A-1050

1995 Hard Red Spring Wheat Production Guide

NDSU EXTENSION SERVICE

INDEX

Introduction 3

Telephone directory 4

Fertilization 6

Nutrient Deficiencies 9

Rotations, Tillage 12

Varieties 14

Scab Ratings 16

Leaf Disease Ratings 17

Planting Date, Rate, Replanting 18

Seeding Equipment Operation 21

Grain Drill Calibrations 22

Sprayer Calibration 26

Nozzles 29

Weed Control 33

Disease Control 64

Insect Control 76

Harvesting 84

Drying/Storage 88

Pesticide Safety Rules ....inside back cover

Fertilization

Varieties

Planting

Sprayers

Weeds

Diseases

Insects

Harvest

Drying

INTRODUCTION

Profitable Wheat Production

Modern technology, fluctuating export markets, uncertain farm policies, and environmental regulations all contribute to wheat producers' need for careful planning and management to assure good production and profitability. Fluctuating weather and stored soil moisture levels also require wheat producers to make careful decisions as to type of tillage, seedbed preparation, rotations, and pest management practices.

This guide will assist you in making timely management decisions. However, extensive details on any one production area are not given, because of space constraints. More detailed and complete discussions of soil fertility, weed, disease and insect control and control of stored grain insects are available in Extension circulars, the Crop Production Guide and North Dakota Farm Research.

The pesticide use suggestions in this guide are based on Federal label clearances and on research information from the North Dakota Agricultural Experiment Stations. All pesticides listed had a federal or state label at the time of publication.

The publishers do not assume any responsibility, make any guarantees, or offer any warranties in regard to the results obtained from use of the data appearing in this guide.

WHEAT EXTENSION STAFF

Fargo

Dwight Aakre, Farm Management	(701) 231-7378
Greg Dahl, Pesticide Programs	231-7180
David Franzen, Soil Fertility	231-8884
Jim Helm, Production Practices	231-7574
Ken Hellevang, Grain Storage	231-7243
Vern Hofman, Equipment, Harvest Losses	231-7240
George Maher, Agriculture Safety	231-8288
Phil Glogoza, Insects	231-7581
Marcia McMullen, Diseases	231-7627
Richard Zollinger, Weeds	231-8157
NDSU Soil Testing Lab	231-8942
NDSU Plant Pest Diagnostic Laboratory	231-7854

Area Agronomists

Greg Endres – Carrington	652-2951
Terry Gregoire – Devils Lake	662-7080
Kent McKay – Minot.	857-7682

County Extension Agents

Adams	(701)567-2735
Barnes	845-8528
Benson	473-5363
Billings	264-7665
Bottineau	228-2253
Bowman	523-5271
Burke	377-2927
Burleigh	221-6865
Cass	241-5700
Cavalier	256-2955
Dickey	349-3211
Divide	965-6501
Dunn	764-5593
Eddy	947-2454
Emmons	254-4811
Fort Berthold	627-3446
Foster	652-2581
Golden Valley	872-4332
Grand Forks	780-8229
Grant	622-3470
Griggs	797-3312
Hettinger	824-2095

County Extension Agents (continued)

Kidder	475-2672
LaMoure	883-5389
Logan	754-2504
McHenry	537-5405
McIntosh	288-3465
McKenzie	842-3451
McLean	462-8541
Mercer	873-5195
Morton	667-3340
Mountrail	628-2835
Nelson	247-2521
Oliver	794-8748
Pembina	265-8411
Pierce	776-6234
Ramsey	662-7027
Ransom	683-5823
Renville	756-6392
Richland	642-7793
Rolette	477-5671
Sargent.	724-3355
Sheridan	363-2242
Sioux	854-3412
Slope	879-6270
Stark	264-7665
Steele	524-2253
Stutsman	252-9030
Towner	968-4362
Traill	436-5665
Walsh	284-6248
Ward.	857-6444
Wells	547-3341
Williams	572-1717

Experiment Stations

Carrington	652-2951
Casselton	347-4743
Dickinson	227-2348
Hettinger	567-4323
Langdon	256-2582
Mandan	663-6445
Minot	838-1434
Streeter	424-3606
Williston	774-4315

Fertilizing Hard Red Spring Wheat

Fertilizer recommendations for hard red spring wheat are given in Table 1. These recommendations are based on soil tests results from soil samples collected from the field during the season directly before planting. Samples for nitrates should be taken to a depth of at least 24 inches. Broadcast applications of fertilizer can be made prior to seeding. Many producers with fertilizer banding or air-seeding equipment can economize on phosphorus and potassium costs with band applications. Rates of P and K can be reduced by 1/3 from the chart recommendations with banding. No reduction in nitrogen is recommended, whether the N is banded or not.

Set Realistic Yield Goals

Fertilizer recommendations are based on soil test levels of plant nutrients and the total nutrients needed to reach a certain yield goal. Once soil test levels are known, yield goals must be thoughtfully estimated to increase the efficiency of the fertilizers used. Unrealistic yield goal can either limit yield potential, or waste valuable nutrients and farm operating capital. Information which helps define yield goals are:

1. Yield history (disregarding unusual years)
2. Knowledge of general soil productivity of the farm
3. Knowing the water status of the soil prior to planting
4. Management intensity of the producer
5. Ability of the producer to understand and assume risks.

Table 1. Fertilizer recommendations - hard red spring wheat.

			Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Yield goal	Soil N plus fertilizer N required		VL	L	M	H	VH	VL	L	M	H	VH
		Bray-I	0-5	6-10	11-15	16-20	21+	0-40	41-80	81-120	121-160	161+
		Olsen	0-3	4-7	8-11	12-15	16+					
bu/a	lb/acre-2'		------ lb P_2O_5/acre ------					------ lb K_2O/acre ------				
20	50		20	15	10	0	0	50	35	20	0	0
40	100		40	30	15	10	0	95	70	40	15	0
60	150		60	40	25	10	0	140	100	60	20	0
80	200		80	55	35	10	0	190	135	80	25	0

Nitrogen recommendation = 2.5 YG − STN − SDA − PCC
Bray-I P recommendation = (1.071−0.054 STP)YG
Olsen P recommendation = (1.071−0.067 STP)YG
Potassium recommendation = (2.710−0.017 STK)YG

YG = yield goal
STN = soil test nitrogen
STP = soil test phosphorus
STK = soil test potassium
SDA = sampling date adjustment
PCC = previous crop credit

Soil Sampling

Analysis for phosphorus, potassium, trace elements, soil pH and organic matter are done on the plow layer depth. This is normally 0-6". Nitrate, sulfur and chloride recommendations are based on analytical results from the 0-24" soil depth. When other depth increments are submitted for analysis the depth collected should be indicated on the sample information sheet. Accurate recommendation can be made from any known sampling depth. Increasing numbers of growers sample to 4 ft to gain information on stored water and plan for deep nitrogen use.

Guidelines for Management Decision Estimates

- Wheat in the Northern Plains will require about 2.5 lbs of nitrogen/bushel.
- About 20 lbs/A of added P_2O_5 is required to increase test levels one ppm (part per million).
- Low potassium is rare in North Dakota. Potassium needs attention with test levels below 150 lbs/A.
- Chloride test levels below 60 lbs/A need management attention.
- Low soil sulfur levels are sometimes present in some areas of North Dakota. Sulfur additions are recommended with 24" soil sulfur levels below 15 lbs/A. Sulfate sources are usually more quickly effective than the elemental form.

NUTRIENT DEFICIENCY SYMPTOMS - WHEAT

Nitrogen, phosphorus, sulfur and chloride are the nutrient deficiencies commonly found in North Dakota. Potassium and other trace element deficiencies are rare in North Dakota wheat fields. Nutrient devidiency symptoms are difficult to determine absolutely in the field. Suspected deficiencies should be followed up by laboratory plant or leaf analysis.

Deficiency	Field View	Individual Plants
NITROGEN		
Severe (Visible early)	Conspicuous early season yellowing not associated with wet ground or chemical application patterns.	Older leaves yellow. Emerging leaves green. Reduced tillering.
Moderate (Crop may look good until mid-season)	Yellowing in patches at boot stage not associated with drought or wet spots.	Compared with the flag-leaf other leaves are yellow. Tiller die back. Older leaves die early.
Low (Harvest is disappointing)	No obvious problems. Crop matured early. Crop appears to suffer drought stress by early heading.	Small mainstem head. Tiller heads didn't fill.

Deficiency	Field View	Individual Plants
PHOSPHORUS		
Severe (early season, after weather warms)	Slow growth in a stand with conspicuous thin spots.	Stunted slow growing plants with reduced tillering. Stems may show purpling similar to cold weather purpling.
Moderate (Crop looks good at mid-season)	Crop may appear drought stressed by early heading.	Excessive tiller die back at heading.
Low (Disappointing yields)	No visible symptoms.	Small mainstem head. Tiller heads didn't fill.
SULFUR		
Severe (Early season)	Yellowing not necessarily associated with landscape features. Looks like nitrogen deficiency.	Top leaves yellow.
Moderate	Early season yellowing in patches that disappears with crop growth and root extension.	Reduced tillering
Low	No visible symptoms. On sandy gound, plants appear to suffer drought stress by early heading.	Tillers fail to fill.
CHLORIDE	No visible symptoms. Leaf disease may be more prevalent. Yield response to other nutrient applications disappointing.	No visible symptoms. Leaf and root disease may be more prevalent.

ROTATIONS

The organic matter levels of many soils in North Dakota have decreased to around half of what they were when first cropped. Fallow was as much adopted early in this century to take advantage of extra nitrogen breakdown from this organic matter as from water accumulation. In many areas of western North Dakota, there is little advantage of fallow in either water retention or nitrate accumulation. By managing recrop and rotational crops instead of fallow, a producer can take advantage of good rainfall years without overextending himself in low rainfall years. Using soil testing and modifying yield expectations on continuous crop to conservatively optimistic levels will efficiently predict fertilizer input needs.

In a continuous crop system, wheat should be replaced with an alternative crop. Long-term studies show that wheat does best when following soybeans, sugarbeets, sunflower, corn, flax and barley, in that order. It is not a good practice to grow continuous wheat. Pest problems grow in continuous wheat, increasing costs for that year and following years. Other factors which may influence rotation decisions are herbicide residues from previous crops, government farm programs and commodity pricing.

TILLAGE

There are many tillage systems used by North Dakota wheat producers. No single practice is the best, and under certain sets of conditions they all will work satisfactorily. No matter what tillage system is used, a good seed bed is required. This means the seed should be placed in moist soil as shallow as possible and the moist soil firmed around the seed. This will allow rapid absorption of water, and if temperatures are adequate, rapid germination.

The tillage system you use will depend on your available equipment, rotation sequence, residue management and to some degree, soil type. All of these factors also affect how planting into a good seed bed is achieved.

VARIETY SELECTION

Use of adapted varieties is a positive management decision. Varieties being grown in North Dakota are described in the following table for Hard Red Spring Wheat. Characteristics to evaluate in selecting a variety are: yield potential in your area; protein content when grown with proper fertility and milling, processing and baking quality; straw strength and plant height; reaction to important diseases; and days to maturity. See tables for variety characteristics and disease responses.

HARD RED SPRING WHEAT

Variety Descriptions

Variety	Agent or Origin[1]	Year released	Awns	Straw Ht	Straw Strength	Maturity	Reaction to disease: Stem rust[2]	Reaction to disease: Leaf rust[2]	Quality factors: Test wt.	Quality factors: Protein	Score[3]	Comments
Grandin	ND	1989	y	s.d.	strg.	early	R	R	high	avg.	4	
Gus	ND	1989	y	s.d.	strg.	m.early	R	R	high	high	4	
Amidon	ND	1988	y	med.	med.	med.	R	R	high	avg.	4	Tol. root rot
Len	ND	1979	y	s.d.	v.strg.	m.early	R	R	high	avg.	4	
Coteau	ND	1978	y	med.	m.strg.	med.	R	R	avg.	high	4	Some res. tan spot*
Waldron	ND	1969	n	med.	strg.	m.early	R[4,5]	MS	avg.	high	4	Ergot susc.
Butte 86	ND	1986	y	med.	m.strg.	early	R[5]	R	high	avg.	3	False bl. chaff
Kulm	ND	1994	y	med.	strg.	early	R	R	high	high	3	
Stoa	ND	1984	y	med.	m.strg.	m.early	R	R	high	avg.	3	
Katepwa	Can.	1984	n	med.	med.	m.early	R[7]	MS	avg.	high	3	
2371	NDSURF	1991	y	s.d.	v.strg.	m.early	R[5]	R	high	avg.	3	
Lew	Mont.	1976	n	med.	med.	med.	R[6]	MS	high	low	2.5	Res. sawfly
2375	NDSURF	1990	y	s.d.	med.	m.early	R	R	high	avg.	2.5	
2370	NDSURF	1990	y	s.d.	v.strg.	m.early	R[6]	R	high	avg.	2.5	
Norm	MN	1992	y	s.d.	v.strg.	med.	R	R	high	low	2	
Vance	MN	1989	y	s.d.	strg.	med.	R	R	high	low	2	
Sharp	SD	1990	y	med.	med.	early	R	R	v.hi.	avg.	2	
Prospect	SD	1988	y	s.d.	v.strg.	m.early	R[6]	MR	high	avg.	2	
Hi-line	Mont.	1991	y	s.d.	v.strg.	m.early	R[6]	R	avg.	low	2	
CDC-Teal	CDC	1991	n	med.	med.	m.early	R	MR	high	avg.	N/A	
AC Minto	Can.	1991	n	med.	med.	med.	R[6]	R	low	avg.	N/A	Preharvest dormancy
Pasqua	Can.	1990	y	med.	med.	v.late	R[5]	R	avg.	high	N/A	Preharvest dormancy
Sonja	AgrPro	1992	y	s.d.	v.strg.	m.early	R	MR	high	avg.	N/A	
Krona	AgrPro	1991	y	s.d.	v.strg.	m.late	R	R	high	low	2	
Dalen	AgrPro	1991	y	s.d.	v.strg.	early	R[5]	R	high	avg.	2	
Bergen	AgrPro	1990	y	s.d.	v.strg.	m.early	R[6]	R	high	avg.	2	Some tol. to leaf spot
Nordic	AgrPro	1986	y	s.d.	strg.	m.late	R	MR	high	low	2	Low protein
Express	WPB	1990	y	s.d.	v.strg.	m.early	R	MR	low	avg.	N/A	
Rambo	WPB	1987	y	s.d.	v.strg.	m.early	R[7]	R	high	avg.	2	Res. sawfly
McNeal	Mont.	1993	y	s.d.	strg.	m.early	MS[7]	S	avg.	low	N/A	
Glenman	Mont.	1984	n	s.d.	strg.	med.	R[4,7]	MS	avg.	low	1	Res. sawfly

[1] Refers to agent or developer; AgrPro = AgriPro, NDSURF = North Dakota State University Research Foundation, WPB = Western Plant Breeder, CDC = Crop Development Center, University of Saskatchewan; Can. = Agriculture Canada.

