In-Season Management for Maximum Soybean Yield

Grain yield of U.S.-grown soybean has not kept pace with that of corn (Figure 1). As a percentage of 1987, corn yield in 2011 had increased 53 percent, while that of soybean only 36 percent. This supports many producers' observations that yield of soybean compared to corn often falls short of expectations. For the 14-year period from 1998 to 2011, soybean relative yield has been less than that of corn every year. In contrast, soybean relative yield was equal to or greater than corn relative yield in six of 12 years from 1987 to 1998. The widening gap between corn and soybean yield has led Pioneer to redouble its efforts in both breeding and management.

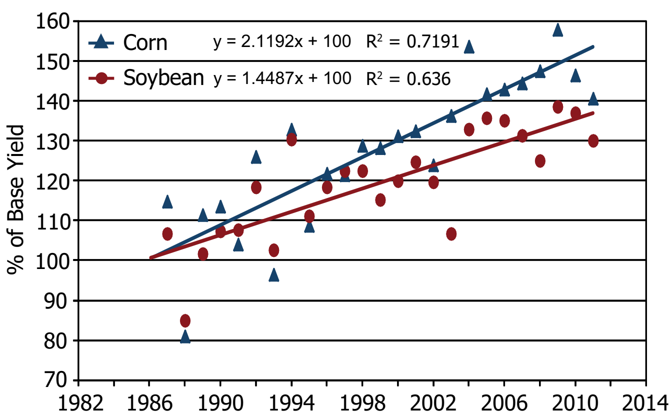

Figure 1. Relative yield of U.S. corn and soybean from 1987 to 2011. Source: USDA/NASS.

Study Objective and Description

Our objectives in this study were to examine in-season management practices that producers can readily implement, that are likely to improve soybean yield.

Experiments were conducted at three Illinois locations (Champaign, Mascoutah, and Princeton) with treatments consisting of two planting dates and two varieties in each planting date. Within each variety (Var.) and planting date (P.D.) soybean was either unfertilized or fertilized with nitrogen (N), and either untreated or treated with a foliar fungicide + insecticide (Fol.)

Planting dates were considered either normal (early to mid-May) or late (late-May to early-June) for the region. Varieties were selected to represent short or full-season relative maturity for a location within the region. Nitrogen was applied to the soil surface at R2 with 80 lb N per acre of encapsulated urea (ESN), and labeled rates of Headline and Asana were foliar-appied at R3.

Results – Nitrogen Fertilizer

The 2011 season was marked by an excessively wet spring, followed by a droughty summer, and high soybean yield. The average yield for all three locations was 66 bu/acrt. Due to its high protein concentration, soybean requires large quantities of N. These quantities range from 3.2 to 9.4 lb N per bushel, and average 4.7 (Salvagiotti et al., 2008). An acre of soybean in this experiment would have contained about 310 lb N – or roughly 50 percent more than that of a 180 bu/acre corn crop.

Biological N fixation is especially sensitive to both flood (Bacanamwo and Percell, 1999) and drought (Sprent, 1976). Under moderate levels of either condition, crop dry matter accumulation declines much less than that of N fixation. Furthermore, fixation does not keep pace with crop N demand (Figure 2). However, when that demand is relatively low (<300lb N/acre), N supplied by the soil may often provide the balance. As soybean yield increases above 64 bu/acre (requiring more than 300 lbs of N/acre), however, N supplied by the soil and fixation is increasingly unlikely to meet crop demand.

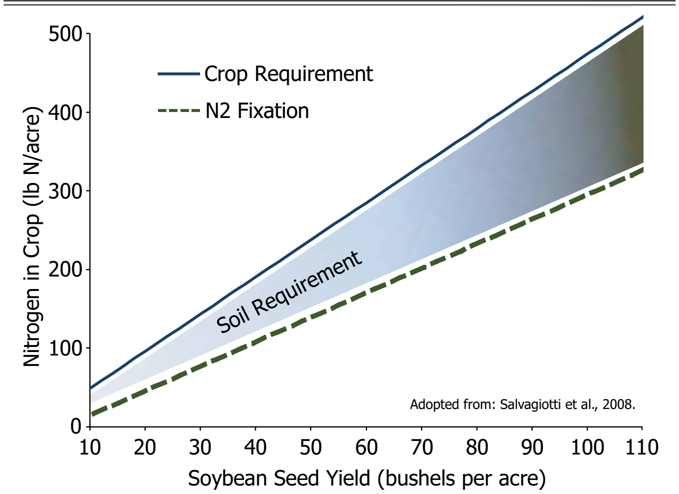

Figure 2. Influence of soybean yield on N in the crop, N supplied by fixation, and required soil N.

