What's Cropping Up?

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Field Crops Dominate NY Crop Acreage and Rival Milk in Value

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Total field crop acreage in NY, which approximated 3,500,000 in 2012, has averaged approximately 3,385,000 from 2003-2012 (Figure 1). Total cropland harvested in NY averaged about 3,700,000 acres from 2003-2012 so field crops represent more than 90% of the harvested crop land in NY. All grain crops (grain corn, wheat, oats, and barley) as well as soybeans, grown mostly by cash crop

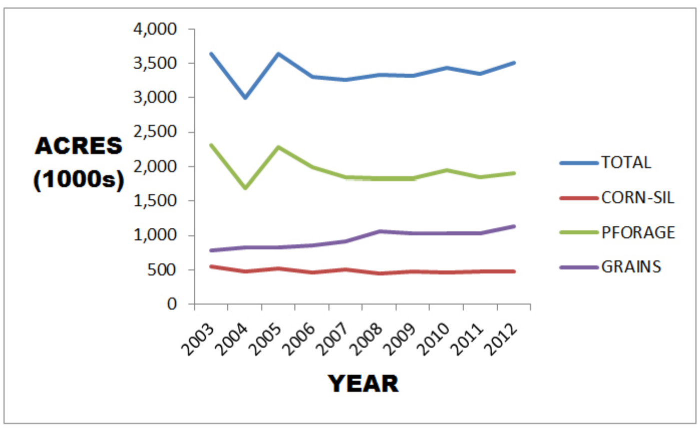

Figure 1. Total acres (in thousands) of all field crops (corn silage, perennial forages, and grains) as well as acreage of corn silage, perennial forages, and grains in NY from 2003-2012.

producers, have averaged about 950,000 acres from 2003-2012 (Figure 1). Consequently, a high percentage of field crop acreage resides on dairy farms. Corn silage, grown mostly by dairy producers, has averaged about 480,000 acres over the last 10 years (Figure 1), The bulk of the field crop acreage on dairy farms, thus, is in perennial forages with an average of about 1,950,000 acres from 2003-2012 (Figure 1).

In 2010, the National Agricultural Statistics Service began to estimate the value of all perennial forages, including haylage and green chop, instead of just the price of all hay. A significant percentage of perennial forages are harvested as haylage or green chop by dairy producers in NY. Consequently, the value of perennial forages in NY in 2010 was no longer $272M, the value of all hay, but rather $844M, the value of all perennial forages (Figure 2). The value of perennial forages now exceeded the value of grain crops (grain corn, soybean, wheat, oats, and barley) in 2010 and 2011 and was similar in value in 2012 at $942M (Figure 2). Similar to grain corn, the value of corn silage also increased significantly with a value of ~$310M in 2010, $430M in 2011, and ~$530M in 2012 in NY (Figure 2). Consequently, the value of perennial forages and corn silage produced by dairy producers approached almost $1.5B ($942M +$532M in 2012). **That is B for a billion**. Obviously, dairy producers contribute greatly to the value of NY field crops.

So just what is the total value of field crops grown in NY, including perennial forages and corn silage produced on dairy farms? Well, the number may surprise some

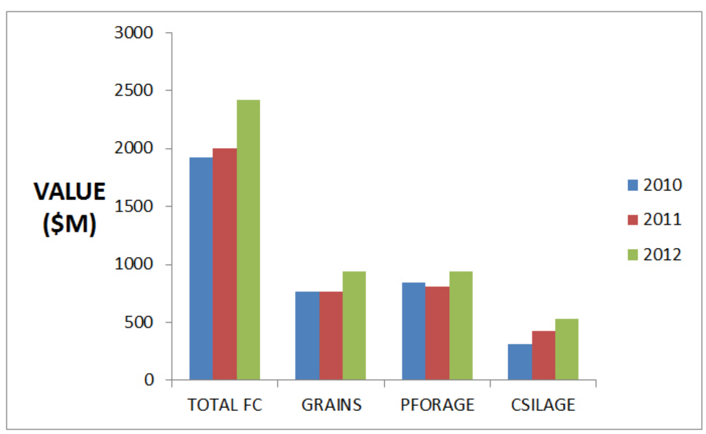

Figure 2. The value (in millions) of all field crops (corn silage, perennial forages, and grains) as well as grains (including soybeans), perennial forages, and corn silage in NY in 2010, 2011, and 2012.

Crop Management

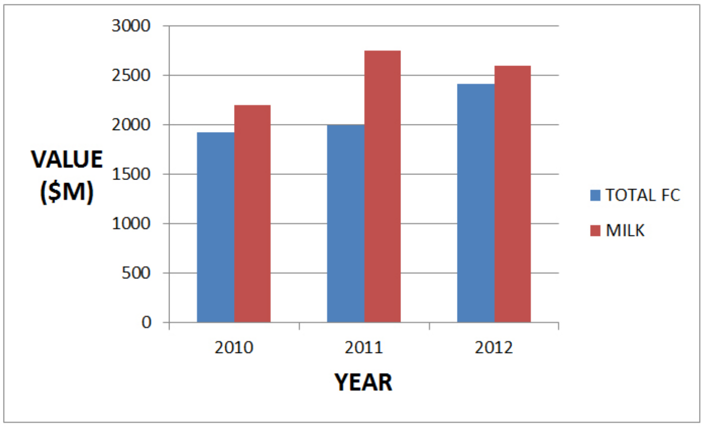

Figure 3. The value of all field crops (perennial forages and corn silage, produced mostly by dairy producers; and grain corn, soybeans, wheat, oats, and barley, produced mostly by cash croppers) compared to the value of milk in NY in 2010, 2011, and 2012.

because of the almost complete lack of awareness on the value of field crops throughout NY. The value of all field crops averaged close to $2B in 2010 and 2011 and approached $2.5B in 2012 (Figure 3). Just to put that value in perspective, the total value of milk approximated $2.2B in 2010 and averaged about $2.6B in 2011 and 2012 (Figure 3). The total value of field crops over the last 3 years approximated 85% of the value of milk in NY. Crop consultants, who scout much of the crop acreage on dairy farms because dairy producers are busy managing the entire operation, are aware of the value of these crops. Unfortunately, in many regions of the state, the value of field crops is not recognized.

