CHAPTER 11

Small Grains

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A diversity of small grains is grown by organic farmers. In 2005, Minnesota organic growers led the nation in rye production and were number two in organic oat production. Acreages for all grains have made modest increases from 2000-2005. Wheat, followed by oat, are the most commonly grown small grains in Minnesota.

Small grain crop profiles

The four main small grain crop species that are grown in Minnesota and the Upper Midwest region include wheat, barley, oat, and rye. Triticale is a man made crop that combines the advantages of wheat and rye and may have potential in organic production systems.

The Grain Inspection, Packer and Stockyard Administration (GIPSA) is the regulatory body in the United States that sets and maintains the classes and grade standards. There are eight basic classes of wheat based on color and kernel characteristics. For barley there are two

STEPHEN AUSMUS, ARS

Figure 11-1. ***Wheat.***

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Figure 11-2. ***Wheat plants and seed.***

classes, feed and malt, and there are single classes for oats, rye and triticale. Within each class there are four, or in the case of wheat, five grades.

The quality parameters used to set the grades do not necessarily predict end-use quality. In recent years, more and more buyers are demanding additional information to predict functional quality better. Examples of these quality requirements are falling number, wet gluten content, and vomitoxin content. This trend is likely to continue with the need for additional information about the functional qualities for the end-user of the crop.

WHEAT

The genus *Triticum* encompasses all of the cultivated wheat species that are grown today. The genus is very broad and contains many species and subspecies, including wild and primitive wheat species that preceded our modern wheat. Based on make-up of the genome of the species, the domesticated wheat species and their wild ancestors can be separated in three groups. In the first group, only einkorn is a cultivated species. Emmer and durum wheat are the crop species in the second group, while spelt and common or bread wheat are the two important crop species in the third group. Each class of the eight wheat classes has its own area of adaptation and end-use characteristics. The three classes of wheat most commonly grown and best adapted to the Midwest are:

Hard Red Spring wheat (HRSW)

HRSW is an important bread wheat that generally has the highest protein content of any class, usually 13 to 14 percent, in addition to good milling and baking characteristics. This spring-seeded wheat is primarily grown in the north central United States including North Dakota, South Dakota, Minnesota and Montana. HRSW comprises just over 20 percent of U.S. wheat exports. Subclasses are based upon the dark, hard and vitreous kernel content and include dark northern spring, northern spring and red spring.

Hard Red Winter wheat(HRWW)

HRWW is an important bread wheat which accounts for almost 40 percent of the U.S. wheat crop and wheat exports. This fall-seeded wheat is produced in the Great Plains, which extend from the Mississippi River west to the Rocky Mountains and from the

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Figure 11-3. ***Six-row and two-row barley and seed.***

Dakotas and Montana south to Texas. HRWW has a moderately high protein content, usually averaging 11 to 12 percent, and good milling and baking characteristics. In Minnesota and eastern South and North Dakota, HRWW is grown on limited acreage because it will not consistently overwinter.

Durum wheat

Durum wheat is the hardest of all wheat classes and provides semolina for spaghetti, macaroni and other pasta products. This spring-seeded wheat is grown primarily in the same northern areas as hard red spring. It is especially adapted to drier growing conditions. Durum comprises nearly five percent of total U.S. wheat exports. Subclasses are hard amber durum, amber durum and durum.

SPELT

Spelt is a hulled subspecies of bread wheat that is thought to be the ancestor of our modern wheat. There are no GIPSA standards for spelt at this time. Spelt can be used as an alternative feed grain to oats and barley and is gaining in popularity as an alternative to bread wheat for human consumption. It contains moderate amounts of gluten and can be used for baking. The nutritional value is close to that of oats. The commercially available spelt varieties all have a winter annual growth habit but are less winter hardy than common HRWW varieties. It is more tolerant of low fertility and wet soils than other wheat types.

BARLEY

Barley can have both a winter and spring growth habit. Spring barley is the most commonly grown in the Upper Midwest. Currently available winter barley varieties have only marginal winter hardiness to survive the winters in the Upper Midwest.

A second characteristic used to differentiate barley varieties is the culm or spike. In two-rowed varieties only the central spikelet is fertile, while in the six-rowed the lateral spikelets are also fertile. Six-row barley varieties are most commonly grown in the Upper Midwest. The two-row barley varieties that are adapted to the Upper Midwest tend to be less disease resistant and earlier maturing than adapted six-rowed varieties. Two-rowed varieties tend to also have lower grain pro-

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Figure 11-4. ***Oat plants and seed.***

tein content, higher test weight, and a higher percent of plump kernels than comparable six-rowed varieties.

