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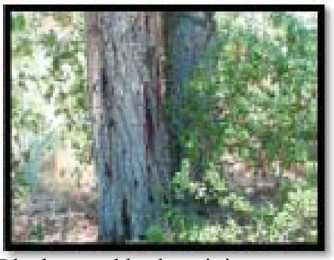
Adult emergence holes



Black or red bark staining

Outer bark removed by woodpeckers

Photo credits: USDA Forest Service.

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FINE TUNING NITROGEN MANAGEMENT FOR VEGETABLE PRODUCTION

Richard Smith, Vegetable Crop and Weed Science Farm Advisor

Summary: New proposed regulations by the Regional Water Quality Control Board (RWQCB) may change nitrogen (N) fertilization practices in the Salinas Valley. The best tool for managing N fertilization is the nitrate quick test which measures residual soil nitrate; this information can be used to adjust nitrogen fertilization rates either up or down. Effective water management is also critical to reducing the loss of nitrate from the root zone. Other technologies that may have a role in further fine tuning nitrogen management include slow release fertilizers and nitrification inhibitors, but both technologies have challenges that limit the extent of their impact. Fall applied nitrogen is highly susceptible to nitrate leaching in significant winter rain events and appears to be a bad investment in most years.

Background: If approved, new regulations included in the renewal of the Irrigated Lands Discharge Waiver by the RWQCB, Region 3 proposed on February 1, 2010 have the potential to greatly impact vegetable crop fertilization practices in the Salinas Valley. Many growers have reduced fertilization rates over the past few years and feel they have made efforts to safeguard the environment. In spite of these efforts, the regulations as proposed will likely expect greater reductions in nitrogen application rates.

In the accompanying article in this issue of Crop Notes entitled, "Summary of 2008-09 large scale irrigation and nitrogen fertilizer management trials in lettuce" we discussed reductions in nitrogen fertilizer use that were achievable by utilizing timely information on residual soil nitrate levels and careful irrigation to minimize losses of nitrate by leaching beyond the root zone. The use of the nitrate quick test and careful irrigation are the most important tools that a grower can use to successfully reduce nitrogen fertilizer rates without jeopardizing yield. This is important because as we move from fertilizer programs that have a buffer of N built into them to leaner fertilizer programs, weak areas of the fields may be more evident and the risk of economic losses becomes higher. It is therefore important to use tools, such as the nitrate quick test for nitrogen and ET for irrigation management decisions which are both reliable and help improve N use efficiency.

In the 2008-09 trials it is interesting to note that in three of the five trials we applied less fertilizer N than was taken up by the crop. This underscores the importance of residual soil N provided by both prior crop residues as well as mineralization of soil organic matter. As an example, in a 2008 trial conducted on 2nd crop romaine following rapini,

(Cont'd to page 13)

New proposed regulations by the Regional Water Quality Control Board (RWQCB) may change nitrogen (N) fertilization practices in the Salinas Valley. The best tool for managing N fertilization is the nitrate quick test which measures residual soil nitrate; this information can be used to adjust nitrogen fertilization rates either up or down.

(Cont'd from page 12)

we applied 65 lbs N/A to 6 seedline romaine; the romaine contained 133 lbs N/A in the crop biomass at harvest which indicated that over half of the N in the crop came from non-fertilizer sources.

Slow Release Fertilizer: Slow release fertilizers have the potential to provide a best management practice (BMP) by providing metered amount of nitrogen over time for crop growth from an initial application. However, during the main part of the growing season, when fertilization of crops is unhampered by weather, their use does not seem justi ed. However, they may provide bene ts during winter production when the highest rainfall and greatest potential for leaching occurs. We conducted trials on the slow release fertilizers Duration and Polyon from 2000 to 2003 on winter-grown broccoli. One of the challenges that we encountered during these trials was low rainfall which did not create leaching conditions that would have highlighted the touted bene ts of the slow release materials. In addition, we confronted high residual nitrogen in the soil at the beginning of each trial. In spite of these obstacles, all fertilizer treatments yielded higher than the untreated control, but there were no differences between fertilizer treatments or rates (Table 1). In these trials, slow release fertilizers looked promising, but the biggest obstacle to their adoption was the cost, which at that time were substantially more expensive than standard sidedress materials.