[2] R = resistant, MR = moderately resistant, M = intermediate, MS = moderately susceptible. S = susceptible; 4 = occasionally mixed with some susceptible plants; 5 = MR, 6 = M, 7 = S or MS in artificial induced epidemics.

[3] 1 = Very poor quality; 2 = Poor quality; 2.5 = Poor to average quality; 3 = Average quality; 3.5 = Average to good quality; 4 = Good quality. (N/A - Quality data not available.) Quality assessed by North Dakota State University Cereal Quality Laboratory.

* During prolonged wet periods, all varieties are susceptible to tan spot.

Scab

Disease Severity Ratings of HRS Wheats for North Dakota

Classification based on severity of scab infection in field trials at 5 locations in 1994; Carrington, Fargo, Grand Forks, Langdon, and Prosper.

Varieties are arranged alphabetically within columns.

More Susceptible	Intermediate/ Variable	Less Susceptible*
Amidon	2371[1]	2370
Bergen	CDC Merlin	2375
CDC Teal	Grandin	AC Domain
Dalen	Krona[2]	Butte 86
Express	Len	Hamer
Gus	Prospect	Lars
Kulm		Marshall
Minnpro		Nordic
Norlander		Sharp
Norm		Stoa
Sonja		
Vance		

[1]2371 - Reported as highly susceptible in Minnesota, but it appeared to be less susceptible in North Dakota.

[2]Krona - Reported as highly susceptible in Minnesota, but it appeared to be less susceptible in North Dakota.

*Varieties on this list are not immune to scab. If infection is severe, they will show disease but at lower levels than more susceptible varieties.

If a variety is not listed, not enough data available.

Foliar

Disease Severity Ratings of HRS Wheats for North Dakota

Classification based on severity of foliar disease infection in field trials from 5 to 14 locations during the years 1992-1994.

Varieties are arranged alphabetically within columns.

More Susceptible	Intermediate/ Variable	Less Susceptible*
2370	CDC Merlin	2371
2375	Coteau	AC Minto
AC Domain	Dalen	Amidon
AC Eatonia	Dutchboy	Bergen
Alex	Gus	CDC Teal
Butte 86	Marshall	Express
Cutless	Norlander	Hamer
Grandin	Sharp	Invader
Hi-Line	Stoa	Krona
Kulm	Vance	Lars
Len		McNeal
Lew		Minnpro
Penewawa		Nomad
Prospect		Nordic
Rambo		Norm
		Pasqua
		Sonja
		Wheaton

*Varieties on this list are not immune to leaf disease. If infection is severe, they will show disease but at lower levels than more susceptible varieties.

If a variety is not listed, not enough data available.

PLANTING DATE

Plant as early as possible—as soon as a satisfactory seedbed can be prepared. In general you can expect a 1% per day reduction in yield for each day delay after the first day you can plant. At a 50 bu/acre yield goal this is one half bushel per day. For those with a 100 bu/acre yield goal it amounts to one bushel per day. For very late plantings into June, greater yield reductions can occur with adverse growing conditions. The main factor contributing to yield reduction due to delayed seeding is the possibility and probability of higher temperatures during the 4.0 to 5.5 leaf stage. This growth stage is when the number of spikelets on the head is determined. The number of spikelets per spike decreases whenever the maximum day temperatures are above 63 F during this specific growth stage.

PLANTING RATE

To assure the planting of enough seed, planting rate should be obtained on a seed count basis. You will need to know the following to calculate rate:

1. Desired population of main stems at harvest.
2. Average predicted stand loss for your farm.*
3. Germination value for your seed lot.
4. Number of seeds per pound of your seed lot.

* It is not uncommon for stand losses of 40% to occur on some early planted fields.

An example for calculating planting rate:

1. Desired population is 1,125,00 main stems at harvest.
2. Historic field stand loss is 10%.
3. Seed lot germination is 95%.
4. Wheat seed lot has a seed count of 900,000 seeds/bu.

Then: 900,000 seeds/bu ÷ 60 lbs/bu x 0.95 = 14,250 viable seed per pound.

1,125,000 seeds x 110% = 1,237,500 viabl seed needed per acre.

1,237,500 seeds ÷ 14,250 seeds/lb = 87 pounds per acre seeding rate.

The following table gives a rough estimate of pl count (main stems) needed at harvest for various yi goal levels.

Rough Estimate of Plant Count Needed at Harv For Various HRS or Durum Yield Goal Levels.

Growing Condition/Yield Goal Level	Plants/Acre at Harv
Favorable Environments 60 bu/acre and up yields	1.3 million and
Less Favorable Environments 30-60 bu/acre yields (Under less favorable environments, a larger portion of total yield comes from main stems. Less tillers survive. Thus, to obtain high yields, more main stems are needed and this comes from a higher plainting rates.)	1.3 to 1.8 millic
Unfavorable Environments 15-30 bu/acre yields	0.7-1.0 million

REPLANTING DECISIONS

1. Assume you wanted a stand of 1,125,000 plants per acre. That requires at least 32 plants per square foot.
2. Replanting costs must be recovered from a later maturing crop that has a lower yield potential than original crop. Plus, replanting uses extra moisture as a function of soil disturbance.
3. A) If reduced stand is uniform, (no big skips or holes) then keep stands of 15 plants per square foot.

   B) If skips are large (3 to 6 ft) or holes are 4 to 6 feet in diameter and stand is 18 plants per square foot or less - replant if moisture is adequate.

   C) After 30 days of planting season, a replant decision should be to a crop other than wheat.

SEEDING EQUIPMENT OPERATION

The double disc press wheel drill used by many North Dakota growers provides best stands when traveling less than 4 mph and seeding less than 2 inches deep in a clean, firm, high moisture seedbed. Faster speeds may cause extreme variation in seeding depths. Some newer reduced tillage drills are designed to seed into high residue conditions. Some of those are hoe drills, air seeders, double disc drills and single disc drills. Hoe drills move soil to place seed in a deep moist seedbed at ground speeds limited by soil movement and front rank covering. Air seeders using sweeps perform best in high moisture seedbeds and can operate at higher ground speeds than other units. Disc drills work best when residue is dry, but when residue is wet, "hairpinning" of straw may occur. Seeding unit design dictates seedbed preparation and preseeding tillage needs.

Seeding unit settings and seed placement performance should be checked in each field. Performance should be checked frequently as seedbeds dry.

Packing soil over and around seed is essential for uniform emergence and becomes critical for rough, cloddy, rapidly drying seedbeds and late seedings. Reduced ground speeds enhance uniform seed covering and packing consistency.

GRAIN DRILL CALIBRATION

The seeding rate tables found in your operators manual or on the hopper lid are based on a standard weight per bushel for various crops. Wheat has a standard weight of 60 pounds per bushel. Due to differences in varieties, the seed size and weight may vary from the standard.

Seed metering systems are based on volume displacement. Therefore, if one lot of seed varies in size and weight from another, two different amounts of seed will be metered if the drill setting is not changed. For this reason, metering systems should be calibrated for a seed size to plant a particular population per acre.

To determine the amount of seed to plant, a desired plant population at harvest time is needed. This has a major affect on yield. For maximum yield, across the entire state, a plant population of 1,250,000 plants per acre at harvest is desired. This is recommended in the western part of the state as well as the east, as main stem heads will yield better than heads on tillers.

To arrive at a particular plant population, an estimate of the field stand loss must be made. This can often be as low as 10% or as high as 40%. Often, a 10 to 20% loss occurs due to disease, weed competition and seed damage during handling.

Usually all seed does not grow. A germination test should be done on all seed so the amount planted can be increased to account for this loss.

The pounds of seed to plant should be determined by a seed count. This is done by:

1. Count out 100 seeds. (Count out a larger amount if the scale is of marginal accuracy).
2. Weigh on a gram scale. (Some elevators or high school chemistry labs have gram scales. If you are near an NDSU Experiment Station, take your sample there and they can weigh it for you).
3. Calculate the seeds per pound.
   Example: 100 seeds weigh 2.89 grams

$$\frac{453.6 \text{ grams/lb}}{2.89 \text{ grams}} \times 100 \text{ seeds} = \text{seeds/pound}$$

$$156.95 \times 100 = 15{,}695 \text{ seeds/pound}$$

   NOTE: There are 453.6 grams/pound or there are 7,000 grains in 1 pound. By knowing the seeds in a pound, the seeds to plant or the pounds of seed to plant can be determined.

A simple way to check calibration is to count the number of seeds dropped in a square foot or lineal foot of drill row. To do this:

1. Operate your drill on a firm soil surface at your normal operating speed. A slow speed will drop more seed than a faster speed.
2. Count the seeds dropped in one foot of drill row.
3. Multiply the single row seed count by the following drill row adjustment factor.

Drill Row Spacing (inches)	Adjustment Factor
6	2
7	1.7
8	1.5
10	1.2
12	1

4. Make several counts and compare the seeds counted to the values found. NOTE: The values listed in the adjoining table, Wheat Seeding Plant Population Per Square Foot, do not allow for a reduction in germination.
5. Make adjustments if necessary and repeat your calibration.

Wheat Seeding Plant Populations per Square Foot*

	Spring Wheat		
Seeding Rate (Lbs/Acre)	13,000 seeds/lb	15,000 seeds/lb	17,000 seeds/lb
	- - - seeds/square foot. - - -		
60	18	20	23
70	21	24	27
80	24	27	31
90	27	31	35
100	30	34	39
110	33	38	43
120	36	41	47

* The numbers in the chart are based on seeds planted per square foot and does not consider stand reduction from less than 100 percent germination. Many times adjustment for seed size must be made. A large or small seed may require an adjustment different than listed in the table. Be sure to make this adjustment when making initial drill setting.

The most accurate method of determining seeding rate is to collect the seed metered from your drill over a measured distance.

The steps to follow are:

1. Measure out a distance for your drill width to equal 1/10 acre. This distance is listed in the following table.
2. Place bags under all drop tubes.
3. Operate the drill through the measured distance in the field at your normal operating speed.
4. Weigh the seed collected, multiply the weight by 10 as the amount collected was from 1/10 acre.
5. Compare this amount to your desired seeding rate. Make adjustments if necessary and repeat your calibration.

NOTE: This procedure can also be used to check the calibration of fertilizer applicators.

Drilling Distance for 1/10 Acre

Drilling Width (feet)	Distance for 1/10 acre (feet)
6	726
7	622
8	544
9	484
10	435
11	396
12	363
13	335
14	311

SPRAYER CALIBRATION

The procedure for calibrating a sprayer is not difficult. It is measuring the volume delivered by the sprayer to a part of an acre and then calculating how much would be delivered to an entire acre.

The first thing in any calibration procedure is to check the flow rate of all nozzles on the sprayer. All nozzles should discharge the same amount and produce a good pattern. This can be checked by collecting the flow from individual nozzles in a measuring cup for a period of time. Thirty seconds works well. Also, a sprayer calibrator works well. Any nozzles that are showing abnormal flow (either high or low) should be cleaned or replaced.

Several methods for calibrating sprayers are available. The following method is simple but accurate. Included is a chart listing the seconds to drive various distances converted to speed in miles per hour (MPH). This also allows you to check the accuracy of your tractor or pickup speedometer.

SPRAYER CALIBRATION METHOD

A sprayer can be calibrated by determining the time required for a sprayer to travel a measured distance and the delivery rate of the nozzles during that time. The following chart lists the travel distance required for a single nozzle or group of nozzles spraying 1 row to spray 1/128 acre. When a nozzle treats 1/128 acre, one ounce of spray collected equals one gallon per acre.

