FLOWER : predicting flowering times of cereal crops

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predicting flowering times of cereal crops

By Georgette Elliott and Stephen Loss, Research Officers, Division of Plant Industry

FLOWER is a computer program which predicts the flowering date of a given wheat or barley variety at a specified location and sowing date. Department of Agriculture agronomists, breeders and advisers are using the program to provide useful information on how the development of cereals responds to different environments across Western Australia's cereal growing areas.

The FLOWER model
Temperature and photo-period (or daylength) are the most important factors influencing the duration from sowing to flowering for Australian wheats and barleys. The model used by FLOWER to predict flowering dates is based upon how each variety responds to temperature and daylength.

The model's parameters are calculated by the FLOWER program from observations obtained from agronomic time of sowing experiments or from plant development nurseries in the Department's plant breeding programme. The nursery plots are irrigated to avoid moisture stress. Observations include the location's latitude, from which daylength can be calculated, the duration from sowing to flowering and daily temperature data.

Unlike other plant developmental models, FLOWER considers sowing to flowering as one development stage. This simplifies the collection of data as other less important and less conspicuous growth stages do not have to be observed.

The FLOWER program is significant because simple observations can be used to predict flowering times at many other sites or during other seasons. From a series of sowing dates at two or three sites, the range of observed temperatures and daylengths can encompass most of those experienced throughout the cropping area. This ensures that the model is not used to predict flowering times outside the range of data on which it was based.

The program can predict flowering times for a series of sowing dates or years for any number of varieties. Results can be restricted to any combination of sowing time and variety which flowers within a specified flowering period, for example that resulting in highest long term yield.

Accuracy of predictions
The FLOWER model was originally developed for Australian wheat varieties, most of which are 'spring types' with small requirements for cold (vernalization) and moderate responses to daylength. The predictions of the model have been tested against flowering times observed independently of those used to derive the model. FLOWER's predictions were accurate to within three to seven days of the observed flowering date for most varieties (Figure 1).
The model also predicts, with a reasonable accuracy, the flowering times of barleys that do not have a strong vernalization requirement.

Use

Within the Department of Agriculture’s wheat and barley breeding programme, the flowering times of parental lines and those in advanced stages of testing are routinely recorded for processing by FLOWER. The computer program predicts flowering times of these lines from a series of sowing dates at other locations across the wheatbelt.

This information allows scientists to screen and allocate breeding lines more efficiently to those environments where they are best adapted in terms of development. When these breeding lines are recommended for release as registered cereal varieties, scientists will have more knowledge of how a variety responds to different environments and sowing times. This knowledge is important when grain industry committees determine variety recommendations for sowing in subsequent seasons.

Similarly, agronomists and advisers have used the predictions of FLOWER to select combinations of variety and sowing time that will flower within the best flowering period for a location. The results of these predictions can be used to minimize the combined risks of rapid development resulting in poor growth, and frost and drought in the long term.

Changes in agronomic practices such as early sowing, the introduction of cereal production into high rainfall coastal regions or environmental changes caused by the increasing carbon dioxide content of the atmosphere could lead to cereal crops being grown outside conventional environments in Western Australia. FLOWER can help scientists choose the variety and sowing time most suited to these ‘new’ environments.

Future development

At present the FLOWER program will only run on the Department of Agriculture’s main-frame computer system in South Perth, however future development could produce a version that will run on micro-computers. This could mean that FLOWER could be run at the Department’s regional offices or made available directly to farmers.

Figure 1. The plot of the observed flowering dates versus those predicted by FLOWER for the wheat variety Gutha, obtained at three sites in three years. Mean difference between observed and predicted dates was three days.

Figure 2 shows how FLOWER predicts that the barley variety, Moondyne, flowers within the best flowering period for late April to early May sowings at Chapman Valley. Stirling barley is better suited to late May sowings at this site and Yagan barley to June sowings.

FLOWER predicts that if Yagan were sown in early May at Chapman, it would flower within 75 days, about mid July in the average season. In a warmer than average season, flowering could be brought forward to the end of June. Early sown crops of fast maturing varieties (such as Yagan barley) have poor growth and small yield potential. Late flowering varieties are more suited to early sowing as they make full use of the available growing season.

Figure 2. Predicted durations from sowing to flowering for three barley varieties sown at a series of dates in an average year at Chapman Valley. The best flowering period is also shown.