

# ELEMENT STEWARDSHIP ABSTRACT

for

*Coronilla varia* L.

Crown vetch, trailing crown vetch

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## SCIENTIFIC NAME

*Coronilla varia* L.

The genus name “*Coronilla*” is derived from the Latin “*corona*” meaning crown. “*Coronilla*” means little crown. The flowers and fruits are arranged in rings, suggesting little crowns. The species epithet “*varia*” means difference or variation, and refers to the plant’s multi-colored flowers.

## SYNONYMS

*Securigera varia* (L.) Lassen is the only synonym for *C. varia* (TROPICOS 2001).

## COMMON NAMES

Crown vetch and trailing crown vetch are common names used for *C. varia*, but it is not a true vetch. True vetches are plants in the genus *Vicia*, which have tendrils for climbing (USDA, NRCS 1999; Hitchcock & Cronquist 1973).

## DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

*Coronilla varia* is a perennial herb in the pea/legume family (Fabaceae or Leguminosae). *C. varia* has spreading to diffuse stems that can measure up to 1.8 meters long and up to 0.6 meters tall. Its leaves are dark green and odd-pinnately-compound, usually with 9 to 25 leaflets per leaf. Leaflets are generally oblong, elliptic to obovate in shape, and 1 to 2 cm long. *C. varia* has a multi-branched root system and can spread vegetatively by its strong fleshy rhizomes.

Flowers of *C. varia* typically appear from late spring through summer, and occur bunched (14 to 20 flowers) in umbels on long, extended stalks. Individual flowers are pea-like with two lips (bilabiate), and can vary in color from pinkish-white to deep pink. The corollas are 10 to 12 mm long and exhibit clawed petals with a 5-toothed calyx. The seed pods (loment) are slender, segmented, pointed, and are borne in crown-like clusters (Harper-Lore 1996; Heim 1990; Heim & Glass 1989; Hitchcock & Cronquist 1973).

## STEWARDSHIP SUMMARY

*Coronilla varia* has been widely planted since the 1950s across the northern two-thirds of the U.S. for erosion control, pasture, green fertilizer, mine reclamation, or as an ornamental ground cover. It is often used as a bank stabilizer along roads and waterways. *C. varia* becomes problematic when it invades into natural areas, such as into native grassland prairies and dunes, where it works to exclude native vegetation by fully covering and shading those native plants. It can climb over small trees and shrubs, and eventually form large single-species stands. *C. varia* seeds prolifically, but it can also spread rapidly by rhizome growth. *C. varia* is able to change soil nutrients, as it works to enrich soils with nitrogen (via its symbiotic relationship with nitrogen-fixing cyanobacteria). Further, *C. varia* alters available fuel loads in fire-adapted ecosystems.

To control *C. varia* in small areas, careful pulling or digging-out the entire plant, followed by the pulling of any new seedlings in successive years, can be successful. Repeated mowing over several years has also been successful for the control of *C. varia*. There are no available

biological controls for the control of *C. varia*. In large infestations, *C. varia* is best controlled with an integrated management approach. This may involve first removing much of the *C. varia* standing biomass (by manual removal, cutting or burning), then spraying herbicide (either glyphosate, 2,4-D, triclopyr, or clopyralid) at recommended label rates on the cut stems and foliage. Follow-up treatment with herbicide is likely required to control any surviving stems or new seedlings. After control efforts, active restoration to create dense native vegetation has the highest probability of long-term success. In areas with residual native vegetation, post-control restoration efforts may not be necessary, especially if the herbicide applied did little or no damage to those desirable native species.

## **RANGE & HABITATS**

*Coronilla varia* is native to the Mediterranean region of Europe, southwest Asia and northern Africa. It was first introduced into the U.S. in the 1950s primarily for erosion control, and has since been planted for other uses, such as for pasture, mine reclamation, as a green fertilizer, or as a showy ornamental ground cover. *C. varia* is now documented as naturalized in all states in the U.S., except for California, North Dakota, Louisiana and Alaska (USDA, NRCS 1999).