Sprayer Calibration Chart

Nozzle or Row Spacing (inches)	Travel Distance to equal 1/128 acre (feet)
40	102
30	136
22	185
20	204
10	408

Instructions for use:

1. Use the chart for distance to drive in the field (Use nozzle spacing for broadcast sprayers or row spacing for directed and band rigs.)
2. Set throttle for spraying and operate all equipment. Measure the seconds required to drive the measured distance. To check your travel speed in miles per hour, use Speed Calibration Chart.
3. Catch spray for the noted time in step 2 in a measuring cup. If a boom sprayer, catch spray from 1 nozzle for noted time. On directed spray rigs, catch spray from all nozzles per row for noted time.
4. Nozzle or nozzle group output in ounces = gallons/acre actually applied.
5. Repeat for each nozzle to assure uniform application.

Speed Calibration Chart

Speed (MPH)	102 ft	136 ft	185 ft	204 ft	408 ft
	The Time (Seconds) to Drive Various Indicated Distances (Feet)				
	- - - - - - - - - - seconds - - - - - - - - - -				
2.0	35	46	63	69	139
2.5	28	37	50	56	111
3.0	23	31	42	46	92
3.5	20	26	36	40	80
4.0	17	23	32	35	70
4.5	15	21	28	31	62
5.0	14	18	25	28	56
5.5	13	17	23	25	50
6.0	12	15	21	23	46
6.5	11	14	19	21	43
7.0	10	13	18	20	40
7.5	9	12	17	19	37
8.0	9	12	16	17	34
8.5	8	11	15	16	33
9.0	8	10	14	15	31
9.5	7	10	13	15	29
10.0	7	9	13	14	28

Example: If it takes 18 seconds to travel a distance of 136 feet, your travel speed is 5.0 MPH.

Flat Fan Spray Nozzles

Manufacturer Tip No. * (Nozzle Screen Size)	Liquid Pressure (PSI)	Capacity Gal/Min (GPM)	Capacity Oz/Min (OPM)
Delavan LF 80-.67	20	.047	6.0
Spraying Systems 800067	25	.053	6.8
	30	.060	7.7
	40	.067	8.6
	50	.075	9.0
(100 mesh)	60	.082	10.5
Delavan LF 80-1	20	.071	9.0
LF 100-1			
Spraying Systems 8001	25	.079	10.1
11001	30	.09	11.5
Lurmark 01-F80	40	.10	12.8
01-F110	50	.11	14.1
(100 mesh)	60	.12	15.4
Delavan LF 80-1.5	20	.11	14.1
LF 100-1.5			
Spraying Systems 80015	25	.12	15.4
110015	30	.13	16.6
Lurmark 015-F80	40	.15	19.2
015-F110	50	.17	21.8
(100 mesh)	60	.18	23.0
Delavan LF 80-2	20	.14	17.9
LF 100-2			
LF 110-2	25	.16	20.5
Spraying Systems 8002	30	.17	21.8
11002	40	.20	25.6
Lurmark 02-F80	50	.22	28.2
02-F110	60	.24	30.7
(50 mesh)			

* Some nozzles may not interchange exactly among manufacturers. However, flow rate differences are usually small so interchanging nozzles should cause little problem.

Manufacturer Tip No. * (Nozzle Screen Size)	Liquid Pressure (PSI)	Capacity Gal/Min (GPM)	Capacity Oz/Min (OPM)
Delavan LF 80-3	20	.21	26.8
LF 110-3	25	.24	30.7
Spraying Systems 8003	30	.26	33.3
11003	40	.30	38.4
Lurmark 03-F80	50	.34	43.5
03-F110	60	.37	47.4
(50 mesh)			
Delavan LF 80-4	20	.28	35.8
LF 110-4	25	.32	41.0
Spraying Systems 8004	30	.35	44.8
11004	40	.40	51.2
Lurmark 04-F80	50	.45	57.6
04-F110	60	.49	62.7
(50 mesh)			
Delavan LF 80-5	20	.35	44.8
LF 110-5	25	.40	51.2
Spraying Systems 8005	30	.43	55.0
11005	40	.50	64.0
Lurmark 05-F80	50	.56	71.7
05-F110	60	.61	78.1
(50 mesh)			
Delavan LF 80-6	20	.42	53.8
LF 110-6	25	.47	60.2
Spraying Systems 8006	30	.52	66.6
11006	40	.60	76.8
Lurmark	50	.67	85.8
(50 mesh)	60	.73	93.4

* Some nozzles may not interchange exactly among manufacturers. However, flow rate differences are usually small so interchanging nozzles should cause little problem.

Drift Reducing Flat Fan Nozzles

Manufacturer Tip No. * (Nozzle Screen Size)	Liquid Pressure (PSI)	Capacity Gal/Min (GPM)	Capacity Oz/Min (OPM)
Spraying Systems XR8001	15	.06	7.7
XR11001	20	.07	9.0
	25	.08	10.2
	30	.09	11.5
(100 mesh)	40	.10	12.8
	50	.11	14.1
	60	.12	15.4
Spraying Systems XR80015	15	.09	11.7
XR110015	20	.11	14.1
	25	.12	15.4
Delavan 80-1.5R	30	.13	16.6
100-1.5R			
	40	.15	19.2
	50	.17	21.8
(100 mesh)	60	.18	23.0
Spraying Systems XR8002	15	.12	15.4
XR11002	20	.14	17.9
	25	.16	20.5
Delavan 80-2R	30	.17	21.8
110-2R			
	40	.20	25.6
(50 mesh)	50	.22	28.2
	60	.24	30.7

* Some nozzles may not interchange exactly among manufacturers. However, flow rate differences are usually small so interchanging nozzles should cause little problem.

Manufacturer Tip No. * (Nozzle Screen Size)		Liquid Pressure (PSI)	Capacity Gal/Min (GPM)	Capacity Oz/Min (OPM)
Spraying Systems	XR8003	15	.18	23.0
	XR11003	20	.21	26.8
		25	.24	30.7
Delavan 80-3R		30	.26	33.3
110-3R				
		40	.30	38.4
(50 mesh)		50	.34	43.5
		60	.37	47.4
Spraying Systems	XR8004	15	.24	30.7
	XR11004	20	.28	35.8
		25	.32	41.0
Delavan 80-4R		30	.35	44.8
110-4R				
		40	.40	51.2
(50 mesh)		50	.45	57.6
		60	.49	62.7
Spraying Systems	XR8005	15	.31	39.7
	XR11005	20	.35	44.8
		25	.40	51.2
Delavan 80-5R		30	.43	55.0
110-5R				
		40	.50	64.0
(50 mesh)		50	.56	71.7
		60	.61	78.1
Spraying Systems	XR8006	15	.37	47.4
	XR11006	20	.42	53.8
		25	.47	60.2
Delavan 80-6R		30	.52	66.6
110-6R				
		40	.60	76.8
		50	.67	85.8
		60	.73	93.4

Weed Control

Good cultural practices are one of many methods of controlling weeds. Always plant weed free seed, prevent weed seed proliferation, and clean tillage and harvest equipment between fields to minimize weed infestations. Selective herbicides, if used properly, will control weeds satisfactorily without damaging the crop.

Herbicide effectiveness is influenced by crop tolerance, weed species, and environment. Herbicides are generally most effective when climatic conditions promote vigorous plant growth. Weeds which are growing under environmental stress generally absorb less herbicide and are more difficult to control than actively growing plants. However, crops under stress may be more susceptible to herbicide injury. The ideal temperature for applying most postemergence herbicides is between 65 and 85 F. Herbicides are generally less active at low temperatures than high temperatures (except barban and diclofop). Thus weeds usually die very slowly or not at all if cool weather occurs during and after treatment. Herbicides usually become more active at high temperatures, and therefore crop injury is more likely to occur if herbicides are sprayed on extremely hot days.

HERBICIDE RESISTANCE: Weed biotypes resistant to a herbicide occur from repeated use of a selective herbicide that eliminates susceptible weed species and allows tolerant weed species to increase in the absence of competition from the susceptible plant species. Likewise, individual plant species also may have biotypes in the population that vary in susceptibility to certain herbicides. Weed species that are very susceptible to certain herbicides may contain a small percentage of plants which are tolerant or resistant to those herbicides. Repeated exposure of a weed population to a herbicide or other herbicides with the same mode of action may result in a rapid buildup of biotypes resistant to that class of herbicides. Resistant biotypes dominate the population over time due to this selection pressure. The time required for buildup of a herbicide resistant weed population depends on many factors including: effectiveness of herbicides, frequency of herbicide use, genetic variability within the species, frequency of the resistant biotype in the population, beginning level of resistance, and characteristics of the weed, including fitness or ability of the biotype to compete with other weeds both within and outside the species.

Within North Dakota since the mid 1980s, three weed species have developed significant resistance to herbicides:

1) Kochia resistant to sulfonylurea herbicides, and Kochia resistant to growth regulator type herbicides.
2) Green foxtail resistance to the dinitroaniline herbicides
3) Wild oat resistance to ACCase inhibitor herbicides.

Sulfonylurea Resistant Kochia. According to a survey taken in 1993, sulfonylurea (SU) resistant kochia is found primarily in regions of the state where Glean herbicide was extensively used. This area is along the northern, western, and southwestern sections of the state. However, resistant biotypes were found scattered throughout the entire state. Extensive use of Glean along with its long residual activity is believed the

main factor contributing to the expression of SU resistant kochia biotypes. Common use of other SU herbicides like Ally, Amber, Express and Harmony Extra may also contribute to this development.

Growth Regulator Resistant Kochia. From a survey conducted in 1993, SU resistant kochia biotypes have been discovered that are resistant to growth regulator type herbicides. Growth regulator type herbicides control a broad spectrum of weeds, are inexpensive, and are common tank-mix partners with other herbicides. These factors contribute to the wide use of growth regulator type herbicides. To prevent further buildup of cross and multiple resistant kochia biotypes the current recommendations of tankmixing SU herbicides with growth regulator type herbicides must be supplemented with additional herbicide rotational strategies. Rotate often with herbicides having a different mode of action other than SU or growth regulator type herbicides. If using an SU herbicide, tank-mix with a non-growth regulator type herbicide (for example, bromoxynil) even though cost per acre will be higher.

Trifluralin Resistant Green Foxtail is found mainly in the central and eastern portion of North Dakota where consecutive, year after year use of trifluralin is common. Similar to SU resistance, expression of green foxtail resistance was caused by successive, year after year use of trifluralin in small grain crops, row crops, and fallow. A common practice in the central part of the state is to grow continuous small grains, or a small grain/fallow rotation, or a small grain/sunflower rotation. For these cropping rotations, trifluralin can be used every year. Also, trifluralin can be applied at high rates in broadleaf crops with small grains seeded the next year. Trifluralin carryover into the small grain crop would reduce green foxtail infestations but not injure the small grain. Either continuous application or high rates resulted in a high selection pressure and expression of trifluralin resistant green foxtail.

Hoelon and fenoxaprop resistant wild oat is found within the Red River Valley of North Dakota and Minnesota. Development of resistance can be attributed to extensive use of Hoelon or fenoxaprop premix products (Tiller and Cheyenne) for wild oat control in small grains and yearly single and/or multiple applications of Poast in sugarbeet.

Resistant kochia can be expressed after 3 to 5 applications of an effective herbicide. Resistant green foxtail and wild oat can be expressed after 8 to 12 applications of an effective herbicide.

Other resistant weed situations may continue to develop in North Dakota. Many weeds have developed resistance to other herbicides, classes of herbicides (cross resistance), and to more than one class of herbicide (multiple resistance) in areas other than North Dakota. For example, in Canada, green foxtail has developed resistance to trifluralin and Hoelon. In Montana and Canada, wild oat has developed resistance to Far-Go and Avenge. In summary, herbicide resistant weeds are most likely to develop by using: 1) Herbicides that act on a single site of action, 2) Herbicides applied multiple times during the growing season or with a long residual herbicide, 3) Herbicides used for several consecutive growing seasons or repeated application of herbicides with the same mode of action to the same or different crops, and 4) Herbicides used as "stand alone" products, without other weed control options (e.g. cultivation) utilized.

Resistant weed development can be reduced by using integrated pest management (IPM) practices, such as crop rotations, tillage, herbicide rotations, and herbicide mixtures of chemicals with different modes of action. All of these techniques are sound agronomic practices which help minimize continuous exposure to a herbicide and reduce the selective pressure for specific resistant biotypes. Failure to practice these techniques and follow label guidelines on herbicides where resistance has occurred may eventually lead to loss of effectiveness of otherwise useful herbicides.

For a thorough discussion on weed resistance and management strategies for avoiding and managing herbicide resistant weeds, refer to NCR Extension Publication 468, Herbicide Resistant Weeds. A copy may be purchased from the NDSU Distribution Center.

Rainfall shortly after application often reduces weed control from postemergence herbicides because the herbicide is partially washed from the leaves. Herbicides vary in absorption rate and in ease of being washed from the leaves. The rainfall effect can also vary depending on rainfall amount and intensity. The approximate time between application and rainfall needed for maximum weed control is given in the following table.

Off target movement of herbicides is a problem in North Dakota each year as herbicides move from target fields into nontarget fields containing crops susceptible to the herbicide. Herbicide drift can be a result of particle movement with the wind or as vapor fumes. Particle drift is most likely to occur with small droplets and high wind velocities. All herbicides are subject to particle drift. Particle drift can be minimized by spraying large droplets at low wind velocities when the wind direction is away from susceptible crops.

