Tolerence of temperature stress in phaseolus vulgaris.

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Summary: Two accessions of beans *(Phaseolus vulgaris L)* from Mexico, M674 tolerant to pre-flowering heat stress and M685B to post-flowering stress were compared with the local variety Actolac, in controlled temperature glasshouse studies. A sharply defined optimum temperature of 25?/20?C for Actolac was observed for both total dry matter and seed yield, but an optimum pre-flowering temperature of 30?/25?C was indicated for M674 while at 20?/15?C both M685B and M685B were superior to Actolac for total dry matter. M685B had superior pod retention in both 20?/15?C and 35?/30? treatments, and was relatively stable for both biomass and reproductive growth over the temperature range.

Introduction

Beans, grown as a summer crop in southern Queensland, are subject to irregular periods of heat stress at flowering causing grain yield loss. Genetic variation for grain yield of beans under heat stress in the field has been identified (1). Five accessions from this work were studied in controlled temperature glasshouses (2), comparing 24/19?C (optimum) and 34/29?C. Three high temperature treatments, 8 days pre-flowering, 16 days pre- and postflowering and 10 days over the flowering to post flowering stages, were compared with the optimum. Among selected heat tolerant accessions from Mexico (1), accession M674 was found to be the most tolerant for pod and seed production under pre-flowering stress, and accession M685B was the most tolerant for these traits under post-flowering stress. All however failed to set seed under heat stress pre and post-flowering. The aim of the current study was to characterise responses to temperature at flowering of these two accessions and the local check variety Actolac.

Methods

Three bean cultivars M674, M685B and Actolac were subjected to three day/night temperature treatments 20/15?C, 30/25?C, and 35/30?C at three time (T) periods plus a 25/20?C control. Those temperature stress periods were, T1: 32-40 days after sowing during pre-flowering, T2 during flowering days 40-48, and T3: days 44-46. All reproductive buds, plus flowers and pods were tagged at 2 day intervals in each treatment. Physiologically mature seed were harvested on day 79. The design was a randomised complete block with 5 replicates for the 27 cultivar x stress combinations plus three varieties grown at 25/20?C as a control. Plots were 20cm diameter pots with 2 seeds sown and thinned to one plant/pot. Plants were staked to guide vines. The plant density in the control (25/20?C) glasshouse the location for all pots before and after Ti, T2 and T3 treatments, was higher than for the applied temperatures in other glasshouses, hence the control was only suitable for comparison with T1 before shading effects developed. Grain yield, yield components, biomass and the survival of reproductive organs were measured on a per plant basis.

Results

Only the results for significant cultivar x temperature interactions arc reported, with corresponding I.s.d.'s under Figures 1-3. Pre-flowering stress (T1) of 35/30?C completely inhibited seed set hence only the responses to 20/15?C, 25/20?C and 30/25?C are reported (Fig. I). M674 maximised seed yield, biomass increment (days 3240), pod number and seed weight under 30/25?C however the seed yield was significantly reduced at 25/20?C in comparison with 20/15?C and 30/25?C. In contrast Actolac maximised grain yield, pod number, seed/pod, and biomass at 25/20?C. M685B displayed no response to temperature for seed yield and pod number, and was superior in the percentage of bud branches that formed pods, at 20/15?C only (the seed yield reduction at 25/20?C was non significant). For all three accessions seed weight was maximised at 30/25?C.

Stress during flowering (T2) greatly depressed seed set and most yield components at 35/30?C (Fig 2). For biomass production under 35/30?C stress M685B was least affected, and seed weights for M685B and M674 were little affected by temperature in comparison with Actolac with a peak at 30/25?C. At 20/15?C Actolac maximised percentage of pod bearing branches, pod number and seeds/pod but minimised seed weight. M674 also maximised seed weight. biomass, seed yield and percentage of pod bearing branches at 20/15?C. Thus at flowering Actolac and M674 outperformed M685B for reproductive growth especially at 20/15?C, however biomass increment was notably superior for M685B especially at 35/30?C.