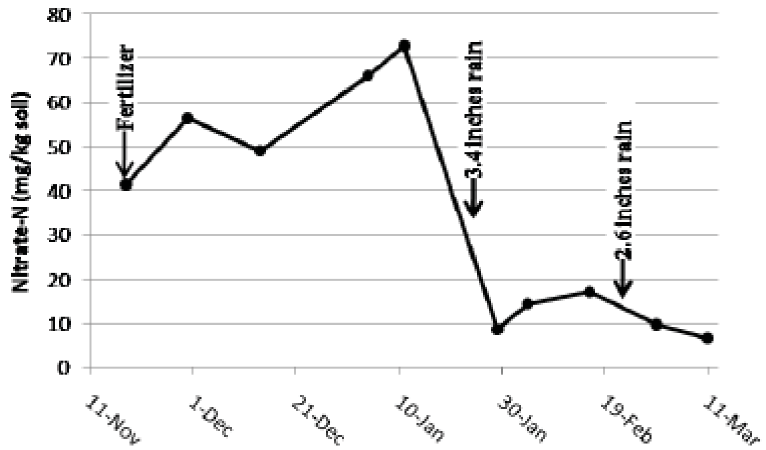
A nitri cation inhibitor is a chemical which inhibits the conversion of ammonium to nitrate. This is desirable in some situations because ammonium is positively charged and is less subject to leaching. An effective nitri cation inhibitor would be a useful tool for retaining a higher percentage of applied nitrogen in the root zone.

Nitri cation Inhibitor: A nitri cation inhibitor is a chemical which inhibits the conversion of ammonium to nitrate. This is desirable in some situations because ammonium is positively charged and is less subject to leaching. An effective nitri cation inhibitor would be a useful tool for retaining a higher percentage of applied nitrogen in the root zone. Currently there is one proven nitri cation inhibitor, dicyandiamide (DCD); a nitrogen fertilizer containing DCD (Agrotain Plus, manufactured by Agrotain International, LLC) is commercially available for use in California. In a study conducted on eld corn, this material appeared to improve nitrogen use ef ciency of applied fertilizer. Two eld trials were conducted on lettuce in 2008. In the rst trial residual soil nitrogen levels were high and no yield response or improvement in soil nitrogen status was observed (Table 2). In the second trial, there was a yield response to all fertilizer treatments over the untreated control, but differences between fertilizer treatments were not observed (Table 3). Tim Hartz conducted both laboratory and eld trials that indicated that DCD is susceptible to leaching, and its effect can be quickly lost. His results may be a partial explanation for the lack of better results in these trials. In my mind, nitri cation inhibition remains a useful concept and deserves further evaluation.

Fall Nitrogen Application: We monitored the fate of fall preplant N applied at bed listing and found it to be highly susceptible to leaching by a sizeable rain event (Figure 1). The nitrate in the rst foot of soil moved down to the 2nd foot and beyond during the series of storms during the week of January 18th. We recognize that N applied in the fall is often as part of triple carrier fertilizer. In such cases, the quantity of N in these materials should be minimized (eg 1-3-3 ratio vs 1-1-1 ratio). If P and K are not needed, fall N applications appear to be a good place to economize on N fertilizer applications.

We monitored the fate of fall preplant N applied at bed listing and found it to be highly susceptible to leaching by a sizeable rain event.

Figure 1. Loss of nitrate from fall applied fertilizer from the top foot of soil following series of winter storm events during week of Jan. 18 and Feb. 22, 2010



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(Cont'd from page 13

Table 1. Three year summary of broccoli yield: 2000 - 2003

Treatment & lbs N/A	**Total No. Heads**	**Total Wt. (lbs)**	**Mean Head Wt.**
Duration 100	173.2	85.3 a[1]	0.50 a
Duration 150	171.8	85.6 a	0.50 a
Duration 200	173.5	86.1 a	0.50 a
Polyon 100	177.8	88.8 a	0.50 a
Polyon 150	178.5	89.4 a	0.50 a
Polyon 200	170.4	88.2 a	0.51 a
Standard 200	177.5	87.3 a	0.50 a
Untreated	173.0	80.5 b	0.46 b

1 – Numbers followed by the same letter do not differ at 95% con - dence interval.

Table 2. Trial 1: Harvest evaluation on May 24.

