Cooperative Extension • Monterey County

Crop Notes

May/June, 2006

In This Issue:

University of California, U.S. Department of Agriculture, and County of Monterey cooperating

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TISSUE TESTING AND FERTILIZATION PRACTICES REVISITED FOR LETTUCE AND CAULIFLOWER

Tim Hartz, UC Davis Extension Vegetable Specialist;
Richard Smith, Farm Advisor Vegetable Crops and Weed Specialist, UCCE-Monterey County

Tissue testing to assess crop nutrient status has been a routine practice for a number of Salinas Valley vegetable growers, and others have used it periodically to diagnose field problems. It has been several decades since the UC tissue macronutrient sufficiency recommendations were established, and much has happened in that time – new varieties, higher density plantings, higher yield expectations, conversion to drip irrigation, etc. We conducted a large-scale survey of commercial lettuce and cauliflower fields in 2004-2005 to reconfirm tissue macronutrient sufficiency standards, to develop tissue micronutrient sufficiency standards, and to evaluate industry fertilization practices.

The survey covered 112 commercial fields in the Salinas and Santa Maria production areas. The fields were divided among head lettuce (35), romaine lettuce (43), and cauliflower (34). Fields were chosen to cover the production season from early spring through fall, with fields scattered from low ET_o environment near the coast to higher ET_o environments farther inland. Sampling was conducted on more than 20 ranches, representing a number of grower/shipper operations.

In each field samples of soil, whole leaves and midribs were collected at midseason, and again just days before harvest. Soil was analyzed for NO_3-N, bicarbonate P, exchangeable cations (K, Ca, Mg and Na), and DTPA-extractable micronutrients. Whole leaves were analyzed for the full range of macro- and micronutrients, while in midribs NO_3-N, PO_4-P and K concentrations were determined. The cooperating growers provided information on fertilizer rate applied and commercial yield and quality for each field. To develop leaf nutrient sufficiency standards we used the Diagnosis and Recommendation Integrated System (DRIS) approach. DRIS analysis is a complex mathematical system for comparing tissue nutrient concentrations, and ratios of the various nutrients, between high-yield and low-yield fields. From this analysis, sufficiency ranges can be calculated that represent the nutrient concentrations typical of nutritionally balanced, high-yield fields. Midrib sufficiency ranges for NO_3-N, PO_4-P and K were also calculated using data from high-yield fields found to be 'nutritionally balanced', based on DRIS analysis. Head and romaine lettuce had very similar leaf nutrient concentrations, and the data were therefore combined to create one set of standards for lettuce.

Table 1 lists the DRIS nutrient sufficiency ranges for both crops. By using data from so many fields we are confident these sufficiency ranges have broad applicability. In comparison to current recommendations, the DRIS-derived leaf macronutrient sufficiency ranges were generally higher for N and lower for K. The DRIS leaf micronutrient ranges were in general agreement with recommendations developed in other parts of the country with the exception of Ca, which we found to be in lower concentrations in both crops than these current recommendations suggest is desirable.

The only serious discrepancy between the DRIS midrib sufficiency ranges and existing recommendations was for PO_4-P, with the DRIS values being significantly lower. However, in this project we developed information that clearly showed midrib nutrient content to be strongly influenced by environmental factors unrelated to soil nutrient supply; this finding, which call into question the value of midrib analysis as a nutrient management tool, is the subject of a separate article in this newsletter.

To ensure that the DRIS-derived nutrient sufficiency ranges are appropriately used, several points need to be emphasized. If a field has tissue nutrient concentrations within these ranges, it is valid to assume that soil nutrient availability was sufficient for high-yield production. If a field has tissue nutrient concentrations above these ranges, it clearly suggests excessive nutrient availability; the farther above the sufficiency range, the more likely this excessive availability might be detrimental to crop productivity. However, tissue nutrient concentrations below the sufficiency ranges should not automatically be considered 'deficient', and limiting to plant growth. For some nutrients, luxury consumption is common in coastal fields, whether as a result of naturally high soil levels (Fe, for example), or excessive fertilization (N or P, for example). For

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these nutrients, low tissue concentrations should be considered deficient only if they fall substantially below the DRIS ranges.

Cu was the nutrient most frequently present in concentrations below the DRIS sufficiency range, with nearly half of low-yield fields of both crops having low leaf Cu. Low leaf molybdenum (Mo ≤ 0.2 PPM) was also common with lettuce, but not cauliflower. Additional research to determine whether soil Cu or Mo supply actually limits commercial yield should be pursued. Most fields with low leaf Cu concentrations had DTPA-extractable soil Cu < 2 PPM), so this level of soil Cu could be considered the provisional agronomic threshold until further research is conducted.

Beyond establishing tissue sufficiency ranges, this study allowed us to compare grower fertilization practices, and evaluate the effectiveness of those programs. Seasonal N/P/K fertilization varied widely among fields (Table 2), but that variability did not reflect differences in soil characteristics. Rather, examination of the records showed that many of the cooperating growers simply fertilized on a 'recipe' basis, with all fields of a given crop receiving the same fertilizer, regardless of soil characteristics or soil test levels. The net effect of this approach to fertilization was wasteful application of N and P, and apparently inadequate K fertilization in a number of fields. Fig. 1 shows that high N fertilization rates had no effect on N concentration in lettuce plants immediately preharvest, meaning that crop N uptake was virtually independent of N fertilization rate. While some growers did eliminate P application in high P soils (recent research has documented that lettuce response to fertilizer P is unlikely if bicarbonate-extractable soil P is > 50-60 PPM), others continued to fertilize regardless of soil test level. The 'recipe' approach to fertilization was particularly clear with K (Fig. 2). The growers who had K in their routine fertilization program tended to have high soil K values, the results of K buildup over many years. Those growers who did not routinely apply K generally had much lower soil K levels, and in a number of fields soil K had actually reached a point of marginal deficiency. From our analysis of the survey fields we conclude that K fertilization for cool-season vegetable production is warranted in fields with exchangeable K < 150 PPM. Conversely, there is no agronomic advantage in continuing to apply K to fields with high soil K (> 300 PPM).

