

Forage Radish: New Multi-Purpose Cover Crop for the Mid-Atlantic

Forage radish (*Raphanus sativus* var. *niger*) is a unique fall/winter cover crop that is relatively new to the Mid-Atlantic region. It is a member of the *Brassica* family that also includes rapeseed, canola, mustard, cabbage, and the like. Forage radish is also known as 'Daikon' (sometimes spelled 'Dichon') radish or 'Japanese' radish and is used as a vegetable in many types of Asian cuisine. When planted by early September in the Mid-Atlantic region, forage radish exhibits a number of unique and desirable characteristics that distinguish it from other types of cover crops more commonly grown in the region.



The oilseed radish (*Raphanus sativus* var. *oleiformis*) such as 'Adagio' or 'Colonel' radishes is similar to the forage radish (probably the same subspecies) but the oilseed radish has a stubbier, more branched taproot and tends to be somewhat more winter hardy than the forage radish

('Daikon'). The precise classification of these and other types of radishes is not well established because they can easily cross-pollinate and therefore distinctions among subspecies are often blurred. Most of the traits and management recommendations described here for forage radish should also apply to oilseed radish.

Forage Radish Traits:

- **Rapid germination and growth.**
- **Large deeply penetrating tap root.**
- **Winter-kills.**
- **Quick to decompose residues.**
- **High nutrient (N, P, S, Ca, B) content.**
- **Bio-active plant chemicals (glucosinolates).**

Multiple benefits from one cover crop

Because of its unique plant characteristics, a forage radish cover crop can provide many different benefits to the farmer, the soil, and the environment. As a result, farmers who use it are likely to find that a forage radish cover crop *pays for itself with tangible benefits.*

Alleviation of Soil Compaction

Forage radish cover crops are used by many farmers as a biological tool to reduce the effects of soil compaction, leading some farmers to refer to this cover crop as "tillage radish" or "radish ripper." The roots of all cover crops can penetrate compacted soils in fall to some extent because they are growing when soils are relatively wet and soft. Forage radish roots can penetrate plow pans or other layers of compacted soil better than

the other cover crops (such as rye and rapeseed) tested in our research. The thin lower part of the

Multiple Benefits

Forage radish has been shown to:

- **Alleviate soil compaction** - save on deep tillage
- **Suppress weeds** - save on herbicides / cultivation
- **Enhance seedbed** - save time and plant earlier in spring
- **Build organic matter** - improve soil quality
- **Release N early and increase topsoil fertility** - save on N and other fertilizers
- **Reduce nitrate leaching** - save the Bay
- **Control erosion** - save your soil
- **Reduce runoff** - conserve rainwater

taproot can grow to a depth of six feet or more during the fall. The thick, fleshy upper part of the taproot grows 12 to 20 inches long and creates vertical holes and zones of weakness that tend to break up surface soil compaction and improve soil tilth. After the cover crop dies in the winter and their roots decompose, the remaining root channels used by the growing roots of following crops to penetrate compacted deep soil layers.

This process, termed “bio-drilling,” improves root access to water in the subsoil and makes crops more resilient under drought conditions. In research plots, four times as many corn roots penetrated compact subsoil after a forage radish cover crop as after winter fallow, and

