2015 Tillage Radish Planting Date x Seeding Rate Trial

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Farmers are interested in growing tillage radishes as they may potentially offer many environmental and economic benefits. Tillage radishes are quick at scavenging excess nitrogen, provide good ground cover, and break down very quickly in the spring to make way for spring planting. The plants winter kill, but the dead frozen plant material can still supress the earliest spring weeds from establishing. The roots themselves are known to drill through compacted soil layers as they grow, and the holes left by decomposed roots the next spring may also allow more water to infiltrate into the soil. Growing tillage radish as a cover crop in the northeast is new and best practices for success have yet to be established. Although a tillage radish crop may have many benefits, it must be planted earlier than our other cereal grain cover crops commonly used following corn silage. Proper planting and seeding rates must be determined to enable the crop to provide quick ground cover and substantial root growth while minimizing planting costs. The goal of this project was to determine the impact of planting date and seeding rate on tillage radish survival and crop characteristics including nitrogen content and root volume. While the data presented are only representative of one year, this information can be combined with other research to aid in making planting decisions for tillage radishes in the Northeast.

MATERIALS AND METHODS

A trial was conducted at Borderview Research Farm in Alburgh, Vermont in 2015 to evaluate four tillage radish planting dates and three seeding rates. Agronomic information for the trial can be found in Table 1. The soil was a Benson rocky silt loam and the previous crop was spring wheat. Plots were prepared with fall chisel plow and disk, and finished with a spike tooth harrow. The experimental design was a randomized complete block with split plots replicated four times. The plot size was 5'x20', and plots were seeded with a Great Plains cone seeder. The main plots were four planting dates (18-Aug, 24-Aug, 31-Aug, and 8-Sep). The subplots were three seeding rates: 3, 6 and 12 lbs of viable seed per acre.

Table 1. Agronomic practices for the 2014 winter canola planting date trial, Alburgh VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam 3-8% slope
Previous crop	Spring wheat
Tillage operations	Fall chisel plow, disk and spike tooth harrow
Seeding rate (lbs ac^{-1})	3, 6, 12
Planting equipment	Great Plains cone seeder
Row width (in.)	6
Plot size (ft)	5 x 20
Planting dates	18-Aug, 24-Aug, 31-Aug, and 8-Sep
Variety	Groundhog
Harvest dates	8-Oct

Tillage radish biomass was measured on 8-Oct. All plants in a 0.5 m^2 quadrat from each plot were collected, and counted. Weights for the harvested material (root and vegetation) were recorded. Five plants were selected at random from each plot sample to record root diameter and length. Subsamples of vegetation and roots were weighed before and after drying to determine dry matter for each plot. After drying, roots and tops were combined and ground with a Wiley laboratory mill. The coarsely-ground plot samples were brought to the lab where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. A subsample of each was retained for nitrogen analysis. The subsamples were analyzed for nitrogen content at the University of Vermont's Testing Laboratory in Burlington, VT.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate means when the F-test was significant ($P < 0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. All data was analyzed using a mixed model analysis where replicates were considered random effects. At the bottom of each table a Least Significant Difference (LSD) value is presented for each variable (e.g. yield). LSDs at the 10% level (0.10) of probability are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two values. In the example below, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these two treatments were significantly different from one another. The treatment in bold had the top observed performance, while treatments with an asterisk did not differ significantly from the top performer.

Planting date	Yield
A	**2100***
B	1900*
C	1700
LSD (0.10)	300

RESULTS

Weather data collected with an onsite Davis Instruments Vantage Pro2 Weather Station at Borderview Research Farm in Alburgh, VT, are summarized for the 2015 tillage radish growing season (Table 2). August and September were warmer than the historical average (1981-2010), while October was slightly cooler. The warm fall overall resulted in 211 more growing degree days than the 30-year average, as calculated with a base temperature of 41°F. The 2015 fall growing season was very dry, with 8.31 fewer inches of rain than normal between August and October.

Table 2. Summarized weather data for fall 2015 – Alburgh, VT.

Alburgh, VT	August	September	October
Average temperature (°F)	69.7	65.2	46.5
Departure from normal	0.9	4.6	-1.7
Precipitation (inches)	0.00	0.34	2.51
Departure from normal	-3.91	-3.30	-1.09
Growing Degree Days (base 41°F)	903	740	252
Departure from normal	41	152	29

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Impact of Planting Date

Table 3: Tillage radish dry matter yields by planting date, Alburgh, VT 2015.

