

## PLANT MATERIALS TECHNICAL NOTE

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### Radish *Raphanus sativus* L.

#### An Introduced Cover Crop for Conservation Use in Montana and Wyoming

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A daikon forage radish root grows laterally until it can penetrate a soil hardpan.

#### General Description

Radish is a winter annual in the Brassicaceae (or Cruciferae) family with stiff, straight hairs near the base of the leaves. Leaves are deeply dissected in shape and grow from a basal rosette. Seed stalks grow 2 to 3 feet tall from the rosette. Flowers have four petals and are pink, white, or lavender in color. Fruits are called siliques and look like small bean pods (Jacobs, 2012). Radishes are insect pollinated and cross-pollinate readily. Forage radish *Raphanus sativus* L. var. *niger* J. Kern., has a very large tap root. Originally developed for oil production, oilseed radish *Raphanus sativus* L. var. *oleiformis* Pers., is similar to forage radish, but its tap root is stubbier and more branched.

#### Adaptation or Range

In the Rocky Mountain region, radishes grow best in cooler temperatures of the spring and fall and on well-drained soils with a pH range of 5.5 to 8.5 (Clark, 2007). Radishes require 8 to 10 weeks of temperatures at 60°F to achieve optimum growth. Oilseed radishes are tolerant of frost until temperatures dip below 25°F. Several nights of low 20° to 25°F temperatures kill forage radish. If mild temperatures resume after a night of 20° to 25°F and the growing point is intact, top re-growth may occur.

## Conservation Uses

Forage and oilseed radishes have become standard species in many cool and warm season cover crop mixes. Because radishes establish quickly even under moderately drought conditions, the plants provide good protection against wind and water erosion, which can be particularly helpful for stabilizing wet clay or sandy soils. However, if radishes are planted in late summer to early fall, the addition of a grass species to the radish crop, such as winter wheat *Triticum aestivum*, is recommended for erosion control. This is especially important if a warm season crop is planned for the following May and open ground is extended through the spring. After a killing frost, the plants decompose rapidly, leaving minimal residue and relatively open ground by spring. This is beneficial for subsequent crops requiring little or no spring tillage.

The forage radish has an aggressive, expanding rosette which spreads laterally filling available space. Radishes are excellent at breaking up shallow layers of compacted soils, earning them the nicknames “biodrills” and “tillage radishes”. They are excellent scavengers of nitrate, phosphorous, potassium and other nutrients from deep soil layers after harvest of cash crops. These nutrients remain in place after radish decomposition. A soil test taken only 15 inches away from a radish row indicated fewer nutrients there than within the radish row (Gruver, 2014). In addition, decomposed radish roots leave channels for deep water infiltration over the winter, allowing the soil surface to dry and warm more quickly in the spring.



Holes created by radish root decomposition

Radish, like most *Brassica* species, release chemical compounds called glucosinolates that are toxic to many soil-borne pathogens and pests, such as nematodes, fungi, and some weeds. The by-products from glucosinolates decomposition are volatile and similar to the active chemical in the commercial fumigant, Vapam<sup>®</sup> (Ngouajio and Mutch, 2004). Because of this characteristic, they fit well into Montana and Wyoming malting barley *Hordeum vulgare*-sugar beet *Beta vulgaris* subsp. *vulgaris*, rotations. After malting barley harvest in the Big Horn Basin region of Wyoming, volunteer barley is controlled, and 50 to 75 pounds of nitrogen fertilizer applied and then irrigated. A trap crop of radishes is then planted and used to stimulate sugar beet nematode *Heterodera schachtii*, eggs to hatch. Non-host or neutral crops, such as corn and barley, have no effect on the sugar beet nematodes. After hatching, juvenile nematodes are attracted to radish root exudates, whereupon they penetrate the root. Nematodes cannot develop and reproduce in radish roots as they do in susceptible crops and essentially become trapped. Because trap crops are planted in late summer, the trapped nematodes die over the ensuing winter months, resulting in a reduction of their number in the soil. One University of Wyoming study found a radish trap crop resulted in a 50 to 75 percent reduction in the sugar beet nematode population (Koch et al.,

1999). In that study, sugar beet yields increased the following year by 4.0 to 4.9 tons per acre as compared to the control plot having no radish trap crop the previous year. An additional benefit identified in the study was significant lamb gains resulting from grazing the radishes. Average lamb gains in the study were 0.32 pounds per day, which is similar to lamb gains when grazing turnips *Brassica rapa* var. *rapa* L. The 270 pounds per acre of lamb gain, on average, was enough in most years to defray the cost of growing the trap crop. The fodder from all types of radishes provides good forage for cattle, deer, and sheep and is similar in nutritional value to turnips. It is best to plan for only one grazing period, since radishes do not tolerate livestock traffic well.

