Cornell Cooperative Extension

Effect of Spring-Applied Nitrogen Fertilizer on Garlic Yield, 2017-2018 CCE Research Results Indicate 50 lb/A is Enough

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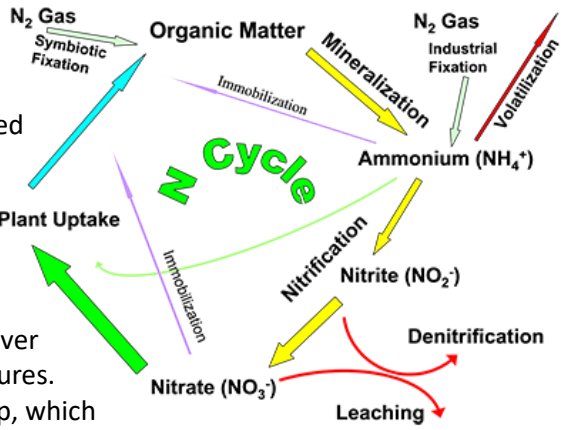
50 lb/A is all that was needed!

In 100% of eight side-by-side comparisons, there were no differences in yield among 50 lb/A, 100 lb/A and 150 lb/A of spring-applied inorganic nitrogen in German hard neck garlic (Fig. 1 and 2). Trials encompassed two years of trials (2017, 2018), three trial sites, three planting configurations, three types of inorganic nitrogen fertilizer, three fertilizer application techniques, and different seed sources and sizes (Table 1). In the second year of study, 50 lb/A of spring-applied nitrogen significantly increased yield by 20% compared to 0 lb/A applied nitrogen. **These results suggest that garlic only needs 50 lb/A of nitrogen to be available in the spring when the crop begins to grow.**

This seems low! University recommendations state that garlic needs between 150 and 175 lb/A nitrogen. So, why did we NEVER see a yield response with greater than 50 lb/A of applied nitrogen? In Western NY, the garlic trials followed sod (Batavia 2017) and oat cover crop (Albion 2018). Additionally, liquid dairy manure was applied in the fall at the Albion site. The increased organic matter made available by turning in sod/cover crop and the manure application in western NY provided an unmeasured credit, which should be factored in. The Long Island site, however, only has about 2% organic matter, so should only receive a maximum nitrogen credit of 15 lbs/percent organic matter, or 30 lbs. If we use trial planting configuration to calculate yield per acre, actual laboratory results for % N in bulb tissue at harvest (Albion 2018 data), and assume that the bulbs are 36% dry matter, we can crudely estimate the amount of nitrogen taken up by the garlic bulbs harvested in our trial, which was roughly 55 to 85 lb/A. This does not include the amount of N that would have been left in the field in the foliage at the end of the season. Interestingly, the amount of available nitrate-nitrogen (NO_3-N) left in the soil at harvest in the Albion trial in 2018 (only time this data was collected) was 6, 22, 38 and 76 lb/A for the 0, 50, 100 and 150 lb/A rates of applied N, respectively (data not shown). These results are another indication that the garlic in these trials had taken up all of the nitrogen that they needed and that excessive nitrogen was applied.