Note: a more comprehensive report on this project can be obtained from either Richard Smith rifsmith@ucdavis.edu or Tim Hartz tkhartz@ucdavis.edu

We conducted a large-scale survey of commercial lettuce and cauliflower fields in 2004-2005 to reconfirm tissue macronutrient sufficiency standards, to develop tissue micronutrient sufficiency standards, and to evaluate industry fertilization practices.

However, in this project we developed information that clearly showed midrib nutrient content to be strongly influenced by environmental factors unrelated to soil nutrient supply; this finding, which call into question the value of midrib analysis as a nutrient management tool, is the subject of a separate article in this newsletter.

Table 1. Tissue nutrient sufficiency ranges for lettuce and cauliflower.

	Lettuce		Cauliflower	
Nutrient	midseason	preharvest	midseason	preharvest
		whole leaf		
N (%)	4.3 - 5.1	3.3 - 4.8	5.4 - 7.9	4.3 - 5.9
P (%)	0.45 - 0.75	0.35 - 0.75	0.65 - 1.05	0.55 - 1.00
K (%)	3.3 - 6.4	2.9 - 7.8	2.7 - 4.6	2.0 - 4.7
Ca (%)	0.45 - 0.75	0.60 - 1.10	0.60 - 2.20	0.50 - 2.50
Mg (%)	0.25 - 0.40	0.25 - 0.45	0.25 - 0.45	0.20 - 0.60
S (%)	0.25 - 0.35	0.20 - 0.35	1.0 - 1.4	0.8 - 1.2
B (PPM)	20 - 30	25 - 35	25 - 35	20 - 35
Zn (PPM)	20 - 75	25 - 75	35 - 70	30 - 75
Mn (PPM)	35 - 75	45 - 75	30 - 50	20 - 75
Fe (PPM)	85 - 230	115 - 255	120 - 160	70 - 195
Cu (PPM	5.6 - 8.2	5.0 - 8.6	5.4 - 8.4	3.6 - 6.9
		midrib		
NO_3-N (PPM)	5,000 - 11,500	3,600 - 14,900	5,700 - 13,800	2,100 - 10,900
PO_4-P (PPM)	1,800 - 3,600	1,700 - 5,000	3,800 - 5,500	2,900 - 6,400
K (%)	5.1 - 8.2	4.8 - 10.3	4.2 - 6.5	2.8 - 4.7

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Table 2. Macronutrient fertilizer application in survey fields.

Crop	Nutrient	Seasonal fertilizer application (lb / acre) mean	max	min
Head lettuce	N	173	392	47
	P_2O_5	34	94	0
	K_2O	26	78	0
Romaine lettuce	N	155	267	27
	P_2O_5	41	111	0
	K_2O	36	84	0
Cauliflower	N	264	459	116
	P_2O_5	19	120	0
	K_2O	19	100	0

From our analysis of the survey fields we conclude that K fertilization for cool-season vegetable production is warranted in fields with exchange-able K < 150 PPM. Conversely, there is no agronomic advantage in continuing to apply K to fields with high soil K (> 300 PPM).

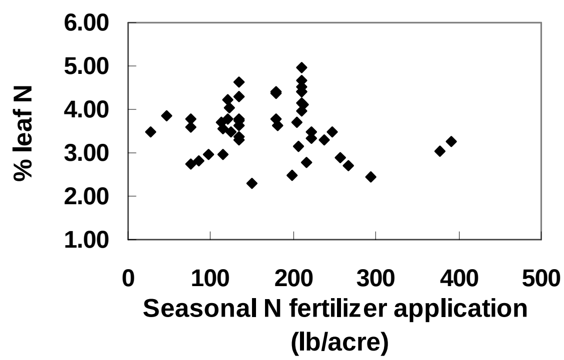

Fig. 1. Relationship between seasonal N fertilization rate and lettuce preharvest leaf N concentration.

Note: a more com prehensive report on this project can be obtained from either Richard Smith rifsmith@ucdavis.edu or Tim Hartz tkhartz@ucdavis.edu

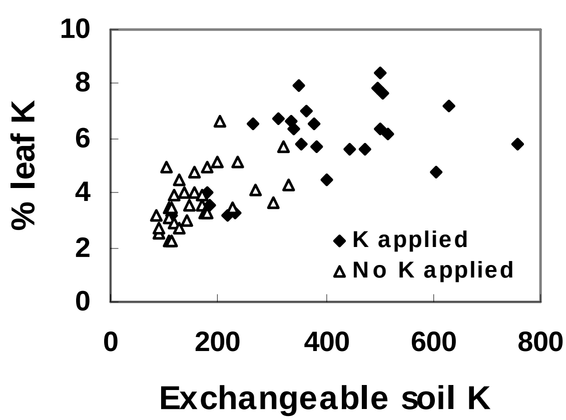

Fig. 2. Effect of exchangeable soil K and K fertilizer application on preharvest leaf K concentration in lettuce.

HOW USEFUL IS PETIOLE TESTING?

