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Using focus groups to assess almond growers' plant nutrition information needs

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Abstract

University of California (UC) scientists have established critical values (CVs) for almond production, but the nutritional information the CVs provide may be outdated and insufficient. In December 2006, researchers at UC Davis conducted focus group interviews with a sample of stakeholders in California's almond industry. The focus groups were designed to collect information relating to factors affecting growers' nutrition decisions, priorities in education and research relating to plant nutrition, and expected consequences of environmental regulation for the industry. Stakeholders identified problems with the CVs and voiced concern about the future of the almond industry in light of impending environmental regulations. Many stakeholders identified university research as a way to protect the industry by providing strong, recent scientific data on which nutritional limits and environmental regulations can be based. The focus groups served as a useful research method for obtaining detailed information about stakeholders' motivations and priorities and also for informing a quantitative follow-up survey that was subsequently mailed to a larger population of Californian almond growers.

Key words: focus groups, almond, critical values, nutrition

Introduction

Critical values (CVs) describe the nutrient levels in plant tissues at which plants begin to show deficiency symptoms. University of California-established CVs (UC CVs) for determination of almond nutrient status and the methods used to manage fertilization in almonds may be outdated; specifically, UC recommendations may not adequately reflect the significant changes in orchard management, fertilizer formulations and application technologies or the increasing demands for environmental stewardship that have occurred in the almond industry in recent years. The research conducted from the 1950s through the 1980s has not been adequately re-examined in recent years and has not been adapted to the modern production context, and laboratory methodologies have not kept pace with advances in extraction procedures and analytical techniques[1]. Efforts to develop best management practices (BMPs) for nitrogen management in almonds have been hampered by an inadequate research base and by the state's diversity of almond growing conditions, which make identifying best practices difficult. In the absence of viable and well-regarded standards and guidelines for nutrient management, growers may not have the resources needed to use fertilizers wisely.

In addition to being possibly outdated, the UC CVs may be limited in their practical application because they measure nutrient deficiency rather than nutrient status associated with yield optimization, and it is widely accepted that the appearance of visual symptoms of nutrient deficiencies occurs only after growth and productivity have been negatively impacted[2]. While this approach to nutrient management may have been appropriate in the past, given difficulties in conducting large-scale yield-based experiments and given the nature of production systems at the time of experimentation; modern production systems and awareness of the environmental impacts of poor fertilization practice may require that nutrients be managed more precisely to eliminate any potential negative impact on plant establishment, yield and the environment.

There is a good deal of uncertainty about current practices and standards for plant nutrition in almond production. Further, there has not been a significant review of the 'state of the industry' and no meaningful consideration of where future investment of educational, outreach, or research activities should be directed in the field of plant

nutrition for almonds. In an effort to fill this information gap, researchers from the University of California, Davis (UC Davis), with the support of the Almond Board of California and the California Department of Food and Agriculture, decided to investigate almond growers' current fertilization practices, factors influencing their fertilization decisions, and growers' priorities and concerns relating to future research and outreach programs.

A meaningful assessment of the current state of plant nutrition knowledge could not be conducted without a detailed consultation process, so we coordinated focus group interviews with industry stakeholders in order to identify current practices, concerns and needs in almond nutrition. The information collected from the focus groups was used to inform the content of a survey that was subsequently administered to a larger population of almond growers. With the data from the focus groups and survey, UC researchers hope to collate existing information and BMPs and design a new research and extension initiative to increase the efficiency of fertilizer usage and guide subsequent nutrition research and education programs.

Mail surveys are commonly utilized by university researchers and extension agents to investigate agricultural industries. Agricultural researchers have recently used mail surveys to pursue a variety of goals, from investigating the state of California's cattle industry in light of economic change[3] to assessing the pest management decision-making processes of almond, cotton and cranberry growers[4–6]. Interpretation of these survey results has allowed researchers to predict future industry trends, identify stakeholder needs and assess how future extension and research efforts can be tailored to meet these needs[3–6].