*Coronilla varia* is widely distributed in the U.S. and is tolerant of a broad range of environmental conditions. It can withstand periods of drought as well as heavy precipitation (up to 165 cm annual precipitation), but cannot tolerate flooded soil conditions. It is tolerant of cold temperatures (down to  $-33^{\circ}\text{C}$ ), but is intolerant of shade (USDA, NRCS 1999). Therefore, *C. varia* prefers sunny, open areas. Since *C. varia* was largely planted for erosion control, it is now located mostly along roadsides, rights-of-way, open fields, waste grounds and on gravel bars along streams (Heim & Glass 1989). It is from these areas, that *C. varia* can invade into high-quality wildlands, such as into grasslands and dunes in Missouri, Minnesota, and Illinois (Heim 1990). *C. varia* is also common in native grassland prairies in the Tallgrass Prairie in Iowa (Moats, pers. comm.), and is pestiferous in both native shale barren communities in the Allegheny forest in Pennsylvania (Keech 2002) and in the glade/barrens system and grasslands in the Rolling Fork/Salt River drainage in Kentucky (Mazyck 2002).

## **IMPACTS AND THREATS POSED BY *CORONILLA VARIA***

*Coronilla varia* can invade and dominate a variety of vegetation types. It is a serious management threat in many natural areas due to its prolific seeding ability and its rapid rate of vegetative spread via its rhizomes, which can create dense single-species stands. When plant communities become thoroughly infested by *C. varia*, native plant biodiversity decreases and natural successional processes become altered. *C. varia* is able to competitively reduce and/or exclude the growth of most native plant species (primarily by shading), including the native rare plant *Solidago shortii* in the southeastern U.S. (Walck et al. 1999). By excluding those native plants, the native wildlife that relies on those habitats and communities are then compromised.

In the Tallgrass Prairie system in Iowa, *C. varia* displaces native perennial grasses and forbs at the Broken Kettle Grasslands and at Ames High Prairie preserves (Moats, pers. comm.). In the Allegheny forest in Pennsylvania, *C. varia* competes with and excludes those native species of the open woodlands in the globally restricted shale barren communities (Keech 2002). In the Rolling Fork/Salt River drainage in Kentucky, *C. varia* competes with and displaces tall warm-season grasses such as *Andropogon gerardii* (big bluestem), *Schizachyrium scoparium* (little

bluestem), and *Sorghastrum nutans* (Indian grass). It also competes with native forbs such as *Echinacea pallida* (pale purple coneflower), *Physostegia virginiana* (obedient plant), and with the federally-endangered *Leavenworthia exigua* (glade cress) and *Helianthus eggertii* (Eggert's sunflower) (Mazyck 2002). The Ottawa Bluffs Preserve in Minnesota reports that *C. varia* invades and displaces native plants in its intact prairie communities (C. McGuigan, pers. comm.).

Lastly, *C. varia* can alter ecosystem function and nutrient cycling, leading to further degradation of those infested habitats. When *C. varia* invades new habitats, there is an increase in soil nitrogen (it fixes nitrogen with a symbiotic cyanobacteria), as well as changes to the overall fuel load in fire-adapted communities.

## **BIOLOGY AND ECOLOGY**

### **Moisture, light and temperature**

*C. varia* can survive in a variety of environmental conditions, but grows best (has the highest yields) in areas with 46 cm (18 in) or more annual precipitation. Established stands of *C. varia* can tolerate up to 165 cm (65 in) of annual precipitation, as well as withstand long periods of drought, but cannot tolerate flooded or anaerobic soil conditions (USDA, NRCS 1999). *C. varia* prefers sunny, open areas, as it is intolerant of shade, and mature plants can withstand minimum temperatures of  $-33^{\circ}\text{C}$  ( $-28^{\circ}\text{F}$ ) (USDA, NRCS 1999).

### **Soil texture and soil pH**

*C. varia* is well-adapted to all coarse and medium textured soils, including sands, gravelly-rocky soils, and loams. It does not grow particularly well in fine textured soils, but can survive in silts and clays (USDA, NRCS 1999). *C. varia* can grow on low fertility sites and on soils ranging in pH from 5.0 to 7.5. It is not tolerant of saline and alkaline soils (USDA, NRCS 1999).

### **Reproduction & seed viability**

*C. varia* can reproduce vegetatively by rhizome sprouts, or via the production of seeds. Art Gover of Pennsylvania State University Extension (pers. comm.) reports that *C. varia* will typically have a large seed bank stored in the soil, and that these seeds do not require a period of cold stratification to germinate. He adds that *C. varia* management sites that have been monitored for a number of years, still have seeds that continue to germinate. It is unknown how long seeds of *C. varia* remain viable in soil.