A third characteristic that can be used to differentiate barley varieties is hulled versus hulless or naked varieties. Analogous to spelt and common wheat, hulless varieties of barley varieties have no hull or glumes that enclose the grain. Hulled barley can be processed (pearled) to remove the hull and bran.

Barley matures earlier than wheat, is an excellent weed competitor, demands less fertility than wheat, and can produce a high quality forage. Harvested for grain, barley can provide a high quality feed or food with malt being the most important use. Quality standards for malting barley are stringent and require that not only the desired varieties are grown but also that minimum quality standards, including absence of fungal toxins, are met. Producers should ask potential buyers what their needs are.

OAT

Oat can have both a winter and spring growth habit. Spring oat is the most commonly grown in the Upper Midwest. Currently there are no winter oat varieties that have enough winter hardiness to survive the winters in the Upper Midwest. Like hulless barley, there are also hulless varieties of oat. Grain protein content is approximately 12 percent, but increases three or more percentage points in hulless varieties because of the missing hull. The grain is grown mostly used for livestock feed and to a lesser extent for processing for human food. The straw is highly absorbent and desirable source of bedding or can be left in the field to enhance soil organic matter and soil structure. Oat is the most commonly used nurse crop for small-seeded legume establishment and green manure. The early dough stage is the optimum growth stage if oat is to be harvested for as a forage (refer to Chapter 12 – Forages).

RYE

Rye, like the other small grains, can have both a winter and spring growth habit. Winter rye is the most winter hardy of all the small grain species and most commonly grown in the Upper Midwest. It is the only of the four species that is cross pollinating instead of self pollinating. This means that

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Figure 11-5. ***Rye plants and seed.***

rye varieties are not only genetically more diverse than varieties of other small grains (which all are true breeding lines), the crop itself is more susceptible than the other small grain species to the fungal disease ergot (caused by *Claviceps purpurae*). The sclerotia or ergot bodies that ultimately replace the developing kernel in an infection can contaminate the harvested grain and are difficult to separate. Grain containing too much ergot is unfit for feed or food usage as the ergot bodies contain alkaloids that are toxic. Rye can be grazed as forage, used as a cover crop, and provides excellent weed control.

TRITICALE

Triticale is a man-made crop. It is a hybrid of either bread wheat or durum wheat and rye in an attempt to combine the drought resistance and yield of rye with the quality of wheat. The first report of a hybrid of wheat and rye was in 1876. By the 1930s, breeders and geneticists across Europe were working on triticale. After initial problems with sterility of the offspring, breeders were able to produce a stable, fertile progeny and in essence a new species. Triticale can be an excellent substitution for rye or wheat, especially in drought prone areas or areas with poorer fertility.

Table 11-1. Small grain adaptation.

	TOLERANCE TO:							
Small grain	**Heat**	**Drought**	**Wet/Poor drainage**	**Acidity**	**Alkalinity**	**Salinity**	**Weeds**	**Low fertility**	**Winter hardiness**
Spring wheat	Moderate	Moderate	Moderate	>5.0	<8.2	Moderate	Moderate	Low	--
Winter wheat	Moderate	Moderate	Moderate	>5.5	<8.2	Moderate	Moderate	Low	Moderate
Durum wheat	Moderate	Moderate	Moderate	>5.0	<8.2	Moderate	Moderate	Low	--
Spelt	Moderate	Moderate	Moderate	>5.0	?	?	Moderate	Moderate	--
Barley (spring)	Moderate	Moderate	Low	>5.0	<8.2	High	Moderate	Moderate	--
Oat (spring)	Low	Low	Low	>5.0	<8.0	Moderate	Low	Moderate	--
Winter rye	Low	Moderate	Moderate	>5.0	<7.0	High	High	Moderate	High

Table 11-2. Optimum growth temperature ranges for small grain species. *Adapted from Wiersma and Ransom, 2005.*

CROP	MINIMUM	MAXIMUM	OPTIMUM
	---------- Temperature °F ----------		
Wheat	37-39	86-90	75-77
Barley	37-39	82-86	68-70
Oat	37-39	82-86	68-70
Rye	37-39	82-86	65-70
Triticale	37-39	82-86	68-70

Reducing risk: selecting small grains. Choose a small grain species that is adapted to your growing conditions (see Table 11-1) and market needs.