Conclusion

Field crops, long associated with the dairy industry, occupy more than 90% of the harvested cropland in NY. More than 70% of the field crop acreage resides on dairy farms in large part because of perennial forage acreage. Total value of field crops exceeded $2B when averaged from 2010-2012 with about 40% of the value derived from grain crops and soybeans and 60% of the value derived from corn silage and perennial forages. Despite the significant rise in the value of grain crops in the last few years, field crops grown on dairy farms still exceed grain crop and soybean value in NY. Obviously, forages, especially perennial forages, are one of the most valuable agricultural commodities in NY. Together, field crops produced by cash croppers and by dairy producers equaled about 85% of the value of NY milk averaged over the last 3 years, a fact that escapes many individuals familiar with NY agriculture.

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Corn, Soybean and Wheat: Unsung Segment of NY Agriculture Over Last 5 Years

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Crop Management

Unbeknownst to many, the value of corn, soybeans, and wheat has increased greatly in NY over the last 5 years, led by the dramatic increase in the value of grain corn (Figure 1). Grain corn value, which approximated $700M in 2012, averaged over $500M annually from 2008-2012 compared to just less than $200M annually from 2003-2007. The approximate 2.5-fold increase in grain corn value in NY is only exceeded by the soybean value increase. Soybean value in NY, which approximated $200M in 2012, averaged about $140M from 2008-2012 compared to just over $50M from 2003-2007, a 2.8-fold increase (Figure 1). Although the overall value of wheat is much more modest, nevertheless, wheat had a 2-fold value increase averaging above $40M annually from 2008-2012 compared to $20M annually from 2003-2007 (Figure1).

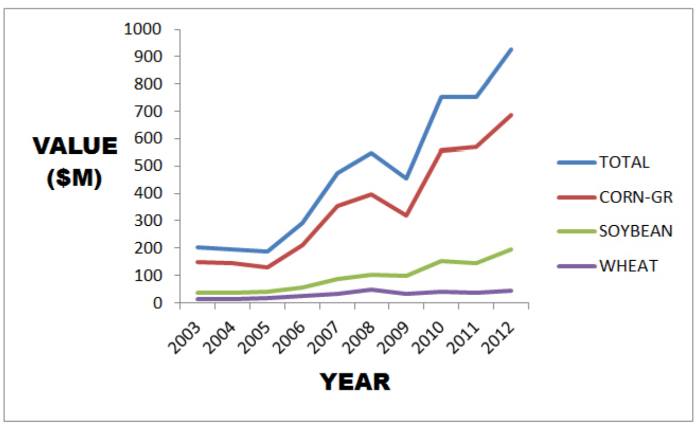

Figure 1. The total value (in millions of dollars) of grain corn, soybean, and wheat as well as the value of each individual crop in New York from 2003 through 2012.

To place the value of these three crops in perspective, **the value of grain corn, soybeans, and wheat averaged about $930M in 2012, $150M more than the combined value of all fruit and all vegetables produced in NY** (Figure 2). That's right- the value of corn, soybean and wheat exceeded the combined value of all fruit (apples, pears, grapes, cherries, strawberries, blueberries, etc.) and all vegetables (fresh market and processed). As you can see from Figure 2, the total value of corn, soybeans, and wheat in NY were somewhat less than the value of all fruit alone or all vegetables alone from 2003 until 2006. The total value of corn, soybeans, and wheat averaged about $270M annually from 2003-2007 in NY compared to about $275M annually for all fruit and almost $310M annually for all vegetables. In contrast, the total value of corn, soybeans, and wheat has approximated $700M annually from 2008-2012 in NY, nearly equal to the combined value of almost $325M annually for all fruit and almost $400M annually for all vegetables. Obviously, the paradigm of the value of NY crops has shifted in the last 5 years.

The 2.5-fold increase in grain corn value in NY over the last 5 years can be attributed in part to a 1.3-fold increase in acreage (Figure 3). Grain corn acreage averaged 625,000 annually from 2008-2012 compared to 485,000 annually from 2003-2007. The annual price of grain corn, however, also increased from $3.20/bushel from 2003-2007 compared to $5.82/bushel from 2008-2012. More importantly, grain corn growers in NY responded to the increased selling price not only by planting more acres but also by increasing yields as indicated by the annual average of 125 bushels/acre from 2003-2007 compared to 139 bushels/acre from 2008-2012. Thus, the combination of about 140,000 more acres, a $2.60/bushel price increase and a 14 bushel/acre yield increase over the last 5 years have contributed to this dramatic increase in corn value in NY.

Likewise, the almost 2.8-fold increase in soybean value in NY can be attributed in part to a 1.5-fold increase in acreage as indicated by an average of 270,000 acres from 2008-2012 compared to about 180,000 acres from 2003-2007 (Figure 2). The annual price of soybean also increased from $7.15/bushel from 2003-2007 compared to $11.35/bushel from 2008-2012. As with corn, soybean growers in NY responded to the increased selling price not only by planting more acres (new soybean growers also contributed to the acreage increase) but also by increasing yields as indicated by the annual average of 40 bushels/

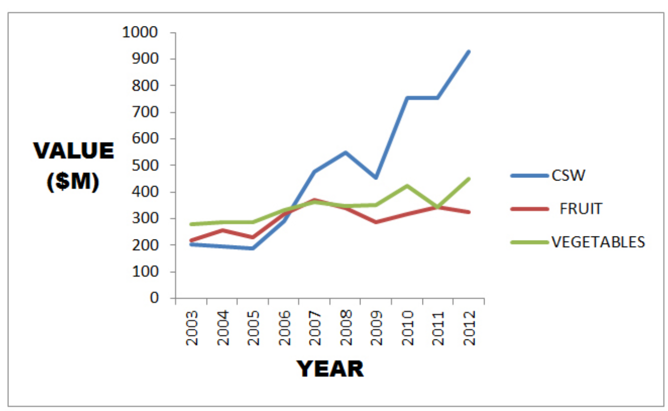

Figure 2. The total value (in millions of dollars) of grain corn, soybean, and wheat (CSW), all fruit (apples, grapes, pears, cherries, strawberries, blueberries, etc.), and all vegetables (processed and fresh market) in New York from 2003 through 2012.