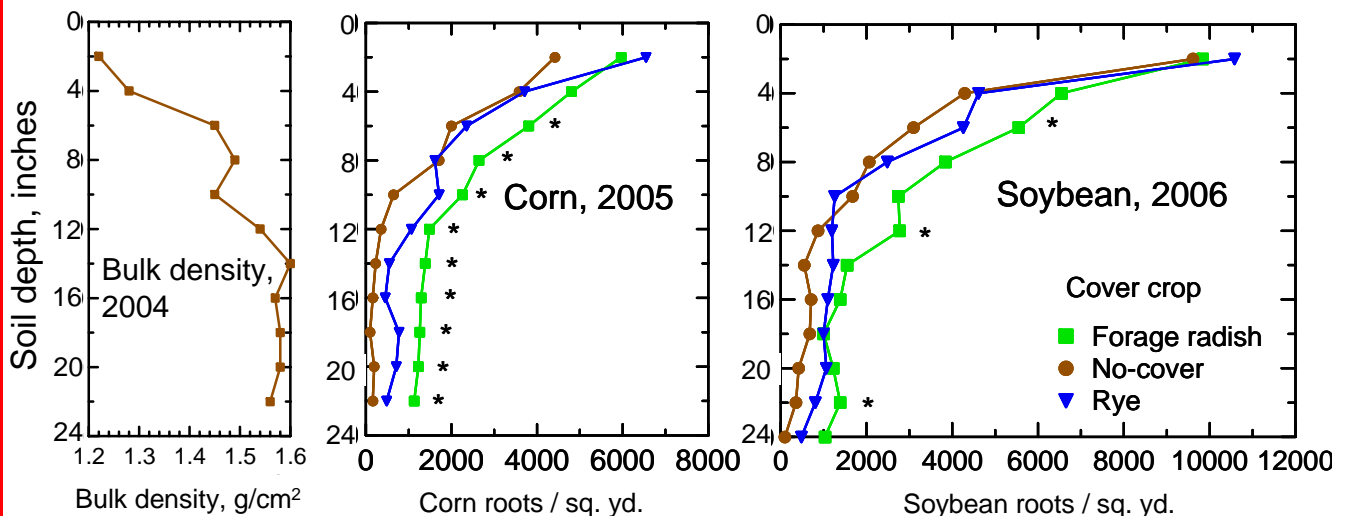
twice as many as after a rye cover crop.

Data suggests that biodrilling with cover crops like forage radish can substitute for expensive and energy intensive deep ripping and other mechanical methods to reverse soil compaction. Some farmers plant forage radish in 24 or 30 inch wide rows (with another cover crop species broadcast in between rows - see cover crop mixtures, below) to maximize the root to shoot ratio of the forage radish. They then plant the following summer crop in these same wide rows to alleviate restriction of root growth into the subsoil.

Suppression of Weeds

A good stand of early-planted forage radish produces a dense canopy that all but eliminates weed emergence in the fall and winter. This action produces a virtually weed-free seedbed in early spring. To obtain this near-complete weed suppression forage radish should be planted by September 15 (in Maryland) with a stand of 5 to 8 plants per square foot.

The near-complete weed suppression can be expected to last until early April, but does not extend into the summer cropping season. The low amount and fragility of residue and weed-free seedbed conditions in early spring make it possible to plant the summer crop without any seedbed preparation tillage or application of a burn-down (pre-plant) herbicide. In Maryland research where in-season (post emergence) weed control was applied, yields of corn planted after a forage radish cover crop were not affected by



Summer crop roots in soil profile as affected by previous cover crop. Bulk density of the soil (left, measured before cover crop treatments) shows the typical higher density found in subsoils. Chen and Weil (2006).

skipping the burn-down herbicide before planting.



Early April appearance of plots planted in fall to cereal rye (left) and forage radish (right).

This system may be of particular interest to organic farmers because it allows no-till planting without herbicides, although cultivation or other weed control will be needed later in the season. Forage radish cover crops have also been observed to suppress or delay the emergence of horseweed or marestail (*Conyza Canadensis*) and may provide a useful new tool for controlling herbicide-resistant biotypes of this weed.



