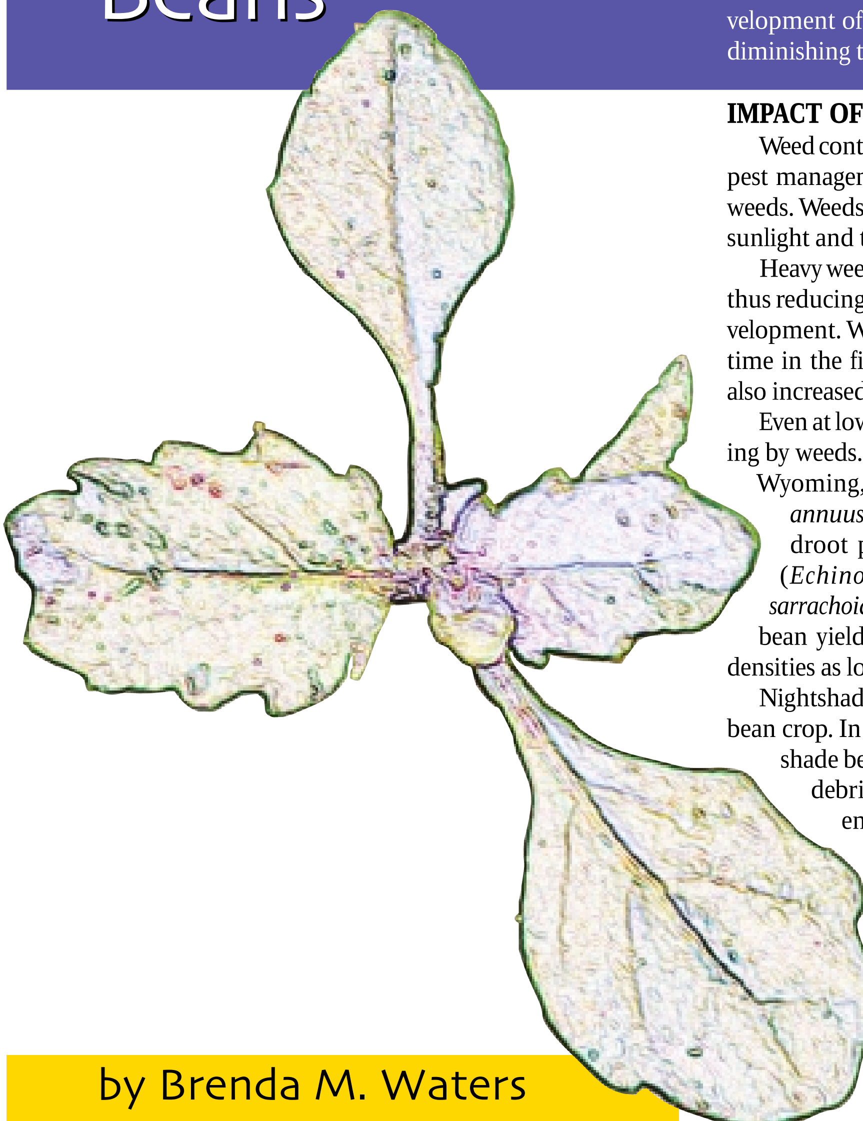
PNW 545

Integrated Weed Management in Dry Edible Beans



by Brenda M. Waters and Don Morishita

INTRODUCTION

Weeds have been a pest to bean growers for as long as beans have been cultivated. Prior to the 1940s, growers were limited to hand pulling and mechanical methods such as cultivation to remove weeds. Modern chemical weed control began in the 1940s with the discovery of 2,4-D; however, selective chemical weed control in dry beans did not begin until the early 1950s with the development of dinoseb and chloropropham. The herbicide EPTC was used extensively in the early 1960s until trifluralin was introduced in the late 1960s. Together, these two herbicides served as the primary selective herbicides in dry beans for many years.

Today, the emphasis is on integrating all available weed control methods. This approach, called integrated weed management (IWM), allows growers to control problem weeds by utilizing preventive, cultural, mechanical, and chemical methods. Reliance on a single method, such as herbicides, to control weeds should be avoided as it often causes a shift to other weed species or the development of resistance within the target weed population, thus diminishing the effectiveness of that particular tool.

