EFFICIENT N FERTILITY AND IRRIGATION MANAGEMENT IN VEGETABLE AND BERRY PRODUCTION

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ABSTRACT

Nitrogen (N) fertility and irrigation management for vegetable and berry production has historically been done on an 'agronomic' basis, with the sole focus on producing the optimal crop. For these crops N fertilizer and water costs are a small portion of overall production costs, and an even smaller portion of crop value; consequently, these inputs have not been scrutinized as closely as they have been for lower value crops. However, throughout the West concern over environmental water quality is increasing regulatory pressure on agriculture to improve nitrogen use efficiency, and reduce nitrogen losses to the environment. In California, regulators have for the first time proposed N fertilization targets based on an N budget concept, with seasonal N application 'targets' linked to crop N uptake requirements; for many horticultural crops current N application rates are substantially higher than crop N uptake, and can be as much as twice the rate of N removal from the field in harvested products. To meet future regulatory requirements growers will have to start thinking strategically about N management, and about irrigation management, since it is inextricably linked to N use efficiency. This summary outlines five ways to improve N fertilization and irrigation practices while maintaining crop productivity.

Minimize preplant N application:

Historically, nearly all vegetable and strawberry fields received preplant N fertilization. For vegetable crops the amount of N applied preplant is usually modest, but for strawberries preplant application of as much as 100 lb N in a controlled release form (CRF) is common. A reevaluation of preplant N fertilization is warranted for both crop types. In vegetable rotations it is common to have a substantial amount of residual soil NO_3-N present at planting; this is particularly true in systems in which multiple crops are produced per year, or in areas of low rainfall. Preplant N is often not necessary under these circumstances, since crop N demand during the initial month of vegetable crop establishment and growth is very low. Fall preplant N application for spring planting is particularly inefficient in areas in which the soils do not freeze, and winter rainfall is substantial. Preplant application may be an appropriate way to apply needed P and K, but fertilizer choice should be considered to minimize or eliminate N application.

Recent research has demonstrated that the efficiency of preplant CRF N fertilization in strawberry production is poor because N release from the fertilizer is much more rapid than crop N uptake between fall planting and early spring. Reducing the amount of preplant CRF, or using a formulation with slower N release than the current 6-9 month materials, should decrease the potential for winter NO_3-N leaching.

Evaluate residual soil NO_3-N before sidedressing or fertigating:

Fields differ widely in the amount of residual soil NO_3-N present in the root zone at the time of the first in-season fertilization (sidedressing or fertigation). Soil sampling in 50 commercial lettuce and tomato fields in which we have done trials in recent years showed that residual soil NO_3-N varied from < 5 PPM to > 40 PPM. Since each PPM represents about 4 lb N per acre in the top foot of soil, it is clear that efficient N management would require that these fields be treated differently. Soil testing before the initial in-season N application, and adjusting N application based on the level of residual NO_3-N, can dramatically reduce unnecessary fertilization. In cropping systems in which multiple in-season N applications are made, repeated soil NO_3-N testing could pay even larger dividends.

Apply N in sync with crop N demand:

As the use of N fertigation through drip or center pivot irrigation becomes more common, there is increased opportunity to apply a 'just in time' philosophy regarding N application. The old paradigm of one or two large N sidedressings applied early in the crop season was inherently inefficient, because some leaching with rain or irrigation was virtually inevitable before the crop could utilize the applied N. The N uptake pattern of strawberry and the major annual vegetable crops are well documented. For strawberries, N uptake between fall planting and active growth in the spring is typically < 40 lb/acre; from first harvest onward, crop N uptake is relatively constant at about 1 lb /acre/day through the rest of the season. Annual vegetables typically have an establishment phase, lasting about 3-5 weeks depending on crop and growing conditions, during which crop N uptake is very low (< 0.5 lb N/acre/day). From that point forward until harvest (for vegetative crops like lettuce and celery) or until the fruit, bulb or tuber maturation phase (melon, tomato, onion, potato, etc.), N uptake is rapid (between about 3-8 lb N/acre/day (depending on crop and growing conditions). This reliable crop N uptake pattern provides a useful template to guide in-season N fertigation.

Manage irrigation to limit NO_3-N leaching:

Unfortunately, strawberries and most vegetable crops are shallowly rooted, so it takes relatively little water in excess of crop irrigation requirements to leach soil NO_3-N below the reach of the crop. Therefore, efficient irrigation is critical to N use efficiency in these crops. We have measured NO_3-N leaching in a number of commercial fields through the use of suction lysimetry. We have found that NO_3-N content of leachate in these crops can range from < 10 lb N/acre·inch to > 30 lb N/ acre·inch. In the upper end of that range even a couple of inches of leaching over a cropping season can remove a considerable amount of N from the root zone.

There are two main elements to efficient irrigation: good system design and operation, and appropriate irrigation scheduling. Our California experience with drip irrigation has been that both elements can be problematic. Regarding design and operation, portable surface drip systems that are reused for multiple crops get increasingly leaky, lowering the distribution uniformity. In both vegetable and strawberry drip systems the operating pressure is often controlled by irrigators manipulating valves rather than by mechanical regulators, which results in uncertain flow rates and poor uniformity. Regarding irrigation scheduling, Inaccurate estimation of crop irrigation requirements can result in excessive application volume, while using long irrigation intervals can result in more water being applied during an irrigation than can be retained in the root zone.

Use crop rotation or cover crops to limit NO_3-N loss:

Even where irrigation and N fertilization are managed efficiently, a significant amount of NO_3-N may be present in the root zone at harvest, or accumulated just below the root zone; this NO_3-N is at risk of being permanently lost to the environment during the winter fallow period in areas where the soil doesn't freeze, and winter rainfall is substantial. Rotating with deeper-rooted crops, whether for harvest (wheat or other grains) or for green manuring (annual rye, mustards, etc.), can recover large amounts of N (potentially > 100 lb/acre) that would otherwise be lost from the field. Different cropping systems have different cultural and economic constraints to the use of crop rotation or cover crops to reduce NO_3-N leaching, and to date many growers have been reluctant to utilize this management practice. However, increasing regulatory pressure may change the cost/benefit calculation in some circumstances.