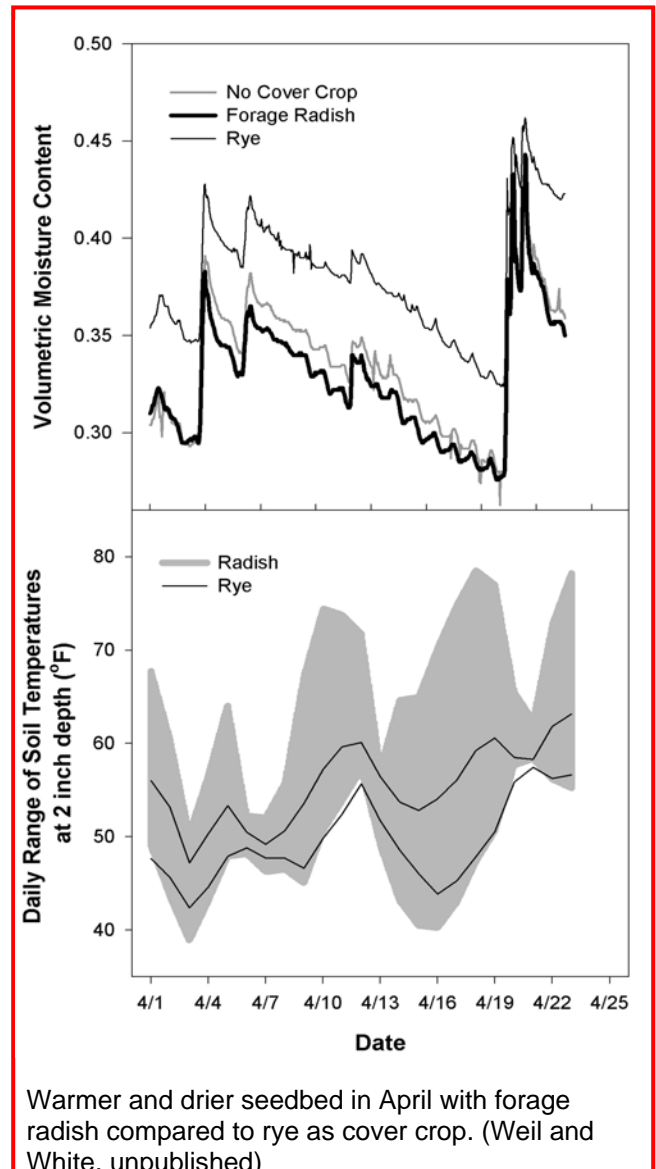
Early corn growth was more vigorous after a forage radish cover crop (right, back) than after a rye cover crop (left, front), due partly to better N availability.

Enhancement of Seedbed

Unlike most other cover crops commonly used in the Mid Atlantic, forage radish won't complicate or delay spring field operations. Because it winter-kills, it does not need to be killed or incorporated to prepare a spring seedbed. When conditions are favorable, the field will be ready for direct

planting. Because forage radish leaves the soil surface weed free, punctured by large root holes, and covered by very thin and sparse residue, the seedbed soil warms up and dries out considerably faster in early spring than do soils covered by either winter weeds or a growing cover crop.

The warmer, drier soil and the elimination of the need for tillage can allow earlier spring planting. The earlier planting may be important for effective utilization of the N released from the forage radish residue in early spring.



Warmer and drier seedbed in April with forage radish compared to rye as cover crop. (Weil and White, unpublished)

Early Release of N and Increase in Topsoil Fertility

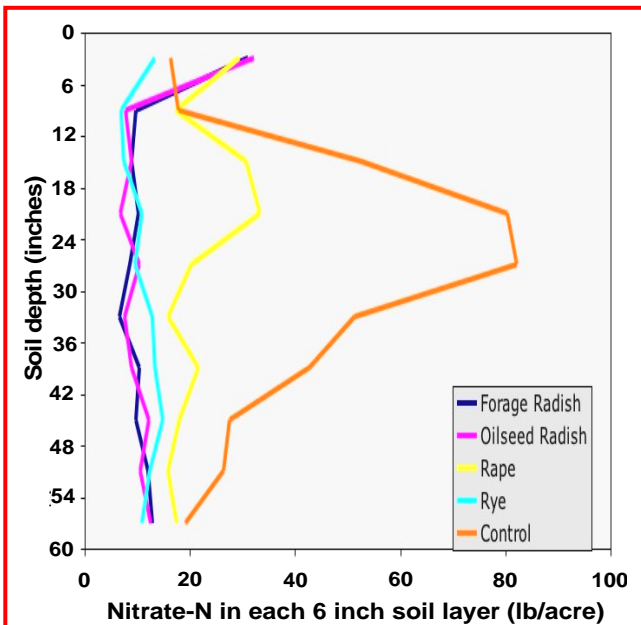
Unlike rye and other cereal cover crops whose residues decompose slowly and immobilize N in the spring, forage radish residue decomposes rapidly and releases its N early. In fact, on sandy soils it is important to plant as early as possible, following forage radish cover crops, to take

advantage of this flush of N before it leaches out of the rooting zone. Forage radish recycles large amounts of N taken up from the soil profile in fall and can reduce the need for N fertilizer in spring.

Because forage radish cover crops do not immobilize N, they are unlikely to slow down growth of the next crop as small grain cover crops sometimes do. In fact, crops often show an early boost in growth and N uptake similar to a planting time N application.

