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OAT PRODUCTION IN NORTH DAKOTA

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Oats are a major grain crop in North Dakota with an average of about one million acres seeded annually. Oats produced in North Dakota generally are of high quality with good test weight and protein levels. When proper management practices are followed, oats can be economically competitive with other grains. The cost of production is about the same for oats, wheat and barley. When oats are selling at $1.50 per bushel, 120 bushels per acre of oats will gross $5.00 per acre more than 50 bushels per acre of wheat at $3.50 per bushel and $43.00 per acre more than 65 bushels per acre of barley at $2.10 per bushel.

Oats differ from wheat, barley and rye in some major agronomically important characteristics. Oat seedlings emerge by elongation of the first internode and coleoptile, whereas wheat and barley seedling emerge by coleoptile elongation only. This place the growing point of the oat seedling closer to the soil surface in early stages of development. Like barley, but unlike wheat, the oat lemma and palea make up the hull and adhere to the caryopsis (groat). Therefore, the oat kernel consists of the hull and groat except in a few varieties of hulless or naked oats. Another important difference is that oats have an open panicle type inflorescence (head) rather than the spike type found in wheat and barley. The kernel color of most oat varieties grown in North Dakota will be various shades of yellow or white. Oats with red kernels are not common.

Seedbed preparation

Seedbeds for oats should be prepared by methods acceptable for other small grains. The seedbed should be relatively firm and free of clods and weed growth. The use of a drag harrow behind the primary tillage implement will firm the seedbed. Excessive tillage will contribute to loss of moisture from the seedbed and should be avoided. Oats have also been successfully grown as a no-till crop. The use of a suitable no-till drill or seeder is recommended.

Seeding date

Oats are well adapted to cool seedbeds and can be seeded as early as any crop. Delay of seeding beyond the earliest possible date will reduce yields and quality in most regions of the state (Table 1).

Oat yields are often depressed by as much as 0.4 bushel per day by seeding later than the optimum dates. Optimum dates will vary by regions within the state but generally would be late April for southern regions and early to mid-May in the northern regions.

Table 1. Oat yields and days required in 1974 to reach various growth stages at six planting dates, Langdon, North Dakota.

Variety	Date seeded	Days from emergence to headed	Days from emergence to mature	T.W.T. 1974 lb/bu	Avg. Yield 1973-74 bu/A
Kelsey	4-17	54.0	106	39.11a	68.8
	4-24	50.5	102	35.12a	62.9
	5-01	44.5	99	36.15a	59.3
	5-08	37.0	93	40.51a	59.4
	5-16	34.5	95	28.46b	51.0
	6-05	35.5	98	25.72b	47.6

Seeding depth

Oats should be seeded at a depth of 1½ to 2½ inches. Seeding at depths in excess of 3 inches may reduce stand and yield.

Seeding rate

The recommended seeding rates for oats in North Dakota are 50 to 70 pounds of pure live seed per acre. Adjust seeding rates upward to compensate for low germination or poor seedbed conditions.

Seed and variety selection

One of the keys to high oat yields is the use of high quality seed of a recommended variety. There are wide differences between the yields of the various oat varieties available. Also, most current varieties are best adapted to specific regions of the state. To guarantee the identity of the variety and to avoid planting substantial amounts of weed seed such as wild oat or buckwheat, the use of certified seed is recommended.

Characteristics of varieties currently available are listed in Table 2. Otana, Kelsey, Moore, and Fidler have been the leading varieties grown the past several years. Yields of Otana have been very good in the western two-thirds of North Dakota, but it lacks adequate straw strength and crown and stem rust resistance for conditions in the Red River Valley. Kelsey has a good yield record and has good drought tolerance but lacks disease resistance and straw strength and is low in grain protein content. Moore is well adapted to eastern regions of the state and has a relatively strong straw. Fidler has resistance to the

Table 2. Oat variety descriptions.

