CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

Project Final Report (2008)

a) Project Title Updating our knowledge and planning for future research, education and outreach activities to optimize the management of nutrition in almond and pistachio production.

CDFA contract number:

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Project Cooperators: John Edstrom, Farm Advisor Colusa County; Roger Duncan, Farm Advisor, Stanislaus County; Bob Beede, Farm Advisor, Kings County; Almond Board of California; Pistachio Commission of California.

b) Objectives

The goal of this project was to survey current practices, concerns, and needs in Almond and Pistachio nutrition, collate existing information and best management practices, and design a new research and extension initiative to increase the efficiency of fertilizer usage and guide subsequent nutrition research and education programs.

c) Executive Summary

There is a growing consensus among UC Faculty and Farm Advisors, consultants and growers that the UC established critical values for determination of Almond and Pistachio nutrient status and the methods used to manage fertilization in these crops may be outdated or underutilized. In the absence of viable and well-regarded standards and guidelines for nutrient management, growers do not have the resources needed to use fertilizers wisely. Our goal was to survey current practices, concerns and needs in Almond and Pistachio nutrition in order to identify how nutrition information is presently used by growers and how future research may best assist growers in increasing fertilizer use efficiency. We combined this survey data with existing information and perceived best management practices, in order to provide the content of a new research and extension initiative to increase the efficiency of fertilizer usage. To meet this goal, we conducted small focus groups with industry stakeholders and used the information we

gathered to inform the content of surveys we distributed to approximately 1800 randomly-selected Almond growers and 300 Pistachio growers throughout California.

Focus group participants were asked a total of eight questions structured around three areas: 1) factors affecting growers' nutrition decisions, including perceived usefulness of critical values and soil and tissue sampling, 2) priorities in education and research relating to plant nutrition, and 3) expected consequences of environmental regulation to the almond industry. Based largely on the information collected from the focus groups, the written surveys were comprised of 37 multi-part questions to collect data regarding 1) grower demographics 2) fertilization use practices 3) factors affecting nutrition decisions 4) priorities in education and research relating to plant nutrition and 5) expected consequences of environmental regulation to the almond industry.

A majority of the originally designed tasks and objectives have been achieved. We conducted three focus groups with at the Almond Industry Conference in Modesto, California (December 2006), and we conducted three focus groups at the Pistachio Convention in Visalia, California (January 2007). In June 2007, we distributed written surveys to over 1800 randomly-selected Almond growers and to over 300 Pistachio growers. Response rates were 30.0% and 36.7% for the Almond and Pistachio nutrition surveys, respectively. Thus far, we have analyzed the data to explore topics including fertilization usage with respect to potential environmental regulations and perceived best management practices, research and extension preferences of industry stakeholders, and regional/irrigational trends in fertilizer usage.

Extension efforts are presently being developed to deliver the survey results to industry stakeholders.

d) Work description

General: Conduct focus group interviews and distribute surveys to collect information regarding Almond and Pistachio nutritional practices, concerns, and needs.

Task 1: To conduct a focus group interview (FGI's) among selected stakeholders to identify current practices, concerns and needs in Almond and Pistachio nutrition management.

- Task 1.1: Focus Group Design
  - Completed 11/06
- Task 1.2: Conduct focus group meetings.
  - Completed 12/06, 01/07

Task 2: To design and conduct a statistically sound and informative survey instrument to identify current practices, concerns and needs in Almond and Pistachio nutrition management.

- Task 2.1: Analyze, prepare survey questions, submit draft survey for field test, and obtain required human subjects research approval.
  - Completed 04/07
- Task 2.2: Design questionnaire for mailing and online submission. Mail survey.
  - Completed 06/07
- Task 2.3: Analyze survey results.
  - Ongoing

Task 3: Design and conduct two regional nutrition workshops and simultaneous focus group interviews to update knowledge in nutrition management and further define concerns and needs in Almond and Pistachio nutrition management.

- Material presented at following workshops to date:
  - Almond Conference: Keynote Speaker and Almond Research Presentation 12/05/07, Modesto. (400 and 300 attendees)
  - FREP Meeting 11/23/07, Tulare. (400 attendees)
  - WPHA Meeting, 11/29/07, Sacramento (80 Attendees)
  - California Agronomy Society Meeting, 02/07. (150 Attendees)
- Ongoing: determining whether additional data collection through focus group interviews will provide useful information for content development of research projects and extension efforts.

Task 4: Collate and analyze existing information, survey and workshop findings and use this data to design an extension initiative to increase the efficiency of fertilizer usage and guide the development of new nutrition research and education programs.

- Ongoing: Collaborating with web designers for Fruit and Nut Research Information Center (www.fruitsandnuts.ucdavis.edu) to provide survey results to stakeholders in interactive format as graphs and tables describing topics of interest.

e) Results and Discussion:

Most Almond and Pistachio growers perform nutrition practices considered to be progressive and/or efficient, such as collecting tissue samples at least once per year, collecting soil samples at least once per year, applying nitrogen with fertigation (where irrigation methods allow), and applying nutrients foliarly. Almond growers who do not perform frequent tissue sampling cited expense and perceived invaluable results as their primary reasons. Pistachio growers who do not perform frequent tissue sampling mainly cited expense and difficulty in interpreting results as their reasons. Very few Almond and Pistachio growers apply nitrogen fertilizer in the winter months, when plants are not actively taking up nitrogen from the soil. Many Almond and Pistachio growers apply nitrogen fertilizer in more than one season, a practice which is perceived to be nutritionally efficient.

There is a positive relationship between the amount of acreage an Almond grower manages and the likelihood that he or she uses fertigation to apply nitrogen, routinely collects tissue samples, and/or routinely collects soil samples. Simply, larger growers are more likely to perform these practices. Growers from Butte County are significantly less likely than growers from other major Almond-producing counties to not use fertigation to apply nitrogen. Growers from Madera are significantly less likely than growers from other major Almond-producing counties to not collect regular tissue samples.

Although most Almond and Pistachio growers use the UC critical values somewhat or a lot, less than one third of Almond growers and less than one quarter of Pistachio growers feel that the critical values are more than “somewhat” adequate to ensure high yields.

Nearly all Almond and Pistachio growers feel that plant nutrition is important to ensure high yields. Most Almond and Pistachio growers are "somewhat satisfied" with their yields and are satisfied with their current nutrition program. Major reasons why some Almond growers are dissatisfied with their program include lack of money to improve their program, perceived lack of adequate available information, and uncertainty as to how best to improve their program. The major factor cited by Pistachio growers for program dissatisfaction is perceived lack of adequate available information.
Almond growers report relying most heavily on consultants/labs and farm advisors for plant nutrition information, and they base their fertilization decisions mostly on tissue samples and personal history. Pistachio growers base their decisions mainly on tissue samples, personal history, and nutrient removal. Almond and Pistachio growers generally believe tissue sampling is a more valuable, accurate, and effective means with which to make nutrition decisions than is soil sampling.

Almond and Pistachio growers reported that better-designed publications, a website to help make personalized decisions, more publications, and more training workshops would all be of approximately equal use to them in the future. Almond growers identified printed information as their preferred form of information delivery, while Pistachio growers showed little preference between receiving information in a printed form, on a website, or as a computer program.

Almond growers are most interested in future research about fertilizer application timing, the relationship between nutrition and disease, the accuracy of critical values to ensure they result in maximal yield, leaf sampling techniques that better reflect tree nutrient demand, and tissue sampling techniques and timings that provide in-season guidance for fertilizer decisions.

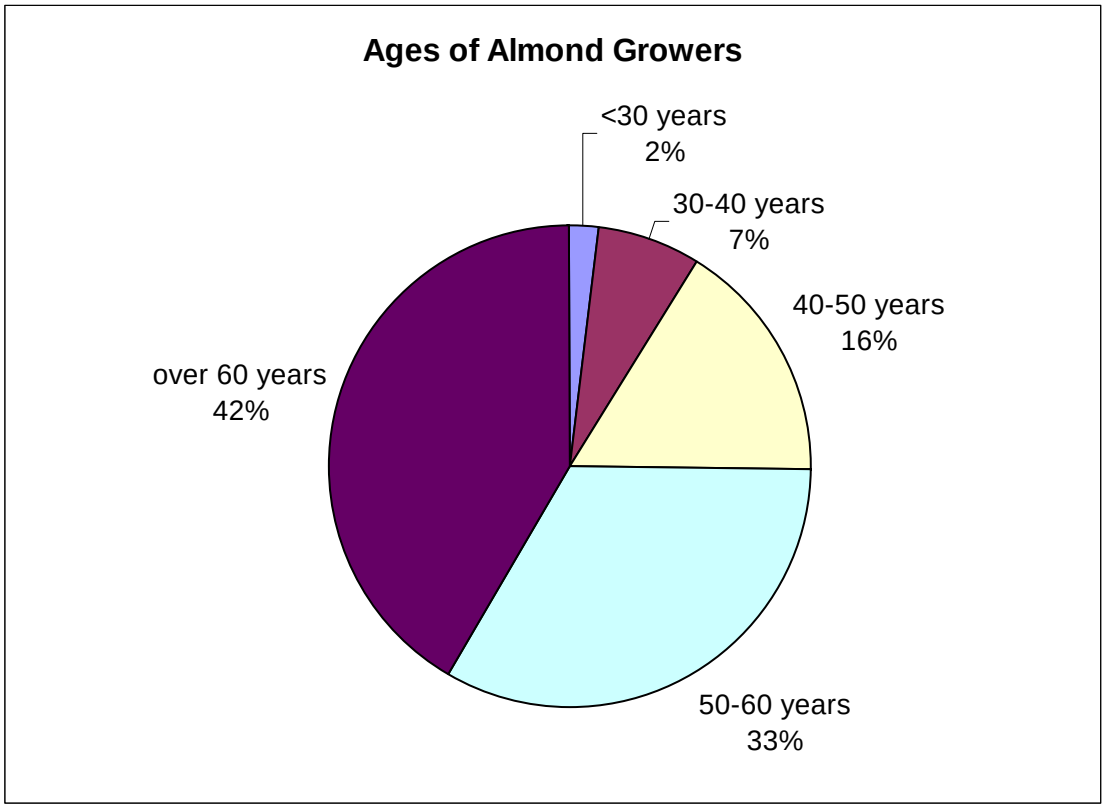
Most Almond and Pistachio growers reported that they consider environmental factors at least most of the time when making fertilizer decisions. Almond and Pistachio growers reported that identifying fertilization practices that optimize yield will be of great importance in order to meet future environmental standards. Most Almond and Pistachio growers expect their future nutrition practices to be affected a good deal both by environmental regulations and by market demands for best management practices.

Detailed presentations of data are on the following pages, separated between Almond and Pistachio.

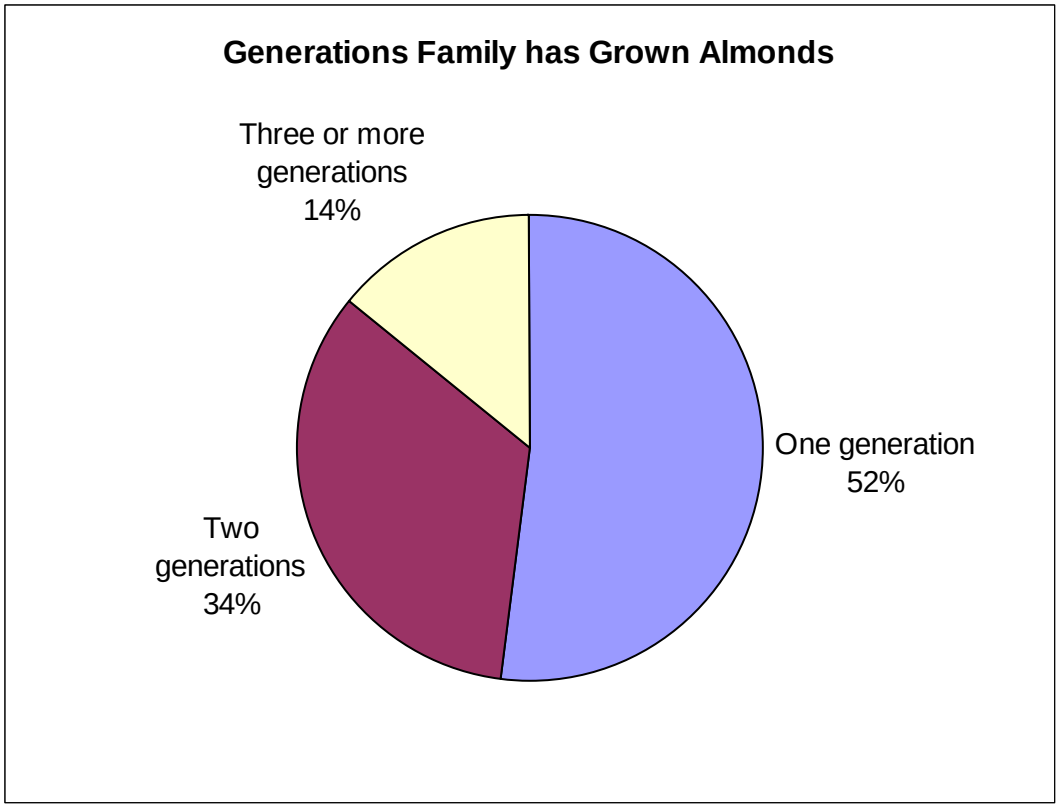
ALMOND

Topic 1: Grower Demographic Data

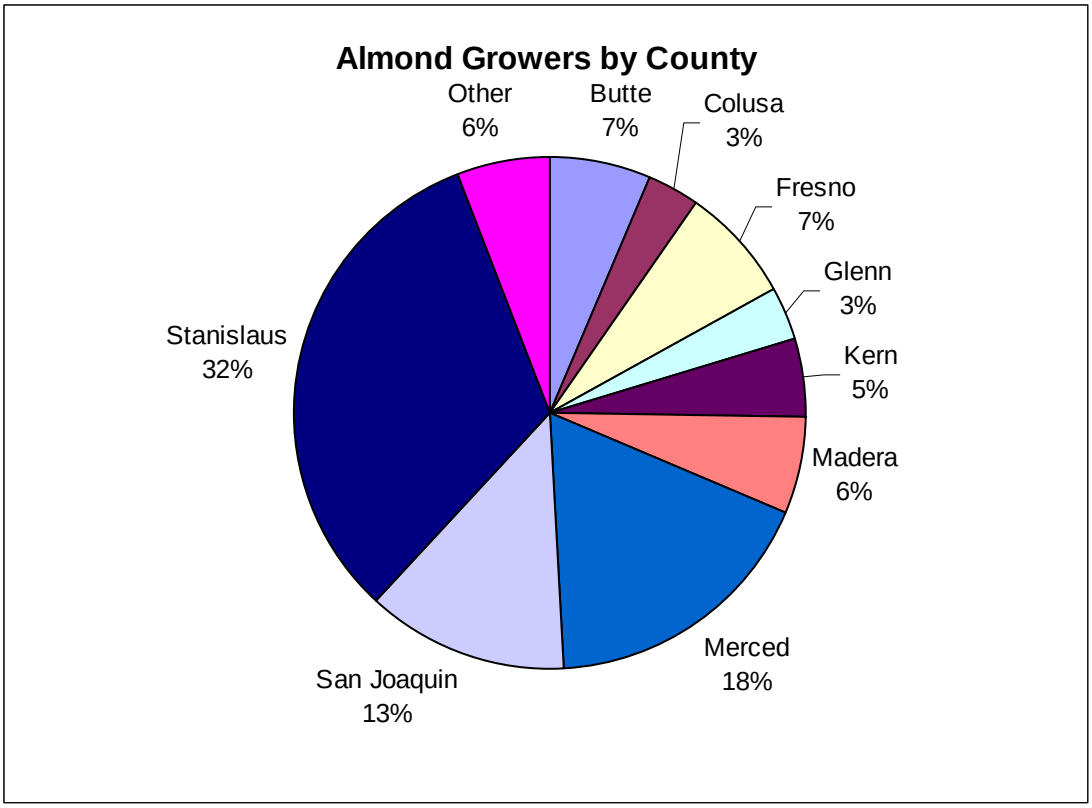
Data was collected relating to growers' demographics. 2% of respondents (10 growers) were under 30 years of age, 7% (36 growers) were 30-40 years old, 16% (86 growers) were 40-50 years old, 33% (174 growers) were 50-60 years old, and 42% (216 growers) were over 60 years old.



52% of respondents (272 growers) are first-generation growers, 34% (178 growers) are in families that have grown almonds for two generations, and 14% (74 growers) are in families that have grown almonds for three or more generations.



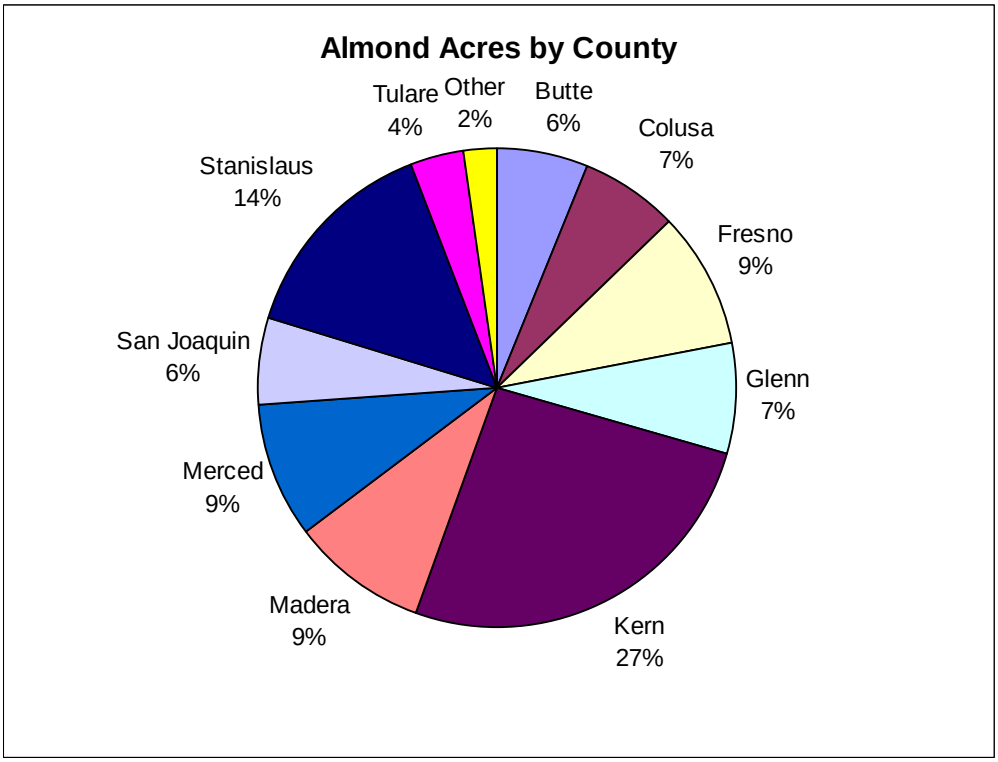
Growers were asked to report the primary county in which they grow Almonds. Most respondents grow Almonds primarily in Stanislaus County (32%, 168 growers), Merced County (18%, 93 growers), and San Joaquin County (13%, 67 growers).



Almond Growers by County

County	# growers	% total
Butte	34	7
Colusa	16	3
Fresno	38	7
Glenn	17	3
Kern	26	5
Madera	32	6
Merced	93	18
Kings	6	1
San Joaquin	67	13
San Luis Obispo	1	0
Solano	1	0.00
Stanislaus	168	32
Sutter	5	1
Tulare	8	2
Yolo	9	2
Total	521	

By acreage, respondents grow Almonds primarily in Kern County (27%, 35,620 acres), Stanislaus County (14%, 19379 acres), Merced County (9%, 12,747 acres), Fresno County (9%, 12,563 acres), and Madera County (9%, 12,553 acres). An example of a contributor to the skewed distribution between growers by county and acreage by county is the single respondent who grows Almonds primarily in Kern County and reports Almond acreage of 14,618 acres.



Almond Acres by County

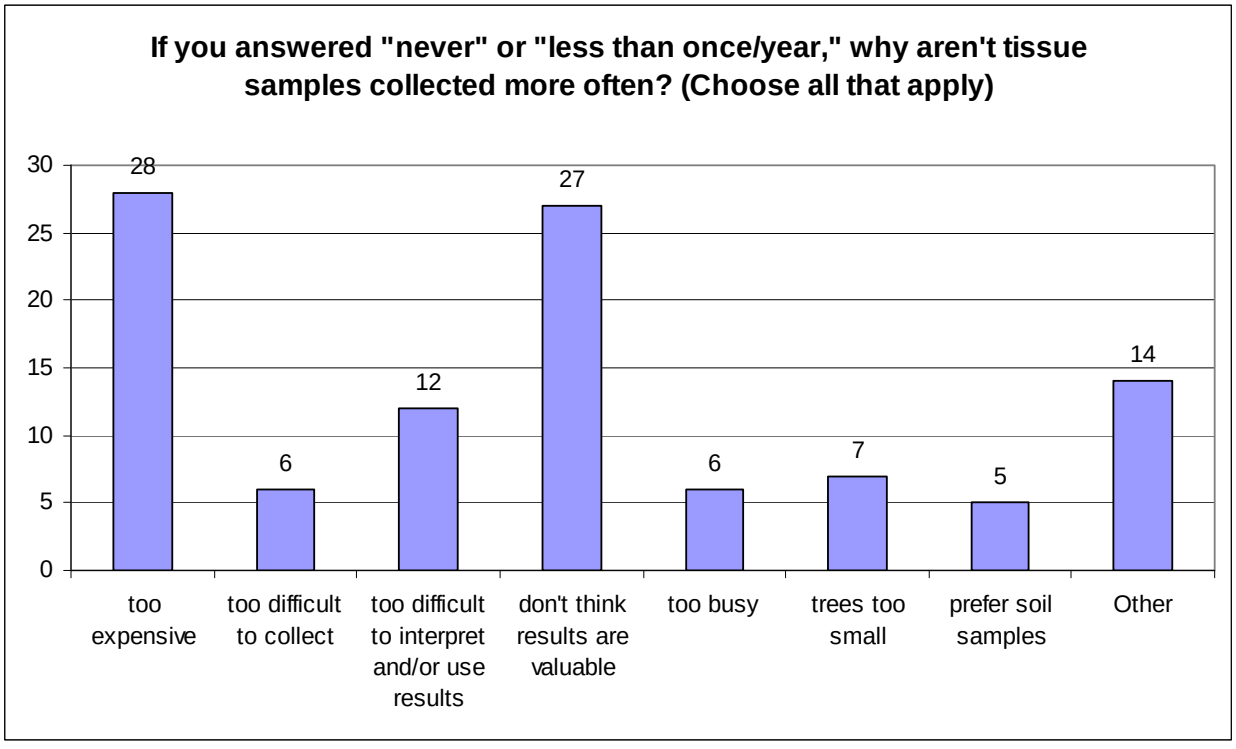
County	# acres	% total
Butte	8328	6
Colusa	8999	7
Fresno	12563	9
Glenn	10162	7
Kern	35620	26
Madera	12553	9
Merced	12747	9
Kings	715	1
San Joaquin	7968	6
San Luis	7	0
Solano	300	0
Stanislaus	19379	14
Sutter	1110	1
Tulare	5077	4
Yolo	918	1
Total	136446	

Topic 2: Fertilization Use Practices, ALMOND

77% of respondents (405 Almond growers) collect tissue samples at least once per year. Growers who collect tissue samples less than once per year cited expense (28 Almond growers) and disbelief in value of results (27 Almond growers) as major reasons why they do not collect tissue samples more often.

