Effect of seeding date on interseeded winter annual cover crop growth and nitrogen uptake

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Abstract

Winter cover crops have the potential to reduce the impact of agricultural production on the surrounding ecosystem in the mid-Atlantic USA, including the Chesapeake Bay. However the seasonality of cash crop harvest is one major issue slowing the expansion of cover crops. The objectives of this study were to evaluate broadcast-seeded winter cover crop biomass production, nitrogen (N) uptake, and residual soil N as affected by date of cover crop seeding. Field experiments were conducted in six total locations in Virginia in 2012-13 and 2013-14. Treatments consisted of barley (*Hordeum vulgare* L.), rye (*Secale cereale* L.), rye+forage radish (*Raphanus sativus* L.), and rye+hairy vetch (*Vicia villosa* L.) hand-broadcast into standing crop beginning in early September and each two weeks afterward in a split plot design with four replications. Planting date affected both winter and spring cover crop biomass and N uptake but effects on soil N were inconsistent.

Materials and Methods

- The winter cereal cover crops barley and rye were broadcast seeded in these studies, along with rye+hairy vetch and rye+oilseed radish at the rates and times shown.
- At the first seeding date, preliminary soil samples were collected from the entire experimental area and basic chemical properties determined for each site.
- Aboveground biomass was hand clipped from a 0.5 m^{-2} area in each treatment in early December and in spring, just prior to killing the cover crop to estimate fall and total biomass, respectively. Also at each sampling period, soil samples were collected at 0-15 and 15-30 cm from each plot.
- Crop samples were dried in a forced air oven at 60°C for 48 hr and then ground to pass a 2 mm screen using a Wiley (Thomas Scientific, Swedesboro, NJ) sample mill and total carbon (C) and nitrogen (N) determined by dry combustion (Leco Corp., St. Joseph, MI).
- Cover crop nitrogen uptake was determined as the product of dry matter yield and tissue N concentration.
- Soil ammonium and nitrate were determined via extraction with 2M KCl and automated colorimetric analysis.
- Analysis of variance was conducted using PROC GLM available in SAS. Results are presented by location and year due to significant interaction of treatment results over sites. In order to compare planting date and species effects in both fall and winter separately, biomass and soil data are presented by time of sampling at each site.

Crop		Seeding Rate
		$kg\ ha^{-1}$
Rye	Secale cereale	125
Barley	Hordeum vulgare	108
Rye+Hairy Vetch	Secale cereale + Vicia villosa	90+11
Rye+Forage Radish	Secale cereale + Raphanus sativa	90+4.5

Year	Location	Previous Crop	Soil and Biomass Sampling Date: Fall	Spring
2012-13	New Kent	Soybean	20-Dec	15-Apr
	Prince George	Soybean	17-Dec	2-Apr
	Dayton	Corn silage	16-Dec	2-May
2013-14	Prince George	Soybean	10-Dec	27-Apr
	Shenandoah Caverns	Soybean	20-Dec	11-Apr
	New Market	Soybean	20-Dec	11-Apr

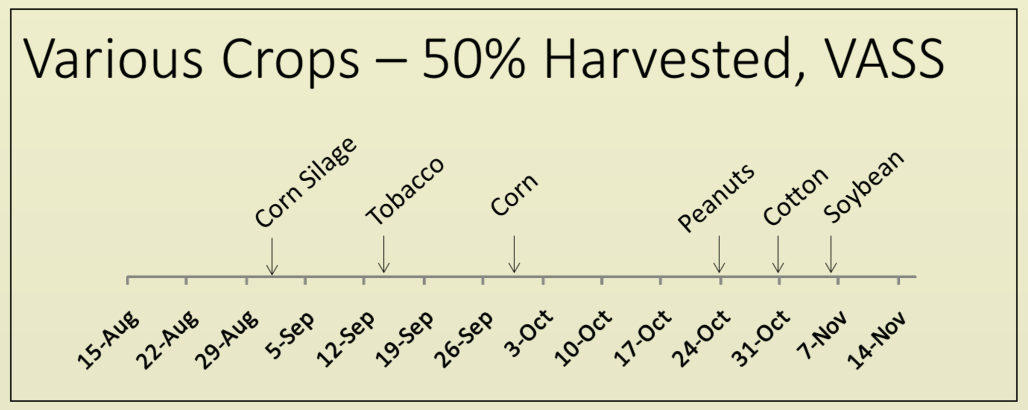
Year	Location	pH[a]	P[b]	K	Ca	Mg	NO3-N	NH4-N	Total N[c]	Organic C[c]
			$mg\ kg^{-1}$						$g\ kg^{-1}$	
2012-13	New Kent	6.0	12	83	521	100	0.5	0.4	1.2	12.1
	Prince George	6.2	36	104	451	89	0.3	0.0	0.7	6.9
	Dayton	5.8	39	77	1445	95	1.3	0.2	1.4	14.1
2013-14	Prince George	6.4	9	127	465	113	0.9	1.3	0.8	7.8
	Shenandoah Caverns	7.3	45	62	2052	143	3.2	1.3	1.5	15.2
	New Market	6.9	130	171	1424	170	2.8	3.2	1.4	13.9