Crop Management

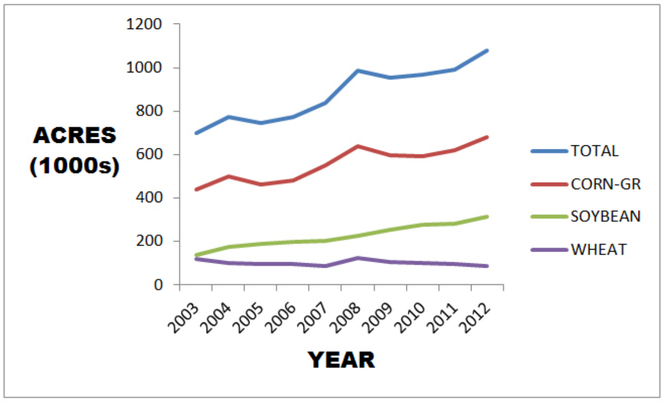

Figure 3. The total acreage (thousands of acres) of grain corn, soybean, and wheat and acreage of each crop in New York from 2003 through 2012.

acre from 2003-2007 compared to 45 bushels/acre from 2008-2012. As with corn, the combination of about 90,000 more acres, a $4.20/bushel price increase, and a 5 bushel/acre yield increase has made soybean a major crop in acreage and value in NY.

Conclusion

The data clearly indicate the importance of grain corn, soybeans, and wheat to NY agriculture over the last 5 years. During this same time period, most of the attention on growing NY agriculture and the upstate economy has focused on Greek yogurt and the dairy industry, grape growers and the wine industry, apple growers and the fruit industry, local foods and Farmers' Markets, organic crops and organic milk, etc. These industries certainly deserve credit for providing considerable attention to the importance of NY agriculture to the upstate NY economy. Furthermore, some of these industries, specifically the wine and fruit industry have significant value-added impact to the upstate NY economy because of agro-tourism. Likewise, the popularity of Greek yogurt has generated new jobs in some communities and has the potential to grow the NY dairy industry and the upstate NY economy. What has been missing in the discussion, however, has been the tremendous value-added impact that corn, soybean, and wheat production has brought to the upstate NY economy via the multiplier effect. The number of purchased planters, combines, and tractors by corn, soybean, and wheat growers in the last 3 years has fueled resurgence in the agricultural implement industry. The new equipment is so sophisticated that new purchases not only generate jobs for sales people and mechanics but also technicians who are conversant with modern computer-driven equipment. Likewise, the number of new storage facilities on farms has created a vibrant new grain storage industry in upstate NY. Furthermore, the transportation of more corn, soybeans and wheat to grain mills and ethanol plants result not only in more jobs for grain mill and ethanol plant workers but also for truckers hauling the grain. Finally, the growth of the crop consultant industry and crop input industries; including the seed industry (~$200M in sales annually of corn, soybeans, and wheat) and fertilizer industry (~$100M annually applied to these three crops) have skyrocketed in the last 5 years, creating new full-time positions in the agricultural sector. The lack of recognition of this vibrant segment of the NY agricultural industry clearly makes grain corn, soybeans, and wheat the unsung segment of NY agriculture over the last 5 years.

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Carbon and Nitrogen Uptake of Cereal Cover Crops Following Corn Silage

Nutrient Management

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Introduction

The inclusion of winter cereals as cover crops into various crop and livestock systems is a relatively common practice in today's agriculture. The primary reasons for this are protection of soil from erosion and enhancement of soil health through organic matter and carbon (C) addition (Long et al., 2012). However, farmers are increasingly interested in using cover crops to sequester nitrogen (N) in the fall (cover crops as catch crops) and carry it over to the spring. As such, the cover crop could reduce the risk of N loss to the environment and benefit the following corn crop (Long et al., 2012). Initial research in New York in fall 2010 suggested average total C and N uptake of 20–30 lbs N/acre and 250–450 lbs C/acre by cover crops seeded after corn silage harvest (Ketterings et al., 2011). In fall 2011, we sampled 49 additional cover crop fields seeded to oats (4), rye (18), triticale (9), and wheat (18) to evaluate N and C uptake. Site selection was determined by producer interest in the project. Cover crop biomass was determined using a sampling area of 8 by 38.5 inches at four locations in each field. Within these areas, cover crops were uprooted so that both above and below ground biomass could be determined. Once back at the laboratory, samples were washed to remove soil, roots and shoots were separated, dried, and weighed to determine dry matter (DM), and then ground and analyzed for C and N content.

Results and Discussion

The total N accumulation averaged 18 to 29 lbs N/acre and total C was 174 to 369 lbs C/acre (Table 1). These averages were very consistent with the 20–30 lbs of total N/acre and 250–450 lbs of total C/acre reported the previous fall (Ketterings et al., 2011), but variability among all fields was large, ranging from 1 to 64 lbs N/acre and 18 to 779 lbs of C/acre.

Table 1. Fall 2011 biomass, carbon (C) and nitrogen (N) content, C:N ratio, and total C and N accumulation of various cover crop species seeded after corn silage harvest in New York.

Species (# of fields)		Biomass DM	Total C	Total N
		ton/acre	lbs/acre	lbs/acre
Oats (4)	Average	0.20	174	18
	Min	0.02	18	1
	Max	0.32	280	28
Triticale (9)	Average	0.42	369	24
	Min	0.08	68	5
	Max	0.91	813	47
Wheat (18)	Average	0.38	331	24
	Min	0.05	44	3
	Max	0.81	707	52
Rye (18)	Average	0.42	365	29
	Min	0.02	21	2
	Max	0.89	779	64

All four oats fields were planted within a short period of time (between 9/16 and 9/25/2011) and had received fall-applied manure. Similarly, for triticale the planting window was relatively small (fields planted between 9/13 and 9/23/2012). The triticale field with the highest C and N accumulation (813 lbs C/acre and 47 lbs N/acre) had received 5,000 gallon/acre surface applied manure versus no manure history for the field with the lowest C and N accumulation, and manure application was positively correlated to total C and N uptake (i.e., more manure, more uptake). Wheat fields were planted 9/16/2011 to 10/12/2011. Total N uptake by wheat ranged from 3 to 52 lbs N/acre. The date of planting plus the amount of N applied with manure explained 90% of the variability in total N uptake for wheat with planting date as the biggest driver, explaining 79% of the variability. Similarly, for cereal rye the planting date was the driver for total N uptake, explaining 51% of the variability in total N uptake. For cereal rye, the lowest accumulation of 2 lbs N/acre was in a field seeded on 10/12/2011 while the largest accumulation of 64 lbs N/acre was for a field seeded on 9/12/2011.