Despite the ease of their administration and the benefits of collecting data from many stakeholders in a single research effort, mail surveys do not always provide researchers with easily interpretable results. In Brodt et al.'s investigation of cotton growers[5], for example, researchers were unable to determine, based on questions about adoption of individual practices, whether growers exhibited multidimensional understandings of their farms as agro-ecosystems. The authors concluded that in-depth interviews would be a more useful tool than mail surveys to collect this type of information. Focus group studies, one of numerous qualitative methods gaining popularity among researchers in agricultural fields[7], allow skilled interviewers to obtain qualitative information from interviewees in discussions. The open-ended approach of focus groups allows interviewees to share experiences and attitudes, conveying their true thoughts and feelings while providing data that are of specific interest to the researcher[8]. Focus group interviews are used commonly in the social sciences by researchers at the exploratory stage of research, as a stand-alone research method or in combination with surveys or individual interviews[9].

Focus groups are a useful tool to rapidly and efficiently gather detailed opinions from stakeholders, and sessions can easily be carried out onsite at industry conventions or field days. As a method of interviewing stakeholders, focus groups can save researchers time as compared with individual interviews by allowing them to hear viewpoints of multiple interviewees in a single sitting. The group atmosphere of focus groups may also be of benefit to researchers because it allows interviewees to compare their views to those of others, often leading them to voluntarily change their opinions to align behind well-informed interviewees, thus increasing the likelihood of reaching consensus[10]. This trend can also be a danger to researchers, however, because there is a possibility of individuals being dominated by others in focus group exercises[10,11]. The results of focus groups are easy to interpret and provide researchers with the opportunity to listen to diverse viewpoints and perspectives developed through open-ended discussion, rather than limiting stakeholders to providing only certain types of answers to questions, as may occur in a survey. The results of focus groups may be used by researchers as the final step in information collection, or researchers may choose to use the information to inform a more quantitative process of data collection.

While focus groups are very useful at surfacing ideas and insights of those interviewed, the qualitative data gathered through this method only reflects those represented in the interviews, which is often very limited in number. The usefulness of focus group interviews, then, is to broadly paint a picture of what interviewees believe is or is not of importance. On the other hand, other social science research techniques, such as mail and internet surveys, allow researchers to select and sample and extrapolate findings to the population. Surveys allow researchers to gain insight into topics such as whether growers base their decisions more on environmental or economic considerations[6,12] and allow growers to express numerically the importance of specific survey items.

For our study of the almond industry's nutrition management practices and research needs, therefore, we used the information we gathered from the focus groups to inform a mail survey of 1800 randomly selected almond growers (the results of which are presented by Lopus et al.[12]). We based the mail survey question topics on the subjects raised by focus group interviewees, and for multiple-choice survey questions, answer choices were based upon the topics discussed in the focus groups. In this way, we were able to construct our mail survey to contain questions of relevance to industry stakeholders, since the subject matter had been discussed in the focus groups by other industry members. We intend to use the results of both research methods when designing a new research and extension initiative and developing subsequent nutrition research and education programs.

Methods

We conducted the focus group study at the Almond Industry Conference in Modesto, California in December 2006. The sample consisted of 34 almond growers,

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nutrition consultants, farm advisors and members of the Almond Board from counties throughout California. Focus group interviewees were invited to take part based on the researchers' personal familiarities with growers and consultants who manage farms of various sizes and locations with diverse management practices. Krueger[13] suggests that focus groups should be homogeneous and should range in size from 4 to 12 participants to allow opportunity for individuals to talk and to provide for practical logistics and management. In this study, the three focus groups fell within this range, with 10 to 12 people participating in each group. Each group was roughly homogeneous in composition, comprised primarily of growers, nutrition consultants, or farm advisors, representatives from the California Environmental Protection Agency and representatives from the California Air Resources Board.

