SOIL TEST N FOR PREDICTING ONION N REQUIREMENTS - AN IDAHO PERSPECTIVE

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ABSTRACT

Universities in the Pacific Northwest provide N fertilization guidelines for onions based, at least in part, on soil test N. But the N recommendations differ appreciably among institutions, and the foundations for the recommendations are difficult to document. A soil test calibration database for Treasure Valley onions was developed from field trials conducted between 1978 and 1996. Field trials involved variable N rates ranging from 0 to 320 lb/A as urea or ammonium nitrate sidedressed at planting (late March -early April) or after bulb initiation (early to late June). Early season soil samples from unfertilized soils (0-12" and 12-24" depth) were collected just prior to or soon after planting at all sites, and just prior to sidedressing in some of the same trials. Mineralized N was measured in each trial conducted since 1991 (18 trials) using a buried bag technique. Onion yield and grade were measured at maturity. Pre-sidedress soil test N was confounded by furrow irrigation and soil NO_3-N movement into the bed. Sidedressed N did not increase marketable onion production when early season soil test NO_3-N from the 0-12" depth exceeded 20 ppm or the combined concentrations from the first two feet exceeded 25 ppm. Measuring NH_4-N did not improve the relationship to relative yield. Mineralized N contributed significantly to onion N requirements based on the dynamics of its release and periodically measured onion N content. Soil organic matter content was unrelated to mineralizable N. Early season soil test NO_3-N to a depth of 12" or 24" can provide useful estimates of onion N requirements.

INTRODUCTION

Adequate nitrogen (N) is essential for optimal growth and development of onions. Whereas low available N can limit production, excessive N can reduce yield, delay maturity, and increase storage losses. Although N costs are only a small fraction of total production costs, the positive or negative influence of N can have inordinate consequences on the financial returns to growers.

Nitrogen fertilization practices have been implicated in the contamination of shallow ground waters in the onion production areas of the PNW. Optimal N management will insure adequate N for maximum onion growth while protecting ground waters.

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Land grant institutions in the PNW differ widely in their N recommendations for onions, and it's not always clear whether the recommendations are research based. Our objective was to evaluate UI N recommendations for onions by expanding the limited data base used for their formulation.

METHODS

Data from variable N rate onion trials at Parma, conducted from 1978 to 1985 were included in this evaluation. For these trials N was banded at planting 3-4" deep on bed shoulders as urea or ammonium nitrate. An additional eighteen Treasure Valley field trials involving N rates sidedressed at bulb initiation (June) were conducted primarily in grower fields from 1991-1996. Treatments in all trials were arranged in randomized complete blocks with at least five replications.

Early season soil samples were collected from the 0-12" and 12-24" depths either prior to planting or shortly thereafter. At some of the more recent sites soil samples were also collected just prior to sidedressing from both depths. Mineralized N in the 0-12" and 12-24" depths was monitored in buried bags throughout the season in all 1991-96 trials. Also in recent trials, onion plant N content was measured periodically during the season from 7 ft^2. At maturity, soil samples were collected from onion beds to a depth of 5 ft for the determination of residual N. All soil and plant samples were analyzed by the UI Analytical Services Laboratory.

The onions in grower fields received the same cultural practices as the surrounding field with the exception of applied N. All onions were furrow irrigated. Onions grown at all but two locations were yellow sweet Spanish types. Onions were harvested from two 3.5' beds for a distance of 35 ft prior to 1985, and from twice this area (four beds) beginning in 1991. Onions were graded into <2", 2-3", 3-4", and >4"diameter bulbs.

RESULTS AND DISCUSSION

Site information for the trials are shown in Table 1. The field trials were conducted on soil types ranging in texture from fine sandy loams to silt loams. The previous crop at most sites was wheat There was a considerable range in residual N as NO_3-N, as well as mineralized N in the first and second foot. The maximum yields also varied appreciably due to variable stands, hail, weed control success, and no doubt other factors.