[a]pH: 1:1 Soil: Water
[b]P, K, Ca and Mg: Mehlich I extraction
[c]Total N and Organic C: Elementar CN dry combustion analyzer

Rationale

Winter cover crops have the potential to reduce the impact of agricultural production on the surrounding ecosystem, including the Chesapeake Bay. Cover crops are one of the main tools that will be relied upon in the coming years to help meet water quality goals and acreage need to expand by over 50,000 ha of cover crop annually to help meet the agreed upon goals. However, the incrementally "easiest" acres, those that lend themselves to cover cropping, are likely already enrolled in the program. Thus, a dramatic increase in acreage is going to require adaptation and innovation of the current cover crop systems so that they offer greater flexibility and greater appeal.

Establishment of winter annual cover crops is often delayed beyond the optimum planting date due to cash crop harvest timing

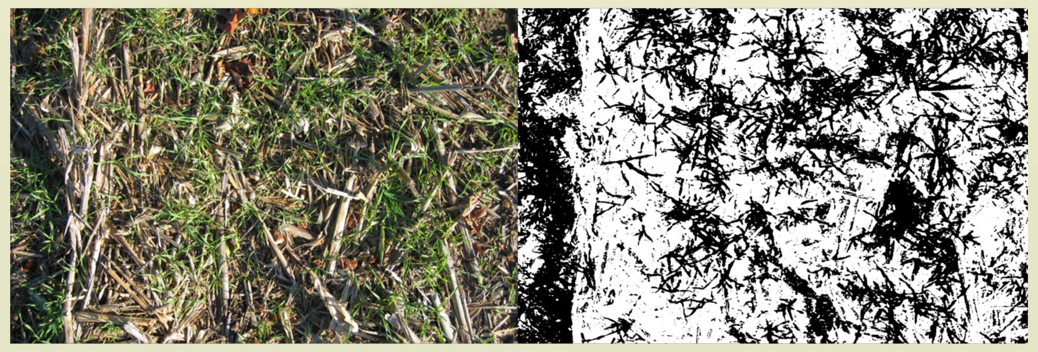


Experimental site weather, 2012-13 and 2013-14

Results

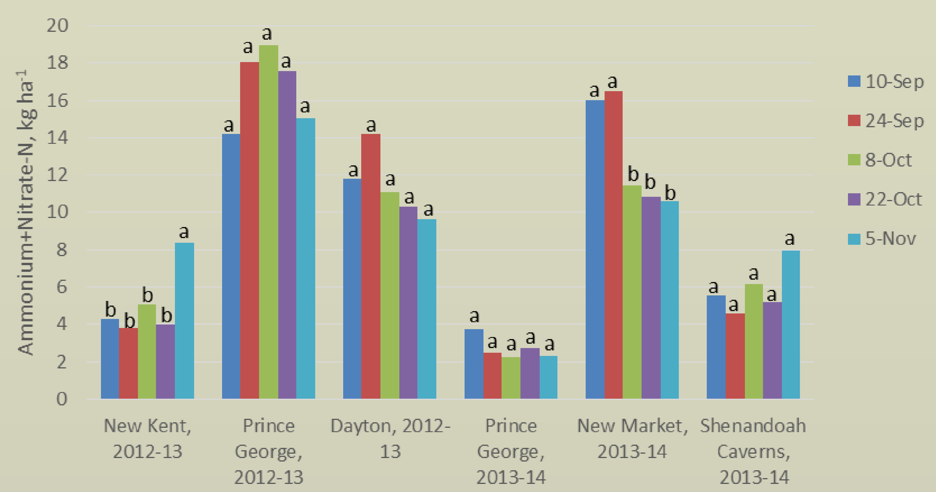
Early winter cover crop biomass and N uptake

