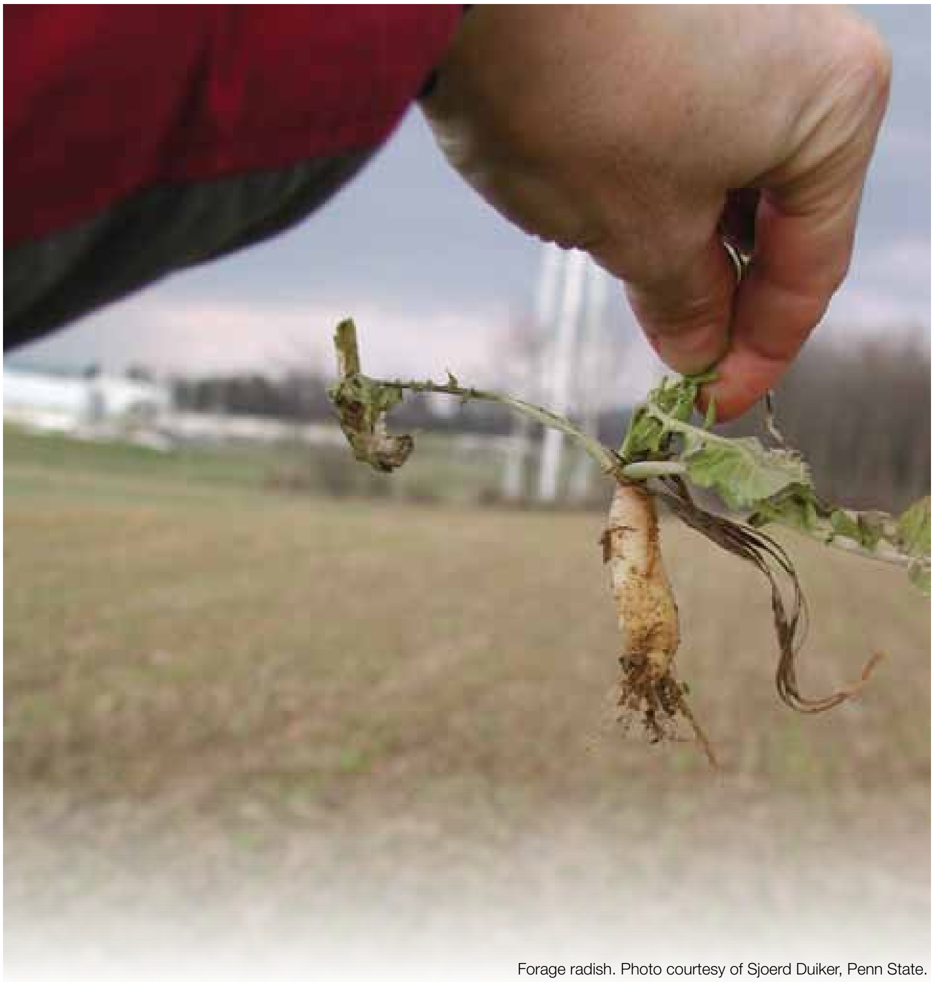
Radishes: A new cover crop option



Forage radish. Photo courtesy of Sjoerd Duiker, Penn State.

Planting forage or oilseed radishes began to take root several years ago, and their use as cover crops is growing. Both are members of the mustard family (Brassicaceae), which has a long history of being used for cover crops and animal forages. Forage radish (*Raphanus sativus* L. var. *niger* J. Kern.), also known as the daikon radish or Japanese radish, has a very large taproot. Originally developed for oil production, oilseed radish (*R. sativus* L. var. *oleiformis* Pers.) is similar to the forage radish, but its taproot is stubbier and more branched, and it tends to be somewhat more winter hardy than the forage radish.

Forage and oilseed radishes can be helpful in no-till operations where their large roots can help retain soil moisture and reduce erosion. They are excellent at breaking up shallow layers of compacted soils, earning them the nickname "biodrills" or "tillage radishes." Once planted in late summer, the radishes are not harvested but die in the winter, decay, and contribute a nitrogen store for spring planting. Dying off in the winter, the radishes leave root channels so that soil dries and warms up faster in the spring.