Herbicide	Time between application and rain
Ally	4 hours
Amber	24 hours
Assert	3 hours
Avenge	6 hours
Banvel, SGF	6-8 hours
Bronate	1 hour
Buctril	1 hour
Carbyne	5 minutes
Cheyenne	4 hours
Curtail	6-8 hours
Dakota	1 hour
Express	4 hours
Glyphosate	6 hours
Gramoxone Extra	0.5 hour
Harmony Extra	4 hours
Hoelon	1 hour
MCPA amine	4 hour
MCPA ester	1 hour
Stampede	4 hours
Stinger	6-8 hours
Tiller	1 hour
Tordon 22K	6-8 hours
2,4-D amine	4 hours
2,4-D ester	1 hour

Vapor drift occurs when volatile herbicides vaporize following application. Vapor drift is most likely to occur with volatile herbicides such as dicamba and the ester formulations of 2,4-D and MCPA. Volatility increases as temperature increases so the risk of vapor drift is greater with high temperatures. Susceptible crops can be injured from vapor drift even if the herbicides were sprayed when the wind was blowing in the opposite direction. Thus, to minimize the risk of drift injury, herbicides with high potential to form damaging vapors should not be used near susceptible plants.

Damaging drift to non-target plants is primarily a problem with 2,4-D, MCPA, Banvel (Cyclone and Gramoxone Extra, Glyphosate, Pinnacle, Harmony Extra, Express, Pursuit, and Tordon in North Dakota. All herbicides may drift and cause significant damage to susceptible non-target plants, so caution must be observed with all herbicide applications.

Herbicide combinations may provide more complete control and control of more weed species than individual treatments. However, the herbicide mixtures must be compatible to avoid poor results. Generally, the recommended sequence of addition of various formulations in tank mixes is: 1) water, 2) wettable powders or dry flowables with agitation, 3) liquid flowables, 4) emulsifiable concentrates, and 5) water soluble materials. It is often beneficial to mix each pesticide with water before addition to the spray mixture. If no information is available about a tank mixture, a compatibility test should be conducted on a small scale prior to adding the chemicals to the spray tank.

Several herbicide-insecticide combinations have been shown to increase crop injury compared to either pesticide applied alone. For example, crop injury has increased with sulfonylurea herbicides (Ally, Amber, Harmony Extra, and Express) plus organophosphate insecticides, or Stampede plus organophosphate or carbamate insecticide combinations. Increased crop injury even has occurred with sequential applications. Efficacy data on herbicide-insecticide mixtures are limited because of the number of potential combinations. Nonregistered tank-mixtures should be used with caution until experience or research has shown that the combination is effective and safe.

Herbicides can be legally tank mixed with other pesticides or fertilizers if all chemicals in the mixture are registered for use in a crop and applied as directed on the label. However, the user must assume liability for any resulting crop injury, inadequate weed control, or illegal residues for nonlabeled tank mixtures. The manufacturers of the products are no longer responsible for performance of the pesticides when a nonregistered combination is used.

The weed control suggestions in this production guide are based on the assumption that all herbicides mentioned will have a registered label with the Environmental Protection Agency. Herbicides should not be used which are no longer registered or have not yet received registration for wheat. Wheat treated with a non-registered herbicide may have an illegal residue which, if detected, could cause condemnation of the crop. Non-registered herbicide use is illegal and a user could be subject to a heavy fine even without detectable residue.

RELATIVE HERBICIDE EFFECTIVENESS ON WEEDS AND PERSISTENCE IN SOIL

SOIL APPLIED HERBICIDES	Barnyardgrass	Field Sandbur	Foxtail	Quackgrass	Volunteer Cereals	Wild Oat	Wild Proso Millet	Herbicide Persistence
Buckle (PPI)	E	G	E	N	N	E	F	S
Far-Go (PPI)	N	N	N-P	N	N	E	N	N
Far-Go (PoPI)	N	N	N-P	N	N	G	N	N
Trifluralin (PPI)	E	G	E*	N	N	F-G	F	S
Trifluralin (PoPI)	E	F-G	E*	N	N	P	F	S

SOIL APPLIED HERBICIDES	Buckwheat, Wild	Cocklebur, Common	Flixweed	Kochia	Lambsquarters, Common	Lanceleaf Sage	Mallow, Venice	Marshelder	Mustard, Wild	Nightshade, Black	Pigweed, Redroot	Prickly Lettuce	Ragweed, Common	Smartweed, Annual	Sunflower	Thistle, Russian
Buckle (PPI)	F	N	P	F-G	F-G	N	P	-	N	N	F-G	-	P	P	N	F-G
Far-Go (PPI)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Far-Go (PoPI)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Trifluralin (PPI)	F	P	P	G	G	N	F-G	-	N	N	G-E	-	P	P	N	G
Trifluralin (PoPI)	F	N	P	F-G	F-G	N	P	-	N	N	F-G	-	P	P	N	F-G

PPI=Preplant Incorporated, PRE= Preemergence, PoPI=Postal plant incorporated, S = Seldom, O=Often
E=Excellent, G=Good, F=Fair, N=None
*Except where resistant populations have developed.

RELATIVE HERBICIDE EFFECTIVENESS ON WEEDS AND PERSISTENCE IN SOIL

POST APPLIED HERBICIDES	Barnyardgrass	Field Sandbur	Foxtail	Quackgrass	Volunteer Cereals	Wild Oat	Wild Proso Millet	Herbicide Persistence
Ally + 2,4-D	N	N	P	N	N	N	N	O
Ally + 2,4-D + Banvel	N	N	P	N	N	N	N	O
Amber + 2,4-D	N	N	N	N	N	N	N	O
Assert	P	N	P	N	N	E	N	S
Avenge	N	N	N	N	N	G-E	N	N
Bromoxynil	N	N	N	N	N	N	N	N
Carbyne	N	N	N	N	N	F-G	N	N
Cheyenne	G-E	F	E	P	N	E	E	N
Curtail	N	N	N	N	N	N	N	S
Dakota	G-E	P-F	G-E	P	P	P	E	N
Dicamba	N	P	N	N	N	N	N	N
Express + 2,4-D	N	N	P	N	N	N	N	N
Express + 2,4-D + Dicamba	N	N	P	N	N	N	N	S
Glyphosate	E	E	E	E	E	G-E	E	N
Harmony Extra + 2,4-D	N	N	P	N	N	N	N	N
Hoelon	F	P	G-E	P	P	G-E*	P-F	N
MCPA	N	N	N	N	N	N	N	N
Paraquat	G	G	G	P	F-G	G	F-G	N
Stampede EDF + MCPAe	G	P	G	N	N	N	P	N
Stinger	N	N	N	N	N	N	N	S
Tiller	G-E	P	E	N	N	G-E	E	N
Tordon 22K + 2,4-D[a]	N	N	N	N	N	N	N	O
2,4-D	N	N	N	N	N	N	N	N

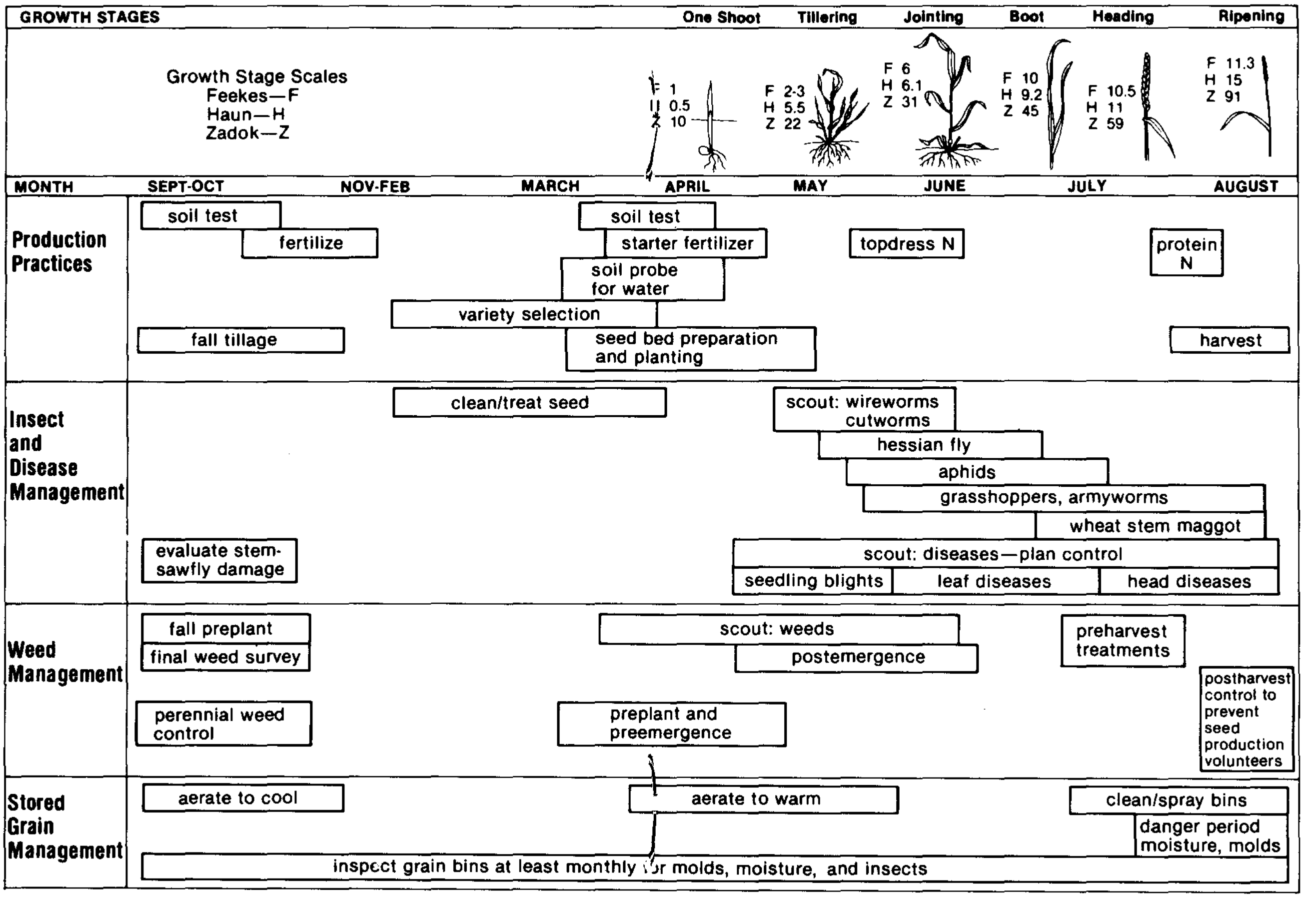
PPI=Preplant Incorporated, PRE= Preemergence, PoPI=Postal plant incorporated, S = Seldom, O=Often
E=Excellent, G=Good, F=Fair, N=None
*Except where resistant populations have developed.
[a]Tordon + 2,4-D at 1 to 1.5 fl oz/A + 2,4-D at 0.5 to 0.75 pt/A

RELATIVE HERBICIDE EFFECTIVENESS ON WEEDS AND PERSISTENCE IN SOIL

POST APPLIED HERBICIDES	Buckwheat, Wild	Cocklebur, Common	Flixweed	Kochia	Lambsquarters, Common	Lanceleaf Sage	Mallow, Venice	Marshelder	Mustard, Wild	Nightshade, Black	Pigweed, Redroot	Prickly Lettuce	Ragweed, Common	Smartweed, Annual	Sunflower	Thistle, Russian
Ally + 2,4-D	F-G	F	E	E*	E	F-G	G-E	G-E	E	F-G	E	E	E	F	G-E	E*
Ally + 2,4-D + Banvel	G-E	E	E	E	E	F-G	E	E	E	E	E	E	E	G	E	E
Amber + 2,4-D	F-G	F-G	E	E*	F-G	F-G	-	E	E	F-G	E	E	E	F	E	E*
Assert	F-G	P	G-E	P-F	P	N	N	N	E	-	P	N	N	P	N	P-F
Avenge	N	N	P	N	N	N	N	N	N	N	N	N	N	N	N	N
Bromoxynil	E	E	F-G	G-E	G	E	G-E	E	F-G	E	F-G	E	E	G-E	G-E	E
Bronate	E	E	G-E	E	E	E	G-E	E	E	E	G	E	E	G	E	E
Carbyne	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Cheyenne	F-G	G	E	E*	E	F-G	G	E	E	F-G	E	E	E	E	E	G-E*
Curtail	G	E	E	F-G	G	F-G	G	E	E	F	G	E	E	E	E	G
Dakota	P	G	G	F	E	G-E	F	G	E	F	P	G-E	G	G	G	P
Dicamba	E	E	P-F	E	G	P-F	F	E	G	E	G	G-E	E	E	G-E	G
Dicamba + MCPA	G-E	E	F-G	G-E	E	G-E	G	G-E	E	E	G	E	E	E	E	G
Express + 2,4-D	F	G	E	E*	E	F-G	-	E	E	F-G	G	G-E	G	G	F-G	E*
Express + 2,4-D + Banvel	G-E	E	E	E	E	F-G	-	E	E	E	E	E	E	E	G-E	E
Glyphosate	F	G-E	G-E	F-G	G	E	E	E	G	G-E	G	E	E	E	G	F-G
Harmony Extra + 2,4-D	G-E	G	E	E*	E	F-G	-	E	E	F-G	E	E	E	G	G-E	E*
Hoelon	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
MCPA	N	G	G-E	F	E	G-E	F	G	E	F	F	F	G	F	G	P
Paraquat	F	F-G	G	G-E	E	E	G	G	E	G-E	E	E	G-E	E	E	E
Stampede EDF + MCPAe	G-E	G	P	G	E	N	-	F	E	-	E	-	P	F	G	F
Stinger	F-G	E	P	N	P-F	F	G	E	P	F-G	P	E	G-E	G-E	G-E	P-F
Tiller	P	G-E	G	F	E	G	F-G	F-G	E	F	F	E	F	P	G-E	F
Tordon 22K + 2,4-D[a]	E	E	F-G	F-G	E	-	G-E	E	E	G-E	E	E	G-E	G	E	G-E
2,4-D	P-F	G-E	F-G	F-G	E	P-F	G-E	E	E	N	G	E	G-E	F-G	E	G

PPI=Preplant Incorporated, PRE= Preemergence, PoPI=Post plant incorporated, S = Seldom, O=Often
*Except where resistant populations have developed.