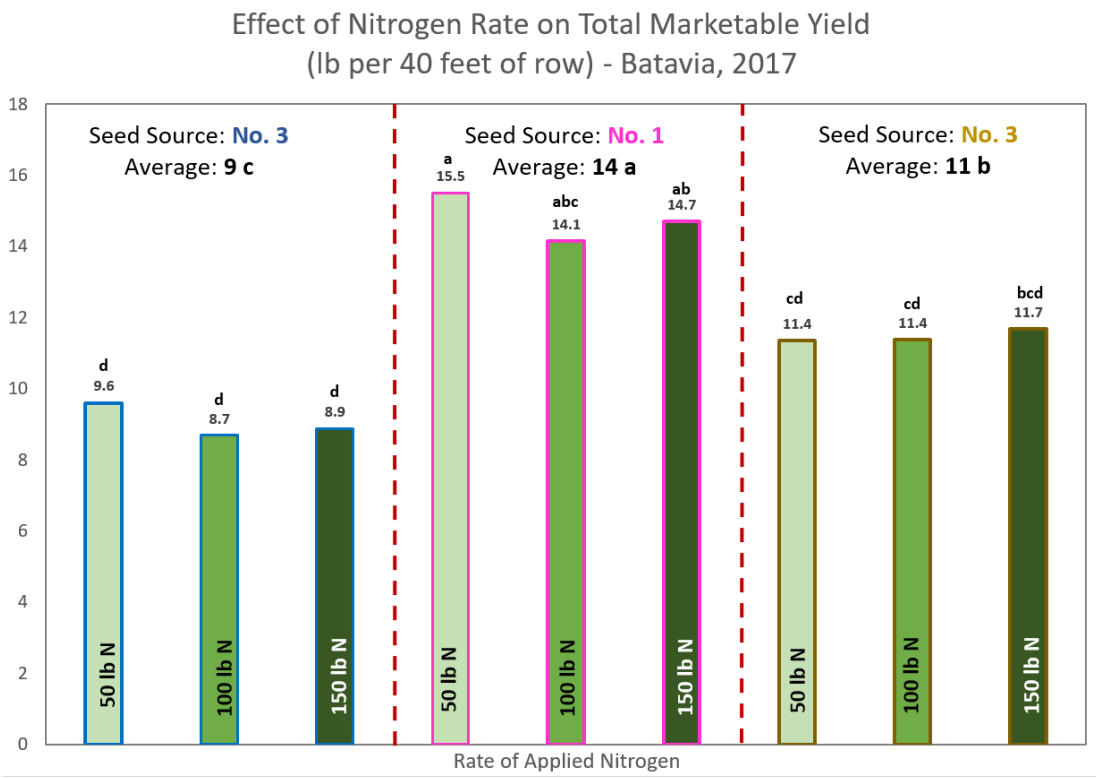
Organic Growers who rely on fall applications of fertilizer will need to consider when the nitrogen sources they are using will become available, and likely need to use total higher rates because of this. Some organic matter is converted to available forms (mineralized) starting at 32 degrees, with rates of conversion being higher in soils with high biological activity and soil moisture at or below field moisture capacity. However, organic matter converts to available forms optimally at soil temperatures above 50 degrees. This is good news for holding onto organic matter over the winter, since it will not become soluble at cold temperatures. However, it leads to some lag in availability for the garlic crop, which starts growing at 40 degrees. Previous work using organic fertilizers has shown that the crop responds favorably up to 100 lbs of N, including soil credits from organic matter.



Simple Diagram of Nitrification process. Source: Iowa State

Garlic has all nitrogen it needs by end of May.
We saw a slight and insignificant increase in leaf tissue % N between 50, 100 and 150 lb/A applied N rates at both May and June evaluation dates in the trials in Western NY. According to some published sufficiency tables, >3% N is considered excessive in garlic. Interestingly, there was no difference in tissue % N between 4 weeks post-N application (May) and during bulbing (June), especially for the 100 and 150 lb/A N rates (Fig. 3). **These results support previous work suggesting the garlic crop has accumulated all of the nitrogen that it needs by the end of May, and that application of additional nitrogen would be unnecessary, at least in situations when leaf tissue %N exceeds 3.5% by the end of May.**

Seed source/size most important determinant of yield.
In 2017, we had seed from three and two different sources in Batavia and Long Island, respectively, and in 2018, we planted seed from large (>2 inch) and medium/small (<2 inch) bulbs. In 2017, Seed Source No. 1 yielded significantly 27% and 36% more than Seed Source No. 2 in Batavia and Long Island, respectively. In Batavia, Seed Source No. 2 and No. 1 yielded 22% and 55% higher than Seed Source No. 3 (Fig. 1). In 2018, garlic of the same seed source grown from seed from large bulbs yielded 50% more than when it was grown from seed from small/medium bulbs (Fig. 2). **These results indicate that that clove size, as a measure of ability to supply nutrients to the developing seedling in the Fall is far more important than nitrogen availability during the following spring. In our trial, increased rate of applied nitrogen in the spring could not make up for smaller seed size.**



