Winter Wheat Fertilization

---in Northeast Oregon

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Circular of Information 610
October 1961

Agricultural Experiment Station
Oregon State University · Corvallis

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Summary

1. Winter wheat planted on summer fallow land will need 30 to 60 pounds per acre of nitrogen fertilizer. Wheat planted on recropped or irrigated land or where a large quantity of straw has been turned under will require 60 to 90 pounds per acre of nitrogen fertilizer. Five exceptions to these nitrogen recommendations are noted (page 2).

2. Early spring applications of nitrogen have proved more effective in increasing the yield of winter wheat than applications of nitrogen made before wheat planting in the fall.

3. Not all nitrogen effects are beneficial. Nitrogen fertilizer produces a greater increase in straw production than grain production of winter wheat. Nitrogen fertilizer application increases the protein (nitrogen) content of the grain, which may be desirable or undesirable according to the type of grain grown.

4. Most soils in northeast Oregon are able to supply enough phosphorus for maximum yields of winter wheat. For soils needing phosphorus fertilizer, 20 to 40 pounds per acre of available phosphorus will be adequate.

5. The best method and time of fertilizing with phosphorus is to drill the phosphorus fertilizer before or during wheat planting in the fall.

6. For soils needing sulfur, 15 to 25 pounds of sulfur per acre should be applied. Because of the much greater need for nitrogen fertilization of wheat, sulfur deficiency should be suspected from observing deficiency symptoms only after it is known that nitrogen has been applied.

7. Potassium fertilizer has not given a beneficial response on winter wheat in northeast Oregon.

Introduction

Field experiments on winter wheat fertilization were begun in Baker, Union, and Wallowa counties in 1957. Since that time, 47 experiments have been completed in the three-county area. These experiments are summarized in this report and provide a guide for the application of commercial fertilizers on winter wheat in northeast Oregon. The general recommendations were developed jointly by the Eastern Oregon Branch Experiment Station and Oregon State University.

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Lack of nitrogen and moisture usually limit winter wheat production in this area. Field experiments were designed primarily to evaluate the amount and timing of nitrogen fertilization under different moisture conditions. In addition, phosphorus, sulfur, and potassium were included to determine the need for these nutrients.

A simple description of soils, climates, and cultural factors affecting winter wheat production in northeast Oregon is not possible. These factors vary so widely that a single concise fertilizer recommendation would apply to only a small portion of the area. The variation in annual rainfall and its distribution during the year are uncontrollable but have definite influence on fertilizer needs. Where moisture is adequate either from rainfall or irrigation, higher rates of nitrogen can be used. Deep soils are able to hold more water than shallow soils and therefore are able to utilize additional nutrients more effectively.

Previous cropping has a direct bearing on plant nutrients which are available during the crop year. Soil which has been used for growing legumes will have the ability to supply more nitrogen than soil which has been continuously cropped to nonlegumes. The returning of large amounts of straw to the soil often will tie up available nutrients, especially nitrogen.

The native fertility of soil varies widely in northeast Oregon. The history of fertilizer response on a given field often gives a good indication of its fertilizer needs.

Nitrogen

In spite of variations in rainfall, soils, and management, most soils in northeast Oregon require the addition of nitrogen fertilizer for maximum grain yields.

> Wheat planted on summer fallow land will need 30 to 60 pounds per acre of nitrogen fertilizer. Wheat planted on recropped or irrigated land or where a large quantity of straw has been turned under will require 60 to 90 pounds per acre of nitrogen fertilizer.

Five exceptions to these recommendations should be noted:

1. Fields which have been regularly rotated between grains and forage legumes or pasture do not give an increase in yield from nitrogen application. Usually large numbers of livestock are associated with these farms. Farms within Wallowa Valley and the Rock Creek-Muddy Creek communities are examples.

2. Deep, dark colored, alluvial soils which have been well managed and have high native fertility will require less nitrogen fertilizer for maximum wheat yields. Catherine and Wingville soils are examples.