Treatment total lbs N/A applied	Untrimmed yield lbs/A	Mean head weight Untrimmed lbs/head	Nitrogen in tops percent	Nitrogen in tops lbs/A	Trimmed head weight lbs/A	Mean head weight Trimmed lbs/head
198.1 (Standard)	89,022	2.9	3.9 a[1]	115.7	51,929	1.7
146.6+ Agrotain	82,495	2.8	3.4 c	113.9	54,344	1.8
146.6	81,075	2.7	3.7 ab	118.5	49,199	1.7
119.1+ Agrotain	82,420	2.7	3.4 c	104.6	50,070	1.6
119.1	89,207	2.8	3.6 b	134.1	47,205	1.5
Untreated	83,229	2.7	3.4 c	112.0	46,262	1.5

1 – means followed by the same letter do not differ from each other at 95% con dence interval

Table 3. Trial 2: Harvest evaluation on August 11

Treatment total lbs N/A applied	Untrimmed fresh biomass lbs/A	Untrimmed dry biomass lbs/A	nitrogen in tops Percent	Nitrogen uptake in tops lbs/A	Trimmed fresh biomass lbs/A	Percent marketable after trimming
155 (Standard)	63,424.5	3,855.4	2.9 a[1]	110.3 a	30,572.2	48.3
119+ Agrotain	63,205.5	3,642.1	2.7 a	96.3 a	26,334.6	42.2
119	67,654.8	4,096.4	2.5 ab	104.1 a	32,352.9	48.4
85+Agrotain	61,366.4	3,764.0	2.4 b	90.3 a	29,818.9	49.3
85	71,945.1	4,193.8	2.5 ab	106.3 a	32,731.8	45.5
Untreated	44,442.2	2,903.7	2.1b	61.2 b	26,046.8	61.4

1 – means followed by the same letter do not differ from each other at 95% con - dence interval

NITROGEN AVAILABILITY FROM LIQUID ORGANIC FERTILIZERS

Tim Hartz, Richard Smith and Mark Gaskell

Providing sufficient soil nitrogen availability to reach maximum yield potential can be a challenge in organic production. While cover cropping is generally the most economical way to provide plant-available N in organic systems, it is not always practical, nor can cover cropping always provide sufficient N availability. Composted manures contain significant amounts of N, but the rate at which that N becomes plant-available is usually quite slow. Consequently, there is often a need for supplemental in-season N application. In recent years a number of liquid organic fertilizer products have become available; since they can be applied through irrigation they offer an organic grower more flexibility in N management than dry organic fertilizer products like feather meal. There is little solid information regarding the N availability from these liquid organic fertilizers, so in 2008 we conducted a study to document the N mineralization dynamics of three commercial products.

Liquid organic fertilizers can provide relatively rapid N availability. We believe that a key to this rapid availability is that a substantial portion of the organic N contained in these fertilizers is in simple chemical forms such as amino acids, which can be rapidly broken down.

The fertilizers chosen for this study, Phytamin 801, Phytamin 421 and Biolyzer, were made from a variety of feedstocks ranging from fishery wastes to crop residues (Table 1). Through laboratory analysis we determined the concentration of total N (all forms) and mineral N (NH4-N and NO3-N, the plant-available forms). Additionally, we filtered fertilizer samples to simulate the removal of particulate matter by drip irrigation filters, and measured the amount of N associated with that particulate matter. The fertilizers ranged from 2.6 to 6% total N; both Phytamin products had a substantial amount of mineral N. All products had a significant amount of particulate N. This is important for two reasons. First, this N may be removed by filtration when injected into a drip irrigation system, and represents a potential economic loss to the grower. Second, it underscores that these products contain particulates that may pose a clogging threat to drip emitters, and care should be exercised when injecting these products into a drip system.

We collected soil from two fields under organic management, then dried and screened them for uniformity. Dry soil samples were wetted to field capacity moisture content using either water, or solutions of the fertilizers. The wetted soil samples were put in sealed containers to maintain moisture content, and placed in temperature controlled chambers at either 59 or 77 oF (15 or 25 oC); these temperatures represent typical coastal winter and summer soil temperature, respectively. At 1, 2 and 4 weeks, soil NH4-N and NO3-N concentrations were determined; at each time 4 samples of each soil x fertilizer combination were measured. The increase in mineral N concentration over time (compared to the change in the unfertilized soils) represented net N availability from the organic fertilizers.