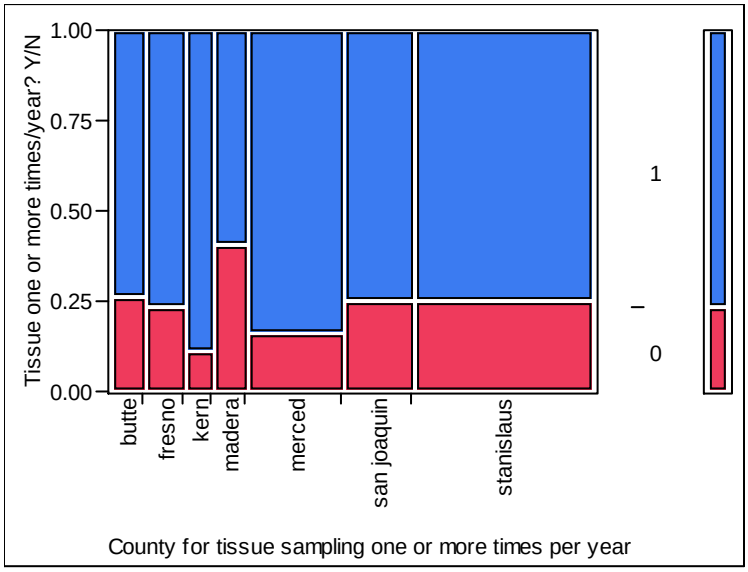
Frequency with which Almond growers collect plant tissue samples (choose all that apply).

	# respondents	% total
Never	40	8
Less than once/year	43	8
Once/year	307	58
More than once/year	98	19
When problems are detected	32	6
I don't know	5	1
Total	525	



There is a positive relationship between the number of Almond acres a grower manages and the likelihood that he or she collects tissue samples at least once per year. Growers with fewer than 20 Almond acres are significantly more likely than average to not collect tissue samples at least once per year ($p<0.001$), while growers with greater than 250 Almond acres are significantly less likely than average to not collect tissue samples ($p<0.001$).

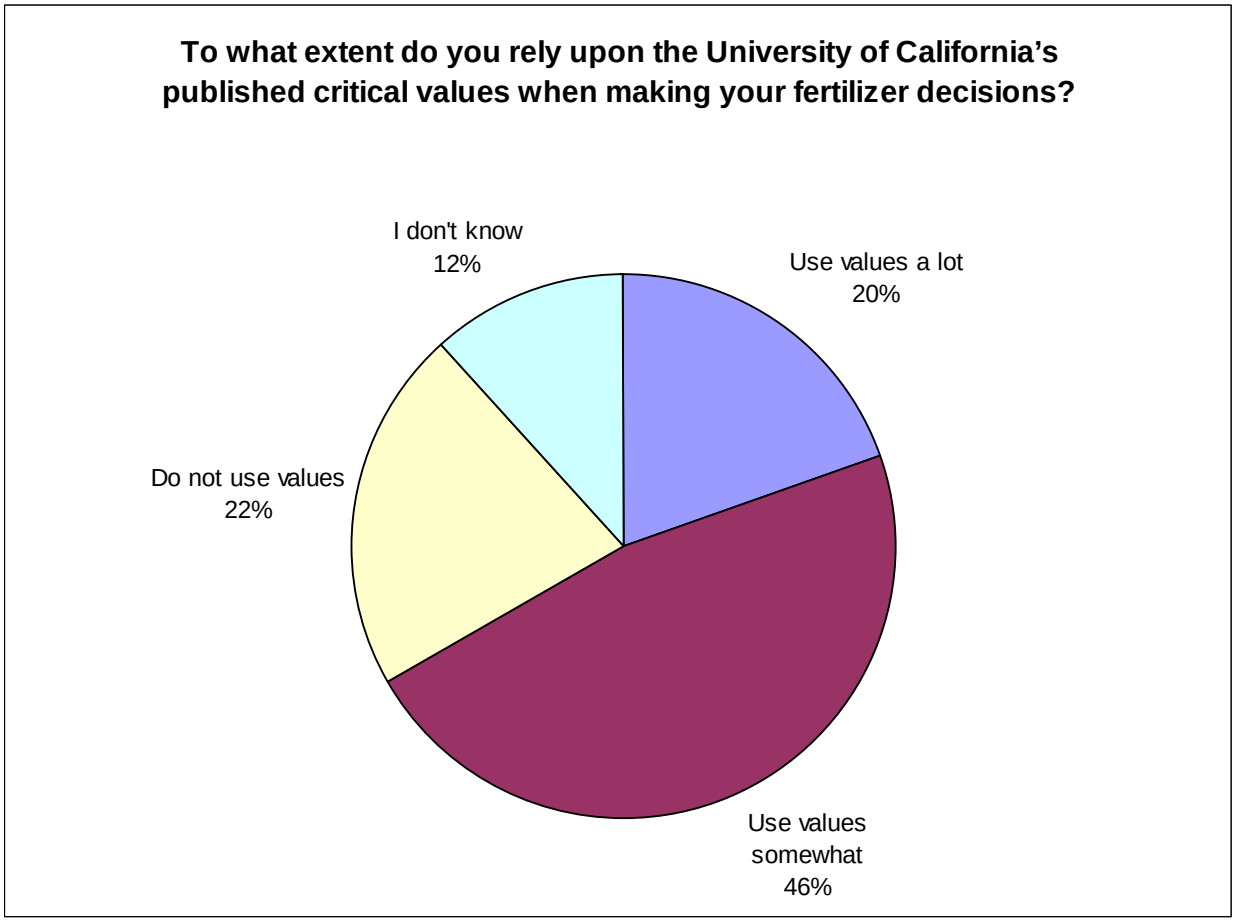
The following graph depicts the major counties in which Almonds are grown, with red blocks representing the proportion of growers who do not collect tissue samples at least once per year and the blue blocks representing the proportion of growers who do. Growers from Madera county are significantly more likely than average to not collect tissue samples at least once per year ($p<0.05$).



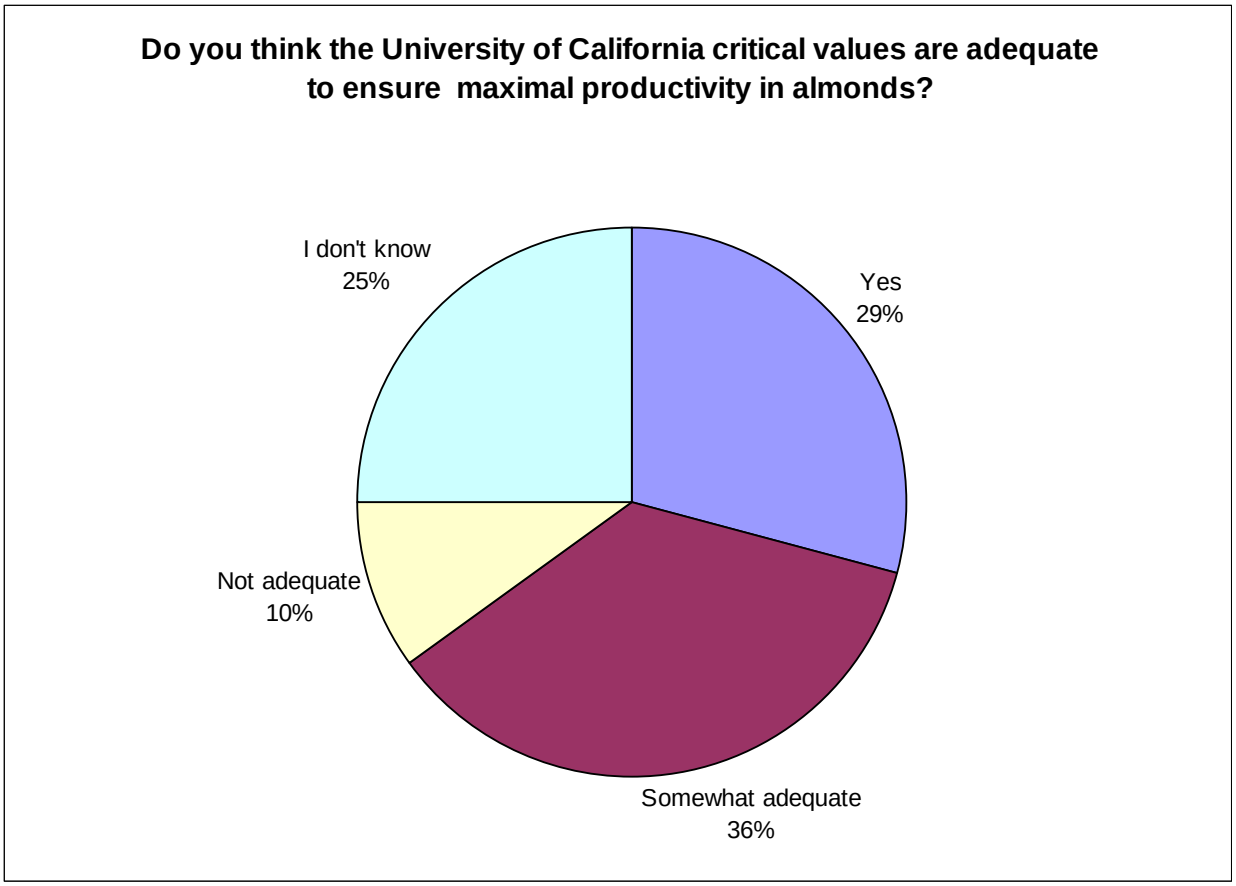
There is no significant relationship between a grower's concern for the environment (based on his answer to a question about how often he/she considers the environment when making nutrition management decisions) and his/her likelihood to collect tissue samples at least once per year ($p=0.74$).

There is also no significant relationship between a grower's opinion that plant nutrition is extremely/very important vs. important/somewhat/not important to ensure high yields in almonds and his/her likelihood to collect tissue samples at least once per year ($p=0.13$).

20% of respondents (100 growers) rely on the UC critical values for Almond a lot, 46% (239 growers) rely on the values somewhat, and 22% (110 growers) do not use the values.

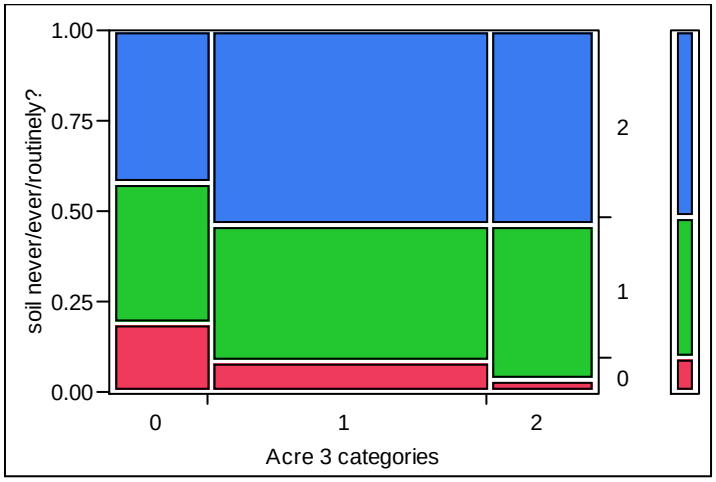


29% of respondents (150 Almond growers) think the UC critical values are adequate to ensure maximal productivity in Almonds, 36% (183 growers) think they are somewhat adequate, 10% (51 growers) think they are not adequate, and 25% (128 growers) do not know whether they are adequate.



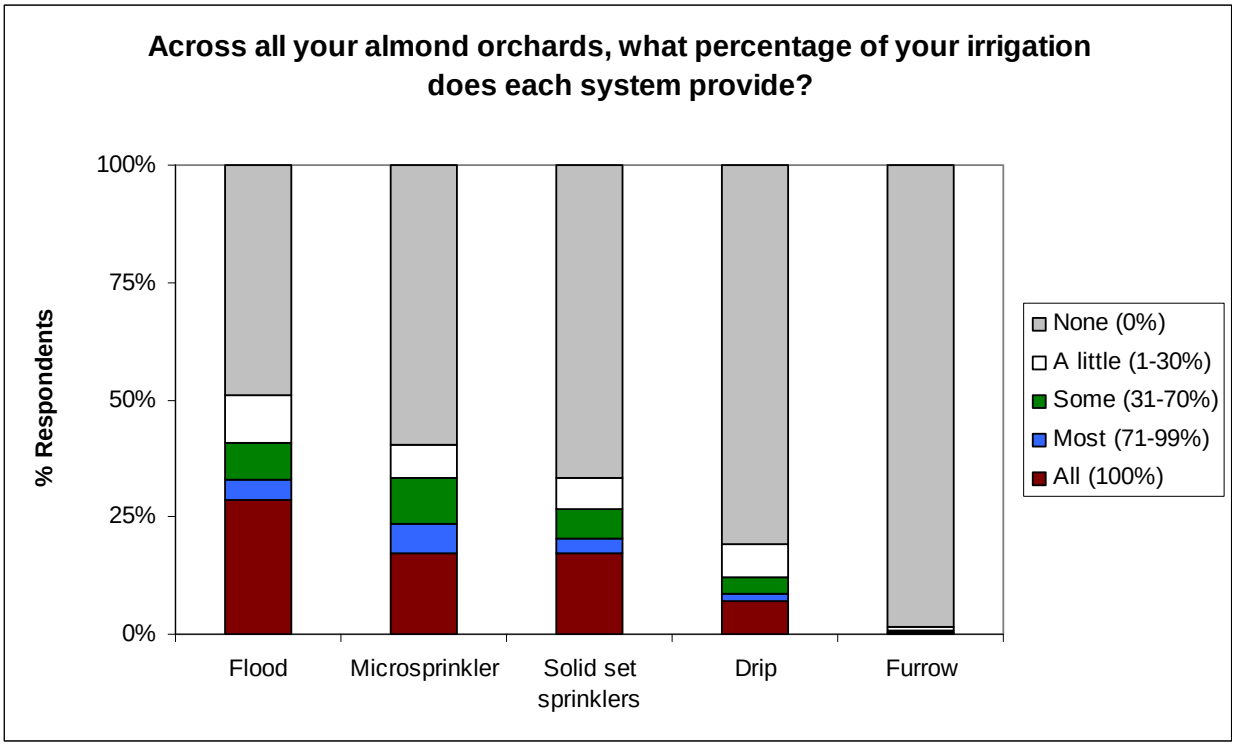
51% of respondents (255 Almond growers) collect soil samples routinely, while 39% (193 growers) collect soil samples only at orchard establishment and/or when problems are detected, and 10% (51 growers) never collect soil samples.

The following figure depicts the frequency with which growers in three acreage categories ("0" = <20 acres, "1" = 20-250 acres, "2" = >250 acres) never collect soil samples (red), collect only at orchard establishment and/or when problems are detected (green), and collect soil samples routinely (blue). Almond growers with fewer than 20 total acres are significantly more likely than average ($p<0.01$) to never use soil sampling on their orchards, and growers with more than 250 acres are significantly less likely than average ($p<0.05$) to never use soil sampling on their orchards.

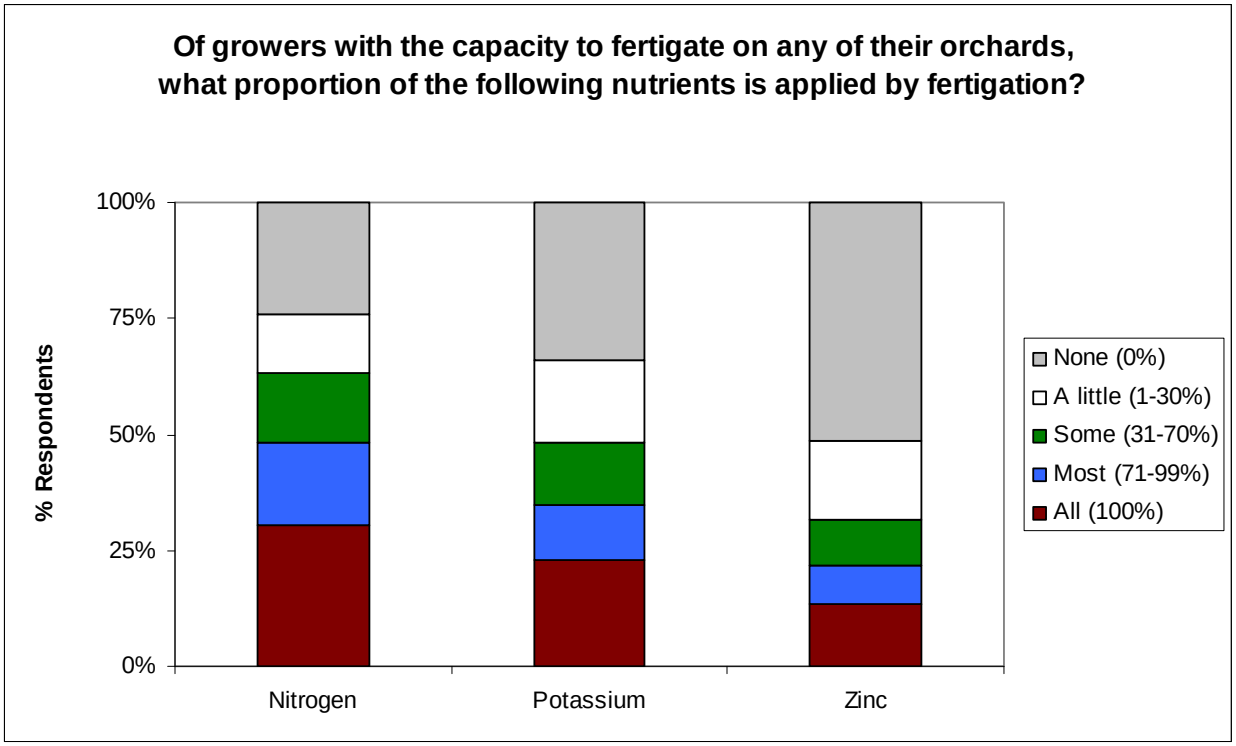


There is no difference in likelihood to collect soil samples between major Almond-producing counties.

Almond growers reported the proportion of irrigation delivered by flood, microsprinklers, solid set sprinklers, drip, and furrow irrigation as is displayed below.

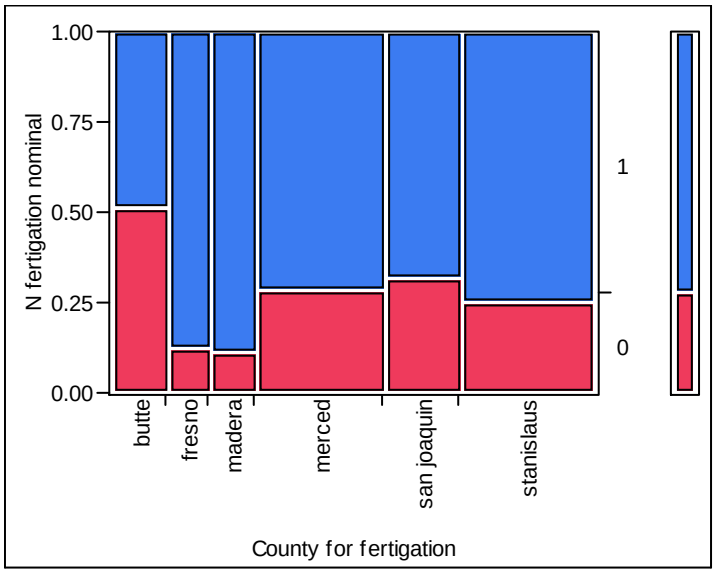

Across all your almond orchards, what percentage of your irrigation does each system provide?
% Respondents
100%
75%
50%
25%
0%
Flood
Microsprinkler
Solid set sprinklers
Drip
Furrow
None (0%)
A little (1-30%)
Some (31-70%)
Most (71-99%)
All (100%)

Of Almond growers with the capacity to utilize fertigation (those who do not irrigate all of their fields entirely with flood irrigation), 76% (265 growers) use fertigation to apply at least some of their nitrogen fertilizer, 66% (222 growers) use fertigation to apply at least some potassium, and 49% (157 growers) use fertigation to apply at least some zinc fertilizer. Almond growers who answered "I don't know" or left that portion of the question blank have been excluded from analysis.

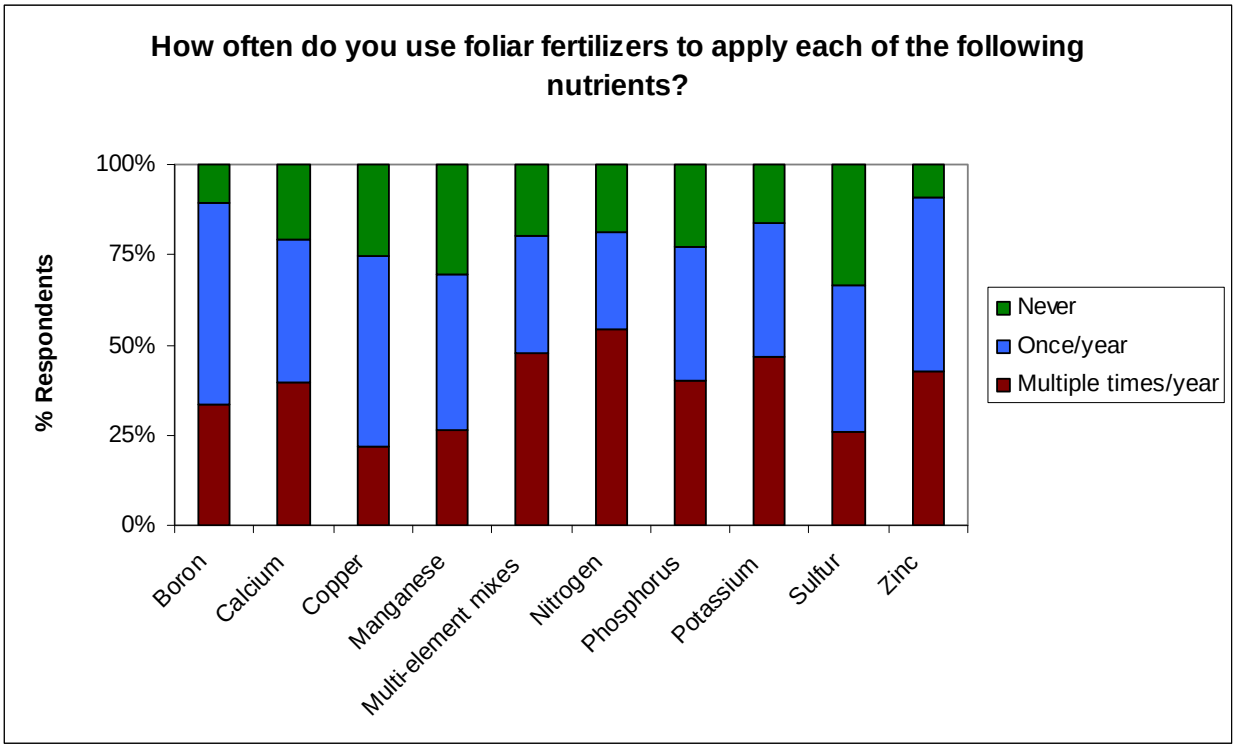


Of Almond growers with the capacity to use fertigation, there was a positive relationship between total acreage owned and likelihood to apply some or all nitrogen fertilizer with fertigation. Growers with 19 or fewer acres were significantly more likely than most growers to not utilize fertigation to apply nitrogen ($p<0.05$), and growers with greater than or equal to 250 acres were significantly more likely than most growers to utilize fertigation to apply nitrogen ($p<0.05$).