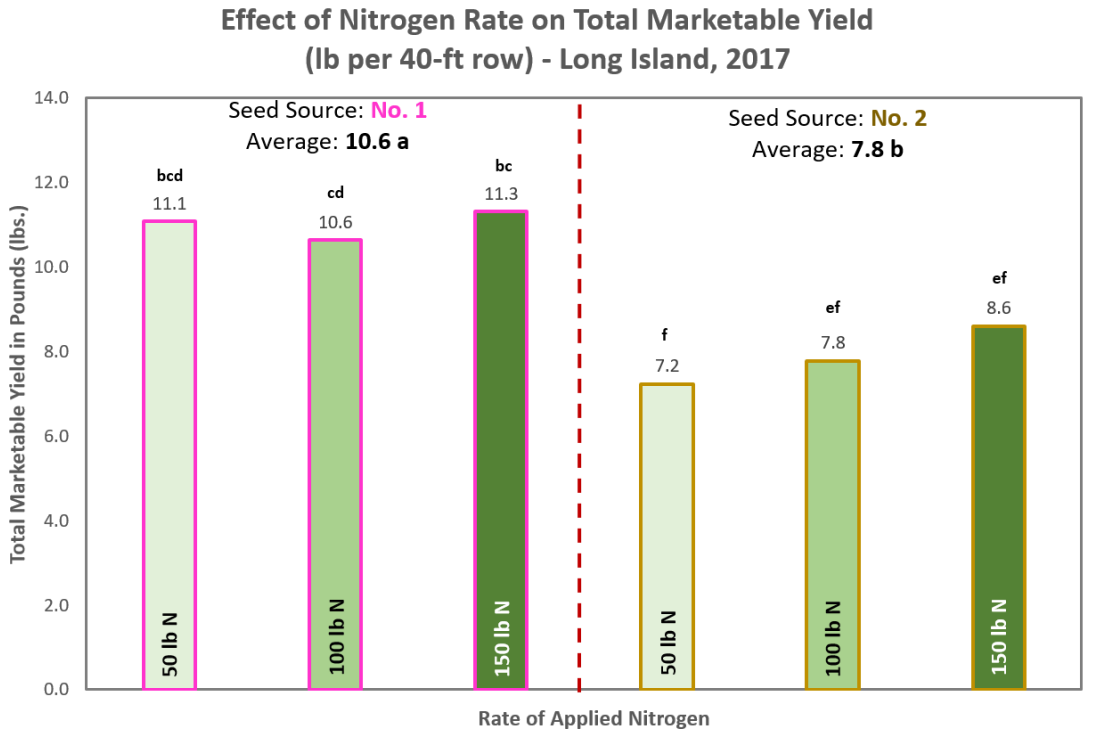
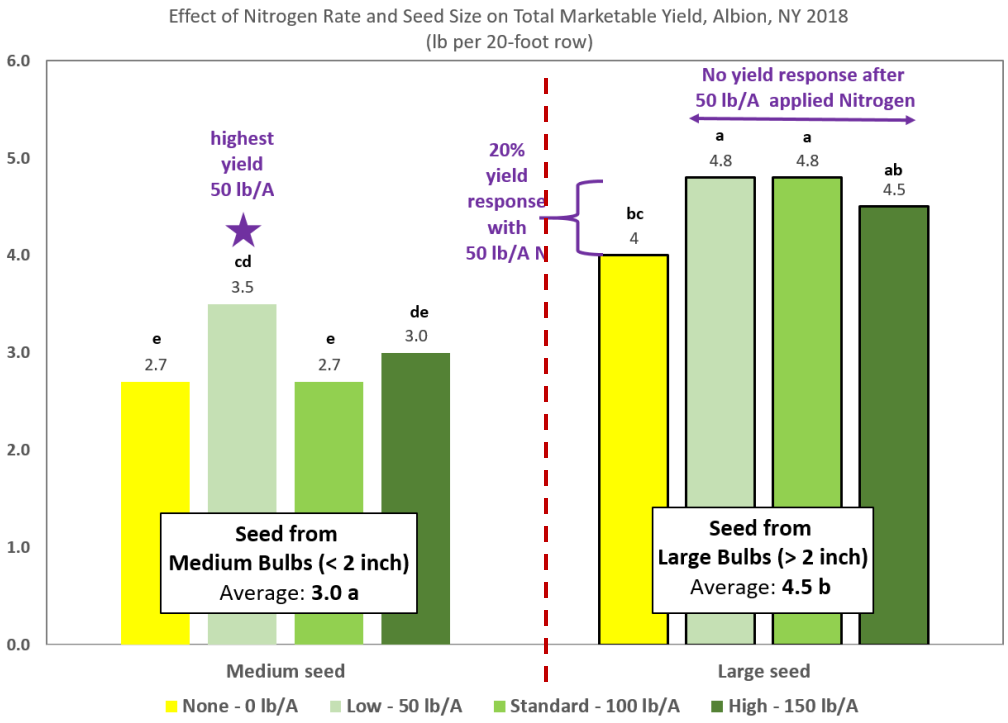


Fig. 1. Effect of rate of spring-applied inorganic nitrogen on garlic yield of three seed sources in Batavia (top) and Long Island (bottom) in 2017. There was no difference in yield among 50, 100 and 150 lb/A in either location in either seed source. Seed source had greater impact on yield than nitrogen. Bars followed by the same number are not significantly different, Fisher's Protected LSD test ($p<0.05$).



