Evaluating Nitrogen Use Efficiency in Almond Using an Isotopic Tracer Approach

Project No.: **08-AIR4-Smart**

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Objectives:

The overall objective of this project is to close the nitrogen budget in almond using a stable (non-radioactive) tracer of nitrogen (nitrogen-15 or ^{15}N). The information acquired can be used to develop commodity specific emissions factors for nitrogen-based greenhouse gases and to improve the usefulness of critical values for nitrogen in fertility programs. The project is part of an integrated effort between the Almond Board of California, the University of California at Davis, Fresno State University and California Department of Food and Agriculture.

Interpretive Summary:

The passage in June of 2006 of **The California Global Warming Solutions Act of 2006 (AB32)** has turned the attention of regulatory agencies such as the California Air Resources Board (CARB) and information gathering agencies such as the California Energy Commission's Public Interest Energy Research program (CEC PIER) to the subject of California's greenhouse gas production. These agencies have calculated emissions of nitrous oxide (N_2O) (and other greenhouse gases) from agriculture due to fertilization practices, as N_2O has 300 times the atmospheric warming potential of CO_2. The impact of AB32 on the agricultural industry is yet to be decided; however, the Air Resources Board recognized N_2O from fertilizer inputs as an "early action" mitigation strategy. For now the focus is on researching options to reduce N_2O emissions from fertilizer inputs, with the plan to develop required actions based on the results.

In order to implement regulations, and to assess carbon footprints (total net greenhouse gas production and consumption) in agriculture, such agencies must rely upon emission factors developed by the International Panel on Climate Change (the IPCC). The current IPPC standard emission factor (EF) for offsite transport of nitrogen assumes 30% of nitrogen applied in the form of fertilizer is transported offsite. CARB and CEC recognize that the standard emission factor may not apply to a Mediterrenean climate and perennial crop situation. Thus, it is critical that we acquire more information about how efficient the use of nitrogen fertilizers is in California agriculture, especially for pernennial crops. There is much misunderstanding about N use in the agricultural sector and the only way to fix this misunderstanding is through better knowledge concerning its use.

Nitrogen use efficiency (NUE) can be defined as the quantity of nitrogen harvested in crop biomass versus that applied. Alternatively, NUE could be defined as the quantity of fertilizer N applied versus the amount retained in the total biomass of the crop versus loss of the principle oxidized forms of N (NO_3^-, NO_2^-, and the gaseous species of NO, NO_2, N_2O), and thus, this definition would require NUE to be characterized in terms of environmental impacts, or sustainability. The only way we can get reliable data on NUE in almond is by using an isotopic tracer approach. In other words, we need to apply nitrogen enriched with the stable (non-radioactive) isotope of 15N and then trace its fate through loss of the aboas gases from the soil, movement downward in the soil, and as harvestable biomass.

The primary goal of this investigation is to examine the concept of nitrogen use efficiency (NUE) where an opportunity exists within a vertically integrated project on nutrient use efficiency being conducted by Dr. Patrick Brown and colleagues from UC Davis. The primary purpose of that project is to establish new critical values for nitrogen (N) (and potassium, K) fertility and re-evaluate the amounts of N applied relative to both production and environmental impacts. The effort being brought forward in this project will be conducted within the project being led by Dr. Patrick Brown, and represents an attempt to help 'close' the N budget within the context of the more practical definitions of NUE discussed above. We hope our results will provide more comprehensive information on:

- The fate of N lost during fertigation, including leaching, the denitrification products of N_2 and N_2O and the (mostly) nitrification products of NO and NO_2.
- The amount of N absorbed and translocated to wood, leaf, and fruit production.

Thus, it will provide critical information concerning nutrient use efficiency for nitrogen in California almond production systems. It will also allow us to start developing commodity (almond) specific emissions factors that can be used in assessments of almond carbon footprints.

The project will commence in the spring of 2009 when nitrogen applications commence.