



INTEGRATED MANAGEMENT OF MUSTARD SPECIES IN WHEAT PRODUCTION SYSTEMS

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Integrated Management of Mustard Species in Wheat Production Systems

Abstract

Mustard species commonly infest winter wheat fields and can cause significant yield losses if not controlled. This publication focuses on blue mustard (*Chorispora tenella*), flixweed (*Descurainia sophia*), and tumble mustard (*Sisymbrium altissimum*), although many of the management recommendations apply to other mustard species as well. Prevention can play an important role in managing mustard species since infestations often begin along field edges. There are a number of herbicides that can provide effective control of mustard species, but these must be applied early before the plants get large or enter the reproductive stage when rapid stem elongation begins. **Mustards should be controlled by late winter or early spring!**

Introduction

Weed species belonging to the mustard family (Brassicaceae, previously known as Cruciferae) are often collectively referred to as mustards. The mustard family contains nearly 400 genera and more than 4000 species. Members of the family include the economically important Brassica crops such as broccoli, cabbage, kale, turnip, and rapeseed (including canola).

Some of the more common mustard weed species found in the wheat production systems of the inland Pacific Northwest (PNW) are: black mustard (*Brassica nigra*), birdsrape mustard (*Brassica rapa*), shepherd's-purse (*Capsella bursa-pastoris*), blue mustard, flixweed, bushy wallflower (*Erysimum repandum*), wild mustard (*Sinapis arvensis*), tumble mustard, and field pennycress (*Thlaspi arvense*). This publication is focused on the three most widely distributed and troublesome species in wheat production systems of the PNW: blue mustard, flixweed, and tumble mustard, also known as Jim Hill mustard, named after the railroad builder James Hill who was thought to have introduced it (Gaines and Swan 1972).

Many of the weedy mustard species are winter annuals, that is, they germinate and emerge in the fall or winter and complete their life cycle with seed production in late spring or early summer. These weeds can cause severe yield loss in winter wheat because they begin to compete with wheat in the fall when it is small, and if left unchecked, they will

compete with wheat for resources over much of the growing season (Table 1).

There are herbicides that effectively control the mustard species in wheat. Unfortunately, many growers fail to realize that they have a mustard problem until the plants begin to bolt (rapid elongation of the stem) or produce flowers in the spring. Herbicides applied after bolting has begun provide much less effective control. Many poor performance complaints can be attributed to later-than-recommended herbicide applications.

Table 1. Winter wheat yield loss from blue mustard in the Pacific Northwest.*

Period of growth	Blue mustard (plants/ft ²)		
	1	3	9
	--- yield loss (%) ---		
Fall to spring	13	21	29
Fall to maturity	28	42	51

*Adapted from Swan, D.G. Competition of blue mustard with winter wheat. 1971. *Weed Science* 19:340-342.

Identification

Winter annual mustard plants usually begin growth as rosettes (leaves radiating outwards from a short stem at soil level). They remain as a rosette until the start of the reproductive stage in the spring when the stem begins to elongate or bolt. Dense clusters of four-petaled flowers are produced at the tips of branches. The four petals of the flowers form a cross (Figure 1). Mustard flowers are white, yellow, or purple-blue. Mustard seeds are formed inside a pod. These pods are either long and narrow (silique) or flattened and broader than long (silicle). The seeds are small, less than 1/8 inch in diameter and round to egg shaped, depending on the species.



Figure 1. Mustard species form dense clusters of white, yellow, or purple flowers at the tips of branches. The four flower petals of a mustard species, in this case blue mustard, form a cross.