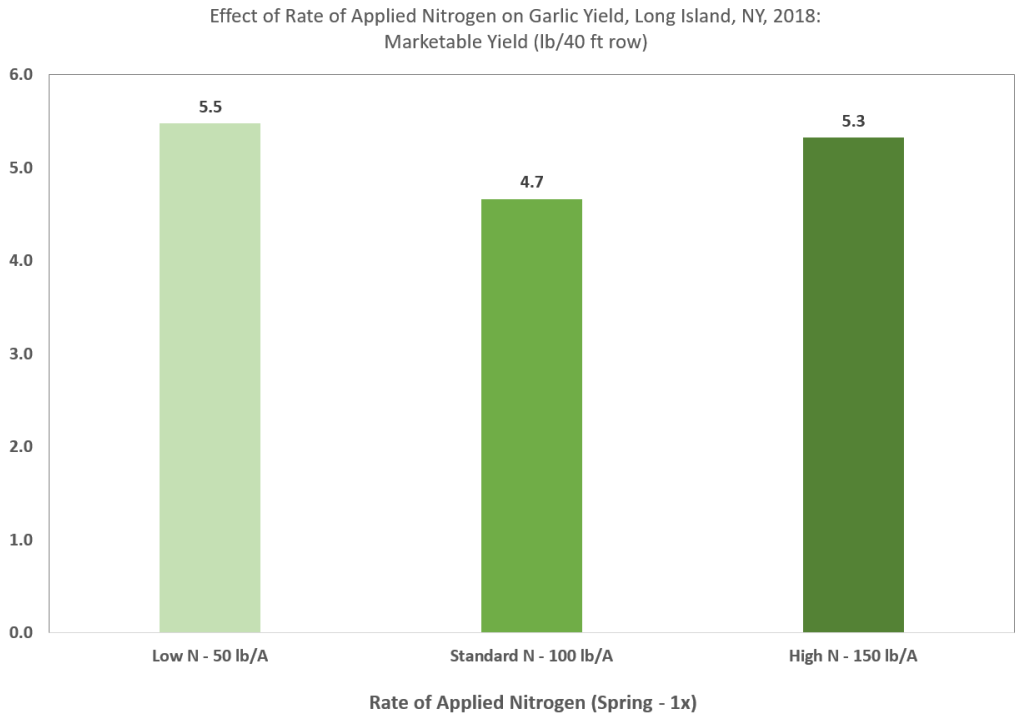


Fig. 2. Effect of rate of spring-applied inorganic nitrogen on garlic yield of three seed sources in Albion (top) and Long Island (bottom) in 2018. There was no difference in yield among 50, 100 and 150 lb/A in either location in either seed source. Seed size had greater impact on yield than nitrogen. Bars followed by the same letter are not significantly different, Fisher's Protected LSD test ($p<0.05$).