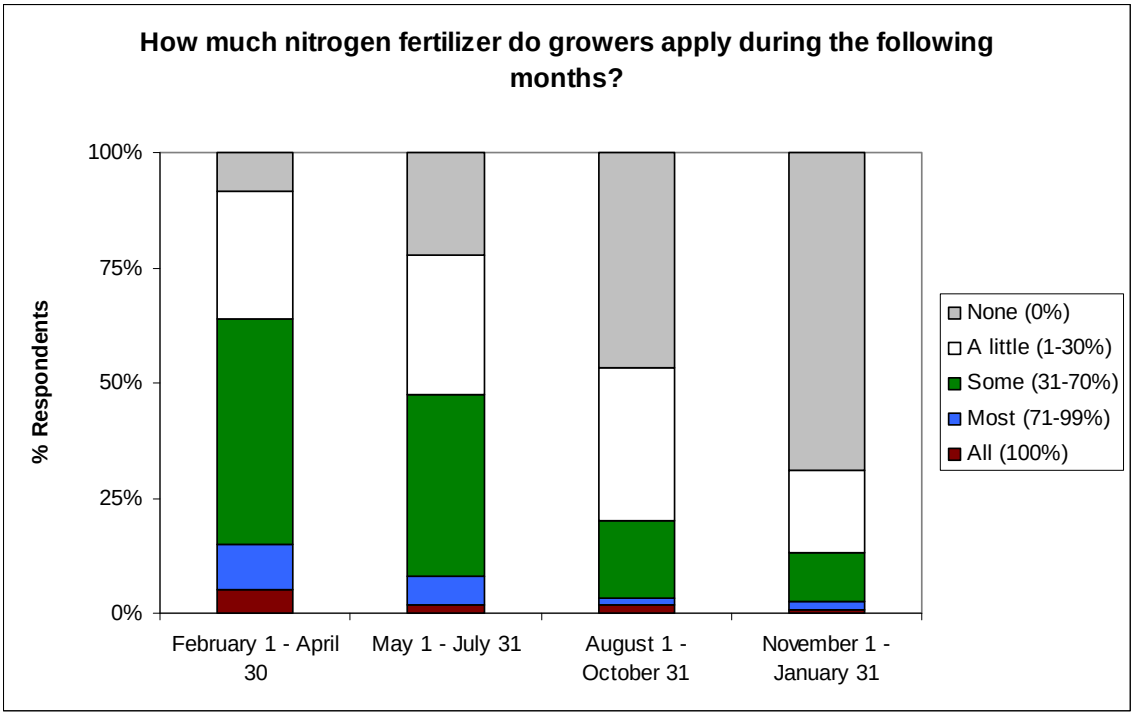
The following graph depicts the major counties in which fertigation is an option for nitrogen application by Almond growers, with red blocks representing the proportion of growers who do not apply nitrogen by fertigation and the blue blocks representing the proportion who do apply nitrogen by fertigation. Growers from Butte County are significantly more likely than most growers to not use fertigation to apply nitrogen ($p<0.05$).



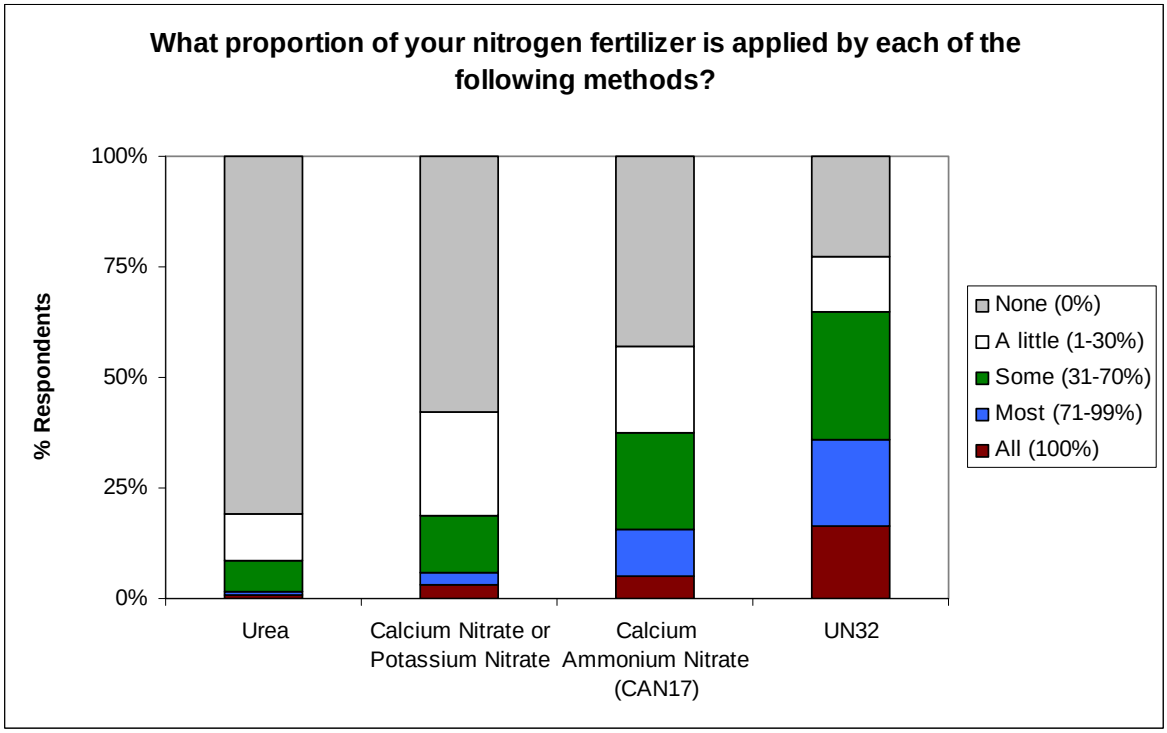
Excluding Almond growers who answered "I don't know" or left the question blank (approximately 25% of respondents for most elements), most Almond growers apply boron, calcium, copper, manganese, multi-element mixes, nitrogen, phosphorus, potassium, sulfur, and/or zinc foliarly at least once per year.



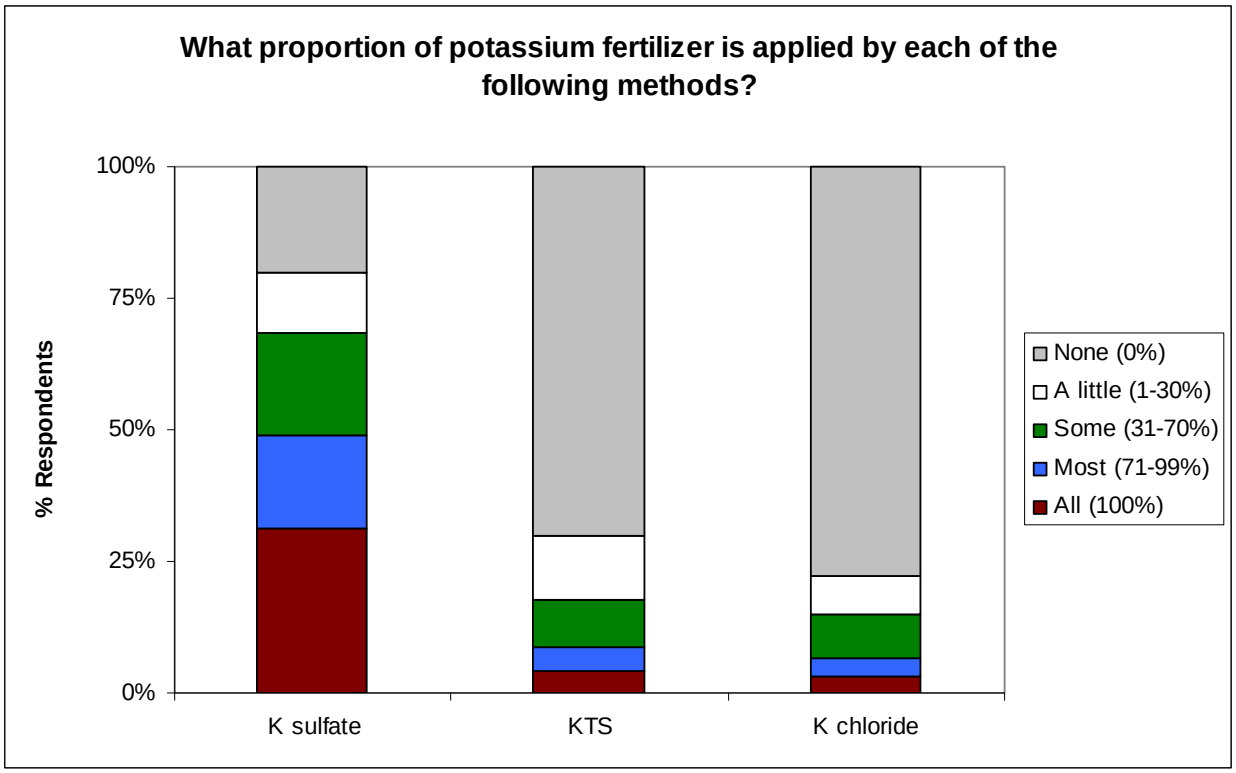
Almond growers apply much of their nitrogen fertilizer in Spring (February through April), and they apply the least nitrogen during the Winter (November through January). Many growers apply nitrogen fertilizer in more than one season.



Almond growers apply much of their nitrogen in the form of UN32, followed by calcium ammonium nitrate, calcium nitrate or potassium nitrate, and urea.

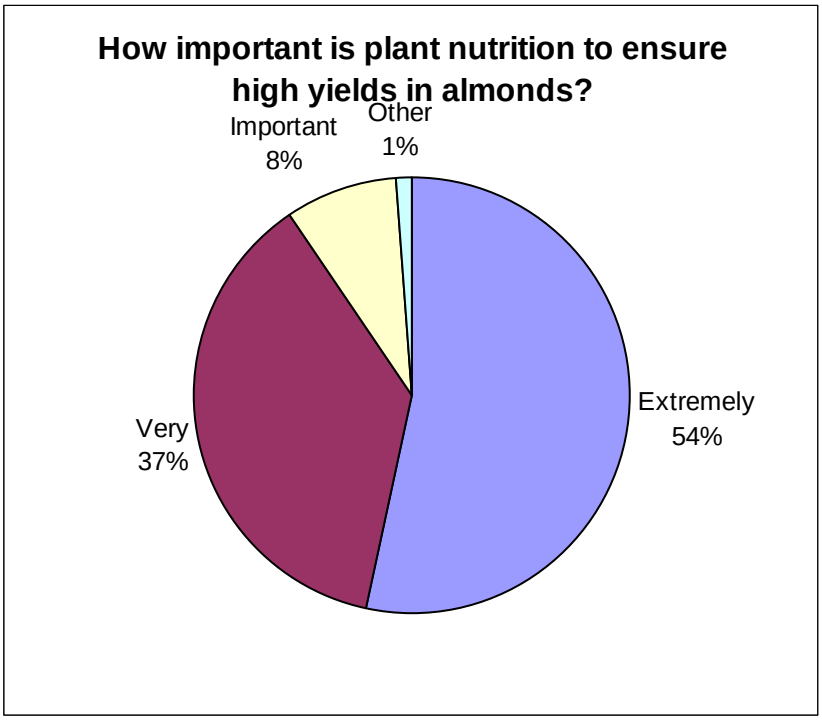


Almond growers apply most of their potassium as K sulfate, followed by KTS and K chloride.

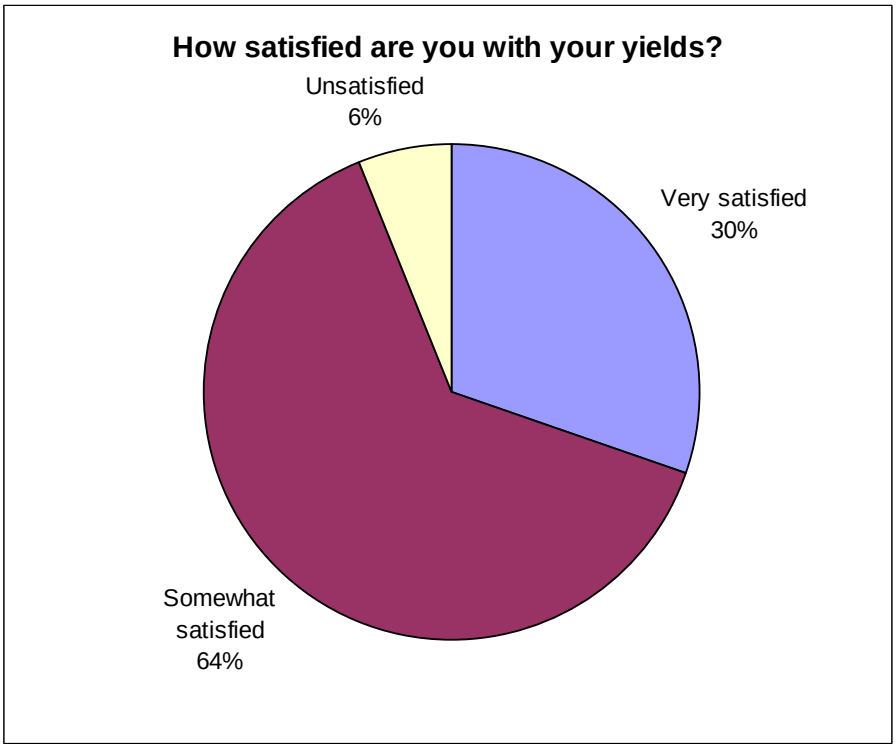


Topic 3: Factors Affecting Nutrition Decisions, ALMOND

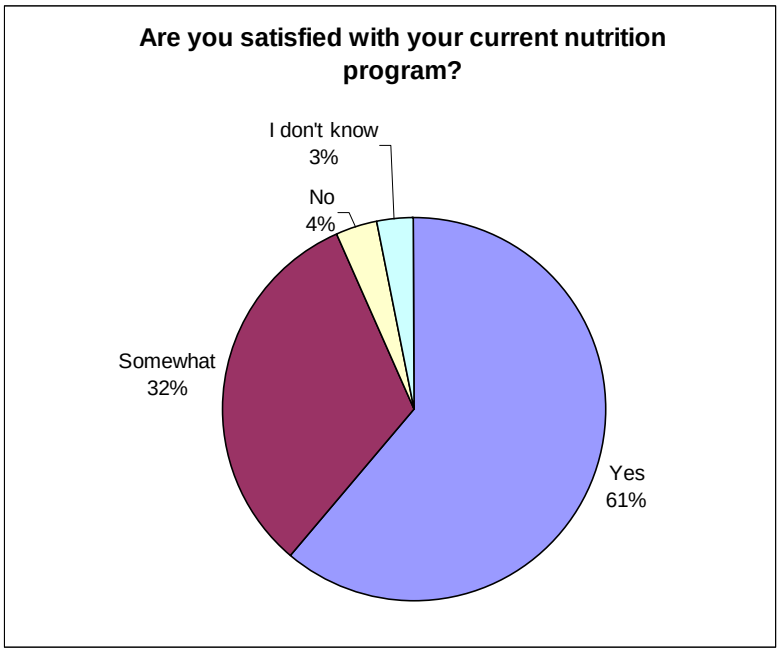
54% of respondents (280 Almond growers) reported that they think plant nutrition is extremely important to ensure high yields in Almonds, 37% (195 growers) reported that they think it is very important, 8% (43 growers) reported that they think it is important, 0.6% (3 growers) reported that they think it is somewhat important, and 0.2% (1 grower) reported that it is not important.

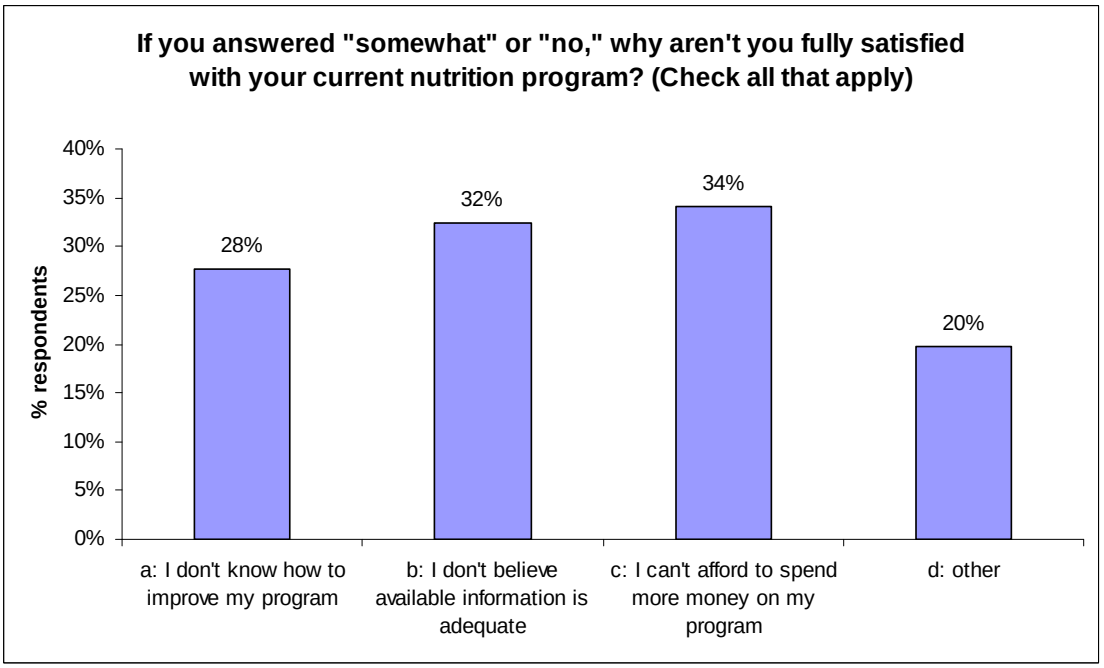


30% of respondents (156 Almond growers) reported that they were very satisfied with their yields, 64% (330 growers) reported that they were somewhat satisfied with their yields, and 6% (31 growers) reported that they were unsatisfied with their yields.

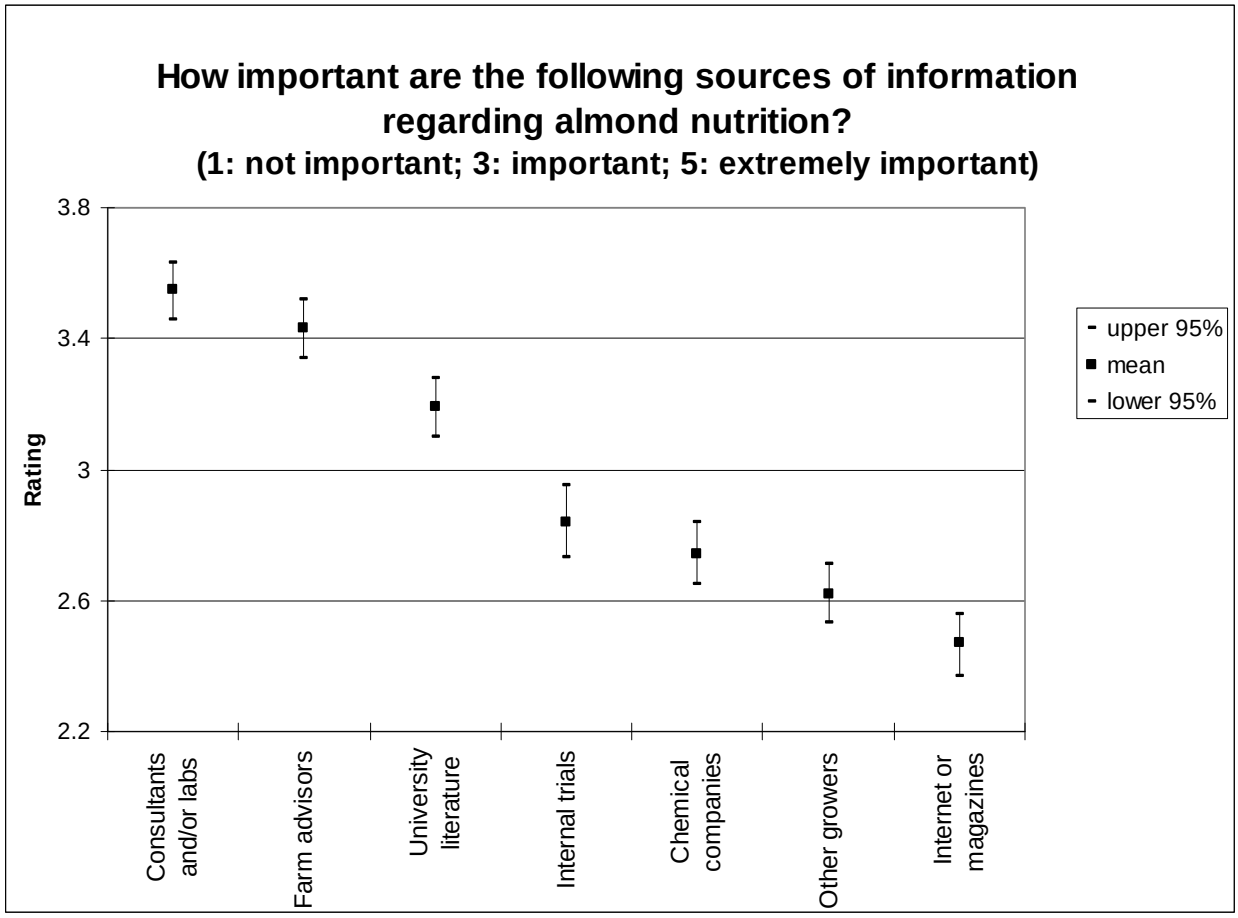


61% of respondents (318 Almond growers) reported that they are satisfied with their current nutrition program, 32% (168 growers) reported that they are somewhat satisfied, and 4% (19 growers) reported that they were not satisfied. When asked why they were not satisfied or were only somewhat satisfied with their current nutrition programs, Almond growers reported that they couldn't afford to spend more money on their program (34%), that they didn't believe the available nutrition information is adequate (32%), and/or that they didn't know how to improve their program (28%).