Reduction of Nitrate Leaching

Because of their exceptionally deep root system, rapid growth and heavy N feeding, forage radish cover crops can clean up most of the N in the soil profile after summer crops have ceased their uptake. This prevents excess N from leaching into groundwater during the fall/winter/spring period when there is little or no plant evapotranspiration or N uptake in fallow fields. The forage radish takes up N from both the topsoil and from deep soil layers, storing the N in tissues near the soil

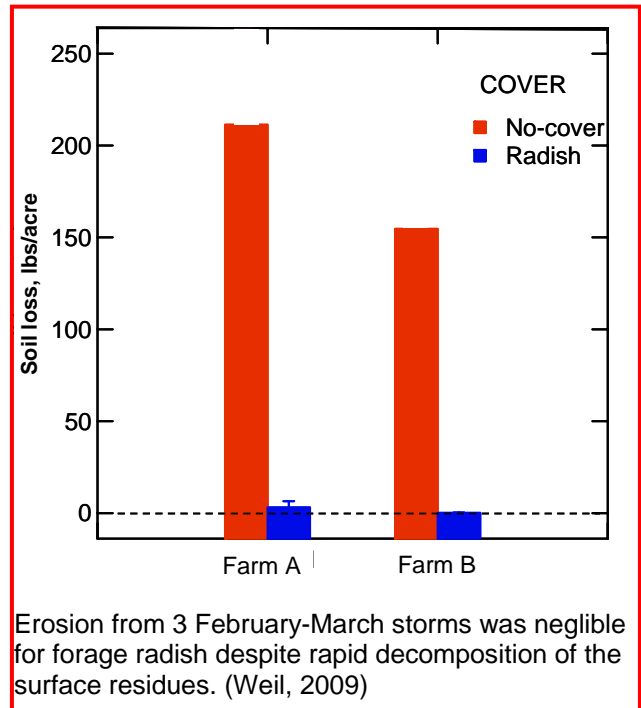


Forage radish and other cover crops clean up nitrate from a sandy soil profile by mid November. Control soil had no cover crop, only winter weeds. (Data from Dean and Weil, 2009)

surface for use by the next crop. If planted while soils are still warm, forage radish cover crops typically take up 100 to 150 lb/ac of N. Greater amounts of N may be taken up by forage radish when a drought-stricken summer crop has failed to utilize most of the fertilizer applied, or on soils which mineralize large amounts of N in the fall due to previous manure applications.

Control of Soil Erosion and Runoff

Forage radish cover crops grow rapidly if planted in late summer or early fall and a good stand can provide full canopy closure in three to four weeks. This canopy intercepts rain drops preventing soil erosion. Even after forage radish is killed by a hard frost, a layer of decomposing residue remains on the soil surface through the winter and into the early spring providing protection from soil erosion. After surface residues have fully decomposed in spring, runoff and erosion are reduced because of the many large holes left behind from the large tap roots. Rainwater rapidly infiltrates into these holes eliminating runoff and trapping sediment before it leaves the field



Erosion from 3 February-March storms was negligible for forage radish despite rapid decomposition of the surface residues. (Weil, 2009)

Building of Soil Organic Matter

With typical dry matter production of 5,000 lb/acre shoots plus 2,000 lb/acre of root dry matter, a good forage radish cover crop adds significant quantities of easily decomposed organic material to the soil. Microbially active organic matter and soil aggregation have been observed to increase after using forage radish for several years.

Effects on Crop Yields

In about half the trials that included a good stand of forage radish, corn (with normal N fertilizer rates) and soybean yields following the forage radish cover crop were significantly higher than

those after fallow or winter rye. These yield increases may be due to improved N fertility, alleviation of soil compaction or other effects.

How to Grow Forage Radish as a Cover Crop

Seeding

Establish a good stand of pure forage radish by seeding at 8 to 10 lb/ac using either a conventional or no-till drill (typically in a small seed box) or by broadcasting at 12-14 lb/ac. When using a drill, seeds are best planted between ¼ inch deep when moisture conditions are good, but can be planted as deep as 1 inch during dry conditions, if this is



Fully grown forage radish plants showing variation in size and root formation with differing populations.

necessary to place seed in contact with soil moisture. When broadcasting, germination will be best if seeder is followed by a corrugated roller or very light disking to encourage some seed-soil contact.