IMPACT OF WEED COMPETITION

Weed control costs bean producers more money than any other pest management practice. Bean plants compete poorly against weeds. Weeds compete with bean plants for water, nutrients, and sunlight and thereby decrease crop yield and quality.

Heavy weed densities can increase humidity within the canopy, thus reducing airflow and increasing the possibility of disease development. Weeds that are green at cutting increase bean drying time in the field, resulting in yield losses due to shattering and also increased disease potential.

Even at low weed densities, bean yields are reduced from shading by weeds. In studies conducted in western Nebraska, eastern Wyoming, and Colorado, common sunflower (*Helianthus annuus*), common cocklebur (*Xanthium strumarium*), redroot pigweed (*Amaranthus retroflexus*), barnyardgrass (*Echinochloa crus-galli*), hairy nightshade (*Solanum sarrachoides*), and green foxtail (*Setaria viridis*) reduced dry bean yields 40, 30, 22, 18, 15 and 6 percent, respectively, at densities as low as two plants per 6 feet of row.

Nightshade species are extremely troublesome in an edible dry bean crop. In addition to being poisonous, juice from the nightshade berry stains bean seed coats and causes dirt and other debris to adhere to bean seed during harvest. The presence of nightshade berries can also render green beans unsuitable for canning.

PROBLEM WEED SPECIES

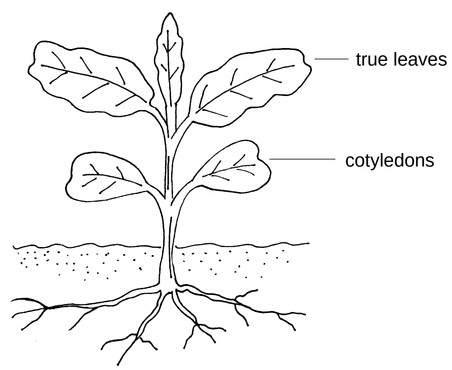
Several grass weed species are a problem in Pacific Northwest (PNW) bean fields including green and yellow foxtail (*Setaria glauca*), barnyardgrass, field sandbur (*Cenchrus incertus*), wild oat (*Avena fatua*), wild-proso millet (*Panicum miliaceum*), and witchgrass (*Panicum capillare*).

Broadleaf weeds found in PNW bean fields include common lambsquarters (*Chenopodium album*), common mallow (*Malva neglecta*), kochia (*Kochia scoparia*), prickly lettuce

(*Lactuca serriola*), redroot pigweed, Powell amaranth (*Amaranthus powellii*), common cocklebur, prostrate knotweed (*Polygonum aviculare*), common purslane (*Portulaca oleracea*), common sunflower, and hairy nightshade. Yellow nutsedge (*Cyperus esculentus*), field bindweed (*Convolvulus arvensis*), Canada thistle (*Cirsium arvense*), perennial sowthistle (*Sonchus arvensis*), and quackgrass (*Elytrigia repens*) are perennial weeds occasionally found in bean fields. A series of photos of weed species that commonly infest PNW bean fields can be found on pages 4 and 5.

■ **Nightshade**—In the PNW, the predominant nightshade species is hairy nightshade. Cutleaf nightshade (*Solanum triflorum*) and black nightshade (*Solanum nigrum*) are also found in PNW bean fields. Unfortunately, poor preventive and cultural weed management practices are a primary cause of spreading nightshade seed from one field to another. It can spread on tillage and harvest equipment, and it can also contaminate various crop seeds planted in the spring. Nightshade plants are unaffected by the shade from the bean canopy and usually continue germinating after preemergence herbicides have begun to lose their effectiveness. One nightshade plant can produce as many as 178,000 seeds that become viable early in the development of the poisonous berries. Nightshade seed can remain viable in the soil for 10 years and sometimes longer.

Parts of a broadleaf seedling



WHAT IS INTEGRATED WEED MANAGEMENT IN DRY BEAN PRODUCTION?

Integrated Weed Management (IWM) is an environmentally sound system of long-term crop production that uses all available weed management knowledge and tools to grow and harvest a crop free of economically and environmentally damaging weed competition. It is the combination of as many different agronomic and weed management practices as possible. IWM works to minimize the effect of weed competition on the crop and decrease the potential for weed population shifts to weeds that are even more difficult to control than the present population. The objective of IWM is to manipulate the crop-weed relationship so that the growth of the crop is favored over that of the weeds.