Varieties listed in order of maturity	Origin	Year released	Color grain	Height	Straw Strength	Maturity[2]	Resistance to stem rust races[1]	Crown rust	Rel. yield	Bu. Wt.	Protein[3]
Kelly	SD	1984	white	m.tall	strong	E	S	MR	good	v.good	MH
Lancer	SD	1979	tan	short	strong	E	S	MS	good	good	H
Preston	MN	1982	tan	short	strong	E	S	MR	good	good	H
Noble	IN	1973	yellow	short	v.strg.	E	S	S	good	good	M
Ogle	IL	1981	yellow	short	strong	M	S	S	good	fair	L
Kota	SD	1969	yellow	m.tall	m.strg.	M	S	MS	v.good	v.good	M
Lyon	MN	1976	white	m.tall	m.strg.	M	S	MR	good	good	M
Steele	ND	1984	white	tall	strong	M	R	VR	v.good	good	M
Benson	MN	1979	white	med.	m.strg.	M	S	MR	good	good	M
Kelsey	Canada	1967	white	m.tall	m.strg.	L	S	MR	v.good	good	VL
Cayuse	NY	1966	yellow	short	strong	L	S	MS	v.good	fair	VL
Moore	MN	1979	white	tall	strong	L	S	MR	v.good	good	M
Rodney	Canada	1953	white	tall	m.strg.	L	S	MS	good	good	L
Harmon	Canada	1965	white	tall	m.strg.	L	S	S	good	good	L
Otana	Montana	1977	white	m.tall	m.weak	L	S	S	v.good	v.good	ML
Centennial	WI	1983	yellow	m.tall	strong	L	S	R	good	v.good	MH
Marathon	WI	1979	tan	med.	strong	L	S	R	good	good	H
Dal	WI	1972	tan	med.	good	L	S	MR	fair	good	H
Menominee	MI	1977	white	med.	m.strg.	L	S	S	v.good	good	M
Dumont	Canada	1982	white	m.tall	m.weak	L	R	VR	v.good	good	ML
Border	WY	1982	white	short	strong	L	S	S	good	fair	L
Pierce	ND	1983	tan	m.tall	m.strg.	L	S	R	good	v.good	H
Porter	IN	1982	tan	med.	strong	L	S	MR	v.good	v.good	M
Fidler	Canada	1980	white	med.	strong	L	R	R	good	fair	L
Hudson	Canada	1974	white	med.	strong	L	MR	MR	v.good	fair	L
Terra	Canada	1977	naked	med.	m.strg.	L	S	S	good	v.good	L

[1]Stem rust races most prevalent now. S = susceptible, M = moderately, R = resistant.

[2]E = early, M = medium, L = late.

[3]H = high, M = medium, L = low, V = very.

prevalent races of both crown and stem rust but has not performed well in the southern half of North Dakota. Two new varieties that show promise for some regions of the state are Steele and Pierce. Steele is well adapted to the east central regions and his resistance to both crown and stem rust and has strong straw. Pierce is a late-maturing variety with good yield potential and adequate protein and test weight. Oat variety recommendations for each region of the state are updated annually and are available in Circular A-574 from local county agent offices.

Fertilization of oats

Oats respond well to good soil fertility. Nitrogen and phosphorus are the plant nutrients most often deficient. Fertilizer recommendations for oats (Table 3) are based on soil test results. Drill row applications of non-urea nitrogen plus potash should not exceed 30 pounds per acre or 15 pounds per acre of nitrogen plus potash if urea nitrogen is applied. Excessive nitrogen applications (Table 3) may increase lodging and should be avoided. However, adequate nitrogen is needed to obtain high yields and maintain good protein levels.

Oat rotations

Oats in rotation with other crops will usually yield more than oats grown on oat ground. Oats are considered to be a good rotation crop because they are resistant to many of the leaf diseases which affect wheat and barley. Oat stubble fields are excellent sites to seed no-till winter wheat. Oats are resistant to scab and are therefore the most suitable small grain crop to seed after corn.

Highest oat yields are obtained when seeded after row crops such as soybeans, dry beans and potatoes. Oats are sensitive to dinitroaniline and other types of herbicides, so the herbicide used on the previous crop should always be known prior to seeding oats.

Weed control

Oats are more competitive with annual weeds than other small grains. Fields with excessive wild oat infestations should be avoided. Wild oats present should be destroyed by tillage or the use of the knockdown

Table 3. Nitrogen, phosphate, and potash recommendations for oats.