Rye 42.4%



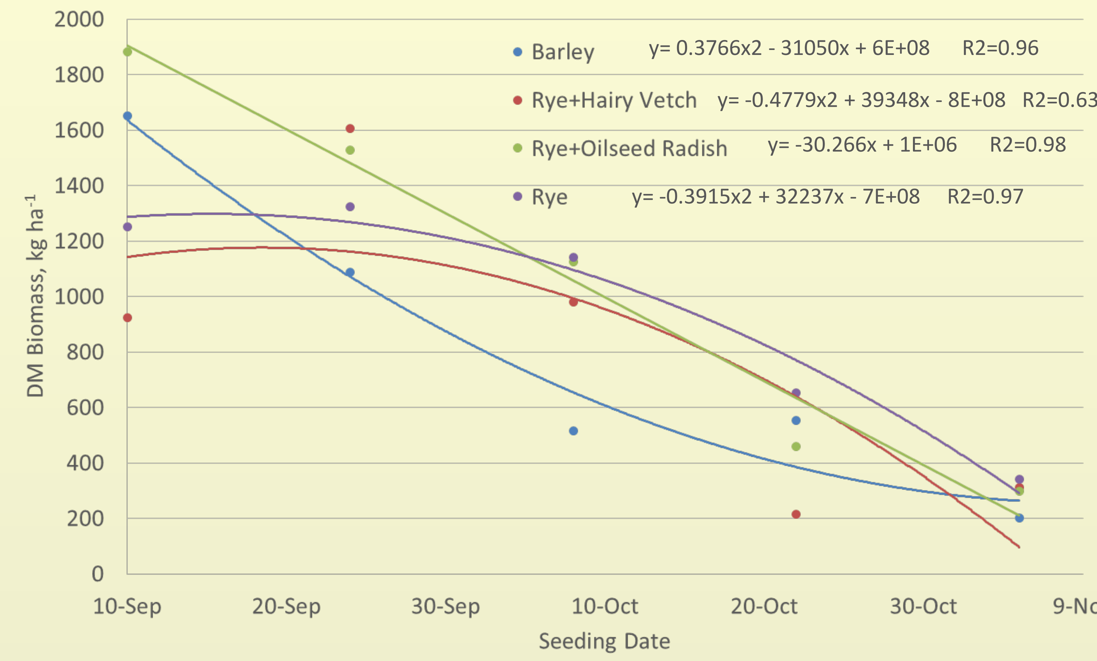
Barley, 40.1%

Early winter residual soil ammonium and nitrate, 0-30 cm

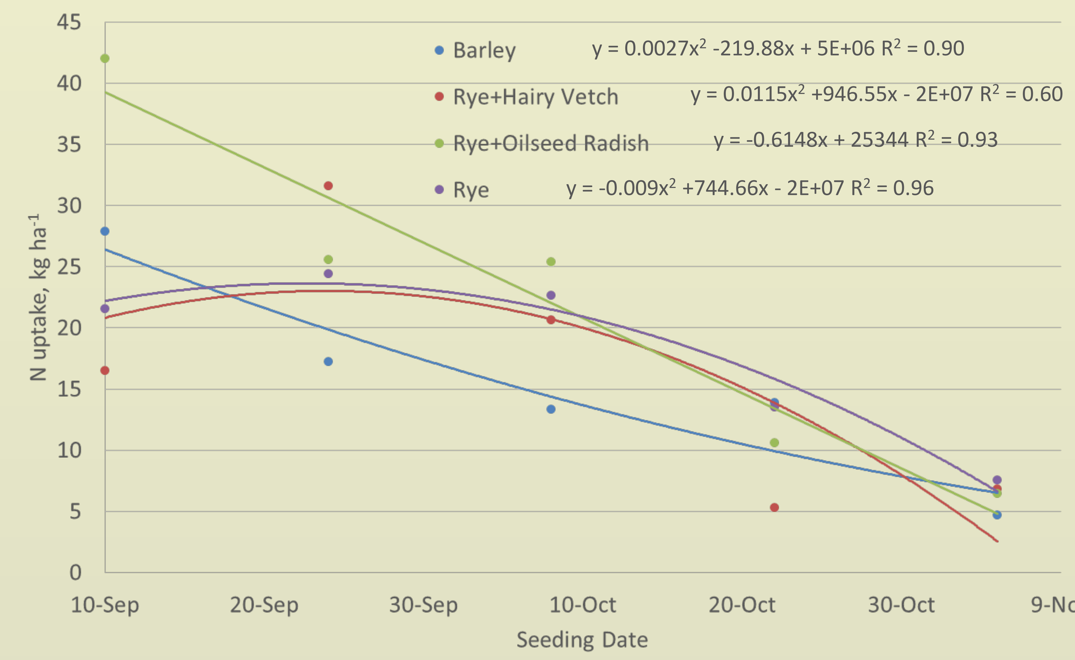


Results (cont.)

Spring (cover crop termination) aboveground biomass by seeding date, over years and locations



Spring (cover crop termination) N uptake by seeding date, over years and locations



Spring (cover crop termination) soil residual nitrate-N

Date	Species	New Kent, 2012-13	Prince George, 2012-13	Dayton, 2012-13	Prince George, 2013-14	New Market, 2013-14	Shenandoah Caverns, 2013-14
		Nitrate, 0-15 cm, $mg\ kg^{-1}$					
10-Sep	Barley	0.4 a	1.7 a	1.3 abc	6.0 a	5.4 a	3.7 a
	Rye+Hairy Vetch	1.6 a	2.2 a	2.4 abc	1.8 a	4.1 a	4.1 a
	Rye+Oilseed Radish	0.4 a	2.2 a	1.2 abc	1.9 a	4.6 a	4.6 a
	Rye	0.4 a	1.8 a	1.3 abc	5.5 a	2.9 a	3.6 a
24-Sep	Barley	0.4 a	3.9 a	1.0 bc	4.4 a	5.9 a	3.1 a
	Rye+Hairy Vetch	0.9 a	1.7 a	1.4 abc	2.0 a	7.9 a	3.4 a
	Rye+Oilseed Radish	0.4 a	9.4 a	1.1 bc	1.7 a	6.7 a	2.8 a
	Rye	0.5 a	1.5 a	0.8 c	2.0 a	9.9 a	3.5 a
8-Oct	Barley	0.4 a	1.5 a	2.0 abc	7.1 a	6.8 a	3.5 a
	Rye+Hairy Vetch	0.3 a	1.7 a	2.4 abc	5.9 a	6.4 a	2.9 a