Tim Hartz, UC Davis Extension Specialist
Richard Smith, UC Cooperative Extension Monterey County Farm Advisor

Testing the nutrient concentration of leaf petioles is an established practice in the California vegetable industry. In contrast to whole leaf sampling for total nutrient content (which provides an overall assessment of plant nutrient status), testing the concentration of unassimilated nutrients (NO_3-N, PO_4-P and K) in petiole tissue is thought to give an estimate of recent crop nutrient uptake. In theory, this provides an indication of current soil nutrient availability, and therefore may be useful in guiding fertilization practices. However, there have been serious questions raised about the accuracy of petiole testing, and whether or not this monitoring practice can provide reliable information on which to base fertilization decisions. As part of a large-scale nutritional survey of coastal lettuce and cauliflower fields we examined the issue of petiole (or in the case of these crops, midrib) testing from several angles. We wanted to document the effects of variety, weather, soil moisture, time of day of sampling, and post-sampling handling practices on midrib nutrient concentrations, and to see how well midrib NO_3-N concentration was correlated with actual soil NO_3-N supply.

A total of more than 100 commercial fields were sampled in the Salinas and Santa Maria production areas, divided about evenly among head lettuce, romaine lettuce, and cauliflower. Fields were chosen to cover the production season from early spring through fall, with fields scattered from low evapotranspiration (ET_o) environments near the coast to higher ET_o environments farther inland. In each field at midseason a sample of midribs was collected, oven-dried and analyzed for NO_3-N, PO_4-P and K; at the same time a composite soil sample (top 12 inch depth) was collected and analyzed for NO_3-N concentration.

To evaluate the effect of variety on midrib nutrient concentrations, variety trials in two cauliflower and three romaine lettuce fields were sampled at midseason and again just before harvest. There were four cauliflower varieties per field, and three romaine varieties per field.

To determine the effect of weather conditions on midrib nutrient concentrations, daily ET_o was obtained from the CIMIS weather station nearest to each Salinas Valley field for the two days prior to the midseason sampling. (There are no CIMIS weather stations currently operating in the Santa Maria area, so no ET_o estimates were available for fields in that region.) To determine the effect of soil moisture and time of day of midrib sampling, one cauliflower, two romaine and three head lettuce fields were intensively sampled over one irrigation cycle. Two days after an irrigation three composite midrib samples were collected in the morning (before 11 AM), and three more in the afternoon (after 1 PM). This AM/PM sampling was repeated at 2 day intervals twice more before the next irrigation.

To evaluate the effects of post-collection handling, a large sample of midribs were collected from each of 7 fields (two cauliflower, three head lettuce and two romaine). For each field this large sample was divided into 9 subsamples. Three replicate samples were immediately placed in an oven to dry. Three samples were placed in paper bags and held at room temperature for 24 hours before oven drying; the remaining 3 samples were refrigerated in plastic bags for 24 hours before oven drying.

We found that varieties growing in the same field had very similar midrib nutrient concentrations. On average, varieties differed by less than 10% in NO_3-N or PO_4-P concentrations. Similarly, neither time of day, nor post-collection handling practice had any significant effect. Averaged across all the fields sampled, morning and afternoon samples had almost identical NO_3-N and PO_4-P concentrations; that was also the case for the post-collection handling methods.

However, field environmental conditions had a large impact on midrib nutrient concentrations, particularly for NO_3-N. In the fields monitored over an irrigation cycle there was a large degree of variability in midrib NO_3-N concentration within just a couple of days (Fig. 1). That variability did not seem to be a function of soil moisture, as there was no consistent pattern through the irrigation cycle (as the soil dried out); weather appeared to be a dominant influence. There was a strong negative correlation between midrib NO_3-N and the average ET_o in the two days before sample collection (Fig. 2). Midrib NO_3-N declined with increasing ET_o; apparently, higher temperature and solar radiation (the factors that drive ET_o) allow the plant to more rapidly assimilate this mineral form of N into organic compounds. This effect was particularly strong for lettuce, but was significant for cauliflower as well.

Given this strong effect of weather on midrib NO_3-N concentration, it was no surprise that there was no correlation between midseason lettuce midrib NO_3-N and concurrently measured soil NO_3-N (Fig. 3). Even when corrected for the confounding effect of weather (as represented by ET_o), there was no significant correlation between soil NO_3-N and lettuce midrib NO_3-N.

This lack of relationship between midrib NO_3-N status and soil NO_3-N availability suggested that midrib testing has very limited value as a nutrient management tool. A very low level of midrib NO_3-N or PO_4-P may indicate low soil nutrient supply, but that would

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We wanted to document the effects of variety, weather, soil moisture, time of day of sampling, and post-sampling handling practices on midrib nutrient concentrations, and to see how well midrib NO_3-N concentration was correlated with actual soil NO_3-N supply.

To evaluate the effect of variety on midrib nutrient concentrations, variety trials in two cauliflower and three romaine lettuce fields were sampled at midseason and again just before harvest. There were four cauliflower varieties per field, and three romaine varieties per field.

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have to be confirmed by soil testing. Moderate to high midrib nutrient concentrations suggest that soil nutrient availability is probably not limiting crop growth, but nothing more definite can be concluded. A change in midrib nutrient concentration over time may indicate a change in soil nutrient availability, but it is equally likely that the change is related to factors unrelated to soil nutrient supply. Therefore, midrib testing is not a reliable practice to determine whether to sidedress, or how much N to apply.

Averaged across all the fields sampled, morning and afternoon samples had almost identical NO_3-N and PO_4-P concentrations; that was also the case for the post-collection handling methods.

