Crop Profile for Barley in North Dakota

Prepared December, 2000

General Production Information

North Dakota ranks first in the US for barley production, producing 31% of the total US barley crop (5 year average). In 1998, 106,150,000 bushels were produced with an estimated value of $177 million dollars. Barley is grown in all 53 counties of North Dakota. Approximately 23 % of the state s Barley crop is grown in the north-eastern area of the state, with Cavalier County being the greatest production county at 4.7 million bushels in 1999. Other North Dakota agricultural statistics reporting regions and their percent of statewide production are: northwestern, 13 %; north-central, 14 %; west-central, 8 %; central, 16 %; east-central, 10 %; southwestern, 3 %; south-central, 6 %; and southeastern, 7 %.

Table 1. Barley Production and its Economic impact on North Dakota's Economy

Year	National Rank	Total Acres Planted	Total Production (bushels)	Cash Value ($)
1996	1	2,650,000	143,000,000	346,060,000
1997	1	2,400,000	101,250,000	198,450,000
1998	1	2,000,000	106,150,000	177,271,000
1999	1	1,350,000	59,520,000	---

Cultural Practices

The majority of North Dakota barley acres are spring planted starting in early to mid April. Only 0.2 % (approximately 4,000 acres in 1999) of planted barley is irrigated in North Dakota. Approximately 86 % of the 1999 crop was malting barley varieties and 13 % was feed varieties.

Insect Pests

Foliar insecticides were applied to 0.8 %, 20,000 acres, of the ND barley acres in 1996. Insecticides used were carbofuran and encapsulated methyl parathion targeted at barley thrips, grasshoppers, or cereal aphids. The seed treatment insecticide, lindane, was used on 4 % of the barley acreage for wireworm protection in 1996.

Barley Thrips (*Limothrips denticornis*):

Barley thrips are small dark brown to black insects that can cause economic yield losses in barley. Occasionally there are reports of thrips in durum. Thrips emerge from overwintering sites in late May and early June. Early seeded barley is the preferred host for thrips.

Aphids

Greenbug (*Schizaphis graminum*), English grain aphid (*Sitobion avenae*), Bird cherry oat aphid (*Rhopalosiphum padi*), and Russian wheat aphid (*Diuraphis noxia*).

The English grain aphid, bird cherry oat aphid, and the greenbug are the most common aphid pests of small grains in North Dakota. The Russian wheat aphid has only been a minor pest in the state. The greenbug and the Russian wheat aphid are considered to be the most injurious of the aphids. During feeding these aphids inject saliva which is toxic to the plant causing yellowing and death of leaf tissue. Large populations of bird cherry oat aphid are associated with high infection levels of Barley yellow dwarf virus.

Problems with cereal aphids are dependent on when they migrate into the region, weather conditions when they arrive, and growth stage of barley when populations increase. Aphids are present in barley fields each season. Aphids are usually the most troublesome during periods of cool, wet weather. Late seeded crops are likely to be most severely infested. Growers are discouraged from applying excess nitrogen, since excessive plant growth will promote aphid infestations. Most infestations are minor and are kept in check by natural enemies such as syrphid fly larvae, aphid lions, ladybird beetles, several parasitic wasps, and parasitic fungi. When natural enemies are present in large numbers, farmers are discouraged from applying insecticides.

Grasshoppers

Clearwinged grasshopper (*Camnula pellucida*), Two-striped grasshopper (*Melanoplus bivittatus*), Migratory grasshopper (*Melanoplus sanguinipes*), differential grasshopper (*Melanoplus differentialis*), and Redlegged grasshopper (*Melanoplus femurrubrum*).

Grasshoppers are sporadic pests in North Dakota, especially in regions that receive little rainfall. Weather is one of the main factors affecting grasshopper populations. Outbreaks are usually preceded by several years of hot, dry summers and warm falls, allowing populations to increase. Damage to barley is usually concentrated near field margins. Individual plants can be damaged by leaf stripping, awn loss, head clipping, and damaged kernels.

Natural enemies include parasites, predators, and diseases. Some type of natural enemy attacks all grasshopper stages. Early seeding establishes vigorously growing plants that are more tolerant to grasshopper injury. Early seeded crops will mature earlier and reduce the risk of late season migrations of adult grasshoppers. Crop rotation, tillage, trap strips, and harvesting crops early are other cultural control practices used to reduce grasshopper damage. Grasshoppers are more easily controlled in the nymphal stage. Treatment is advised when 50 or more nymphs per square yard are found in field margins or 30 or more nymphs per square yard are found within the field.

Armyworms *Pseudaletia unipuncta*

Outbreaks in North Dakota occur when large migrations of moths from the south occur in late spring and early summer. Armyworms feed at night on above ground vegetation, and hide under the foliage and in the soil during the day. In most years, populations are kept low by unfavorable weather conditions such as cool wet weather.

A number of diseases and parasites attack armyworms. Tachinid flies, parasitic wasps, and viruses are all natural controls of the armyworm. These natural enemies often do not destroy armyworm larvae until after severe crop damage has occurred. Their greatest impact is preventing excessive increases in the next generation.

Current treatment recommendations are when four to five or more worms per square foot are present.