Onion yields increased at several sites with sidedressed N, but at other locations yields were either unaffected by applied N or were reduced. Where onion yield increased with N, the optimum N rate was seldom above 80 lb N/A.

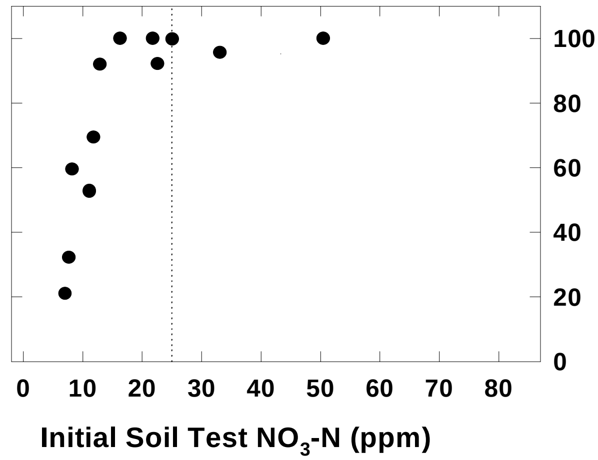
Unfertilized onion yield was related to initial early season residual NO_3-N in the first and second foot (Fig. 1a-b). Onions did not increase yield when early season residual NO_3-N in the first foot exceeded 20 ppm, or 25 ppm for the first and second feet combined. Maximum onion yields occurred with much lower residual N at many sites,

Table 1. Site information.

Trial	Soil Type	Previous Crop	Initial NO_3-N 0-12”	Initial NO_3-N 12-24”	Maximum Yield	Mineralized N 0-12”	Mineralized N 12-24”
			ppm		cwt/A	lb/A	
78 Parma	silt loam	f. corn	5.2	6.6	577	--	--
80 Parma	silt loam	wheat	4.5	6.6	418	--	--
80 SCU	silt loam	wheat	4.5	6.6	577	--	--
81 SCU	silt loam	wheat	3.7	4.0	625	--	--
83 Parma	silt loam	wheat	10.3	--	418	--	--
84 Parma	silt loam	wheat	3.2	2.0	342	--	--
91 Parma	silt loam	wheat	4.1	2.9	733	76	8
91 Saito	silt loam	wheat	27.9	14.3	518	112	35
92 Nyssa	silt loam	s. corn	12.0	21.1	635	77	59
92 Notus	silt loam	wheat	10.7	11.9	881	61	14
92 Uriu	silt loam	wheat	32.6	17.9	633	45	94
92 Mio	f. sandy lm	s. corn	10.2	14.9	1047	142	59
92 Saito	silt loam	wheat	8.2	4.7	883	84	31
93 Takatori	f. sandy lm	wheat	10.0	3.5	684	49	17
93 Hamby	silt loam	wheat	8.0	10.5	550	95	40
94 Hartman	silt loam	wheat	8.5	12.4	532	11	24
94 Takatori	f. sandy lm	wheat	9.5	6.5	534	31	14
95 Takatori	f. sandy lm	wheat	16.0	4.8	524	114	20
95 Mio	silt loam	mint	39.3	24.7	574	349	71
95 Hamby	silt loam	wheat	11.1	20.0	736	57	8
96 Parma	silt loam	wheat	4.0	6.3	633	54	9
96 Hartman	silt loam	wheat	34.7	47.8	260	73	21
96 Mio	f sandy lm	wheat	12.6	9.2	647	78	47

particularly where mineralized N was significant.

The current UI onion fertilizer guide provides a N recommendation based on the sum of $NO_{3ndatil92\ 185.5N}$



N in the first foot to also predict onion N requirements, in addition to soil test N in the first two feet. This probably is related to the onion's shallow root system which accesses residual N primarily from the first 15-20 inches, as well as the loss of deeper N with irrigation. The early season NH_4-N values at these sites were negligible and NH_4-N did not improve the relationship of relative yield to residual N. Mineralized N was appreciable at many locations, but including a term for mineralized N in a multiple regression analysis with residual NO_3-N did not improve the R^2.