Three 90-min focus group sessions were conducted; by conducting three focus group sessions, we were able to detect patterns and trends across the groups and increase our chances for a saturated response[14], in which members of multiple groups voice the same idea. Since information was collected from only one of each group type, we do not have adequate samples to analyze across multiple groups of farmers, nutrition consultants, or farm advisors, and it is not possible for us to compare and contrast between stakeholder types. Only with multiple groups of each type would we know whether we reached saturation, the point at which the full range of ideas has been heard, and draw conclusions with some certainty[8]. Instead, when saturation was reached across the groups, we drew conclusions about stakeholders in general but not linked to stakeholder type.

Two UC researchers attended each focus group, with one moderating the interview, while the other took field notes. The researchers had attended a focus group training workshop and were familiar with topics in plant nutrition. Each focus group followed a format outlined by Krueger and Casey[8], and interview questions were structured around three areas: (1) factors affecting growers' nutrition decisions, including perceived usefulness of CVs 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.

We followed Krueger and Casey's 'long-table approach' to data analysis for the focus groups[8], relying initially on field notes and supplementing our research with an audiotape-based analysis approach to fill in details. In accordance with the long-table method, we identified field notes with colors to indicate which group had provided the information, physically cut the notes apart, and placed the clippings of similar concepts together. When ideas came up repeatedly, we considered these themes to be of importance, and we structured our written report and survey questions around these themes[8]. Analysis of focus group data in this way is a proven and established procedure for collecting verifiable information about populations[8].

Results

Stakeholders identified three primary sources of information that growers depend upon when making decisions related to nutrition management. Interviewees in all focus groups identified universities and other farmers as important sources of information, but most stakeholders expressed that private nutrition consultants are many growers' first line of information. Although nutrition consultants may have superceded extension agents as the primary point of contact with many almond growers, complex relationships exist between growers, universities and nutrition consultants, since a private consultant's recommendation may be based upon UC research. In this way, research developed by the university may still be of great importance to the almond industry, even if the information it provides is disseminated to growers through a privately hired source.

When asked their opinions about the effectiveness of the UC CVs, interviewees in all focus groups expressed that the values are better than nothing and may provide a general guideline for nutrition management program (Table 1). The focus groups comprised primarily of growers and nutrition consultants talked at length about concerns with the accuracy of values and whether they are outdated, with one grower stating, 'Aren't there varieties now that weren't there thirty years ago? 'Cause that's when a lot of this stuff was developed'. Stakeholders confirmed our belief that the industry is concerned with the suitability of the CVs to inform modern nutrition management practices, questioning whether the values have kept up with changes in production related to yields and planting densities. The primary concerns interviewees expressed about CVs related to problems with timing, sampling method, yield maximization and nutrient interactions.

Stakeholders repeatedly cited timing as a limitation to using CVs to inform nutrient management decisions on orchards (Table 1). Interviewees were concerned that the CVs relate to nutrient levels in plant tissue during only a 10-day period in July. Although sampling is supposed to occur during this period to allow nutrient levels to be measured when they have reached a plateau, some interviewees were concerned with the accuracy of this sampling method, stating that weekly samples would be necessary to ensure the plateau had been reached. Another problem with the small sampling window is that information is not available for other times of the year, so growers find themselves 'flying blind' much of the time. Interviewees prioritized future research projects that would allow growers to measure nutrient levels during the time of the year between dormancy and leaf production. Other interviewees were concerned with misuse of the CVs by growers who sample in the wrong month. CVs were also thought to be of little use for those nutrients (e.g., Mn, Zn and Fe) in which deficiencies may stand out in other months (early spring) but look normal when tissue samples are collected in July.

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Table 1. Topics addressed by each focus group (roughly divided as growers, industry members and Farm Advisors) when asked their opinions about the effectiveness of UC CVs. Accuracy of CVs, timing of tissue sampling, interactions affecting nutrients, specific nutrients, challenges with sampling methods and applying information, and development of personal CVs were discussed by members of all focus groups, indicating that 'saturation' was reached. Specific points raised by members of each focus group demonstrate the context in which the saturated topic was discussed. An 'x' indicates a sub-topic not recorded in the transcript of a particular focus group; however, since information was collected from only one of each group type for each study, it is not possible for us to compare and contrast between stakeholder types.