Photo courtesy of Joan Campbell, University of Idaho

Blue Mustard

The cotyledons (seed leaves) of blue mustard seedlings are oval and somewhat glandular or warty (Figure 2a), as are the first true leaves. Seedling leaf margins have some hairs and are entire (smooth, undivided outline) to deeply lobed. Later emerging leaves are oblanceolate (lance-shaped with the thin end at the base) with wavy to coarsely-toothed leaf margins (Figure 2b). All leaves have petioles (stems), but the petioles of upper leaves are shorter than the petioles of lower leaves. The flowers are purplish-blue and about ½ inch wide. The seed pods are ¼ to 1¾ inch long with a conspicuous beak about 1/3 the length of the pod (Figure 2c). No seeds are borne in the beak. Mature blue mustard plants may grow to be up to 18 inches tall.

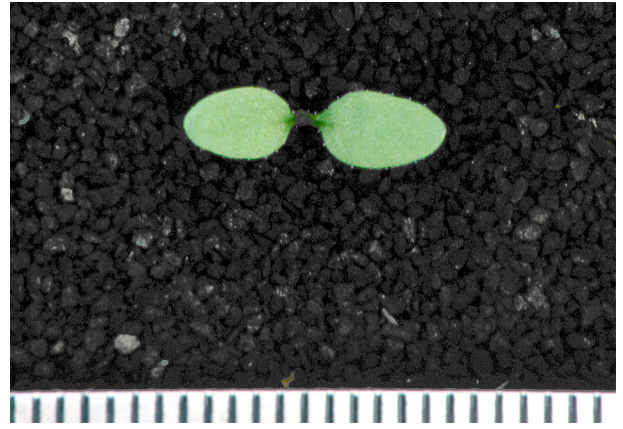


Figure 2a. Blue mustard cotyledons (seed leaves) are oval and somewhat glandular or warty.

Photo courtesy of University of Idaho Extension.



Figure 2b. Blue mustard leaves are oblanceolate (lance-shaped with the thin end at the base) with wavy to coarsely-toothed leaf margins.

Photo courtesy of University of Idaho Extension.



Figure 2c. Blue mustard seed pods, also known as siliques, are 1¼ to 1¾ inch long with a conspicuous beak about 1/3 the length of the pod.
Photo courtesy of University of Idaho Extension.



Figure 3b. Flixweed leaves are finely dissected, fernlike.
Photo courtesy of University of Idaho Extension.

Flixweed

The cotyledons of flixweed are ovate (egg-shaped with broadest part nearest to the stem) with the first true leaves notched or lobed (Figure 3a). Flixweed is easily distinguished from blue mustard and tumble mustard by its finely dissected, fernlike leaves (Figure 3b). Flower petals are very small and yellow or greenish-yellow in color. The seed pods of flixweed are ½ to 1¼ inch long and usually longer than the attached stalk. Mature flixweed plants grow up to 28 inches tall. Flixweed is an introduced species from Eurasia that has spread rapidly. It is easily confused with the native species pinnate tansymustard (*Descurainia pinnata*). The two species are most easily identified once the pods have formed after flowering (Figure 3c). The seed pods of pinnate tansymustard are less than ¾ inch long and usually shorter than the stalks (pedicels) to which they are attached. In 1972, it was estimated that 80% of the *Descurainia* population in eastern Washington was flixweed (Gaines and Swan 1972). Today, it is difficult to find pinnate tansymustard in eastern Washington.

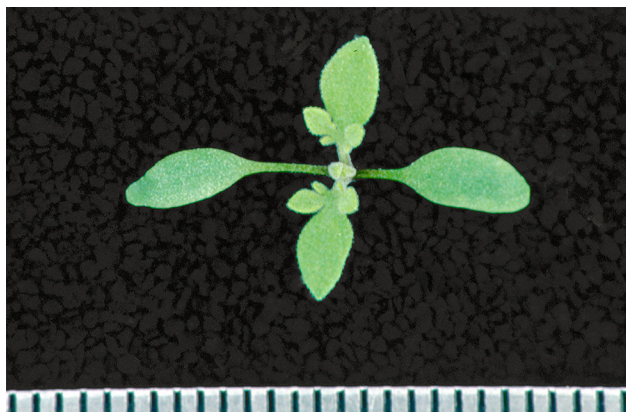


Figure 3a. Flixweed cotyledons are ovate (egg-shaped with broadest part nearest to the stem) and the first true leaves are notched or lobed
Photo courtesy of University of Idaho Extension.



