Fertilization and Legumes Influence Spring Wheat Yield Trends

By C.A. Campbell, G.P. Lafond and R.P. Zentner

A 34-year crop rotation study on a heavy textured thin Black Chernozem soil in Saskatchewan has shown that adequate fertilization with nitrogen (N) and phosphorus (P) is necessary to sustain long-term yields of spring wheat. Using a legume green manure in a 3-year wheat rotation produces better yields than fallow in unfertilized systems, but cannot sustain long-term yields because the green manure provides no P.

CAN LONG-TERM cereal yields be maintained without proper fertilization? Can legumes replace N fertilizers? The relative benefits and environmental impacts of fertilizers compared to legumes for maintenance of sustainable agriculture systems are important considerations.

A 34-year study (1958-1991) on a heavy textured, thin Black Chernozem soil at Indian Head, SK, has shown the long-term impact of fertilizer and legumes on spring wheat yield trends. This rotation study included fertilized (N and P) and unfertilized continuous wheat (Cont W) and fallow-wheat-wheat (F-W-W), and unfertilized sweet clover green manure-wheat-wheat (GM-W-W) cropping systems. Fertilizer N and P were applied according to general recommendations for the first 17 years and according to soil test recommendations thereafter. Soil test N rates in the latter period were triple that of the first 17 years, but P rates were generally similar for the two periods.

The positive influence of N and P fertilizers on yields of wheat grown on stubble is shown in **Figures 1 and 2**. The 34-year average fertilizer-induced rate of increase in wheat yield grown on stubble (wheat after wheat) was about 0.5 bu/A/year in both F-W-W and the Cont W rotations.

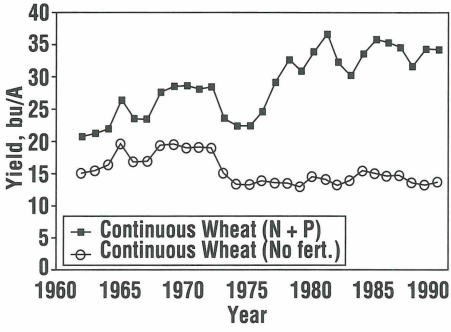


Figure 1. Yield trends of continuously grown hard red spring wheat as influenced by fertilizer. The points are 5-year running means. (Indian Head, SK).

The increasing difference between fertilized and unfertilized systems was partially due to an increase in N rate since 1978 when recommendations were based on soil tests and partially due to a gradual decline in natural soil fertility in the unfertilized system. The unfertilized F-W-W system had lower soil organic matter and less N-supplying power than the unfertilized Cont W system.

Legume green manure increased yields of wheat grown on stubble by an average of 6 bu/A more than the unfertilized F-W-W rotation (**Figure 2**) and supplied 56 percent more N, likely because of N fixa-

The authors are research scientists with Agriculture Canada, located at Swift Current Research Station, Saskatchewan, Canada.

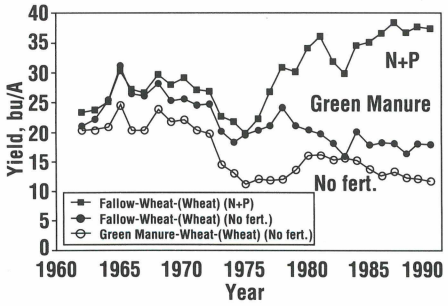


Figure 2. Yield trends of hard red spring wheat grown on stubble (wheat after wheat) in a fallow-wheat-wheat rotation, showing the influence of sweetclover green manure and of N + P fertilizer. The points are 5-year running means. (Indian Head, SK).

tion. Even so, the yield trends for wheat grown on stubble in this green manure system still declined at a rate of 0.39 bu/A/year. This downward trend was probably because legumes do not supply P, and more P was exported in the grain produced from this system.

When fertilized with N and P according to soil test recommendations, the F-W-W system maintained higher yields of wheat grown on stubble than the unfertilized GM-W-W system, indicating that the latter system is not sustainable. The lower yields in the GM-W-W system were related to lower soil test P. In 1991, that system had only half as much bicarbonate extractable P (Olsen-P) in the soil profile (0-4 ft) as the fertilized F-W-W system (i.e., 23 lb/A vs. 50 lb/A).

Summary

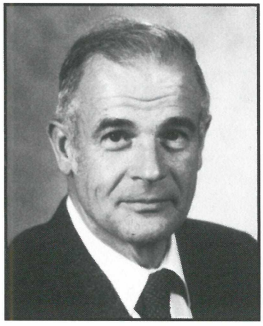
Replacing fallow with a legume green manure crop in a 3-year, unfertilized wheat rotation will produce higher wheat yields. However, neither fallow nor green manure will sustain wheat yields in the long-term without adequate fertilization, because neither system can meet the long-term P requirements of wheat. Proper fertilization with N and P can sustain and increase long-term wheat yields in both continuous- and fallow-wheat rotations. ■

Dr. J.D. Beaton Receives WCFA Award of Merit

THE Western Canada Fertilizer Association (WCFA) recently presented its Award of Merit to Dr. James D. Beaton, Senior Vice President, International Programs, of the Potash & Phosphate Institute (PPI) and President of the Potash & Phosphate Institute of Canada (PPIC). The recognition was given during the recent 1993 annual meeting and convention of WCFA.

The organization also welcomed PPIC as an affiliate member of WCFA, recognizing several years of cooperation.

A native of British Columbia, Dr. Beaton earned his B.S.A. and M.S.A. degrees from the University of British Columbia and gained his Ph.D. at Utah State University. He later worked as a researcher with Agriculture Canada, as an industry agronomist, and then as Chief Agronomist with The Sulphur Institute.



Dr. Beaton

He joined the staff of PPI/PPIC in 1978 as Western Canada and Northwest U.S. Director. In 1988, Dr. Beaton was named Vice President, International Programs, PPI, and President, PPIC. He served two terms as WCFA President, in 1977-78 and 1978-79.

Dr. Beaton is co-author of the widely used textbook, *Soil Fertility and Fertilizers*, now in its fifth edition. ■