As part of a recent Illinois extension telnet series on utilizing cover crops in conventional cropping systems, Joel Gruver, assistant professor of soil science and sustainable agriculture at Western Illinois University, spoke on the benefits and management of brassicas and legumes as cover crops.

"Cover crops are multi-functional," Gruver said. "It is important to remember that capturing multiple benefits takes more management. Cover crops are not idiot proof, but there are few profits in idiot-proof systems!"

If you want to reduce soil compaction, good cover crop choices are radish, canola, turnip (and hybrids), sugarbeet, sunflower, and sorghum-Sudangrass, according to Gruver. For nitrogen fixation, legumes such as clovers, vetches, lentils, cowpeas, soybean, and field peas are best. For nutrient cycling, Gruver recommended sunflower, sugarbeets, brassicas, and small grains.

Brassica cover crops have a number of beneficial attributes, including rapid fall growth, high biomass production, a well-developed taproot, excellent nutrient-scavenging ability, high responsiveness to nitrogen, competitiveness with other plants, and special pest resistance capabilities.

According to Gruver, the large taproot of radishes and other brassicas gives the crops an above-average ability to penetrate compacted layers; this promotes deeper rooting by subsequent crops and increases water infiltration. The residue from brassicas decomposes very quickly, and this means that they immobilize less nitrogen than cereal cover crops and often result in net nitrogen mineralization. They also tolerate cold temperatures very well.

An additional special feature of most brassicas is that they produce compounds, called glucosinolates, which are toxic to soil-borne pests and pathogens. Mustards usually have higher concentrations of these chemicals. More than 100 different glucosinolates are found in brassicas. Breakdown products from glucosinolates are volatile and similar to the active chemical in the fumigant Vapam. Glucosinolate concentrations differ according to plant part, age, health, and nutrition. Despite this complexity, Gruver said there is evidence that brassica cover crops can be used to reduce pests, pathogens, and weeds if the right species/cultivar is planted and managed strategically.

Benefits of radishes

Various research groups have been growing different types of radishes in different areas to determine their efficiency as a cover crop.

Ray Weil, Charlie White, and Yvonne Lawley at the University of Maryland have studied the use of forage radish. Although it is fairly new to the Mid-Atlantic region, the use of forage radish as a cover crop has some advantages over other cover crops in the region. Mathieu Ngouajio and Dale Mutch at Michigan State University have experimented with the use of oilseed radish. Because of its quick establishment and rapid growth in cool weather, it has been used successfully in Michigan as a cover crop in diverse production systems.

According to the Michigan researchers, the classification of these and other types of radishes is not well defined because they can easily cross-pollinate, and therefore distinctions among subspecies are often blurred. Most of the traits and management recommendations described in this article apply to both forage and oilseed radishes.

One of the great features of forage radish cover crops is that they can be used as a biological tool to reduce the effects of soil compaction, hence the term "tillage radish." 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. But the Maryland researchers found that forage radish roots can penetrate plow pans or other layers of compacted soil better than most other cover crops. The thin lower part of the taproot can grow to a depth of 6 ft 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 its roots decompose, the remaining root channels are used by the growing roots of following crops to penetrate compacted deep soil layers.

In Maryland research, four times as many corn roots penetrated compact subsoil after a forage radish cover crop than 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 Cocktails" section on page 17) to maximize its root-to-shoot ratio. They then plant the following summer crop in these same wide rows to alleviate restriction of root growth into the subsoil.

In a similar manner, oilseed radish produces large taproots. Upon decomposition, these roots leave large holes in the ground that improve water infiltration and possibly soil microbial activity.

Oilseed radish emerges shortly after planting and provides quick ground cover that smothers weeds. When planted in fall, it prevents weed germination and, consequently, seed production. Early planted forage radish can also produce a dense canopy that all but eliminates weed emergence in the fall and winter. 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/ft^2. The near-complete weed suppression can be expected to last until early April but does not extend into the summer cropping season.