	Sample context in which topic was discussed by each focus group		
Saturated topic	**(A) Growers**	**(B) Industry members**	**(C) Farm advisors**
Accuracy of CVs	Don't think CVs are accurate	Don't think CVs are accurate	x
	CVs give guidance for some nutrients	CVs are better than nothing	CVs provide general guidelines
Timing of tissue sampling	Values are only for June and July	Year-round decisions must be based on values from the first 10 days of July	Deficiencies present in other months may not appear in July
Interactions affecting nutrients	CVs should consider nutrient interactions	Researchers should determine ratio of nutrients relative to each other for optimum growth	Researchers should assess how elements work with plants
	Production regime affects nutrient levels	Foliar versus other application methods affects nutrient levels	Research of other variables (such as the irrigation method) could lead to better understanding of how nutrients fluctuate
Specific nutrients	Concerned with potassium	People use more than the CV levels of potassium	Research trials showed that CVs aren't far off for potassium, but the industry disagrees. More trials needed
	Concerned with zinc: leaf analysis doesn't help	x	Can't use leaf analysis for zinc because of foliar applications and because zinc is not held in leaves
	Boron levels are questionable	x	In some orchards, boron CVs appear too high and in others they appear to be correct
Challenges with the sampling method and applying information	x	Values fluctuate: the same person taking a sample could get two different results	Growers and consultants may not recognize margin for error in lab analyses
	Unsure of how lab results relate back to CVs	x	Labs provide average values
	How do CVs tie in with yield maximization?	CVs aren't designed to maximize yields	x
Development of personal CVs	Some growers rely on consultants to give them information about CVs	Some labs use modified CVs or interpret CVs independently	Different labs have their own interpretations of the UC CVs

Another major topic of discussion of CVs related to the difficulties of accurately sampling plant tissue to measure nutrient levels (Table 1). In addition to problems with the timing of tissue collection, interviewees were concerned with sampling inaccuracies due to spatial variation across orchards or even within trees, creating the possibility that 'you could pick one[leaf] with your left hand and one with your right hand and get two different numbers'. Interviewees stressed that the small sample sizes relative to the size of the orchard mask variability, and growers or nutrition consultants may be unaware of the large margin of error associated with the lab results. If an orchard's number drops from one year to the next, growers and consultants may unnecessarily apply more fertilizer in the future, even if the change was not significant.

Many interviewees were also dissatisfied with the CVs' dependencies on average values (Table 1). As one farm advisor expressed, if the critical level for a tree is 2.2, a grower might aim for an average level of 2.5 across his orchard to ensure that few of his trees are below the critical level. As another farm advisor explained, 'If the average is 2.2, it's likely that there are some 2.0, and there are some 2.4'. Since an orchard-wide average of above a critical level may be associated with half of the orchard's trees falling below that critical level, interviewees felt there was a disconnection between tree-scale sampling and orchard-wide nutrition optimization. One nutrition consultant called tree replicates 'almost meaningless', and interviewees in all focus groups prioritized future research addressing tree variability and nutrient status on the landscape scale.

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Many interviewees were unclear about how a grower could practically apply the information provided by CVs to an orchards' nutrition management program (Table 1). In cases of lab tests indicating nutrient deficiencies, it was unclear to some interviewees what steps should be taken to remedy the problem, and they questioned how lab results relate to the CVs. Interviewees questioned the best remedy for an orchard slightly deficient in a particular nutrient and highlighted this as an important field for future research. The relationship between CVs and yield maximization was also discussed. As one grower simply stated, 'Obviously, those levels show when you have symptoms, but they don't show what impact they have on yield, and that's the question a lot of people ask'. Growers are interested in optimizing their trees' performances, rather than managing their orchards just above a critical level.