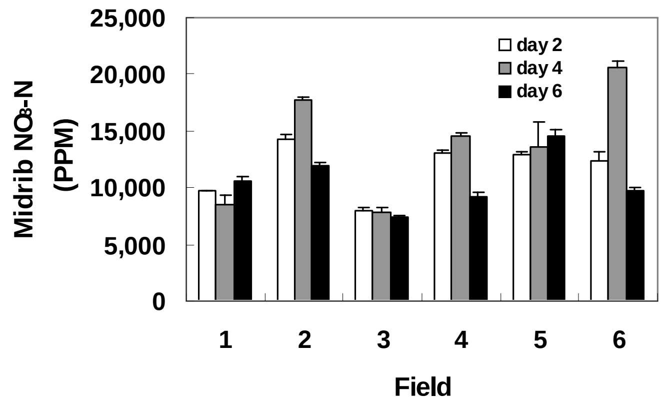

Fig. 1. Variability in midrib NO_3-N concentration over an irrigation cycle; fields sampled every 2 days following an irrigation. Bars indicate standard error of measurement.

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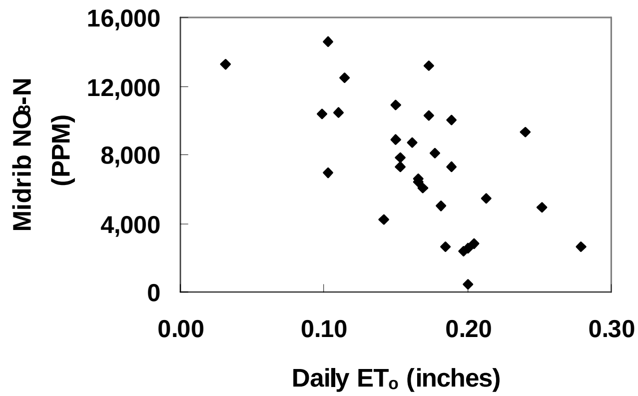

Fig. 2. Effect of average daily reference evapotranspiration (ET_o) in the two days prior to sample collection on lettuce midseason midrib NO_3-N (r = -0.62).

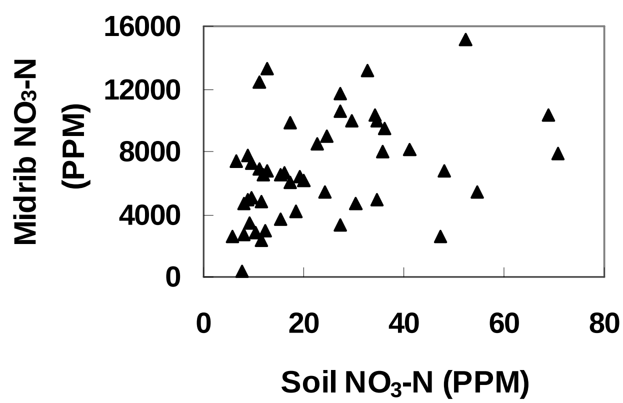

Fig. 3. Relationship between midseason lettuce midrib NO_3-N and concurrently measured soil NO_3-N.

JOINT ARIZONA, CALIFORNIA, AND TRIBAL *PESTICIDE SAFETY* *TRAIN-THE-TRAINER WORKSHOP*

A Workshop for Worker Protection Standard (WPS) Pesticide Safety Trainers

July 11-12, 2006 (Spanish)
July 13-14, 2006 (English)

Salinas, California

Course Description: This workshop will train pesticide safety educators (growers, outreach workers, labor contractors, commercial/custom applicators, etc.) who operate in multiple jurisdictions (California, Arizona, and on Tribal lands) by clarifying responsibilities under the Federal, State (Arizona and California) and Tribal codes. This course will qualify you in both states to be a trainer for WPS.

This two day course will be presented in English and Spanish. Breakout sessions will cover pesticide labels, personal protective equipment, pesticide-related health issues, and training requirements. Participants will also receive an overview of the Worker Protection Standard and information about laws and regulations that are unique to California, Arizona, and local Tribal communities. Participants receive an instructor's handbook, trainer's packet, EPA materials, and other useful resources. Once we receive your registration form we will send a confirmation note and directions to the workshop.

Registration is **FREE**, however **SPACE IS LIMITED to 50 people**. Please register early to reserve a space in the workshop and to ensure that you will receive handout materials.

Continuing Education Credit will be available for pesticide applicators pending approval by the California Department of Pesticide Regulation and the Arizona Department of Agriculture.

Please send your pre-registration form by July 3, 2006 to:

Deborah Atkinson
Arizona Department of Agriculture
Fax: (602) 542-0466
Phone: (602) 542-3579
E-mail: datkinson@azda.gov

The Arizona Department of Agriculture reserves the right to cancel any classes if there are not enough participants registered by the cut off date. You will be notified in such case at the e-mail, fax or mailing address provided by you on your registration form.

JOINT ARIZONA, CALIFORNIA, AND TRIBAL
PESTICIDE SAFETY
TRAIN-THE-TRAINER WORKSHOP

Salinas, California

July 13-14, 2006

(Thursday and Friday)

PRE-REGISTRATION FORM

Please print (One registrant per form. Photocopy this form for additional registrants.)