The ranges in C and N uptake for the 49 fields in this study indicate the importance of early planting for C and N accumulation and the potential for higher accumulation for fields with a recent manure history. In this study fields were randomly chosen and no side by side comparisons of the impact of planting date or manure history were done. To evaluate and quantify the impact of planting date and manure history, replicated trials will need to be conducted in future years.

In the dataset that was collected in fall 2010, 10 to 15% of the total N uptake was in the roots (Ketterings et al., 2011). For the 49 fields sampled in fall 2011, the roots contained 7 to 13% of the total amount of N (Table 2). Total C in the roots varied from 16 to 22%, also consistent with the data reported for the fall of 2010, where 10 to 24% of total C was present in the roots (Ketterings et al., 2011).

All species had very similar C:N ratios for shoots, ranging from an average of 9:1 for oats to 13:1 for triticale (Table 2). The field-to-field variability within a species was small and all samples had C:N ratios below 25:1, indicating that breakdown of the plant material upon termination of the stand would not be hindered by N availability. The root C:N

Nutrient Management

ratios averaged 23:1 across species, ranging from an average of 17:1 for oats to an average of 30:1 for triticale, reflecting lower N content compared to the shoots (Table 2). The average C:N ratio for roots of a single species exceeded 25:1 for triticale only, although there were individual cereal rye and wheat fields where root C:N ratios also exceeded 25:1.

Table 2: Fall 2011 biomass, carbon (C) and nitrogen (N) content, C:N ratio, and total C and N accumulation for roots versus shoots of various cereal cover crop species seeded after corn silage harvest in New York.

Species (# of fields)		Biomass DM*		C content	N content	C:N Ratio	Total C*		Total N*	
		ton/acre	%	% of DM			lbs/acre	%	lbs/acre	%
Oats (4)	Shoots	0.17	85	43.25	4.84	9:1	147	85	16	89
Triticale (9)	Shoots	0.32	76	43.93	3.34	13:1	287	78	21	88
Wheat (18)	Shoots	0.31	83	44.08	3.80	12:1	272	82	22	92
Rye (18)	Shoots	0.35	83	44.30	4.21	11:1	306	84	26	93
Oats (4)	Roots	0.03	15	39.85	2.41	17:1	27	16	2	11
Triticale (9)	Roots	0.10	24	42.64	1.46	30:1	82	22	3	13
Wheat (18)	Roots	0.07	18	41.58	1.82	25:1	60	18	2	8
Rye (18)	Roots	0.07	17	41.30	1.85	24:1	60	16	2	7

* Percentage columns indicate the percent of DM, C or N of the total amount of DM, C or N in roots and shoots combined. Percentages may not add up to 100% due to rounding.

The C:N ratio in the 2011 dataset (17:1–30:1 for roots and 11:1–13:1 for shoots) was consistent with the findings in 2010 (14:1–25:1 for roots and 10:1–16:1 for shoots as reported in Ketterings et al., 2011). The C:N ratio for roots indicated that some immobilization of N upon crop termination could occur, but since only a small portion of the total biomass is in the roots; such immobilization is unlikely. Furthermore, these species overwintered, so evaluation of root and shoot C:N ratios in the spring is needed to determine if an impact of N availability for the following crop could be expected.

Conclusions and Summary

For cereal cover crops seeded after corn silage harvest in 2011, average C accumulation ranged from 174 to 369 lbs C/acre (average 310 lbs C/acre) while N uptake varied from 18 to 29 lbs N/acre (average 24 lbs N/acre). As these results are very similar to measurements from the previous year, they support a general estimation of 20–30 lbs N/acre accumulation in the fall for cereal cover crops seeded after corn silage in NY, independent of species. Early planting is essential for the greatest N uptake, but to evaluate and quantify the impact of planting date and also manure history on fall growth; replicated trials will need to be conducted in future years.

> Research in New York in 2010 and 2011 supports an estimate of 20–30 lbs N/acre fall accumulation for cover crops seeded after corn silage.

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Fall Carbon and Nitrogen Uptake of Various Cover Crop Mixtures Following Small Grains; Fall 2010 and 2011 Data

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Nutrient Management

Introduction

Cover crops have become an important component of rotations over the past several years, especially in small grain rotations where an August harvest date allows for early planting of the cover crops. In fall 2010 and 2011, 31 individual cover crop plots (five different farms) were sampled to determine fall dry matter (DM), carbon (C) and nitrogen (N) accumulation in the cover crop. The sampling included 15 different mixtures of cover crops seeded after small grains: oats/peas (1), radishes/annual ryegrass (1), turnips/oats (1), radishes (5), forage turnips (1), radishes/peas/oats (3), annual ryegrass/crimson clover (1), crimson clover (3), oats (4), radishes/oats (3), radishes/peas (1), annual ryegrass (1), sorghum sudangrass (2), crimson clover/oats (2), radishes/crimson clover (2). In fall 2010, 13 plots had above ground biomass sampled; while root biomass was also sampled in plots containing radishes or turnips. In 2011, 18 plots were sampled for both roots and shoots. At the laboratory, samples were washed to remove soil, roots and shoots were separated, dried, ground, and analyzed for C and N content. The 2011 data showed that on average 79% of the total C and 81% of the total N was in the above ground biomass for non-radish mixtures. This percentage was used to calculate the total C and N pools for fall 2010 where no root sampling had taken place. See Table 1 for field management histories.

Findings

The total biomass accumulation for individual plots ranged from 0.97 to 5.29 tons DM/acre, while average biomass for each of the five farm locations ranged from 1.55 to 5.29 tons DM/acre (Table 2).

The C content for individual plots ranged from 0.38 to 0.42% C, averaging 0.40% C of DM, resulting in an average accumulation per field of a little more than 1000 lbs C/acre to more than 4000 lbs C/acre. If we assume that 40% of this cover crop C pool contributes to soil organic matter (Sullivan and Andrews, 2012), this would imply an addition of 400 to 1600 lbs C/acre with the potential to increase soil organic matter levels by 0.03 to 0.14% organic matter per acre (absolute values, assuming 58% C in soil organic matter).

Total N uptake for fields (averaged across species) ranged from 47 to 169 lbs N/acre, with individual plots ranging from 28 to 169 lbs N/acre (Table 2). These ranges reflect differences in biomass accumulation plus a large variation in N content; the N content of crops in individual plots ranged from 1.27 to 3.05% N of DM, while field average N contents ranged from 1.52 to 2.41% N of DM. In August 2010, the nine day spread in planting date (August 10 and 19) did not impact the cover crop biomass, C and N accumulation (Table 2). Of all species and mixtures, those that included oats and/or radishes or turnips took up 100 lbs N/acre or more, while annual ryegrass, sorghum sudangrass and crimson clover accumulated less C and N.