Yield Goal	Broadcast Recommendations								
		Phosphorus P Soil Test Levels (lb/A)				Potassium K Soil Test Levels (lb/A)			
Oats	Soil N Plus Fertilizer N Needed*	L 0-9	M 10-19	H 20-29	VH Over 30	L 0-99	M 100-199	H 200-299	VH Over 300
bu/acre	lb/acre-2'	---------P_2O_5 lb/acre---------				----------K_2O lb/acre----------			
30	40	15	10	0	0	45	30	0	0
40	50	15	10	0	0	55	35	0	0
50	65	20	15	0	0	60	40	0	0
60	80	20	15	0	0	65	45	0	0
70	95	30	20	0	0	75	50	0	0
80	110	30	20	0	0	85	55	0	0
90	120	35	25	15	0	95	65	20	0
100	140	35	25	15	0	105	70	25	0
110	155	45	30	20	0	120	80	30	0
120	170	45	30	20	0	130	85	35	0
130	190	50	35	25	0	145	95	40	0

*Subtract amount of NO_3-N in top 2 feet of soil from these figures to determine the amount of N fertilizer to apply. These figures are for soil samples taken between September 1 and April 1.

herbicide such as glyphosate prior to planting. No postemergent wild oat herbicides are available for use on oats. Wild oats are best controlled by rotating with another crop which permits the use of wild oat herbicides. Weed control recommendations for oats are listed in Table 4. Revised and updated weed control recommendations for North Dakota are published annually in Circular W-253 available at local county agent offices.

Disease control

Oats are subject to a large number of diseases which can cause severe damage to quality and substantial yield losses. One of the major goals of oat breeding programs has been to develop varieties resistant to the more serious diseases. Prior to availability of resistant varieties, North Dakota farmers were all too familiar with the red and black "dusts" at oat harvest time, which resulted from the rust diseases.

Crown rust. Crown rust (leaf rust) generally is the most widespread and destructive disease of oats in North Dakota. Crown rust results in reduced yields, lower test weight and increased lodging. The disease is caused by a fungus, *Puccinia coronata*, whose spores generally blow in during the summer months from oat-producing regions farther south. The fungus produces masses of yellow-orange spores on the green oat leaves and these spores spread from diseased plants to healthy plants via wind. A black spore stage also is found on the oat leaves, appearing late in the season as a black or dark brown ring around the yellow-orange spores.

Stem rust. Serious stem rust problems occur less frequently than crown rust, but stem rust has the potential to be very serious if oats are planted late and spores from the south are abundant. Damage to the oat crop is primarily through reduced yields, lower bushel weight and lodging.

Stem rust is caused by the fungus *Puccinia graminis* f. sp. *avenae*. The major source of infection is from spores blown up in summer winds from southern grown oats. The spores infect the stem and leaf sheaths and blades, and when the spores break through the plant's epidermis, a red-rust colored mass of spores is visible. Stem rust and crown rust are distinguished fairly easily on the basis of spore color. Stem rust spores are more brick-red, while crown rust spores are a bright yellow-orange. The red-rust colored spores of stem rust also are carried from diseased plants to heathy plants via wind. These spores are replaced with a mass of black spores later in the season.

Control of crown rust and stem rust is best accomplished by growing resistant varieties. Current

Table 4. Weed control in oats.

