



Selecting Plant Materials for the Next Generation of Roadside Groundcovers

Groundcover refers to a planting used to stabilize the soil, prevent erosion, and reduce maintenance. Except for ornamental planting beds and areas where the forest was not originally cleared, the entire roadside is planted to groundcovers.

Though often overlooked, groundcovers serve a valuable role in the maintenance of the roadway. By stabilizing the soil and preventing erosion, the integrity of the roadbed and the pavement is preserved, and surface water drainage systems function longer between maintenance operations.

The Makings of a Good Groundcover

The ideal roadside groundcover will establish quickly; grow in poor, construction-impacted soils; be low-growing to prevent hindering sight distance; and stay where it's planted. It also helps if the motoring public thinks that it looks nice.

No single plant material can provide all of these characteristics over the wide range of site conditions and maintenance expectations on the roadside. That is why PennDOT has several seeding formulas, and each of these seeding formulas has at least two species.

Groundcover mixtures often contain a fast-establishing, temporary species, and a slower-establishing permanent component.

The most common permanent components of groundcover seed mixes are grasses and *legumes*. Grasses are a diverse and extremely useful family of plants we rely on for food, feed, conservation, and ornamental purposes. Grasses have a fine-textured, fibrous root system that holds soil in place, and many species are adapted to grow in poor conditions.

Legumes are a family of plants that can get the essential nutrient nitrogen from the air, allowing them to grow in infertile soils where nitrogen is scarce. Legumes accomplish this by forming a symbiotic relationship with a unique type of bacteria. The bacteria live in nodules in the roots of the legume plant, and in exchange for shelter and food (carbohydrates) from the plant, the bacteria are able to take nitrogen from the air (the air we breathe is 78 percent nitrogen) and share it with the legume plant (Figure 1). Plants growing with legumes also benefit from this bacteria-fixed nitrogen as the legume plants drops

leaves and other nitrogen-rich tissue, and because nitrogen is exuded into the soil from the roots of legumes.

A groundcover that includes grasses and legumes will have the benefits of a fibrous root system and the ability to grow in nitrogen-poor soils.

PennDOT Seeding Formulas

PennDOT publication 408 *Specifications* currently lists six seeding formulas to address the different site-quality and maintenance requirements for roadside areas.

Formula B

Formula B is a turfgrass mixture for safety rest areas and other facilities where a lawn is desired. This formula is a mixture of Kentucky bluegrass (*Poa pratensis*), perennial ryegrass (*Lolium perenne*), and creeping red fescue (*Festuca rubra*). This mixture is seeded where there is existing topsoil or topsoil has been furnished and placed.

Formula C

Formula C is used to vegetate slopes and unmowed areas after construction. This formula includes annual ryegrass (*Lolium perenne* ssp. *multiflorum*) and



Figure 1. The oval-shaped nodules on these crownvetch roots harbor bacteria that provide nitrogen to the plant, allowing it to grow in soils that have low nitrogen levels. These nodules occur in plants known as legumes, which include species such as beans, peas, clovers, and alfalfa.

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crownvetch (*Coronilla varia*). Annual ryegrass is a fast-growing annual that germinates within days of seeding and provides a quick cover for the first growing season. Crownvetch is a legume adapted to poor, dry soils. It has a viny growth habit and provides effective soil cover even on very poor sites.

Formula D

Formula D is seeded to areas that will be mowed, such as medians and shoulders. It includes tall fescue (*Lolium arundinaceum*, variety 'Kentucky 31') and creeping red fescue (*Festuca rubra*). Tall fescue is a coarse, durable grass that tolerates moderately poor soils and physical abuse such as vehicle traffic and mowing. Topsoil is placed before Formula D is seeded.

Formula E

This formula consists solely of annual ryegrass and is used during construction when a quick, temporary cover is needed to stabilize disturbed soil.

Formula L

Formula L is a grass-based formula that is used for mowed or non-mowed areas. It consists of hard fescue (*Festuca trachyphylla*), creeping red fescue, and annual ryegrass. Annual ryegrass provides quick cover, and the fescues provide a low growing groundcover adapted to poor sites. Formula L will not grow on the poorest sites that crownvetch will tolerate, and it will not tolerate traffic and abusive mowing as well as Formula D. It does however provide a low-growing groundcover that does not need to be mowed and is easier to keep weed-free than crownvetch (Figure 2).

Formula W

Formula W is used primarily to revegetate the non-inundated perimeters of wetlands created during highway



Figure 2. The grass-based Formula L (l) and crownvetch (r) are shown growing side-by-side on a soil berm. Crownvetch will grow on harsher sites than Formula L, but on sites such as this the grass-based formula provides a low-growing, densely rooted cover that is easier to keep free of broadleaf weeds by using selective herbicides.

construction. The mix includes tall fescue, the legume birdsfoot trefoil (*Lotus corniculatus*), and the perennial grass redtop (*Agrostis gigantea*).