Wireworms (Coleoptera: Elateridae):

Wireworms can affect barley in North Dakota. This early season, spotty pest is difficult to detect, which results in great uncertainty regarding the economic value of seed treatments which are the only labeled chemical control. Using seed treatment strictly as insurance against injury is discouraged.

Table 2. Registered insecticides and their usage in North Dakota to manage barley insect pests.

Common Name	Trade Name	Acres Treated [1]		Application Rate (product/acre)	Target Insects	Pre-harvest Interval (Days)
		x1000	%			
carbofuran	Furadan	3.4	0.1	0.25 - 0.5 pt	Grasshoppers	---
disulfoton	Di-Syston	NR	NR	0.5 - 1 pt	Aphids	30
ethyl parathion	Parathion	NR	NR	8 fl oz 4 - 6 fl oz	Aphids, Armyworms Barley Thrips	15
lindane	lindane	107.5	4	---	Wireworm	---
malathion	Malathion	NR	NR	1.5 - 2 pts	Aphids	7
methomyl	Lannate	NR	NR	12 - 24 fl oz	Aphids, Armyworms	7
methyl parathion	methyl parathion	NR	NR	8 fl oz 4 - 6 fl oz	Aphids, Armyworms Barley Thrips	15
	Penncap M	2.9	0.1	2 - 3 pts	Aphids, Armyworms	15

[1] Zollinger et al, 1998. NR = Not Reported.

Diseases

Disease control in Barley depends largely on preventive measures. Chemical controls for barley diseases are either unavailable or not economically feasible after the infection has occurred. Crop rotation, tillage, early seeding dates, pathogen-free seeds, and disease resistant varieties reduce the impact of disease on Barley production in North Dakota.

Fusarium head blight (Scab): *Fusarium graminearum* and *Fusarium culmorum*

Repeated scab epidemics and large economic losses have resulted from Fusarium head blight infections during the 1990's. Scab is a problem when long periods of high humidity and wet weather occur at heading and grain-fill. Scab can severely reduce yields and test weight. Additionally, infected seed may contain fungal toxins to which affect feed and food quality. At this time scab is the most serious fungal disease in small grains in the Upper Midwest.

Scab occurs in barley, spring wheat, durum and many grasses. The disease is found throughout the state. Appears first as brownish water-soaked lesions at the base of the glumes or on the rachis. Discoloration may then spread in all directions from initial infection. In severe infections, salmon-orange spore masses may appear at the base of the glumes. Cultural practices such as rotation to broadleaf crops, tillage to bury residues, and alternating planting dates can lower the risk of scab. Fungicides used in combination with these practices may reduce the severity of the disease. Use disease-free seed to avoid subsequent seedling blight. Fungicides applied to barley heads for scab suppression have resulted in significant yield increases, but they have not resulted in significant reductions in levels of vomitoxin or deoxynivalenol (DON).

Therefore, if barley producers chose to try and control scab in barley, they should anticipate a yield increase, but not enough reduction in vomitoxin to achieve levels required by the malting industry.

Table 3. North Dakota Section 18 emergency fungicide exemption for barley protection from Fusarium head blight, 2000.

Active Ingredient	Trade Name	Acres Treated in 2000	Application rate (product/acre)	Application Method	Diseases Controlled	Pre-harvest Interval (days)
Tebuconazole	Folicur	40,000 [1]	4 fl oz	Foliar Spray	Fusarium head blight	30

[1]Dr. Marcia McMullen, personnal communication.

Common Root Rot (*Cochilobolus sativus*)

Barley, spring wheat and durum are affected. No variety is completely resistant. Diseased seedlings have dark brown spots near the seed or on stems below the soil line. Crown rot develops later in the season. Affected plants may turn prematurely white. Kernels in the head are shriveled and roots are dark brown and rotted. Yields often are reduced by root rot even though symptoms are not well developed. Promote rapid emergence by planting in well prepared, warm seed bed. Avoid herbicide stress. Rotate with crops such as oat, flax or legumes. Fungicide seed treatments also are available for suppression of common root rot.

Spot Blotch (*Cochliobolus sativus*)

Recently released barley varieties have good resistance. Fungus spores produced on crop residue are carried by air currents to the leaves. Infections appear as dark, chocolate_colored blotches. The spots merge, eventually forming irregular dead patches on the leaves. Heavily infected leaves dry up completely, and infections on the flag leaf during kernel filling are the most serious. Controls: Grow resistant varieties. Fungicides can be used on varieties that are more susceptible. Rotate with crops such as oat, rye, legumes or flax to reduce source of fungus spores from residue.

Net Blotch (*Pyrenophora teres*)

Most current barley varieties are susceptible to net blotch. Other crops are not affected. A characteristic "netting" of the dark, chocolate-colored blotches on leaves, sheaths and glumes distinguishes this disease from spot blotch. Grow least susceptible varieties. Fungicide sprays will protect against infections. Rotation with crops other than barley will reduce the amount of fungal spores residing in residue.

Stagonospora Leaf Blotch (*Stagonospora avenae f. sp. triticea*)

All barley varieties are susceptible. This disease also attacks spring wheat, durum and some grasses. Leaf spotting develops from infections by fungus spores produced on barley or wheat stubble and residue. Spots first appear as small yellow flecks, later becoming tan with a yellow border. Spots are boat shaped at first then merge to form blotches. The margins of the spots are indefinite. Leaves dry and shrivel. Minimize residue on soil surface of re-crop land. Fungicides may be used to prevent infections.

