



FERTILIZER FOR BETTER BREAD

BY W. M. STEWART







Did you know that wheat provides greater nourishment for people globally than any other food grain? It's easy to see why wheat production is a top priority for farmers and the agricultural industry that feeds the world. Did you know that commercial fertilizer nutrient inputs produce about 30 to 50% of crop yield, including wheat, in North America? The use of fertilizer is clearly important to producing enough wheat to meet global demands. In the year 2000, fertilizer inputs were responsible for the production of an estimated 1.28 billion bushels of wheat in North America... enough to make 90 billion loaves of bread!

Regardless of region, class of wheat, or specific conditions, fertilizer inputs are responsible for a large portion of the grain produced in North America. Proper fertilization is an important determinant of the quality of bread and other food items made from various kinds of wheat.

The world consumes more wheat than any other food grain. Wheat is used in a wide range of products—bread, tortillas, crackers, bagels, pastries, and pasta. Wheat is also an important source of animal feed and forage in many areas. More land is devoted to wheat production worldwide than any other commercial crop. One reason is that wheat is a highly adaptable crop and can be grown across a wide range of environments. Wheat is clearly important to human nutrition, and anything that affects wheat management and production has the potential for significant worldwide impact.

North America produces about 15% of the world's wheat (based on 1998 to 2000 averages). There are six classes of wheat produced in North America (**Table 1**). Wheat classes are determined by the time of year they are planted and harvested, and by their kernel hardness, color, and shape. Each class of wheat has similar family characteristics, especially as related to milling, baking, and other food use. Where each class of wheat is grown depends largely on rainfall,

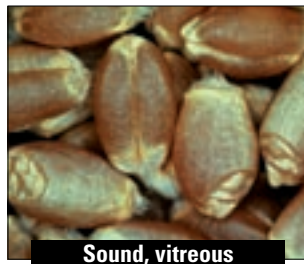
TABLE 1. Classes of wheat produced in North America, their uses, and where they are produced.

						
Wheat class:	Hard red winter (HRW)	Hard red spring (HRS)	Soft red winter (SRW)	Hard white winter (HWW)	Soft white winter (SWW)	Durum
Major uses:	Bread, rolls, bagels	Bread	Crackers, pastries, cakes	Yeast breads, hard rolls, bulgur, tortillas	Crackers, pastries, cakes	Pasta
Regions of production:	U.S. Great Plains	Northeastern Great Plains, Canadian Prairies	Eastern U.S.	CA, ID, KS, MT	Pacific Northwest	Northern Great Plains, AZ, CA

temperature, soil conditions, and tradition.

Nutrient inputs make a substantial contribution to wheat yields. For example, a long-term study at Oklahoma State University demonstrated that fertilizer was responsible for 40% of wheat grain yield over a 71-year period. In another long-term wheat study at the University of Missouri, nutrient inputs contributed 62% of wheat grain yield over a 100-year period. These and other estimates show that a reasonable assumption is that about 40% of wheat production is due to nutrient inputs. In other words, fertilizer inputs are responsible for about four out of every 10 loaves of bread produced from North American wheat.

Lack of nitrogen nutrition has the potential to substantially limit wheat yield. Nitrogen deficiency of wheat can be expressed as a yellowing of foliage during the season, or it can be expressed in the grain at harvest. The photo at left below shows effects of nitrogen deficiency on grain. It takes about 2 to 2.5 pounds of available nitrogen to produce one bushel of hard red winter wheat. Soft wheat requires less nitrogen since its protein content is lower. Assuming that 2 pounds of nitrogen fertilizer are required to produce one bushel of wheat, that other factors are not limiting, and that a bushel of wheat produces 70 loaves of bread, then a 100 pound bag of nitrogen fertilizer will produce about 3,500 loaves of bread...an efficient conversion by any standard.



Without adequate nitrogen, wheat grains may be starchy, faded, and low in protein, as shown in the photo at left. This condition is sometimes called “yellow berry” or “piebald,” and results in flour with poor baking quality (such as used in the loaf of bread at left in the photo below). With adequate nitrogen, wheat kernels have more protein and a sound, vitreous appearance, as shown at right above. The higher protein content results in better baking quality, as illustrated by the loaf of bread at right in the photo below.

Source: Grain Biology, Grain Research Laboratory, Canadian Grain Commission.



Higher protein content of wheat fertilized with nitrogen results in better quality bread. The lower protein wheat at left produced a more dense loaf of bread...855 cubic centimeters (cc)...while the higher protein wheat enabled the bread dough to rise more. Loaves shown are from 2001 Canadian western spring wheat harvest. *Source: Ken Preston. Grain Research Laboratory, Canadian Grain Commission, Winnipeg, Manitoba.*

Nutrient inputs can affect wheat quality as well as yield. Nitrogen fertilizer impacts wheat quality by affecting protein content. Wheat contains water insoluble gluten proteins. These proteins enable leavened bread dough to rise by trapping carbon dioxide gas. Thus, as the protein content of wheat used in baking bread increases, the loaf size also tends to increase, as shown in the photos. In other words, nitrogen fertilization is important in producing wheat with optimal protein levels that in turn produces better quality bread.

Although nitrogen is important in wheat production from the standpoint of both yield and quality, it is of limited value if other needed nutrients are not in adequate supply. Phosphorus nutrition is an important component of wheat production. Lack of phosphorus is second only to inadequate nitrogen in North America as the nutrient deficiency that most commonly limits wheat growth and development. Phosphorus affects wheat growth throughout the season. It is important in seedling and early season development. Enhanced availability of phosphorus encourages the early season development of roots and early proliferation of shoots, increasing grain and forage yield potential. Winterhardiness is improved with adequate available phosphorus. Also, wheat with adequate phosphorus nutrition matures earlier and more uniformly. The top photo at right compares wheat plots with and without phosphorus.

In recent years, chloride has been identified as a nutrient often needed in some regions of North America for wheat production. Research conducted across the Great Plains and Canadian Prairies has demonstrated that wheat is sensitive to chloride deficiencies. Chloride plays an important role in suppressing wheat fungal disease infection and in hastening maturity. Lack of sufficient chloride in wheat production can result in substantial yield and economic losses.

Wheat may also be responsive to other fertilizer inputs such as potassium and sulfur. Soil testing is a useful tool, frequently used to determine which specific nutrients are needed in each situation. When wheat and other crops are harvested, they remove nutrients from the soil which must be replaced to maintain productivity. **BC**

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Acknowledgment: Photos in Table 1 courtesy of Minnesota Association of Wheat Growers.



Wheat response to phosphorus fertilizer is shown at right (no phosphorus fertilizer on the left).



Chloride deficiency symptoms appear on wheat leaves at right. Wheat leaves at left are from a plot which received chloride fertilization.