

Members Forum

Semidwarf Soybeans Show Potential for Major Yield Breakthrough in the Midwest

by Richard L. Cooper

As a young soybean breeder at the University of Minnesota in 1962–1967, I was amazed when I learned of grower contest yields of 90 to 100 bu/ac. At the time, the highest yields achieved in replicated research plots were in the 70 bu/ac range. In 1967, I accepted the position as the USDA-ARS Agronomist-In-Charge of the U.S. Regional Soybean Laboratory at the University of Illinois. The first thing I did was to contact one of the yield contest winners and ask if I could conduct soybean research on his high-yielding (80+ bu/ac) contest field.

I will never forget what I observed that first year. The grower's soybeans reached a height of more than 5 ft and became severely lodged. He said he believed that soybeans liked poorer ground because when he planted this field to corn, he got his highest yield on the lower black ground with good water-holding capacity, but when he planted soybeans there, he got his highest yield on the sandier ground where the beans didn't get so tall and didn't lodge.

Eureka Moment

This was a "eureka moment" for me. It was then that I first recognized there was a major lodging barrier to higher soybean yields and that it helped explain why grower contest yields were higher than in replicated research plots. In replicated research plots, when environmental conditions were right for record soybean yields, lodging was the barrier to higher soybean yields.

Based on Dr. Norman Borlaug's experience developing semidwarf wheat varieties to overcome the lodging barrier that lead to a yield breakthrough in wheat and the International Rice Research Institute's similar yield breakthrough in rice by the development of semidwarf rice, it became obvious that we needed to develop semidwarf soybean varieties to overcome the lodging barrier to higher yields.

I initiated a soybean semidwarf breeding program at the University of Illinois in 1968 and released my first semidwarf variety, Elf, in 1977, that lead to a yield breakthrough in replicated soybean research plots. In a high-yielding

environment in central Illinois, in 1976, Elf outyielded the indeterminate check variety, Williams, by 5.7 bu/ac (54.8 vs. 49.1 bu/ac) in 30-inch rows and by 21.5 bu/ac (80.0 vs. 58.5 bu/ac) in 7-inch rows. Note how much more yield responsive the semidwarf varieties, at the recommended higher seeding rate for semidwarf varieties, were to 7-inch row spacing.

Results from subsequent yield trials in Ohio show the potential yield advantage of properly managed semidwarf varieties over conventional indeterminate varieties under normal rainfall, and irrigated, conditions. Averaged over three high-yielding locations in Ohio in 1979, the semidwarf variety, Sprite, outyielded Williams by 8.9 bu/ac (57.7 vs. 48.8 bu/ac) in 30-inch rows and 17.8 bu/ac (82.1 vs. 64.3 bu/ac) in 7-inch rows.

In two long-term, 10-year studies—one at Hoytville in northwestern Ohio and one at South Charleston in west-central Ohio—The Wide Row Indeterminate (WRI) system (the indeterminate variety Williams planted in 30-inch rows at a seeding rate of 150,000 seeds/ac) was compared with the Solid-Seeded-Semidwarf (SSS) production system (the semidwarf variety Sprite planted in 7-inch rows at a seeding rate of 300,000 seeds/ac). Averaged over the 10 years, the SSS system out yielded the WRI system by 11.8 bu/ac (60.9 bu/ac vs. 49.1 bu/ac) at Hoytville and 14.2 bu/ac (75.0 vs. 60.8 bu/ac) at South Charleston.

All of these yield data were obtained from research plots planted before 15 May. It has been subsequently observed, from grower experience, that later planting of semidwarf varieties, late May and early June, can result in excessive vegetative growth due to the higher temperatures during the vegetative growth stage, i.e., before the formation of the terminal cluster of flowers. This results in a reduced harvest index and can result in lodging at the recommended high seeding rate for semidwarf varieties. Thus, early planting, before 15 May, is recommended for maximizing their yield.