Septoria Leaf Blotch (*Septoria passerinii*)

Current barley varieties are susceptible, while other crops are not affected. The fungus causes yellowish to light brown elongated spots of varying sizes. Initially spots are long with definite margins parallel to leaf veins. Spots may merge and involve large areas of leaf tissue. Margins of leaf often pinch and dry. Small black fruiting bodies form in rows in diseased areas.

Grow the most resistant varieties. Use fungicides to protect leaves. Bury infected crop debris and use in rotation with other crops.

Scald (*Rhynchosporium secalis*)

All barley varieties are susceptible. Scald occurs primarily in the northern tier of counties in North Dakota. Leaf spots develop during cool, wet weather. The spots are oval shaped and the margins of the spots change from bluish-green to zonated brown or tan rings, with bleached straw-colored centers. Minimize residue on soil surface of re-crop land. Rotate with other crops. Systemic fungicides are registered for control.

Leaf Rust (*Puccinia hordei*)

Most barley varieties are susceptible. Leaf rust has been a problem primarily on late-planted barley in northern counties. Orange-red pustules erupting from the leaf surface contain spores which are spread by wind to other leaves. Heavily infected leaves die prematurely.

If conditions for epidemic development prevail, leaf rust can be controlled with systemic fungicides.

Powdery Mildew (*Blumeria graminis f. sp. hordei*)

Develops when cool, humid and cloudy weather persists on barley. Symptoms include white to gray powdery-surfaced pustules that are scattered on or completely cover the leaf blade, with associated yellowing, browning and drying of leaf tissue. May be controlled with sulfur or systemic fungicides, but the disease generally is not an economic problem in North Dakota.

Bacterial Blight (*Xanthomonas campestris pv. transluscens*)

Bacterial blight affects barley, spring wheat, durum and grasses. Symptoms include linear water-soaked areas and exudate droplets develop on leaves after several days of rainy, damp weather. The lesions elongate and merge into irregular glossy-surfaced stripes. Rotate to non-grain crop. Bury crop refuse. Use disease free seed.

Barley Stem Rust (*Puccinia graminis f. sp. tritici and f. sp. secalis*)

Barley and wheat are hosts for *Puccinia graminis f. sp. tritici*, while barley and rye are hosts to *Puccinia graminis f. sp. secalis*. Symptoms of barley stem rust include masses of brick-red spores (pustules) erupting primarily on stems and leaf sheaths, with leaf blades, glumes and awns also being infected. Spores are easily spread by wind to other plants, and the disease is favored by warm, moist weather. Most current varieties are susceptible to race QCC of *Puccinia graminis f. sp. tritici*, but resistance is being incorporated into new lines. All commercial varieties are susceptible to *Puccinia graminis f. sp. secalis*, but this form is rarely found. Stem rust also can be controlled with systemic fungicides. Development of stem rust on the barley crop depends on several factors, including: how extensively the fungus overwinters in the Southern plains, environmental conditions that favor buildup of spores that could be carried north by prevailing winds, and planting time of the barley crop in North Dakota. A late-maturing crop is more likely to be damaged by stem rust because the grain has not yet filled at the time the rust spores generally arrive.

Planting early is the most effective preventative measure to avoid major yield and quality losses from stem rust. The earlier the field is planted, the better the chance of avoiding heavy levels of infection on stems and heads. Barley producers should also avoid high levels of nitrogen fertilizer to lessen lodging problems. Lodged grain is a more favorable environment for stem rust infection. Mancozeb and Tilt are fungicides registered for rust control on barley. Tilt must be applied at early flag leaf emergence, which may be before stem rust is detected. Mancozeb is applied at flag leaf emergence and seven to ten days later.

Barley Yellow Dwarf Virus

Yellow Dwarf Virus affects barley, spring wheat, oat, and other monocots. The virus is transmitted by several species of aphids. Bright yellow chlorosis shows first on the tips and margins of older leaves. Other symptoms may include stunting, reduced kernel size and weight, sterility, and failure of heads to emerge. Use resistant or tolerant varieties if available. Early planting may allow crop to develop prior to an influx of large populations of aphids which may be carrying the virus. Barley yellow dwarf symptoms in small grains are fairly common every year, but usually aren't severe unless a late planting of a barley, wheat or oat crop coincides with an influx of a high populations of cereal aphids that are carrying the barley yellow dwarf virus. Random patches of stunted, yellowing plants ranging from one or a few plants up to fairly large areas can be seen in barley fields.

Early season infection can lead to significant stunting and leaf discoloration. Late infection often is seen only as discoloration of the upper leaves. Adverse growing conditions can aggravate symptoms and ultimately increase yield loss. Barley yellow dwarf/oat red leaf is a virus disease transmitted by cereal aphids. An early influx from states to our south of aphids carrying the virus could mean more damage from this disease.