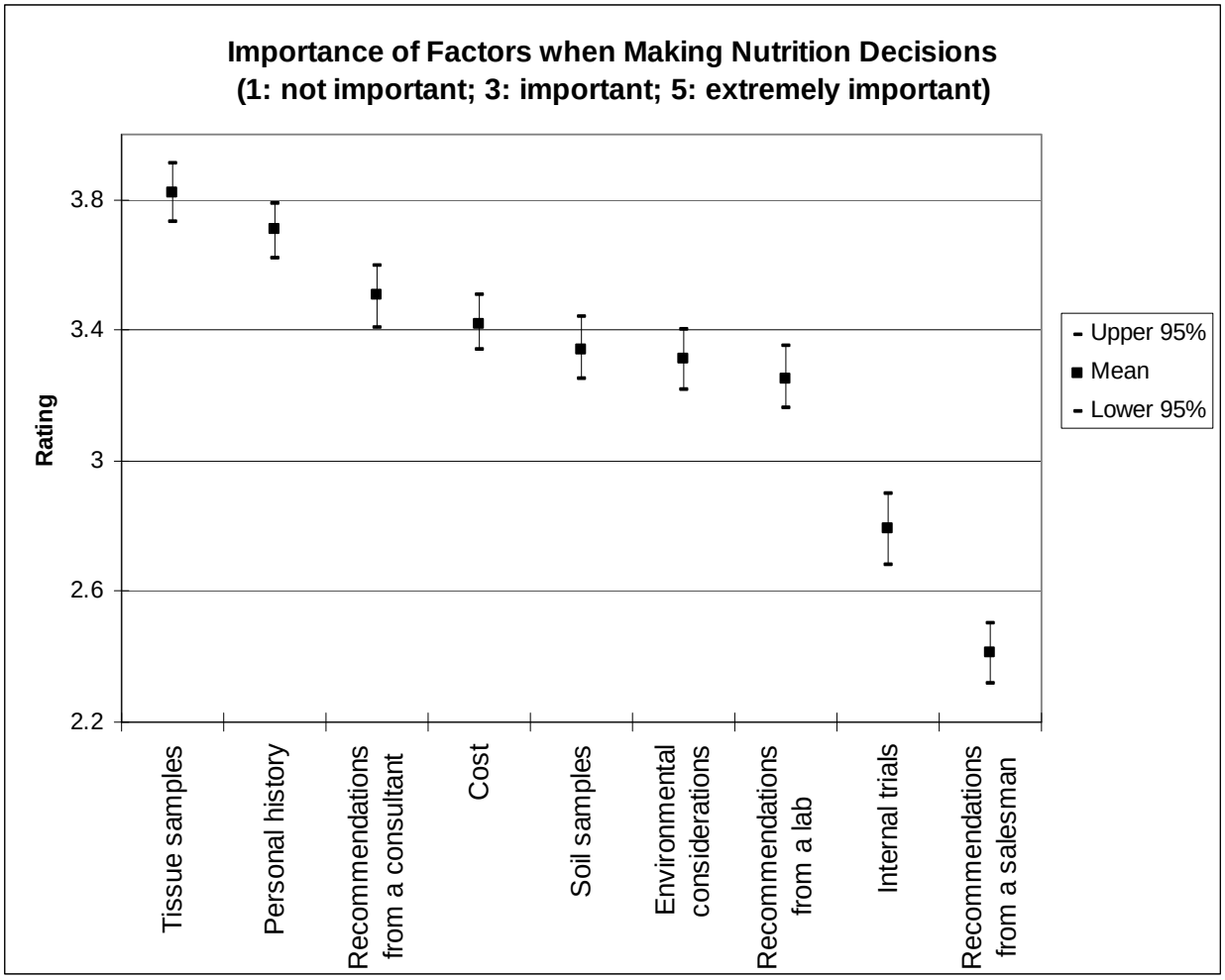




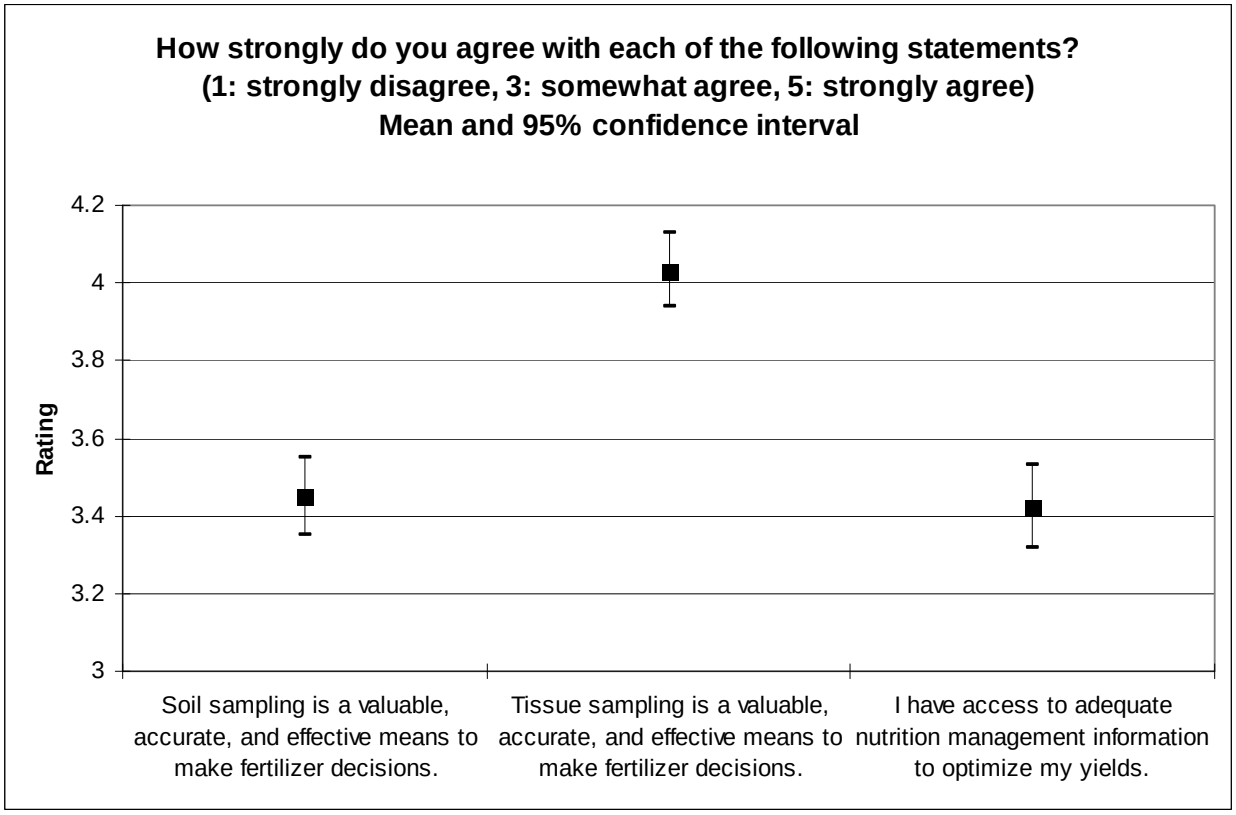
Respondents rated chemical consultants and/or labs as their most important source of information regarding Almond nutrition (mean score=3.55/5), followed by farm advisors (3.43/5) and university literature (3.19/5).



Respondents rated tissue samples as the most important factor when making Almond nutrition decisions (mean score=3.82/5), followed by personal history (3.71/5), recommendations from a consultant (3.51/5), cost (3.42/5), soil samples (3.34/5), environmental considerations (3.31/5), and recommendations from a lab (3.25/5).

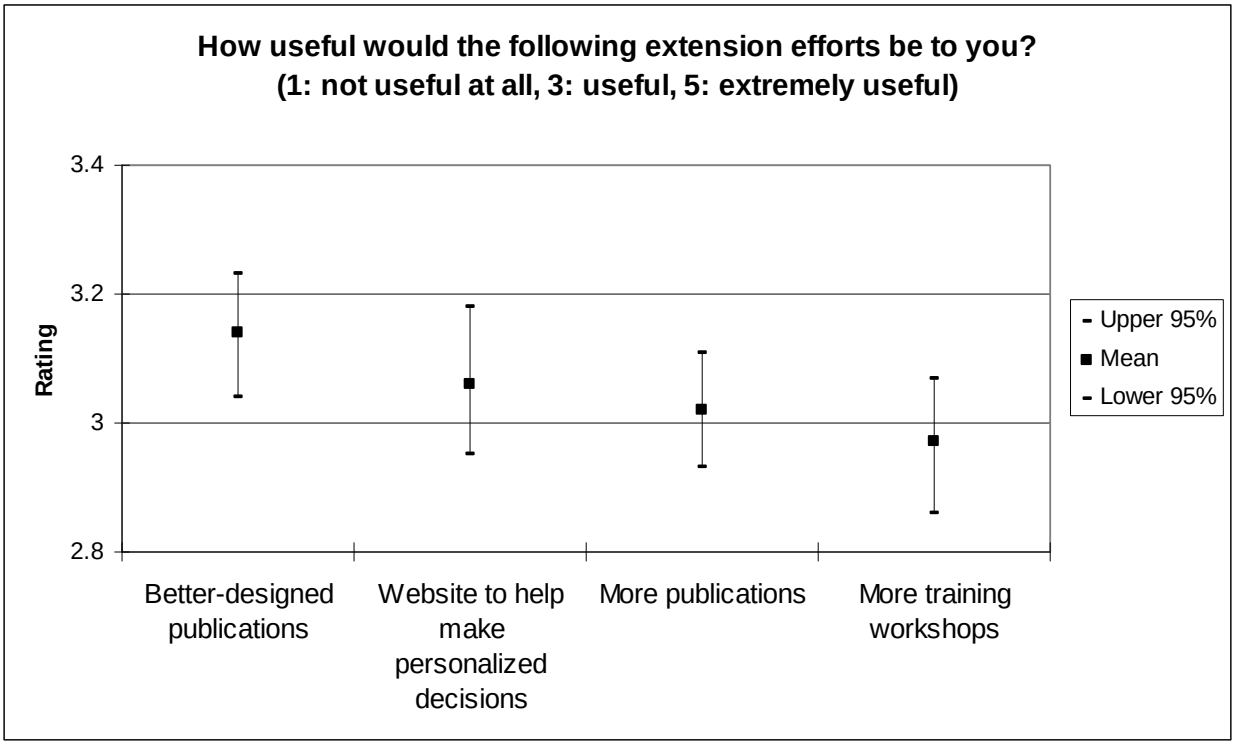


Almond growers most strongly agreed with the statement “tissue sampling is a valuable, accurate, and effective means to make fertilizer decisions” (mean score=4.03/5), followed by the statements “soil sampling is a valuable, accurate, and effective means to make fertilizer decisions” (3.45/5) and “I have access to adequate nutrition management information to optimize my yields (3.42/5).

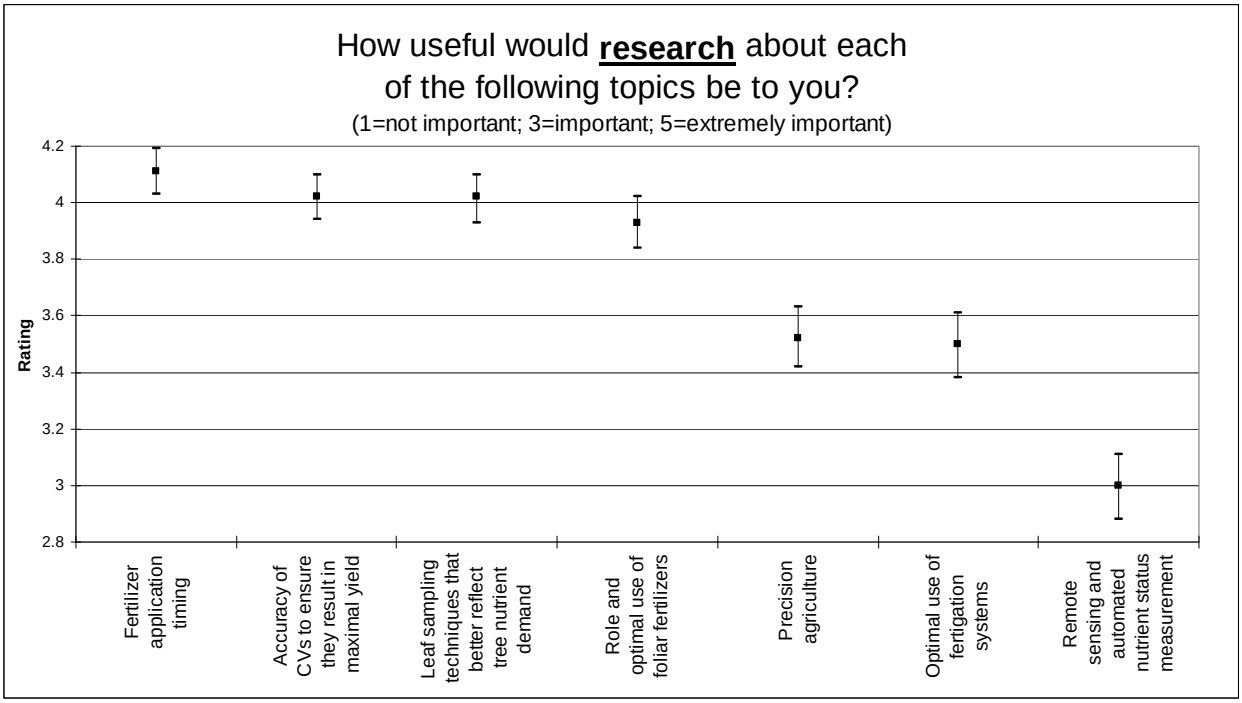


Topic 4: Priorities in Education and Research Relating to Plant Nutrition, ALMOND

Almond growers reported that better-designed publications, a website to help make personalized decisions, more publications, and more training workshops would all be of approximately equal use to them in the future.



Respondents identified research about fertilizer application timing for Almond as being very useful to them (mean score=4.11/5), along with research about the relationship between nutrition and disease (4.03/5), the accuracy of critical values to ensure they result in maximal yield (4.02/5), leaf sampling techniques that better reflect tree nutrient demand (4.02/5), and tissue sampling techniques and timings that provide in-season guidance for fertilizer decisions (3.98/5). Respondents were significantly less interested in research about precision agriculture (3.52/5), the optimal use of fertigation systems (3.50/5), the effectiveness of non-fertilizer foliar and soil products (3.19/5), and remote sensing and automated nutrient status measurement (3.00/5). Only selected categories are displayed in the following graph.

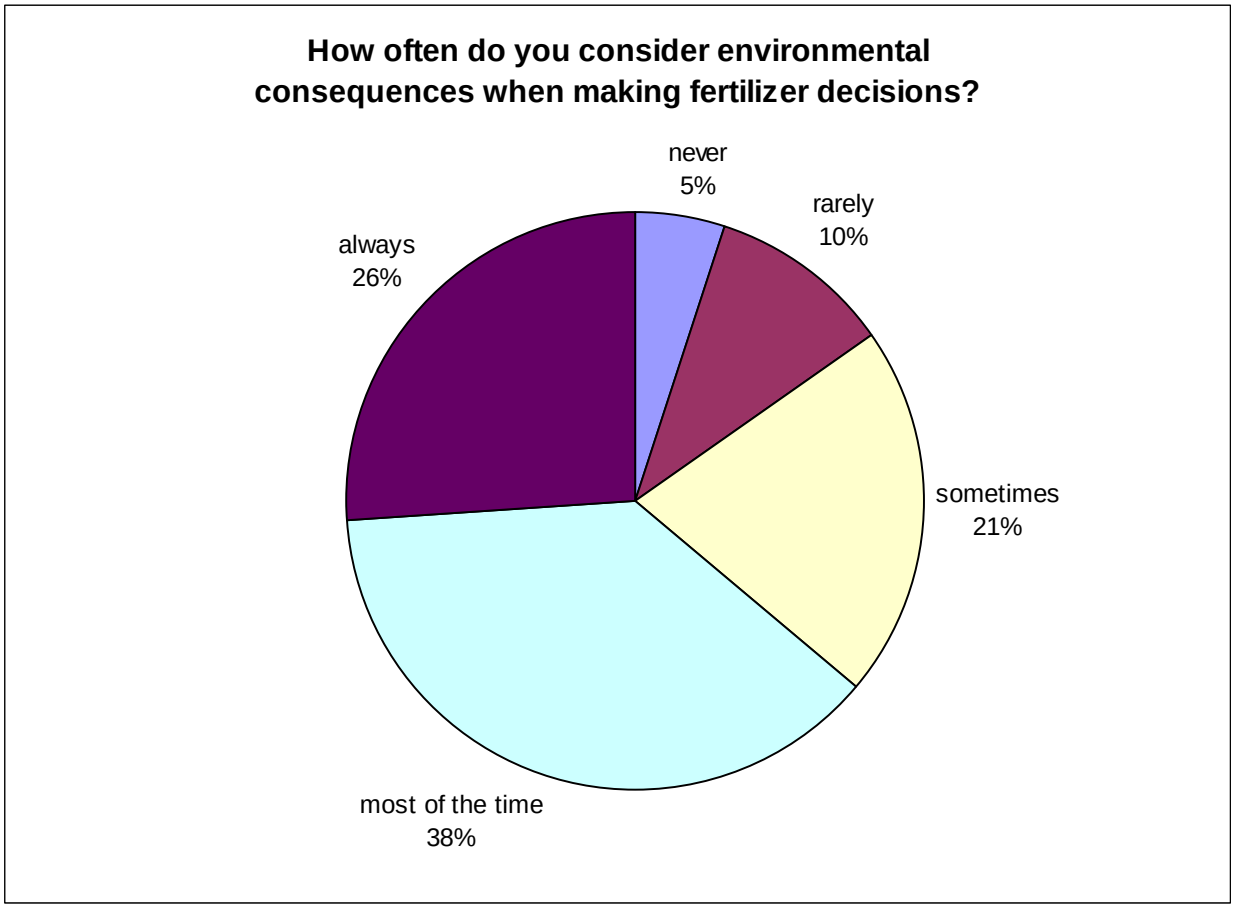


Usefulness of Research Topics to Almond growers (mean score out of possible 5 points)

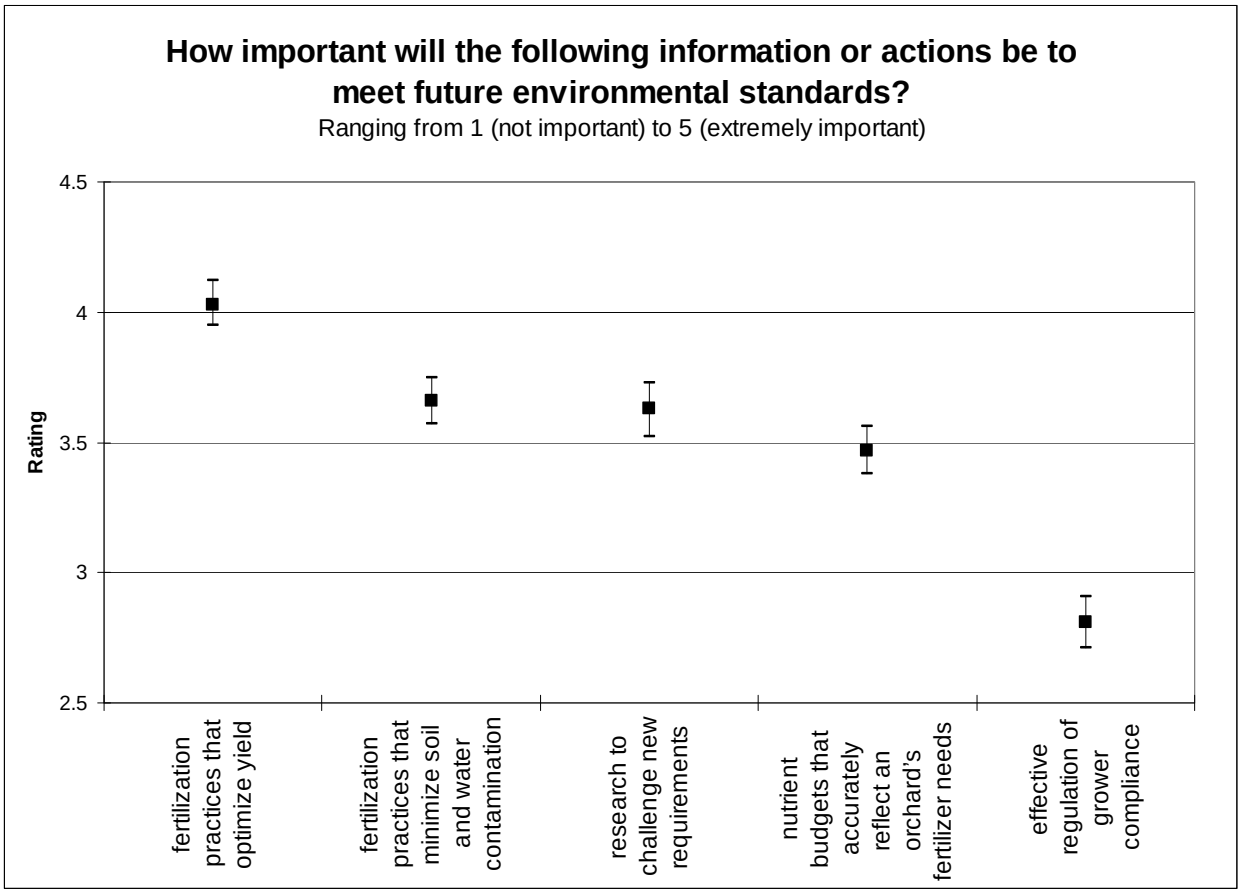
	Mean
Fertilizer application timing	4.11
Relationship between nutrition and disease	4.03
Accuracy of CVs to ensure they result in maximal yield	4.02
Leaf sampling techniques that better reflect tree nutrient demand	4.02
Tissue sampling techniques and timings that provide in-season guidance for fertilizer decisions	3.98
Role and optimal use of foliar fertilizers	3.93
Relationship between fertilization and irrigation	3.88
Nutrition management in problem soils	3.85
Interactions between nutrients	3.8
Fertilization practices to optimize orchard establishment	3.76
Precision agriculture	3.52
Optimal use of fertigation systems	3.5
Effectiveness of non-fertilizer foliar and soil products	3.19
Remote sensing and automated nutrient status measurement	3

Topic 5: Expected Consequences of Environmental Regulations to the ALMOND Industry

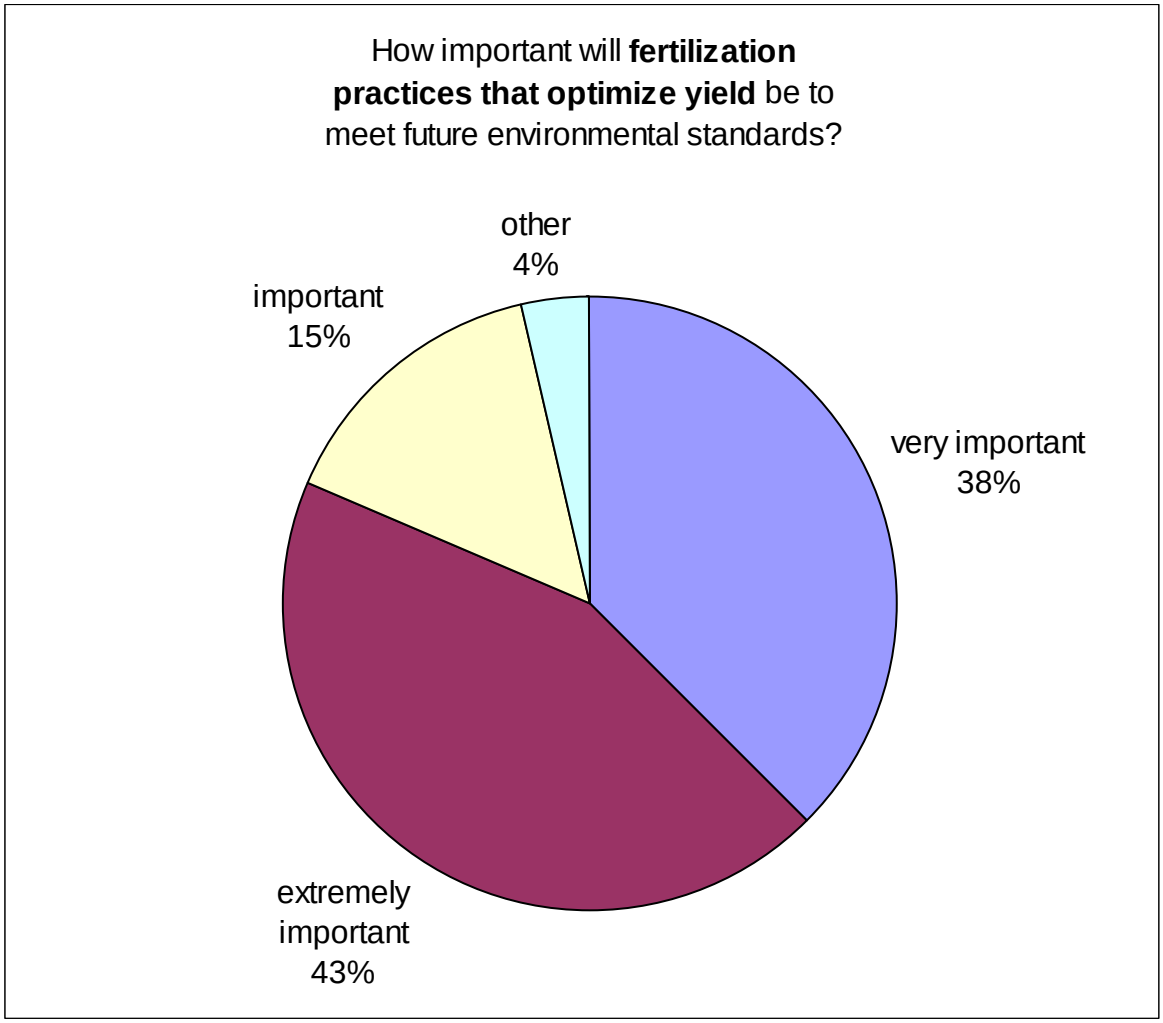
26% of respondents (130 Almond growers) reported that they always consider environmental consequences when making fertilizer decisions, 38% (190 growers) reported that they consider environmental consequences most of the time), 21% (104 growers) consider them sometimes, 10% (51 growers) rarely consider them, and 5% (25 growers) never consider them.