SPRING WHEAT and DURUM CALENDAR



Herbicide Names, Formulations, and Prices

Trade Name[1]	Common Name	Concentration and Formulation[2]	Cost/Unit[3]
Amber (Ciba)	triasulfuron	75% DF	$10.50 oz
Assert (American Cyanamid)	imazamethabenz	2.5 lb/gal S	$110.00 gal
Avenge (American Cyanamid)	difenzoquat	2 lb/gal S	$41.00 gal
Bromoxynil (Rhone Poulenc)	bromoxynil		
Buctril		2 lb/gal EC	$51.00 gal
Buctril Gel		4 lb/gal GEL	$104.00 gal
Bronate (Rhone-Poulenc)	bromoxynil + MCPA	2 + 2 lb/gal	$51.00 gal
Buckle (Monsanto)	triallate + trifluralin	10% + 3% G	$1.15 lb
Carbyne (Sandoz)	barban	2 lb/gal E	$37.50 gal
Cheyenne (AgrEvo)	fenoxaprop-P + MCPA + thifensulfuron + tribenuron	0.53 + 2.16 lb/gal L + 0.375 lb Harmony Extra (2-3.5 gallon jugs/case)	$700/case Case treats 40 acres.
Curtail (DowElanco)	clopyralid + 2,4-D	0.38 + 2 lb/gal S	$33.00 gal
Dakota (AgrEvo)	fenoxaprop-P + MCPA	1.85 gal of fenoxaprop + 3.78 gal of MCPA	$51.00 gal
Dicamba (Sandoz)	dicamba		
Banvel		4 lb/gal S	$71.25 gal
Banvel SGF		2 lb/gal S	$36.00 gal
Express (DuPont)	tribenuron	75% DF	$18.00 oz
Fallow Master (Monsanto)	glyphosate + dicamba	1.1 + 0.5 lb/gal S	$23.00 gal
Far-Go (Monsanto)	triallate	4 lb/gal E, 10% G	$38.00 gal $0.85 lb
Glyphosate	glyphosate	3 lb/gal S	$44.00 gal $38.00 gal RT
Harmony Extra (DuPont)	thifensulfuron + tribenuron	50% + 25% DF	$12.00 oz
Hoelon (AgrEvo)	diclofop	3 lb/gal E	$56.50 gal
Landmaster BW (Monsanto)	glyphosate + 2,4-D	0.9 + 1.5 lb/gal S	$18.75 gal
MCPA	MCPA	3.8 lb/gal amine 3.8 lb/gal ester	$13.25 gal $15.90 gal
Metsulfuron (DuPont)	metsulfuron	60% DF	
Ally			$27.10 oz
Escort			$31.00 oz
Paraquat (Zeneca)	paraquat	2.5 lb gal S	
Cyclone CF			$25.00 gal
Gramoxone Extra			$30.00 gal
Stampede 80EDF	propanil	80% EDF	$4.55 lb
Stinger (DowElanco)	clopyralid	3 lb/gal S	$446.00 gal
Tiller (AgrEvo)	fenoxaprop-P + 2,4-D + MCPA	0.44 + 0.58 + 1.75 lb/gal L	$75.00 gal
Tordon 22K (DowElanco)	picloram	2 lb/gal S	$90.00 gal
Trifluralin (Various)	trifluralin	4 lb/gal E, MTF, 10% G	$31.25 gal $0.95 lb
2,4-D amine or ester	2,4-D amine or ester	3.8 lb/gal amine 3.8 lb/gal ester	$12.00 gal amine $14.00 gal ester

CHEMICAL WEED CONTROL GUIDE FOR HARD RED SPRING WHEAT

Herbicide	Act. Ingred. lb/A (Formulation/A)	Weeds	When to Apply	Remarks
Glyphosate	0.19 to 0.75 (0.5 to 2 pt of 3 lb ae/gal conc.)	Emerged grass and broadleaf weeds.	Preplant or any time prior to crop emergence	A nonselective, translocated POST herbicide. No soil activity. Apply with a nonionic surfactant at 0.5% v/v. Combinations of 2,4-D or dicamba with glyphosate have increased the spectrum of weeds controlled. Commercial mixtures of 2,4-D + glyphosate (Landmaster BW) and dicamba + glyphosate (Fallow Master) are available.
Dicamba + Glyphosate	0.0625 + 0.28 to 0.38 (2 fl oz Banvel + 12 to 16 fl oz)			Residual activity of dicamba may control or suppress other weed flushes that may germinate after application. Apply with a NIS at 0.5% v/v.
Gramoxone Extra (paraquat) **RUP***	0.47 to 0.94 (1.5 to 3 pt)	Emerged annual grass and broadleaf weeds.		A nonselective, POST herbicide. No soil activity. Apply with nonionic surfactant at 0.12 to 0.25% v/v. Good coverage is essential. Restricted use herbicide.
Far-Go (triallate)	1 as liquid or 1.25 as granular (1 qt, 12.5 lb 10G)	Wild oats	Fall: Apply within 3 weeks of freeze-up.	Apply and incorporate with recommended equipment in the fall. Second incorporation should be done in fall or spring. Granules can be surface applied in the fall with a delayed two-pass incorporation performed in the spring prior to planting. Delayed incorporation may not provide wild oat control equivelent to fall incorporation. For most reliable wild oat control incorporate within 48 hours after application.
	1 (1 qt, 10 lb 10G)		Spring: Apply before or after planting. Preplant treatments 3 days or more before seeding.	PPI with field cultivator set 4 inches deep. Two pass incorporation is recommended. For application after seeding, apply before kernel sprouts exceed 0.5 inch in length. Postplant incorporate with harrows set shallower than seed.

*RUP = Restricted Use Pesticide

Herbicide	Act. Ingred. lb/A (Formulation/A)	Weeds	When to Apply	Remarks
Buckle (triallate + trifluralin)	1 + 0.3 (10 lb G)		Spring: Preplant incorporation only.	Use in North Dakota except in counties which border the Red River. Apply to fields fallowed the previous year. Do not apply to soil treated with trifluralin the previous year.
Far-Go (triallate) + trifluralin	1 + 0.5	Wild oats and foxtail		
	1 + 0.5 (2 pt + 1 pt 4E)		Spring: Immedi-ately after planting. Plant 2 to 2.5 inches deep.	Incorporate herbicide shallowly twice with flex-tyne or diamond harrows to depth of 1 to 1.5 inches and above crop seed.
trifluralin	0.35 to 0.4 (3.5 to 4 lb 10G)	Foxtail	Spring: PPI	For suppression of foxtail only. For west of Hwy 3 only.
	0.5 (1 pt 4E)		Spring: After planting.	Plant 2 to 2.5 inches deep. Incor-porate shallowly twice with flex-type or diamond harrow 1 to 1.5 inches deep.
	0.5 (1 pt 4E, 5 lb 10G 0.83 60DF)		Fall: After September 1 until freeze-up.	Incorporate once in fall within 24 hours after application. Keep spring incorporation depth shallower than fall. Stand reduction may occur.
	0.35 to 0.5 (3.5 to 5 10G)			For foxtail suppression only.
bromoxynil	0.25 to 0.5 (1 to 2 pt, 2.5 to 5 A/pack)	Wild buckwheat, vol. sunflower, and most	Crop emergence until prior to boot.	Apply when weeds are in early leaf weeds.seedling stage for best results. Weak on wild mustard.
Bronate (bromoxynil + MCPA ester)	0.19 to 0.5 + 0.19 to 0.5 (0.75 to 2 pt)	broadleaf weeds.	Crop from 3-leaf until prior to boot.	Apply when weeds are in early seedling stage for best results. Volunteer sunflower control better than 0.5 lb/A 2,4-D.

Herbicide	Act. Ingred. lb/A (Formulation/A)	Weeds	When to Apply	Remarks
Tordon 22K (picloram) + 2,4-D or MCPA **RUP***	1/64 to 1/43 + 0.25 to 0.38 (1 to 1.5 lf oz + 0.5 to 0.75 pt of 4 lb/gal conc.)	Wild buckwheat, volunteer and wild sun-flower and most broadleaf weeds.	3- through 5-leaf stage.	Use only on land to be planted the following year to grass, small grains, or flax.
Dicamba + 2,4-D	0.06 + 0.25 (0.12 pt Banvel or 0.25 pt SGF + 0.5 pt of 4 lb/gal conc.)		4-leaf stage only	Proper timing of application is important to avoid crop injury.
Dicamba + MCPA	0.06 to 0.12 + 0.25 to 0.38 (0.12 to 0.25 pt Banvel or 0.25 to 0.5 pt SGF + 0.5 to 0.75 pt of 4 lb/gal MCPA)		2- through 4-leaf stage.	Use low dicamba rate and high MCPA rate on 4-leaf HRSW.

MCPA amine or MCPA ester	0.25 to 0.66 (0.5 to 1.33 pt of 4 lb/gal conc.)	Broadleaf weeds.	Emergence until prior to boot.	Apply 0.25 to 0.5 lb/A from emergence to tiller stage. Use 0.5 lb/A for volunteer sunflower and kochia. Use high rate for large or perennial weeds.
2,4-D amine or 2,4-D ester	0.25 to 0.5 (0.5 to 1 pt of 4 lb/gal conc.)		5-leaf until prior to boot.	Do not apply from early boot to dough stage. Do not apply in fall.
Ally (metsulfuron) + 2,4-D (or MCPA)	1/267 + 0.25 to 0.38 (0.1 oz + 0.5 to 0.75 pt of 4 lb/gal conc.)	Most broad-leaf weeds. Partial control of wild buckwheat	Crop: Not prior to the 2-leaf stage. Also follow crop stage restrictions on label of tank-mix herbicide.	Do not apply within 22 months of last metsulfuron or treatment. See sections on herbicide resistant and rotation restrictions. Apply with a NIS except when adding phenoxy type herbicide at 0.75 pt/A. Do not apply to soils above pH 7.9.
Ally (metsulfuron) + 2,4-D + Dicamba	1/267 + 0.25 + 0.06 to 0.09 (0.1 oz+0.5 pt + 2 to 3 fl oz or 4-6 fl oz SGF)	Broadleaf weed including sulfonylurea resistant kochia and Russian thistle.	Crop: 4- to 5-leaf stage.	

*RUP = Restricted Use Pesticide

Herbicide	Act. Ingred. lb/A (Formulation/A)	Weeds	When to Apply	Remarks
Harmony Extra (thifensulfuron + tribenuron) + 2,4-D (or MCPA)	1/107 to 1/53 + 1/213 to 1/107 + 0.25 to 0.38 (0.3 to 0.6 oz + 0.5 to 0.75 pt of 4 lb/gal conc.)	Most broadleaf weeds including wild buckwheat, common cocklebur, common ragweed and lanceleaf sage.	Crop: 2-leaf stage until prior to flag leaf emergence. ALSO follow crop stage restrictions on the label of tank-mix herbicide.	Apply with another broadleaf herbicide. The addition of 2,4-D enhances weed control and crop safety. Apply with a NIS except when adding phenoxy type herbicide at 0.75 pt/A. Do not tank-mix with Hoelon. See section on weed herbicide resistance. No rotational restrictions for the following year.
Harmony Extra (thifensulfuron + tribenuron) + 2,4-D + Dicamba	1/107 + 1/64 + 1/213 to 1/128 + 0.25 + 0.06 to 0.09 (0.3 to 0.5 oz + 0.5 pt + 2 to 3 fl oz or 4 to 6 fl oz SGF)	Broadleaf weeds including sulfonylurea resistant kochia and Russian thistle.	Crop: 4- to 5-leaf stage.	
Express (tribenuron) + 2,4-D (or MCPA)	1/128 to 1/64 + 0.25 to 0.38 (1/6 to 1/3 oz + 0.5 to 0.75 pt of 4 lb/gal conc.)	Most broadleaf weeds. Weak on wild buckwheat.	Crop: 2-leaf stage until prior to flag leaf. ALSO follow crop stage restrictions on label of tank-mix herbicide.	Apply with another broadleaf herbicide. The addition of 2,4-D enhances weed control and crop safety. Apply with a NIS except when adding phenoxy type herbicide at 0.75 pt/A. Do not tank-mix with Hoelon.
Express (tribenuron) + 2,4-D + Dicamba	1/171 + 1/64 + 0.25 to 0.38 + 0.06 to 0.09 (1/8 to 1/3 oz + 2 to 3 fl oz or 4 to 6 fl oz SGF	Broadleaf weeds including sulfonylurea resistant kochia and Russian thistle.	Crop: 4- to 5-leaf stage.	See section on weed herbicide resistance. No rotational restrictions for the following year.
Amber (triasulfuron) + 2,4-D (or MCPA)	0.013 to 0.026 + 0.25 to 0.38 (0.28 or 0.35 oz + 0.5 to 0.75 pt of 4 lb/gal conc.)	Most broadleaf weeds including wild buckwheat.	Crop: 2-leaf through through pre-boot stage. Also follow crop stage restrictions on the label of the tank-mix herbicide.	Apply with another broadleaf herbicide. The addition of 2,4-D enhances weed control and crop safety. Apply with a NIS except when adding phenoxy type herbicide at 0.75 pt/A. Do not tank-mix with Hoelon. See section on weed herbicide resistance. No rotational restrictions for the following year.
Amber (triasulfuron) + 2,4-D + Dicamba				

