20 - 0.40
	% S	0.15 - 0.21	> 0.10	0.25 - 0.80
	PPM B	40 - 70	35 - 200	20 - 40
	PPM Zn	11 - 20	20 - 50	20 - 40
	PPM Mn	65 - 320	30 - 700	25 - 100
	PPM Fe	85 - 200	50 - 3,000	50 - 100
	PPM Cu	2.6 - 4.9	3 - 30	5 - 10

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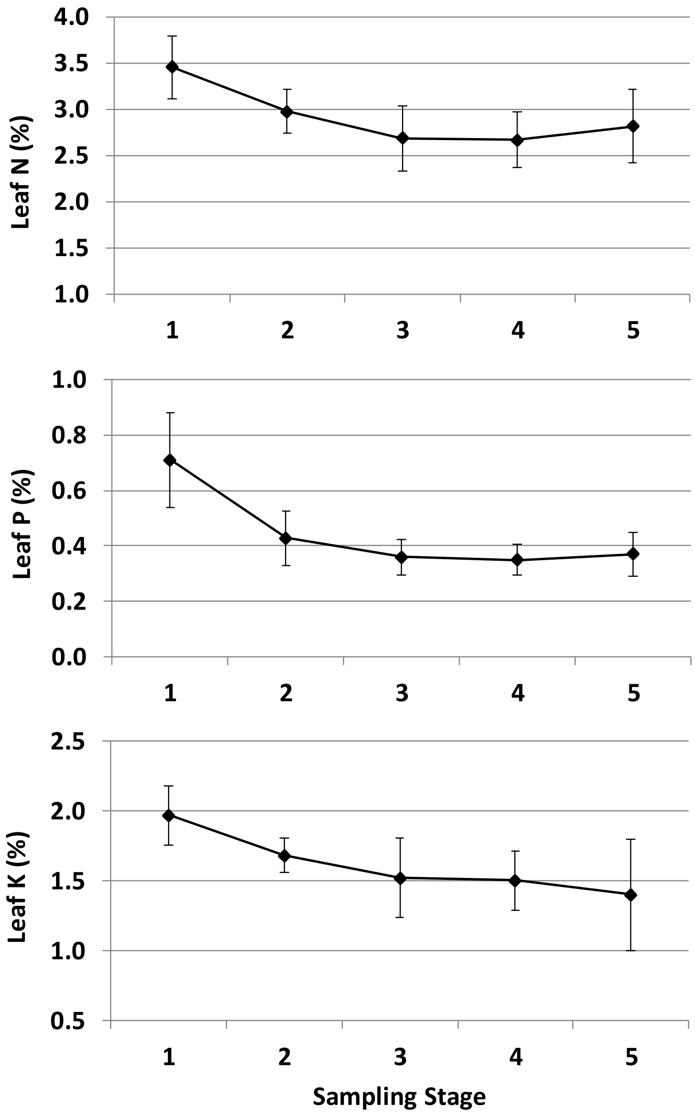


Fig. 1. Trend in leaf macronutrient concentrations over the growing season in nutritionally balanced, high yield fields; the bars indicate the DRIS sufficiency ranges.

Update on 2011 insecticide trial on managing western flower thrips on lettuce

Surendra Dara, UC Santa Barbara and San Luis Obispo Counties

Western flowers thrips, *Frankliniella occidentalis*, is an important pest of lettuce. Feeding damage causes brown scarring. Western flower thrips is more important for its ability to transmit topsoviruses such as *tomato spotted wilt virus* and *impatiens necrotic spot virus*. Thrips acquire viruses in the larval stage when they feed on infected weeds or other plants near lettuce fields and spread the infection when they move on to lettuce fields.

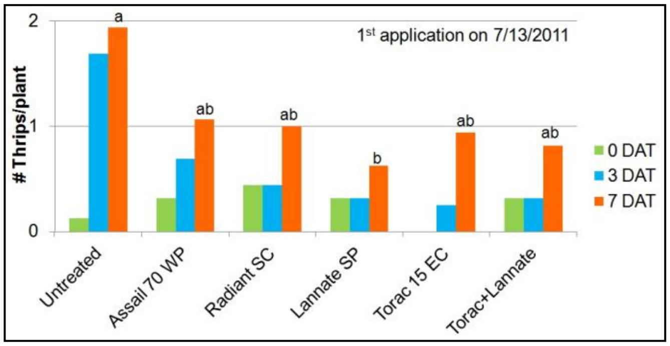
Insecticidal treatment is a common management option for controlling thrips on lettuce. However, the importance of cultural practices such as removal of weeds and other virus hosts near lettuce fields, removal of crop residue, and choosing a location that is less vulnerable to thrips infestation are also very important. Conserving natural enemies like lacewings, minute pirate bugs, and predaceous mites is also beneficial to thrips management. Regular monitoring of the fields and initiation of the treatments when the damage was first detected is recommended for good control.

