Predicting Soybean Growth Stages in Manitoba

Soybeans grown in Manitoba spend 42 days in vegetative development and 59 days in reproductive development, compared to Ontario where they spend 25 days and 70 days, respectively.

SOYBEANS BEGIN TO sense photoperiod (day length) as early as the unifoliate stage (VC). Manitoba represents the northern reaches of soybean production and day lengths are longer than those in other soybean growing regions. Soybean development may be delayed when grown under long day lengths (>14 hours), however, varieties vary in their sensitivity to day length.

The purpose of this research was to evaluate differences in soybean phenological development between southern Manitoba and eastern Ontario and use this information to develop an accurate model to predict critical growth stages of soybeans based on temperature, day length and soybean maturity group. A controlled environment experiment was also conducted to isolate the effect of day length on time from emergence to beginning bloom.

Ten short-season, food-type soybean varieties were planted at Ottawa (45.4°N) and Carman (49.5°N) in 2017 and 2018. Soybean growth stage was evaluated every three days. Variety maturity groups ranged from MG 000 to 1. The difference of four degrees in latitude between the Manitoba and Ontario sites translates to a day length that is 49 minutes longer in Manitoba during the summer solstice.

On average, it took soybeans in Manitoba 18 days longer to reach R1 (beginning bloom) from VE (emergence) than in Ontario (42 days vs. 24 days, respectively). Since flowering occurred earlier in Ontario, soybeans then spent 70 days in reproductive development stages in Ontario and only 59 days in Manitoba. The total time to R8 (full maturity) was the same at both sites.

Among maturity groups, time from planting to VE, time from VE to R1 and from R1 to R5 (beginning seed) were similar. Time from R5 to R8 (seed development and maturity) increased with later maturity groups, resulting in a 20-day difference between the earliest maturity group and the latest. Later maturity groups tended to have greater yield than earlier maturity groups.
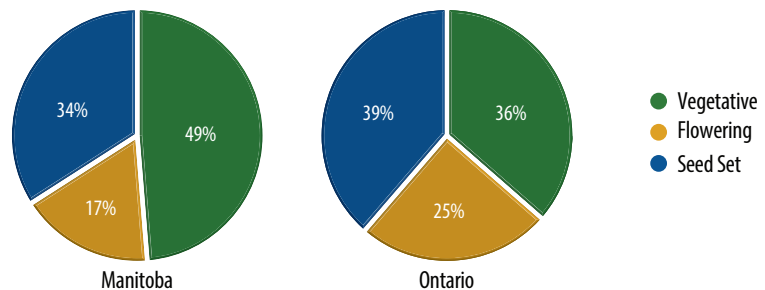
Using data collected from the field experiment, two models were developed to predict soybean phenology and developmental stages - a growth stage interval unit (GSIU) and a photothermal unit (PTU), which were then verified using data from the regional soybean variety trials. Compared to current growing degree day and crop heat unit models, both models developed in this study were more accurate at predicting soybean growth stages. The GISU model was more accurate than the PTU, but also more complex because it included more equations. This complexity could be overcome by building the model into a user-friendly app which may be used by farmers and agronomists to predict critical growth stages for pesticide application timing and predicting maturity.

In the controlled environment experiment, varieties were grown in 14-, 15-, 16- and 17-hour days at a constant 25°C temperature. The longest day length of 17 hours extended the time from emergence (VE) to R1 by two to three days compared to the shortest day length. The rate of development from VE to R1 was slower for varieties of later maturity groups. Varieties were classified into two photosensitivity groups and early maturing varieties tended to be relatively insensitive to changes in day length. Later-maturing soybean varieties were more sensitive to changes in day length, delaying time to flowering.

The models developed in this project to predict soybean development in Manitoba can be used as a foundation for developing new predictive tools, such as crop adaptation models, for farmers and agronomists in Manitoba. Results from this research are valuable to soybean breeders and plant physiologists, increasing the understanding of how soybeans behave in northern environments where the growing season is shorter and the days are longer. ◗

Figure 1. Percentage of the total number of days soybeans spent in critical developmental stages in southern Manitoba and eastern Ontario, averaged over five site-years and 10 food-type soybean varieties.