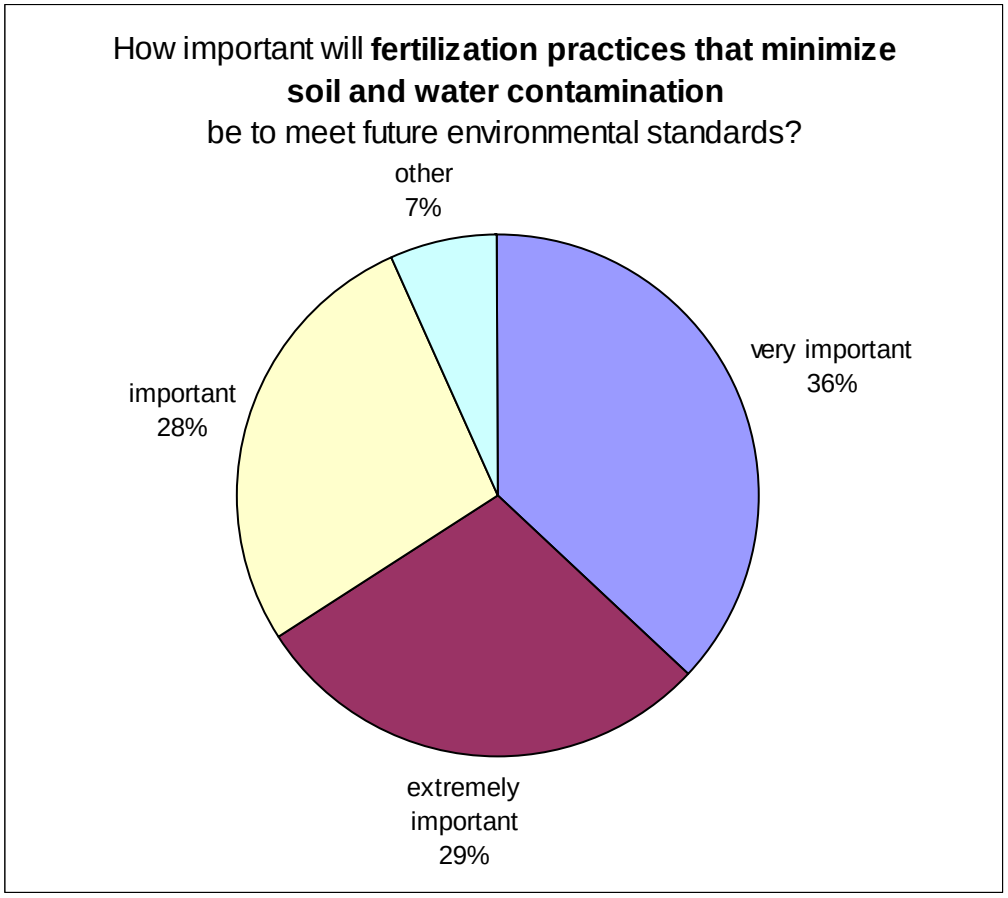
Almond growers reported that identifying fertilization practices that optimize yield will be of the most importance to them (4.03/5) in order to meet future environmental standards, followed by identifying fertilization practices that minimize soil and water contamination (3.66/5), performing research to challenge new requirements (3.63/5), and creating nutrient budgets that accurately reflect an orchard's fertilizer needs (3.47/5). Growers identify the effective regulation of grower compliance as being comparatively less important (2.81/5) to them in order to meet future environmental standards.



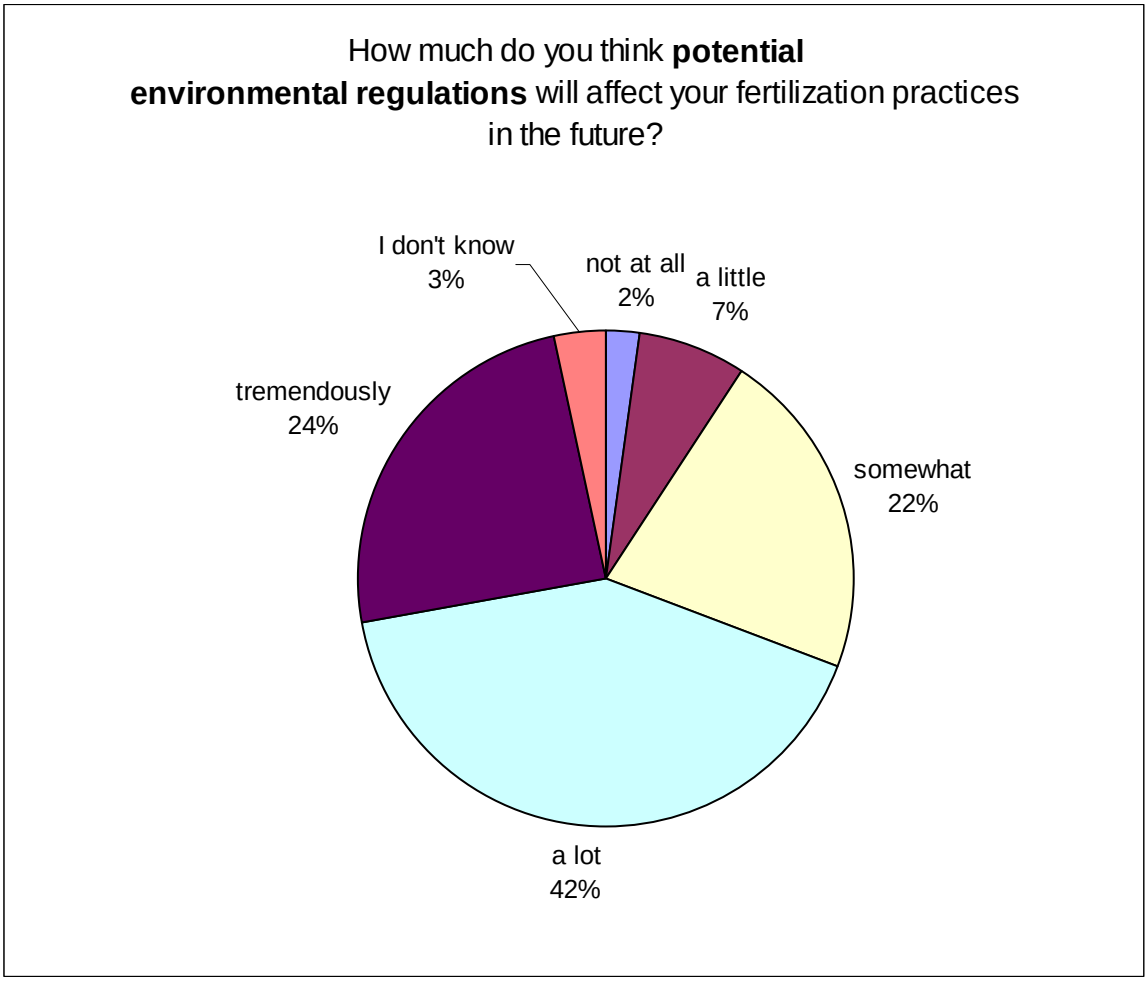
43% of respondents (218 Almond growers) reported that identifying fertilization practices that optimize yield will be extremely important to meeting future environmental standards, 38% (187 growers) reported that they will be very important, 15% (75 growers) reported that they will be important, 2% (11 growers) reported that they will be somewhat important, and <1% (3 growers) think they will not be important.



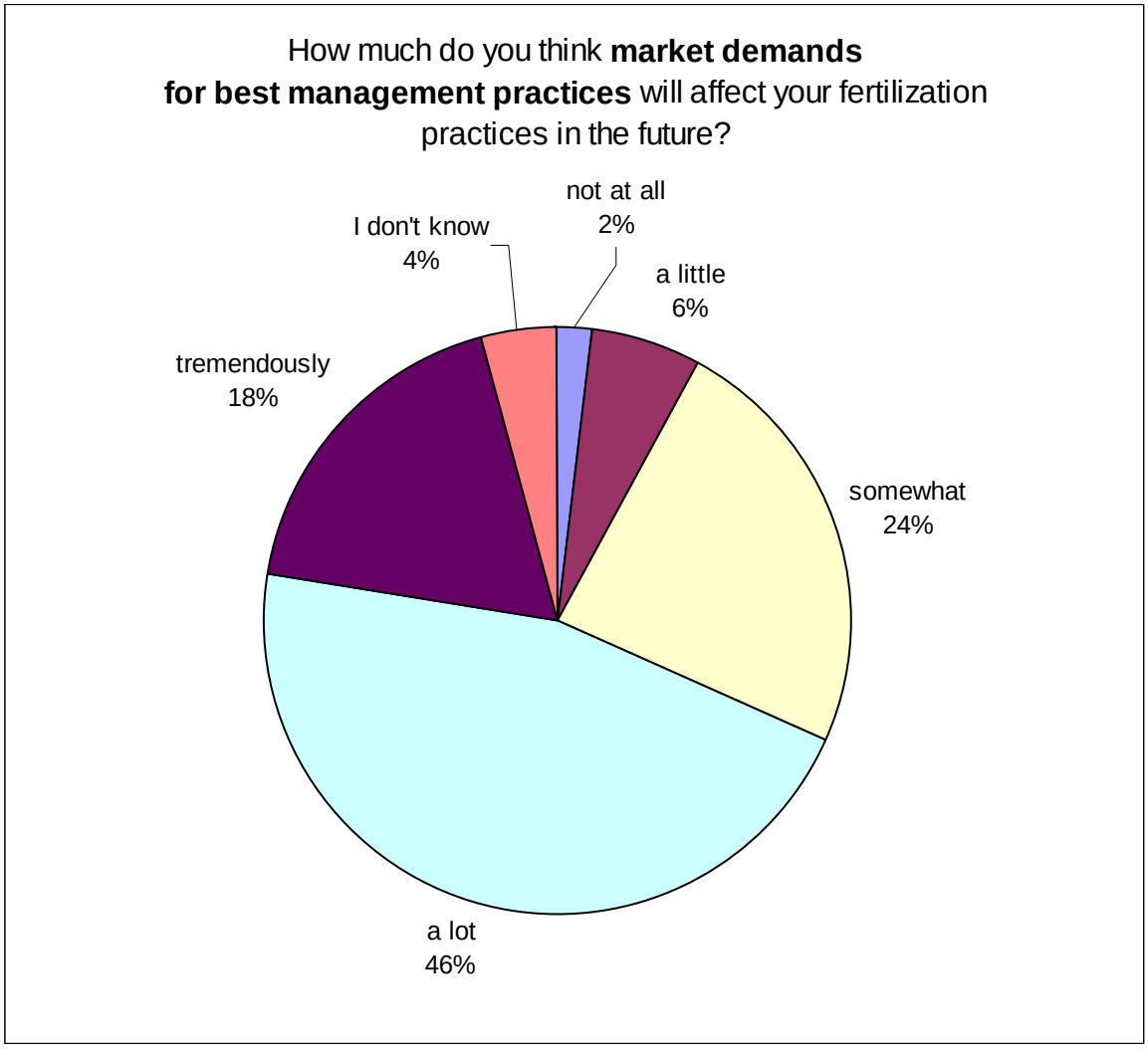
29% of respondents (144 Almond growers) reported that identifying fertilization practices that minimize soil and water contamination will be extremely important to meeting future environmental standards, 36% (185 growers) reported that it will be very important, 28% (138 growers) reported that it will be important, 4% (22 growers) reported that it will be somewhat important, and 1% (6 growers) reported that it will not be important.



24% of respondents (121 Almond growers) think that potential environmental regulations will affect their fertilization practices tremendously in the future, 42% (206 growers) think they will affect their practices a lot, 22% (108 growers) think they will affect their practices somewhat, 7% (35 growers) think they will affect their practices a little, and only 2% (11 growers) think they will not affect their future practices.



18% of respondents (91 Almond growers) think that market demands for best management practices will affect their fertilization practices tremendously in the future, 46% (228 growers) think they will affect them a lot, 24% (117 growers) think they will affect them somewhat, 6% (30 growers) think they will affect them a little, and only 2% (10 growers) think they will not affect them at all.

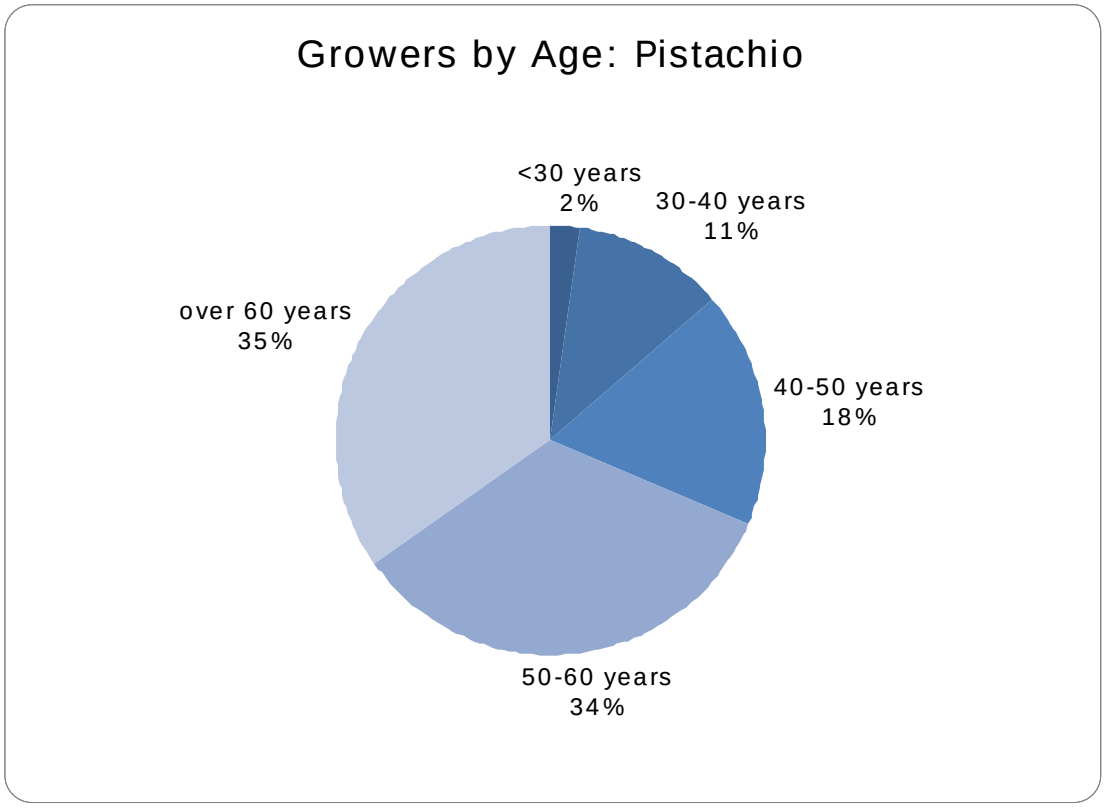


There was no significant difference in the overall means of Almond growers' concerns about the effects of potential environmental regulations (mean rating=3.53/5) and the effects of market demands for best management practices (3.51/5) on their future fertilization practices.

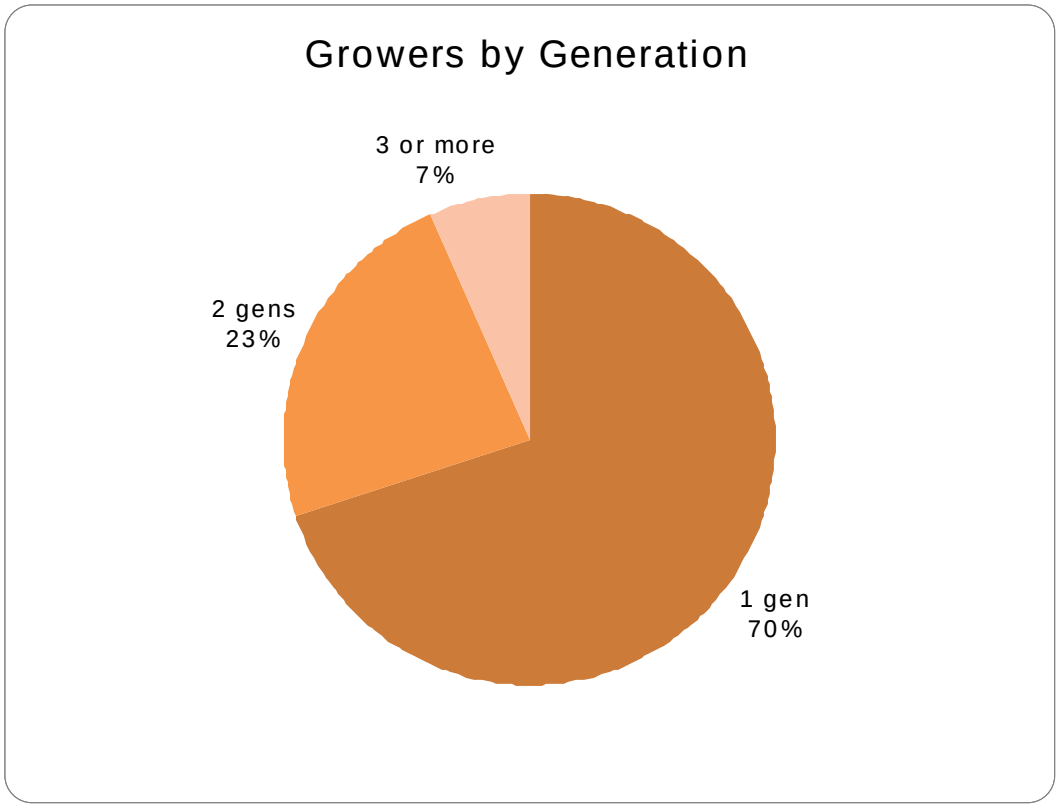
PISTACHIO

Topic 1: Grower Demographic Data, PISTACHIO

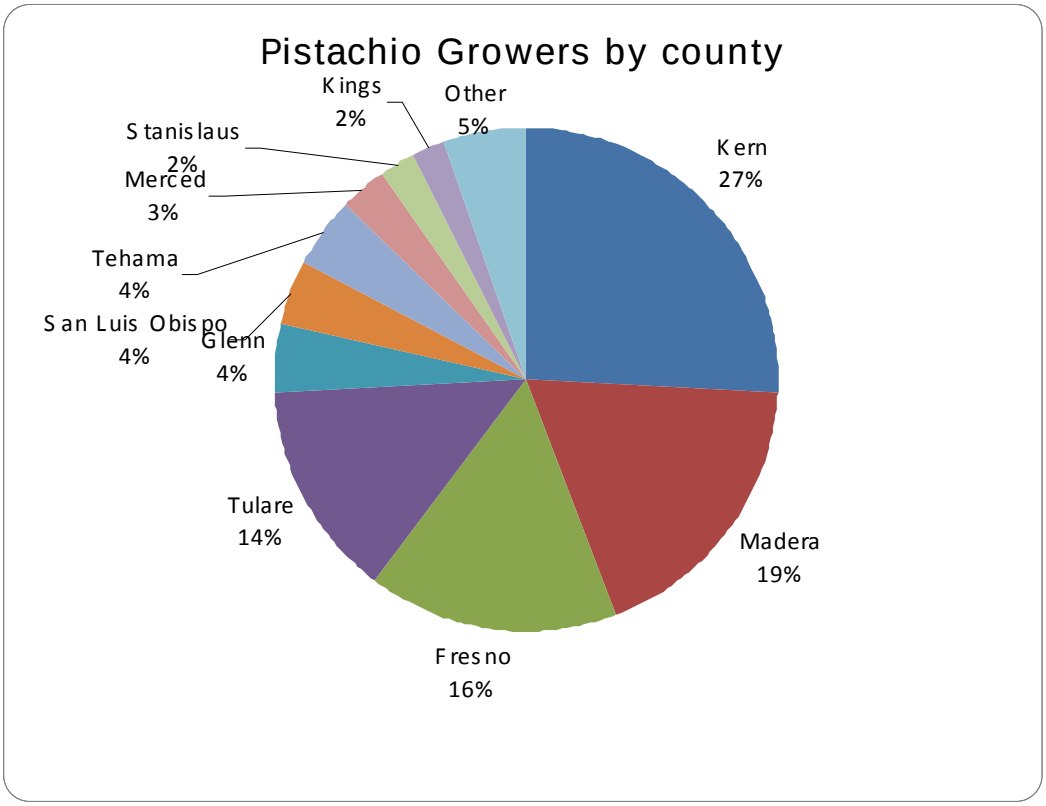
Data was collected relating to growers' demographics. 2% of respondents (2 growers) were under 30 years of age, 11% (10 growers) were 30-40 years old, 18% (16 growers) were 40-50 years old, 34% (30 growers) were 50-60 years old, and 35% (31 growers) were over 60 years old.



70% of respondents (63 growers) are first-generation growers, 23% (21 growers) are in families that have grown Pistachios for two generations, and 7% (6 growers) are in families that have grown Pistachios for three or more generations.



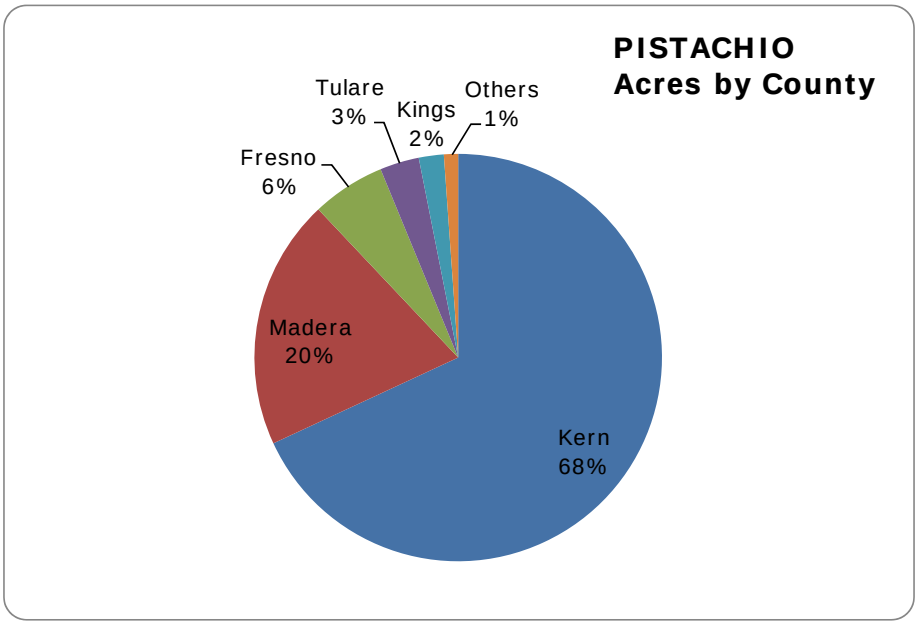
Growers were asked to report the primary county in which they grow Pistachios. Most respondents grow Pistachios primarily in Kern County (27%, 24 growers), Madera County (19%, 17 growers), Fresno County (16%, 15 growers), and Tulare County (14%, 13 growers).



Pistachio Growers by County

county	# growers	%
Butte	1	0.01
Colusa	0	0.00
Fresno	15	0.16
Glenn	4	0.04
Kern	24	0.26
Madera	17	0.18
Merced	3	0.03
San Joaquin	1	0.01
Stanislaus	2	0.02
Tulare	13	0.14
Yolo	1	0.01
San Luis Obispo	4	0.04
Sutter	1	0.01
Kings	2	0.02
Contra costa	1	0.01
Tehama	4	0.04
Total	93	

By acreage, respondents grow Pistachios primarily in Kern County (68%, 48,198 acres). These overall results do not include 2 growers, who reported to have 1,200 acres in Fresno and Madera, and 500 acres in Madera and Merced, respectively, because the acreage could not be increased to a single county for analysis. These two respondents increase the total surveyed acres to 72,496.75.



