The Changing Pattern of Winter Wheat Production in North Dakota

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Historically, winter wheat production in North Dakota has been located in the southwestern corner of the state because of winter injury risk in other parts of the state. Also, planting small grains into summerfallow is an established practice in this region because of benefits associated with additional stored water. Winter wheat survival was shown to be greater when seed placement was in furrows rather than with surface drilling (Agronomists and Cereal Chemists of North Dakota State Univ., 1969; Alessi and Power, 1971). The furrows trapped snow, providing protection from cold temperatures and supplying water from snow melt during thaws. Seeding into stubble was not recommended during the early years of winter wheat production in North Dakota because of increased risk associated with planting into dry surface soil (Sarvis and Thysell, 1936).

Winter Wheat Production Trends

The popularity of hard red winter (HRW) wheat has increased dramatically in the Northern Great Plains of the U.S. and the Canadian Prairies during the last three years. Saskatchewan records over 1,000,000 acres of winter wheat seeded in the fall of 1984. Two hundred thousand acres of winter wheat were planted in North Dakota in the fall of 1982, 620,000 acres in 1983, and an estimated 750,000 acres in 1984 (Carver et al., 1984) (Fig. 1).

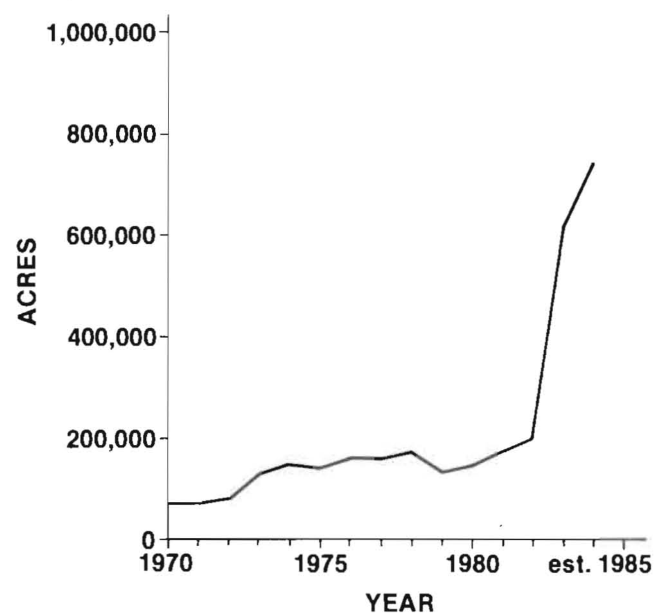

Figure 1. Acres of winter wheat planted in North Dakota, 1970-1984.

Southwestern North Dakota is no longer the predominant production area. Winter wheat has moved eastward with 56 percent of the 1983 production total harvested in the eastern one-third of the state (Fig. 2). Steele, Barnes and Bowman lead all counties in production in 1983. Redistribution of winter wheat production can in part be attributed to improved cultural practices including the adoption of reduced or no-till systems.

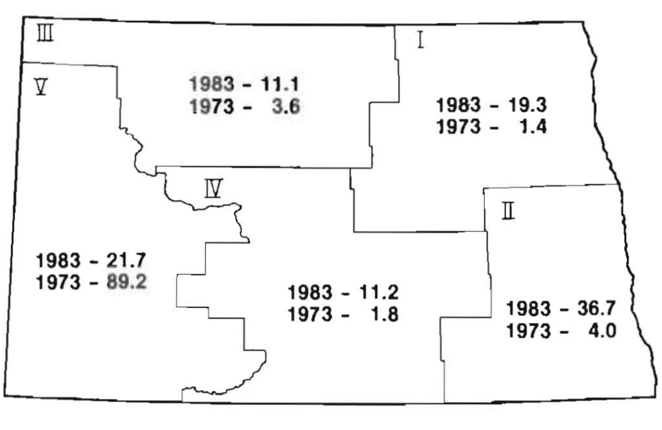

Figure 2. Percentage of total North Dakota winter wheat production harvested from five Soil Conservation Areas during 1983 and 1973.