Planting Date	Whole plant nitrogen yield lbs ac^{-1}	Vegetation dry matter yield lbs ac^{-1}	Root dry matter yield lbs ac^{-1}	Total dry matter yield lbs ac^{-1}
18-Aug	35.5	1134	**845***	**1947***
24-Aug	40.8*	1363*	617	1928*
31-Aug	**46.4***	**1466***	428	1815*
8-Sep	22.4	567	83.6	609
LSD (0.10)	9.8	288	217	475
Trial mean	36.3	1133	494	1575

Treatments indicated in **bold** had the top observed performance.
* Treatments that did not perform significantly lower than the top performer.

The 18-Aug planting date resulted in the highest root dry matter yield (845 lbs ac^{-1}) and total dry matter yield per acre (1947 lbs ac^{-1}) (Table 3). However, the 31-Aug planting date resulted in the highest vegetation dry yield (1466 lbs ac^{-1}) and whole plant nitrogen yield (46.4 lbs ac^{-1}). The second planting date (24-Aug) was not significantly different than the top performer in nitrogen yield, vegetative dry matter yield, or total dry matter yield. The last planting date (8-Sep) was significantly lower than the top performer in all categories.

Table 4: Tillage radish root length and diameter, plant height, and soil cover by planting date, Alburgh, VT, 2015.

Planting date	Root length	Root diameter	Plant height	Soil cover
	cm	in	cm	%
18-Aug	19.0*	**1.8**	34.3	**96.6***
24-Aug	19.7*	1.8	**35.1**	95.3*
31-Aug	16.3	1.4	30.4	93.5*
8-Sep	**21.3***	1.7	33.3	80.1
LSD (0.10)	3.94	NS	NS	4.3
Trial mean	19.1	1.7	33.3	91.4

Treatments indicated in **bold** had the top observed performance.
* Treatments that did not perform significantly lower than the top performer.
NS = No significant difference.

Surprisingly, the latest planting date (8-Sep) had the longest roots, although both the 18-Aug and 24-Aug planting dates were statistically similar in root length (Table 4). There was no significant difference between planting dates in root diameter or plant height. The earliest planting date (18-Aug) had the highest percent soil cover, but this was statistically similar to the next two planting dates of 24-Aug and 31-Aug and differed only from the latest planting date.

Impact of Seeding Rate

Table 5: Tillage radish dry matter yields by seeding rate, Alburgh, VT 2015.

Seeding Rate	Whole plant nitrogen yield	Vegetation dry matter yield	Root dry matter yield	Total dry matter yield
lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}
3	32.1	975	456	1376
6	34.8*	1037	416	1402
12	**42.0***	**1386***	**609***	**1947***
LSD (0.10)	9.8	288	188	411
Trial mean	36.3	1133	494	1575

Treatments indicated in **bold** had the top observed performance.
LSD – Least significant difference.
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The 12 lbs per acre seeding rate had significantly higher yields in terms of both aboveground and belowground biomass than either of the other seeding rates (Table 5). It was the highest performer in nitrogen yield, although this was not significantly different than the 6 lbs per acre seeding rate.

Table 6: Root length and root diameter by seeding rate, Alburgh, VT, 2015.

Seeding rate	Root length	Root diameter	Plant height	Soil cover
lbs/ac^{-1}	cm	in	cm	%
3	17.9	1.6	33.6	85.7
6	**20.1**	**1.7**	**33.7**	92.3*
12	19.3	1.7	32.6	**96.0***
LSD (0.10)	NS	NS	NS	3.7
Trial mean	19.1	1.7	33.3	91.4

Treatments indicated in **bold** had the top observed performance.
LSD – Least significant difference.
NS = Not significant difference.

Seeding rate did not significantly impact plant height, root length or diameter (Table 6). The 12 lbs per acre seeding rate had the highest percent soil cover (96%) but this was not significantly different than the 92.3% soil cover for the 6 lbs per acre treatment.

Planting Date by Seeding Rate Interactions

The only significant interaction between tillage radish planting date and seeding rate affected percent soil cover (Figure 1). In terms of biomass yield or nitrogen scavenging, seeding rate does not need to be modified regardless of planting date. However, if the primary goal is soil cover, seeding rate should be increased for later planting dates to provide optimal coverage.