Variety selection

All the small grain species and varieties described above are cool season annuals. Photosynthesis is optimum around 70°F and a maximum around 85°F, depending on the species (Table 11-2).

For this reason, varieties that mature before the heat of summer should be selected. Producers should consult variety trials that evaluate grain yield potential of small grains (Tables 11-3 and 11-4). Although many variety trials are not conducted under organic conditions, these tests still provide useful information to start the process of selecting a variety. See Chapter 9 – “Selection Factors” section for more details on the process of variety selection.

While grain yield is an important criterion in variety selection, grain quality is as important as grain yield if the harvested grain is to be marketed. For all small grains, plant diseases are a major factor affecting yield in conventional and organic systems. Grain quality and disease data for varieties of barley, oat, hard red spring wheat and hard red winter wheat are published in variety trials and are a good starting point for varietal selection (Table 11-5).

Table 11-4. Organic oat variety trial, Polk County, MN in 2003 and 2004. *‘Ebeltoft’ and ‘HiFi’ performed among the top varieties each year. Adapted from Kandel and Porter, 2004 & 2005.*

	2003	2004	Average
	------bushels/acre------		
Morton	112	115	114
HiFi	111	121	116
Youngs	108	111	109
Ebeltoft	107	131	119
Wabasha	97	113	105
Richard	93	114	104
Sequi	92	123	108
Leonard	86	116	101
Hytest *	73	91	82
Buff *	66	72	69

* hull-less variety

Table 11-3. Small grain variety trials in the Upper Midwest.

UNIVERSITY	WEBSITE	SMALL GRAINS INCLUDED
University of Minnesota	*http://www.maes.umn.edu/vartrials/*	Wheat, oat, barley
North Dakota State University	*http://www.ag.ndsu.edu/varietytrials/*	Spring and winter wheat, durum, spelt, oat, barley
South Dakota State University	*http://plantsci.sdstate.edu/varietytrials/*	Spring and winter wheat, oat, barley
University of Wisconsin	*http://soybean.uwex.edu/wheattrials/printable/index.cfm*	Winter wheat, oat, barley
Iowa State University	*http://www.croptesting.iastate.edu/smallgrains/*	Winter wheat, oat, barley
University of Illinois	*http://vt.cropsci.illinois.edu/wheat.html*	Wheat, oat
Michigan State University	*http://www.css.msu.edu/varietytrials/*	Wheat
Ohio State University	*http://www.ag.ohio-state.edu/~perf/index.html*	Wheat

Table 11-5. Organic wheat variety trial, Polk County, MN in 2003, 2004 and 2005.
'Alsen' and 'Oklee' were among the highest yielding varieties. Adapted from Kandel and Porter, 2004, 2005, & 2006.

	2003		2004		2005		AVERAGE	
	Yield (bu/ac)	% protein	Yield (bu/ac)	% protein	Yield (bu/ac)	% protein	Yield (bu/ac)	% protein
Alsen	35	13.7	69	14.3	39	15.5	48	14.5
Oklee	43	13.4	65	14.1	35	15.1	48	14.2
Walworth	44	13.3	35	13.3	34	15.1	38	13.9
Hanna	--	--	61	13.4	32	13.9	47	13.7
Dapps	35	14.1	67	15.6	30	16.0	44	15.2
BacUp	33	15.0	51	15.6	--	--	42	15.3
Glupro	30	16.0	44	16.6	--	--	37	16.3

Reducing risk: variety selection. **Select varieties based on use or markets and growing conditions in your region. Consult results from variety trials to aid in variety selection. Plant several disease-resistant, high-yielding varieties on your farm to spread out risk. When selecting winter grains for planting in Minnesota, choose only the most winter hardy.**

An organic producer from Lac Qui Parle County says that planting small grains following corn can lead to inadequate fertility for the small grain. He believes that if you plant wheat after corn, you should supply nutrients for the wheat with manure or compost.

Quality seed

Profitable grain production begins with planting of high quality seed. Seed quality is determined in terms of germination, test weight, and freedom from seed-borne diseases. It is best to use seed from registered and certified seed classes of known varieties. Certified seed must be sold with an accompanying blue tag that lists the variety name germination, weed seed, and inert matter percentage; seed lot number; and source of production. Certified seed must meet purity requirements and typically contains less than one percent seed of other same crop varieties or other crops.