Integrated weed management for growers can be broken into four main weed control strategies, which should be used in combination:

1. Preventive
2. Cultural
3. Mechanical
4. Chemical

WEED PREVENTION

Field sanitation, or practices that prevent weeds from entering or spreading through fields, is the first step in prevention. It is also the easiest practice to implement. Wind, irrigation water, livestock, and humans spread most weeds and weed seed.

- Plant certified weed-free bean and other crop seed.
- Properly clean tillage, cultivation, and harvest equipment to remove all soil and organic materials to prevent spread of both annual and perennial weeds.
- Properly compost manure to eliminate or reduce the number of viable weed seeds before spreading it on a field.
- Control weeds growing on field perimeters and along irrigation ditches to prevent their spread into the field.
- Irrigation water can be a source of weed seed. Use a weed screen or filter for surface irrigation water to reduce the number of weed seeds introduced into a field. Recent research in Idaho has shown that using polyacrylamide (PAM) for reducing soil erosion in furrow-irrigated crops also reduces the movement of weed seed from fields.
- Scout fields to detect patches of newly invading weeds or herbicide-resistant weeds.
- Control small weed patches by spot spraying (annual or perennial weeds) with an appropriate herbicide, or by removing the weeds by hand (most effective for annual weeds) before the weed has had the chance to produce seed.

CULTURAL PRACTICES

■ **Crop Rotation**—Rotating between less competitive annual row crops such as dry beans and sugarbeets and more competitive crops such as small-grain cereals, especially winter cereals, and alfalfa aides in preventing and reducing the build-up of troublesome weeds in dry beans. In contrast, planting the same crop year after year using the same agronomic practices tends to favor a build-up of weeds that are crop-associated. It is difficult to control a grass weed, such as green foxtail, growing in a grass crop such as wheat or barley. But green foxtail growing in a broadleaf crop such as beans can be controlled using a selective herbicide with comparative ease. The same principle applies to broadleaf species growing in broadleaf crops: it is easier to control broadleaf weeds when they are growing in grass crops than when they are growing in broadleaf crops.

An effective crop rotation plan alternates dry beans with crops that have contrasting characteristics and associated weeds in a minimum three- or four-year crop rotation. An example would be to grow wheat, followed by dry beans, followed by sugarbeets, onions, or alfalfa. Crop rotation not only decreases weed populations but increases harvest quality and yield, improves soil conditions, and can decrease disease and insect problems.

■ **Crop Competition**—The first four to five weeks after a bean crop emerges is the critical weed-free period. During this period it is essential to prevent weed competition in order to attain the maximum crop yield. Once the crop canopy becomes established, late-emerging weed growth will slow.

Paying attention to the management of soil fertility, water, insects, and disease is critical for competitive dry bean production. Proper fertilizer placement, seeding rates, plant spacing, cultivation, and irrigation timing all contribute to giving beans the competitive edge.

■ **Fertilization**—Use soil sampling and soil tests to determine what kind of fertilizer is needed and how much. Optimal fertilizer placement such as banding or shank-injection should make more nutrients available to the bean crop and less available to the weeds. Banding near the bean row or lay-by applications of fertilizer may help to make soil nutrients less available to the weeds than a broadcast application.

■ **Planting**—Plant at the maximum recommended seeding rate for the chosen variety. Reduced row spacing (22 inches or less), uniformly placed seed (2.5 to 3 inches apart), and a planting depth of 3 inches or less can enable faster plant emergence and give the crop a better chance at successfully competing for the necessary resources such as nutrients, light, and space.

Research in Alberta, Canada, has shown that increased bean plant density results in higher bean yield and greater hairy nightshade suppression. However, increased planting density may also increase the potential for white mold.

When possible, choose a competitive bean variety that will germinate and become established quickly. Indeterminate bean varieties tend to have broader canopies than determinant varieties and therefore are more competitive. Plant as early in the spring as is possible once the soil temperature is 55°F and is expected to remain there or increase. Generally, varieties that emerge rapidly, become established, and close the row quickly are more competitive.