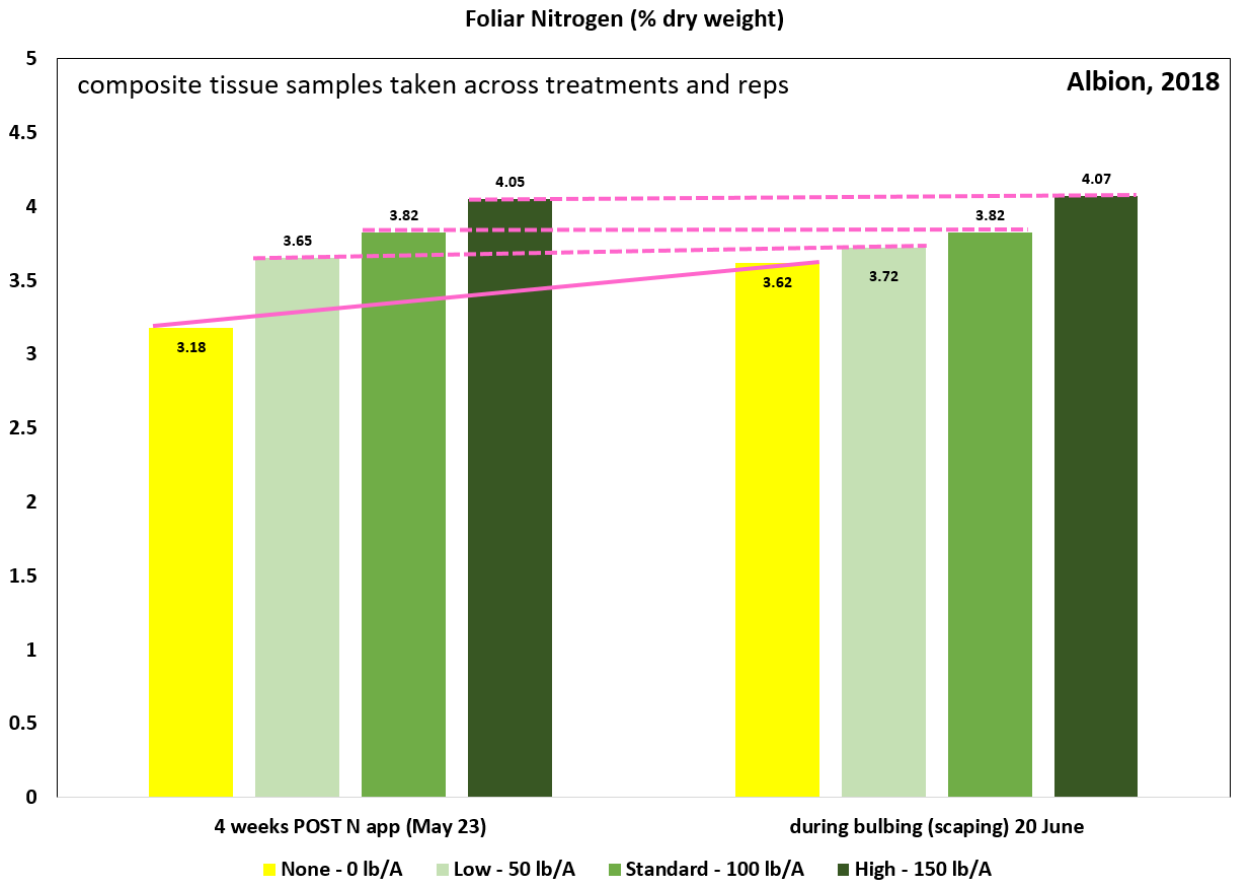


Fig. 3. Effect of rate of spring-applied inorganic nitrogen on foliar tissue nitrogen in garlic, Albion, 2018. Tissue % N insignificantly increased as rate of applied N increased. There was no difference in % N between 4 weeks post-nitrogen application and during bulbing. This is an indication that garlic plant has all the N it needs before bulbing.

Table 1. Evaluation of spring-applied nitrogen on garlic yield: trial details, 2017 and 2018.

	Batavia 2017	Long Island 2017	Albion 2018	Long Island 2018
Soil type	Gravelly loam	Sandy loam	Hilton loam	Sandy loam
Previous crop	sod	Rye cover crop, turned over in spring	Oat cover crop	Sunflower windbreaks
Planting configuration	• 2 rows 15-inch apart per 5 ft • 6-inch plant spacing • Flat bed	• 2 rows 15-inch apart per 5.6 ft • 6-inch plant spacing • Flat bed	• 2 rows 7-inch apart per 2.5 ft • 6-inch plant spacing • Flat bed	• 2 rows 15-inches apart per 5.6 ft • 6-inch plant spacing • Flat
Nitrogen application	Urea (46-0-0) broadcast per area (Apr 13)	Ammonium Nitrate (34-0-0) Side-dressed at emergence and incorporated (Apr 10)	Urea (46-0-0) rate/A concentrated over rows (Apr 23)	(32-0-1) Side-dressed at emergence and incorporated (Apr 12)
Other fertilizer	P & K according to soil test in fall	P & K according to soil test in fall	Dairy manure in fall; P & K in fall according to soil test	P & K according to soil test in fall
Seed Source(s) (all German hardneck)	1, 2 & 3	1 & 2	• Combo of healthy bulbs from 1 & 2 • Seed from large bulbs (> 2-inch) & small/medium bulbs (< 2 inch)	Combo of bulbs from sources 1 &2

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