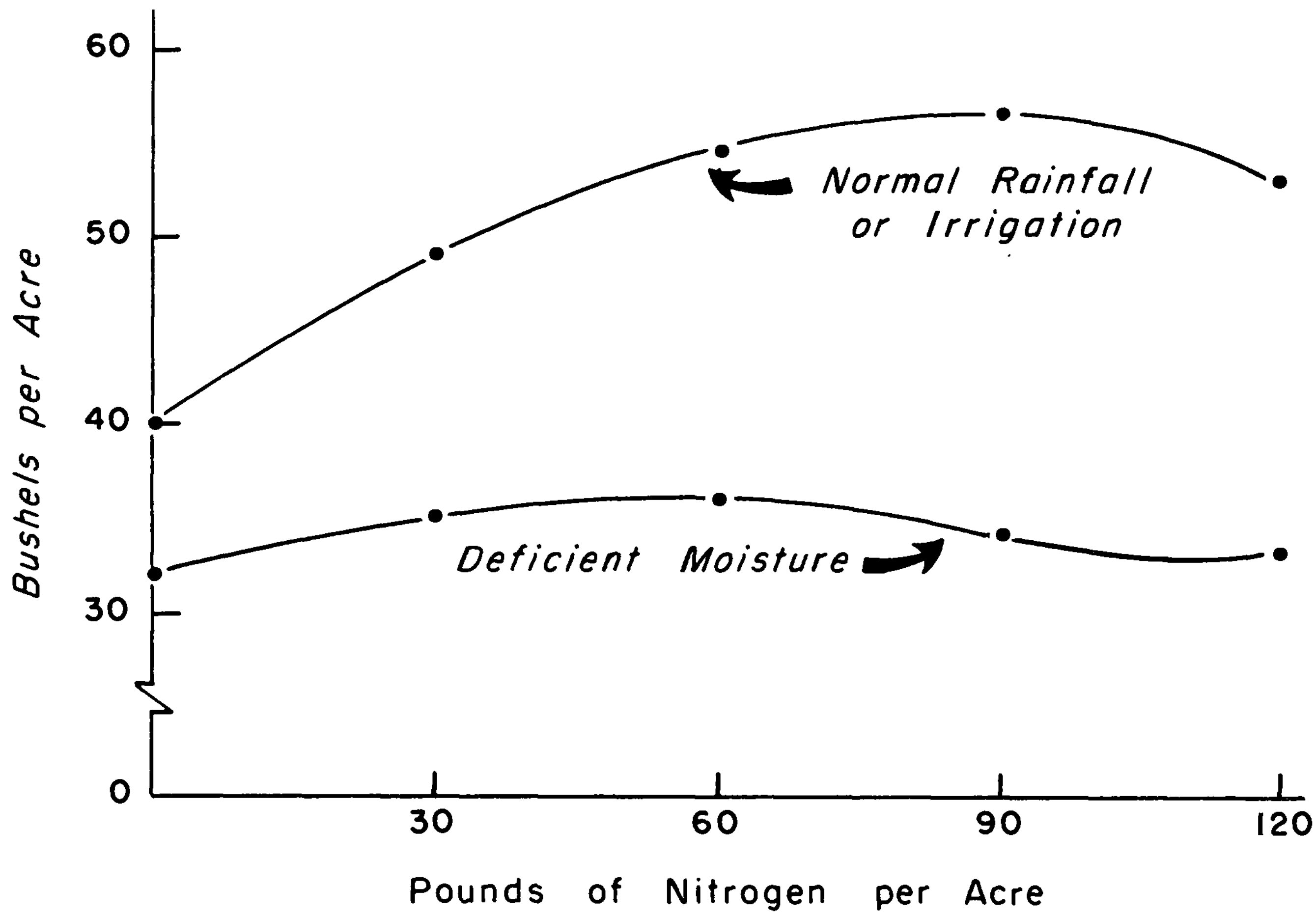
3. Shallow soils which are not irrigated will show a need for nitrogen only in those years when rainfall is above normal and is well distributed through the growing season. Wheat growing on irrigated shallow soils which have been continuously cropped to nonlegumes will show a large yield increase from applied nitrogen fertilizer. Hutchinson, Lookout, and Springdale soils are in this group.