Figure 3c. Pinnate tansymustard (left) seed pods are less than ¾ inch long and the same length or shorter than the length of the stalk (pedicel) to which they are attached. Flixweed (right) seed pods are ½ to 1¼ inch long, which is typically longer than the stalk.
Photo courtesy of the College of Veterinary Medicine & Biomedical Sciences at Colorado State University and used with permission.

Tumble mustard

The cotyledons of tumble mustard are very small and egg shaped. The first true leaves are somewhat larger than the cotyledons with slightly toothed leaf margins (Figure 4a). Later leaves grow larger, 3 to 9 inches long, with deep lobes that are often toothed (Figure 4b).

Leaves that form after bolting are shorter with more slender lobes, becoming threadlike near the top of the mature plant. Flowers are pale yellow and clustered on thick, spreading stalks (Figure 4c). Seed pods are 2 to 4 inches long, stiff, spreading, and widely spaced along the stem. Tumble mustard is one of the largest mustard plants, reaching heights of 5 feet. Mature plants often break off at soil level and spread seed as they tumble in the wind.

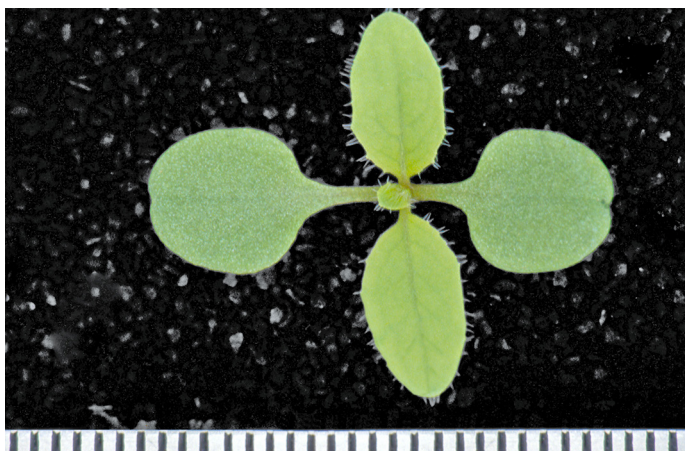


Figure 4a. Tumble mustard cotyledons (seed leaves) are very small and egg shaped. The first true leaves are somewhat larger than the cotyledons with slightly toothed leaf margins. Photo courtesy of University of Idaho Extension.



Figure 4b. Tumble mustard leaves grow to be 3 to 9 inches long, with deep lobes that are often toothed. Photo courtesy of Lindsay Koby, graduate student, Washington State University.



Figure 4c. Tumble mustard flowers are pale yellow and clustered on thick, spreading stalks. Tumble mustard plants can reach a height of 5 feet. Photo courtesy of Drew Lyon, Washington State University.

Information on the identification of other common mustard species in the PNW can be found in [Mustards in Mustards: Guide to Identification of Canola, Mustard, Rapeseed and Related Weeds](#) (Callihan et al. 2000). This University of Idaho Extension publication has excellent pictures for 17 Brassica and associated species, including the three species discussed in this publication.

Integrated Management

Prevention

Plant only certified, weed-free crop seed. Clean equipment and vehicles whenever they are moved from infested to non-infested fields. Eliminate small infestations before they spread.

Mustard infestations often begin along roadsides and field edges and then move into cultivated fields. These infestations are more easily managed when field borders are planted with perennial, cool-season grasses. Vigorous stands of grasses are highly competitive with mustards and other annual weeds. Growing perennial grasses also allows the use of some selective broadleaf herbicides in these areas for mustard control. Mowing immediately before the mustard plants start to flower can reduce seed production.