Loose Smut (*Ustilago nuda*)

Currently, all barley varieties are susceptible to one or more races. Masses of smut spores replace the entire head of plants. Smutted heads often emerge before healthy heads. Spores are dislodged and scattered by wind soon after emergence. The fungus infects open flowers and becomes established in the embryo of the developing seed. The State Seed Department tests for the presence of loose smut in barley seed. Grow smut-free seed. Treat seed with effective, registered seed treatments. All suspect seed lots should be treated.

Table 4. Registered seed treatment fungicides and their usage in North Dakota Barley Production.

Common Name	Trade Name	Acres Treated[1]		Application	Application Rate	Diseases Controlled[2]
		x 1000	%			
benomyl	Benlate	0.6	0.0	Dust or Slurry	1-2 oz/bu	CS,LS
carboxin	Vitavax	398.4	15.0	Slurry	2-3 fl oz/cwt	CS, LS, SB
carboxin + captan	Enhance	NR	NR	Drill Box	4 oz /cwt	CS, LS, SB
carboxin + maneb	Enhance Plus	43.2	1.6	Drill Box	2 oz/ cwt	CS, LS, SB
carboxin + PCNB	Vitavax-PCNB	NR	NR	Slurry or Mist	3-4 fl oz/cwt	CS, LS, SB
carboxin + thiram	Vitaflo 280 Vitavax 200 Flowable RTU-Vitavax-Thiram Vitavax-Thiram-Lindane	28.6	1.1	Slurry Slurry or Mist Liquid or Slurry Slurry	5 oz/cwt 3-4 oz/cwt 5-6.8 oz/cwt 6 fl oz/cwt	CS, LS, SB CS, LS, SB CS, LS, SB CS, LS, SB

fluidioxonil	Maxim 4FS, 40.3%	NR	NR	Slurry	0.08-0.16 fl oz/cwt	SB
imazalil	Agsco Double R II Seed Treatment, 10% Flow-Pro IMZ Flowable, 31% Nu-Zone 10 ME, 10%	23.2	0.9	Slurry Slurry/on-farm trmt Slurry	0.8-1.5 fl oz/cwt 0.25-0.5 fl oz/cwt 0.8-1.5 fl oz/cwt	SB, RR SB, RR SB, RR
mancozeb	Dithane WSP, 80% Grain Guard, 50% Grain Guard Plus, 50% Manzate 75 DF, 75%	2.3	0.1	planter box only Drill Box Drill Box Slurry	1.3-2.0 oz/bu 2 oz/bu 2 oz/bu 1.3-2 oz/bu	CS, SB CS, SB CS, SB CS, SB
maneb	Agsco DB Green, or Granol NM, or Seed Mate Maneb-Lindane (all 50%) Agsco DB-Green L, 25.6%	327.6	12.4	Dust or drill box Auger treater, Slurry	2 oz/bu 3 fl oz/bu	CS, SB CS, SB
mefenoxam	Apron XL-LS, 32.3%	NR	NR	Mist or Slurry	0.32-0.64 fl oz/cwt	SB
metalaxyl	Allegiance FL, 28.35%	NR	NR	Mist or Slurry	0.375-0.75 fl oz/cwt	SB
metalaxyl + PCNB + carboxin	Prevail, 3.12%: 15%	NR	NR	Drill Box	2-4 oz/bu	CS, LS, SB
PCNB (Terraclor)	Terra-Coat LT-2N, 23.7% RTU-PCNB, 24% PCNB Seed Coat, 24%	1.0	0.0	Liquid or Slurry Liquid or Slurry Slurry	2-4 oz/bu 3.75-7.5 fl oz/bu 2-4 oz/bu	CS, SB CS, SB CS, SB
thiram	42-S Thiram, 42% Thiram 50 WP Dyed	13.2	0.5	Liquid or Slurry Drill Box or slurry	2 fl oz/bu 4.1 oz/cwt	SB SB
tebuconazole	Raxil 2.6F, 28.3%	NR	NR	Slurry or mist	0.1 fl oz/cwt	CS, LS, SB, RR
tebuconazole + thiram	Raxil-Thiram, 0.6%: 20.0%	NR	NR	Liquid or slurry	3.5-4.6 fl oz/cwt	CS, LS, SB, RR
triadimenol	Baytan 30F	NR	NR	Slurry	0.75 fl oz/cwt for control of smuts. 1.5 fl oz/cwt for control of seed borne glume blotch and for suppression of take-all, foot rot. 1.5 fl oz/cwt for control of early season foliar disease.	CS, LS, SB, RR
triadimenol + thiram	RTU-Baytan-Thiram 5.0%: 15.3%	NR	NR	Slurry or mist	4.5-9 fl oz/cwt	CS, LS, SB, RR

[1]Zollinger et al. 1998. NR = Not Reported. Acres reported seeded with treated seed include multiple applications to the same seed and seed treatment products applied as a tank mixture were totaled separately unless applied as a commercial premix.
[2]CS = Covered Smut, LS = Loose Smut, SB = Seedling Blight, and RR = Common Root Rot.

Foliar fungicide use is warranted if certain guidelines are met, based on knowledge gained through scouting of the

diseases present and their severity. Guidelines include high yield potential, approximately 60 bushels for barley. If fungal leaf diseases are severe on leaves just below the emerging flag leaf and wet and humid weather continues, this favors infection and continues to spread disease. Fungicide application should be seriously considered when above conditions are met.