	Rye+Oilseed Radish	0.4 a	2.7 a	2.6 abc	5.9 a	6.7 a	5.8 a
	Rye	0.3 a	1.6 a	2.0 abc	5.0 a	5.6 a	4.8 a
22-Oct	Barley	0.3 a	1.7 a	2.0 abc	5.8 a	4.9 a	3.5 a
	Rye+Hairy Vetch	0.3 a	1.9 a	3.4 ab	5.9 a	6.3 a	4.8 a
	Rye+Oilseed Radish	0.2 a	2.6 a	2.2 abc	5.7 a	5.8 a	2.7 a
	Rye	0.3 a	2.4 a	2.8 abc	6.4 a	6.2 a	4.9 a
5-Nov	Barley	0.5 a	4.0 a	3.5 a	5.0 a	8.1 a	4.5 a
	Rye+Hairy Vetch	0.4 a	2.6 a	3.2 abc	3.8 a	8.6 a	4.4 a
	Rye+Oilseed Radish	1.1 a	2.7 a	2.2 abc	5.0 a	7.0 a	9.5 a
	Rye	0.2 a	3.7 a	3.1 abc	5.9 a	7.3 a	5.6 a

Conclusions

- Initial soil residual N varied by location and year, likely due to differences in soil and previous management.
- Cover crop seeding date had inconsistent effects on winter soil residual N.
- Following corn silage or when soybean canopy was thin, early broadcast seeding resulted in greatest winter biomass, however when soybean leaf canopy resulted in significant shading, there was no advantage compared to seeding in early October.
- When seeded early, rye+radish produced the greatest spring biomass, probably due to the contribution of radish.
- Early-seeded barley spring biomass declined rapidly with delayed planting.