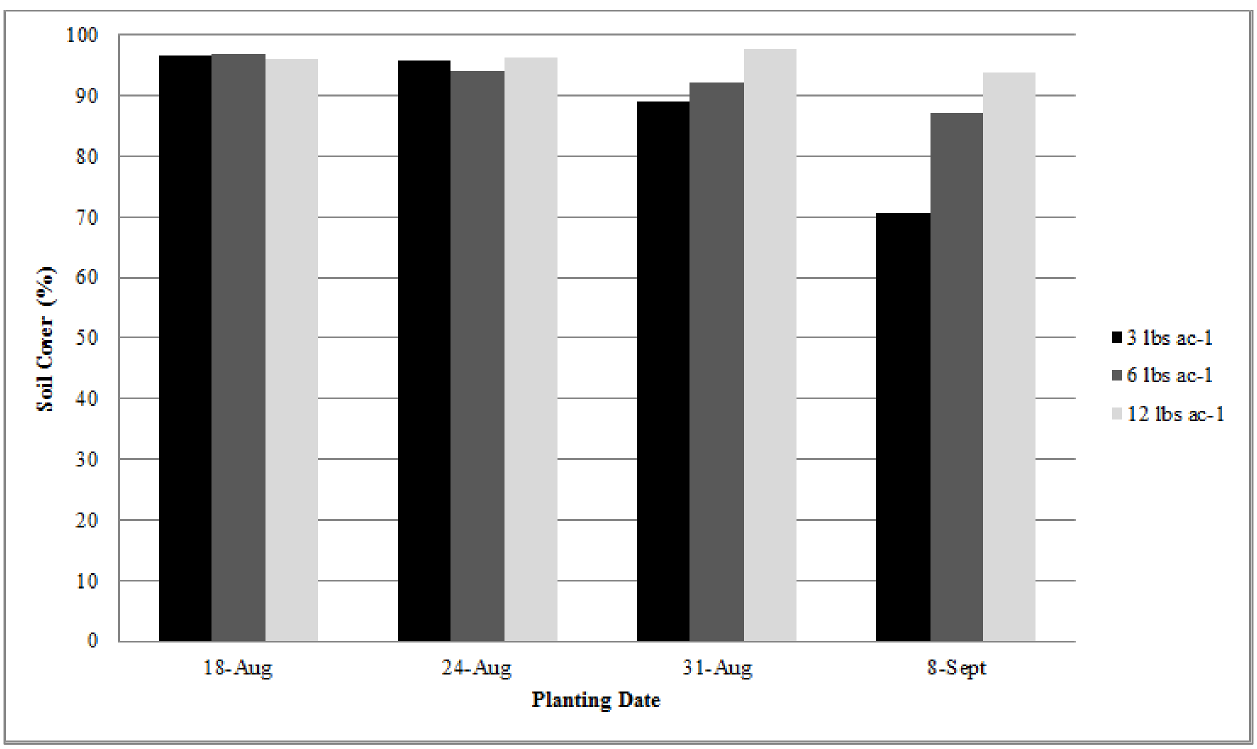

Figure 1: Percent soil cover by planting date for three seeding rates.

DISCUSSION

On average, tillage radishes produced 1575 lbs of dry matter per acre and were able to scavenge 36.3 lbs of nitrogen per acre from the soil. These results were very similar to the trial averages from the 2014 trials (1573 lbs of dry matter and 40.4 lbs of nitrogen per acre).

The planting date results suggest that planting tillage radishes before the end of August will improve biomass yields, nitrogen retention, and soil cover compared to planting by the middle of September. While root length and diameter were not impacted by the later planting date, the overall amount of below-ground biomass was significantly lower for the latest planting date of 8-Sep.

In this study, seeding rate did significantly impact tillage radish yield, nitrogen retention and percent of soil cover. The current recommended seeding rate provided by most seed companies is 6 to 8 lbs of tillage radish seed per acre. This seeding rate performed comparably to the higher rate of 12 lbs per acre in terms of soil cover and nitrogen retention. Based on this data, the lower seeding rate of 6 lbs per acre is adequate to accomplish the nitrogen retention goals that most farmers are hoping to achieve when planting this cover crop.

At sites where erosion is a major concern or when planted later in the season, it may be advisable to use the higher seeding rate of 12 lbs per acre to achieve optimum soil cover.

These data in this study represent only one year and should not alone be used to make management decisions.

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