Pistachio Acres by County

county	# acres	%
Kern	48197.5	0.68
Madera	14077	0.20
Fresno	4118.75	0.06
Tulare	2208	0.03
Kings	1400	0.02
San Luis Obispo	285.5	0.00
Glenn	172	0.00
Tehama	97	0.00
Stanilaus	48	0.00
Butte	40	0.00
Contra costa	40	0.00
Merced	36	0.00
Sutter	30	0.00
Yolo	30	0.00
San Joaquin	17	0.00
Total	70796.75	

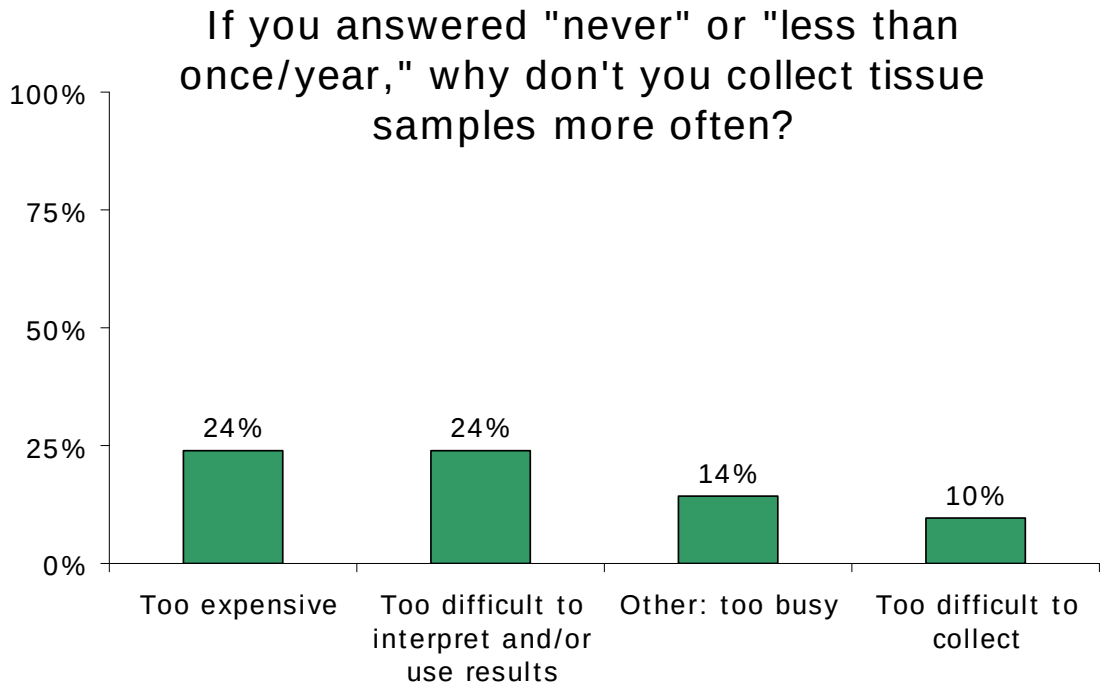
* Total surveyed acres = 72,496.75.

Topic 2: Fertilization Use Practices, PISTACHIO

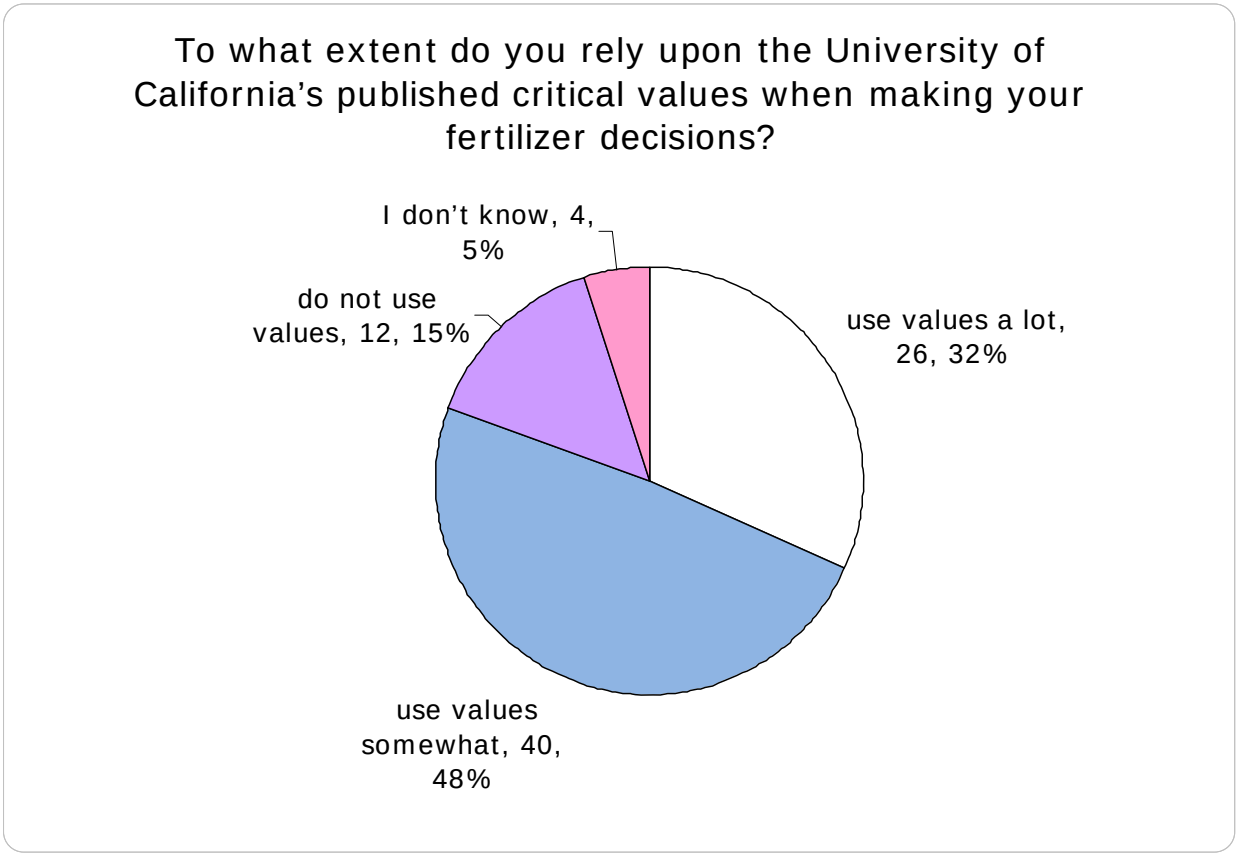
89% of respondents (81 Pistachio growers) collect tissue samples at least once per year. Growers who collect tissue samples less than once per year cited expense (5 Pistachio growers) and difficulty in interpreting results (5 Pistachio growers) as major reasons why they do not collect tissue samples more often.

Frequency with which Pistachio growers collect plant tissue samples.

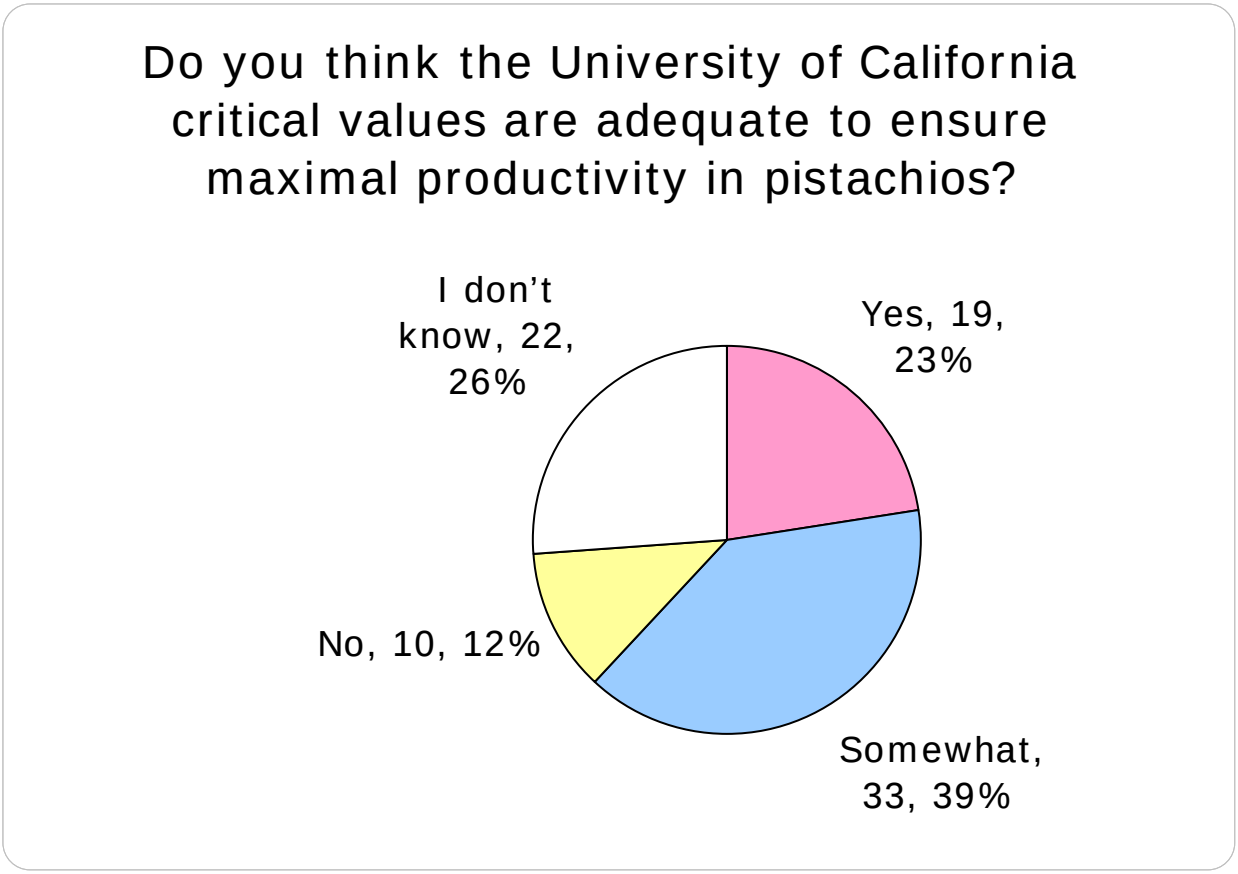
	#	%
Never	9	0.10
Less than once/year	4	0.04
Once/year	48	0.53
More than once/year	23	0.25
When problems detected	6	0.07
I don't know	1	0.01
Total	91	



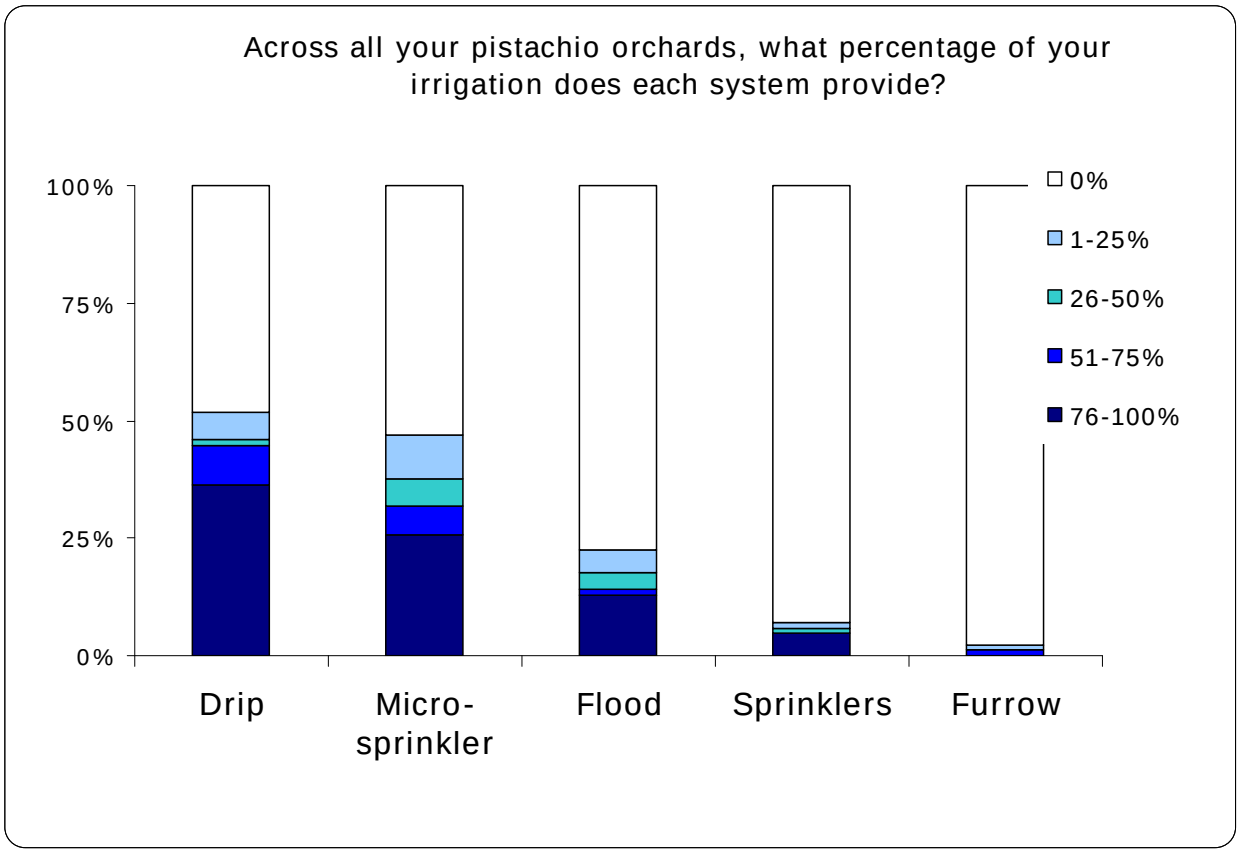
32% of respondents (26 growers) rely on the UC critical values for Pistachio a lot, 48% (40 growers) rely on the values somewhat, and 15% (12 growers) do not use the values.



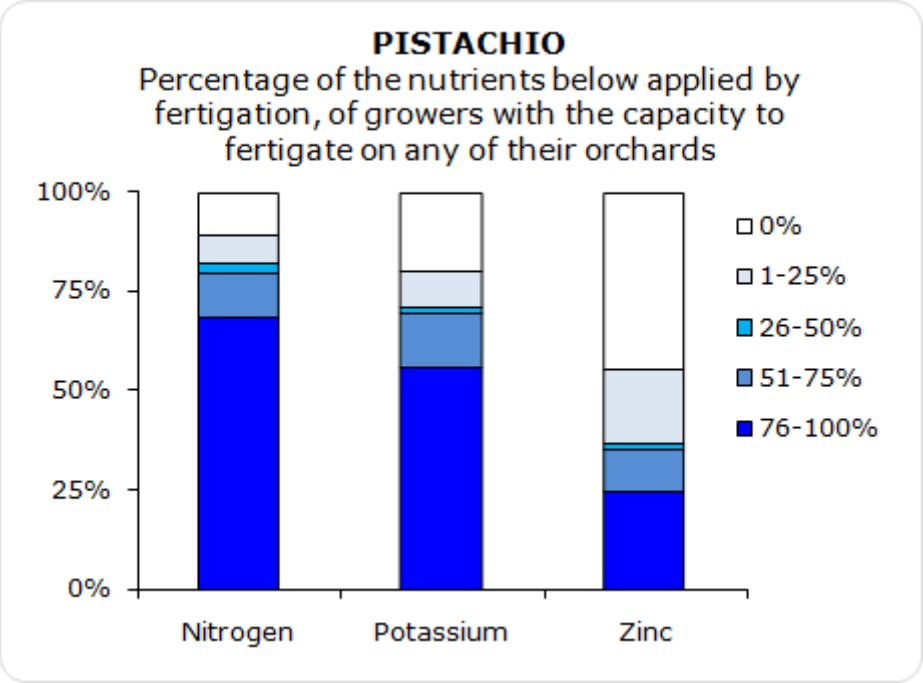
23% of respondents (19 Pistachio growers) think the UC critical values are adequate to ensure maximal productivity in Pistachios, 39% (33 growers) think they are somewhat adequate, 12% (10 growers) think they are not adequate, and 26% (22 growers) do not know whether they are adequate.



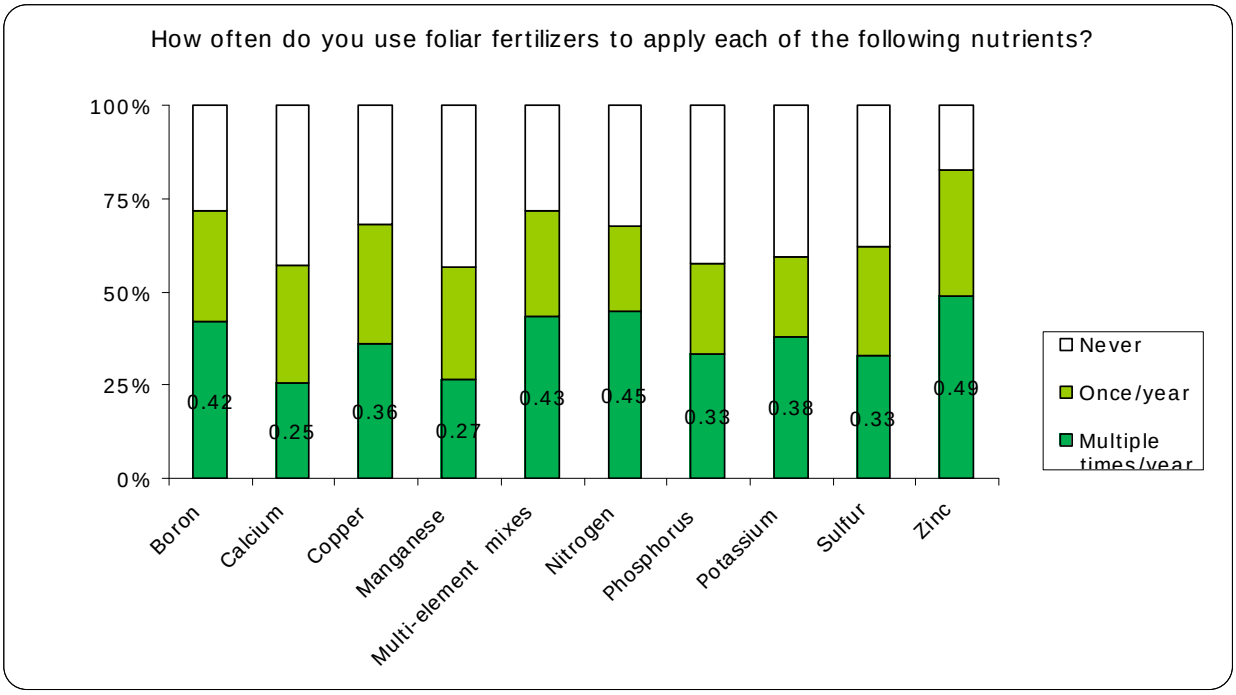
Pistachio growers reported the proportion of irrigation delivered by drip, microsprinklers, flood, solid set sprinklers, and furrow irrigation as is displayed below.



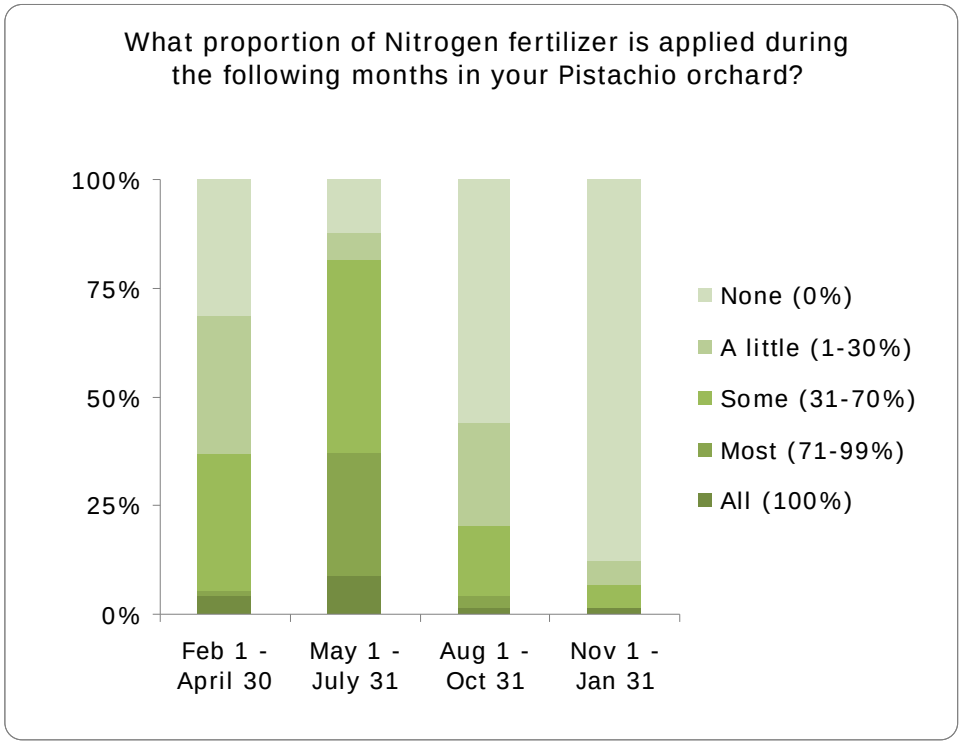
92% of the respondents (73 growers) would be able to fertigate, since they reported having drip, microsprinkler and/or sprinkler irrigation in their orchards. Of them, 89% of respondents (65 growers) use fertigation to apply at least some of their nitrogen fertilizer, 73% (53 growers) use fertigation to apply at least some potassium, and 49% (36 growers) use fertigation to apply at least some zinc fertilizer. Pistachio growers who answered "I don't know" or left that portion of the question blank have been excluded from analysis.



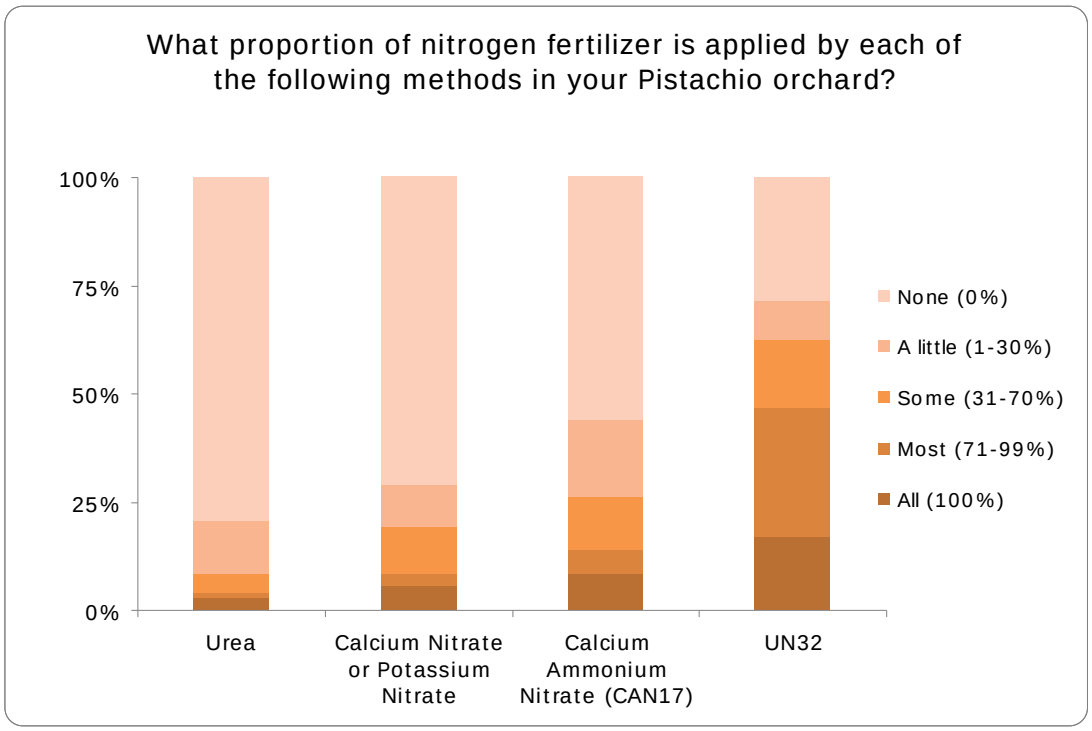
Excluding Pistachio growers who answered “I don’t know” or left the question blank, most Pistachio growers apply boron, calcium, copper, manganese, multi-element mixes, nitrogen, phosphorus, potassium, sulfur, and/or zinc foliarly at least once per year.