In 2011, the spread in planting dates was much larger (August 8, 12, and 24) than in the previous year, contributing to a considerable range in C and N accumulation and a much lower C and N accumulation for the field planted August 24 (see Table 2 and compare Figures 1 and 2). The importance of early planting is consistent with the findings reported in Ort et al. (2013) for cover crops seeded after corn silage harvest; earlier planting allows for considerably greater accumulation of C and N in the fall.

Despite lower C and N accumulation for the field seeded August 24, the C and N uptake values for this field still exceeded the 174 to 369 lbs C/acre and 20 to 30 lbs N/acre documented

Table 1. Field information for the five farm fields where cover crops were seeded after small grain harvest and sampled for fall accumulated biomass, carbon and nitrogen.

Producer	Branton	Lightfoote	Lott	Kemmeren	Merrimac
Soil type	Odessa	Ontario	Dunkirk Schoharie	Lordstown	Lansing
Soil pH	5.4	6.5	6.4	.	7.5
Organic matter (%)	1.88	2.66	2.1	.	3.4
Seeding date	8/10/2010	8/19/2010	8/8/2011	8/12/2011	8/24/2011
Harvest date	11/3/2010	11/3/2010	11/9/2011	11/7/2011	11/9/2011
Fertilizer applied	21-0-0-24S (100 lbs/ac), 18-46-0 (100 lbs/ac), 0-0-60 (100 lbs/ac)	21-0-0-24S (100 lbs/ac), 18-46-0 (100 lbs/ac), 0-0-60 (100 lbs/ac)	21-0-0-24S (143 lbs/ac) and 0-0-50 (250 lbs/ac)	46-0-0 (100 lbs/ac)	30-0-0 (10 gals/ac)
Fertilization date	8/10/2010	8/10/2010	8/29/2011 10/20/2011	8/20/2011	Fall 2011
Manure applied	.	.	.	20 tons/acre	.
Manure date	.	.	.	8/3/2011	.

Nutrient Management

Figure 1 (left) and 2 (right). Peas/oats/radishes on 11/9/2011 at Lott Farm. Field planted 8/8/2011 (left) and peas/oats/radishes on 11/9/2012 at Merrimac Farm. Field planted 8/24/2011(right)

for cover crops seeded after corn silage harvest (Ort et al., 2013), once again showing the importance of early seeding for the greatest end-of-season C and N accumulation (and ground coverage).

Conclusions

Average biomass accumulation for cover crops seeded in August after small grain harvest for each of the five farm locations ranged from 1.55 to 5.29 tons DM/acre with values for individual species or mixtures ranging from 0.97 to 5.29 tons DM/acre. Averaged per location (farm), total C accumulation ranged from 1265 to 4084 lbs C/acre, while N accumulation ranged from 47 to 169 lbs N/acre with the lowest accumulation occurring at the farm planted in the last week of August. Field history such as planting date, manure application, and fertilizer application greatly impacted biomass, total C, and total N accumulations among and within cover crop mixtures. Those cover crop fields planted the earliest and/or fertilized the most tended to have the greatest biomass, C, and N accumulation. These data indicate that fall N uptake by cover crops seeded in early to mid-August can be large. However, it is unclear how much of the N accumulated in the fall will carry over to the next season and be available for the following crop, as many of the species in this study winterkilled. Also, no recommendations can be made for a particular species/mixture because trials were not replicated on the same farm field. Such replicated trials are needed to conclude which species and/or mixture is most effective in taking up N in the fall, and to evaluate the impact of inclusion of such cover crops and mixtures on the crop that follows them in the rotation.

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Acknowledgments

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Nutrient Management

Table 2. Fall 2010 and 2011 total biomass, carbon (C), and nitrogen (N) accumulation by various cover crop types and mixes seeded in August after small grain harvest in New York.

Farm	Cover Crop Species	Planted	Sampled	Biomass	Total C	Total N
				ton/acre	lbs/acre	lbs/acre
Branton*	Oats	8/10/2010	11/3/2010	4.47	3632	179
	Peas/Oats/Radishes	8/10/2010	11/3/2010	3.09	2328	158
	Radishes	8/10/2010	11/3/2010	3.00	2246	128
	Sorghum Sudangrass	8/10/2010	11/3/2010	2.17	1741	102
	Annual Ryegrass	8/10/2010	11/3/2010	2.56	1977	93
	Field average			3.06	2385	132
Lightfoote*	Radishes	8/19/2010	11/3/2010	2.91	2186	167
	Turnips/Oats	8/19/2010	11/3/2010	2.99	2324	156
	Radishes/Oats	8/19/2010	11/3/2010	2.99	2309	138
	Oats	8/19/2010	11/3/2010	4.43	2653	136
	Forage Turnips	8/19/2010	11/3/2010	2.75	2096	136
	A. Ryegrass/Crimson Clover	8/19/2010	11/3/2010	2.51	1972	127
	Crimson Clover	8/19/2010	11/3/2010	1.70	1385	104
	Sorghum Sudangrass	8/19/2010	11/3/2010	1.36	1116	81
	Field average			2.70	2005	131
Lott	Crimson Clover	8/8/2011	11/9/2011	3.90	3216	161
	Oats/Peas	8/8/2011	11/9/2011	4.41	3591	160
	Radishes/ Annual Ryegrass	8/8/2011	11/9/2011	4.15	3170	156
	Radishes/Oats/Peas	8/8/2011	11/9/2011	4.57	3599	148
	Radishes	8/8/2011	11/9/2011	4.66	3541	119
	Radishes/Crimson Clover	8/8/2011	11/9/2011	3.06	2295	118
	Radishes/Oats	8/8/2011	11/9/2011	3.45	2689	104
	Oats	8/8/2011	11/9/2011	3.79	3152	96
	Crimson Clover/Oats	8/8/2011	11/9/2011	2.43	1988	92
	Field average			3.82	3027	128
Merrimac	Radishes/Peas	8/24/2011	11/9/2011	2.50	2053	82
	Radishes/Crimson Clover	8/24/2011	11/9/2011	1.87	1498	54
	Radishes	8/24/2011	11/9/2011	1.85	1444	53
	Crimson Clover	8/24/2011	11/9/2011	0.99	821	48
	Radishes/Oats/Peas	8/24/2011	11/9/2011	1.44	1201	41
	Radishes/Oats	8/24/2011	11/9/2011	1.49	1238	38
	Oats	8/24/2011	11/9/2011	1.26	1060	34
	Crimson Clover/Oats	8/24/2011	11/9/2011	0.97	801	28
	Field average			1.55	1265	47
Kemmeren	Radishes	8/12/2011	11/7/2011	5.29	4084	169

*For all plots on these two farms except pure radish and forage turnip plots, biomass, C and N data were adjusted to include below ground biomass (not measured that year); the roots averaged 23% of total biomass, 21% of total C, and 19% of total N for plots without radishes. The roots of non-radishes in radish mixtures accounted for 7% of biomass, and 6% of total C and N.