Oilseed radish can scavenge nitrate from deeper soil layers after harvest of the cash crop. Upon decomposition, the nitrogen uptake becomes available to the next cash crop. In the Michigan State tests, a cultivar called Renova, for example, was shown to recycle more than 140 lb of nitrogen/acre in a growing season. In muck soil, the common cultivar recycled more than 60 lb of nitrogen/acre in two months. The Maryland group found that, unlike rye and other cereal cover crops whose residues decompose slowly and immobilize nitrogen in the spring, forage radish residue decomposes rapidly and releases its nitrogen 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 nitrogen 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 nitrogen fertilizer in spring.

Growing radishes as a cover crop

Oilseed radish cultivars used as cover crops include the common variety, Adagio, Arena, Colonel, Remonta, Revena, Rimbo, and Ultimo. According to the Michigan researchers, most of these cultivars are imported from Europe. The common cultivar is the most readily available in Michigan. ▶

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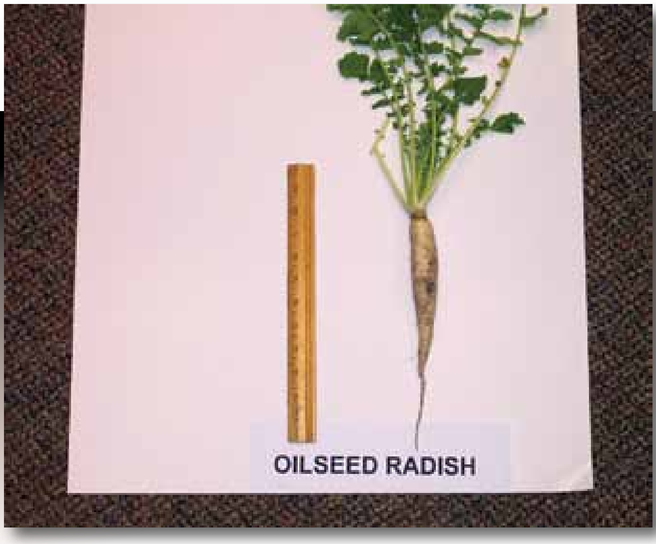

Left: **Oilseed radish taproot compared with 1-ft ruler.** *Photo by Alan Sundermeier.* ***Right:*** **"Tillage radishes" can be used as a biological tool to reduce the effects of soil compaction.** *Photo by Steve Groff (www. tillageradish.com).*

Oilseed radish seed is generally more expensive than seed of other cover crops commonly grown in Michigan.

Whether planted in spring, late summer, or early fall, oilseed radish grows quickly and produces a large amount of biomass in a relatively short time. Four oilseed radish cultivars (Adagio, Arena, Rimbo, and common), seeded in August, were tested in Michigan over two years and produced similar amounts of dry biomass. Total biomass generally exceeds 4 tons/acre. Most cultivars produce more shoot than root biomass, but the common cultivar produces more root biomass and tends to have a better balance of shoot-to-root biomass. Because oilseed radish establishes very fast, even under moderate drought situations, the plants provide good protection against wind and water erosion, which can be particularly helpful for muck or sandy soils.

Oilseed radish seeding rates are typically 10 to 20 lb/acre. Studies conducted in Michigan showed that rates of 10, 15, and 20 lb/acre produced similar amounts of biomass. Low rates are generally recommended because of the high cost of seeds. In some situations, however, high rates may be more beneficial. These include cases where control of weeds, diseases, and nematodes is the primary focus. Oilseed radish leaves low surface residue in the spring, so it is very appropriate for crops that require a well-prepared seedbed. To improve weed and pest management, planting oilseed radish on the same field more than two years in a row is not recommended.

The Maryland researchers recommend seeding at 8 to 10 lb/acre using either a conventional or no-till drill or by broadcasting at 12 to 14 lb/acre to establish a good stand of forage radish. When using a drill, seeds are best planted between 0.25 inches deep (when moisture conditions are good) and 1 inch deep (during dry conditions). When broadcasting, germination will be best if the 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/acre broadcast into standing corn or soybean canopies that have begun senescence (yellowing of lower leaves). Forage radish usually emerges within just three 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.