Name: ______________________________

Company/Organization/Tribe: ______________________________

Mailing Address: ______________________________

City: ____________________ State: __________ Zip: __________

Daytime Phone: ____________________ Fax: ____________________

E-Mail: ______________________________

Please send your pre-registration form by July 3, 2006 to:

Deborah Atkinson
Arizona Department of Agriculture
Fax: (602) 542-0466
Phone: (602) 542-3579
E-mail: datkinson@azda.gov

TALLER DE ENTRENAMIENTO ENTRE ARIZONA, CALIFORNIA Y LAS TRIBUS PARA CAPACITACION EN LA SEGURIDAD DE LOS PESTICIDAS AGRICOLAS

Un taller para entrenadores de la Norma de Protección para el Trabajador Agrícola

11 al 12 de julio del 2006 (español)
13 al 14 de julio del 2006 (inglés)

Salinas, California

Descripción del curso: Este taller capacitará a entrenadores en la seguridad de pesticidas agrícolas *(rancheros, contratistas, promotores de salud y aplicadores de pesticidas, etc.)* quienes operan/trabajan bajo la jurisdicción de gobiernos multiples (Arizona, California, y las comunidades de Tribus). Nuestro propósito es aclarar las responsabilidades bajo los códigos del gobierno Federal, Estatal, (Arizona y California) y las Tribus locales. Este taller/curso, le califica para entrenar sobre la Norma de Protección para el Trabajador Agrícola en ambos estados.

Este curso de **dos días** será presentado en español e inglés. Habrá sesiones que cubrirán sobre las etiquetas de pesticidas, equipo de protección personal, salud y los pesticidas, al igual que requisitos de entrenamiento. Los participantes recibirán un repaso de la Norma de Protección para el Trabajador Agrícola e información sobre leyes y reglamentos en Arizona, California y las comunidades de Tribus locales. Los participantes también recibirán un manual de instructor, paquete de entrenador, materiales de EPA (Agencia de Protección de Medio Ambiente), y otros recursos útiles.

La Registración es **GRATIS,** pero el **CUPO ES LIMITADO a 50 personas**. Le pedimos que reserve su lugar con tiempo, para asegurar su lugar y sus materiales. Mandaremos por correo una confirmación junto con el horario y direcciones de cómo llegar al taller.

Crédito de Educación Continua: La aprobación de crédito de educación continua esta pendiente con el Departamento de Agrícola de Estado de Arizona y el Departamento de Regulación de Pesticidas de California (CDPR).

Por favor, mande su forma de registro antes del 3 de julio del 2006 a

Deborah Atkinson
Departamento de Agricultura de Arizona
Fax: (602) 542-0466
Phone: (602) 542-3579
Correo electrónico: datkinson@azda.gov

El Departamento de Agricultura de Arizona se reserva el derecho de cancelar cualquier clase debido a poca registración. En dado caso que la clase se cancelará, se le avisará atraves del correo electrónico o dirección que usted proveyo en su forma de registración.

TALLER DE ENTRENAMIENTO ENTRE ARIZONA, CALIFORNIA Y LAS TRIBUS PARA CAPACITACION EN LA SEGURIDAD DE LOS PESTICIDAS AGRICOLAS

SALINAS, CALIFORNIA

11-12 de julio del 2006
(martes y miércoles)

INFORMACION DE PRE-REGISTRACION

Letra en molde (Solo un registrante por forma. Puede sacar copias para registrantes adiciónales.)

Nombre: ______________________________

Compañía/Organización/Tribu: ______________________________

Dirección: ______________________________

Ciudad: ______________ Estado: ________ Codigo Postal: ________

Teléfono (día): ______________ Fax: ______________

Correo Electrónico: ______________________________

Por favor, mande su forma de registro
antes del 3 de julio del 2006 a

Deborah Atkinson
Departamento de Agricultura de Arizona
Fax: (602) 542-0466
Phone: (602) 542-3579
Correo electrónico: datkinson@azda.gov

INSECT PESTS OF STRAWBERRY ROOTS

Mark Bolda, Farm Advisor - Strawberries and Caneberries

Introduction: There are several soil insects which can cause significant damage to strawberries. While not common, they can be found from time to time, especially in strawberries which are grown organically or over multiple years.

Hoplia beetle grubs: Hoplia grubs are occasionally found in strawberries grown in Central Valley of California, and are most often associated with unfumigated fields. Resembling the common June beetle grubs found in turfgrass, Hoplia grubs are white, "C" shaped larvae, and measure almost ½ inch in length.

Hoplia grub affected plants are stunted and can have root damage to the extent that plants pull out of the ground easily. Plants dug out of the ground will show Hoplia grubs clustered around the root, sometimes several tens in number. Infested plants wilt in warm weather, and in cases of severe infestations, the plant will die from the extensive root feeding of this grub.

The most effective control of Hoplia grubs are pre-plant soil fumigation with methyl bromide or the alternative soil treatments such as metam sodium or solarization. Other methods, such as soil drenches with insecticides, may have poor efficacy, can be difficult to implement because of the plastic tarp covering the beds and can also be in conflict with the label. Treatments using parasitic nematodes have not been successful.

Garden symphylans: Although resembling centipedes or millipedes, garden symphylans are actually insects with 10-12 pairs of legs. Garden symphylans are ½ inch long, white in color and move rapidly when discovered. Since immature centipedes and millipedes are generally not white, one should not have difficulty distinguishing garden symphylans from them.

Garden symphylans are mostly found in heavy soils with a lot of organic matter such as undecomposed crop residue. Lighter texture soils lacking in natural tunnels for symphylan movement, such as sands, do not generally have problems with this pest.

Damage from garden symphylans appears as stunted plants found in localized areas of the field, along and across plant rows. Affected plants have smaller roots and root hairs consumed. The roots of plants which have been dug up show stubby roots with very few small root extensions. Damage will occur in the same area of the field and spread over time if the symphylans are not controlled.