Nutrient Management

Adapt-N Wins Best New Product Award

The Adapt-N tool (http://adapt-n.cals.cornell.edu) for weather-adapted precision nitrogen management in corn was selected as the Best New Product of the Year 2012 by *AgProfessional* magazine, the leading publication related to agronomic and business management for agricultural retailers/distributors, professional farm managers and crop consultants.

Voting for the product was conducted online at www.AgProfessional.com. It is the first time a non-commercial organization received the award.

An article on the award was published in February's edition of the magazine, and is also available on-line at http://www.agprofessional.com/agprofessional-magazine/2012-Top-Product-of-the-Year-Chosen-190086841.html.

Field-Scale Studies Evaluating Soybean Inoculants and Other Seed Treatments

Bill Cox, Department of Crop and Soil Sciences, Cornell University

Crop Management

Soybean acreage in NY has increased from 140,000 acres in 2003 to 310,000 acres in 2012. Some NY fields have a soybean history of only 2 to 3 cropping years, even on farms that have included soybeans in their rotation for 20 years or more, because of limited soybean acreage in the 1990s and the preponderance of numerous small fields in NY. In some Midwestern states, where growers have produced soybeans for 30 years or more, rhizobium inoculants are not routinely used because the rhizobium now resides in their fields. Consequently, the question arises: Should veteran soybean growers in NY inoculate their soybeans with rhizobium on fields that have a history of 2 or 3 soybean plantings? Of equal importance, is the question of pre-treated seed with rhizobium inoculum? Pre-treated seed with rhizobium inoculum has become prevalent in the last 5 years and some growers question whether pre-treated seed is as effective as the traditional method of inoculating soybeans with liquid or dry peat rhizobium at planting.

Adding complexity to the soybean seed treatment question is that insecticide, fungicide or insecticide/fungicide combinations were commercialized by most seed companies about 10 years ago. Furthermore, recently-commercialized biological seed treatments that contain microbes, which purportedly colonize the soybean root system to provide stimulatory compounds to enhance nitrogen-fixing nodulation, nutrient uptake, and rhizobium activity, are now available. Consequently, growers can now order seed pre-treated with rhizobium inoculum and fungicide/insecticide/biological products. With the proliferation of seed treatment products and increased soybean acreage in NY, field-scale seed treatment studies should help veteran and novice growers make informed decisions on the use of these products.

We evaluated the following five seed treatments on the early Group II variety, P92Y12, at four sites in field-scale studies: **1) untreated seed, 2) untreated seed + Cell-Tech (a liquid rhizobium) applied at planting, 3) PPST 120 (pre-treated seed with rhizobium inoculum) +PPST 2030 (a biological seed treatment) +FST (fungicide seed treatment), 4) PPST 120 + PPST 2030 +IST/FST (insecticide and fungicide seed treatments), and 5) PPST 2030 +IST/FST + Cell-Tech at planting**. Growers at the Livingston and Seneca Co. sites planted the 5-10 acre studies with a grain drill in 15-inch row spacing on 24 and 25 May, respectively. Growers at the Tompkins and Yates Co. sites planted the 5-10 acres studies with a Kinze row crop planter also in 15-inch row spacing on 23 and 25 May, respectively. All fields, chisel tilled, either in the fall or spring, had a soybean history with corn as the immediate preceding crop. The growers used their own typical seeding rates and herbicide and fertility programs. We estimated stand establishment in all studies by counting emerged plants in mid-June in 6 to 8 regions of the field in all treatments. No aphid or disease occurrences were noted on subsequent visits to each field in July and August. Likewise, there were no spider mite infestations in any of the studies. The growers harvested all studies with their respective combines in October (Livingston and Yates

Table 1. Yield and final stand establishment of P92Y12 soybean variety with different seed treatments in field-scale studies on farms in Livingston, Seneca, Yates and Tompkins Counties in 2012.

	LIVING	SENECA	TOMPKINS	YATES	AVG
SEED TREATMENT	**YIELD (Bushels/acre)**				
Untreated	68	68	63	51	63
Cell-Tech-planting	66	69	65	54	64
PPST 120 PPST 2030+FST	69	69	65	53	64
PPST 120 +PPST 2030+FST/IST	66	74	65	54	65
PPST 2030+FST/IST +Cell-Tech-planting	68	73	66	55	66
LSD 0.05	**NS**	**NS**	**NS**	**NS**	**NS**
	FINAL STANDS (plants/acre)				
Untreated	144,690	147,675	**125,218**	157,520	143,775
Cell-Tech-planting	140,700	144,800	110,025	155,085	137,653
PPST 120 PPST 2030+FST	**157,815**	**165,485**	**118,725**	153,425	148,862
PPST 120 +PPST 2030+FST/IST	**160,025**	151,875	**125,590**	150,440	146,982
PPST 2030+FST/IST +Cell-Tech-planting	**156,043**	**164,375**	100,145	156,525	144,272
LSD 0.05	9,250	10,005	8500	NS	6500

Co.) and November (Tompkins and Seneca Co.). We or the growers provided calibrated Weigh Wagons or calibrated grain carts to determine yield.

Seed treatments did not improve stand establishment at sites where growers used a Kinze planter (Table 1). At the Yates Co. site, stand establishment for all treatments ranged from about 150,000 to 157,000 plants/acre. At Tompkins Co., there was a difference in stand establishment among treatments but the untreated seed had as high a stand establishment (~125,000 plants/acre) as the treatments with fungicide and insecticide. At sites where the growers planted with a grain drill, seed treatments containing fungicide, in particular, resulted in improved stand establishment. At Livingston Co, stand establishment increased from 145,000 plants/acre in the untreated seed to about 158,000 plants/acre in the **PPST 120 +PPST 2030 + FST** treatment with no further increase in stand establishment when insecticide (IST) was added to the seed. Likewise at Seneca Co, stand establishment increased from about 147,000 plants/acre for the untreated seed to about 165,000 plants/acre in **the PPST 120 + PPST 2030 + FST** with no further increase when insecticide seed treatment was applied. It is not clear why there were stand establishment responses with drill-planted beans but not Kinze-planted beans.