■ **Irrigation**—Preplant irrigation ensures proper soil moisture is available for seed germination and also activates soil-applied herbicides. After bean emergence, schedule irrigations so that available soil-water does not drop below 60 percent, at which point dry beans become stressed and therefore less competitive.

MECHANICAL CONTROL

Mechanical weed control continues to be an important weed management tool in dry bean production. A preplant tillage operation removes early emerging weeds and often is performed in combination with a preplant herbicide application.

After planting and prior to emergence of the bean seedlings, a harrow can be used to remove weed seedlings as they emerge. One or two cultivations after bean emergence will effectively control many weeds. However, late-emerging weeds often emerge following cultivation, when the soil is disturbed. These late flushes of weeds can become a problem late in the season, especially if crop stand is poor. Therefore, cultivation and/or a selective postemergence herbicide is necessary to control weeds for the first four to five weeks, or until row closure.

CHEMICAL CONTROL

Selecting the proper herbicide for the weeds present in the field is essential. Keep annual records on each field and use them to anticipate the spectrum of weeds you will need to control. Preplant herbicide selection is usually based on records from previous years, while selection of a postemergence herbicide is based on the population of emerged weed seedlings. A preplant herbicide application normally controls weeds for the first 4 to 6 weeks, depending on the herbicide and weather conditions.

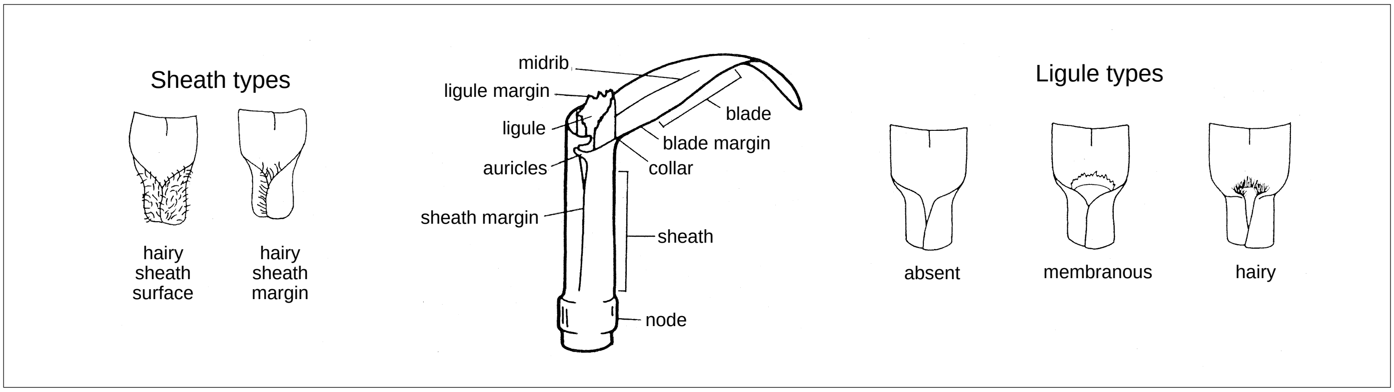
Identify weed seedlings as they emerge in the field (see pages 4-5), and apply an appropriate selective herbicide. In drier climates of the Pacific Northwest, postemergence herbicides sometimes do not control weeds as effectively as in more humid or wetter climates (table 1).

Dry edible beans are a minor crop, and therefore fewer herbicides are registered for use in beans than in major crops because companies cannot economically afford to pay for registration of new selective herbicides. This means that bean producers will probably rely more heavily on programs such as IR-4, which facilitates registration of pesticides on minor crops.

■ **Herbicide Recommendations**—Herbicides and recommendations for their use in dry beans change periodically. Up-to-date information is contained in the annually revised *Pacific Northwest Weed Management Handbook* (see ordering information on page 7). In addition specific herbicides and their effectiveness for controlling individual weed species can be found in the same publication. Be sure to check herbicide labels for the most current information relative to timing and rate recommendations for your state. Do not apply herbicides that are not labeled for use in your area.