4. Commercial fertilizers are not a substitute for the many cultural practices necessary for good crop production. Weed control, pest and disease control, and timeliness of operations are all essential to high yields.

5. Nitrogen and commercial fertilizers cannot overcome the ill effects of excess soluble salts in the soil.

Yield responses of wheat that can be expected from various rates of early spring-applied nitrogen in years of normal or above normal rainfall or where irrigated are shown in Figure 1. Thirty pounds of nitrogen increased the yield 9 bushels per acre; 60 pounds of nitrogen increased the yield 17 bushels per acre. Ninety or 120 pounds of nitrogen per acre produced very little additional yield over 60 pounds of nitrogen per acre.

Figure 1. Effect of early spring-applied nitrogen on winter wheat yields for two moisture levels.



The effect of applying nitrogen fertilizer on nonirrigated land during years of below normal rainfall and especially below normal during June also is shown in Figure 1. Yield increases for 30 and 60 pounds of applied nitrogen were 3 and 4 bushels per acre respectively. Higher rates of nitrogen produced slightly less yield than 30 or 60 pounds of nitrogen under these moisture conditions.

Early spring applications of nitrogen have proved more effective in increasing yield than applications of nitrogen made prior to the planting of the wheat in the fall.

Thirty pounds of nitrogen applied in early spring increased the yield as much as did 60 pounds of nitrogen applied prior to planting in years of favorable moisture (Table 1). When moisture conditions in the later stages of growth are adverse, approximately the same yield increases are obtained from fall--or early spring--applied nitrogen.

Table 1. Effect of Time and Rate of Nitrogen on Winter Wheat Grain and Straw Yields

Nitrogen rate	Time of application	Yield	Straw	Straw per bushel of grain
Lbs./A.		Bu./A.	Lbs./A.	Lbs.
None		40	5,100	128
30	Planting time	43	5,800	135
60	Planting time	48	7,000	146
90	Planting time	49	8,000	164
120	Planting time	51	7,800	154
30	Early spring	49	6,200	127
60	Early spring	55	7,300	132
90	Early spring	56	8,300	147
120	Early spring	57	8,300	146

Wheat absorbs most of the nitrogen it will need to complete growth to maturity during the first few weeks of growth in the spring. Thus, nitrogen applied with favorable moisture conditions either just before or during this stage of growth is very effective. Nitrogen applied in early spring is less subject to the hazards of leaching, microbiological tie-up, and denitrification as compared to a planting time application.

Spring application of nitrogen on winter wheat should be made anytime from before spring growth starts and until the wheat is several inches high. Anhydrous nitrogen, which must be placed several inches deep in the soil, should be applied as early in the spring as possible. Such applicators are less injurious to smaller wheat plants than to larger wheat plants. Spring applications of dry fertilizers can be broadcast as late as when the wheat is 6 to 10 inches tall; however, adequate moisture must be available during the late stages of wheat maturity if maximum yield increases are to be obtained. Maturity is several days later when nitrogen is not applied until the wheat is 6 to 10 inches tall.

Applying nitrogen in two applications--part at planting time and the rest in early spring--resulted in less yield than when the same amount of nitrogen was applied in early spring.

Not all effects of nitrogen are beneficial. Nitrogen fertilizer produces a greater increase in straw production than in grain production. As the rate of nitrogen increases above that needed by the wheat for grain yield increase, the growth of straw becomes excessive if there is adequate moisture available for plant growth (Table 1). Lodging, especially prior to heading, favors diseases such as rust and foot rots, delays maturity, and reduces yield and test weight. Slight differences among varieties exist in response of straw growth to nitrogen. For instance, Omar will increase straw height more rapidly than Burt.