Aerial seeding has been successful using 14 to 16 lb/ac broadcast into standing corn or soybean canopies that have begun senescence (yellowing of lower leaves). Forage radish usually emerges within just 3 days if the soil is warm and not too dry. Even unincorporated broadcast seed will achieve rapid germination if seeding is followed by a timely rain or irrigation. A regional seed source is Groff Seeds, <http://www.tillageradish.com/>.

Forage radish has a very flexible and aggressive growth habit and will spread out in a rosette to fill the space it is given. Radish plants --

especially their fleshy root -- will become much larger when grown at lower plant densities.

Planting Date

In the Mid-Atlantic, forage radish grows best when planted in late August or early September but significant amounts of N can be captured by this cover crop when planted as late as October 1. Forage radish planted in late September may be less susceptible to frost and more likely to overwinter. When planted in late March as a spring cover crop, forage radish did not emerge quickly or grow as well as when planted in fall.

Frost

Forage radish is tolerant of frost until temperatures dip below 25 °F. It takes several nights of temperatures in the low 20's °F to kill forage radish. If mild temperatures resume and the growing point is intact, green leaves may grow back. Usually in Maryland forage radish is damaged by frost by early December but does not die completely until the longer cold spells of January. Under the freeze-thaw winter conditions of the Mid-Atlantic, forage radish tissues (shoots and roots) decompose rapidly once killed by frost and leave only a thin film of residue by March.

Crop Rotations

Forage radish winter cover crops fit well into corn silage and vegetable crop rotations that have openings for cover crop planting by the end of August. Forage radish has successfully been aerially seeded in early September into standing corn grain and soybeans on commercial farms. Because forage radish seeding rates are low, the seed may be mixed with other cover crop seed of similar size to bulk it up for more even aerial seeding. To follow grain corn harvest, if forage radish can be planted by September 30, you will not achieve effective biodrilling and weed suppression, but significant amounts of N can be captured.

Cover crop mixtures

Many farmers are experimenting with cover crop mixtures that combine forage radish with other cover crops that fix N or provide N immobilizing residues in the spring. Because forage radish can out-compete most other plants in early fall, seed forage radish in two feet wide rows to allow enough space for a companion cover crop to grow

in between. Taping-off alternating openers in the small and large seed boxes of a no-till drill is one way to create alternating rows of forage radish and the companion crop. Alternatively, reducing the forage radish seeding rate by half also allows other cover crop species to compete and stay in the cover crop mix.

Spring oats and sorghum-Sudangrass (Sudex) compete well with forage radish, winter kill in the Mid-Atlantic, and provide longer lasting residues to immobilize some of the N released from forage radish residues in the spring. These additional residues may also help maintain soil moisture, reduce weed growth, and reduce erosion during the next growing season. When rye is mixed with forage radish, the rye overwinters and grows into the spring when it can take up the N released by the decomposing forage radish. Hairy vetch is an N fixing cover crop that overwinters



Forage radish planted alone (left) and in alternating rows with Sudex (right). The Sudex was already frost killed in this late October photo.

and has performed well when mixed with forage

radish. Sun hemp fixes N but will winter kill with the forage radish in the Mid-Atlantic.

Problems to avoid

Forage radish does not tolerate very wet soils, so avoid planting it in low spots that collect standing water. Nitrogen deficiency will limit forage radish growth and may limit its ability to compete with weeds or grow through compacted soil. Nitrogen deficiencies have been observed when planting after silage or grain corn on sandy soils or soils that do not have a history of manure application. Nitrogen deficient plants have also been observed to be less susceptible to frost and are more likely to overwinter. If they survive the winter, forage radishes may be attacked by harlequin bugs and flea beetles. Also, be warned that during warm spells in winter, rotting forage radish residues may produce a rotten egg-like odor.

Summary

Forage radish is a unique cover crop that can provide multiple benefits when suitably integrated into your crop rotation. Provision of most of the benefits mentioned depends timely planting in early fall.

There is still much to learn about this new cover crop, so experiment! Our work with forage radish has been inspired by the creativity of farmers developing solutions to problems on their own farms. We hope that this fact sheet will provide you with information that will help you innovate on your own farm.

References:

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