The critical level for the two foot depth above which N is not recommended is 25 ppm. Only four of the sites involved yields that were less than 100% relative yields when initial residual N (as NO_3-N) was above 25 ppm, and the unfertilized treatment yields at these sites did not differ statistically from the maximum yields.

Presidedress soil test NO_3-N was spatially more variable across the onion bed than early season soil test N. Early season samples were collected prior to irrigation of the crop, and thus avoided the influence of a wetting front emanating from the wetted furrow. Bed center concentrations of NO_3-N were invariably higher, after the first two irrigations, than concentrations in the onion row or furrow. The NO_3-N concentrations in the onion row were more comparable to concentrations in the furrow, and sometimes lower, reflecting the uptake of N from the root zone. This spatial variability makes difficult the use of pre-sidedress soil NO_3-N for predicting onion N requirements.

The relative yield response of jumbo (>3") onions to the sum of residual NO_3-N and fertilizer N is shown in Figure 2a-b. Figure 2 includes only the relative yield data for the positive yield response to N or, in the event that no positive response to N was measured, the relative yield of the unfertilized check. Onions required from 40 to 160 lb N/A of residual NO_3-N in the 0-12" depth plus fertilizer N for maximum yields. Onions did not require more than 160 lb N/A of residual NO_3-N and fertilizer N at any site. By comparison, total N accumulated at maturity by onions ranged from about 80 to 140 lb/A,

indicating onion N requirements the following season could result in either too little or too much N being applied.

Producers are familiar with the positive effects of applied N and the risks of not providing adequate N for maximum growth. Consequently onions are frequently fertilized with excessive N in relation to their actual requirements because the costs are low in relation to total production costs and growers are unwilling to accept the risk of reduced production from limiting available N. They seldom acknowledge the considerable risks associated with excessive N applications.

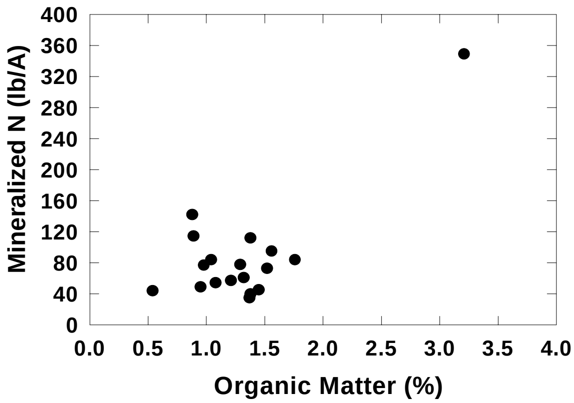


Figure 3. Relationship of mineralized N in p96 186.72 5605.474mags to soil 625.32 c5 598.56 19cm

In addition to yield losses, maturity is delayed with excessive N and a delay in maturity makes field curing more difficult. Poorly cured onions shrink more in storage and are more susceptible to storage related diseases.

Excessive N also leaves N in the soil after harvest that is susceptible to leaching and the contamination of shallow wells. Under furrow irrigation, a surprising amount of the N remains in the first foot or two of soil rather than deeper in the profile. This is due to the movement of nitrates with the wetting front to bed centers where it tends to accumulate. As long as the N requirements of the onions are not exceeded with fertilizer N, residual N after harvest is minimal.

Effective N management insures that N is adequate for maximum production while minimizing the risks associated with excessive N. Spring soil testing is the most effective means currently available to predict the N requirements of onions at planting. Once the requirements are determined, N should be applied as close to the bulbing period as practical for maximum effectiveness. For the Treasure Valley this coincides with early to late June depending on the planting date and onion development.