Current Groundcover Issues

The species used in current seeding formulas have a proven track record and have been used for decades in roadside and other utilitarian settings by many agencies. However, the qualities that make for an effective groundcover often make that plant weedy when it is growing out of its intended setting.

Annual Ryegrass

Few species compare to annual ryegrass for providing fast, vigorous, cheap, temporary cover. A drawback to annual ryegrass is that it freely reseeds. Although this is a good characteristic when the permanent cover is not yet established, it also leads to annual ryegrass popping up where it is not welcome. Annual ryegrass is a common weed in fall-planted grain crops in the southeast US, up to the southern-tier counties of Pennsylvania. In recent years an herbicide-resistant biotype has emerged that makes it more difficult to control. If continued use of annual ryegrass makes it more likely that it will become a weed problem in PA, then alternative cover crop species need to be used.

Crownvetch

By far, the most contentious groundcover species used by PennDOT is crownvetch. Crownvetch is native to the Mediterranean region and was introduced to the U.S. primarily as contaminant in seed. This is probably how it came to a hillside pasture on the Gift Farm in Berks County, where Penn State Agronomist Fred Grau discovered it in 1935. He collected seed and eventually developed the *Penngift* variety that came to the attention of the Pennsylvania Department of Highways in the 1940's.

Crownvetch was first used on PA roadsides in 1948, and its use became operational in the 1950's. It was planted to thousands of acres during construction of the interstate highway system, almost 6500 acres on Interstate 80 alone. Crownvetch has been very effective at providing cover and preventing erosion on the infertile and droughty cut- and fill-slopes created by roadway construction.

After 50 years of use it has become apparent that crownvetch is a problematic species when it occurs where it was not planted. Roads planted to crownvetch are everywhere, and therefore the potential exists for crownvetch to infest many locations. Crownvetch and many other legumes produce 'hard seed'. Hard seed remains viable in the soil for many years. When construction and maintenance activities move soil from crownvetch-planted roadsides, the seed goes with it. Crownvetch also spreads by way of its creeping root system. One crownvetch plant eventually becomes a crownvetch patch.



Figure 3. The familiar, sweetly fragrant blooms of crownvetch turn the roadside slopes pink as summer begins. The blooms give way to slender seedpods. The viny stems can be 6 feet long, and the stand will be 2 to 4 feet tall, depending on the growing conditions of the site.

The extensive root system of crownvetch makes it difficult to completely control, and the long-lived seed allow it to continually reappear.

The utility of crownvetch and its weedy tendencies have created considerable debate. In 1982, the PA Legislature declared crownvetch as the State Conservation Plant. In 2000, the PA Department of Conservation and Natural Resources included crownvetch as a 'situational invasive' on its brochure *Invasive Plants in Pennsylvania*. The USDA Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) developed and released *Chemung* and *Emerald* crownvetch in the early 1960's. The Plant Fact Sheet published by NRCS for crownvetch now describes it as 'useful but overused'. In its guidelines for implementing the Federal *Executive Order on Invasive Species*, The Federal Highway Administration discourages the use of crownvetch, but has no authority to prevent it because crownvetch is not regulated by any state Noxious Weed laws.

Alternatives to Crownvetch

There are no 'easy' alternatives to crownvetch. The seeding formula that ultimately becomes an alternative to Formula C will require several species to provide the same range of site adaptability, rate of establishment, and seeding-time flexibility as crownvetch.

Native vs Exotic Species

Most of the species we use in agriculture and conservation are *exotic* - they are from other regions of the world. Most plants we consider to be weeds are exotic, and by definition, a species has to be exotic to be *invasive*. Species that behave as invasives are well adapted to their new setting, but they are free of the plant, insect, and disease competition that kept them in check in their native habitat.

Much emphasis is being placed on considering native species as replacements for exotic species. Native species are less likely to be weedy. Native species will be adapted to the region, but they are often not readily available commercially. There are many native species that have potential as groundcover plants, but they have not been developed to the point of being economically available.

Components of the Mix

Formula C has two components - a cover crop (annual ryegrass) and the permanent cover (crownvetch). The mixes we are investigating as alternatives will most likely have four components - a cover crop, an 'intermediate' cover that will provide groundcover for a season or two after the cover crop fades, a legume to provide nitrogen, and the permanent species. Formula C doesn't require this complexity because crownvetch serves as the permanent component and it is a legume, and because crownvetch usually establishes quickly enough to provide stable groundcover when the annual ryegrass sets seed and dies.

