Understanding Nitrogen Use in Cabbage: New York Study

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The Cabbage Research and Development Program (CRDP) funded a three-year project to investigate various aspects of nitrogen dynamics in cabbage from 2014 to 2016. Following are highlights from this work.

The project involved two on-farm small-plot trials, a grower survey and four case studies. In 2014, treatments included five rates of total applied nitrogen (31, 66, 132, 197, 262 lb/A), which were applied at three different timings (ratio at planting: side-dress; 100:0, 50:50, 25:75) in storage cabbage (c.v. Constellation). In 2016, treatments included three rates of total applied nitrogen (100, 150, 200 lb/A) and two application timings (100:0, 50:50), each with and without nitrogen stabilizer (will not be discussed in this article) in summer cabbage (c.v. Bronco). In 2014, in mid-September, nine fields of summer cabbage were sampled for available nitrate-nitrogen (NO_3-N) in soil and grower nitrogen records collected. In 2015, nitrogen dynamics were studied in three commercial fields of summer cabbage (c.v. Transam) and in one field of red storage cabbage (c.v. Kilmaro). Christy Hoepting (CVP) was the project lead and Steve Reiners, Department of Horticultural Sciences served as an advisor.

Cornell University recommends 100 to 120 lb/A of nitrogen divided among broadcast and incorporated prior to planting (40 lb/A), banded at planting (40 lb/A) and side-dressed 4 weeks after planting (20-40 lb/A). However, there is tremendous variability in nitrogen use among cabbage growers in New York. **In our sampling of 11 large-scale cabbage NY growers, total amount of applied nitrogen ranged from 72.6 to 210 lb/A and averaged 149 lb/A.** Timing of nitrogen application ranged from ratios of at planting: side-dress of 100:0 to 15:85 and everything in between (66:33, 50:50, 40:60, 23:75) with some growers making two side-dress applications.

Consistent trends in nitrogen dynamics in New York studies, 2014-2016:

When 100% of total nitrogen was applied at planting, yield/head size continued to increase as rate of total applied nitrogen increased. Maximum yield was not achieved at maximum applied rate.

Trial Year	Increase in Yield per 50 lb/A N:	Highest Rate of Applied Nitrogen	Yield at Highest Rate of Applied Nitrogen	Yield at 150 lb/A N
"Normal year" (2014 trial)	2.3 ton/A* (storage cabbage)	262 lb/A	38.8 ton/A	34.2 ton/A
Hot & dry year (2016 trial)	0.6 ton/A (summer cabbage)	200 lb/A	34.1 ton/A	33.5 ton/A

*results confounded by club root. As rate of total applied nitrogen increased, severity of club root increased. Would nitrogen use been more efficient in absence of club root (e.g. increase per 50 lb/A even higher)?

<u>Split applications of nitrogen</u> between at-planting (pre-plant incorporated and during planting) <u>resulted in more efficient use of nitrogen</u> and maximum yields were achieved.

	Split Application (at-planting: side-dress)	Rate of Total Applied Nitrogen When Maximum Yield Achieved
2014 trial	50:50	197 lb/A
2014 trial	25:75	132 lb/A
2016 trial	50:50*	150 lb/A

*In 2016, 50:50 split applications of nitrogen increased yield by an average 4.6% (Fig. 2).