Herbicide	Act. Ingred. lb/A (Formulation/A)	Weeds	When to Apply	Remarks
Curtail (clopyralid + 2,4D)	0.09 + 0.5 (2 pt)	Canada thistle and other broadleaf weeds.	Crop: 4-leaf stage through jointing.	Do not rotate to any other crop except small grains, grass, corn, or sugarbeets within one year of application.
Stampede EDF propanil + MCPA iso-octyl ester	1 to 1.13 + 0.25 (1.25 to 1.4 lb + 0.5 pt)	Foxtail and some annual broadleaf weeds including wild buckwheat.	HRSW: 2-5 lf Foxtail: 1-3 lf Broadleaf weeds: 1-4 lf.	Petroleum oil must be added at 1 pt/A. Do not apply when soil applied systemic insecticide was used at planting. Fields with Maneb/Lindane seed dressings may be treated. Malathion or pyrethroids may be used 14 days before or after application.
Hoelon (diclofop) RUP*	0.75 to 1.0 (2 to 2.7 pt)	Wild oats and foxtails.	Grass weeds: 1 to 4 leaves. Crop: up to 4-leaf stage.	Use higher rate for dry conditions or grass weeds with 3 to 4 leaves. Oil adjuvant enhances weed control under dry conditions. Only mix with bromoxynil or bromoxynil plus 1.5 fl oz/A of MCPA ester.
Hoelon (diclofop) + Bromoxynil RUP*	0.75 to 1.0 + 0.25 to 0.375 (2 to 2.7 pt + 1.0 to 1.5 pt)	Wild oats, foxtails and broadleaf weeds.	Grass weeds: 2 to 3 leaves. Broadleaf weeds: Small.	Use the higher rate for dry conditions. Oil adjuvant at 1 to 2 pt/A may increase weed control but also increases risk of crop injury.
Hoelon (diclofop) + Bromoxynil + MCPA ester RUP*	1.0 + 0.25 to 0.38 + 0.05 (2.7 pt + 1.0 pt to 1.5 pt + 1.5 fl oz)		Grass weeds: 1 to 3 leaves. Broadleaf weeds: Small.	
Avenge (difenzoquat)	0.62 to 1 (2.5 to 4 pt)	Wild oats.	Crop: Prior to flag leaf emergence. Wild oats: 3- to 5-leaf stage.	Use high rate on 3-leaf wild oats. Refer to narrative for herbicide tank-mix options and registered wheat varieties. Injury may occur when crop is under evnironmental stress.

*RUP = Restricted Use Pesticide

Herbicide	Act. Ingred. lb/A (Formulation/A)	Weeds	When to Apply	Remarks
Assert (imaza-methabenz)	0.31 to 0.38 (1.0 to 1.2 pt)	Wild oats, wild mustard, and winter annual mustards.	Crop: 2-leaf to jointing. Wild oats: 1- to 4-leaf stage.	See narrative for rotational restrictions. Do not tank-mix with propanil plus MCPA, dicamba, picloram, or amine formulations of 2,4-D or MCPA. See label for addition of adjuvants.
Dakota (fenoxaprop-P + MCPA) **Hard Red Spring Wheat Only RUP***	0.029 to 0.039 + 0.36 to 0.47 (16 to 21.3 fl oz, 1 to 1.33 pt)	Green foxtail, foxtail millets and several broadleaf weeds.	Crop: 3-leaf to end of tillering. Grass: 2-leaf to 2-tiller. Broadleaf weeds: Up to 4 inches.	Do not apply to wheat after jointing begins. Tank mixing with Banvel at 2 fl oz or SGF at 4 fl oz increases kochia and Russian thistle control. Refer to narrative for tank-mix information.
Tiller (fenoxy-aprop-P + 2,4-D + MCPA) **Hard Red Spring Wheat Only**	0.047 to 0.08 + 0.073 to 0.12 + 0.22 to 0.37 (1 to 1.7 pt)	Foxtails, millet, wild oats, barnyardgrass and several broadleaf weeds.	Crop: 3- to 4-leaf stage to end of tillering. Grass: 2-leaf to 2-tiller. Broadleaf weeds: Up to 4 inches.	Do not apply to wheat after jointing begins. Tank-mixing with some broadleaf herbicides will reduce yellow foxtail and wild oat control. Refer to narrative for additional rates with specific weeds.
Cheyenne (fenoxaprop-P + MCPA + Thifensul-furon + Tribenuron) **Hard Red Spring Wheat Only**	0.082 + 0.38 + 0.014 (1.4 pt + 0.3 oz of X-tra)	Green foxtail, foxtail millets, wild proso millet, wild oats, and most broadleaf weeds.	Crop: 3-leaf stage to end of tillering. Wild oats: 1- to 4-leaf stage. Green foxtail: 2-leaf to 2-tiller. Broadleaf weeds: Less than 4 inches tall or in diameter.	Do not apply to wheat after jointing begins. Contents of each container must be tank-mixed to insure crop safety and weed control.

*RUP = Restricted Use Pesticide

DISEASE CONTROL OF HARD RED SPRING WHEAT

Seedling Diseases, Seed Treatment - Shriveled, low test weight, diseased, or weathered seed is benefited by seed treatment through protection from soil-borne fungi or seed-borne fungi. Cold, moist soils slow the growth of seedlings, and favor growth of certain disease organisms. Seed treatment stops these organisms from causing decay, rot, and blight. Different fungicides may be used for different purposes. Select the fungicide correctly for the job to be done (See Fungicide Tables). Some are a combination of fungicide and insecticide. Always avoid over-application with seed treatment products.

Loose smut - Loose smut of wheat can be controlled with seed treatment fungicides containing carboxin, difenoconazole, or triadimenol (See Fungicide Tables). All currently grown wheat varieties are susceptible to loose smut, but it generally is not a severe problem in most wheat or durum cultivars. The embryo test to detect loose smut in barley seed can't be used to accurately determine loose smut in wheat seed. Suspected seed lots should be treated.

Root rots - Common root rot is a potential problem on wheat every year in North Dakota. Damage often is more severe under heat and moisture stress. Root rot shows as a seedling blight or as mature plant root and crown rot, with brown discoloration of the roots and crown. Heads on diseased plants have fewer seeds and shriveled seeds. Some plants turn white and die prematurely. The fungus that causes common root rot of wheat (and barley) survives in the soil and crop debris. Crop rotation

away from wheat and barley, to crops such as flax, sugarbeets, corn, or beans, as well as fallow, helps reduce the disease. Difenconazole, imazalil and triadimenol fungicides are registered for use as seed treatments to suppress common root rot.

Take-all is another serious root rot and it can completely destroy a crop. It is recognized by a black shiny discoloration of the base of the plant. Take-all is found primarily in fields of continuous wheat cropping and very high soil moisture. When take-all occurs in a field, no wheat or barley should be grown in that field for at least 3 seasons. Oats is a good rotation crop, being much less susceptible to take-all. Difenconazole and triadimenol seed treatments are registered for suppression of take-all of wheat.

Rusts - Stem and leaf rust fungi attack hard red spring and durum wheat. However, many varieties are resistant to both stem and leaf rust (See variety lists). Spores of the rust fungi overwinter in southern states and then are carried to North Dakota by winds. New races of rust appear periodically making rust research and the release of new varieties necessary. Leaf rust can be controlled with fungicide sprays (See Fungicide Tables) when susceptible varieties are grown. Use of fungicides may be economic if yield potentials are 45-50 bu/A or more, and the price received for the wheat is $3.00 or greater.

Leaf diseases - Fungi, such as the tan spot organism, and several bacteria cause leaf diseases. If enough leaf area is killed, especially the flag leaf, grain fill and seed set are reduced. The results are lower test weights and poorer yields (yield losses from 10%-40% possible). Leaf disease-causing fungi and bacteria survive in infected cereal debris and trash, in grassy weeds, and sometimes in seed. Most of these disease organisms require long periods of dew or high humidities for infection to occur. The **tan spot** fungus produces tiny, black fruiting bodies on wheat residue from which spores are wind blown to leaves, from early May to September. Other leaf diseases that may occur include **Septoria leaf blotch**, **spot blotch**, and **powdery mildew**.

Chemical control (See Fungicide Tables) of fungal leaf spots is possible and practical under certain conditions – high yield potential, disease organisms present, and if humid weather persists. Crop rotation with a non-cereal crop reduces the risk of leaf spot diseases. Burying crop residue and fallow also help reduce disease; this can be done in the spring before planting, so stubble and straw can catch winter snow.

Wheat streak mosaic - Severe yield losses due to wheat streak occur some years on spring wheat and durum. Some late planted durum fields suffered severe yield losses in 1988. The wheat streak virus is carried by the tiny, wind-blown, wheat curl mite. The mite lives and reproduces on wheat and many other grass hosts. It survives the winter on seeded and volunteer winter wheat and on some perennial grasses.

Control wheat streak in spring wheat and durum by preventing its development in nearby winter wheat – destroy all volunteer wheat in the winter wheat field to be planted and in all nearby fields at least 2 weeks before planting. Control these volunteers plus grassy weeds with cultivation or knock-down herbicides. Avoid planting winter wheat near green corn fields which also are reservoirs of the mite and the virus. Winter wheat should not be planted too early, preferably not before September 15. Planting earlier dramatically increases the danger of wheat streak infection and also root rot, which decreases winter survival. In the spring, destroy any volunteer winter wheat still standing or any obviously infected winter wheat crop, or they will be sources of infection for nearby spring wheats. Spring wheat and durum should be planted early to avoid severe infection.

Scab - A *Fusarium* fungus causes scab when extended periods of humid, rainy weather occurs at flowering and during grain-fill. Parts or all of the heads become infected and infected areas have a bleached or white appearance. Scabby kernels or glumes often show a salmon-pink color at their base. Scab severely reduces yields and test weight. Scabby seed may contain fungal toxins. Among livestock, swine are the most susceptible to the scab toxins. The Veterinary Diagnostic Laboratory can test scabby grain for toxins. A fee is charged.

Reduce scab with crop rotation, allowing at least a one year break in small grains, corn, or grass. The severest scab often occurs in wheat that has been planted on last year's corn ground. Spring tillage to bury crop residues also helps reduce scab potential. Varieties vary in susceptibility to scab. Scabby grain should not be used for seed. If seeding scabby grain is unavoidable, treat with a seed treatment fungicide such as carboxin plus thiram, or maneb plus imazalil to minimize seedling blight due to the scab fungus.

Glume blotch - The glume blotch fungus, *Septoria nodorum*, has been endemic in wheat leaves in North Dakota, causing slight to moderate damage. In 1986 glume blotch was confirmed for the first time in North Dakota on wheat glumes, primarily in the northeast, and primarily on durum. This fungus, and other species of

Septoria, have contributed to low yields and low test weights in recent years throughout the state. The glume blotch fungus survives on wheat residue. Infection of glumes is favored by wet, warm weather following heading. The disease is managed by crop rotation and tillage practices. Foliar fungicides (See Fungicide Tables) help protect against leaf infection and have been shown to reduce glume infection in research done in southern states.

Note: *The fungicide tables for disease control of wheat are based on the latest information available from the North Dakota Agricultural Experiment Station, United States Department of Agriculture, Environmental Protection Agency (EPA) and the agricultural chemical industry. The information conformed to federal and state regulations at the time of printing. Always follow label directions, making certain to check instructions on how to apply, when to apply, waiting periods prior to harvest, whether treated crops can be fed to livestock, and important safety precautions. Check NDSU Extension Circular PP-622 "Field Crop Fungicide Guide" for further information.*

SEED TREATMENT

Chemical	Dosage (Formulations/ bu or cwt)	Disease Control[1] Loose Smut	Seedling Blights	Common Root Rot	Remarks
Benomyl					
Benlate	1-2 oz/bu	G-E	-	No	To be used in conjunction with a standard seed protectant.
Captan + Thiabendazole					
Agrosol Flowable	1.5 fl oz/bu	No	G-E	No	
Carboxin					
Vitavax 34	2-3 fl oz/cwt	E	(G)	No	
Carboxin + Captan					
Nu-Gro Captan 20 Carboxin 20	4 oz/cwt	E	E	No	
Seed Mate Captan - Vitavax 20-20	4 oz/cwt	E	E	No	
Enhance	4 oz/cwt	E	E	No	
Carboxin + Maneb					
DB-Green + Vitavax	2 oz/bu	E	E	No	DB Green + Vitavax and Enhance Plus contain 18.75% lindane insecticide.
Enhance Plus	2 oz/bu	E	E	No	

[1] P = Poor; F = Fair; G = Good; E = Excellent; N = No control; () = Not registered for the disease; - = No Data.