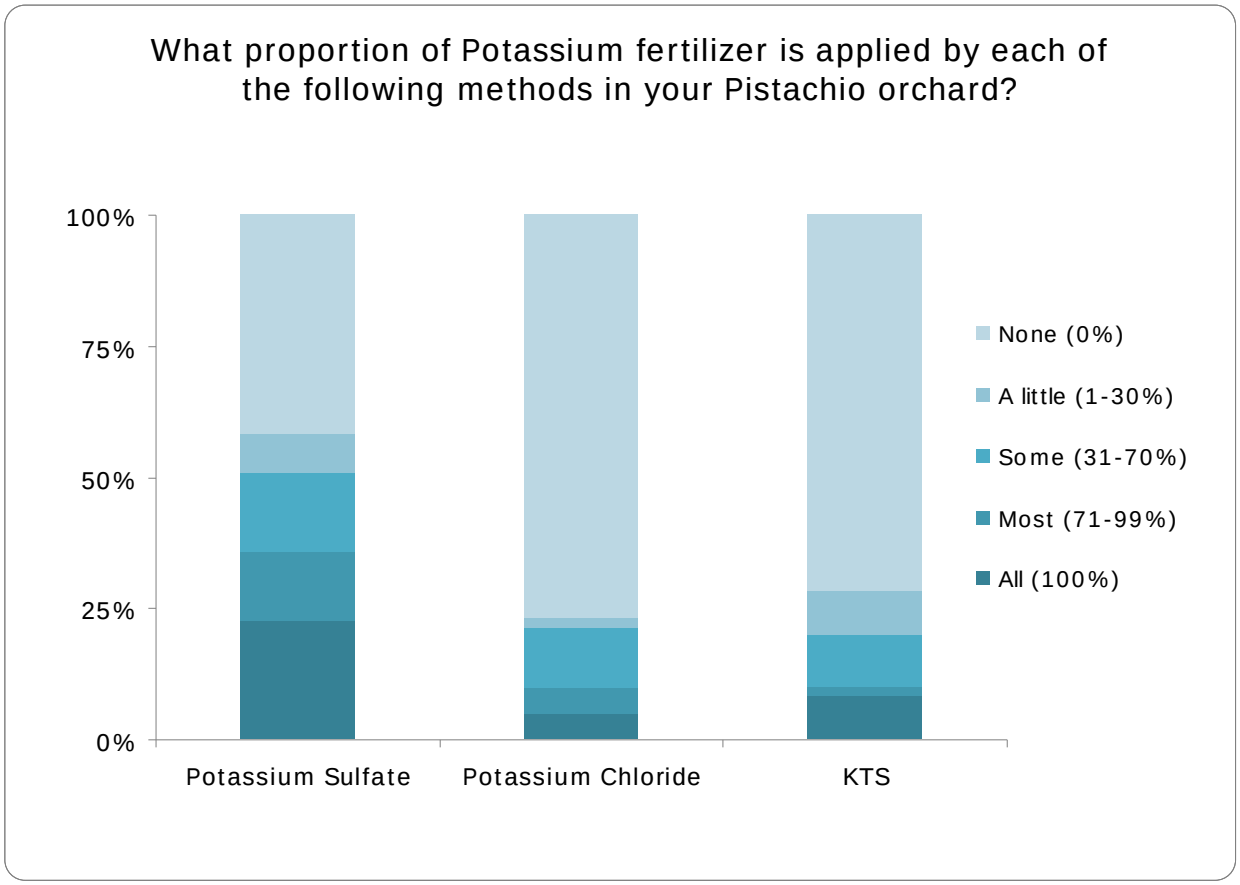
Pistachio growers apply much of their nitrogen fertilizer in Summer (May through July), and they apply the least nitrogen during the Winter (November through January). Many growers apply nitrogen fertilizer in more than one season.



Pistachio growers apply much of their nitrogen in the form of UN32, followed by calcium ammonium nitrate, calcium nitrate or potassium nitrate, and urea.

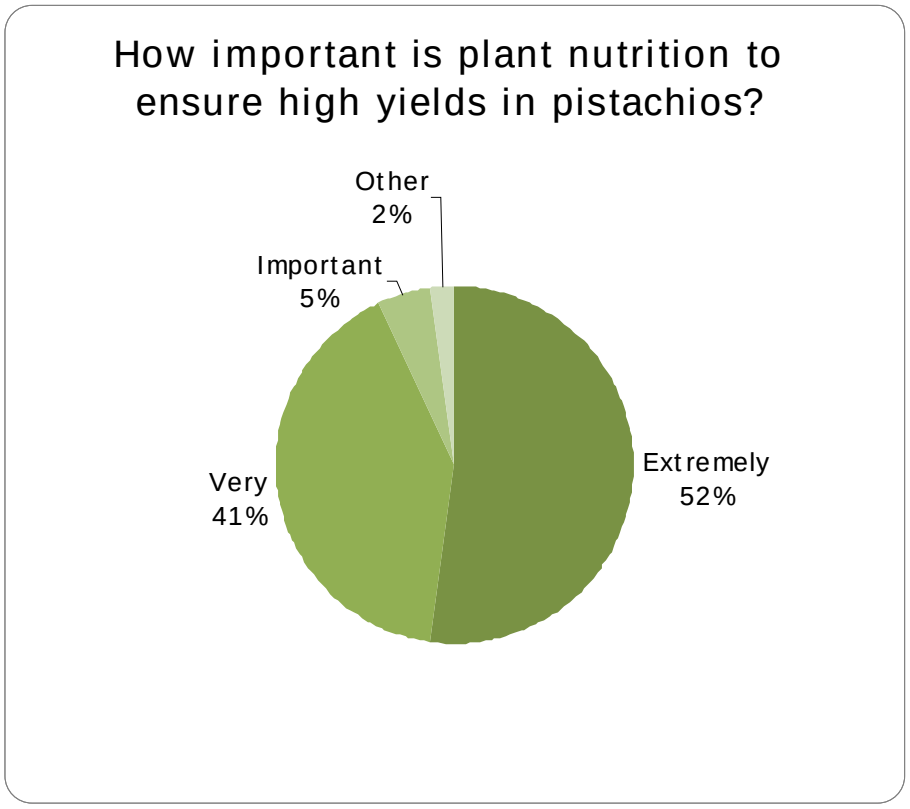


Pistachio growers apply most of their potassium as K sulfate.

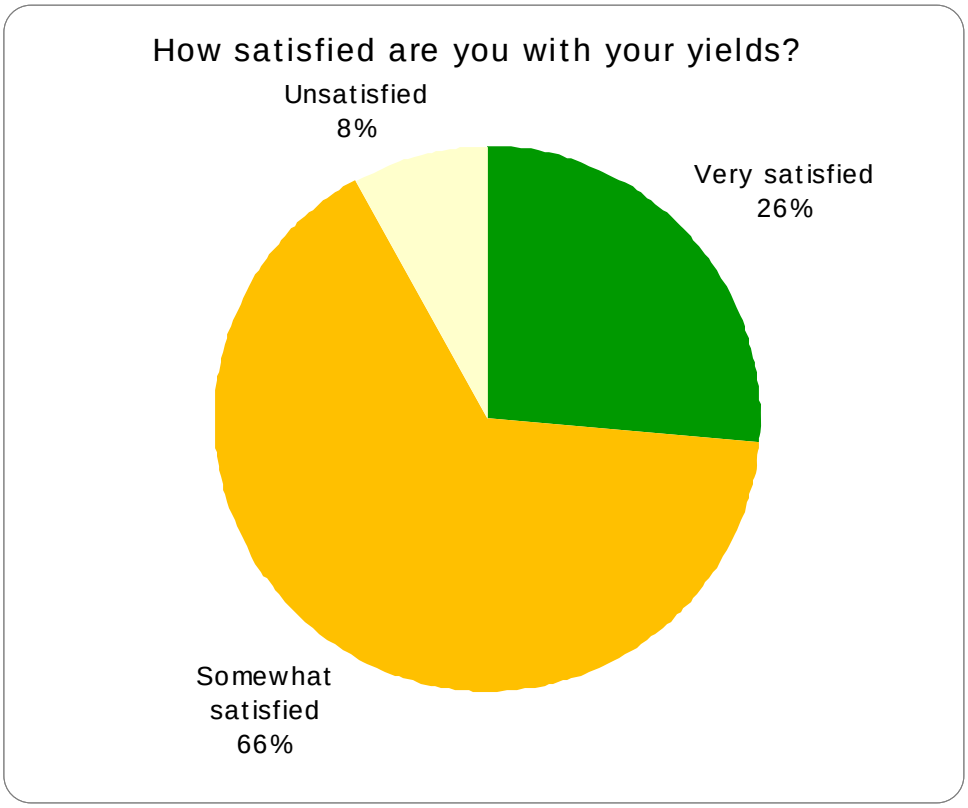


Topic 3: Factors Affecting Nutrition Decisions, PISTACHIO

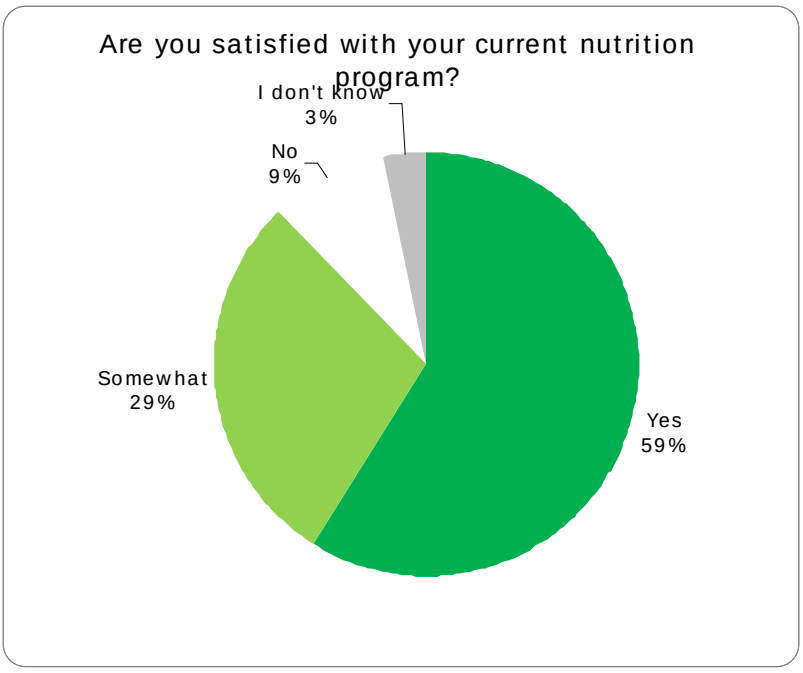
52% of respondents (46 Pistachio growers) reported that they think plant nutrition is extremely important to ensure high yields in Pistachio, 41% (36 growers) reported that they think it is very important, 5% (4 growers) reported that they think it is important, and 1% (1 growers) reported that they think it is somewhat important.

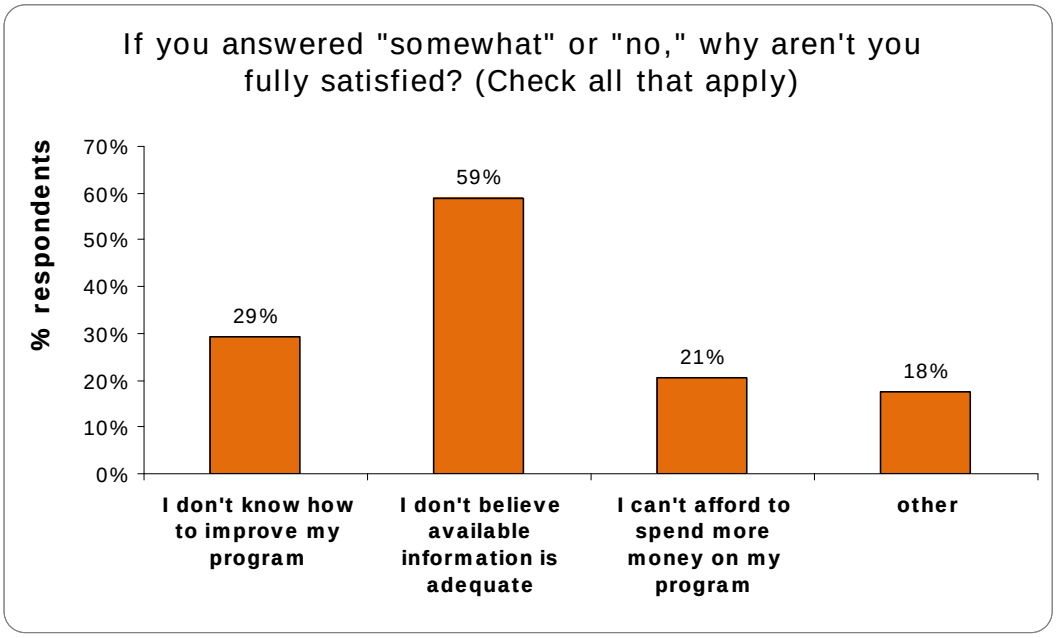


26% of respondents (23 Pistachio growers) reported that they were very satisfied with their yields, 66% (57 growers) reported that they were somewhat satisfied with their yields, and 8% (7 growers) reported that they were unsatisfied with their yields.

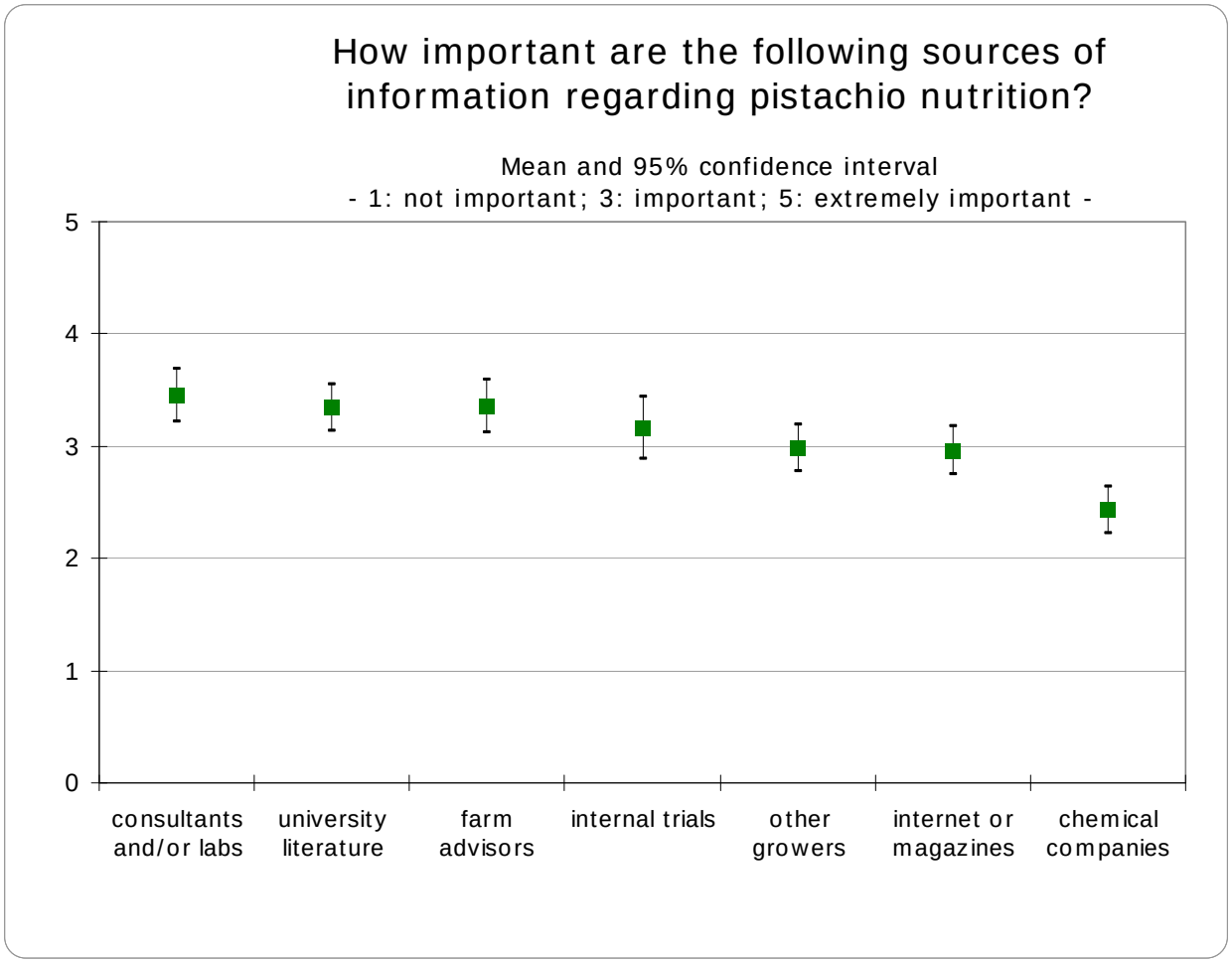


59% of respondents (53 Pistachio growers) reported that they are satisfied with their current nutrition program, 29% (26 growers) reported that they are somewhat satisfied, and 9% (8 growers) reported that they were not satisfied. When asked why they were not satisfied or were only somewhat satisfied with their current nutrition programs, Pistachio growers reported that they don't believe the available nutrition information is adequate (59%), they don't know how to improve their program (29%), and/or they can't afford to spend more money on their program (21%).

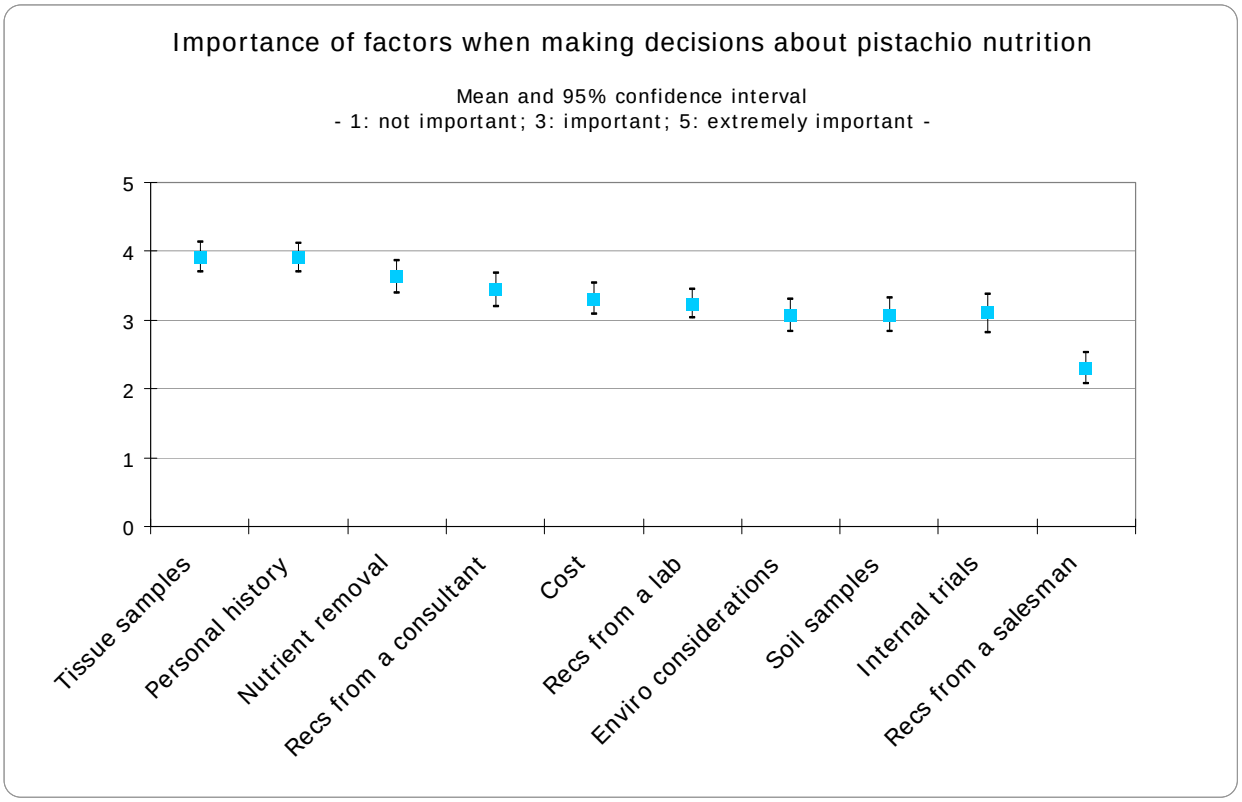




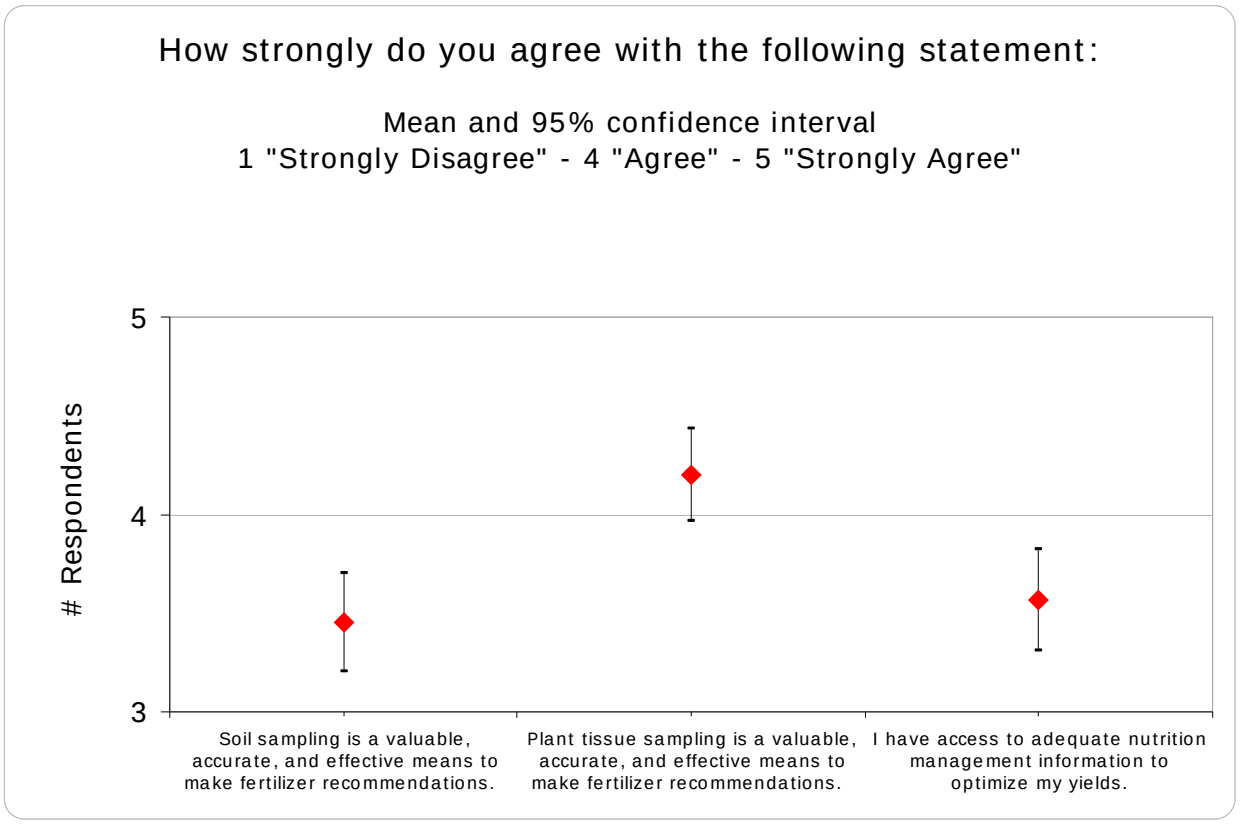
Respondents rated chemical consultants and/or labs (mean score=3.45/5), university literature (3.34/5), farm advisors (3.36/5), and internal trials (3.44/5) as their most important sources of information regarding Pistachio nutrition.