In addition to citing the practical problems of timing, sampling and yield maximization when using CVs to inform nutrition management, interviewees in all focus groups were concerned that the established CVs ignore interactions between nutrients in an orchard (Table 1). Interviewees cited the importance of conducting high-yield research of multiple nutrients simultaneously to understand complex situations in which the CV for one element may depend upon the level of another element. Some interviewees suggested the development of ideal ratios between nutrients, since too much nitrogen can throw off an orchard's potassium balance, or a drop in zinc occurs with an increase in phosphorus. As one nutrition consultant expressed, it has been the industry's tendency to improve yields with the application of more nitrogen, 'but maybe if they'd added some other nutrient, the roots would have gone better, or more [nitrogen] would have been utilized, or something else'.

Concerns about interactions went beyond just those between nutrients in an orchard, and many interviewees expressed interest in research focusing upon relationships between plant nutrition and external factors such as fertilizer application method, soil type, propensity to disease and irrigation method (Table 1). Some interviewees believed that fertilizer use efficiency is closely related to the irrigation system, and water mobilizes the nutrients, but they would like to see more research on the topic. Questions about irrigation particularly focused on cases of micro and drip irrigation, in which roots grow closer to the surface than with other irrigation methods, causing one nutrition consultant to ask, 'If our technology has changed how the tree grows, should we be changing our application technique to go along with it?' Another consultant observed that

> There needs to be better education on what antagonizes, or what uses up. I mean, you put phosphorus on, your zinc goes down. You put boron on, your calcium goes in a different direction. You put more calcium on, your boron goes in a different direction. . .. We should be thinking in terms of more than just a single shot of calcium, a single shot of boron.

Implications

Lack of useful information and inadequate management of existing information are commonly cited barriers to adoption of sustainable practices in many agricultural settings[15], and California's almond industry also identified these factors as problems. Input from the focus group interviewees confirmed our beliefs that there are numerous uncertainties as to which nutrition management practices will optimize almond production. Without viable management standards providing growers with clear information about how to best balance yields, production costs and environmental considerations, many growers have responded by increasing the level of fertilizer they apply in order to avoid deficiencies. Expressed one grower,

> We have been farming with these fertilizers pretty hard. I will bet you if you looked at the amount of spray we have put on in the last 5 years, it is probably higher than at any time in the industry. And I think it is time to reevaluate that.

Interviewees expressed that when laboratories provide growers with average nutrient levels for trees in their region, growers may respond by trying to push their trees' levels higher in an effort to be better than average. The results of over-fertilization may have a negative economic effect on growers, if their improved yields do not meet the costs of increased fertilization inputs. Negative environmental effects could occur in surrounding communities, should the excess nutrients run off from farms or leach into groundwater.

Interviewees in all focus groups expressed concern about impending regulations on the almond industry, worrying that environmental pressures will be extreme. As one grower asked,

> Environmentally, what are those critical levels? Are we putting on excess nitrogen? Are we contaminating the groundwater? What are the optimum levels that we should be applying? We don't have the relationship between those and what yield is returned. All we have is 30- or 40-year-old data, and that's not adequate.

Interviewees feared that regulations based on the outdated values, which may not relate to modern cultivars, will 'handcuff the growers' and prevent them from being able to grow high-yielding crops. One farm advisor worried that when regulations are created, regulators will 'grab for the first thing on the shelf', which he described as a 'pretty sloppy' nitrogen budget. Currently, there are few sources of information related to almond nutrition management to help the industry address this problem.