Tillage

Shallow, light tillage after crop harvest can be used to increase seed-to-soil contact and encourage weed seed germination. Emerged mustard seedlings can subsequently be controlled with tillage or nonselective herbicides. Tillage for weed management works best when soils are dry, air temperatures are warm enough, and relative humidity is low enough to cause the disturbed weed seedlings to wilt quickly and die.

Mustard seed may remain viable in the soil for many years. This makes deep inversion tillage less effective for managing mustard than it is for a species such as downy brome that has little viable seed in the soil after three years. Deep tillage done within ten years of an initial deep tillage operation to bury mustard seed simply brings viable buried seed back to the soil surface where it can germinate and grow.

Cultural Practices

A competitive stand of healthy wheat is one of the most effective means of controlling annual weeds. Establishing a competitive wheat stand requires choosing a well-adapted wheat variety and seeding at the appropriate seeding rate and depth (usually 1½ to 2 inches deep) into a firm, moist seedbed at the optimum time for your region. Adequate soil fertility is needed to promote early wheat growth. Placing the fertilizer close to the wheat seed, although not too close as to cause damage, gives wheat seedlings preferential access to the fertilizer compared to the weed seedlings. Using large, fungicide-treated seed can increase seedling vigor and improve early season competition with weeds.

Mustards are most easily controlled in cereal and grass crops because selective broadleaf herbicides may be used for weed control with minimal risk for crop injury. Rotating winter wheat with spring crops or summer fallow provides opportunities to apply non-selective herbicides, including glyphosate or paraquat prior to crop emergence, for the control of mustards. Alternatively, tillage may be used after mustard emergence in the spring when mustard seedlings are easier to control.

The longevity of mustard seed in the soil, which is measured in decades, makes the prevention of seed production a critical component of managing these weeds.

Although crop rotation should be a component of the management plan, it will take longer to see the impact of crop rotation on mustard species compared to that seen for weed species with relatively short seed viability.

Herbicides

Mustards should be controlled by late winter or early spring! Many farmers don't think about applying herbicides to control mustards until the spring when the plants become more conspicuous as they bolt and begin to flower. Although some control can be achieved at that stage, mustard control is much more difficult after plants shift from vegetative to reproductive growth, which is characterized by rapid stem elongation or bolting. In addition to being more difficult to control after bolting, much of the competition and wheat yield loss will have occurred by this time, making the economics of later control less favorable than earlier control. However, later control treatments may still reduce seed production, which is beneficial in the long run.

Mustard plants that emerge in the fall with the winter wheat will be more competitive, produce more seed, and reduce crop yields more than plants that emerge in the winter or early spring. If mustards are present in the fall, growers should consider applying herbicides in the fall to control them. The ALS-inhibiting herbicides (Group 2) generally provide excellent control of the mustard species and are safe to apply to wheat in the fall, before it is well-tillered. Effective ALS inhibitors include metsulfuron (Ally or other trade names) (Table 2), triasulfuron (Amber or other trade names), chlorsulfuron + metsulfuron (Finesse or other trade names), thifensulfuron + tribenuron (Affinity BroadSpec or other trade names), propoxycarbazone (Olympus or other trade names), or pyroxsulam (PowerFlex HL or other trade names). Two exceptions are: (1) sulfosulfuron (Outrider or other trade names), which is not effective on blue mustard, and (2) flixweed biotypes resistant to several ALS inhibitors were confirmed in Kansas in 2006, and resistant biotypes have likely developed in the PNW since then.

Table 2. Flixweed and tumble mustard control in winter wheat averaged across at least two sites (Pullman, Lind, or Davenport) or two years (2008–2011) in eastern Washington. All herbicide treatments were applied in the spring to actively growing wheat and weeds.