Chemical	Dosage (Formulations/ bu or cwt)	Disease Control[1] Loose Smut	Seedling Blights	Common Root Rot	Remarks
Carboxin + Thiram					
Vitaflo 280	5 oz/cwt	E	E	No	
Vitavax 200 Flowable	3-4 fl oz/cwt	E	(E)	No	
RTU-Vitavax-Thiram	5-6.8 fl oz/cwt	E	(E)	No	
Vitavax-Thiram-Lindane	5 fl oz/cwt	E	(E)	No	Vitavax-Thiram-Lindane contains 8 % lindane insecticide
Carboxin + Imazalil + Thiabendazole					Also controls seed borne Septoria nodorum. Do not graze or feed livestock on treated acres for six weeks after planting.
Vitavax Extra	3 fl oz/cwt	E	E	G-E	
Difenconazole					
Dividend	0.25 fl oz/cwt Common bunt, loose smut 0.50 fl oz/cwt Seed-borne Septoria, loose smut, general seed rots, Fusarium seed scab, partial control of common root rot 1.0 fl oz/cwt Suppression of take-all	E	E	P-G	For commercial seed treaters only.
Imazalil					Registered for suppression of common root rot of wheat and barley. May be used with other fungicides. if used in combination with seed treatment products that contain lindane, treated seed should be planted as soon as possible. Do not graze or feed livestock on treated acres for six weeks after planting.
Agsco Double R	0.5-0.8 fl oz/bu	No	G	G-E	
Flo-Pro IMZ Flowable	0.25-0.5 fl oz/cwt	No	G	G-E	
Nuzone 10 ME	0.8-1.5 fl oz/cwt	No	G	G-E	
Mancozeb					
Clean Crop Mancozeb 80WP	1.3-2 oz/bu	No	G-E	No	
Clean Crop Mancozeb 4L	2.2 fl oz/bu	No	G-E	No	
Dithane M-45	1.3-2 oz/bu	No	G-E	No	
Grain Guard	1.3-2 oz/bu	No	G-E	No	
Manzate 200 DF	1.3-2 oz/bu	No	G-E	No	
Maneb					
Agsco DB Green, or		No	G-E	No	All combined with 18.75% lindane for wireworm control.
Granol NM, or	2 oz/bu	No	G-E	No	
Trinox, or Seed	(1.5 oz/bu Trinox)	No	G-E	No	
Mate Maneb-Lindane		No	G-E	No	
Agsco DB-Green L	3 fl oz/bu	No	G-E	No	Contains 8.6% lindane insecticide.

[1] P = Poor; F = Fair; G = Good; E = Excellent; N = No control; () = Not registered for the disease; - = No Data.

Chemical	Dosage (Formulations/ bu or cwt)	Disease Control[1] Loose Smut	Seedling Blights	Common Root Rot	Remarks
Maneb + Thiabendazole					
Granox Plus	1 oz/bu	-	G-E	No	
Metalaxyl + PCNB + Carboxin					For protection against smuts, Pythium and Rhizoctonia seedling disease complex.
Prevail	3 oz/bu	E	E	No	
PCNB (Terraclor)					
Terra-Coat LT-2N	2 fl oz/bu	No	G-E	No	
RTU-PCNB	3 fl oz/cwt	No	G-E	No	
Thiram					
42-S Thiram	2 fl oz/bu	No	G-E	No	
Thiram 50WP	3.3 oz/cwt	No	G-E	No	
Thiram + Thiabendazole					
Agrosol T	6.6 fl oz/cwt	No	G-E	No	
Triadimenol Baytan 30F	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, common root rot, 1.5 fl oz/cwt for early season foliar diseases	E	G-E	(G-E)	For use only through commercial seed treaters. Green forage may be grazed 40 days after seeding. Baytan 30 treated seed should not be planted at depths greater than 1 1/2". Baytan 30 cannot be used in combination with any seed treatment insecticide such as Lindane.

[1] P = Poor; F = Fair; G = Good; E = Excellent; N = No control; () = Not registered for the disease; - = No Data.

FOLIAR SPRAYS

Chemical	Dosage (Formula- tions/A)	Disease Control[1] Leaf[2] Spots	Leaf Rust	Stem Rust	Powdery Mildew	Remarks
Benomyl						Also registered for Septoria leaf and glume blotch of wheat when used in a tank mix with Bayleton or Manzate 200. Apply at boot stage and 14 days later. Do not apply within 21 days of harvest. Also labeled for fungigation.
Benlate WP	0.25-0.5 lb/A	-	-	-	G	
Copper						Spray in early boot, when flag leaf emerged (Feekes 10). Second application 7-10 days later. Use 5 gal. water with airplane.
Champion WP	1.5-2 lb/A	F-G	(G)	-	No	
Champ Flowable	2-2.66 pt/A	F-G	(G)	-	No	
Champ Formula 2	1-1.33 pt/A	F-G	(G)	-	No	
Kocide 101	1.5-2 lb/A	F-G	(G)	-	No	
Kocide 606	2-2.66 pt/A	F-G	(G)	-	No	
Kocide DF	1.5-2 lb/A	F-G	(G)	-	No	
Kocide LF	1.33-2.66 pt/A	F-G	(G)	-	No	

[1] P = Poor; F = Fair; G = Good; E = Excellent; - = No Data; ( ) = Not registered specifically for this disease; N = No control.
[2] Leaf spots include tan spot, Septoria leaf blotches and spot blotch.

Chemical	Dosage (Formula-tions/A)	Disease Control[1]: Leaf[2] Spots	Leaf Rust	Stem Rust	Powdery Mildew	Remarks
Mancozeb						Do not make more than 3 applications of mancozeb; do not apply mancozeb within 26 days of harvest.
Clean Crop Mancozeb 80WP	2 lb/A	G-E	E	(G-E)	(No)	Do not graze livestock in mancozeb treated acres prior to harvest.
Clean Crop Mancozeb 4L	1.7 qt/A	G-E	(E)	(G-E)	(No)	
Dithane DF	2 lb/A	G-E	E	(G-E)	(No)	Also labeled for fungigation.
Dithane F-45	1.6 qt/A	G-E	E	(G-E)	(No)	
Dithane M-45	2 lb/A	G-E	E	(G-E)	(No)	
Manzate 200 DF	1-2 lb/A	G-E	E	(G-E)	(No)	1 lb rate of Manzate 200 DF is covered by Section 2 (ee) label in N.D. and Minn.
Penncozeb	1-2 lb/A	G-E	E	(G-E)	(No)	
Penncozeb DF	1-2 lb/A	G-E	E	(G-E)	(No)	
Propiconazole						
Tilt 3.6E	4 fl oz/A	G-E	E	G-E	E	Apply at start of flag leaf emergence (Feeke's growth stage 8). Apply only once. Do not apply after heads have emerged. Do not graze or feed livestock treated forage or harvest treated crop for hay or silage After harvest, straw may be used for bedding or feed.
Triadimefon						
Bayleton	2-6 oz/A, powdery mildew 4-8 oz/A, rusts, Septoria leaf blotch	P	E	E	E	1-2 applications; do not apply over 16 oz/A; do not apply within 21 days of harvest. Registered for Septoria leaf blotch. If leaf blotch is severe it is recommended that Bayleton be tank mixed with another registered fungicide with good activity against this disease.
Sulfur						
Sulfur DF	6-15 lb/A	-	-	-	G	Do not apply when temperatures are high (above 90 F). For powdery mildew only.
Thiolux	6 lb/A	-	(G)	-	G	

[1] P = Poor; F = Fair; G = Good; E = Excellent; - = No Data; ( ) = Not registered specifically for this disease; N = No control.
[2] Leaf spots include tan spot, Septoria leaf blotches and spot blotch.

INSECT CONTROL

NOTICE: This section contains information on the control of common wheat insects occurring in North Dakota. Due to space limitations the reader will not find information on the prevention and control of stored grain insects. Interested individuals seeking this kind of material are referred to extension publication EB-45 (revised), "Insect Pest Management For Farm Stored Grain," available from local county extension offices.

Note: Insecticides showing an asterisk (*) have been classified by the EPA as a restricted use pesticide.

Pest	Insecticide	Dosage (Actual Toxicant)	Remarks
APHIDS (Greenbug, Corn Leaf, English Grain Aphid and others)	Cygon 400 Dimethoate 400	0.25 - 0.5 lb per acre	Do not apply within 14 days of grazing immature plants. Do not harvest grain within 35 days (Cygon 400) or 60 days (Dimethoate 400) of last application. Do not make more than two applications per season. Do not enter treated fields without protective clothing until sprays have dried.
	Di-Syston*	0.5 - 1 lb per acre	Aerial application only. Do not apply within 30 days of grain harvest. Use lower rate on plants up to tillering and higher rate after tillering.
	Ethyl parathion*	4 oz per acre	Aerial application only. Do not apply within 15 days of harvest. Do not enter treated fields within 3 days after application. Fields must be posted.
	Malathion EC	1 lb per acre	Do not apply within 7 days of harvest on wheat, oats, rye and barley. Do not apply below 60°F.
	Methomyl* (Lannate)	0.225 - 0.45	Do not harvest within 7 days or feed treated forage within 10 days of applications. Do not enter treated field within 24 hours after application.
	Methyl parathion EC*	0.5 lb per acre	Aerial application only. Do not use within 15 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
	Penncap-M*	0.5 - 0.75 lb per acre	Do not apply within 15 days of harvest or grazing. To avoid injury to bees, do not apply during pollen shed if bees are visiting the areas to be treated during the foraging hours. Do not enter treated fields within 48 hours after application. Fields must be posted.

Pest	Insecticide	Dosage (Actual Toxicant)	Remarks

Aphid Thresholds For Small Grains: Grain aphid research in recent years has revealed that previously utilized economic threshold levels have probably been too high. It now appears that economic threshold levels for grain prior to heading need to be lowered. Therefore, the following economic thresholds levels have been tentatively set and will be used until such time that more definitive research might indicate a ned for further revision.

Aphid Species

English Grain, Bird Cherry-oat, Green bug, and Corn Leaf .... **12-15/tiller - seedling to boot stage**

Russian Wheat Aphid .... **15-20% of tillers infested up to flowering; 20+% of tillers infested from flowering to early milk. (NOTE: A tiller is considered infested whether it has one or several Russian wheat aphids present.)**

Pest	Insecticide	Dosage (Actual Toxicant)	Remarks
ARMYWORMS	Carbaryl (Sevin)	1 - 1.5 lb per acre	Do not apply within 21 days of harvest. Do not make more than two applications after the boot stage.
	Ethyl parathion*	0.5 lb per acre	Aerial application only. Do not apply within 15 days of harvest. Do not enter treated fields within 3 days after application. Fields must be posted.
	Methomyl (Lannate)*	0.25 - 0.5 lb per acre	Do not harvest within 7 days or feed treated forage within 10 days of application. Do not enter treated fields within 24 hours of application.
	Malathion	1.25 lb per acre	Do not harvest for 7 days.
	Methyl parathion*	0.5 lb per acre	Aerial application only. Do not apply within 15 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
	Penncap-M*	0.5 - 0.75 lb per acre	Do not apply within 15 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.

NOTE: Treat when 4 to 5 worms or more per square foot are present in small grains. Most infestations are likely to appear in lodged grain, especially barley. Infestations may also appear in rye, oats, wheat and grassy roadsides or field margins.

CUTWORMS In western North Dakota, the pale western and the army cutworms are important pests of small grains. Eggs of pale western hatch in the spring and larvae feed underground. Eggs of the army cutworm hatch in the fall and spring feeding is above ground. Treatment is recommended when cutworms number 4 to 5 per square foot. There are no registered insecticides currently available for control of these pests in wheat. If economic infestations are found, contact your extension representative so emergency clearance of insecticide may be pursued.

Pest	Insecticide	Dosage (Actual Toxicant)	Remarks
GRASSHOPPERS	Dimethoate (Cygon 400, Dimethoate 400)	0.38 lb per acre	Do not apply within 14 days of grazing immature plants. Do not harvest wheat within 35 days of last application. Do not make more than two applications per season. Do not enter treated fields without protective clothing until sprays have dried.
	Ethyl parathion*	0.5 lb per acre	Aerial application only. Do not apply within 15 days of harvest. Do not enter treated fields within 3 days after application. Fields must be posted.
	Furadan 4F*	0.125 - 0.25 lb	*****Do not make more than two applications at 0.125 lb or one application at 0.25 lb per season. Do not apply within 21 days of harvest.*** Use a minimum of 10 gallons of finished spray per acre with ground equipment and two gallons per acre with aerial equipment. Do not feed treated forage to livestock. Do not apply in proximity of waterfowl nesting or feeding areas. **Allowable under North Dakota state label #860002 issued 06/23/89.
	Malathion EC	1.5 lb per acre	Wait 7 days before harvest of grain. No time limitation on grazing or straw for dairy or slaughter animals.
	Malathion (ULV) (95% Concentrate)	8 fl oz per acre	Commercial aerial applicators only. Do not harvest for 7 days.
	Methyl parathion*	0.5 lb per acre	Aerial application only. Do not apply within 15 days of harvest. Do not enter treated fields within 48 hours after application. Fields must be posted.
	Penncap-M*	0.5 - 0.75 lb per acre	Do not apply within 15 days of harvest. Aerial application only. Do not enter treated fields within 48 hours after application. Fields must be posted.
	Carbaryl (Sevin)	0.5 - 1.5 lb per acre	Do not apply within 21 days of grain harvest. Do not apply more than two applications after the boot stage. No limitations on forage. The lower rate (0.5 lb) is suggested for nymphs on small plants or sparse vegetation. The higher rate is suggested for mature grasshoppers or when material is applied to crops requiring greater coverage.