Nitrogen fertilizer application increases the protein (nitrogen) content of the grain (Table 2). This may be desirable or undesirable according to the type of wheat grown. The protein content of soft white wheat may be raised to a level which is objectionable to millers and bakers. On the other hand, protein may be increased to a desirable level in types such as hard red winter. The desirable protein content for soft white wheat has been considered to be 10% or less. In general, the protein content of soft white wheat will not exceed the desired level unless more nitrogen than is needed for maximum yield is used.

Table 2. Effect of Nitrogen on Protein Content of Winter Wheat

Nitrogen rate	Time of application	Protein content of grain
Lbs./A.		%
None		8.3
30	Planting time	9.0
60	Planting time	9.3
90	Planting time	10.1
120	Planting time	11.6
30	Early spring	8.5
60	Early spring	9.5
90	Early spring	11.0
120	Early spring	11.7

The availability of moisture during the later stages of growth is very critical in determining whether nitrogen fertilizer will have a beneficial effect. If nitrogen has increased vegetative growth, the need for moisture is increased during the later stages of growth; thus, nonirrigated wheat production depends on June rainfall. Wheat growing on soils that do not have a large capacity for holding available moisture suffer severely when June rainfall is below normal. Yield and especially test weight reductions occur under these conditions. Table 3 presents data showing the effects of nitrogen fertilization on test weight when moisture becomes very limited in the later stages of growth. The reduction in test weight becomes serious when high rates of nitrogen have been applied.

Nitrogen is lost from the soil in many ways. Crop removal takes much nitrogen from the soil (Table 4). Burning crop residues prevents the return of the nitrogen in the straw to the soil. Nitrogen in the form of nitrate is very soluble and can be leached out of the root zone. Certain bacteria under water-logged soil conditions break down nitrogen compounds in the soil allowing the nitrogen to escape as a gas. Usually less than half the nitrogen fertilizer applied to winter wheat is used by the first crop (Table 4). A part of the unused nitrogen remains in the soil and is available to the next crop. More work needs to be done to fully understand how nitrogen is lost from the soil and how the efficiency of nitrogen fertilizer can be increased.

Table 3. Influence of Nitrogen on Test Weight of Winter Wheat When Moisture is Deficient During Later Stages of Growth

Nitrogen rate	Time of application	Yield
Lbs./A.		Lbs./Bu.
None		58
30	Planting time	58
60	Planting time	57
90	Planting time	56
120	Planting time	56
30	Early spring	58
60	Early spring	56
90	Early spring	54
120	Early spring	53

Table 4. Effects of Time and Rate of Nitrogen on Pounds N. in Straw and Grain and Percent of Recovered N.

Nitrogen rate	Time of application	Nitrogen Grain	Nitrogen Straw	Recovery of nitrogen applied
Lbs./A.		Lbs./A.		%
None		33	10	
30	Planting time	38	13	30
60	Planting time	47	16	36
90	Planting time	50	20	31
120	Planting time	60	24	35
30	Early spring	44	12	46
60	Early spring	57	16	51
90	Early spring	65	22	50
120	Early spring	74	24	47

Phosphorus

Most soils in northeast Oregon are able to supply enough phosphorus for maximum yields of winter wheat.

To date, only one area has been found that consistently responds to phosphorus fertilization. This area is centered around Wingville but extends northward to the Baker County line.

Soil series mapped as Wingville, Baldock, and Baker will need phosphorus fertilizer for winter wheat if they have not been heavily fertilized with phosphorus for legume production. If the rotation has not included legumes, phosphorus supplemented with nitrogen will be more effective than phosphorus alone or nitrogen alone. An occasional field of winter wheat in the Grand Ronde Valley will respond favorably to phosphorus fertilization.

For soils needing phosphorus fertilizer, 20 to 40 pounds per acre of available phosphorus will be adequate.