Of the three locations in Figure 3, the Champaign site had the largest yield response to N fertilizer (3.5 bu/acre), which occurred with the full-season variety planted at the earlier date. Later varieties extend the reproductive growth period, and early planting is known to have a similar effect (Bastidas et al. (2008)), which may provide a greater opportunity for N to be limiting. This location was also the driest of the three, and below optimal soil moisture conditions have been known to increase soybean yield response to N (Ray et al., 2005; Purcell and King, 1996).

Yield response to N at Princeton did not differ by variety, so data are averaged over varieties for both planting dates, and the response to N was greater with the earlier date. Similar to Champaign, yield at Mascoutah was increased with N when the full-season variety was planted at the earlier time. Unlike the other two locations, though, an N response at Mascoutah occurred at the later planting date. Due to a large rainfall event there late in the season, soils were saturated for some time. These extensively saturated soils may have reduced fixation late in the season that earlier-planted soybean avoided.

Results – Foliar Fungicide and Insecticide

Numerous disease and insect pests are a major obstacle to producing consistently high yielding soybean. Disease alone is estimated to cause the annual loss of 363 million bushels of

U.S. soybean (Koenning and Wrather, 2010). New pests such as soybean aphid and soybean vein necrosis virus, and the increasing prevalence or virulence of bean leaf beetle, Japanese beetle, white mold, sudden death syndrome, frog eye leaf spot, and soybean cyst nematode can frustrate attempts at high yield soybean production.

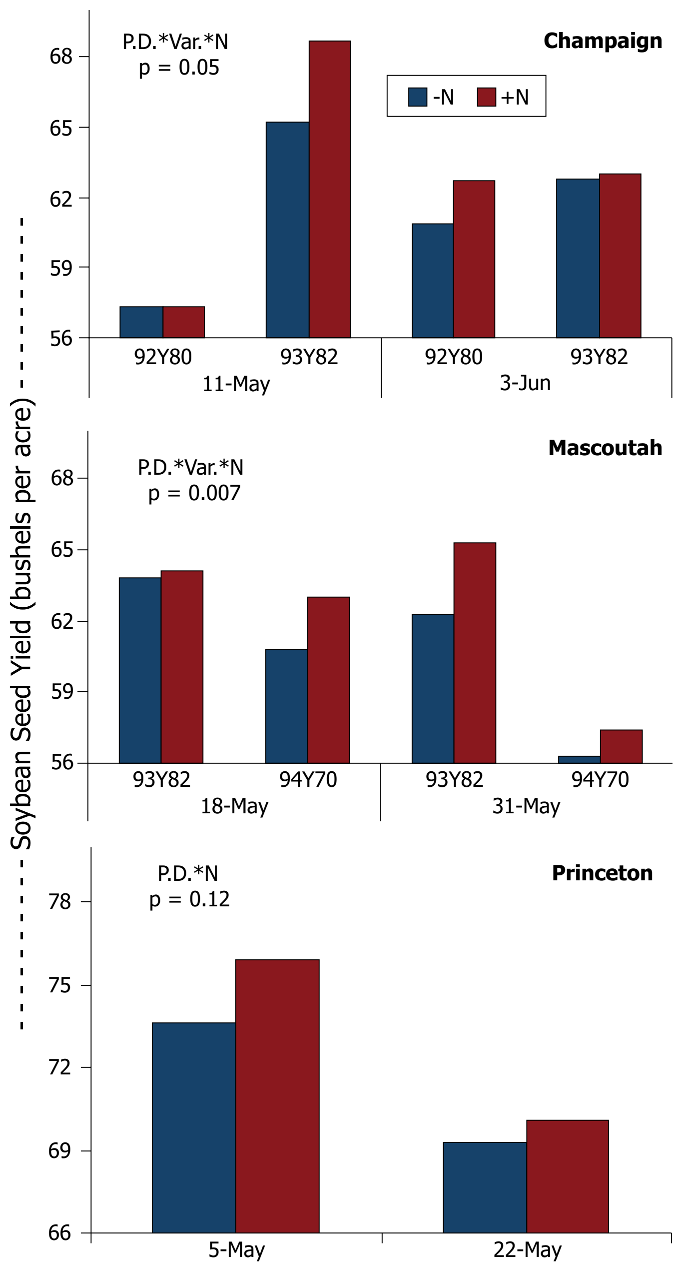

Figure 3. Influence of planting date (Princeton) and planting date and variety (Mascoutah and Champaign) on the seed yield of soybean grown without or with nitrogen fertilizer (-N +N) in Illinois in 2011.

Given the droughty conditions throughout much of Illinois in 2011, observations of foliar disease symptoms were much reduced when compared to recent years. Insect defoliation in 2011, however, tended to be similar or more severe in locations where Japanese beetles were abundant.

