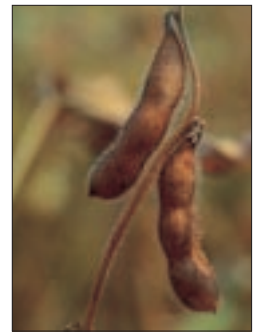
The Soybean Yield Challenge: Research for Improved Production Systems



By H.F. Reetz, Jr.

Many Midwest farmers have traditionally treated soybeans as a secondary crop...usually in a rotation with corn. Fertility programs, and management systems in general, have been designed for the "main" crop, with soybeans getting what is left over from the previous year. Relatively few research projects have focused on development of a management system to provide the optimum conditions to maximize soybean yields. Yet, soybeans remove large amounts of potassium (K), so soil K depletion has become more rapid as more soybeans are grown. Nutrient management plans must account for these differences to maintain productivity.

For continued progress toward breaking soybean yield barriers, several components are needed. A concept known as "high-yield-system-in-place" (HYSIP) has helped maximize production, especially in years with favorable weather conditions.

Soybeans respond well to the best growing conditions for the other crops in the rotation, but there may be some special considerations that will help optimize soybean production as well. When management is adjusted for best soybean production, other crops in the rotation may be at less than optimum. For this reason, the corn/soybean rotation probably will not produce maximum yields of either crop, but still provides a well-balanced rotation with many advantages.

Dr. Richard Cooper, USDA-ARS Soybean Breeder at Wooster, Ohio, has devoted much of his program to looking for better soybean production systems. Through use of semi-dwarf genotypes, higher plant populations, high fertility, and supplemental irrigation, he has built a system that has produced over 100 bu/A soybean yields. Dr. Cooper's system is centered around putting a "high-yield-system-in-place"...the HYSIP concept. He emphasizes that for continued progress in maximizing yields, it is essential to pay close attention to the total production system. This doesn't guarantee high yields every year, but helps ensure that all controllable factors are managed at or near their optimum levels.

To obtain his record yields, Dr. Cooper developed a soybean maximum yield production system with the following components:

1. Well-drained soil with good surface drainage to avoid possible flooding injury from a heavy rainfall event, especially if it occurs just after an irrigation application.
2. Maintenance of high fertility levels in the soil with annual applications of 1,000 lb/A of 0-18-36 fertilizer plus 600 lb/A of 33-0-0 broadcast and incorporated prior to planting.
3. Two-year corn/soybean rotation to minimize disease and insect buildup.
4. Early planting to take advantage of the longer days and higher light intensity earlier in the growing season (last week of April or first week of May at Wooster, Ohio).
5. Use of soybean cultivars with known high yield potential and excellent lodging resistance (determinate semi-dwarf or shorter indeterminate cultivars).
6. Solid-seeding, 7-inch row spacing with a seeding rate of 300,000 seeds/A for semi-dwarf cultivars and 225,000

seeds/A for indeterminate cultivars.

7. Irrigation, with a goal of 2 inches/week (rainfall plus irrigation), beginning at the V-3 (2nd trifoliolate) or V-4 (3rd trifoliolate) growth stage, depending on natural rainfall.
8. Use of fungicides as needed to prevent or minimize foliar diseases.
9. Use of insecticides to minimize insect feeding.

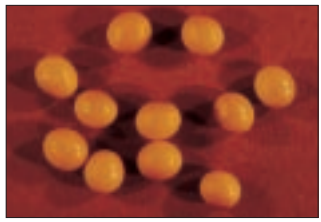
This is a research system, and some components may need adjustment for implementation on the farm. For example, nitrogen (N) fertilization is not routinely recommended for soybeans, but was used here to be sure N was not limiting.

Using this system from 1977 to 1999, Dr. Cooper produced average annual yields of 70 bu/A, with highest single cultivars averaging up to 80 bu/A. In 1982, 64 cultivars averaged 89.4 bu/A with four lines exceeding 100 bu/A. These high yields were postulated to be a result of a very early warm spring, which resulted in soybeans flowering two weeks earlier than usual. This meant they also entered the reproductive stage earlier in the season when days were longer and light intensity was higher. The length of the reproductive period was also increased. Similar early warm spring conditions occurred in 1998 and 1999. Again, yields averaged across all cultivars were over 80 bu/A, with highest individual cultivar yields of over 90 bu/A both years.

In 1999, in a sub-irrigation/drainage experiment at Wooster, nine soybean cultivars, sub-irrigated as needed, averaged 98 bu/A with three cultivars exceeding 100 bu/A. Under drainage only, these cultivars averaged 67.3 bu/A, and when constant water table was maintained by sub-irrigation, 93.6 bu/A.

While highest yields have been obtained with sub-irrigation, the HYSIP concept also works on non-irrigated fields. In a 10-year comparison at two Ohio locations, its advantages are clearly demonstrated (**Table 1**). Since the high-yield system will equal the yield of a lower yield system in dry years and produce much higher yields in favorable moisture years, having the high-yield system in place (HYSIP) every year results in higher long-term average yields.

The exceptionally high yields in 1982, 1998 and 1999, when above-normal May temperatures triggered earlier flowering, indicate early season cool temperatures can be a major barrier to higher soybean yields. Dr. Cooper has initiated a breeding program to develop earlier flowering, full season cultivars to overcome this yield barrier. In the meantime, for maximum yields, he recommends that growers plant their soybeans as early as possible and have the high yield management system in place to take advantage of those early warm spring conditions when they occur.



Future

Farmers must continue to work toward higher soybean yields to maintain a financially sound production system. Site-specific management, along with management for specific quality components, will become important to soybean production systems. BC

Dr. Reetz is PPI Midwest Director, located at Monticello, Illinois. E-mail: hreetz@ppi-far.org.

TABLE 1. Comparison of solid-seeded-semi-dwarf (SSS) management system with wide-row-indeterminate (WRI) management system at two Ohio locations over 10 years, 1988-1997.

	Management system	
System characteristics	Solid-seeded-semi-dwarf	Wide-row-indeterminate
Variety	Sprite	Williams 82
Seeding rate	300,000 seeds/A	150,000 seeds/A
Row spacing	7 inches	30 inches
Location	**Yield results**	
Northwest Ohio		
Highest yield	84.1 bu/A	66.5 bu/A
10-year average	60.9 bu/A	49.1 bu/A
West Central Ohio		
Highest yield	83.2 bu/A	68.2 bu/A
10-year average	75.0 bu/A	60.8 bu/A