Central vs. Northern Great Plains Winter Wheats

Grower interest in high-yielding semidwarfs originating in the Central Great Plains states has increased with reports of 80 to in excess of 100 bushels per acre yields in variety trials in those states.

Ten of the most winterhardy and 10 less winterhardy HRW wheat varieties were compared under North

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Dakota growing conditions in a 1984 variety trial (Table 1). Level of winterhardiness of these 20 wheats had been determined in several North Dakota yield trials prior to 1984. The trial was planted at Casselton, Minot and Williston. The winter wheat was sown into bare fallow at Williston and Minot and into flax which was seeded into bare fallow in early August at Casselton. Williston and Casselton exemplify the diverse production environments found in North Dakota. However, in 1984 the precipitation received during the April through July growing season was greatest at Minot followed by Casselton and Williston (8.76, 8.30 and 4.28 inches, respectively). Mean grain yields for the Casselton, Minot and Williston locations were 72.3, 49.4 and 17.2 bushels per acre, respectively.

The trial at Casselton during the winter of 1983-84 received sufficient snow cover for nearly 100 percent survival of all 20 varieties. Little winterkill occurred at Minot, except with the less winterhardy varieties. The 1983-84 winter environment at Williston was ideal for obtaining a differential rating of winter survival; i.e., 5 percent survival for the most non-hardy varieties to 95 percent survival for the most winterhardy. December was very cold with a record setting -50°F temperature recorded at Williston. Roughrider and Norstar, the two most winterhardy winter wheats normally grown in North Dakota, experienced 14 and 11 percent winterkill, respectively, at Williston. Roughrider was grown on 78 percent of the winter wheat acreage in North Dakota in 1984. Norstar was planted on 18 percent of the acreage.

Table 1. Origin of varieties grown in 1984 Hard Red Winter Wheat Variety Trial at Williston, Minot and Casselton.

Less winterhardy		Winterhardy	
Variety	**Origin**	**Variety**	**Origin**
Archer	NAPB	Agassiz	N.Dakota
Bighorn	SeedTec	Froid	Montana
Brule	Nebraska	ND8001	N.Dakota
Centurk 78	Nebraska	ND8002	N.Dakota
Colt	Nebraska	ND78104	N.Dakota
Hawk	NAPB	Norstar	Alberta
Rita	S.Dakota	Roughrider	N.Dakota
Rose	S.Dakota	Sundance	Alberta
Scout 66	Nebraska	Winalta	Alberta
Vona	Colorado	Winoka	S.Dakota

Comparisons between the mean grain yields of the two groups of varieties, the 10 winterhardy and the 10 less winterhardy varieties, provide a tool to evaluate some of the advantages associated with growing both winterhardy and non-winterhardy varieties (Table 2). The 10 most winterhardy varieties yielded more grain than the less winterhardy varieties under conditions (Williston) where winterkill of the non-winterhardy types was so extensive that stand loss could not be compensated for by spring tillering. Conversely, the 10 less winterhardy varieties, as a group, yielded more grain than the 10 winterhardy varieties when little or no winterkill occurred (Casselton). The winterhardy varieties yielded more grain at Minot than the less winterhardy varieties; however, the two groups had similar yields if the less winterhardy varieties which sustained greater than 20 percent winterkill were not included in the calculations. The range of mean grain yields for varieties planted at Minot and Casselton indicated that some winterhardy lines included in the trial yielded as much or more grain than the most recently released less winterhardy varieties. These high-yielding winterhardy types are currently experimental lines being evaluated in the HRW wheat breeding project at North Dakota State University.

Table 2. Grain yield and percentage winter survival for 10 winterhardy and 10 less winterhardy winter wheats grown at three North Dakota locations, 1984 harvest.