NOTE: Control may be necessary when grasshoppers exceed 8 per square yard in the field or 20 per square yard in the margin. Control may or may not be necessary depending upon the amount of plant injury or stage of crop development.

Pest	Insecticide	Dosage (Actual Toxicant)	Remarks
GRASSHOPPERS (Wheat field border treatment)	Thimet 20G*	1.2 oz/1,000 ft of row for any row spacing (minimum 8 inch spacing) at planting	Apply at planting time in seed furrow with granual applicator or grass seeder attachment. Do not graze or feed foliage within 45 days of treatment.
HESSIAN FLY	Currently, there are two semi-dwarf hard red spring wheat varieties that have resistance to Hessian fly. They are Guard and Shield, both of which were developed and released by South Dakota State University. While Shield generally yields better than Guard, it is reported to be prone to shattering. Plowing under wheat stubble in the fall and keeping down volunteer wheat growth helps. Crop rotation also aids in suppression. Thimet (as suggested previously for grasshoppers) is registered as a planting time treatment in wheat for Hessian fly, however, population levels in North Dakota rarely warrant such a treatment.		
ORANGE WHEAT BLOSSOM MIDGE	Growers usually discover wheat midge infestations when checking kernel development and moisture levels in late July to early August. They find the small orange maggot(s) feeding on the surface of the kernel. This insect is an economic concern in northeast Saskatchewan. In North Dakota it can be found in northern counties, but rarely at levels high enough to cause concern. Following wet seasons in 1992 and 1993, the 1994 infestations were greater than normal.		
	Examine wheat heads at dusk. The orange colored midge can be seen laying eggs on the wheat heads. Plants are susceptible as the head emerges from the boot. If more than 1 midge is observed for every 4 or 5 heads, treatment may be warranted. Currently, this insect does not appear on any federally approved insecticide.		
WHEAT STEM MAGGOT	No chemical control recommended. In most years, a very small percentage of the stems will be infested. Heads of infested plants usually turn white and they can be easily pulled out. Crop rotation and destruction of volunteer grain and infested straw is helpful.		
WHEAT STEM SAWFLY	No chemical control recommended. Early fall tillage (shallow), crop rotation, early swathing or planting will help reduce crop losses. Seven sawfly resistant varieties of hard red spring wheat are available for planting in sawfly areas. They include Cutless, Fortuna, Glenman, Lancer, Leader, Lew and Tioga. Quality, yield potential, disease resistance and other characteristics vary among these varieties. Consider these factors before selection.		
WIREWORMS	Currently the only insecticide registered for wireworm control that will provide effective suppression is lindane. This insecticide can be purchased as a dry automatic drill box treatment in combination with fungicide (Maneb or Captan) and is also available in liquid (flowable) formulation to be applied alone or with fungicides such as Vitavax, Captan or Thiram.		

Caution: Do not use treated seed for feed or food purposes. Prevent the contamination of commercial grain by thoroughly cleaning bins, grain augers and trucks that have been used to store, handle and/or home treat seed.

GRAIN HARVESTING

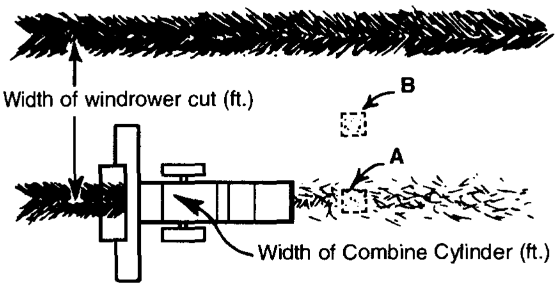
Harvesting is one of the most important farming operations. Grain loss at harvest is a direct loss of income. Harvesting often is a compromise of getting the job done in a reasonable period of time and living with a reasonable seed loss. Studies have shown that losses can run as high as 20 percent, even with a properly adjusted machine when it is overloaded. A reasonable loss is considered to be 3 percent of the total crop or less. Total harvest losses are seldom, if ever, zero.

Usually over 60 percent of the grain left in the field is due to shattering of the crop before harvest and grain loss in getting it cut and into the combine header. Once the crop is in the combine, loss is very low with properly adjusted and operated equipment.

To keep harvest loss low, an operator must determine how much grain is being left in the field. A simple, accurate method to estimate losses requires the use of a one-foot square frame. Pick several typical areas in the field after the combine has passed and follow these steps.

1. Count the kernels left directly behind the rear of the combine. Count several separate square foot areas (A).
2. Count the kernels already in the field due to shatter and cutter bar (B).
3. Subtract (B) from (A).
4. Divide the results of Step 3 by the ratio:

$$\frac{\text{Width of windrower or header cut (ft)}}{\text{Width of combine cylinder (ft)}}$$



5. Divide the result of Step 4 by the number of kernels for the particular crop for one bushel per acre loss (Table). This is the approximate machinery loss in bushels per acre.

TABLE. Number of kernels per square foot to equal one bushel per acre loss.

Hard Red Spring Wheat	20	Oats	10
Durum	16	Sunflower	3
Flax	100	Corn	2
Barley	14	Soybeans	4

6. To find total loss, add the count in (B) to the result in Step 4. This gives the total seed count from shatter, cutter bar and machine losses.
7. Divide the total seed count of Step 6 by the number of kernels for the particular crop for one bushel per acre loss (Table). This will give the approximate total loss in bushels per acre.
8. For a percentage loss, divide the loss in Step 7 (loss in bushels per acre) by the total yield (harvest yield

plus loss) in bushels per acre for the field.

$$\frac{\text{Loss}}{\text{Harvest Yield Plus Loss}} \times 100 = \%\ \text{Loss}$$

Example: A 20 foot windrower is used in a wheat field yielding 26 bu/acre, and the combine has a cylinder 4 feet wide.

1. A = kernels per square foot counted directly behind the combine = 59 kernels per square foot.
2. B = kernels per square foot to the side of the windrow. B = 4
3. A - B = 59 - 4 = 55 kernels per square foot.
4. Ratio:

   $$\frac{\text{width of cut (ft)}}{\text{width of cylinder (ft)}} = \frac{20}{4} = 5$$

   Divide 55 by 5 = 11 kernels per square foot.
5. Divide 11 by 20 (Table) = .55 bu/acre = machine loss.
6. Total loss = "B" plus answer in Step 4.
   = 4 + 11
   = 15 kernels/square foot
7. Divide 15 by 20 (Table) = .75 bu/acre = total loss.
8. % total loss = answer in Step 7 divided by harvest yield plus total loss.

   $$\%\ \text{loss} = \frac{\text{loss}}{\text{harvest yield plus loss}} \times 100$$

   $$\%\ \text{loss} = \frac{.75}{26 + .75} \times 100 = 2.8\%$$

SWATHING VERSUS STRAIGHT COMBINING

Grain grading standards are almost surely to become more rigid; cracked or broken kernels will be discounted at market. Improving quality will require harvesting at optimum moisture levels, expert combine operation, natural air/low temperature drying and minimizing rough handling.

Grain at high moisture contents is subject to damage when threshed. Less damage occurs when grain moisture contents are near storage levels, but as standing grain dries in the field, shatter loss increases. Swathing of grain should occur after grain is physiologically mature. Wheat is mature at about 35 percent moisture. Swath grain at 20 to 30 percent moisture. If grain is left to stand at moisture levels under 20 percent, straight combining shows the least amount of loss. Swathing at this stage causes excessive shatter loss.

Straight combining is best done at 15 to 18 percent moisture and the grain dried to safe storage levels. Cylinder speeds should be as slow as possible to reduce damage to grain, but fast enough to thresh the grain out of the heads. Follow combine manufacturers recommendations. In wet grain, slightly faster speeds may be needed to get complete threshing. Reduce cylinder to concave spacing first, then increase cylinder speed as a last resort.

GRAIN DRYING

Natural air/low temperature drying is energy efficient, economical and reduces drying bottle necks. Drying time is normally three to six weeks using airflow rates of 0.75 to 1.0 cubic foot per minute per bushel, cfm/bu. Generally a centrifugal fan, of adequate size, is needed to provide the airflow. The potential for grain spoilage is high until all the grain reaches the proper storage moisture content, so adequate airflow to dry the wheat within its allowable storage time is critical.

A grain kernel contacting air will either lose or gain moisture, depending on its moisture content and the air's temperature and relative humidity. Water moves from an area of high vapor pressure to areas of low vapor pressure. Eventually, the vapor pressure inside the kernel almost equals the air's vapor pressure. When this occurs, the grain has reached the equilibrium moisture content. Higher temperatures and lower relative humidities result in lower equilibrium moisture contents.

Drying temperatures need to be limited, when using a high temperature dryer, to prevent damaging the quality of the wheat. Baking quality diminishes when kernel temperatures approach about 150 degrees for continuous flow dryers and 135 degrees for batch dryers. Since milling quality is affected by a time and temperature relationship, the maximum recommended drying air temperature for drying milling wheat is 150 F for 16 percent moisture content and 130 F for 20 percent wheat.

Equilibrium Moisture Content of Wheat (wet Basis) at Varying Temperatures and Relative Humidities

Grain	Temperature (F)	Relative Humidity (%) 20	40	60	80
		Equilibrium Moisture Content			
Hard Wheat	35	8.6	11.9	14.9	18.3
	50	8.2	11.3	14.2	17.4
	70	7.7	10.7	13.3	16.5
	80	7.5	10.4	13.0	16.0

A moisture variation develops in the kernel when wheat is dried in a high temperature dryer, with the outside being drier than the inside. This moisture variation causes electronic meters to give an erroneously low value, since they are more influenced by the outer surface of the kernel. If the outer surface is wetter than the inside of the kernel the meter reading will be erroneously high.

For more information refer to circular AE-701 "Grain Drying" and EB-35 "Natural Air/Low Temperature Crop Drying."

MANAGING STORED GRAIN

Grain stores best if cool, dry and clean. The maximum recommended moisture content, for storage with aeration, for wheat is 13 percent for long term storage and 14 percent for just over winter. Grain that contains considerable foreign material or broken kernels will be more susceptible to mold and insects. The grain should be cleaned to reduce this hazard or be dried to a moisture content 1 to 2 percentage points lower than clean grain.

Begin aeration to reduce the grain temperature when the average outdoor temperature is about 10 to 15 F cooler than the grain temperature and the grain can be cooled below 70 F. Cool the grain to about 25 to 30 F for winter storage. Insect activity is stopped at temperatures below about 50 degrees, and insects can be killed if grain temperatures are maintained at or below 32 degrees for about two months. Moisture migration will cause a moisture accumulation in the top central part of a bin if about a 20-degree or more temperature difference exists in the stored grain.

It takes about 150 hours to cool grain with an aeration airflow rate of 0.1 CFM/bu. Increasing the airflow rate reduces the aeration time. Make sure the fan runs long enough to cool all the grain. Little if any drying will occur during aeration. Also very little rewetting will occur if the fan is run just long enough to cool the wheat during humid weather. The aeration fan or duct should be covered whenever the fan is not running.

Grain may be warmed in the spring if desired, but should only be warmed to about 40 F for summer storage. Research has not shown that it is better to warm the grain than to leave it at about 30 degrees. Moisture accumulation during summer due to moisture migration typically occurs at depths of two to four feet below the grain surface. The moisture increase will normally be less than one percentage point. Grain should not be aerated during the summer when outside air temperatures exceed 60 F. Warming the wheat to 70 degrees, for example, will add moisture to the grain and put the grain at a temperature conducive to mold growth and insect activity.

Check the stored grain at least every two weeks during the fall and at least monthly during the rest of the storage period. Search for small changes that are indicators of potential problems. Check and record the temperature and moisture content at several locations. Examine samples from several locations for insects. For more information refer to circular AE-791 "Crop Storage Management" and EB-45 "Insect Pest Management for Farm Stored Grain."

PESTICIDE SAFETY RULES

1. Read label carefully before using product.
2. Store chemicals under lock and key.
3. Keep chemicals in original containers.
4. Use chemicals only on crops specified and at correct rate and schedule.
5. Do not eat or smoke while applying pesticides.
6. Wear protective clothing and masks as directed.
7. Wash clothing and skin immediately if chemicals should come in contact with same.
8. Avoid chemical drift from one crop to another.
9. Apply pesticides so that humans, livestock, fish, wildlife, endangered species and water supplies are not contaminated.
10. Keep a record of materials, amounts used and date of application.
11. Dispose of empty containers in such a way that they're no longer hazardous.
12. In case of accidental poisoning, call physician or take patient to a hospital immediately.

For additional copies of this guide
CONTACT

Marcia McMullen - (701)231-7627
North Dakota State University Extension Service
Fargo, North Dakota 58105

Or: Your nearest county office
NDSU Extension Service

NORTH DAKOTA

TOLL-FREE PESTICIDE POISON INFORMATION

1-800-732-2200

1995 CALENDAR

January 1995

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February 1995

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March 1995

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April 1995

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May 1995

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

June 1995

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

July 1995

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August 1995

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

September 1995

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October 1995

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

November 1995

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December 1995

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

A-1050

NDSU Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. Sharon D. Anderson, Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all persons regardless of race, color, national origin, religion, sex, handicap, age, Vietnam era veterans status, or sexual orientation; and are an equal opportunity employer. 5M-1-95