Cover Crop

The most commonly used alternatives to annual ryegrass are small grains such as spring oats (*Avena sativa*) or winter rye (*Secale cereal*). The small grains germinate quickly, die after setting seed, and are inexpensive. Spring oats are killed by frost so they would only be useful for spring seedings. Rye is winter hardy so it would be effective for fall seedings.

Another alternative to annual ryegrass is perennial ryegrass (*Lolium perenne*). Like its annual cousin, perennial ryegrass germinates very quickly. Though a perennial, it would be short-lived on infertile sites.

Permanent Cover

The current candidates to replace crownvetch as the permanent component of a reclamation seed mix are native, warm-season grasses (NWSG). NWSG are adapted to full-sun and drier conditions, and grow most actively during the summer months. Commonly used species include big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparius*), and switchgrass (*Panicum virgatum*) (Figure 4).

These grasses are adapted to the infertile, droughty soils created by roadside construction. Their deep, fibrous root system holds soil together better than the coarse, less-branched roots of crownvetch. NWSG also provide habitat value that the exotic crownvetch does not. When roadway construction requires habitat mitigation, use of native warm-season grasses can provide credit towards habitat replacement.

The drawback of NWSG compared to crownvetch is slower establishment. In agricultural settings, NWSG are often reported to establish during the first season. In our studies on roadside slopes we have consistently observed much quicker establishment by crownvetch than NWSG.

This is why a seed mix featuring NWSG will require an intermediate-term species that the crownvetch-based Formula C does not. In general, we regard crownvetch as a species that provides satisfactory cover in its second growing season, while our experience is that NWSG require three to four seasons.

The bunch-type habit of NWSG contributes to the slower development of cover. A few plants of crownvetch will spread and fill in gaps between them because of the sprawling nature of the topgrowth and the creeping nature of the roots. The narrow, upright grasses expand laterally much more slowly. When they are mature, the spaces between NWSG are desirable to provide space for other plants such as goldenrods and asters and shelter for wildlife. However, when the NWSG are small, these spaces need to be filled by some other vegetation. Additionally, gaps in a stand of NWSG need to be filled by other plants as the NWSG can only fill those gaps after several years by dropping seed into the gaps.

Another advantage of NWSG is weed management. The quicker establishment of crownvetch compared to NWSG will prevent weeds early in the life of the stand. Eventually, weeds will infest crownvetch on all but the poorest sites. Because crownvetch is a dicot, or 'broadleaf' plant, it is often difficult to remove dicot weeds selectively. Crownvetch stands are where weed species such as Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), and poison hemlock (*Conium maculatum*) are most prevalent. Dicot weeds can be selectively removed from grasses using systemic herbicides.

NWSG are commonly planted in a multiple species mix. Our current approach is to adopt the mix of big bluestem, little bluestem, Indiangrass, and switchgrass.

Intermediate Cover

The slower establishment of NWSG creates a gap in the establishment of the stand between the first season cover provided by the nurse crop and the eventual filling



Figure 4. This naturally occurring stand of big bluestem (*Andropogon gerardii*) is an example of a native warm-season grass suitable for poor roadside soils. These grasses tolerate infertile soils and drought and provide the option for selective removal of broadleaf weeds and brush with herbicides.

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in by the NWSG. This gap will need to be filled with an intermediate-term species that will provide cover in years two and three without competing too much with the NWSG.

The current candidates for this role are cool-season perennial grasses such as hard fescue or the native Canada wildrye (*Elymus canadensis*). Tall fescue would likely be effective in this role, but is regarded as an invasive species in natural settings, particularly in the southern mid-Atlantic states.

Legume Component

Including a legume in a seed mix for poor sites will provide sorely needed additional nitrogen. Unfortunately, the readily available legumes that would work best - white (*Melilotus alba*) and yellow (*M. officinalis*) sweetclover, and birdsfoot trefoil - are weedy and regarded as invasive in several states.

Native legumes such as showy ticktrefoil (*Desmodium canadense*) and hairy bushclover (*Lespedeza hirta*) are being evaluated for reclamation plantings, but are available in limited quantities at a high cost.

Our current choice is alfalfa (*Medicago sativa*). It is readily available, inexpensive, and not regarded as weedy. Alfalfa is a long-lived perennial with a deep taproot.

The legume portion of this seed mix would likely be killed if broadleaf weeds were treated with herbicides. However, this is an acceptable loss if the NWSG component of the mix remains intact.

Summary

Crownvetch has been an effective groundcover for 50 years, and this single plant provided a lot of utility. To replace the crownvetch-based Formula C, we are proposing a seed mix that will contain at least seven species - a cereal grain cover crop, a cool-season grass to provide a few seasons of cover, a legume such as alfalfa, and a mix of perennial, native warm-season grasses that will provide long term cover on the poorest of sites.

It is our hope that this mixture will provide the utility of crownvetch without its weedy tendencies.

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