Seed treatments did not increase yield at any of the sites or when averaged across sites (Table 1). Nevertheless, **PPST 120 + PPST 2030 + FST/IST** yielded 3 to 6 bushels/acre numerically higher compared to untreated seed, very close to significance (Seneca, P=0.08 and Yates, P=0.11). The lack of significant yield responses in 2012 may be because conditions were warm after planting leading to fairly rapid emergence at all sites, 7 days or less. Consequently, soil pathogens or soil insects had less time to reduce stands, as indicated by final plant establishment exceeding 125,000 plants/acre for the untreated seed at all sites. Previous field-scale seeding rate studies indicated that maximum yields occurred at a final plant establishment of 114,000 plants/acre in NY (Cox and Atkins, 2011). Also, aphids were almost non-existent in most soybean fields in New York in 2012, which reduced one of the advantages of the IST treatment. Finally, there were only three replications at each site reducing chances for detecting significance at P=0.05 for yield differences of 6 to 9%.

Conclusion

The use of in-field rhizobium inoculum seed treatment (Cell-Tech) did not increase yields compared with untreated seed (a non-significant 1, 2, and 3 bushel/acre yield increases at three of the four sites in this study). Lack of a yield response indicates either NY fields with a soybean history do not require rhizobium inoculum or that more observations (replications or years) are required before resolving this research question. Despite increases in stand establishment with the use of pre-treated seed with rhizobium, a biological, and a fungicide at two sites (Kinze planter), yield increases averaged only 1 bushel/acre at these sites probably because of high stand establishment in the untreated seed (~125,000 and 145,000 plants/acre). The complete seed treatment package (**PPST 120 + PPST 2030 +IST/FST**), which probably increases seed costs by about $20/acre, increased yield a non-significant 2, 3, and 6 bushels/acre (~6%), which could prove cost-effective if soybean prices remain high. We will repeat this study again and run partial budget analyses to provide a complete picture on the agronomic and economic responses of soybean to seed treatments in NY, based on 2 years of data at four sites. We thank the NY Corn and Soybean Growers Association for their partial support of this project.

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Enhanced Efficiency Fertilizers; Laboratory Study

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Nutrient Management

Introduction
Potential for N loss due to leaching, denitrification, or volatilization has prompted the development of many formulations of enhanced efficiency fertilizers (EEFs). The three main categories of EEFs are urease inhibitors, nitrification inhibitors, and slow or controlled release fertilizers (CRFs). Among the urease inhibitors that have been tested to date, N-(n-butyl) thiophosphoric triamide (NBPT) is known to slow down hydrolysis and hence reduce NH_3 volatilization, allowing time for rainfall to move surface applied urea into the soil profile (Bremner et al., 1986). Previous studies have suggested that higher volatilization losses from unamended urea on soils with higher pH and lower organic matter content can be mitigated by treating urea with NBPT (Watson et al., 1994). Dyciandiamide (DCD) has proven to be an effective nitrification inhibitor, delaying the oxidation of NH_4 to NO_3. Dyciandiamide together with NBPT (as combined urease and nitrification inhibitors) can offer protection from volatilization and leaching or denitrification losses (Watson et al., 1990). Controlled release fertilizers rely on semi-permeable polymers or sulfur (S) membranes to protect the water-soluble N source contained within. Water passes through the membrane and eventually forces the release of the enclosed N. The thickness of the protective coating, as well as soil conditions (temperature and moisture), regulate the amount and rate of N release (Trenkel, 1997).

Small-scale field studies conducted in New York State in 2008 and 2009 showed no benefits of the use of ESN® or NutriSphere-N® over the same N application in the form of urea broadcast and incorporated just prior to planting. The research was conducted for two years at three locations (Willsboro Research Farm, Aurora Research Farm, and the Valatie Research Farm). However, there was also no yield benefit to a split application (starter N at planting plus sidedress application of liquid urea ammonium nitrate) at any of the site years. The lack of a response in yield to the sidedress application indicates that the sites did not experience conditions for early season N loss, and therefore the EEFs were not tested under conditions where they may be able to show a difference. This did not mean the EEFs do not work, it simply illustrates that conditions for early season N loss do not occur every year.

Laboratory Study – Setup
To further investigate the different EEFs, we initiated a laboratory project. The four EEFs that we included in the study were (1) Agrotain®; (2) Super U®; (3) NutriSphere-N®; and ESN®. Agrotain® is a urease inhibitor (N-(n-butyl) thiophosphoric triamide (NBPT) designed to delay urea hydrolysis and hence reduce ammonia volatilization loss for up to 7-10 days. Super U® combines NBPT with the nitrification inhibitor DCD. NutriSphere-N® is described as a maleic acid/itaconic acid copolymer designed to act as a urease/nitrification inhibitor throughout the growing season, while ESN® has a water insoluble, semi-permeable, proprietary polyurethane polymer coating designed to control the rate of dissolution of N contained within the coating. Nitrogen release is gradual for ESN®, increasing as temperatures exceed 32°F and soil moisture content exceeds 25-30% (Alan Blaylock, personal communication, 2010). In contrast to the field trials, the four N fertilizers used in the incubation study were surface applied with urea and no-N as controls. We used a low-N Lima soil with a pH of 7.9 and 3.3% organic matter. Volatilization losses increase with high pH so this soil was ideal to evaluate the effectiveness of the EFFs in reducing volatilization loss. The fertilizers were surface applied on the soil which was incubated at field capacity in a growth chamber that was initially set at a 15-hour daytime temperature of 50°F and a 9-hour nighttime temperature of 34°F. The temperature was incrementally increased to a 15-hour daytime temperature of 69°F and a 9-hour nighttime temperature of 53°F to simulate the normal warming pattern of a 13-wk growing season at the Aurora Research Farm (Climod, 2008).