## **ECONOMIC USES**

*C. varia* has been extensively planted throughout much of the United States. Even though it does not appear to resist erosion well (A. Gover, pers. comm.; B. Harper-Lore, pers. comm.), it has been planted along many roads, highways, and disturbed areas for erosion control or for road bank stabilization. It has also been widely planted for ground cover, mine reclamation, and as a cover crop, since it (through its association with cyanobacteria) provides nitrogen to soil.

*C. varia* produces high quality forage for livestock (Barnes & Dempsey 1992; Elias & Chadwick 1979). While *C. varia* can be poisonous to horses if ingested in large quantities, there is generally little or no bloat hazard to other livestock if they graze *C. varia* (Cornell University 2001). Deer and elk will also eat *C. varia* (Burhardt & Fiedler 1996), and rabbits, ground-

nesting birds, and meadow voles often use *C. varia* as cover (Jones 1990). *C. varia* is sometimes used by caterpillars and butterflies as a host plant (Burhardt & Fiedler 1996; Karowe 1990).

## **MANAGEMENT**

### **Potential for Restoration of Invaded Sites**

As with all prolific invaders, the key to the successful control of *C. varia* is to prevent new infestations or to control them as soon as possible. If controlled during the early stages of invasion, the potential for successful management is high. Since *C. varia* can reproduce both vegetatively and/or sexually, has a wide range of adaptability, and has few pests and predators, it becomes difficult to manage once firmly established. As such, the potential for large-scale restoration of wildlands where *C. varia* has become established is probably medium.

The best control of *C. varia* is probably with the use of an integrated management approach. The use of manual and mechanical methods, then another control treatment (such as a herbicide spray to control seedlings) repeated for several years, followed by active restoration efforts may be necessary to obtain desired results.

### **Manual and Mechanical Control**

Manual and/or mechanical methods of plant removal can control *C. varia* in small, isolated patches. These methods however, are very time and labor-intensive, as all pieces of the stems, roots, and strong rhizomes must carefully be removed to avoid resprouting. Populations must also be monitored for several years following plant removal because seeds stored in the soil seed bank may germinate.

Cutting or mowing *C. varia* at a frequency of less than once per year is not effective at controlling populations, but does offer a method for temporarily stopping or slowing its spread. Heim & Glass (1989) report that mowing around the periphery of the desired vegetation (natural area) will keep *C. varia* from spreading into the area vegetatively, but does not prevent the arrival of seeds. Heim & Glass (1989) and Heim (1990) also report that repeated mowing (several times per year over several years) can eventually control *C. varia*. Repeated late spring mowing appears to be the most effective. Cutting or mowing can also remove standing biomass, so spray herbicides have higher efficacy.

### **Grazing**

*C. varia* is good quality forage and is highly palatable to cattle, horses, goats and sheep. Horses, however, should not ingest *C. varia* in large quantities (Cornell University 2001). When *C. varia* is properly grown and managed as a pasture crop, grazing does not negatively affect its rate of growth. If pastures are continually (or near-continually) grazed, other non-native species will probably invade these pastures (Barnes & Dempsey 1992). Grazing by itself therefore, does not appear to control *C. varia*.

Grazing can, however, be used in combination with a herbicide treatment for good control. Grazing works similarly to cutting or burning, in that it first removes most of the *C. varia* aboveground biomass, which ensures good herbicide spray coverage on its leaves and stems, resulting in good kill results.

## Prescribed Burning

If *C. varia* is not dominant, prescribed burns in late spring can be an effective control treatment, especially if the surrounding native ecosystem is fire-adapted. Burning may need to be repeated for several years to achieve adequate control (Heim 1990).

At sites where *C. varia* is abundant, however, burning alone is not an effective control option. Burning is effective against seedlings or in slowing the spread of *C. varia*, but large populations will not be controlled because *C. varia* does not produce enough fuel to carry a hot fire. Heim & Glass (1989) report that in large infestations with sufficient fuel, fire will set back the periphery of the infestation, but the center of the population will be left unaffected.