The rate of N mineralization from these fertilizers was quite rapid (Table 2). Phytamin 801 and Phytamin 421 had more than 60% of their initial N content in mineral form after 1 week of incubation, and more than 70% after 2 weeks. Biolyzer, which had the lowest initial N content, had significantly lower N availability, but still had 40-55% of initial N content in plant-available form within 2 weeks. N mineralization slowed after 2 weeks, with only marginally higher N availability after 4 weeks. There were small but statistically significant soil and temperature effects on fertilizer N availability, with greater N availability found in soil 2, and at 77 oF. Nitrification (the conversion of NH4-N to NO3-N) occurred rapidly; averaged across fertilizers and soils, more than 90% of mineral N was in NO3-N form after 1 week of incubation at 77 oF, or after 2 weeks at 59 oF (Fig. 1).

The particulate material contained in these liquid fertilizers has been finely milled, and therefore has a high surface area that facilitates microbial degradation.

These results suggest that liquid organic fertilizers can provide relatively rapid N availability. We believe that a key to this rapid availability is that a substantial portion of the organic N contained in these fertilizers is in simple chemical forms such as amino acids, which can be rapidly broken down. Another factor may be that the particulate material contained in these liquid fertilizers has been finely milled, and therefore has a high surface area that facilitates microbial degradation. Prior research suggests that organic fertilizers formulated from animal wastes have more rapid breakdown than those formulated from plant materials, and that was the case in this study as well. The speed with which the mineralized N was converted to NO3-N, even at 59 oF, undercuts the rationale for the use of Chilean nitrate.

The foundation of organic N fertility is soil building through cover cropping and compost application, but in situations in which additional N availability is needed, liquid organic fertilizers can provide a quick boost. The cost of these products will limit their use, but clearly they can be a valuable tool for organic growers.

(Cont'd to page 16)

(Cont'd from page 15

Table 1. Initial nitrogen content and form of the liquid organic fertilizers

Fertilizer	Feedstock	Nitrogen content (%)			
		total	NH_4-N	NO_3-N	particulate[z]
Phytamin 801	fish waste, seabird guano	6.0	1.3	0.04	0.5
Phytamin 421	soy meal, plant extracts	4.0	0.5	0.7	0.7
Biolyzer	grain fermentation	2.6	0.2	0.2	0.6

z potentially removable by drip irrigation system filtration

Table 2. Nitrogen availability from organic fertilizers, as influenced by temperature and time of incubation.

Weeks of incubation	Fertilizer	% of fertilizer N in plant-available form			
		Incubation at 59 °F		Incubation at 77 °F	
		Soil 1	Soil 2	Soil 1	Soil 2
1	Phytamin 801	79 a[z]	85 a	83 a	93 a
	Phytamin 421	62 b	65 b	71 b	75 b
	Biolyzer	35 c	36 c	42 c	50 c
	mean	59	62	65	73
2	Phytamin 801	83 a	89 a	83 a	95 a
	Phytamin 421	71 b	71 b	72 b	80 b
	Biolyzer	40 c	45 c	45 c	55 c

z means within columns within incubation times separated using Duncan's multiple range test, $p < 0.05$

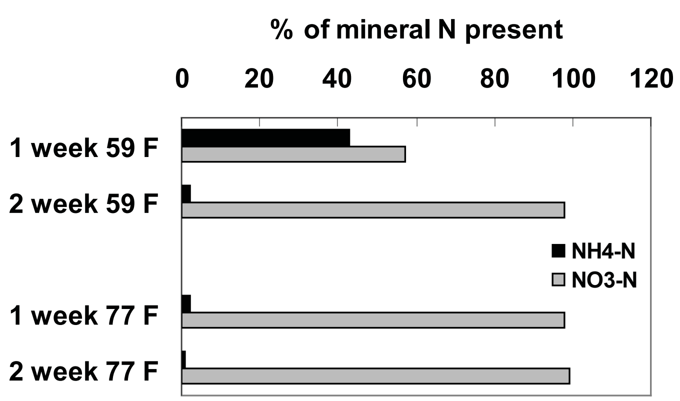

Fig. 1. Effects of incubation time and temperature on the form of mineral N present

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