Herbicide	(Formulation/A)*	Weeds	When to apply	Remarks
Glyphosate (Roundup)	0.19 to 0.75 (0.5 pt to 1 qt)	Emerged annual grasses and broadleaf weeds	Preplant or anytime prior to crop emergence	A nonselective, translocated, postemergence herbicide. No soil residual activity. Apply with a nonionic surfactant.
MCPA amine or MCPA ester	0.25 to 0.5 (0.5 to 1 pt of 4 lb/gal conc.)	Broadleaf weeds	Oats - emergence to boot	Early jointing stage most susceptible. Possible injury to oats at any growth stage. Use 0.5 lb/A for volunteer sunflower.
Bromoxynil (ME4 Brominal, Buctril)	0.25 to 0.38 (0.5 to 0.75 pt) (1 to 1.5 pt)	Wild buckwheat, volunteer sunflower, and most broadleaf weeds	Crop - emergence until just prior to boot	Apply when weeds are in early seedling stage for best results. Weak on wild mustard.
Bromoxynil (ME4 Brominal, Buctril) + MCPA ester	0.25 + 0.25 (0.5 ME4 or 1 pt Buctril plus 0.5 pt of 4 lb/gal MCPA)	Wild buckwheat, volunteer sunflower and most broadleaf weeds	Oats - 3rd leaf to boot stage	Apply when weeds are in early seedling stage for best results. Commercial mixtures (3 + 3 Brominal & Bronate) are available. Volunteer sunflower control better than 0.5 lb/A of 2,4-D.
Chlorsulfuron (Glean)	1/128 to 1/43 (1/6 to 1/2 oz)	Most broadleaf weeds and suppression of foxtails	Crop in 2 to 3-leaf stage and prior to boot. Weeds - small, less than 2" or 2" in diameter	Apply with surfactant WK or X-77 at 0.25% v/v. See narrative for rotational restrictions. Do not apply on soils above pH 7.5.
Picloram (Tordon 22K) + MCPA amine	1/64 to 1/43 + 0.25 to 0.37 (1 to 1.5 fl. oz. + 0.5 to 0.75 pt of 4 lb/gal conc.)	Wild buckwheat and most broadleaf weeds	Oats - 3rd through 5th leaf stage	Use only on land to be planted the following year to grass, small grains, corn, sorghum or flax. Picloram is a restricted use herbicide.
Dicamba (Banvel, Banvel II) + MCPA amine	0.06 to 0.12 + 0.25 to 0.38 (0.12 to 0.25 pt 4S or 0.24 to 0.5 pt 2S + 0.5 to 0.75 pt of 4 lb/gal MCPA).	Wild buckwheat and most broadleaf weeds	Oats - 2nd through 4th leaf stage	Commercial mixture is available. (Mondak, 1.25 lb dicamba + 2.5 lb/MCPA). Use less dicamba and more MCPA on larger oats.

*Formulation values are given for the most commonly used products and not included for most mixtures because of inadequate space. Weed control recommendations are revised and updated on an annual basis so always read label carefully prior to application.

varieties resistant to each disease are identified in Table 2. Susceptible varieties should be planted early to reduce the risk of severe rust infections. The protectant fungicide Mancozeb (Dithane M-45) is registered for control of both crown and stem rust, but its use often is not cost effective unless the yield potential and crop value are high. To control crown rust, fungicide applications should be made to protect the flag leaf; apply the first application when the boot begins to swell and again in 7-10 days later. Stem rust infection usually occurs at the same time as crown rust, so both diseases can be controlled by the same fungicide applications.

Barley Yellow Dwarf. Barley yellow dwarf has the potential to be a destructive disease of oats in North Dakota. It is a virus-caused disease and is often called

oat "red leaf" disease because of the reddish brown discoloration seen on the infected leaves. The disease is caused by the barley yellow dwarf virus, the same virus that causes the barley yellow dwarf disease on barley. The virus is transmitted from plant to plant by several species of aphids. These aphids acquire the virus when feeding on infected plants in the southern half of the USA, and then those aphids are carried to northern oat fields in winds and by storm fronts. The disease potential greatly depends on the northward movement of these aphids from southern fields.

Barley yellow dwarf-infected plants normally are first seen along edges of fields. The leaves turn a yellow-red to reddish brown. The entire leaf blade may prematurely die. The plants generally are stunted and heads of infected plants often are severely blasted and seed is low in test weight. Control is accomplished by growing tolerant or resistant varieties; Ogle and Porter have some tolerance. Screening for barley yellow dwarf resistance is an important part of the current North Dakota State Oat Breeding program.

Other Potentially Economic Diseases

Oat smuts - Smuts of oats have not been serious problems in North Dakota, but loose smut has reached economic levels in Wisconsin and Minnesota. As with loose smut of barley, this disease can be controlled with carboxin seed treatment. Seed treatment of registered and certified seed is recommended.