Reducing risk: seed selection. **Avoid seed sold as VNS (variety not stated) because the seed could be a varietal mixture, an unknown variety, old seed that did not sell well, or a disease-susceptible variety.**

Soil fertility

A consideration of all plant nutrient needs is important for small grains, but N fertility management is especially important in wheat and barley. Excess N fertilization can lead to increased vegetative yield and decreased grain yields, weak stems and lodging, and a grain protein content that is too high for it to be considered suitable for malt in barley. Of the small grains grown in the Upper Midwest, wheat and rye are moderate users of nutrients, while barley and oats use less nutrients in rotations. Generally, compost and manure should not be applied in the same year as oats and barley are grown. Producers should refer to soil testing results for specific fertilizer recommendations for their fields. Soil fertility for organic production is discussed further in Chapter 4 – Soil fertility.

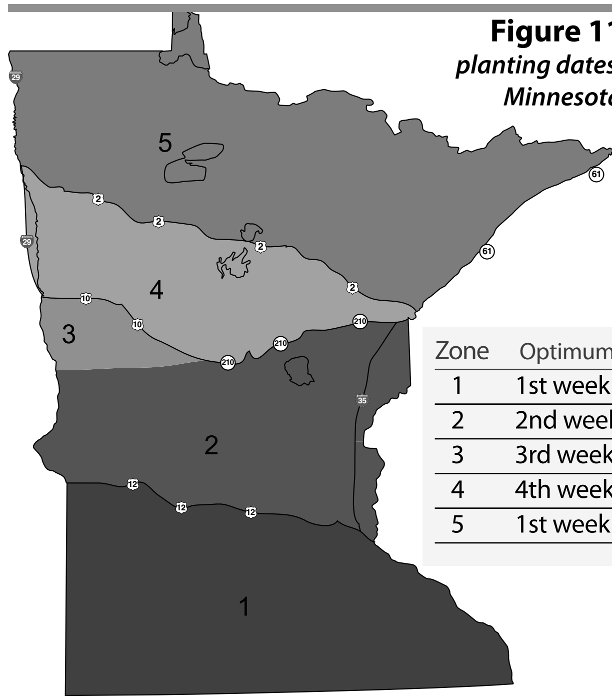


Figure 11-6. *Optimum and latest planting dates for spring small grains in Minnesota. Adapted from Wiersma and Ransom, 2005.*

Zone	Optimum Planting	Last Planting Date
1	1st week of April	1st week of May
2	2nd week of April	2nd week of May
3	3rd week of April	3rd week of May
4	4th week of April	4th week of May
5	1st week of May	1st week of June

Reducing risk: soil fertility. Include legumes in your rotation to supplement nitrogen. Apply organic amendments for small grains only as recommended by soil test results.

Planting

PLANTING DATE

The planting date for small grains will be dependent on whether it is a spring or winter type.

Spring-seeded small grains

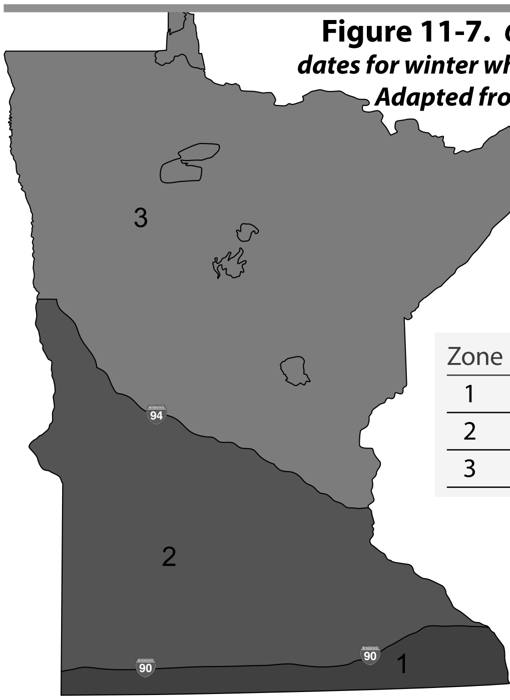
Spring-seeded small grains are summer annuals that include HRSW, spring barley, oat, spring triticale. Spring-seeded small grains should be planted as early as possible to maximize yield (Figure 11-6). Grain yields decrease an estimated percent per day when planting past the optimum planting dates as the odds of heat stress later in the growing season will increase. Unlike corn and soybean where organic producers often use delayed planting as a strategy for weed management, organic small grains are often planted at the same time in early spring as conventional small grains. Yield losses due to delayed planting can partially be offset by increasing the seeding rate about 1 seed per square foot for each week planting is delayed past the optimum planting date.