Laboratory Study – Results: Ammonia Volatilization
Within a week after application of the fertilizer sources,

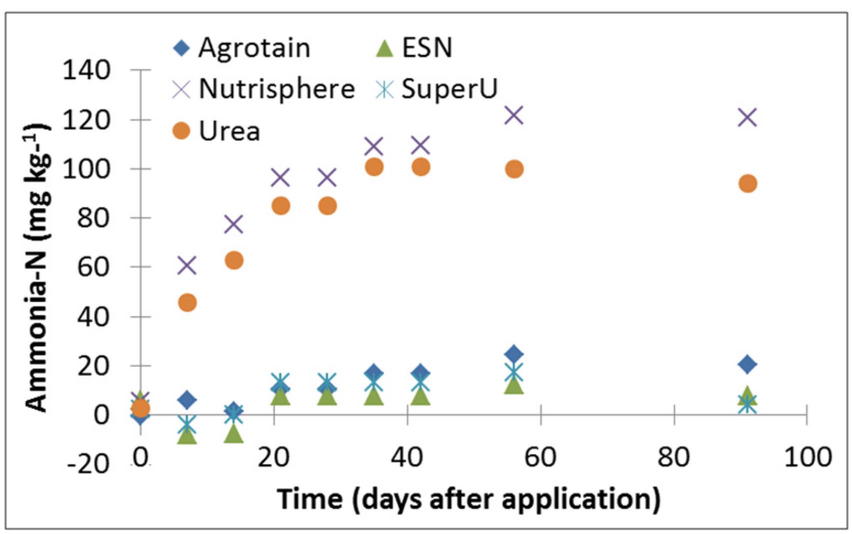

Figure 1. Cumulative ammonia volatilization from surface applied urea and enhanced efficiency fertilizers compared to the control (no N) soil.

Nutrient Management

the ammonia volatilization was three times higher for unprotected urea and NutriSphere-N® than for Agrotain®, Super U®, and ESN® (Figure 1). The urease inhibitor NBPT in Agrotain® and Super U® and the controlled–release polyurethane polymer in ESN® reduced N volatilization over the 13 weeks incubation by 55% compared to unprotected urea. Approximately 40% of the reduction was achieved within the first week after application. These data suggest that both NBPT and the controlled-release polyurethane polymer coating of ESN® are effective in reducing ammonia loss, while the NutriSphere-N® formulation was not effective in reducing N volatilization.

Laboratory Study – Results: Nitrate

Nitrate levels increased over time with warming of the soil with a sharp increase once daytime temperatures reached 66°F (Figure 2). Nitrate levels following ESN® application only exceeded those of the control when daytime temperatures had reached 66°F indicating the coating was effective in delaying nitrification. At the end of the incubation, cumulative nitrate-N levels for Agrotain® and Super U® were higher than for urea and NutriSphere-N® reflecting the loss of N through ammonia volatilization for urea and NutriSphere-N®. Agrotain® provided approximately 15% greater nitrate-N+ammonium-N levels between 35 and 91 days after application versus 3% for Super U®. The latter might reflect a delay in nitrification with Super U® (urease and nitrification inhibitor). The ESN® data suggest a 23% release of N (ammonium-N and nitrate-N) after 35 days and 28% release of N with surface-applied ESN® after 56 days (and exposure to a soil temperature of 66°F) as compared to surface applied urea. For ESN®, total inorganic N at 91 days after application amounted to 61% of the amount determined in the soil when urea was surface applied, reflecting greatly enhanced N release after 56 days when the temperature was raised above 66°F (Figure 2). This raises the question whether in our growing seasons nitrate release post ESN® application might be "too slow" in typical New York growing conditions. We cannot conclude if this is the case based on a short incubation study; instead, continued field studies on N deficient fields are needed to evaluate the timing and size of the nitrate peak post ESN® application.

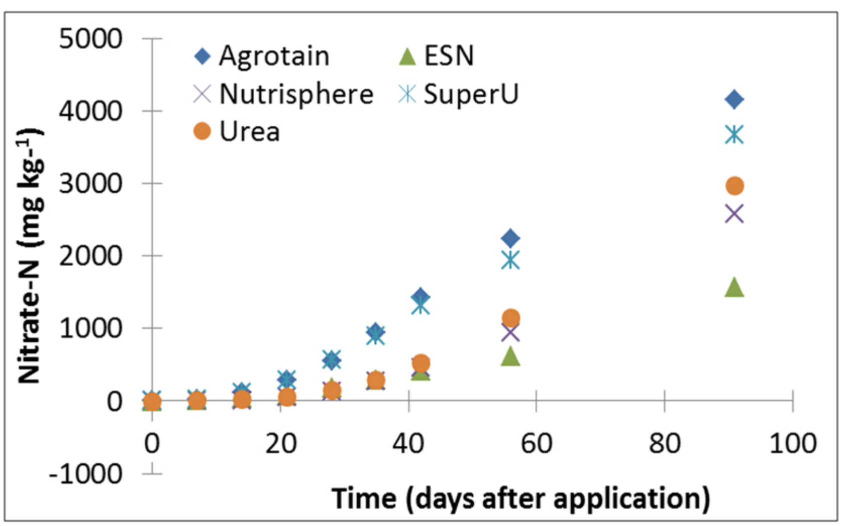

Figure 2. Cumulative nitrate levels over time from surface applied urea and enhanced efficiency fertilizers compared to the control (no N) soil.

Conclusions

Our laboratory data indicate that Agrotain®, SuperU®, and ESN® use effective enhanced efficiency chemistries. In situations where mechanical incorporation cannot be done (no-till, topdressing) a urease inhibitor like Agrotain® can be effective in reducing risk of N volatilization. This can be combined with a nitrification inhibitor as is the case with Super U® to also create some protection against early season leaching or denitrification losses (4-10 week window), allowing for N applications at planting. The urease inhibitor chemistry is not needed where urea can be incorporated. A controlled release fertilizer like ESN® could similarly reduce the risk of N volatilization and/or leaching or denitrification losses. Whether the use of any EEF is an economic improvement over use of un-protected urea depends on crop N needs, growing conditions (particularly N loss potential), and the price difference between urea and the EEF.

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For Further Information

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Calendar of Events

June 6, 2013	Small Grains Management Field Day, Aurora, NY
July 17, 2013	New York Weed Science Field Day, Aurora, NY
July 24, 2013	Aurora Farm Field Day, Aurora, NY
August 13, 2013	NY Corn and Soybean Growers Association Summer Crop Tour, Union Springs, NY

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