The best control of garden symphylans is achieved through the use of pre-plant soil fumigants. Flooding prior to planting for several weeks has been shown to be efficacious against this pest, and compacting soil, when compatible with plant requirements, may also be of use. Insecticide drenches and drip tape injections are difficult to implement in strawberries and may be in conflict with the label.

Root weevils: Root weevils can be found in both strawberries and raspberries. The adults of woods weevils, cribrate weevils, black vine weevils and Fuller rose beetles are small ¼ to 3/8 inch long) gray to black beetles with a curved beak-like snout and elbowed antennae on top of the head. Most easily found at night throughout the growing season, adults will generally be most numerous in the late summer and early fall. Eggs are laid around the crowns of strawberries, and hatched larvae will burrow down to the plant crown and roots to feed.

Root weevil larvae are found in the soil around the roots of plants. While the white to pink "C" shaped like the Hoplia grubs mentioned above, the weevil larvae are smaller, generally measuring 1/8 inch long. Additionally, root weevil larvae do not have legs and have a head darker than the rest of the body. Larvae will overwinter in the soil and complete their life cycle in the following year.

While adults feed on the foliage of strawberry, the damage is usually very light and not easily noticed. Larval damage is more serious, since larvae feed on root hairs, root bark and root cortex and may tunnel into the plant crowns. This root damage manifests itself in stunted plants and extensive plant wilting, especially during warm periods of the growing season. Damage is often found in localized areas of the field and tends to spread down rows as larvae move from dead to living plants.

Pre-plant soil fumigation, annual strawberry culture and periodic rotation to non-host crops are the most effective control measures for root weevils. If

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This article has been a summary of soil insects which affect strawberries. Growers are encouraged to contact Mark Bolda with UC Cooperative Extension regarding the identification and control of these or other pests in strawberries and caneberries.

There are several fumigants and insecticides mentioned in this article. Before using any pesticides, check with your local Agricultural Commissioner's Office and consult product labels for current status of product registration, restrictions, and use information.

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areas adjacent to the field are a source of infestation, sticky barriers can be used to limit the numbers of adults entering the field. Treatments with parasitic nematodes have not been successful.

Strawberry rootworm: The adults of strawberry rootworms are small, round, dark brown beetles about 1/8 of an inch long with irregular shaped black spots on the back of the wing covers. Adults feed on strawberry foliage, but this damage is not significant. Eggs are laid around the crown of the strawberry plant, from which larvae emerge and proceed to feed on the roots, causing plant wilting, especially during hot periods. Strawberry rootworm larvae are distinguished from root weevil larvae by three pairs of short legs towards the front of the body. Infestation tends to be dispersed, and the wilted plants will be found all over the field, rather than in localized areas as with root weevils.

Problems with strawberry rootworm can be avoided by pre-plant soil fumigation and annual planting.

Just Published. . .

Fertigation with Microirrigation
Blaine Hanson, Neil O'Connell, Jan Hopmans, Jirka Simunek, Robert Beede
This manual helps guide users through strategies and decision making for fertigation with nitrogen, phosphorus and potassium, and gypsum. It discusses the environmental effects of chemical applications, and focuses on nitrogen management to reduce groundwater pollution. The guide also covers the characteristics of selected fertilizers commonly used for fertigation, long- and short-duration strategies, how to calculate injection rates, frequency considerations, how to apply fertilizers uniformly, mixing considerations, injection devices, and how to prevent backflow. Publication No. 21620 $25.00

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8189 Methods to Maintain Genetic Purity of Seed Stocks
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New UC IPM Pest Notes. Go to http://www.ipm.ucdavis.edu/PDF/PESTNOTES/index.html

Chickweeds	74129	Puncturevine	74128
Mallows	74127	Hiring a Pest Control Company	74125
Mistletoe	7437		

Updated UC IPM Pest Management Guidelines. Go to http://www.ipm.ucdavis.edu/PDF/PMG/index.html Peach 3454 Cherry 2440 Corn 3443 Apricot 3433

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TIPS ON INJECTING POLYACRYLAMIDE (PAM) INTO SPRINKLER SYSTEMS TO REDUCE SEDIMENT AND NUTRIENT LOSSES

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We have demonstrated that polyacrylamide polymer (PAM), injected at low concentrations (5 ppm) in sprinkler water minimizes losses of sediments, phosphorus and nitrogen in tail water run-off from row crop fields on the Central Coast (Table 1). On fields where run-off is significant, the use of PAM can make both environmental and economic sense. By reducing up to 90% of the sediment losses from vegetable fields, costs of cleaning drainage ditches and sediment basins can be reduced, and water quality can be dramatically improved.

The low concentration needed to control sediment minimizes the costs of using PAM. At a 5 ppm concentration, costs of product are estimated to be between 4 and 7 dollars per acre for each inch of applied water. In addition, cost-sharing of up to 50% is possible through the USDA-NRCS. Also, using low concentrations of PAM is necessary to avoid increasing the amount of run-off. We found that PAM applied at concentrations above 10 ppm could reduce infiltration into the soil, thereby increasing run-off. On many soil types, concentrations of PAM as low as a 2.5 ppm in the irrigation water may reduce sediment and nutrient loss by more than 50%.

By injecting PAM at the time that run-off begins rather than during the entire irrigation set, the amount of applied product (lbs/acre) can be minimized. Some fields do not produce significant run-off until an hour or more after irrigation begins, especially if the soil profile is not yet saturated. Applying PAM for the first 30 minutes of an irrigation set so that some product is on the soil surface and then resuming injection of PAM when run-off begins may reduce the use of product by 30 to 50%.