Fall-seeded small grains

Fall-seeded small grains are winter annuals that include HRWW, spelt, winter barley, winter rye, and winter triticale. Fall-seeded small grains are planted in the late summer and early fall. Establishment is a balance between allowing for adequate growth for the stand to get established and store reserve in the crown that will aid in the winter survival and avoiding the introduction of insect and disease problems that can affect the crop the following growing season. Optimum planting dates for winter wheat are shown in Figure 11-7. The same recommendations can be used for spelt, winter barley, winter triticale or rye. Planting past the optimum window will increase winterkill and likely result in slow spring development and delayed maturity as the vernalization requirements were not met the previous fall. Planting prior to the optimum planting date will create too lush a growth. This not only increases the chances of winter kill but also increases

An organic farmer from Lac Qui Parle County prefers winter wheat over spring wheat. He finds that winter grains seem to promote better soil tilth because he doesn't need to work the soil with spring tillage. He also likes that winter grains have lower protein market demands.

Figure 11-7. ***Optimum planting dates for winter wheat in Minnesota. Adapted from Wiersma, 2009.***



Zone	Date
1	September 20 to October 10
2	September 10 to September 30
3	September 1 to September 15

An organic producer in Pipestone County plants his winter grains by September 15th at the latest.

Reducing risk: planting date. To avoid yield loss, plant spring small grains as early as possible and winter small grains in the late summer or early fall. Planting winter wheat into standing stubble lowers the risk of winter kill substantially compared to planting in a field with little residue because the standing stubble traps and retains snow cover. Snow greatly insulates the crowns from lethal freezing temperatures.

the odds that diseases, such as tan spot in wheat and Barley Yellow Dwarf virus or Wheat Streak Mosaic Virus in wheat, spelt, rye, or triticale, which are transmitted into the young crop by aphids or the wheat curl mite, respectively, can develop.

Legume companion crops

Organic producers often underseed small grains with red clover or alfalfa. Red clover tends to be less competitive with small grains and is more easily terminated, but alfalfa can be used as an acceptable alternative (Tables 11-6 & 11-7). Red clover can be underseeded at six to ten pounds per acre, while alfalfa can be underseeded at eight to ten pounds per acre. Underseeding legumes is an excellent, low-risk way for organic farmers to incorporate green manures into their rotation. See Chapters 4 and 12 for more information on underseeded legumes.

Table 11-6. Organic oat with alfafa underseeding variety trial in Clay County, MN in 2003 and 2004. ***Good yields were obtained when oats were underseeded with alfalfa. Adapted from Kandel and Porter, 2003 & 2004.***

	YIELD (bu/ac)		
Variety	2003	2004	Average
Leonard	138	128	133
Sesqui	136	128	132
Wabasha	124	122	123
HiFi	129	118	123
Ebeltoft	127	112	120
Richard	116	108	112
Youngs	117	104	110
Morton	139	96	118
Hytest	97	90	94

Table 11-7. Organic wheat with alfafa underseeding variety trial in Clay County, MN in 2003, 2004, and 2005. ***Good yields were obtained with wheat underseeded with alfalfa. Adapted from Kandel and Porter, 2003, 2004, & 2005.***

	YIELD (bu/ac)		
Variety	2003	2004	2005
Walworth	60	46	46
Oklee	50	41	43
Dapps	58	40	41
Alsen	53	40	43
Hanna	--	44	38

An organic grower from Cottonwood County says that the organic small grain production is actually very similar to conventional production in his experience. The main difference is organic producers sometimes use a higher seeding rate.

PLANTING RATE

Optimal plant populations are important to maximize grain yields (Table 11-8). Plant populations below optimum can result in increased weed pressure, excess tillering and uneven maturity, and lower grain yield potential; above-optimum populations can result in lack of tillering, weaker stems, and increased risk of lodging. Recommended seeding rates have been established for conventional systems and these also apply to organic farming (Table 11-9).