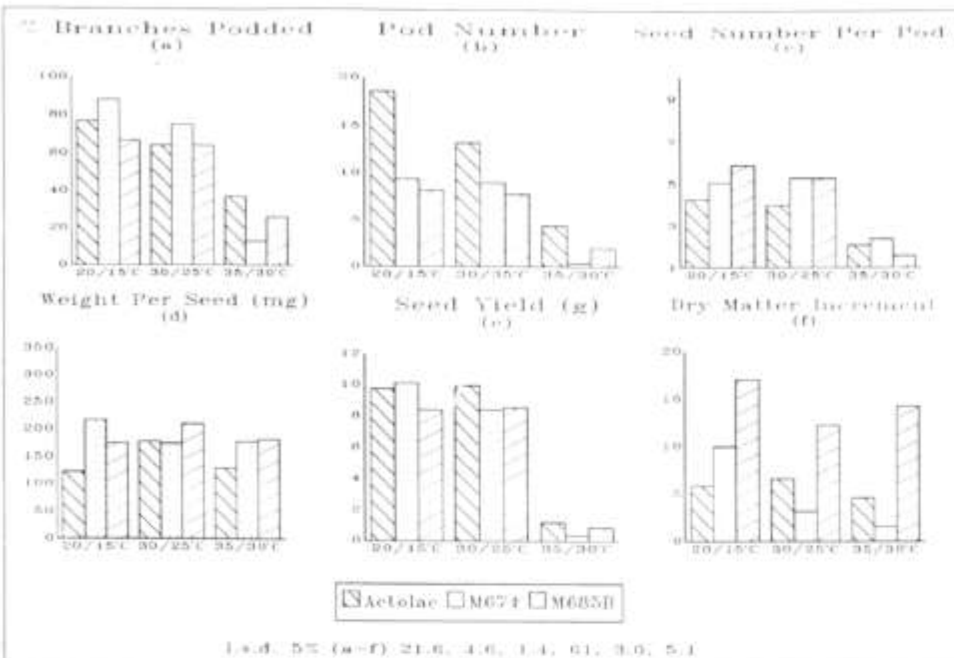

Figure 2. Growth responses of three varieties to three temperature stresses during flowering (Means of 5 Plants).