### Ease of Establishment

Radishes usually emerge within three days after planting if the soil is above 40°F and not too dry. Even un-incorporated, broadcasted seeds will achieve rapid germination if the planting is followed by a timely rain or irrigation. Radishes can be hurt by low moisture conditions, especially if the soil surface is dry and soil moisture is not available to the growing seedlings. There has been success with aerial seeding of radishes into standing silage corn in the Midwest. When broadcasting, however, germination is best if sowing is followed by a corrugated roller or very light disking operation to encourage seed-to-soil contact, keeping in mind that tillage destroys soil structure and can lead to problems such as erosion and loss of soil organic matter.



Oilseed radishes after harvest

### Planting Rates

A current seed test is recommended when planting radishes or other cover crop species. Under good storage conditions, when relative humidity (percent) and temperature (°F) added together are less than 100, radish seeds will last four years (Forever Green Landscaping, 2012). Radish seeding rates of 8 Pure Live Seed (PLS) pounds per acre with a conventional, air, or no-till drill, or 12 PLS pounds per acre when broadcasting, typically result in good stand establishment. When using a drill, radishes are best planted between 0.25 inches (when moisture conditions are adequate) and 1-inch deep (given dry conditions). When planted in a mix with other large-seeded cover crop species, such as beans *Phaseolus spp.*, and field peas *Pisum sativum*, a 1-inch planting depth is recommended as the larger-seeded seedlings will provide channels for the radish seedlings to reach the surface.

Low planting rates (4 PLS pounds per acre) are generally recommended because of high seed cost and larger root size at lower plant densities. In some situations, however, high planting rates (12 PLS pounds per acre) may be more beneficial. These include cases where control of weeds,

diseases, and nematode pests are the primary focus. In diverse cover crop mixes (generally 5 or more species), recommended rates are 1 to 2 PLS pounds per acre. To improve weed and pest management, avoid planting radishes on the same field for more than two consecutive years.

## Production

Whether planted in spring, late summer, or early fall, radishes grow quickly and produce large amounts of biomass in a relatively short time. Most forage cultivars produce more shoot than root biomass. Radishes planted before the summer solstice (longest day of the year) are much more likely to bolt, greatly reducing the root mass and subsequent conservation related benefits. However, even some varieties planted after that date will bolt. Select radish varieties that have been bred or selected for “tap rootedness”.

## Limitations

Radishes are not well adapted to wet, poorly-drained soils. Avoid planting them in low spots that collect standing water. Some brassicas have proven difficult to kill with glyphosate, requiring rates of at least 1 quart per acre and possibly multiple applications. It is therefore recommended to add 1 pint per acre of 2,4-D, if possible. Also, radishes are sensitive to a number of herbicide carryovers. Many of the Group 2 herbicides (acetolactate actohydroxy enzyme inhibitors) and the triazine herbicides can have soil residuals that may injure radish seedlings.

At the USDA-NRCS Bridger Plant Materials Center in Bridger, Montana, and elsewhere, researchers have 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 radishes after Sudan grass *Sorghum x drummondii*, or grain corn *Zea mays*, on sandy soils, and soils without a history of livestock manure application. Adding a starter fertilizer containing 25 to 30 pounds of nitrogen will help alleviate this nutrient shortfall. Conversely, due to their ability to harvest surplus nitrogen from the soil, radishes growing in high nitrogen conditions may accumulate nitrates to levels toxic to grazing animals. If nitrate toxicity is possible, whether the radish crop is grown alone or in a mix, take a sample and test the nitrate level before feeding.

If planted in early September, growers may not achieve effective biodrilling and weed suppression, but significant amounts of nitrogen may still be captured.



Radish roots grown in infertile soils at the Bridger Plant Materials Center

Growers are warned that during warm spells in winter, rotting forage radish residues may produce a rotten egg-like odor. Pod shattering during radish seed production may lead to volunteer plants in succeeding crops (Weil, 2004).

## Releases

There are many forage and oilseed radish cultivars that grow well in Montana and Wyoming. Several trademark varieties in the United States include Tillage Radish®, Nitro™, and Groundhog™. Other varieties with European origins include 'Adagio', 'Arena', 'Colonel', 'Defender', 'Remonta', 'Revena', 'Rimbo', and 'Ultimo'. 'Graza Fodder' and 'Sodbuster' forage radishes are from New Zealand. Most forage radish seed is produced in Idaho or imported from Asia and Europe. These varieties include 'Eco Till', 'Bio Till', and common. Common varieties are also sold under VNS labels (Variety Not Stated).

The photograph of a cover crop field shown below was taken near Wibaux, Montana, and was planted in late July. In this photo, the producer exhausted their supply of a 'biodrill' radish cultivar (right side of photo) and finished the planting with a VNS lot (left side of photo). Fortunately, the VNS portion of the field did not have to be mowed to prevent seed formation because spring wheat was to be planted the following spring. In this cropping scenario, a broadleaf herbicide can be applied to control weeds, as well as volunteer radish. Because of the possibility of situations like this, avoid using VNS or common seed as they may not suit the intent of the planting (i.e., buyer beware).



A field of 'VNS' or common radish on the left and 'BioTill' radish on the right, planted as part of a cover crop mix of lentils, field peas, soybeans, and purple top turnips

## References

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