Respondents rated tissue samples (mean score=3.91/5) and personal history (3.91/5) as the most important factors when making Pistachio nutrition decisions, followed by nutrient removal (3.63/5), recommendations from a consultant (3.44/5), cost (3.31/5), and recommendations from a lab (3.24/5).

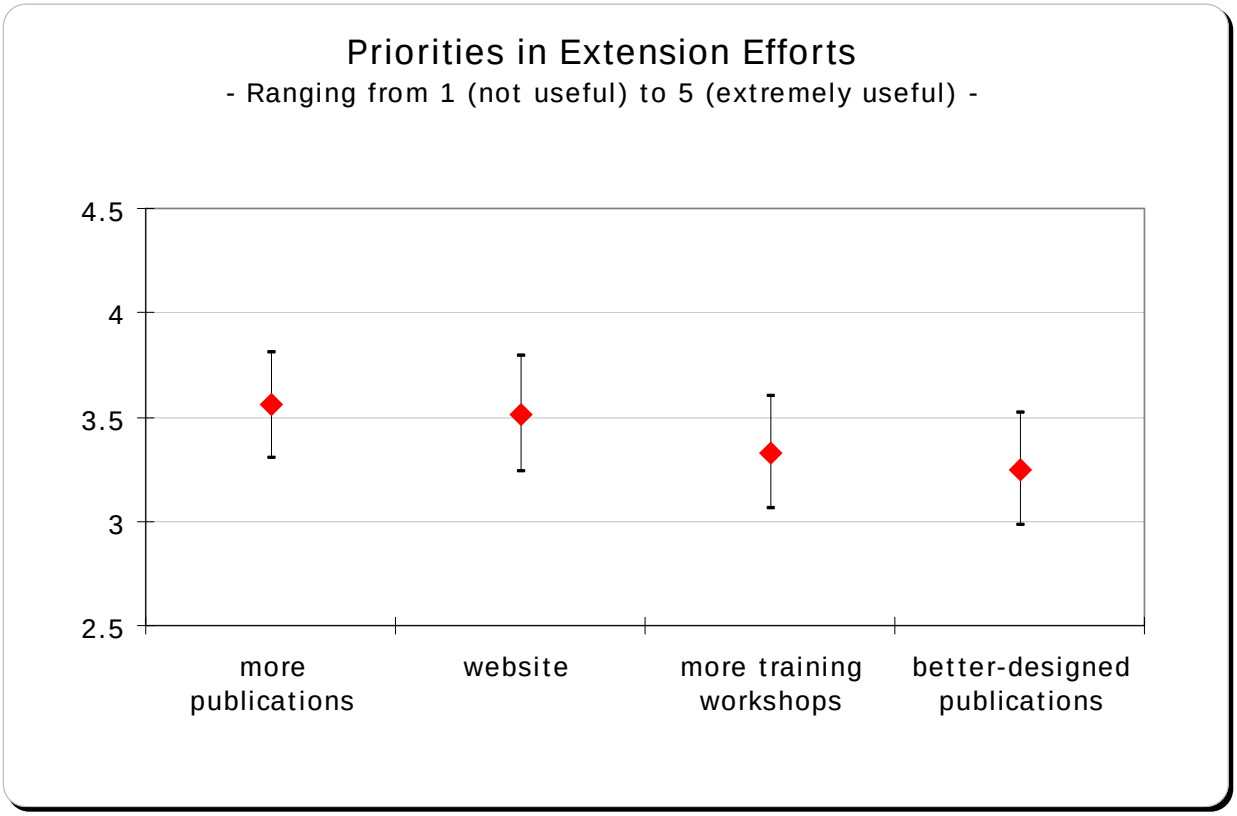


Pistachio growers most strongly agreed with the statement “tissue sampling is a valuable, accurate, and effective means to make fertilizer decisions” (mean score=4.20/5), followed by the statements “I have access to adequate nutrition management information to optimize my yields (3.56/5) and “soil sampling is a valuable, accurate, and effective means to make fertilizer decisions” (3.45/5).

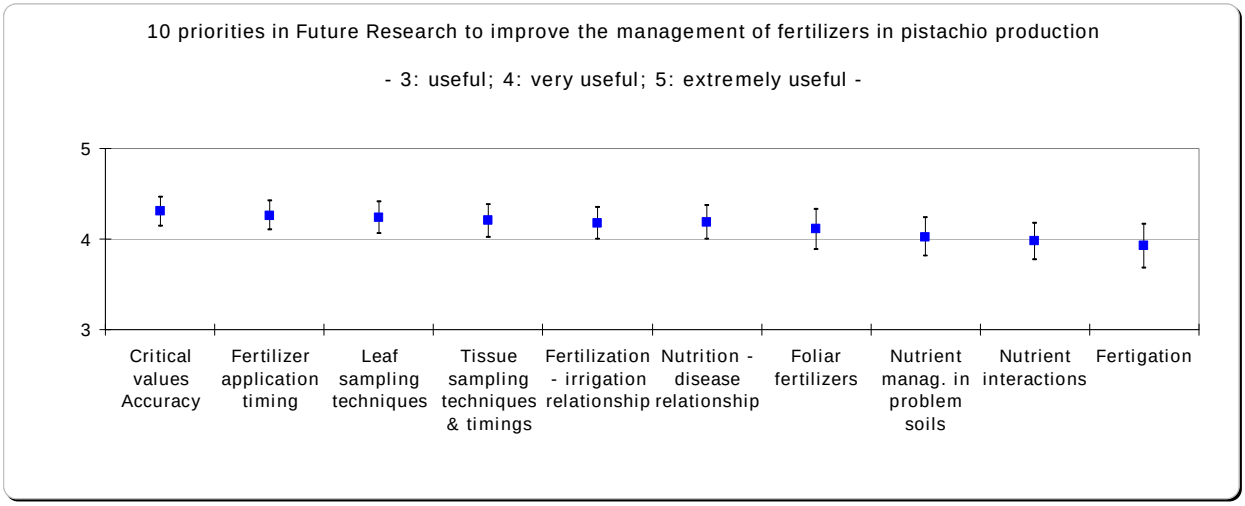


Topic 4: Priorities in Education and Research Relating to Plant Nutrition, PISTACHIO

Pistachio growers reported that more publications, a website to help make personalized decisions, more training workshops, and better-designed publications would all be of approximately equal use to them in the future.



Respondents ranked 10 priorities of future research topics as being of approximately equal use to them.

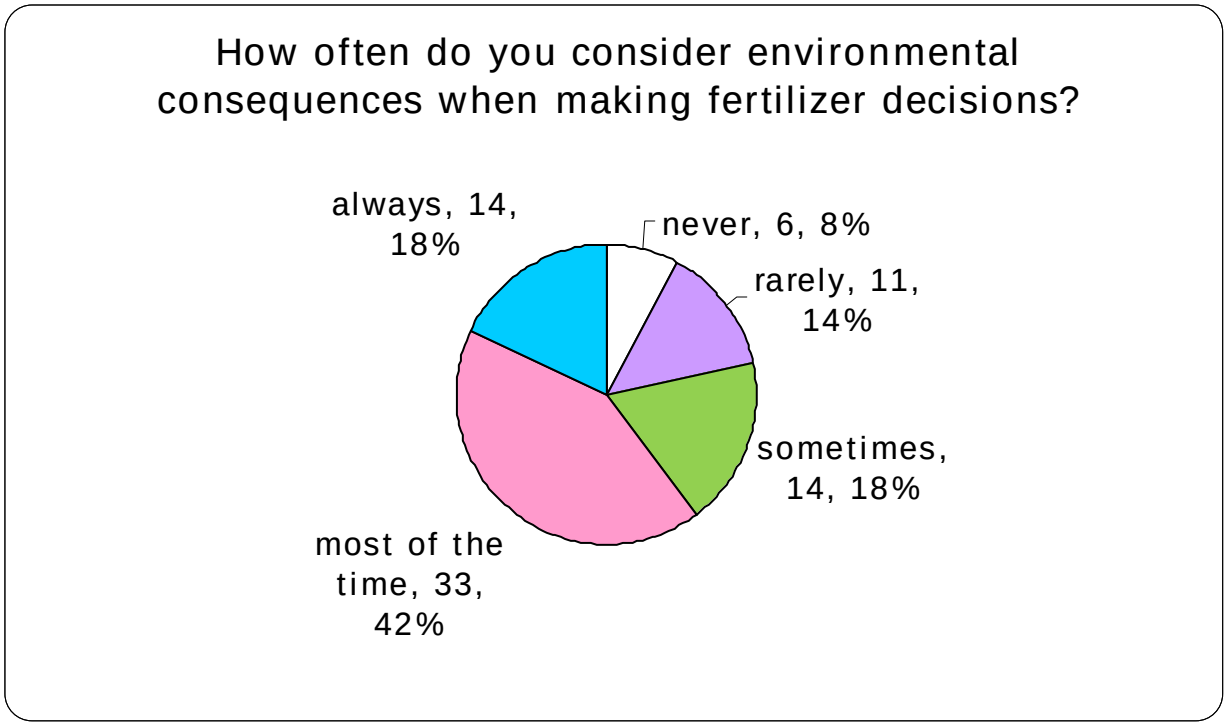


Usefulness of 15 total Research Topics to Pistachio growers (mean score out of possible 5 points)

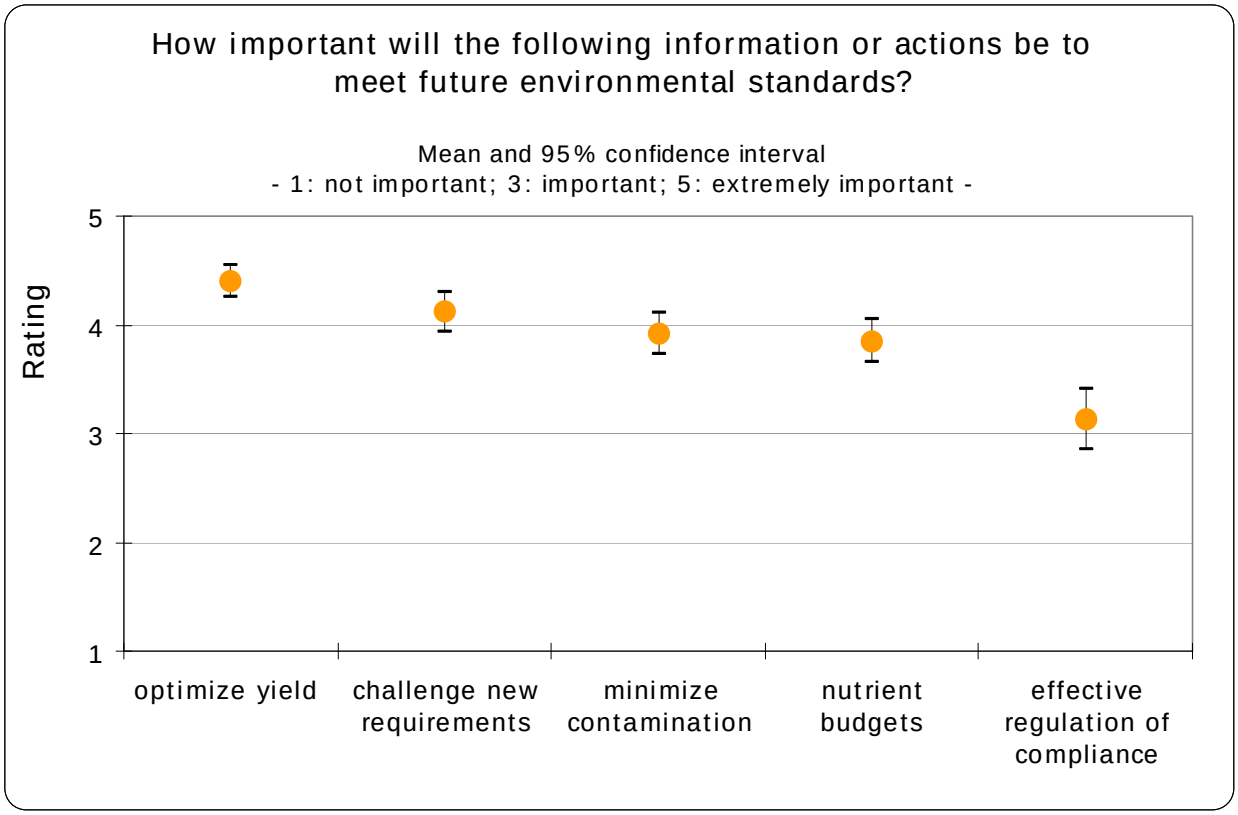
	Mean
Critical values Accuracy	4.30
Fertilizer application timing	4.26
Leaf sampling techniques	4.24
Tissue sampling techniques & timings	4.20
Fertilization - irrigation relationship	4.18
Nutrition - disease relationship	4.19
Foliar fertilizers	4.11
Nutrient manag. in problem soils	4.03
Nutrient interactions	3.98
Fertigation	3.92
Nutrient budgets	3.84
Optimize orchard establishment	3.68
Precision agriculture	3.48
Non-fertilizer foliar and soil products	3.48
Remote sensing	2.93

Topic 5: Expected Consequences of Environmental Regulations to the PISTACHIO Industry

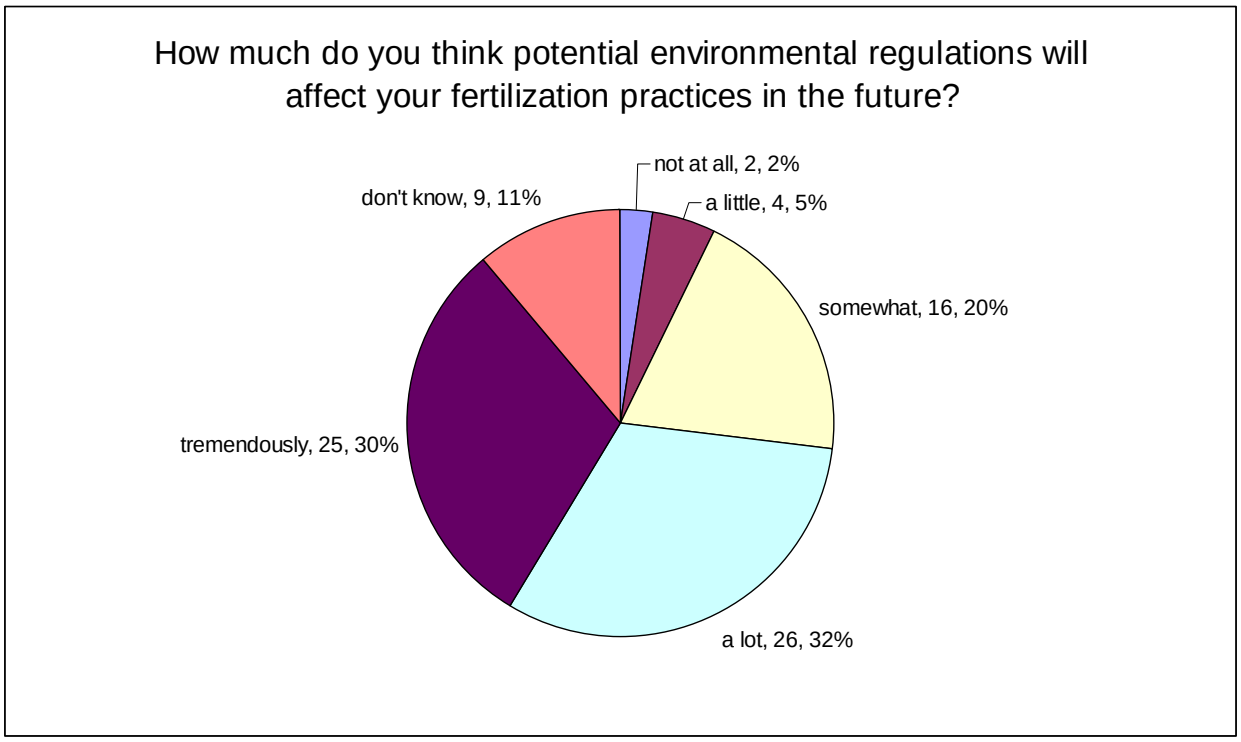
18% of respondents (14 Pistachio growers) reported that they always consider environmental consequences when making fertilizer decisions, 42% (33 growers) reported that they consider environmental consequences most of the time), 18% (14 growers) consider them sometimes, 14% (11 growers) rarely consider them, and 8% (6 growers) never consider them.



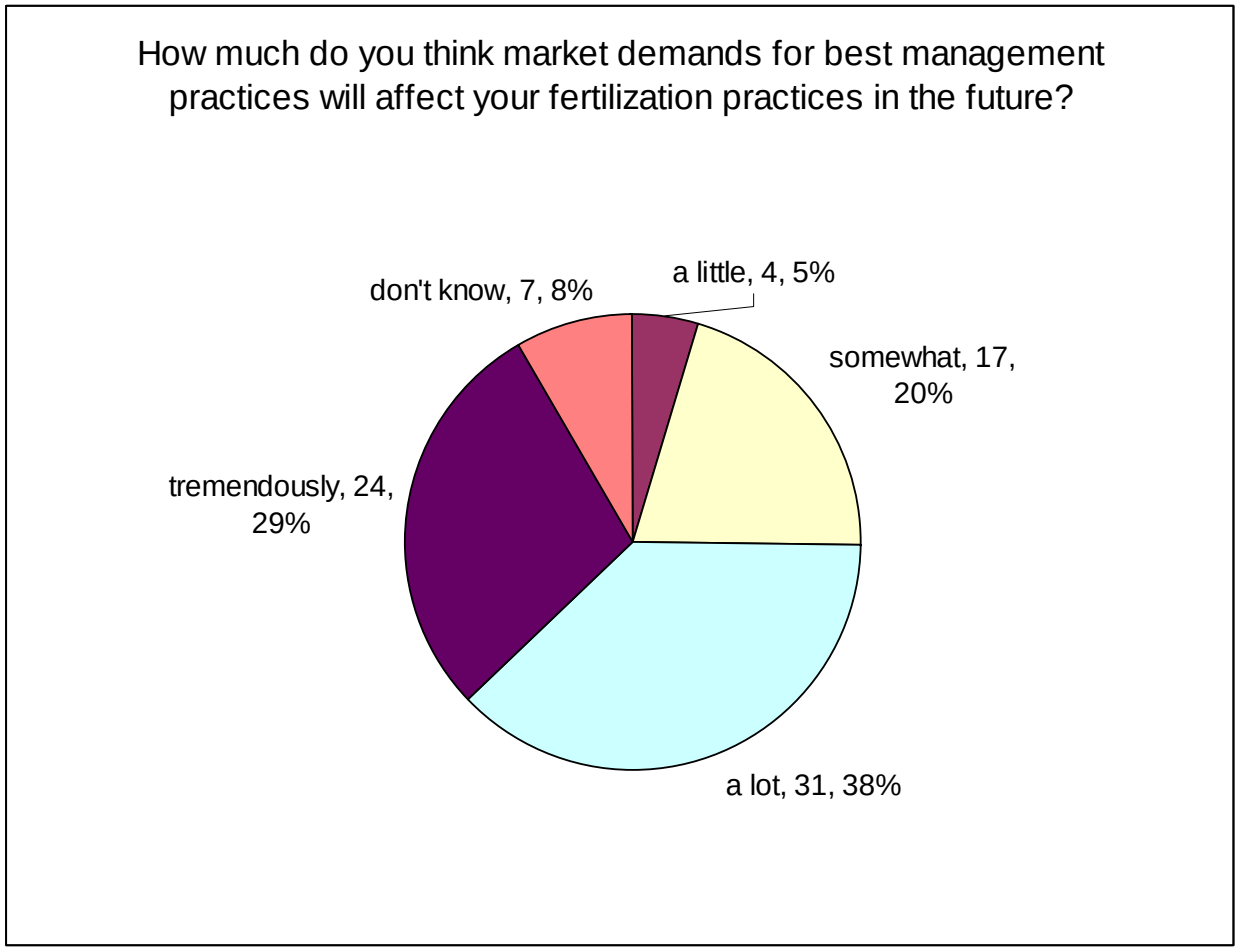
Pistachio growers reported that identifying fertilization practices that optimize yield will be of the most importance to them (4.40/5) in order to meet future environmental standards, followed by performing research to challenge new requirements (4.12/5), identifying fertilization practices that minimize soil and water contamination (3.91/5), and creating nutrient budgets that accurately reflect an orchard's fertilizer needs (3.85/5). Growers identify the effective regulation of grower compliance as being comparatively less important (3.13/5) to them in order to meet future environmental standards.



30% of respondents (25 Pistachio growers) think that potential environmental regulations will affect their fertilization practices tremendously in the future, 32% (26 growers) think they will affect their practices a lot, 20% (16 growers) think they will affect their practices somewhat, 5% (4 growers) think they will affect their practices a little, and only 2% (2 growers) think they will not affect their future practices.



29% of respondents (24 Pistachio growers) think that market demands for best management practices will affect their fertilization practices tremendously in the future, 38% (31 growers) think they will affect them a lot, 20% (17 growers) think they will affect them somewhat, 5% (4 growers) think they will affect them a little, and 8% (7 growers) don't know whether they will affect their practices. No growers think they will not affect them at all.



Conclusions and Practical Application:

The information gathered in these surveys will be of great use to researchers and extension agents in future efforts to effectively meet the needs of stakeholders in the Almond and Pistachio industries. The data relating to current nutritional practices, especially as they vary between counties and with acreage, may provide insight into strategies to take, should the industries face environmental scrutiny in the future. If most large growers are practicing the most efficient practices identified to date, for instance, it may not be cost-efficient for the state to target the remaining small growers to change their practices, if the overall amount of acreage to be affected would be very small. Future analysis may provide insight as to whether this is the case.

Another useful subset of data is that which relates to grower demand for research on various topics. The University of California now knows that its Almond stakeholders would, for the most part, consider research about fertilizer application timing and critical values to be more useful than research about non-fertilizer products and remote sensing. We have collected quantitative data regarding the degree to which critical values are used and the amount of satisfaction with the numbers. This data will all be of great use to us in planning future research projects.

Our major short-term goals are to continue analysis of the data and to make it as accessible as possible to stakeholders in the Almond and Pistachio communities. We plan to submit articles for publication, present this information at future workshops, and to provide the data in numerous forms on the UC Davis Fruit and Nut Research Information Center website. We aim to have the new section of the website available to users by September 15, at which time we will widely advertise its existence to industry stakeholders.