Oat Blue Dwarf - Oat blue dwarf is a virus disease generally occurs in trace amounts in oats and it can occur in other grass hosts, including barley. Oat infected with blue dwarf are severaly stunted, have a dark bluish-green color and spikelets are blasted. No control measures are currently available.

Fungal Leaf Spots - *Helminthosporium* and *Septoria* species cause fungal leaf spots on oats. These leaf spots have not been serious problem in North Dakota. They would be expected to be most serious where oats have been planted on oat stubble and if moist, rainy weather persists. Mancozeb fungicide, Dithane M-45, is registered for control of these leaf spots on oats.

Blast of Oats - Blast of oats occurs when the spikelets don't develop completely and sterility results. Virus diseases such as barley yellow dwarf and oat blue dwarf may cause blast. More frequently, blast is due to excessively high temperatures and moisture stresses occurring at the time of panicle differentiation and pollination. Early planting reduces the likelihood of blast while late seeding and overplanting favor the occurrence of blast.

Harvesting oats for grain

To avoid losses from shattering, oats usually are windrowed (swathed) and threshed by a combine with a pick-up attachment. Swathing of oats should commence when the head (panicle) has turned yellow or brown even though some stems may still show green color. Oats are ready for harvest when kernels reach the hard dough stage and have lost all green color.

Marketing and Utilization

Farmers seeding oats should carefully consider the ultimate market. Three major uses for oats grown in North Dakota are as seed, grain and forage. Each final use requires different production practices, from variety selection to harvest method.

There is as always a demand for good quality oat seed, especially certified seed. North Dakota and other regional farmers usually are searching for seed of new, improved varieties and there is a limited demand for certified North Dakota oat seed for winter forage production in California and Arizona.

Three primary uses of oat grain grown in North Dakota are as: components of local livestock rations for sheep, hogs, dairy and beef; horse rations including recreational, ranchhorse and racehorse; and direct human consumption.

Whole oat protein, groat percentage and test weight are primary considerations for local livestockmen and relative values of common varieties are listed in Table 5.

Table 5. Mean test weight, groat percentage, and whole oat protein percentage from 1982-84 ND locations.

Variety	Test Weight[1] (lb/bu)	Groat[2] Percentage	Whole Oat[3] Protein Percentage
Steele	35.2	72.5	15.1
Moore	36.2	72.4	14.1
Kelsey	34.6	72.6	12.6
Otana	34.5	71.6	13.6
Dumont[4]	35.4	72.0	13.0
Pierce	36.6	72.4	15.1
Fidler	33.6	71.2	13.5
Porter	35.8	70.8	14.3
Marathon	34.5	70.0	14.7

[1]Mean of 15 location years.

[2]Mean of 10 location years.

[3]Mean of 6 location years.

[4]Dumont data from 1983 and 1984 only.

Purchasers of racehorse oats are looking primarily at kernel plumpness, test weight, and the brightness of the kernel. White bright kernels are preferred by racehorse buyers and protein levels usually are not a major consideration. Buyers of milling oats are looking for a high groat percentage with a good test weight. Oats are being produced for several markets, but the major use of oats in North Dakota is as a home grown, locally fed livestock feed.

In situations where homegrown oats are fed on the farm, high protein types such as Benson, Lancer, Pierce, Dal, or Marathon with good test weights may offer some economic advantages, but for general market purposes, high yield and test weight are the primary economic considerations.

Oats are grown more frequently than other small grains for use as a forage crop. Oats grown for forage should be harvested at the milk stage for hay and at the milk to soft dough stage for silage. Medium to late maturing oat varieties have usually produced the highest forage yield and the most total digestible energy per acre. Oats are often planted as a companion crop for underseeding with grass, alfalfa and sweetclover. Early harvesting of the oat crop for hay or silage will permit the more rapid development of the underseeded crop and helps prevent stand losses of the underseeded legume due to dry soil conditions.

Oats seeded as land cover in late July will provide good cover and also can provide for grazing after about September 1. Oats are superior to other spring seeded small grains for grazing purposes. Oats should be seeded at least 30 days prior to grazing. Oats seed zone moisture is rapidly depleted in July and seeding date should be based primarily on availability of seed-zone moisture. Spring seeded oats also can be used for grazing in June and early July.

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