At the Champaign site, low disease but heavy insect defoliation was evident during seed fill. Yield increase due to foliar fungicide and insecticide at Champaign (Figure 4) was much larger and more consistent when compared to either Mascoutah or Princeton. The largest foliar response (4.6 bu/acre) occurred with the earlier planting date and the full-season variety; however, both varieties responded to the foliar treatment at the late planting date. Since most of the insect defoliation occurred very late in the season, the short-season variety at the earlier planting date matured before the most severe defoliation occurred.

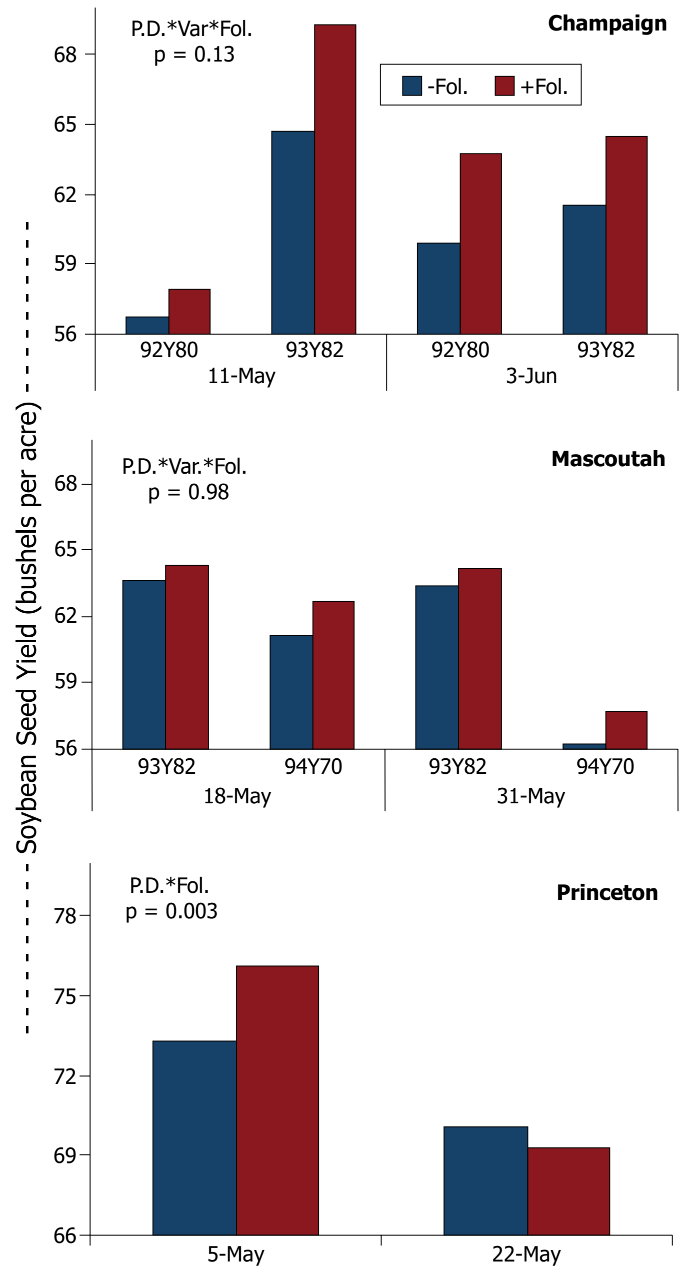

Figure 4. Influence of planting date (Princeton), and planting date and variety (Mascoutah and Champaign) on the seed yield of soybean grown without or with a foliar fungicide and insecticide (-Fol. +Fol.) in Illinois in 2011.

At Mascoutah, lower insect and disease levels were noted compared to Champaign. Neither variety nor planting date significantly (p= 0.98) affected the response to foliar treatment. The full-season variety, however, tended to be more responsive at both planting dates compared to the short-season. The lack of a planting date or variety effect on foliar treatment response at Mascoutah may in part be an artifact of late planting at both planting dates. This location, situated near St. Louis, MO, with a two to three week earlier planting date would likely have increased reproductive growth of the latter maturing variety, and increased the response to foliar treatment.

Variety did not influence the response to foliar treatment at Princeton, so data at that location are averaged over variety for each planting date. Planting date, however, did affect the response to foliar treatment, and a yield increase occurred only at the earlier date.

Conclusions

In-season management is one possible route to higher soybean yield. Our data indicate that both N and a foliar fungicide + insecticide treatment can increase soybean yield. These responses, though, are more likely to occur with full-season soybean varieties planted at normal dates rather than late dates. Since selecting full-season varieties and planting them at early to normal dates increases time spent in reproductive growth, yield is often increased, and response to in-season management improves.

Lengthening reproductive growth increases the likelihood of the crop experiencing a temporal N deficiency by higher yield, and by greater exposure of the crop to weather extremes (flood or drought) affecting both N fixation and soil N supply. Similarly, the accumulated effect of pest injury (insect and disease) is more likely to reach a yield-reducing level with full-season varieties and early planting dates.

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