Table 5. Registered fungicides and their usage in North Dakota to manage barley diseases.

Common Name	Trade Name	Acres Treated [1]		Application Rate	Diseases Controlled	Remarks
		x 1000	%			
copper	Champion WP Champ Formula 2 Kocide 2000 Kocide 4.5 LF	NR	NR	1.5 2 lb/A 1 1.33 pt/A 1.25 1.5 lb/A 1 1.33 pt/A	Leaf spot, Leaf rust	
mancozeb	Dithane DF Dithane F-45 Dithane M-45 Dithane WSP Manex II Manzate 75 DF Penncozeb Penncozeb DF	7.7	0.3	2.1 lb/A 1.6 qt/A 2 lb/A 2 lb/A 1.6 qt/A 2 lb/A 1 2 lb/A 1 2 lb/A	Leaf spot, Leaf rust, Stem rust	Do not apply mancozeb within 26 days of harvest. Do not graze livestock in treated areas prior to harvest.
mancozeb + copper	ManKocide	NR	NR	2 2.5 lbs./A	Leaf spot	Apply at early heading, do not apply within 26 days of harvest.
propiconazole	Tilt 3.6 EC Tilt Gel	29.5	1.1	2 4 fl oz/A	Leaf spot, Leaf rust, Stem rust, Powdery mildew	Do not graze of feed livestock treated crops.
sulfur	Sulfur DF	NR	NR	6 15 lb/A	Powdery mildew	Do not apply when temperatures are high (above 90°F).

[1]Zollinger et al. 1998. NR = Not Reported.

Weeds

Weed control in small grains is generally required to achieve a profitable yield. Broadleaf weeds, foxtails, and wild oat infest small grains statewide. The use of the proper cultural control techniques plus the use of chemical controls may be required to control troublesome weeds.

Herbicides most commonly used in 1996 were; 2,4-D, MCPA, and Tribenuron. They were applied to 45%, 23%, and 17% of the barley acreage respectively. A total of 3,815,000 acres of barley were treated in 1996. The producer applied 90% of the herbicides to barley and 92% was applied by ground equipment.

Foxtails: Green foxtail (*Setaria viridis*), Yellow foxtail (*Setaria glauca*).

Commonly found in field crops across North Dakota, often called pigeongrass. One of the states most serious and widespread annual weeds. Foxtails are most competitive when barley is seeded late and soil temperatures are warm which promotes foxtail germination and growth. Heavy infestations will cause increased elevator dockage, harvest complications and moisture stress during droughty conditions.

Tillage is one of the best strategies for reducing foxtail infestations. Fall moldboard plowing can bury foxtail seed preventing emergence the following spring. Infestations with less than 30 plants per square foot, and foxtails emerging into a crop at the three to four-leaf stage, generally do not require control. At these levels of infestation the crop can usually out-compete foxtail. Heavy infestations with more than 100 plants per square foot require chemical control. Moisture stress and foxtails emerging before or at the same time as the crop can complicate the decision process. Under these conditions yield losses can be more severe.

Kochia: (*Kochia scoparia*)

Is an erect bushy annual, two to seven feet in height. It is an exceptionally competitive weed that can cause severe yield losses. This weed is commonly found in most crops in the state of North Dakota. Kochia is one of the first weeds to germinate in the spring but is late in maturing. Kochia has become difficult to control. In many fields 2,4-D and MCPA herbicides no longer control kochia due to the presence of resistant kochia populations. Some kochia populations have become resistant to ALS, triazine, and dicamba herbicides.

Tillage can be an effective practice for controlling kochia. Tillage in the spring before planting and in the fall following harvest can reduce infestations of this highly competitive weed. Tillage is also a strategy for minimizing herbicide resistant plants. Mechanical removal of any resistant plants will prevent seed production and slow the spread of resistant plants.

Herbicide treatments are applied to small plants (less than 3 inches tall). Spray coverage should thoroughly wet the weed foliage. Fluroxypyr provides good control of ALS, triazine, and dicamba resistant kochia. Dicamba plus MCPA amine and bromoxynil plus MCPA also provides good control.

Wild Oat: (*Avena fatua*)

Wild oat is a cool season annual, one to four feet tall. It is native to Europe but is common throughout much of western North America, including all of North Dakota. Wild oat is one of the most serious weed problems in small grains. It germinates quickly in the spring and can out-compete small grains resulting in severe yield losses. It is difficult to eradicate because the plants drop their seed prior to the crop being harvested. Seed dormancy results in delayed germination.

Delaying seeding is one of the most practical methods of culturally controlling wild oats. By delaying seeding, one or more cultivations can be made to destroy emerged wild oats prior to seeding the crop. Harrowing emerging wild oats following crop seeding may also be effective in reducing wild oat populations before the crop emerges.

Pre-emerge herbicides applied in the fall or spring prior to seeding can provide effective wild oat control. Products such as triallate and triallate + trifluralin (Buckle) can be applied to the soil and incorporated with tillage equipment in advance of seeding. This practice can save the producer time during the growing season and simplifies the timing of herbicide applications. Herbicides applied to the crop after emergence require careful timing of the treatment. Timing treatment at the proper growth stage of the wild oat and the crop is essential for optimum wild oat control. Careful reading of the herbicide label provides the necessary information as to when and how much product to apply.