Additionally, a farmer can calculate planting rates for a particular situation based on the following formula (Figure 11-8). Using this calculation would be especially helpful in situations where a higher than normal planting rate is needed (poor seed vigor, planting beyond the recommended dates, weed suppression, or due to harrowing). Planting rate can also be adjusted when planting is delayed past the optimum planting date. The seeding rate should be increased by about 1 percent per day of delay up to 1.6 million seeds per acre. This will compensate for reduced yields in spring-planted small grains that occur due to reduced spikelet formation and tillering in late plantings.

Reducing risk: planting rate. Calculate and use the optimum planting rate for your crop and circumstances.

One organic producer from Wadena County always plants small grains at an extra 1/2 bushel rate to make up for losses due to harrowing.

Table 11-8. Optimum plant population at harvest. *Adapted from Wiersma and Ransom, 2005.*

CROP	PLANTS PER ACRE	PLANTS PER FT^2
Winter wheat	900,000 to 1,000,000	21 to 23
Spring wheat	1,300,000 to 1,400,000	30 to 32
Durum	1,300,000 to 1,400,000	30 to 32
Barley	1,250,000 to 1,300,000	28 to 30
Oats	1,250,000 to 1,300,000	28 to 30

Table 11-9. Pounds of seed to be planted per acre assuming 15% stand loss and 95% seed germination. *Adapted from Wiersma and Ransom, 2005.*

	DESIRED STAND (TIMES 1 MILLION)							
SEEDS/LB	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
	LBS/ACRE							
10,000	96.8	108.9	121.1	133.2	145.3	157.4	169.5	181.6
11,000	88.0	99.0	110.0	121.1	132.1	143.1	154.1	165.1
12,000	80.7	90.8	100.9	111.0	121.1	131.1	141.2	151.3
13,000	74.5	83.8	93.1	102.4	111.7	121.1	130.4	139.7
14,000	69.2	77.8	86.5	95.1	103.8	112.4	121.1	129.7
15,000	64.6	72.6	80.7	88.8	96.8	104.9	113.0	121.1
16,000	60.5	68.1	75.7	83.2	90.8	98.4	105.9	113.5
17,000	57.0	64.1	71.2	78.6	85.5	92.6	99.7	106.8
18,000	53.8	60.5	67.3	74.0	80.7	87.4	94.2	100.9

Figure 11-8. Formula for calculating seeding rate.
Expected stand loss is 10-20% under good seedbed conditions.

$$\text{Seeding rate (lb/acre)} = \frac{\text{Desired stand (plants/acre)} \div (1 - \text{Expected stand loss})}{\text{(Seeds/lb)} \times \text{(\% Seed germination)}}$$

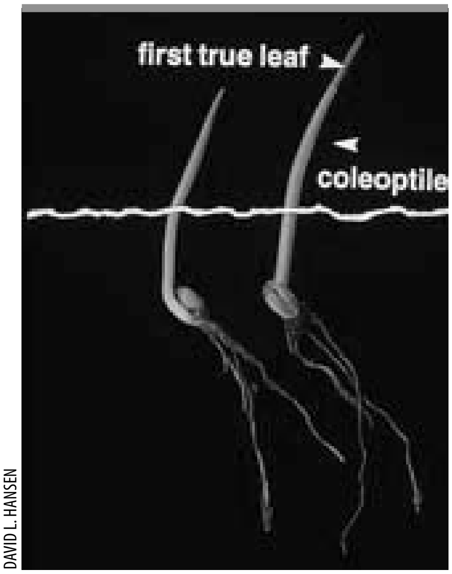


Figure 11-9. ***First true leaf emerging from the coleoptile in wheat. Coleoptile length will vary depending on species and variety.***

Figure 11-10. ***Canada thistle and other weeds growing in oats.***

PLANTING DEPTH

The optimum planting depth for small grains is one and a half to two inches. Seed should be placed deep enough to have access to adequate moisture yet shallow enough to emerge as quickly as possible. Seeds too close to the surface absorb moisture but are at risk of dying because roots cannot reach moisture quickly enough to sustain the germination and seedling growth. Deeper seeding can reduce stand density and plant vigor because the inability of the coleoptile to reach the surface. The maximum coleoptiles lengths differ between varieties within each of the species (Figure 11-9). The average plant height of varieties as reported in the variety trials correlates reasonably well with the length of the coleoptile and can be used guidance to assess the risk of planting too deep. Oat is the most tolerant too planting deep.

Reducing risk: seeding depth. Seeding equipment should be calibrated to deliver seed to the desired depth for a specific seedbed. Prepare an even seedbed to allow uniform planting depth and routinely check the depth of the seeding as conditions vary.