■ **Preventing Herbicide Resistance**—Unfortunately, the repeated use of a particular herbicide, or of herbicides with similar modes of action, on the same field has produced weed biotypes that are herbicide resistant. In order to prevent selection for herbicide-resistant weeds it is necessary to utilize a combination of weed control practices. Growers should utilize cultivation and crop rotation, apply herbicides with different modes of herbicide action, and tank mix herbicides with different modes of action to prevent selecting for herbicide-resistant weed biotypes. A good resource is *Herbicide-Resistant Weeds and Their Management*, PNW 437 (see ordering information). This bulletin helps growers select herbicides from a different mode of action group every year, which reduces the selection pressure for herbicide-resistant weeds.

Parts of a grass seedling



Identifying Weed Seedlings


Barnyardgrass

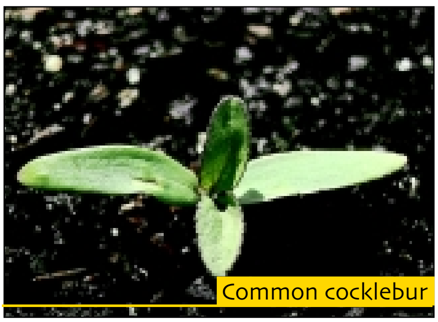

Green foxtail


Wild-proso millet


Wild oat


Witchgrass

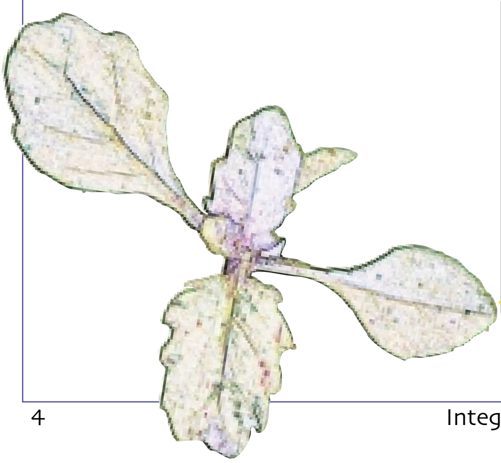

Field bindweed


Common cocklebur


Knotweed


Kochia


Common lambsquarters



Barnyardgrass (*Echinochloa crus-galli*). Sheath (stem) is flattened and sometimes reddish. Ligule is absent.

Foxtail, green (*Setaria viridis*). Sheath margin is hairy. Ligule is hairy. (Neither is visible in this image.)

Millet, wild-proso (*Panicum miliaceum*). Sheath is very hairy. Hairs are soft. Ligule is hairy. (The ligule is not visible here.) Seed often remains attached to seedling.

Wild oat (*Avena fatua*). Leaf blades twist counter-clockwise and have hairs on the margins. Ligule, not visible here, is membranous.

Witchgrass (*Panicum capillare*). Sheath is very hairy. Hairs are rigid. Ligule, not visible here, is hairy. Seed easily detaches from seedling.

Bindweed, field (*Convolvulus arvensis*). Cotyledons are kidney shaped. Leaves are alternate and arrowhead shaped.

Cocklebur, common (*Xanthium strumarium*). Cotyledons are lanceolate (much longer than wide and pointed). Leaves are alternate, rough, and toothed.

Knotweed (*Polygonum aviculare*). Cotyledons are linear. Leaves are alternate, and a papery sheath (ocrea) surrounds the stem where the leaf originates.

Kochia (*Kochia scoparia*). Cotyledons are linear (much longer than wide and blunt tip). Leaves are alternate, hairy, and bluish-green.

Lambsquarters, common (*Chenopodium album*). Cotyledons are linear. First several leaves are opposite, have wavy margins, and often have mealy granules on leaves.

Identifying Weed Seedlings


Prickly lettuce


Common mallow


Nightshades

Lettuce, prickly (*Lactuca serriola*). Leaves are alternate, true green, and toothed, with spiny margins and a white milky juice. Cotyledons, not visible in this slide, are ovate (egg-shaped with broader part at the base).

Mallow, common (*Malva neglecta*). Cotyledons are ovate to heart-shaped. Leaves are alternate, round, and fine toothed on the margins.

Nightshades, hairy (left) and **cutleaf** (right). Hairy nightshade (*Solanum sarrachoides*) cotyledons are lanceolate. Leaves are alternate, toothed, and hairy. Cultleaf nightshade (*S. triflorum*) cotyledons are linear. First leaves are toothed and later leaves are deeply lobed.