We found that applying PAM before irrigating, such as by spraying it on the surface of the soil, or only injecting it at the beginning of the irrigation offers much less control of sediment loss than applying the product continuously during the irrigation. High rates of polymer are also needed (3 to 10 lb/acre) if the application occurs before irrigating rather than during. While some residual control is obtained from previous applications of PAM, in most cases, PAM must be applied with every irrigation to maximize control of sediment and nutrient losses in run-off.

Although PAM can substantially improve water quality, the polymer can be difficult to inject into irrigation systems. Because PAM is a large molecule, it is difficult to mix into water. Though it is water soluble, PAM tends to stick to itself, rather than dissolving into water. Mixing up a batch of PAM solution in a tank can be time consuming and therefore costly.

We found that for pressurized irrigation systems, direct injection of emulsified formulations of the product can be the easiest and the cheapest method of application. However, only certain types of injectors can be used with PAM because of its sticky nature. PAM clogs injection pumps with valves, such as some diaphragm pumps. Centrifugal, peristaltic, and auger type pumps will often work well with PAM. Venturi injectors also can be used for injecting PAM into pressurized irrigation systems. The low injection rate required to achieve the 5 ppm and lower concentrations also limits which pumps can be used with PAM. Centrifugal pumps usually have too high of a flow rate to be used for PAM injection. Table 2 lists injection rates required for a range of system flow rates to achieve a 5 ppm concentration in the irrigation water. Figures 1 and 2 show configurations for using venturi injectors with PAM. Venturi injectors require a pressure differential between the inflow and outflow to create suction. The pressure differential can be created by a booster pump (Figure 1) or by using a centrifugal pump to raise the pressure on the upstream side of the venturi.

A static mixer placed down stream of the injection site is recommended to pre-mix the PAM prior to injection into the main line. Static mixers, which are sections of pipe with baffles to create a mixing vortex in the flowing water, cause additional losses in pressure and should not be placed directly on the main line if possible. The placement of an injection pump near the well pump is shown in Figure 3. We found that satisfactory mixing of emulsified PAM product can be achieved in the irrigation water without a static mixer if the distance traveled between the injection point and the field is more than 500 feet. Inject pumps may need to be configured with a static mixer as shown for the venturi in Figures 1 or 2 if the distance of mixing in the mainline is limited.

Summary

PAM can dramatically reduce sediment and nutrient loss from agricultural fields on the Central Coast; however, PAM can be challenging to use because low concentrations are needed continuously in the irrigation water when run-off is occurring. Injection rates are often very low, (1-3 ounces per minute) which limits which types of injection systems can be used. Furthermore, PAM is difficult to mix into water due to its chemical and physical properties, and it can clog injection pumps. Fortunately, there are injection systems that are well suited for injecting emulsified PAM product which are relatively simple to use.

(Cont'd to page 13)

We have demonstrated that polyacrylamide polymer (PAM), injected at low concentra-tions (5 ppm) in sprinkler water minimizes losses of sediments, phosphorus and nitrogen in tail water run-off from row crop fields on the Central Coast.

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Table 1. Effect of Polyacrylamide (PAM) on concentration of nutrients, sediment and turbidity in run-off from Central Coast fields irrigated with solid-set impact sprinklers. Results are from non-replicated split-field trials.

Treatment	Total N	NO3-N	P (Total)	P (Soluble)	Total Suspended Solids	Turbidity
	ppm					NTU
	Watsonville (clay loam)					
PAM (5 ppm)	0.8	58.6	1.2	1.2	47	33
Control	2.9	48.4	2.0	0.9	652	1289
	Salinas (sandy loam)					
PAM (5ppm)	1.4	1.7	0.7	0.7	72	63
Control	4.2	1.7	1.9	0.7	985	2291
	Salinas (sandy loam)					
PAM (10 ppm)	2.7	1.3	0.4	0.2	179	108
Control	5.5	1.8	2.4	0.5	1332	3536
	Chualar (loamy sand)					
Pam (5 ppm)	2.3	2.7	1.9	0.8	646	218
Control	11.8	6.5	8.2	2.1	3870	503
	Santa Maria					
Pam (5 ppm)	1.6	14.78	0.6	0.51	60	13
Control	7.0	17.02	10.1	0.95	5930	4417
	Gilroy (silt loam)					
Pam (4 ppm)	1.2	8.1	1.0	0.9	74	42
Control	4.0	6.5	3.5	1.2	2057	2408

A static mixer placed down stream of the injection site is recommended to pre-mix the PAM prior to injection into the main line.

Table 2. PAM injection rates for achieving a 5 ppm concentration of active ingredient in the irrigation water for varying system flow rates or varying number of sprinkler heads.

Irrigation System	Impact Sprinkler Nozzle Size[x]		PAM Injection Rate[y]	
Flow rate	7/64"	1/8"	37% w/v [z]	50% w/v
gallons/minute	# of sprinkler heads		ounces/minute	
200	82	63	0.35	0.26
400	163	125	0.69	0.51
600	245	188	1.04	0.77
800	327	250	1.38	1.02
1000	408	313	1.73	1.28
1200	490	375	2.07	1.53
1400	571	438	2.42	1.79
1600	653	500	2.76	2.04
1800	735	563	3.11	2.30
2000	816	625	3.45	2.56

x. assumes 50 psi at the nozzle and a discharge rate of 2.45 and 3.2 gal/min for 7/64" and 1/8" diameter nozzles, respectively.
y. Injection rate to achieve a 5 ppm concentrationi in the irrigaiton water
z. weigh per volume concentration of PAM active ingredient in emulsified product

PAM can be challenging to use because low concentrations are needed continuously in the irrigation water when run-off is occurring.