## Herbicides

Herbicides are currently the most effective means to control large infestations of *C. varia*. Herbicides for *C. varia* control can be applied with either backpack sprayers (to minimize overspray) or with a boom. Complete coverage of all stems of *C. varia* is necessary for good control (i.e., spray to wet). Higher rates of efficacy are generally obtained if the spray herbicide treatment is preceded by the removal of the accumulated plant litter (by first burning, mowing, or grazing) to ensure good foliar coverage. Heim (1990) and Heim & Glass (1989) indicate that 2,4-D, glyphosate, triclopyr, or clopyralid may be used to control *C. varia*.

2,4-D amine can be foliar-applied for good control in early spring when *C. varia* is actively growing. It will generally kill the aboveground portions of the plant(s), but some plants may survive (Heim & Glass 1989). If spot applying by a hand sprayer, Heim (1990) suggests using it at the recommended label rate. He also recommends using the 2,4-D amine formulation instead of the ester formulation, as it has a lower level of volatility and does not drift as readily. 2,4-D is a dicot-specific herbicide, and should not harm grasses or other monocots. Follow-up treatments are usually necessary to obtain good control results. A combination of 2,4-D with dicamba (tradename Weed-b-Gon<sup>®</sup>) can also be successful (Harper-Lore 1996).

Glyphosate (tradename RoundUp<sup>®</sup>) can be foliar applied as a 1% or 2% solution, during early spring when the plant is actively growing. Heim (1990) adds that follow-up treatments are necessary the following fall or early spring.

Triclopyr (tradename Garlon 3A<sup>®</sup>) is also effective at controlling *C. varia*. Heim & Glass (1989) report that a 2% solution of triclopyr kills 99% of *C. varia* in large infestations.

Clopyralid (tradename Transline<sup>®</sup>) is a more target-specific herbicide than glyphosate, 2,4-D, or triclopyr, controlling only certain families of dicot plants, including the legumes (Fabaceae), composites (Asteraceae) and smartweeds (Polygonaceae). Bryon Walters (pers. comm.) of the Illinois Natural Areas Improvements reports that a 0.25% solution of clopyralid with 0.5% surfactant can kill up to 100% of *C. varia* cover (see “Examples” section below for more details).

*C. varia* is tolerant to both imazethapyr and imazapic (tradename Plateau<sup>®</sup>) herbicides. Beran et al. (1999) and Masters et al. (1996) both determined when conducting experiments on grassland restoration, that *C. varia* is not only tolerant to these herbicides, but that its rate of establishment

was actually improved after its competitors (namely *Cirsium arvense*-Canada thistle) were treated and reduced in abundance with these compounds.

### **Biocontrol**

There are no available biocontrol agents for *C. varia*. *Coleophora colutella* (Lepidoptera: Coleophoridae) has recently been reported as immigrating into the U.S., and its larvae feed on *C. varia* (Hoebeke et al. 1993). Wheeler (1991) reports that *Lepyronia coleoptrata* (Homoptera: Cercopidae), a spittlebug from Europe that feeds upon *C. varia*, has recently expanded its range into the northeastern U.S. Due to the continued use of *C. varia* as a forage, pasture, and erosion control plant, it is unlikely that a biocontrol agent will be introduced for its control.

### **Restoration/Competition**

*C. varia* is a strong competitor and is generally able to outcompete and suppress native vegetation once it has invaded. If *C. varia* populations are reduced, however (by herbicide, repeated mowing, etc.), the native plants (if still present) are usually able to rapidly recolonize sites (S. Moats, pers. comm.; Heim 1990). Art Gover (pers. comm.) suggests selecting a variety of cool-season native grasses for competition. He recommends the use of switchgrass (*Panicum virgatum*) where it is native, because it is taller than *C. varia* and may shade it.

In studies of Canada thistle (*Cirsium arvense*) control –a non-native to North America despite its common name- *C. varia* was able to successfully compete with it under certain conditions. In wet years, *C. varia* suppresses Canada thistle better than defoliation alone (Ang et al. 1994a,b). Drought reduces the competitiveness of *C. varia*, resulting in higher densities of thistles the following year (Tipping 2001).

## **EXAMPLES OF MANAGEMENT PROGRAMS FOR *CORONILLA VARIA***

### **Iowa**

In The Nature Conservancy's Northern Tallgrass Prairie Preserve in Iowa, Scott Moats has had several years of experience controlling *C. varia*. He reports that cutting or burning, together or alone, had little negative impact on *C. varia*. However, he adds that these management steps were beneficial and necessary because they first reduce accumulated plant litter, which then allowed the following herbicide treatment to come in more-complete contact with the target plants.