Pigweed, redroot (*Amaranthus retroflexus*). Cotyledons are linear. Leaves are alternate, red-tinged, and often have notched leaf tips.

Puncturevine (*Tribulus terrestris*). Cotyledons are oblong (2 to 4 times longer than wide). Leaves are alternate, compound (have multiple leaflets), and hairy.

Purslane, common (*Portulaca oleracea*). Cotyledons, not visible in this image, are linear. Leaves are alternate, reddish-tinged, and succulent.

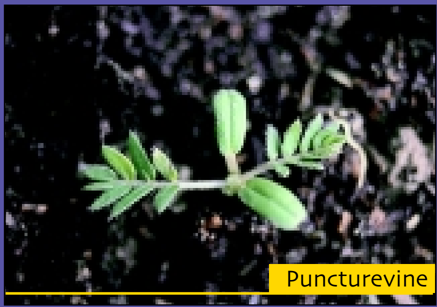
Sowthistle, annual (*Sonchus oleraceus*). Cotyledons are oval to round. Leaves are alternate, bluish-green, toothed, and have a white milky juice.

Sowthistle, perennial (*Sonchus arvensis*). Plants emerging from rootstock are toothed like dandelion leaves and have a white milky juice.

Sunflower, common (*Helianthus annuus*). Cotyledons are oval to round. First leaves are opposite, rough, and hairy.

Thistle, Canada (*Cirsium arvense*). Plants emerging from rootstock have wavy leaves with prickles on the leaf margins.


Redroot pigweed


Puncturevine


Common purslane


Annual sowthistle


Perennial sowthistle


Common sunflower


Canada thistle

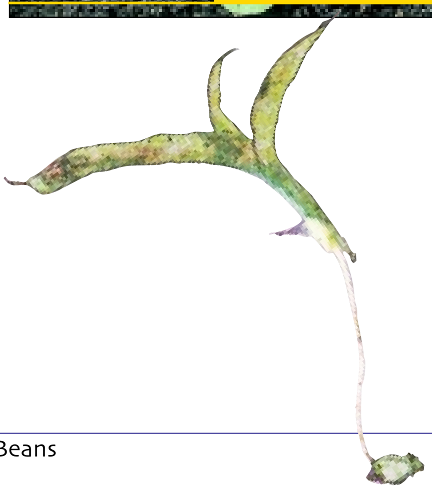


Table 1. Susceptibility of weeds to herbicide use in dry beans.

	PREEMERGENCE							POSTEMERGENCE			
	alachlor	dimethenamid	EPTC	ethalfluralin	metolachlor	pendimethalin	trifluralin	bentazon	glyphosate	quizalofop	sethoxydim
Annual grasses											
barnyardgrass	E	E	E	E	E	E	E	P	E	E	E
foxtail, green	E	E	E	E	E	E	E	P	E	E	E
grain, volunteer	P	F	E	F-G	P	F	F-G	P	E	E	E
millet, wild-proso	F-G	F-G	G	—	F	F-G	—	P	E	E	E
oats, wild	P	F	G	G	P	F	F	P	E	E	E
sandbur, field	F-G	F	F-G	G	F	G	G	P	E	E	E
witchgrass	G	G	G	—	E	G-E	—	P	E	E	E
Annual broadleaf weeds											
buckwheat, wild	P-F	F	F	G	P-F	P-F	G	G-E	G-E	P	P
cocklebur, common	P	P	P	P	P	P	P	E	E	P	P
dodder, field	P	—	P	P-F	P	F	P-F	P	G	P	P
knotweed, prostrate	F	F-G	F-G	G	F	G	G	P	G-E	P	P
kochia	F	F	F	G-E	F	G-E	G-E	F-G	G-E	P	P
lambsquarters, common	F-G	F-G	F-G	E	F-G	E	E	F	E	P	P
mallow, common	P-F	F	P	P	P-F	P	P	F-G	E	P	P
nightshade, hairy	G	E	G	F	F-G	P-F	P-F	F-G	E	P	P
pigweed, redroot	E	E	G	E	G-E	E	E	F	E	P	P
puncturevine	P	G-E	F	G-E	P	F	G-E	P	E	P	P
purslane, common	F	F-G	F-G	E	F	E	E	G-E	E	P	P
sowthistle, annual	F-G	—	G-E	P	F	P-F	F	—	E	P	P
sunflower, common	P	P	P	P	P	P	P	G-E	E	P	P
thistle, Russian	P	F	P	F	P	F	F	—	G-E	P	P
Perennial weeds											
bindweed, field	P	P	P	P	P	P	P	P	F-G	P	P
nutsedge, yellow	F-G	F-G	E	P	G	P	P	F-G	F	P	P
sowthistle, perennial	P	—	—	—	P	P	—	—	F	P	P
thistle, Canada	P	P	P	P	P	P	P	P	G-E	P	P
quackgrass	P	F	F-G	P	P	P	P	P	G-E	G	F
Crop safety											
tolerance	G	G	G-E	E	G	E	E	G	P	E	E
carryover[1]	2-3	3-6	1-2	2-6	2-4	3-6	3-12	0	0	4	1-4