Weed management

Crop rotation is a key component in any weed control strategy (see Chapters 2 and 5). Small grain crops can get infested with a wide variety of weeds. The most troublesome grass weeds in cereals are wild oats, downy brome, jointed goatgrass, foxtail species, and quackgrass. The most troublesome broadleaf weeds are the buckwheat family, wild mustard, kochia, Russian thistle, and Canada thistle. Fall-seeded cereals are better weed competitors than spring-planted cereals with spring barley generally more competitive than HRSW or oat. In addition, there are varietal differences in weed competitiveness of wheat and barley. In general, taller varieties, varieties with higher tillering capacity, and varieties that grow rapidly and mature early, tend to suppress weed growth better. Weed suppression is not the result of any one competitive growth trait but the result of a number of traits. However, in general, planting rate manipulation is a more dependable strategy for reducing weed competition than selecting cultivars that tolerate or suppress weeds.

Organic producers may be tempted to use delayed planting to manage weeds in spring-planted small grains. While early-emerging weed populations (such as wild oats) can be reduced, substantial yield losses will occur, making the practice counterproductive. Overall, a better strategy is to plant early, which allows the small grain crop to compete more successfully with weeds.

Pre-emergence tillage can be used to control weeds that start growing prior to the crop. For spring small grain crops, blind harrowing after germination but before emergence can be performed. If the crop has emerged, post-emergence operations should be delayed until tillering is underway and crown roots are anchoring the young seedling, but prior to jointing as the growing point is more prone to injury. A harrow or rotary hoe can be used at the four- or five-leaf stage, especially if broadleaf annual weeds are problematic.

Weed management can continue after spring-seeded small grain harvest. Post-harvest tillage in the fall can help control of winter annual, biennial and perennial weeds. In addition to killing existing weeds, fall tillage may even encourage germination of some weed seeds that will then winter kill.

See Chapter 6 – Weed Management for more information on weed control.

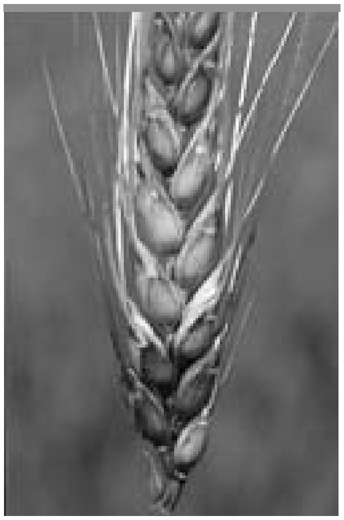
Reducing risk: weed management. Crop rotation, planting rate, and early planting are the main cultural weed control options in organic small grains. Cultivation can be used, but it must be timed early and at the proper growth stage of the small grain. A primary tillage operation prior to seeding in the spring can reduce weed pressures of winter annuals and cool season annual weeds such as wild oats, wild mustard, kochia, and the different pigweed species.

Pest management

There are a number of pests that cause serious problems on small grains in the Midwest. Most of these are managed by crop rotation and resistant varieties (Table 11-10).

There are a few pesticides approved for use in certified organic production systems. However, the cost of these organically-approved pesticides is usually cost prohibitive for field crop production and some of these products have not been proven particularly effective. Organic small grain producers in the Midwest generally rely on cultural methods to deal with insects and diseases.

Diverse crop rotations are extremely important in organic small grain production. Organic producers are not allowed to plant the same crop two years in a row in a field, which in of itself aids in pest management as a two-year break between small grains greatly decreases the risk of foliar and head diseases. At a minimum, wheat and barley should not follow another small grain or corn due to the risk of Fusarium Head Blight. Fusarium spores overwinter on the corn,



ROGER JONES

Figure 11-11. *Fusarium Head Blight on wheat.*

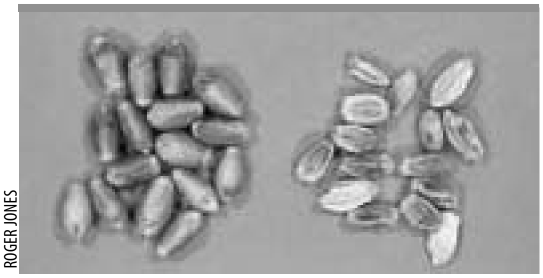


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Figure 11-12. *The wheat seeds on the right are infected with Fusarium Head Blight disease, while the wheat on the left is healthy.*

wheat, or barley residues and can infect the subsequent crop if weather conditions just prior and during anthesis are favorable for the development of the disease (Figures 11-11 and 11-12). Oats are much less susceptible to the same soil or residue borne diseases that affect wheat or barley, but for most of the diseases in wheat or barley, there are other closely-related fungi that will only affect oats.