Time and method of application of phosphorus are important if maximum returns are to be obtained. The supply of available phosphorus must be plentiful for wheat immediately after germination and during the early stages of growth. The plants must become firmly established in the soil with large root systems to provide adequate fall and spring stooling. Phosphorus is not subjected to moving in the soil by moisture as is nitrogen; thus, phosphorus fertilizers must be placed deep enough in the soil to be in the root zone.

The best time and method of fertilizing with phosphorus is to drill the phosphorus fertilizer before or during wheat seeding.

This will band and place the phosphorus within the root zone. Methods which will work the phosphorus into the soil just prior to planting are more effective than methods which leave the phosphorus on the soil surface or apply the fertilizer after seeding.

A soil test is helpful but not always reliable in estimating phosphorus fertilizer needs for winter wheat. There are too many factors which a chemical test cannot measure. Some of these are available moisture, disease and pest control, temperature extremes such as spring frosts and hot days during maturity, weed control, and the variety planted.

Small scale fertilizer trials coupled with a soil test and good judgment are recommended. You can obtain first-hand information about soil, crops, and management practices in this manner. Large expenditures for fertilizer are not required. For little effort, expense, and record keeping the results from fertilizer applied in three or four narrow strips across a field can be obtained. This information has the possibility of being the most reliable information you can obtain as to how your crop will respond to fertilizer under your management practices.

Sulfur

Wheat yields have increased greatly in recent years from the use of improved varieties, better machinery, herbicides, and nitrogen fertilizers. These higher yields have put more demand on the soil for supplying plant nutrients. During this time the organic matter in the soil, which is the main source of sulfur, has declined. Today some fields of wheat need to be fertilized with sulfur for maxumum yields.

Wheat does not require a large amount of sulfur but does require sulfur continuously during growth.

For soils needing sulfur, 15 to 25 pounds of sulfur per acre applied at planting time or in the early spring is enough.

Materials commonly used as sulfur fertilizers are elemental sulfur, gypsum, or some fertilizer which contains sulfur such as ammonium sulfate or single superphosphate. Many materials such as anhydrous and aqua ammonia and ammonium nitrate do not contain sulfur. Sulfur carriers such as polysulfides can be included with ammonia fertilizers.

Because of the much greater need for nitrogen fertilization for wheat, sulfur deficiency should be suspected from observing deficiency symptoms only after it is known that nitrogen fertilizer needs have been met.

Visible plant deficiency symptoms of nitrogen and sulfur are nearly identical. Plants that lack either nitrogen or sulfur are light green to yellowish-green in color and grow slowly. Lower leaves of the plant may be yellow and upper leaves pale green. Symptoms are most noticeable during cool, wet weather as in early spring soon after spring growth starts. Usually the soil temperature is so low that soil microorganisms are converting only small quantities of nitrogen and sulfur into nitrates and sulfates.

Plants absorb sulfur from the soil as sulfate. The sulfur in gypsum and in many fertilizers is in the sulfate form and can readily be absorbed by plants. Sulfate sulfur is soluble in water; thus, rains will move sulfate, which has been broadcast on the surface, into the soil. Excess rain or over-irrigating will leach the sulfates out of the root zone.

Elemental sulfur must be changed by soil microorganisms to the sulfate form before it is available to plants. Soil microorganisms are active when they have adequate moisture and warm soil temperatures.

Other Elements

Potassium fertilizer has not given a beneficial response on winter wheat in northeast Oregon.

The only area suspected of needing potassium is around Flora in northern Wallowa County. In the Flora area much more consideration should be given to fertilizing with nitrogen, phosphorus, and sulfur than with potassium.

No visible symptoms of nutrient deficiencies except nitrogen, phosphorus, and sulfur have been observed in winter wheat in northeast Oregon. The continual removal of large yields of crops will "mine" the soil of plant nutrients to a point where additional fertilizers must be used. Purchasing and applying elements not known to be deficient for plant growth, however, is costly.