Redroot pigweed: (*Amaranthus retroflexus*)

Redroot pigweed is a coarse erect annual, usually two to three feet tall. The lower stems are usually red, with color continuing down to the taproot. Redroot is widely distributed throughout the western states and commonly found in crops across North Dakota. Large populations of this weed can compete with small grains resulting in moisture stress and yield loss during droughty conditions.

Tillage prior to planting and on fallow ground is an effective way to reduce pigweed populations. The ALS herbicides, dicamba, and 2,4-D also give good control. The label provides necessary information on when to apply and how much product to use.

Russian Thistle: (*Salsola iberica*)

A rounded, bushy, much branched annual, usually one half to three feet tall. Seeds are spread as mature plants break off at ground level and are scattered by the wind as tumbleweeds. Russian thistle was introduced from Russia in the late 1800's and has become a common and troublesome weed in the drier regions of North Dakota. Under good crop conditions, small grains can out-compete Russian thistles.

Tillage prior to planting and on fallow ground is an effective way to reduce Russian thistle populations. Seedling plants have fleshy leaves so herbicide applications should be made by this growth stage or earlier. ALS herbicides, dicamba, 2,4-D, and bromoxynil provide good control.

Field Bindweed: (*Convolvulus arvensis*)

Field bindweed (creeping jenny) is a perennial weed introduced from Europe that is well adapted to North Dakota's climate. It can be found across the state and has been declared a noxious weed by the state of North Dakota. Bindweed has a deep root system that competes with crops for water and nutrients. It is easily spread by seed and root fragments. Field bindweed can reduce yields by 50 percent, cause lodging, and can make harvest difficult.

Intensive cultivation can control newly emerging seedlings, and aid in controlling established bindweed stands by reducing nutrient reserves in the roots. When used in combination with herbicides, cultivation becomes a key part of an effective management program.

Control of bindweed requires a long-term management program. Multiple herbicide applications are required to control bindweed. Herbicides should be applied when the bindweed is actively growing and at least 12 inches long. Field bindweed is more difficult to control in semiarid regions of Central and Western North Dakota due to slower herbicide uptake and reduced translocation when plants are moisture and heat stressed. Systemic herbicides work best to kill the extensive root system of bindweed. 2,4-D, dicamba, picloram (Tordon) and glyphosate (Roundup) are all effective systemic herbicides capable of controlling bindweed.

Canada Thistle: (*Cirsium arvense*)

Canada thistle is a colony-forming perennial weed with an extensive root system. Plants are one to four feet tall with spiny-leaves. Canada thistle is a native of Southeastern Eurasia. It was introduced into Canada in the late 18th century. It has become a major problem throughout North Dakota as a result of reduced tillage practices, wet weather cycle, and lack of effective controls. Canada thistle is an aggressive noxious weed that competes well with small grain for water and nutrients.

Periodic tillage on fallow ground is used to control Canada thistle throughout the summer. Tillage keeps the thistle plants in the rosette stage and prevents them from bolting. Following tillage, a herbicide such as glyphosate or clopyralid can be applied to the rosettes in late September or early October.

Post-harvest treatments give better thistle control than pre-harvest treatments. The highest rate allowed can be used without interfering with next year s crop. Tillage can be a critical factor. Tillage in late fall, after spraying, increases control, adding an additional 30 to 40% control to treatment. Canada thistle can be controlled in wheat with clopyralid, or some sulfonylurea herbicides in tankmix with 2,4-D and dicamba. The maximum rate should be used.

Common Milkweed: (*Asclepias syriaca*)

A stout perennial weed that spreads by seeds and long deep roots. The plant is two to four feet in height and has a milky latex sap. It has become a severe weed pest in North Dakota due to it s extensive root system, the wet weather cycle, tolerance to many herbicides, reduced tillage, and the lack of persistence by chemical and cultural controls. Milkweed can be a severe pest in wet regions of the state, competing with the crop for nutrients.

Preventing establishment and spread of milkweed patches requires continuous scouting and implementation of control efforts. Tillage in the spring, prior to planting, or in the fall after harvest aids in the reduction of milkweed populations. Tillage is also a way to address problems with milkweed tolerance to herbicides. The plants can be removed by cultivation, reducing the need for repeated herbicide applications.

Milkweed control is expensive. Patch spraying allows the use of higher herbicide rates with less expense than if an entire field was sprayed. Apply herbicides when milkweeds are in the late-bud to flowering stage and actively growing. Control patches when plants are small. Use glyphosate prior to heading of small grains. After heading, patch-spray with Tordon.

Table 6. Registered herbicides and their usage in North Dakota to manage weeds in barley.