Note: E = excellent, G = good, F = fair, P = poor, — = no information
Source: Information compiled from 2000 PNW Weed Control Handbook, CSU Dry Bean Prod. and Pest Mgmt Reg. Bull. 562A, UC IPM Pest Mgmt: Dry Beans, and North Dakota State Univ. Ext. Bull. A-1133
[1]Number of months after application to plant a non-labeled crop.

FURTHER READINGS

Anderson, W.P. 1996. Weed science principles and applications. St. Paul, MN.

Berglund, D., T. Courneya, D. Franzen, P. Glogoza, K. Hellevang, V. Hofman, B. Kuntz, A. Lamey, T. Scherer, and R. Zollinger. 1997. Dry bean production guide. North Dakota State Univ. Ext. Bull. A-1133.

Mitich, L.W., W.M. Canevari, and C.A. Frate. 1999. UC IPM pest management guidelines: dry bean. UC DANR Pub. 3339

Weed Science Society of America. 1994. Herbicide handbook, 7th ed. Weed Science Society of America, Champaign, IL

Wilson R.G, S.J. Nissen, and S. Miller. 1996. Dry bean production and pest management. Colorado State Univ., Univ. of Nebraska, and Univ. of Wyoming Regional Bulletin 562A.

WEB SITES OF INTEREST

Crop Data Management Systems, Inc., for pesticide label and MSDS information. http://www.cdms.net/manuf/manuf.asp

Colorado State University Extension, for crop and pest management information. http://www.colostate.edu/Depts/CoopExt/PUBS/CROPS/ pubcrop.html

Lethbridge Research Centre, for crop and pest management information. http://www.res2.agr.ca/lethbridge/

Manitoba Agriculture and Food, for crop and pest management information. http://www.gov.mb.ca/agriculture

North Dakota State University Extension, for crop and pest management information. http://www.ext.nodak.edu/extpubs/

University of California Davis Integrated Pest Management, for crop and pest management information. http://www.ipm.ucdavis.edu

University of Idaho Cooperative Extension System, for crop and pest management information. http://www.uidaho.edu/ag/extension/

Oregon State University Extension Publications for crop and pest management information. http://eesc.orst.edu/agcomwebfile/edmat/ EdmatIndexAg.html

Washington State University Extension, for crop and pest management information. http://gardening.wsu.edu/text/weed.htm

The authors—Brenda M. Waters, former Graduate Student, and Don W. Morishita, Extension Weed Scientist, Department of Plant, Soil, and Entomological Sciences, University of Idaho

ORDERING PACIFIC NORTHWEST EXTENSION PUBLICATIONS

The following publications can be ordered from the University of Idaho, Oregon State University, or Washington State University:

Herbicide-Resistant Weeds and Their Management, PNW 437, $2
Pacific Northwest Weed Management Handbook, $25

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Pesticide Residues—Any recommendations for use are based on currently available labels for each pesticide listed. If followed carefully, residues should not exceed the established tolerances. To avoid excessive residues, follow label directions carefully with respect to rate, number of applications, and minimum interval between application and reentry or harvest.

Groundwater—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

Trade Names—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Pacific Northwest Extension publications are jointly produced by the three Pacific Northwest states—Idaho, Oregon, and Washington. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published more than 400 titles. Joint writing, editing, and production have prevented duplication of effort, broadened the availability of faculty specialists, and substantially reduced costs for the participating states.

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