Assessment of Harvested and Sequestered Nitrogen Content to Improve Nitrogen Management in Perennial Crops (17-0488)

Interim Report
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OBJECTIVES

- Assess N concentration of harvested material removed from fields (N removed [R]) for approximately 25 crops over several growing seasons. Samples of harvested material will be collected and analyzed for twelve of those crops. Data for the remaining crops will come from existing sources. As the project is evolving, it appears that more crops may be included in the study than originally planned.
- Establish values for the annual amount of N sequestered in standing biomass for seven perennial crops. Tissue samples will be collected and analyzed for one of those crops. Data for the remaining crops will come from existing sources.
- Refine crop yield (Y)-to-R conversion factors, and add N-sequestration rate estimates, for use by growers and grower advisors during nutrient management planning and by coalitions for large-scale performance assessment.
- Promote and enable expanded knowledge and appropriate use of N-removal coefficients and N-sequestration rates (as part of routine N-management planning and evaluation) by growers, grower advisors, and coalitions.

SUMMARY

This project is developing updated conversion factors for 25 crops. For some crops, information is coming from other research projects. This project includes sampling and analyzing harvested carrots, corn [grain and silage], peaches, pima cotton, pistachio, plums, pomegranates, raisins, safflower, sorghum [grain and silage], and processing tomatoes. By partnering with commodity organizations, growers, processors, and packers, it has been possible to procure hundreds of

samples that represent a range of varieties and growing environments for each crop. In most cases, substantial information about source fields, such as age of perennial crops, crop management, variety, yield, quality, and dates of bloom or planting, are acquired and related to results. In this way, some of the factors that affect N content of the harvest can be investigated and explained.

These data will be incorporated into updates of *Nitrogen Concentrations in Harvested Plant Parts - A Literature Overview* by Dr. Daniel Geisseler (2016) as part of this project. The existing Y-to-R calculator (http://agmpep.com/calc-y2r/) will be revised to reflect these findings, and the results will be used to update the assessment and planning tools available to growers, grower advisors, and coalitions.

WORK DESCRIPTION

- **Task 1A. Establish sampling protocols and analysis methods for six crops for which N-content data are not available from other sources / Task 1B. Acquire data from others**.

Work completed since the January 2018 grant award includes development of sampling protocols and coordination of year-1 sampling of 11 crops (see Summary for crops) with grower/packer/shipper partners, along with initial lab analysis. Antecedent work was focused on peaches and aimed at answering the following questions, each of which will help to inform sampling design during two or three additional years of sampling and analysis:

1. **Is it necessary to subdivide kernel from shell in the pit for a good analysis, or can pits be analyzed whole?** Pit subsamples for which kernel and shell were analyzed separately had higher N content than pits processed and analyzed whole ($P < 0.0005$), but pit N is a minority of whole-peach N. It is possible that when pits are analyzed whole, that the kernel tends to be under-represented in the ground, mixed sub-subsample of whole-pit material that is analyzed. This should be verified by comparing larger groups of subsamples. In this study, the average %N recovered in whole relative to separated pits was 66%. Pending further verification, this adjustment has been applied to results for whole pits throughout the rest of this analysis. If pits can be analyzed whole, this reduces analysis costs by more than a third relative to segregation of pit components. The influence of errors in measuring pit N on the estimate of whole-fruit N content is minimal because about 92% of the N is in the flesh.
2. **How consistent are subsamples from the same groups of fields?** Samples of as few as seven peaches provided quite consistent (CV = 5%) results for N content of whole peaches. Analyzing multiple subsamples would not add much precision. More fruit may be needed to allow for a range of fruit sizes (see below). This sampling efficiency greatly reduces sampling, processing, and analysis costs.
3. **Do peaches grown in California today have a very different N content from peaches grown under other conditions?** This question arises because much of the literature related to N content in peaches comes from elsewhere (e.g., Spain). Whether N is considered in relation to fresh weight or dry matter, California samples overlap observations from elsewhere, but are situated on the high end of these observations and range to 1.5 (for N as part of the fresh weight) to 2 (for N as part of the dry weight) times the upper end of observations in the literature.

4 **How are applied N and N removed in fruit related?** N fertilization of peaches is thoroughly discussed in Niederholzer et al. (2001). Higher N rates generally increase levels of N in fruit, but this effect diminishes at higher application rates. The amount of N removed in the crop is relatively high per unit applied N in samples from California, except for early peaches that produce lower tonnage. N application rates in California are not high relative to other peach growing areas, despite the elevated fruit N content, suggesting that N fertilizer delivery efficiency into fruit is relatively high in the California fields studied. One likely reason is that soil and weed management may minimize some other losses, such as uptake into weeds and cover crops.

5 **How important is the ratio of flesh to pits? Because the pit is a seed, does it contain most of the N**? N is most concentrated in the kernel of the peach, but 92% of the N of all peach samples was in the flesh. The flesh-to-pit ratio varies, but is not strongly related to N content of the harvested fruit. The proportion of the fruit that is the pit has no regular relationship to fruit size/weight, and does not predict N content of the fruit.

6 **How does harvest date affect N content?** The rate of crop development depends on physiological processes that are affected by ambient temperatures, so that physiological time is measured in units that combine time and heat. One such measure is the growing degree hour (or day, respectively GDH and GDD), which can be calculated from readily available CIMIS (California Irrigation Management Information System) data and bloom dates for the orchard in question. The accumulation of sugars into the fruit, which drives crop yield and gradually dilutes N in the fruit, is the best predictor of plant development. It is closely related to fruit yield of the cooperating orchards growing early through late-late peaches.

7 **How do harvest date and fruit size affect N removal rates?** A thorough discussion of N dynamics in peaches is available in Rufat and DeJong (2001). As GDH accumulate after bloom, dry matter accumulates in fruit, gradually diluting N, leading to lower overall concentration in fruit dry matter and fruit, until late in the season, when this process tapers off. For fruit harvested at the same time, smaller fruit have slightly higher N content.

8 **Since reported yields are for packed fruit, how should losses during shipping and packing be accounted for when calculating N removed by the crop?** Most growers know their pack-out weight and percentage. For cooperators, the latter was about 75% (i.e., 25% of the harvested fruit is not packed).

- **Task 2. Sample and Assess Harvested and Sequestered N Content**. Sampling and assessment through June 2018 were focused on peaches and plums. Sampling and assessment will continue through 2020.
- **Task 3. Interpret results and develop and publish N-concentrations Report updates**. This task will commence as results become available and continue through 2020.
- **Task 4. Develop and publish calculator updates**. This task will commence as results become available and continue through 2020.
- **Task 5. Outreach to growers and advisors**. Work completed to date will be shared at the 2018 FREP conference. Additional outreach will commence as results become available and continue through 2020.