Common Name	Tradename	Acres Treated[1]		Application Rate Product / acre *(lb AI per acre)*	Weeds controlled	Application Timing
		x 1000	%			
Glyphosate	Roundup Ultra/ RT and others	38.0	1.4	0.5 to 2 pt of a 3 lb ae/ gal conc. (0.19 to 0.75)	Emerged grass and broadleaf weeds, and volunteer crops.	Preplant or any time prior to crop emergence.
	Roundup UltraMax			0.4 to 1.6 pt of a 3.7lb ae/gal conc. (0.19 to 0.75)		
	Roundup Custom and others			0.38 to 1.5 pt of a 4lb ae/gal conc. (0.19 to 0.75)		
	Roundup UltraDry			4.7 to 18.5 oz of a 65% SG. (0.19 to 0.75)		
Dicamba + Glyphosate	Banvel Clarity, others + Glyphosate	0.6	0.0	2 fl oz dicamba + 0.75 to 1 pt of a 3 lb ae/gal conc. (0.0625 + 0.28 to 0.38)		
Paraquat	Gramoxone Extra	NR	NR	1.5 to 3.0 pt (0.47 to 0.94)	Emerged annual grass and broadleaf weeds.	

Triallate	Far-Go	52.1	2.0	1.25 qt 12.5 to 15 lb 10G (1.25 as liquid or 1.25 to 1.5 as granular)	Wild oat	Fall: Apply within 3 weeks of freeze-up.
				1.25 qt 12.5 lb 10G (1.25)		Spring: apply before or after seeding.
Triallate + Trifluralin	Buckle	37.3	1.4	10 to 12.5 lb G (1 to 1.25 + 0.3 to 0.4)	Wild oat and foxtails.	Fall: Apply within 3 weeks of freeze up. Spring: For Barley. Prior to or after seeding.
Triallate + Trifluralin	Far-Go	37.3	1.4	1 qt + 1 pt 4E (1 + 0.5)	Wild oat and foxtail.	SPRING: Immediately after seeding.
Trifluralin	Trifluralin	177.9	6.7	1 pt 4E 5 lb 10G 0.83 lb 60DF (0.5)	Foxtail	SPRING: PPI Incorporate twice 2 to 3 inches deep.
				4 lb 10G (0.4)		
				3.5 to 4 lb 10G (0.35 to 0.4)		
				1 pt 4E (0.5)		SPRING: After seeding. Plant 2 to 2.5 inches deep. Incorporate shallowly twice with flex-tyne or diamond harrow 1 to 1.5 inches deep.
				1 pt 4E 5 lb 10G 0.83 lb 60DF (0.5)		FALL: After September 1 until freeze-up.
MCPA amine or MCPA ester	MCPA amine or MCPA ester	596.9	22.5	0.5 to 1.33 pt of 4 lb/gal conc. (0.25 to 0.66)	Broadleaf weeds.	Crop: Emergence until prior to boot. Winter wheat: In spring from 4-leaf until prior to boot.
2,4-D amine or 2,4-D ester	2,4-D amine or 2,4-D ester	1199.6	45.3	0.5 to 1 pt of 4 lb/gal conc. (0.25 to 0.5)		Crop: 5-leaf until prior to boot. Winter wheat: Well tillered until prior to boot.
clopyralid + MCPAe	Curtail M	1.6	0.1	1.75 to 2.33 pt (0.09 to 0.12 + 0.5 to 0.68)	Most broadleaf weeds and Canada thistle.	3-leaf to jointing or to boot if risk of injury is acceptable.
clopyralid + 2,4-D	Curtail	19.6	0.7	2 to 2.33 pt (0.09 to 0.11+ 0.5 to 0.58)		Crop: 4-leaf to jointing.

fluroxypyr	Starane	NR	NR	0.5 to 0.67 pt (1.5 to 2 oz)	Kochia (including ALS resistant), volunteer flax and a few other broadleaf weeds.	Crop: 2-leaf through flag leaf emergence. Weeds: 4 to 6 inches tall.
bromoxynil	Bromoxynil	99.4	3.8	1 to 2 pt (0.25 to 0.5)	Most broadleaf weeds including buckwheat, sunflower, ALS resistant kochia and Russian thistle.	Crop: Emergence until prior to boot.
	Bromoxynil + MCPA ester	280.0	10.6	0.75 to 2 pt (0.19 to 0.5 + 0.19 to 0.5)		Crop: 3-leaf until prior to boot.
carfentrazone	Aim + 2,4-D amine or MCPA amine	NR	NR	1/3 to 0.67 oz DF+ 0.5 to 0.75 pt of a 4 lb/gal conc. (0.128 to 0.24 oz + 0.25 to 0.38)	Most broadleaf weeds including pigweed, control/ suppression of buckwheat and ALS R. kochia.	Crop: Up to jointing stage. Weeds: Up to 4 inches tall.
tribenuron	Express	457.6	17.3	1/6 to 1/3 oz DF (0.125 to 0.25 oz)	Most broadleaf weeds. Weak on wild buckwheat.	Crop: 2-leaf until prior to flag leaf emergence.
thifensulfuron	Harmony GT	84.6	3.2	3/10 to 6/10 oz DF (0.225 to 0.45 oz)		
thifensulfuron + tribenuron	Harmony Extra	164.1	6.2	3/10 to 6/10 oz DF (0.225 to 0.45 oz)	Most broadleaf weeds including wild buckwheat, cocklebur, and lanceleaf sage.	
metsulfuron	Ally	52.5	2.0	1/10 oz DF (0.06 oz)	Most broadleaf weeds with partial control of wild buckwheat.	Crop: 2-leaf until prior to boot.
metsulfuron + thifensulfuron + tribenuron	Canvas	NR	NR	2/10 to 4/10 oz DF or 5 to 10 A/pack (0.03 to 0.06 oz mets + 0.113 to 225 oz thifensulf+tribenuron)	Most broadleaf weeds and improved control of wild buckwheat.	Crop: 2-leaf stage until prior to flag leaf emergence.
prosulfuron	Peak	NR	NR	½ oz DF (0.29 oz)	Most broadleaf weeds.	Crop: 3-leaf until 2nd node is detectable.
triasulfuron	Amber	3.7	0.1	0.28 to 0.56 oz DF (0.21 to 0.42 oz)	Most broadleaf weeds.	Crop: 2-leaf until prior to boot stage.
triasulfuron + dicamba	Rave	NR	NR	2 oz DF (0.176 oz + 1 oz)		Up to 4-leaf stage.
chlorsulfuron + metsulfuron	Finesse	NR	NR	2/10 to 4/10 oz DF (0.15 to 0.3 oz)	Most broadleaf weeds and suppression of foxtail and Canada thistle.	Crop: 2-leaf until prior to flag leaf emergence.
imazamethabenz	Assert Assert SG	76.6	2.9	1 to 1.5 pt 7.5 to 11.2 oz DG (0.31 to 0.47)	Wild oat, wild mustard, and winter annual mustards.	Crop: 2-leaf to jointing. Wild oat: 1- to 4-leaf stage.