Scott applies 2,4-D at label-recommended rates to control *C. varia*, and states that it works well. He reports that it usually takes two years to eliminate a patch, and that he finds a few plants re-emerging in the same locations after 2 to 4 years. He has been treating these new plants before they flower. Since these new patches are small, treatment only takes a few minutes, as compared to 20-30 minutes for the original infestations.

Scott also reports that in all sites where control treatments have taken place, the native vegetation appears to have recovered once *C. varia* infestations decreased in abundance. Therefore, he has not implemented any additional restoration efforts. Since most of these patches are small and isolated, recruitment of native species from the surrounding vegetation is not a problem.

## **Minnesota**

At TNC's Ottawa Bluffs Preserve in central Minnesota, Colin McGuigan reports that he first started controlling *C. varia* using fosamine ammonium (Krenite S<sup>®</sup> at a rate of 1.84 oz/gallon water with Diluent Blue<sup>®</sup> marking agent) in 1996, then in 2000, he started using the herbicide clopyralid (Transline<sup>®</sup> at label rates) because it is a more specific herbicide. Colin reports that he has seen good control using clopyralid spot spraying, but that new seedlings and resprouts (from the rhizomes) continue to emerge. He adds that they have also been using a 3-yr fire rotation cycle, which works to scarify seeds of *C. varia* in the soil seed bank. He hopes that this will eventually exhaust the seed bank of all remaining *C. varia* propagules.

## **Illinois**

Bryon Walters of the Illinois Natural Areas Improvements reports that for the best control of *C. varia*, to spray it in spring (late April to early May) before flowering and before it forms a thick mat. In Illinois, June is too late to spray to get effective results. Spraying should be done before heavy flowering, or seeds may fall to ground.

Bryon uses clopyralid (trade name Transline<sup>®</sup>) in a 0.25% solution with 0.5% surfactant (Miller Nu-Film<sup>®</sup>) and blue dye. He sprays the plants with either a backpack sprayer or a mechanical sprayer (boom with an adjustable nozzle) mounted on an ATV. Bryon says that he sprays all leaf surfaces, but is careful to avoid overspray onto native asters. If all surfaces are covered, he reports a 100% kill rate. He reports that when spraying large patches, the entire outer edge must also be sprayed. Whatever is not sprayed will survive the treatment.

Bryon adds that even when using clopyralid, repeat treatments are necessary at least two times per month immediately following his initial treatment. After a 3-week period, *C. varia* will start to brown. Bad infestations will need additional annual treatments until the seed source has been depleted. This may take several years. Bryon has also tried using 2,4-D amine to control *C. varia*, but reports that this only top-kills the plants.

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## MONITORING

To determine the effectiveness of the management treatments, monitoring should occur both before and after control efforts. Monitoring should be continued for several years following the treatments to determine whether the impacts are lasting, and these data will allow you to assess changes in abundance (percent cover or density) of *C. varia* and desirable natives or “guilds” of natives over time.

Following initial control treatments, further control efforts and monitoring must be performed at least once-a-year for a minimum of 3 to 5 years, due to the ability of many invasive species to resprout, the viability of seeds in the seedbank, or the likelihood of re-invasion from nearby propagule sources.

Monitoring the status of other conservation targets or community attributes, such as the growth and survival of restoration plantings, the regeneration of native plant species, invertebrates, and mammals, may be important indicators of ecosystem health. In general, the objectives of monitoring should track those of management.

While usually considered a research technique, measuring change in both “control” (unmanaged) as well as in the treated areas can be an effective way of assuring that any changes detected in treated areas are actually the result of management actions and not due to other factors. In communities that are in early successional stages or which have been recently disturbed, declines in abundance of invasive species may occur over time without management.

## Research Needs

Although much is known regarding *C. varia* biology and growth due to its pasture and erosion-control potential, little is known regarding its impacts on natural areas or how to control this species. The following research topics need attention:

- 1) What are the mechanisms of *C. varia* invasion and spread in different community types?
- 2) How does native species competition and shading affect the growth, survival, and reproduction of *C. varia*?
- 3) Which, if any, insects or pathogens control *C. varia* abundance in its native range?
- 4) How long do *C. varia* seeds remain viable in soil?

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