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(Cont'd from page 13)

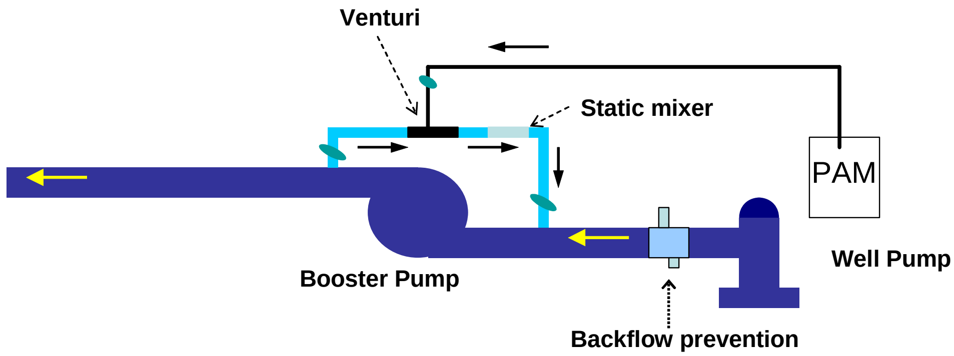

Figure 1. PAM injection using venturi injector between booster and well pump.

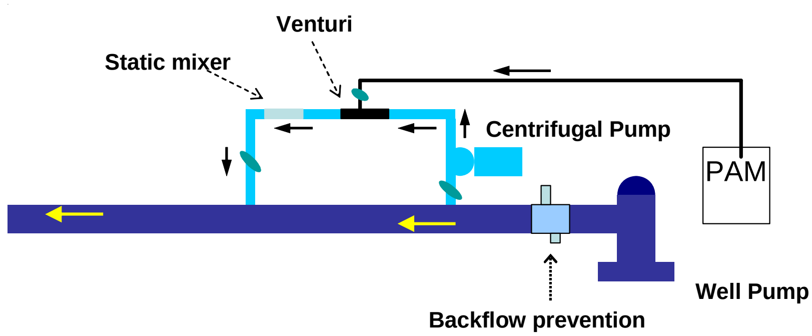

Figure 2. PAM injection using venturi injector and centrifugal pump.

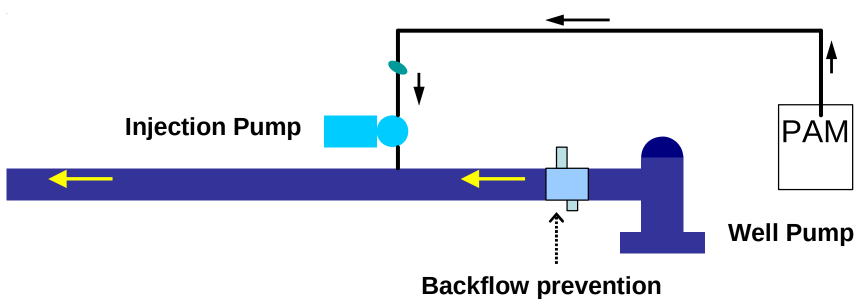

Figure 3. PAM injection using an injection pump.

Though it is water soluble, PAM tends to stick to itself, rather than disolving into water.

The low injection rate required to achieve the 5 ppm and lower concentrations also limits which pumps can be used with PAM.

Safety Note

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For more Safety Notes go to http://danrrec.ucdavis.edu/ehs/safety_notes/index.html

For training materials go to http://danrrec.ucdavis.edu/ehs/safety_training/index.html

Safety Note #8

GENERAL TRACTOR SAFETY

It has been estimated by the National Safety Council that 460 people died from tractor injuries during 1990. Typically, 75% of tractor deaths involve the driver. About 50% of the mortalities are due to tractor overturns and 25% are due to runovers.

Pre-Use Activities

- Thoroughly review and understand information provided in the tractor operator's manual with particular attention given to descriptions of safety procedures.
- Always perform a pre-shift tractor inspection, including checking fluid levels, lights and signals, tires, and guards and shields. Inspect tractor for loose hydraulic connections and worn or loose parts such as hitch pins or lug nuts.
- If a tractor fails the pre-shift inspection, notify your supervisor and remove the tractor from service by attaching a red tag that states "DO NOT USE." Complete red tag with appropriate information.
- Annual tractor training is required by California regulations (Title 8, Section 3664 b) and should incorporate both general tractor training and specific training review on the tractor(s) that employees may use.

Operating Precautions

- Before starting a tractor, look for people or obstructions behind or ahead of the tractor.
- As the tractor begins to move, engage the clutch slowly and evenly – avoid jerky starts, turns, or stops.
- Never carry passengers on a tractor.
- If the tractor has a roll-over protective structure (ROPS), the seat belt must be used.
- Never attach implements unless the power take-off (PTO) shaft is guarded.
- Always hitch towed loads to the tractor drawbar.
- Avoid operating a tractor within six feet of ditches, holes, depressions, and embankments.
- Reduce speed when turning on roads or at row ends, crossing slopes, or driving on rough, slick, or muddy surfaces.
- Do not operate tractors on slopes too steep for safe operation.
- Descend slopes in low gear while using the tractor motor as a brake.
- Never adjust or work on implements unless the tractor is shut off and the implement is deenergized.
- When parking, always lower the three point linkage and towed implement.
- Take regular breaks when operating tractors for long periods of time.
- In order, tractor shutdown procedures are: (1) setting the PTO lever in neutral; (2) engaging the parking brake or shifting the transmission lever to the park position; (3) and turning off the engine.

June 2004

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MONTEREY COUNTY

Crop Notes

May/June, 2006

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

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