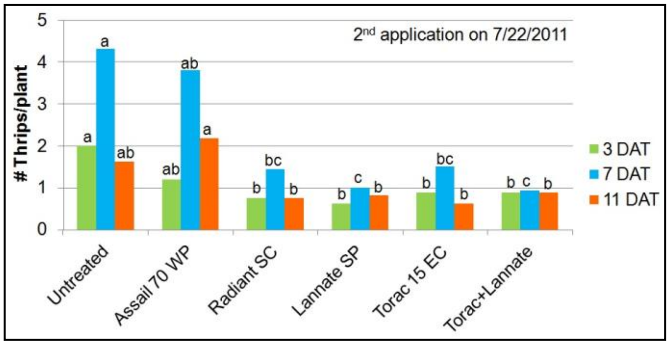
Western flower thrips larva (left) and adult (right)

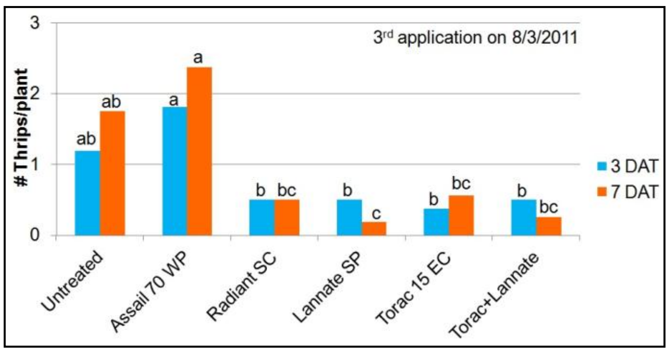
A small plot field trial was conducted in Lompoc in 2011 to evaluate some registered insecticides along with a new chemical. Treatments included acetamiprid (Assail 70 WP at 1.7 oz/ac), spinetoram (Radiant SC at 7 fl oz/ac), methomyl (Lannate SP at 0.75 lb/ac), tolfenpyrad (Torac 15 EC at 21 fl oz), and a combination of methomyl (0.75 lb/ac) and tolfenpyrad (21 fl oz) along with an untreated control. Each treatment had one 10' long and 80" wide bed with five rows of lettuce, and was replicated four times in a randomized complete block design.

Lettuce cultivar Durango was planted on June 8, 2011 and treatments were applied on July 13 and 22, and August 3 using a spray boom with three flat fan nozzles. Thrips populations were observed before the first application and at regular intervals after each application. On each sampling date, four randomly selected lettuce plants from each plot were pulled out and gently beaten on a wire mesh placed on a container with yellow sticky card to dislodge thrips. Sticky cards were covered with plastic wrap and larval and adult stages of thrips were counted on each card by checking under a microscope. Data were analyzed using statistical means and significant ($P < 0.05$) means were separated using Tukey's HSD test. Significant reduction in thrips populations resulted from some treatments on certain observation dates. Most treatments were found effective in controlling thrips on lettuce.

Before using any pesticides, check product labels and consult with your local Agricultural Commissioner's office for information about California registration and allowable usage.







Number of thrips per plant before and 3, 7, or 11 days after treating (DAT) with insecticides. Bars without any letters or with the same letters are not significantly different (*P* <0.05).

Nitrate to nitrogen conversion and estimating N contribution from irrigation waters containing nitrate

Michael Cahn and Richard Smith, UC Monterey County

Conversion between nitrate (NO_3) and nitrate-nitrogen (NO_3-N):

To convert	To	Multiply by
Nitrate (NO_3)	Nitrate-nitrogen (NO_3-N)	0.22
Nitrate-nitrogen (NO_3-N)	Nitrate (NO_3)	4.43

The reason for this conversion is that nitrate molecule weighs 62 grams per mole; the nitrogen content of nitrate is 22.5% of the total weight of the molecule.

Nitrogen content of irrigation water*

Water content of	Multiply by	To determine
PPM NO_3	0.052	Pounds N/acre inch
PPM NO_3	0.62	Pounds N/acre foot
PPM $N0_3$-N	0.23	Pounds N/acre inch
PPM $N0_3$-N	2.74	Pounds N/acre foot

* Water analyses from most labs report NO_3 in units of ppm, but it is very important to pay attention to which units the results are reported.

How much of the nitrogen in water should be credited to your crop is debatable. Consider that lettuce transpires 5 to 8 inches of water between germination and maturity in the Salinas Valley during the summer. Extra water applied beyond crop ET would be lost as drainage and therefore would not contribute N to the crop. The extra water also would likely leach plant available soil nitrate below the root zone. In addition, some ground water that is high in nitrate is also high in salts and may require a leaching fraction (extra water applied to leach salts below root zone) to attain maximum production. The good news is that you can account for the N contribution from the nitrate in the irrigation water using the quick nitrate soil test for previous irrigations. However, this test will not estimate the contribution of N from the irrigation water for future irrigations.

Our best estimate of how much N the irrigation water would contribute to future irrigations is to divide the crop evapotranspiration by the irrigation efficiency. For example, for 7 inches of crop ET and an 80% irrigation efficiency, the following values would approximate the N contribution of irrigation water for the indicated range of nitrate concentrations:

Nitrate (NO_3) concentration in irrigation water	Nitrate (NO_3-N) concentration in irrigation water	Lbs nitrogen/A in seven inches of irrigation water taken up by lettuce*
45	10	13
89	20	25
177	40	51
266	60	76

*** multiplied by 0.8 to account for the irrigation system efficiency**

As can be seen, waters containing less than 45 ppm NO_3 generally do not contribute a significant amount of nitrogen for crop growth. However, if well waters contain more than that amount they begin to contribute greater amounts of water for crop growth.