Cropping sequence data has been developed for MN and ND to assist growers in making good rotation decisions to maximize yield. See Table 11-11 for the best crops to precede small grains in rotations. Refer to Chapter 2 – Rotations for more information of how crop rotations and crop sequence can benefit yield, soil quality, weed pressure, and overall farm success.

Other cultural control methods for pests include choosing resistant small grain varieties or a diversity of varieties. Depending on the pest, stubble management may be a another control option. Fall tillage to reduce crop residue can decrease populations of a pest that overwinters, thus reducing certain pest levels for the next year. Unfortunately, fall tillage also leaves the soil unprotected in the winter.

Table 11-11. *Crops in the first column are recommended to precede small grains in the rotation. Crops in the second column are not recommended to precede small grains. Adapted from Wiersma and Ransom, 2005.*

RECOMMENDED BEFORE SMALL GRAINS IN ROTATION:	NOT RECOMMENDED BEFORE SMALL GRAINS IN ROTATION:
Field pea	Corn
Sunflower	Sudangrass
Alfalfa	Millet
Soybean	Wheat
Flax	Barley
Buckwheat	Oats
Dry bean	Rye

Table 11-10. Diseases and insects that affect organic small grains are primarily controlled by crop rotation and other cultural methods. *Adapted from Wiersma and Ransom, 2005.*

PEST TYPE	PEST NAME	CROP(S) AFFECTED	CONTROL METHOD(S)
Disease	Common root rot	wheat, barley, oat	rotation
	Ergot	Wheat,rye	rotation, tillage
	Bacterial blights	wheat, barley, oat	rotation
	Fusarium head blight	wheat, barley	rotation, resistant varieties
	Tan spot	wheat	rotation, resistant varieties
	Septoria	wheat, barley, oat	rotation, resistant varieties
Insect	Wheat stem maggot	wheat	rotation
	Wheat stem sawfly	wheat	rotation
	Hessian fly	wheat	rotation

Figure 11-13. *An organic producer windrows wheat near Morris, Minnesota.*

Reducing risk: pest management. Utilize rotations and crop sequences that reduce the risk of disease. Check with your certifier before using new pesticides—conditions for use of a pesticide must be documented in the organic system plan. Always use good quality seed and choose resistant varieties whenever possible. Using certified seed ensures that the seed is free or nearly free of a number the economically important seed-borne diseases such as loose smut.

Harvesting

The harvesting process begins once the small grain crop has reached physiological maturity. The most obvious sign of physiological maturity is when the peduncle (the stalk below the spike) loses its green color just below the spike or panicle. Grain moisture is around 35 to 40 percent at this point. Windrowing or swathing can be initiated at that time. If straight combining, grain moisture should be no more than 16% if aeration is not available immediately and no more than 18 percent if aeration and/or drying capacity is available.

When combining, producers should determine how much grain is being left on the field. A simple method is to count the number of seeds per square foot, then consult Table 11-12, which gives an estimate of the number of bushels that are lost. Zero percent harvest losses are unattainable, but well-adjusted combines should be able to limit harvest losses to well under three percent.

The correct moisture at which to store small grains will depend on which crop it is and for how long the grain is to be stored. See Table 11-13 for storage guidelines.

Reducing risk: harvesting. Harvest at the correct moisture level depending on method. Make sure that combine is properly adjusted by gauging harvest losses. Store at the correct moisture for the correct time it will be stored. Monitor stored grain regularly.

Take the following quiz to determine your risk in small grain production.

Table 11-12. Number of kernels per square foot that equals one bushel per acre loss. *For example, finding 20 kernels of oat per square foot indicates the loss of two bushels per acre. Adapted from Wiersma and Ransom, 2005.*

SMALL GRAIN	KERNELS/FT²
Hard red spring wheat	20
Durum	16
Barley	14
Oats	10

Table 11-13. Small grain recommended storage moistures. *Adapted from Wiersma and Ransom, 2005.*

	UP TO 9 MONTHS	OVER 9 MONTHS
Wheat	14.0	13.0
Barley	13.5	12.5
Oat	14.0	12.0
Rye	13.0	12.0