Character		Winterhardy	Less winterhardy	LSD 0.05
Yield, bu/A				
Casselton	mean	66.0	78.6	8.0
	range	51.7-89.7	68.5-85.1	
Minot	mean	54.4	44.5	10.1
	range	45.3-61.4	10.9-63.3	
Williston	mean	24.2	10.3	3.2
	range	19.6-27.4	3.0-17.1	
% Survival				
Casselton	mean	92.1	84.0	4.6
	range	88.8-96.3	70.0-88.8	
Minot	mean	100.0	79.6	18.6
	range	100.0	8.0-100.0	
Williston	mean	83.1	23.5	10.2
	range	70.0-97.5	5.0-45.0	

The 10 most winterhardy varieties tended to be later maturing and taller than the 10 less winterhardy varieties at all three locations. The tendency for tall winter wheats to be more susceptible to lodging is exemplified by the Casselton data (Table 3).

Height is influenced by environment as well as genotype. Winter wheats may grow excessively tall in eastern North Dakota during wet years. Therefore, an objective of the HRW wheat breeding program at North Dakota State University is the development of a winterhardy semidwarf or intermediate height wheat for areas where straw is excessive. Short wheats with the level of winterhardiness and yield potential of Roughrider are currently being evaluated.

Changing Tillage Practices

Winter wheat has become viable alternative crop in North Dakota as a result of changing cultural practices which have increased winter survival. Crown formation is affected by both planting date and fall environmental conditions so that winter survival is increased under conditions in which crown formation occurs. Crown formation begins at the 1.5-leaf stage; however, the likelihood of survival of plants reaching the 3- to 4-leaf stages increases as secondary root formation is initiated. The optimum spring stand has been estimated to be approximately 130 plants per square meter or greater (A. Bauer, 1985, personal communication). Data obtained from the Northern Great Plains Research Center at Mandan indicate that stands greater than 130 plants per square meter will not be associated with significantly greater grain yields. When winterkill occurs, significant yield losses may result when the average spring stand count results in less than 40 to 80 plants per square meter and replanting with a spring seeded crop should be considered.

The popularity of no-till seeding winter wheat into standing stubble has increased because stubble traps snow, reducing the chance of winter injury. Larsen et al. (1983) found 5 to 10 percent survival of Roughrider under conventional tillage and 100 percent survival under no-till during a winter (1981-82) when temperatures were below normal and recorded snowfall was 2.5 times greater than average. Snow cover protects the crown beneath the soil surface from subzero temperatures and also may improve the water status for the crop with snow melt. It is recommended at least 6 inches of stubble from no-till, chemical fallow fields or late summer seeded flax be left to trap snow (Ball et al., 1982).

Estimates of no-till acreage in North Dakota have been made since 1980 when there were approximately 10,000 acres of no-till. The Conservation Tillage Information Center (1984) recorded 168,524 acres of no-till in 1983 and estimated an increase to 643,703 acres of no-till in 1984 using data obtained from the Soil Conservation Service. The proportion of winter wheat planted as no-till in 1984 has been estimated to be about 45 percent of the total winter wheat acreage. Surveys of no-till acreage in 1984 were conducted on September 1 by county agents and on November 1 by the Soil Conservation Service. The difference between these two estimates, 350,000 acres, is a rough estimate of no-till winter wheat acreas planted in the fall of 1984. These data point out the shift to a greater use of conservation tillage in conjunction with winter wheat.

Summary and Conclusions

Winter wheat acreage has increased approximately four fold in the last three years. Acreage growth has been accelerated by recognition that winter wheat and no-till management systems are complementary. In most years, winter wheat benefits from its early spring growth, high tillering capacity, and its ability, through early maturity, to escape temperature and moisture stresses that sometimes occur during flowering of spring wheat. Average grain yields for spring and winter wheat grown in North Dakota for the years 1982-84 show a 4.3 bushels per acre yield advantage to winter wheat. Although price received per bushel has been approximately 20-30¢ less for hard red winter wheat, higher yields produced a $9 per acre advantage for winter wheat harvested in 1984 (Carver et al., 1985).

High yields have been derived from winter wheat, especially in the eastern one-third of the state. The shift in production to eastern North Dakota and other high yield environments has been accompanied by an often undesirable increase in plant height. Consequently,

Table 3. Mean grain yield, winter survival and other agronomic traits of 10 winterhardy and 10 less winterhardy winter wheats grown at Casselton, North Dakota, 1984[1].