To push the yield potential of semidwarf soybean varieties to the limit, maximum yield research, where all manageable yield-limiting factors were minimized, was conducted

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at the Ohio Agricultural Research and Development Center, at Wooster, OH for several years. Results from these trials indicated the 90 to 100 bu/ac yields, reported in grower contest yields, could be duplicated in replicated yield trials with properly managed semidwarf varieties (Reetz, 2000).

These semidwarf varieties were developed by crossing Dt1e1 indeterminate varieties adapted to the Midwest with dt1E1 determinate varieties adapted to the Southern states, and selecting for dt1e1 genotypes and high yield (Cooper, 1985). Like semidwarf wheat and semidwarf rice, semidwarf soybean varieties are a smaller, more efficient plant type than conventional varieties, with a higher harvest index (seed to straw ratio) and greater lodging resistance. To take full advantage of semidwarf varieties, they need to be planted in 7-inch rows at a seeding rate of 300,000 seeds/ac.

Lack of Semidwarf Acceptance in the U.S.

Plant breeders and variety development organizations, whether public or private, have shown a reluctance to adopt new breeding methods, but with this kind of yield advantage, why haven't other U.S. soybean breeders initiated soybean semidwarf breeding programs? Dr. Borlaug experienced a similar problem when he first tried to introduce his semidwarf wheats and high-yield production system, developed in Mexico, into India. The established wheat breeders in India were under political pressure to conform to the status quo to avoid political problems that might threaten their job security, so they were reluctant to initiate semidwarf wheat breeding programs.

It wasn't until the Minister of Agriculture put his full support for Borlaug's efforts to introduce his semidwarf wheats and high-yield production system into India that semidwarf wheats were fully accepted in India. After this, India's wheat breeders quickly initiated wheat semidwarf breeding programs (Vietmeyer, 2011).

Unfortunately, strong ag administrative support for the establishment of soybean semidwarf breeding programs has yet to appear in the U.S., contributing to the lack of other U.S. soybean breeders initiating soybean semidwarf breeding programs (see Cooper, 2014). Lack of support by other public and private soybean breeders, and by ag administrators, has slowed the acceptance of semidwarf soybeans in the U.S., and as a result, Midwest soybean growers are paying the price of slower progress to higher soybean yields.

After my retirement in 2001, further research to develop newer, higher yielding and pest-resistant semidwarf soybeans was terminated. Fortunately, Ohio Foundation Seeds, under the leadership of Jack Debolt, has maintained a seed increase of the latest releases from my semidwarf breeding

program and sizeable quantities of seed are available for yield testing by research scientist and growers interested in growing semidwarf soybeans.

As a result of my consulting trips to China, since my retirement, dt1e1 semidwarf soybean breeding programs have been established in China, and semidwarf soybean varieties are being released. There has been rapid acceptance of the SSS production system by Chinese growers. The acreage of SSS soybeans grown in China increased from 200,000 ac in 2016 to more than 300,000 ac in 2017, indicating the advantage of active dt1e1 semidwarf soybean breeding programs in developing higher yielding and more pest-resistant semidwarf varieties.

I am confident, that in time, other U.S. soybean breeders will initiate soybean semidwarf breeding programs, but significant effort is needed, by both public and private ag administrators, to lessen the political pressure on soybean breeders to conform to developing conventional soybean varieties only. Resistance to change, and political pressure to conform to ensure job security, can be powerful forces against progress (see Cooper, 2009).

It seems hard to believe now the amount of resistance there was to hybrid corn when it was first introduced—in spite of its major yield advantage over open-pollinated varieties. New dt1e1 semidwarf soybean breeding programs need to be established in the U.S. to provide a continuing source of new, higher-yielding and pest-resistant semidwarf varieties that have shown, when properly managed, the potential for a major breakthrough in Midwest soybean yields.

For further information, Google "semidwarf soybeans." To obtain detailed yield tables showing the potential for semidwarf soybeans to lead to a breakthrough in higher Midwest soybean yields, e-mail rlcooper9@gmail.com.

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