Participants in all groups felt future university research provides a primary opportunity to ensure that environmental regulations on the almond industry will be based on viable nutrition management practices that will not seriously detriment the industry economically. As one nutrition consultant stated, 'Having strong data about what the nutrient needs of the trees are, under what conditions, ultimately can help us take a stronger stand, should the

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push-back come'. Interviewees cited the University of California's obligation to look out for impacts to growers and felt the university should communicate the results of its future research projects with the Environmental Protection Agency. New research to bring 'scientific proof back into the picture' has the potential to inform growers of BMPs and to justify those practices, should environmental regulation occur. While it is beyond the scope of this paper to address discrepancies between focus group expectations and researcher roles, we will use the stakeholder opinions and priorities expressed in the focus groups to inform our roles as researchers in the context of broader obligations and capabilities.

> I mean, sometimes, we tend to over-farm our trees a little bit. We had a couple plots up on a hill earlier this year, and all those trees were just yellow for about a month. And I threw everything but the kitchen sink in, and finally I just quit, and then they just greened up on their own.
>
> –Grower

Recommendations

The results of the focus group discussions confirmed the existence of indicators that the UC CVs do not fully meet the almond industry's needs. Results demonstrated widespread concern among the almond industry about the relevance of CVs and the difficulties in applying the information they provide to an orchard's nutrition program.

Focus group interviewees prioritized a number of considerations for future research in almond nutrition management. While research for established CVs was based on single nutrients evaluated on a tree-wide scale, interviewees in the focus groups called for a systems-based approach to research in which interactions between nutrients and external factors are investigated on an orchard-wide scale. The established CVs are reductionistic by nature, but growers manage their orchards systematically and require a solution that allows laboratory results to clearly inform management practices.

An integrated approach to nutrition management research, in which investigators consider multiple elements and factors simultaneously on a large scale, will serve stakeholders in California's almond industry economically and environmentally. By identifying BMPs relating to modern cultivars and technology, researchers will provide growers with the opportunity to optimize yields without using excess fertilizer that does not provide adequate economic returns. The research will also serve to protect the industry when environmental regulations are adopted, giving stakeholders hard data with which to justify their fertilization practices. This focus group study demonstrated a clear and immediate need for a new approach to nutrition management research in almonds, so growers will have adequate information with which to make decisions that will optimize their yields without causing environmental degradation to surrounding communities.

The CVs provide no easily interpretable guidelines to almond growers regarding how to produce high-yielding trees. The challenge to UC researchers is to meet the growers' demands for yield-related plant nutrition information; this could potentially be accomplished by collecting a new type of data, re-interpreting the existing data, and/or performing focus group and/or survey efforts more frequently to consistently achieve a current perspective of whether they are meeting growers' informational needs.

The problems with CVs are both scientific (e.g., too much orchard variability, uncertainty as to how the CVs relate to new varietals) and practical (e.g., how the deficiency-related numbers translate into high yields, how a grower should use the mean values collected from tissue sampling to make decisions about the whole orchard). Since redesigning research projects to focus upon yields rather than deficiency would likely be expensive, it may be possible for UC researchers to creatively re-interpret the existing CVs to better meet growers' information needs. Perhaps, for instance, with understandings of the standard deviations of tissue samples within trees and across orchards, researchers will be able to identify optimal, rather than critical, values based on the existing data that was used to develop the CVs. These optimal values would meet growers' need for yield-related recommendations based on the mean values derived from collecting tissue samples on their orchards, although they still may not account for new varietals and changes in modern almond production.

A one-time, large-scale assessment of stakeholders' needs may be a suboptimal method with which to collect information to inform extension and research efforts because respondents may dramatically change their opinions of perceived needs within only a couple of years[10]. Researchers and extension agents may therefore benefit from frequent small-scale focus groups with stakeholders to ensure that extension and research projects continue to address the industry's changing needs. With the small amount of time and preparation necessary to involve stakeholders in continued research efforts, it may be possible to accurately and efficiently tailor agricultural projects over time, reassessing and redesigning research goals often enough to keep major holes from existing in the information they provide to growers. The results of the focus groups were useful both in their own right, allowing us to thoroughly understand stakeholders' motivations and concerns, and as a tool for informing a more detailed, quantitative research survey of a representative sample of growers.

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