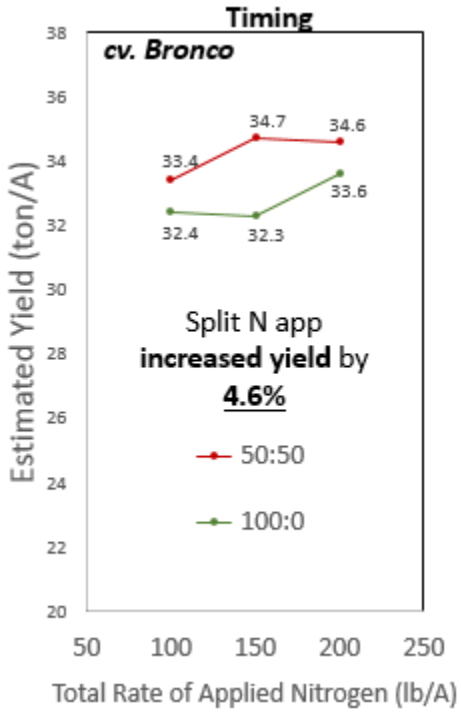

Fig. 1. Effect of timing of nitrogen application on cabbage yield (Hoepting 2016). 50:50 – half of total applied nitrogen applied at planting and half applied at side-dress. 100:0 = 100% of total nitrogen applied at planting. When 100% of nitrogen was applied at planning, yield increased as rate of nitrogen increased. When 50% of nitrogen was applied at side-dressing, maximum yield was achieved at 150 lb/A.

More efficient nitrogen use with split applications makes sense, because **half of the nitrogen uptake by the cabbage crop occurs within the last third of the growing season** during cupping and head formation (Fig. 2). Generally, it takes about two weeks for a newly transplanted cabbage crop to begin to take up nitrogen. At the time of side-dressing, it has only taken up about 10% of its total uptake. During this 4-6 week period, nitrogen applied at planting is especially prone to leaching. Therefore, when 100% of total nitrogen is applied at planting, higher rates are needed to compensate for losses that occur during this time. Alternatively, when nitrogen is applied at side-dressing, it is applied to the crop just ahead of when uptake begins to ramp up, which results in more efficient use.

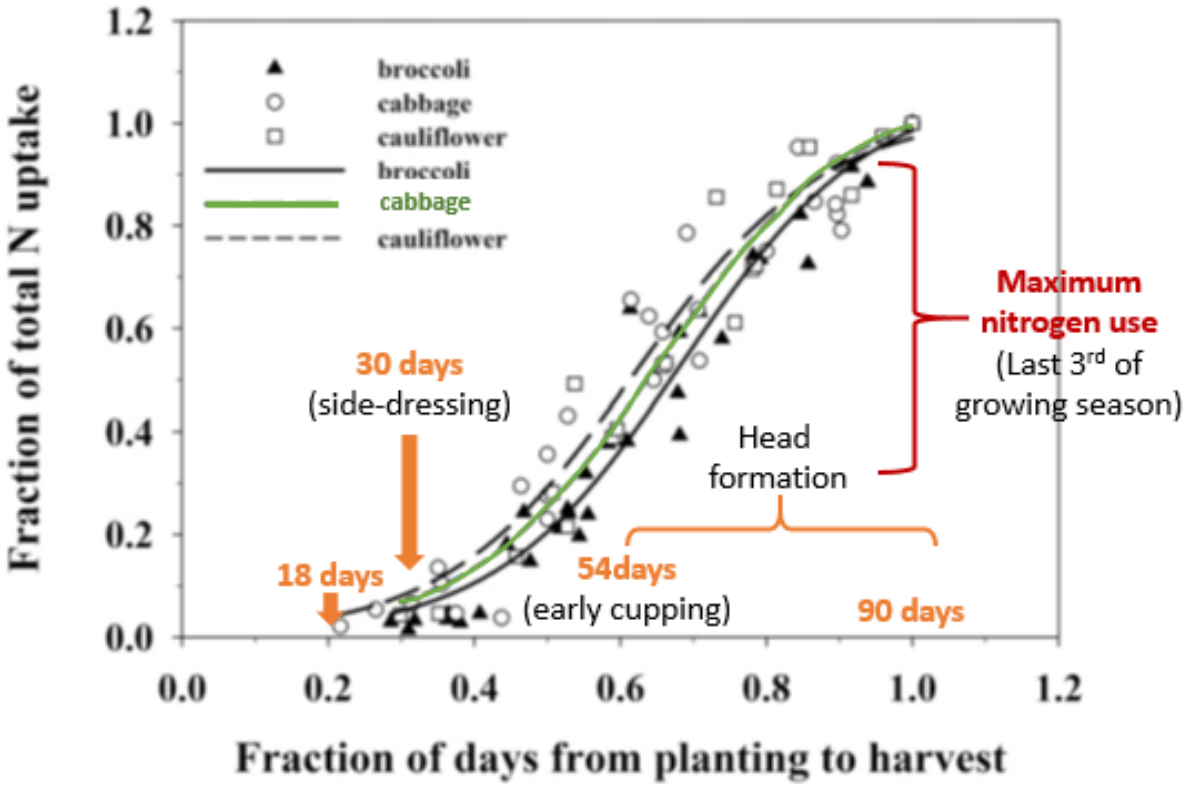

Fig. 2. Nitrogen use in cabbage (green) demonstrated in a recent study in California (Smith et al. 2016) that half of the nitrogen use occurs during the last third of the growing season during cupping and head formation.

