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Environment has bigger impact than soybean seeding date

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Up to 90% of total variation in soybean yield and quality was explained by environment, seeding date, cultivar and their interactions, with environment often responsible for the majority of the response. Overall, very late seeding reduced yield, seed weight, and oil but did not affect protein.

The objective of this study was to determine the impact of delayed seeding on soybean seed yield, yield components, maturity and seed quality in Manitoba, and provide the first characterization of the relative influence of environment, seeding date and cultivar on those variables.

Field studies were conducted from 2015 to 2017 at Arborg, Portage la Prairie and Morden, Manitoba. The study included three seeding dates, separated by 5 to 8 day intervals characterized as normal (May 25-June 12), late (May 31-June 16) and very late (June 6-24). The normal seeding date follows typical agronomic practices for the region, although seeding dates have since become earlier, while the very late seeding date extends beyond current recommendations and crop insurance seeding deadlines.

Very early (000 in 2015, 00.2 in 2016 and 2017), early (00.1) and mid season (00.5) Roundup Ready soybean cultivars were grown. The mid season soybean cultivar represents a full season cultivar for the region and each cultivar is separated by 4 to 8 days to full maturity.

Plots were seeded into a tilled seedbed with disc openers at approximately 15 seeds/foot (50 seeds/m) in row spacings of 9 to 12 inches (23 to 30 cm). This seeding rate was 200-210,000 seeds/ac to target 140-160,000 live plants/ac.

Soybeans were inoculated with *Bradyrhizobium japonicum* inoculant, were maintained weed-free using glyphosate, and an insecticide application was used only when soybean aphid populations exceeded the recommended action threshold.

Plant density was measured four weeks after seeding at soybean development stage V1 (first trifoliate). The total number of pods and seeds/plant was counted during soybean development stages R6 through R7. Plant height was measured at R8. Days to maturity was when the majority of the plants in an experimental unit reached 95% brown pod or full maturity (R8). Yield, seed oil, protein concentration, and seed weight were measured.

Growing season precipitation and heat accumulation varied among sites and years, and this became the most important factor in the study. For example, from May through August, total growing season precipitation varied from 6.3 to 14.6 inches (161 to 370 mm) and mean daily temperature varied from 15.5 to 18.1C across the site years.

Environment explained more of the total variation (33.6 to 74.5%) for each variable than any other factor or interaction, except for seed oil concentration. This indicated that soybeans were highly sensitive to growing conditions in this study. The second most important factor always included cultivar or an interaction with cultivar.

Environment heavily influenced yield

Soybean yield ranged from 24 to 54 bushels per acre (1610 to 3625 kg/ha), and environment alone explained over 70% of this variation.

Below average yields occurred in three environments (Arbog15, Arborg17, Morden15), and delayed seeding and dry conditions (Morden15) and hail (Arborg17) were also constraints to yield. Removing these environments lowered the contribution of environment by only about 20% of the total variation, but did not change the researchers' interpretation of the results.

At the very late seeding date, overall soybean yield was reduced by only about 15% compared to the normal and late seeding dates and this varied by environment. At 3 of 8 environments, yield reduction from the normal to very late seeding date ranged from 15 to 36%. The researchers found the effect of delayed seeding surprisingly small.

Cultivar choice also had a small effect on yield with the earliest maturing cultivar yielding 16% lower overall.

Results from this study suggest that the two later maturing cultivars maximized yield across all environments and seeding dates, because although yield was reduced with delayed seeding, the relative differences among cultivars remained similar.

Days to maturity

Days to maturity ranged from 104 to 119 days. It was similar among seeding dates, with the exception of two sites where delayed seeding reduced days to maturity by 7 to 10 days compared to normal seeding for most cultivars.

Differences in days to maturity between cultivars ranged from 106 to 115 days. The relative number of days required for cultivars to reach maturity within seeding dates remained the same within each environment. The mid or mid and early-season cultivars often required a greater number of days to mature than the very early cultivar.

Seed protein

Overall, seed protein concentration ranged from 32.8 to 35.3% among all environments, with an overall mean of 34.3%. This compared to the Canadian Grain Commission mean range of soybean protein for the region of 32.3 to 33.7%. It was surprisingly similar to those reported in the United States of 34.5 to 34.7, where research has reported on decreasing protein content with increasing latitudes.

Seeding date did not affect seed protein concentration, overall. Cultivar had little effect on seed protein concentration, accounting for <1% of the total variance. Environment was found to be responsible for 37.5% of seed quality components.

Seed oil

Seed oil concentration ranged from 16.1 to 18.7% with overall mean seed oil concentration at 17.8%. Forty-six percent of the variance in seed oil concentration was attributed to cultivar. The very early cultivar always had greater seed oil concentration than the other cultivars.

Lower oil concentrations in this study were observed compared to other regions, and reduced seed oil concentration with very late seeding could be explained by lower temperatures during seed fill in Manitoba, particularly when seeding is delayed.

The researchers also observed no overall relationship between oil and protein at 2 out of 3 environments, and weak negative relationships among seed quality components and yield. This is promising for efforts to breed high yielding, high protein soybean cultivars.

This study demonstrates that environmental conditions in Manitoba have a large influence on soybean performance compared to seeding date or cultivar. For farmers, if seeding is delayed beyond recommended practices, there is potential for seeding soybeans through mid-June in some regions of Manitoba with minimal yield reductions. Maturity risk can be mitigated with appropriate cultivar selection.

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