Flowering characteristics of adzuki bean from China

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Abstract

Temperature and photoperiod effects on time to flowering in adzuki bean (*Vigna angularis* (Willd.) Ohwi and Ohashi) landraces from China were investigated. A core collection of 7% of 2946 landraces representing the species distribution in China was used. Flowering response to temperature was evaluated at Grafton and Armidale, NSW, (30?S) with different temperature regimes, thereby removing photoperiod differences. Flowering response to photoperiod was measured in controlled temperature conditions during in winter at Biloela, Queensland. Mean difference in flowering was 13.6 days longer at Armidale than Grafton. No differential response to temperature was detected.

The photoperiod study confirmed that adzuki is a quantitative short-day plant with a critical photoperiod of 12-13 hours, above which flowering is delayed. Lines could be placed into four groups, based on latitude of origin, differing in their ceiling photoperiod beyond which there is no further response to photoperiod. Results from sowing date trials with 8 diverse accessions confirm that for an Australian sowing (Nov-Feb), time to flowering is driven principally by accumulated temperature once the photoperiod threshold has been reached.

Introduction

For the summer crop adzuki bean, there is little published information on the genetic variation for photoperiod and temperature effects on the control of time to flowering, two key adaptive traits in all crops. In Australia, adzuki bean germplasm from China has shown higher yield potential than, and equivalent seed quality to, current varieties derived from Japan (1). This study investigates genetic variation in the response of flowering to temperature and photoperiod in adzuki germplasm from China, a major centre of diversity, to determine their importance for the adaptation of newly introduced adzuki bean landraces in Australia.

Materials and methods

Three separate studies were conducted with a core collection of 7% of the 2,946 adzuki bean landraces in China, to represent their geographic range (23?N to 48?N). The seed was obtained from a 1998 winter seed increase at Ayr Queensland after a quarantine import generation.

Experiment 1, which examined temperature responses of the core collection was sown on 9 December, 1998 at Grafton and Armidale, which have the same latitude (30?S) but differ in altitude and temperature. The experiment was sown in unreplicated plots, 4 rows x 30cm x 5m, with grid plot checks of variety Erimo. Sowing density was 500,000 seeds per hectare.

Experiment 2, determined the photo-periodic response of the core collection. The experiment was conducted in winter (1998 and 1999) in a greenhouse at Biloela Queensland, where temperature was controlled (26?8?C) and 150 watt incandescent lights at 1.1m spacing used to regulate daylength at photo-periods of 11.2, 14, 15 and 17.5 h. Landraces were evaluated in unreplicated trials using four different genotypes as grid plot checks. Plots were 6 plants in single 30cm rows 0.55 m apart.

Experiment 3 was a sowing date x location trial. Eight lines chosen to sample the range of diversity in the core collection were sown in 1999-00 on 13 Dec., 7 Jan. and 3 Feb. at Grafton and 25 Nov., 18 Jan. and 28 Feb. at Biloela. Plots were 5m x 4 rows with three replications.

For all experiments days from sowing to 50% first flower was measured.

Results

Experiment 1. Minimum temperatures were lower by 2.5 – 4?C at Armidale than Grafton and the maximum temperatures slightly lower, especially in April. Flowering of the adzuki core collection took from 32 to 93 days at Grafton, and was delayed 10 – 20 days (mean 13.6 days) at Armidale compared to Grafton. At both sites, flowering time increased with decreasing latitude, for example landraces originating from >40?N were earliest flowering (less than 40 days). Four lines at both sites did not conform to the general pattern being either from higher altitudes or recently migrated. There was no genotypic interaction for response to temperature.

Experiment 2. There was a differential response to photoperiod that was related to the latitude of origin of the landraces (Figure 1). All landraces flowered in 26 to 34 days under 11.2 h photo-period. Under the 14 h photo-period, 84% of the landraces flowered in 31 to 82 days. The 16% of landraces which did not flower originated from 23-34?N latitude except for three accessions from high altitudes (> 1300m) which flowered in 51-69 days. Under the 15 h photo-period 55% of the landraces flowered in 30 to 82 days and originated from latitudes >31?N. Under the 17.5 h photo-period, the 14% of landraces that flowered in 49 to 81 days originated from 34-50?N; whilst the 86% of the landraces that did not flower originated from 23-45?N latitude.

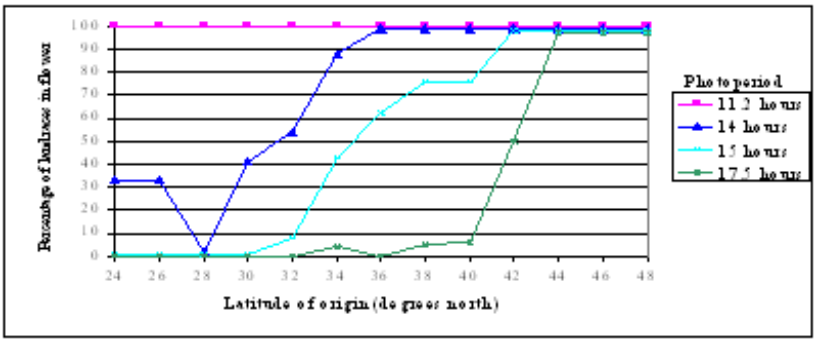

Figure 1. Flowering response to photoperiod of Chinese adzuki bean landraces by latitude of origin.

Experiment 3. Time to flowering showed a similar response to sowing date at Grafton and Biloela, with lines originating >40?N flowering in 37-46 days regardless of sowing date or site. As latitude of origin decreased, the response to sowing date at both sites increased. With the shorter photoperiods associated with later sowing dates, response to latitude of origin decreased at both sites, so that sowing on 28 Feb at Biloela resulted in a flat response to latitude.

Discussion

This study highlights the effects of temperature and photoperiod on flowering in adzuki bean and supports the accepted model that adzuki bean is a quantitative short-day plant.. Our results suggest that the critical photo-period increases as the latitude of origin increases. The critical photo-period requirement of individual landraces ranged from 11 to 17.5 hours per day represented by a sampling of 4 photo-periods in this study. Lines from above 40?N appear to require daylengths longer than 14 to 15 hrs to prevent

flowering and 14% were insensitive to photo-period up to 17.5 hours per day. These photo-insensitive lines were responsive to temperature only, and were similar to Japanese entries from latitudes above 40?N in the study of Wang *et al.* (2001). Lines originating further south, with a photo-period requirement, flowered with the same delay at Armidale relative to Grafton. The few landraces that diverged from the normal pattern reveal there may be some variation to these expected responses.

Acknowledgment

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Reference

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