Cabbage crop leaves 100 lb/A of nitrogen in leaf residue in the field

Originally, CRDP funded closer investigation of nitrogen dynamics in cabbage, because there was concern that too much nitrogen remained in fields of summer cabbage after harvest that later could cause lodging in winter wheat. Winter wheat is prone to lodging when it takes up greater than 150 lb/A of nitrogen. For this project, **we sampled available soil nitrogen after cabbage harvest extensively, and consistently found less than 10 lb/A**, which was in line with studies in Canada and California (Table 1). This in itself poses no concern for lodging of winter wheat.

Analysis of cabbage tissue at harvest revealed that a **summer cabbage crop uses about 200 lb/A of nitrogen**, which was divided fairly equally between the head and the leaf and stump residue (Table 2). Interestingly, our studies showed that **nitrogen uptake by the cabbage crop exceeded the amount of nitrogen applied via fertilizer.** For example, in the 2016 trial, nitrogen uptake exceeded amount applied (150 lb/A) by 35 to 73 lb/A (=23 to 48%). Apparently, this is typical, and an indication that a **cabbage crop is a very efficient nutrient scavenger.**

Approximately 100 lb/A of total nitrogen remains in the field within the leaf and stump residue after cabbage is harvested. Once the residue breaks down, this nitrogen will be mineralized and become readily available for plant uptake again. Depending on when this occurs, this could conceivable contribute to lodging of winter wheat. **Growers should consider cabbage residue as a source of nitrogen for proceeding crops, and potentially reduce their nitrogen inputs for these crops.**

Table 1. Amount of available nitrate-nitrogen remaining in soil in cabbage field after harvest (Hoepting 2014-2016).

Study	Available NO_3-N (lb/A)		
	Average	**Minimum**	**Maximum**
2014 Nitrogen Trial (33-262 lb/A N) Storage cabbage	**7.5**	1.8	29.0
2014 Grower Survey Summer Cabbage	**9.0**	2.1	43.3
2015 4-Field Case Study 3 Summer; 1 storage cabbage	**8.0**	0.0	30
2016 Nitrogen Stabilizer Trial (50-200 lb/A N) Summer cabbage	**8.0**	0	32
Salinas Valley, CA study (30 broccoli, cabbage & cauliflower fields)	**10** (NO_3-N + NH_4-N)	--	--
Canada study (0-446 lb/A N) c.v. Bartolo	**8-10** (0-267 lb/A N)	--	26.7 (267-446 lb/A)

Table 2. Amount of total nitrogen in cabbage tissue at harvest (Hoepting, 2015 & 2016).

Study	Mean Total Nitrogen (lb/A) (range)		
	Head (Harvested)	**Stump & Leaves (Left in Field)**	**Total N Use**
2015 4-Field Case Study **2 Summer; 1 storage cabbage**	101 (=48%)	**109**	**210**
2016 Nitrogen Stabilizer Trial (100-200 lb/A N) **Summer cabbage**	96.5 (=48%) (56-143)	**103** (78-143)	**200** (168-226)

Study indicates 150 lb/A Nitrogen more appropriate for cabbage in New York

When all of the data is compiled from the on-farm trials and the case studies in this project, it appears that the Cornell recommendations for nitrogen of 100-120 lb/A for cabbage are too low and that 150

lb/A would be more appropriate. Our work on nitrogen dynamics in cabbage continues and we hope to have new nitrogen recommendations in the Cornell guidelines in the near future.

For more information:

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Also, an executive summary on this project was presented at the 2017 Empire Expo and is available online at http://www.hort.cornell.edu/expo/2017proceedings.php (scroll down to cabbage session and click on nitrogen dynamics in cabbage).