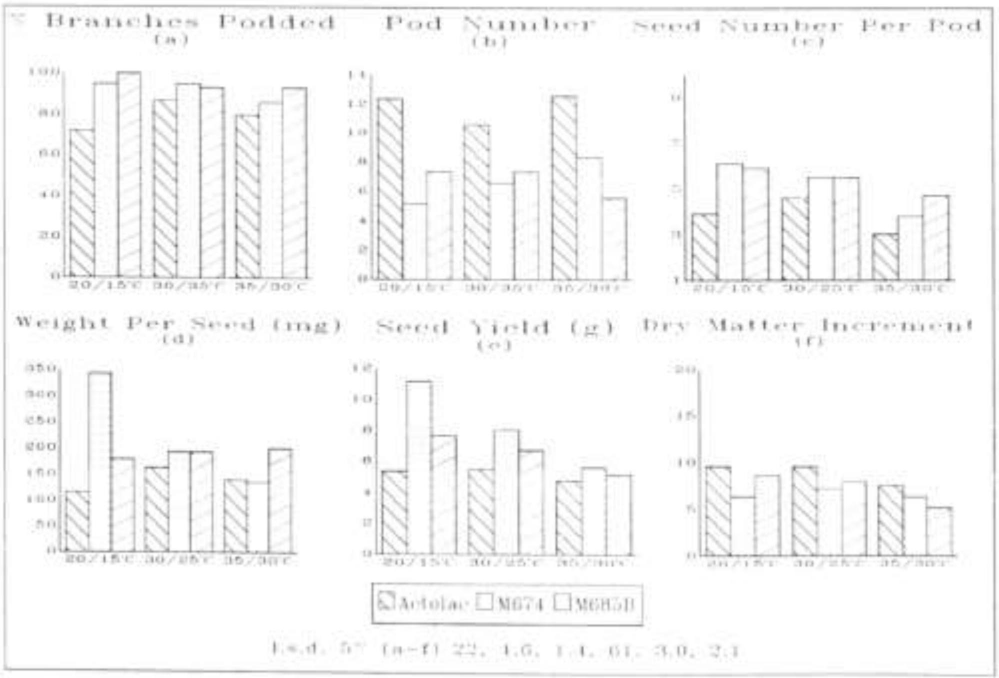

Figure 3. Response of three varieties to short term temperature stresses post-flowering at six temperatures (Means of 5 Plants).

Short term post-flowering stress (T_3) over the temperature range least affected M685B for percentage of reproductive branches with pods, seeds per pod and seed weight (Fig 3). M674 showed a strongly positive response to 20/15?C for seed weight and seed yield both of which were greatly reduced at 35/30?C. Actolac was superior in pod number at all temperatures but inferior in percentage of reproductive branches with pods and in seed weight, for all characters except pod number it performed best at 30/25?C. Actolac tolerated a 35/30?C 2 day stress post-flowering via different yield component responses than M685B, while M674 was very responsive to a 2 day stress at 20/15?C.

Discussion

Actolac appears to have a more sharply defined optimum temperature for yield than the Mexican accessions. The reduced reproductive growth of Actolac under both low and high temperature stresses over three stages of reproduction is consistent with a previous study (2). Also consistent with the previous study. M674 was the most adapted to moderate heat stress pre flowering, but it is also adapted to low temperature stress during flowering and post-flowering particularly for seed size and yield. M685b tended to have the most stable growth pattern over a range of temperatures and reproductive stages, and as before (2) was superior under high heat stress post-flowering for percentage of reproductive branches with pods, seed/pod and seed weight. The short post-flowering temperature stresses demonstrated both a marked sensitivity of beans to stress and differential varietal responses. This study agrees with Wallace (3) on genetically determined optimum temperatures and further suggests genetic differences in adaptation to temperature fluctuation.

References

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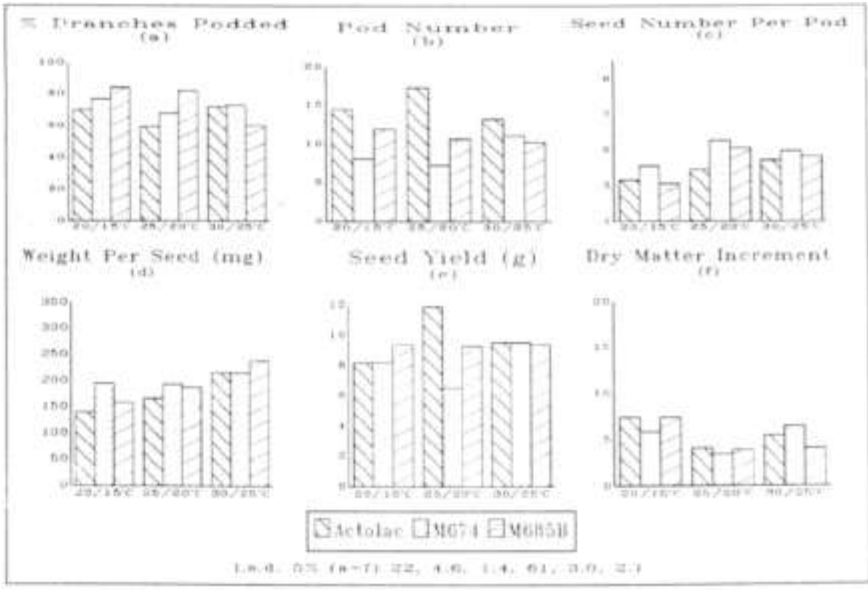

Figure 1. Growth responses of three varieties to four temperature stresses pre-flowering (Means of 5 Plants). Pod set failed in 35/30°C, hence results absent.