Treatment	Rate used in fluid or dry oz product/acre	Visual control (%) ^a	
		Flixweed	Tumble mustard
Linuron + bromoxynil	8 + 16	57	71
Chlorsulfuron + NIS	0.25 + 0.25% v/v	58	77
Metsulfuron + NIS	0.1 + 0.25% v/v	82	88
Prosulfuron + NIS	0.38 + 0.25% v/v	71	88
Diuron	26	56	47
Metribuzin	5	59	53
Triasulfuron + NIS	0.47	51	56
Bromoxynil	24	58	61
Tribenuron + NIS	0.25 + 0.25% v/v	57	59
Thifensulfuron + NIS	0.75	50	63
MCPA	16	64	56
2,4-D	16	93	96
Dicamba	4	68	64
Fluroxypyr	6.4	30	70
Clopyralid + fluroxypyr	16	49	66
Carfentrazone + NIS	1	50	43
Pyrasulfotole + bromoxynil + UAN	13.5 + 1 qt/acre	91	96
Florasulam + MCPA	17	96	84

^aTreatments providing excellent control of one or both mustard species are highlighted in green, treatments providing good to fair control are highlighted in blue, and treatments providing poor control of both species are not highlighted.

^bVisual control scale is from 0 to 100% with 0% being no visible damage and 100% being plant death.

^cNIS = non-ionic surfactant

^dUAN = urea ammonia nitrate (28-0-0).

When dealing with a mustard biotype that is resistant to the ALS inhibitors, or as a proactive management strategy to delay the onset of ALS resistance, use herbicides with different mechanisms of action, either alone or as a tank mix with an ALS inhibiting herbicide. The most effective alternative herbicides are 2,4-D (Synthetic auxins, Group 4), MCPA (Group 4), pyrasulfatole (Inhibitors of 4-HPPD, Group 27) + bromoxynil (Photosystem II inhibitors, Group 6) (Huskie), and bicyclopyrone (Group 27) + bromoxynil (Talinor). Weeds must be actively growing for these alternative herbicides to perform well. The window for effective application in the spring can be small because the mustard plants need to be actively growing but they need to be small and not yet bolting. Dicamba (Group 4) and fluroxypyr (Starane Ultra or other trade names; Group 4) do not provide good mustard control.

Although 2,4-D and MCPA provide good to excellent control of most mustard species when applied to small, actively growing plants, both herbicides can injure wheat. MCPA should not be applied to wheat before plants have reached the 3 to 4 leaf stage, and 2,4-D should not be applied to wheat before it has at least four tillers, which usually does not occur until spring.

Blue mustard begins to bolt two to three weeks earlier than the other weedy mustard species (Lyon et al. 2006). Consequently, growers report less success with herbicide applications for this species than the other mustard species. This is largely the result of late application. Many growers want to make just a single herbicide application in the spring, so they wait until summer annual weeds begin to germinate. This is too late for effective mustard control, especially blue mustard control. If growers wait until it is safe to apply 2,4-D to their winter wheat, they will be too late for effective control of blue mustard. Blue mustard often invades fields from the edges, consequently, only the field edges may need to be treated. Growers may want to consider treating field edges in late winter with an ALS inhibitor, other than sulfosulfuron, and coming back later to control other weed issues in the field.

Flixweed should be treated before the rosettes are 2 to 3 inches across and 2 to 3 inches tall. Delaying application beyond this stage results in dramatically reduced control. The ester formulations of 2,4-D and MCPA provide greater control of flixweed and pinnate tansymustard than the amine formulations. Note, however, that there are state laws restricting the application timing of ester formulations of 2,4-D and MCPA.

There are a number of herbicides that can provide effective control of mustard species if they are applied early, before the mustard plants get big or begin to bolt. Waiting to treat mustard plants until they begin to bolt dramatically reduces the effectiveness of herbicides and increases wheat yield loss.

Herbicide trade names change, new products come to market, some products are removed from the market, and new cases of herbicide resistance develop over time. To stay current with these changes, visit the current edition of the [PNW Weed Management Handbook](#) (Peachey 2022). As with all crop protection chemicals, read and follow label directions and understand their proper use.

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