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.

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 in Maryland tests, forage radish did not emerge quickly or grow as well as when planted in fall.

Forage radish is tolerant of frost until temperatures dip below 25°F. It takes several nights of temperatures in the low 20's to kill forage radish. If mild temperatures resume and the growing point is intact, green leaves may grow back. 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.

Research indicates that forage radish winter cover crops can 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. If planted in late September, growers may not achieve effective biodrilling and weed suppression, but significant amounts of nitrogen can still be captured.

Avoiding problems

According to Gruver, the brassicas have some special management concerns. They are not well adapted to poorly drained soils. Forage radish does not tolerate very wet soils, so avoid planting it in low spots that collect standing water.

Some brassicas have proved difficult to kill with glyphosate—requiring rates of at least 1 qt/acre and possibly multiple applications. Gruver recommends adding 1 pt/acre 2,4-D if possible. Also, they are sensitive to a number of herbicide carryovers. Many of the Group 2 herbicides and the triazine herbicides can have soil residuals that may injure oilseed radish seedlings.

In Maryland, researchers found that 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.

Seed production by oilseed radish may lead to volunteer plants in succeeding crops. In Michigan, this is normally not a problem because oilseed radish planted in August or September will be killed by frost before setting seeds.

Purchase oilseed radish seed early because it may be difficult to locate. Also, growers are warned that during warm spells in winter, rotting forage radish residues may produce a rotten egg-like odor.

Cover crop cocktails

Some farmers are experimenting with cover crop mixtures that combine radishes with other cover crops that fix nitrogen or provide nitrogen-immobilizing residues in the spring.

According to Gruver, current research does not indicate a strong advantage in using these mixes, but individual growers can sometimes get good value for a mix of seeds. He believes additional research on cover crop cocktails is needed.

Gruver said radish seeds cost more than most other cover crops—about two to three times more per acre as seeds for cereal rye, for example. Some farmers plant alternating rows of radishes with other cover crops to try to save money.

Spring oats and sorghum-Sudangrass compete well with forage radish, and since they stop growing in the winter in the Mid-Atlantic, they provide longer-lasting residues to immobilize some of the nitrogen 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 nitrogen released by the decomposing forage radish. Hairy vetch is a nitrogen-fixing cover crop that overwinters and has performed well when mixed with forage radish. Sun hemp fixes nitrogen but will winter kill with the forage radish in the Mid-Atlantic. ■

Portions of this article were adapted from the following sources:

"Forage Radish: New Multi-Purpose Cover Crop for the Mid-Atlantic," published by the University of Maryland Cooperative Extension (http://extension.umd.edu/publications/pdfs/fs824.pdf).

"Oilseed Radish: A New Cover Crop for Michigan," published by Michigan State University Extension (http://fieldcrop.msu.edu/documents/E2907%20Oilseed%20Radish.pdf).

Foodborne pathogens | FROM PAGE 37

production. The centralization and internationalization of food production means that when a problem does occur, it can easily become dispersed. Additionally, new technologies have created gaps in the food safety system, as these improvements come with new requirements for inspection and enforcement, which potentially can lag behind these advancements.

"Why are we seeing so many large multistate foodborne outbreaks? I think better surveillance is part of the answer—it means we're finding some we would've missed before," Tauxe said. "But I also think that large centralized food production means when a problem occurs, it may be widespread. The shift in diet to less cooked and more fresh and raw foods and less processed foods [could be another reason]."

To improve the public health surveillance of foodborne outbreaks, faster processes are needed. The difficulty lies in funding programs on local and state levels in order to do this. At the core of this surveillance is the interview process. Determining the circumstances of one patient of an outbreak can help save many lives, and the development of a core standard of questions can be beneficial to future investigations.

Despite the rigorous efforts of the CDC and other local and state public health agencies, Tauxe warned that future disease outbreaks from foodborne pathogens is likely to occur.

"I think we're going to continue to have problems—I expect the unexpected. New pathogens and new foods arise in new combinations…but with attention to the ecological settings in which we raise the animals and plants, I am sure that there are practical control measures that can be devised. They just need to be explored." ■