difenzoquat	Avenge	28.0	1.1	2.5 to 4 pt (0.62 to 1)	Wild oat	Crop: Prior to flag leaf emergence. Wild oat: 3- to 5-leaf stage.
difenzoquat + imazamethabenz	Avenge + Assert	NR	NR	2 pt + 0.75 pt (0.5 + 0.23)	Wild oat, wild mustard and winter annual mustards.	Crop: 2- to 4-leaf.
tralkoxydim	Achieve	1.7	0.1	7 oz WDG (0.18)	Green and yellow foxtail, wild and volunteer oat, Persian darnel, and annual ryegrass.	Crop: 2-leaf to boot. Foxtails: 1 to 5 leaf. Persian darnel: 1 to 4 leaf. Wild oat: 1 to 6 leaf.
fenoxaprop-p + safener	Puma	7.1	0.3	0.33 to 0.66 pt (0.04 to 0.08)	Green and yellow foxtail, millets, corn, barnyardgrass, and wild oat.	Crop: 2-leaf to 6-leaf. Grass weeds: 2 leaf to 2 tiller.
fenoxaprop-p + 2,4-D + MCPA	Tiller	30.8	1.2	1 to 1.7 pt (0.047 to 0.08 + 0.073 to 0.12 + 0.22 to 0.37)	Green and yellow foxtail, millet, wild oat, barnyardgrass and several broadleaf weeds.	Crop: 3- to 4-leaf up to 6-leaf. Grass weeds: 2-leaf to 2-tiller. Broadleaf weeds: Up to 4 inches.
propanil + MCPA ester	Stampede 80EDF	NR	NR	1.25 to 1.4 lb + 0.5 pt (1 to 1.13 + 0.25)	Green and yellow foxtail and some annual broadleaf weeds including wild buckwheat.	2-4 leaf. Foxtail: 1-3 leaf. Broadleaf weeds: 1-4 leaves.
diclofop	Hoelon	136.9	5.2	2 to 2.66 pt (0.75 to 1.0)	Green and yellow foxtail and wild oat.	Crop: Up to 4-leaf. Grass weeds: 1 to 4 leaves.
diclofop + bromoxynil	Hoelon	NR	NR	2 to 2.66 pt + 1.0 to 1.5 pt EC (0.75 to 1.0 + 0.25 to 0.38)	Green and yellow foxtail, wild oat, and broadleaf weeds.	Grass weeds: 2 to 3 leaves. Broadleaf weeds: Small.
diclofop + bromoxynil + MCPA ester	Hoelon	NR	NR	2.66 pt + 1.0 pt to 1.5 pt EC or 3.33 to 5 A/ pack + 1.5 fl oz (1+0.25to0.38+0.05)		Grass weeds: 1 to 3 leaves. Broadleaf weeds: Small.

[1]Zollinger et al, 1998. NR = Not Reported.

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References

1. Beard, L. and G.E. Waldhaus. 2000. North Dakota agricultural statistics, 1999. Ag Statistics no. 68. North Dakota State University, Fargo, N.D.

2. Glogoza, P.A. 2000. 2000 Field crop insect management guide. NDSU Extension Service. Extension report E-1143.

3. McMullen, M.P. & H.A. Lamey. 2000. 2000 Field crop fungicide guide. NDSU Extension Service. Extension report PP-622.

4. Stefenson, B., J. Pederson, and V. Pederson. 1999. Common barley diseases in North Dakota. NDSU Extension Publication PP-894.

5. Zollinger, R.K., G.K. Dahl, M.P. McMullen, P.A. Glogoza, A.G. Dexter, S.A. Fitterer, G.E. Waldhaus, & K. Ignaszewski. 1998. Pesticide use and pest management practices for major crops in North Dakota 1996. NDSU Extension Service. Extension report no. 43.

6. Zollinger, R.K. 2000. 2000 North Dakota weed control guide. NDSU Extension Service. Extension Circular W-253.