Hardiness	Grain yield	Winter survival	Height	Lodging intensity[2]	Heading date
	bu/A	%	in.		June
Winterhardy	66.0	92.1	46.1	3.0	14.8
Less-winterhardy	78.6	84.0	38.1	1.2	9.7
LSD 0.05	8.0	4.6	2.5	0.8	1.3

[1] Casselton 1984 was a high yield environment.
[2] 0 = Erect, 5 = Flat.

some North Dakota growers, having noted the high yield potential of semidwarf winter wheats from the Central Great Plains, have seeded them and risked the greater potential for winterkill. Results of a recent unpublished NDSU study indicated tillage selection accounted for eight times more of the variation in winter survival than variety selection. For example, there was a 70 percent difference in the survival of Roughrider under conventional and no-till conditions while there was only a 9 percent difference in survival of Centurk 78 and Roughrider when both were planted into stubble. Snow trapping has significantly increased the likelihood of the survival of winter wheat. However, the minimum snow cover required to ensure winter survival is greater for the less winterhardy varieties.

References

Agronomists and Cereal Chemists of North Dakota State University. 1969. Winter wheat in North Dakota. North Dakota Agric. Exp. Stn. and Ext. Serv. Bull. No. 478. Fargo.

Alessi, J., and J.F. Powers. 1971. Influences of method of seeding and moisture on winter wheat survival and yield. Agron. J. 63:81-83.

Ball, W.S., N. Riveland, C. Eberlein, A. Lamey, and C. Fanning. 1982. Winter wheat production in North Dakota. Coop. Ext. Serv. Ext. Bull. No. 33, North Dakota State Univ., Fargo.

Carver, R.F., W.G. Hamlin, and D.P. Knopf. 1984. Winter wheat and rye seedings. North Dakota Crop and Livestock Reporting Service. Farm Reporter Issue No. 22-84.

Carver, R.F., W.G. Hamlin, and D.P. Knopf. 1985. Total value of North Dakota crops in 1984. North Dakota Crop and Livestock Reporting Service. Farm Reporter Issue No. 1-85.

Conservation Tillage Information Center Annual Report. 1984. Conservation Tillage Information Center, Fort Wayne, IN.

Larsen, J.K., L.J. Brun, and J.W. Enz. 1983. The effect of snow depth on winter wheat survival. Agric. Exp. Stn. Res. Rpt. No. 96, North Dakota State Univ., Fargo.

Sarvis, J.T., and J.C. Thysell. 1936. Crop rotation and tillage experiments at the Northern Great Plains Field Station, Mandan, ND. USDA Tech. Bull. 536.

Continued from page 16

reductions exceed 30 to 35 percent, either no yield increase or a reduction in yield from fertilizer applied with the seed can be expected. Fertilizer rate, fertilizer source and type of spreader will influence yields. This information should give some basic guidelines for applying various fertilizer rates and materials with the seed when using pneumatic seeders. The experimental materials SCU and UUP, are not commercially available but show promise as fertilizer sources for direct application with the seed using pneumatic seeders or other reduce tillage equipment.

SUMMARY:

Plant stand measurements indicate that fertilizer rates, fertilizer source, and degree of spread (spreader type) influence the stand reduction and yield potential when fertilizer is placed with the seed. Placing fertilizer with the seed in a single row or narrow band causes the greatest stand reduction. Conversely, spreading fertilizer and seed over a wide (12-inch) spacing causes least damage. Stand and emergence damage increased progressively as N fertilizer rates (40 pound increments) increased, but the degree of damage varied considerably with fertilizer source and spreader type. Most fertilizer materials showed minimal damage at the 40 pound N per acre rate unless fertilizer and seed were placed in a single row. When fertilizer rates were increased to 80 pound N per acre, stand reduction increased, especially with U, U + DAP and U + MAP. The AN, SCU, and UUP materials showed less damage at the higher N rate, even with single row placement. Stand reduction in relation to fertilizer source followed the sequence U > U + DAP = U + MAP > UUP > AN > SCU for all spreader types. Crop maturity was delayed by fertilizer rates that caused stand loss and increased tillering. Wheat yields were reduced when stand reduction exceeded 35 percent.

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