American Journal of Botany

American Journal of Botany 100(10): 1991–1999. 2013.

Chilling-induced water stress: Variation in shoot turgor maintenance among wild tomato species from diverse habitats[1]

Hsien Ming Easlon[2,4], José Salvador Rubio Asensio[3], Dina A. St.Clair[2], and Arnold J. Bloom[2]

Some background

- Tomatoes are chilling sensitive and grow very slowly at cool temperatures
- Chilling can cause significant photodamage and also causes shoot wilting
    - chilling reduces root water absorption
    - stomata need to close to compensate; if not…wilting results
- Domesticated tomato shows shoot wilting at low temperature but *S. habrochaites* is tolerant.
    - Differences are due to stomatal closure.

Figure 2

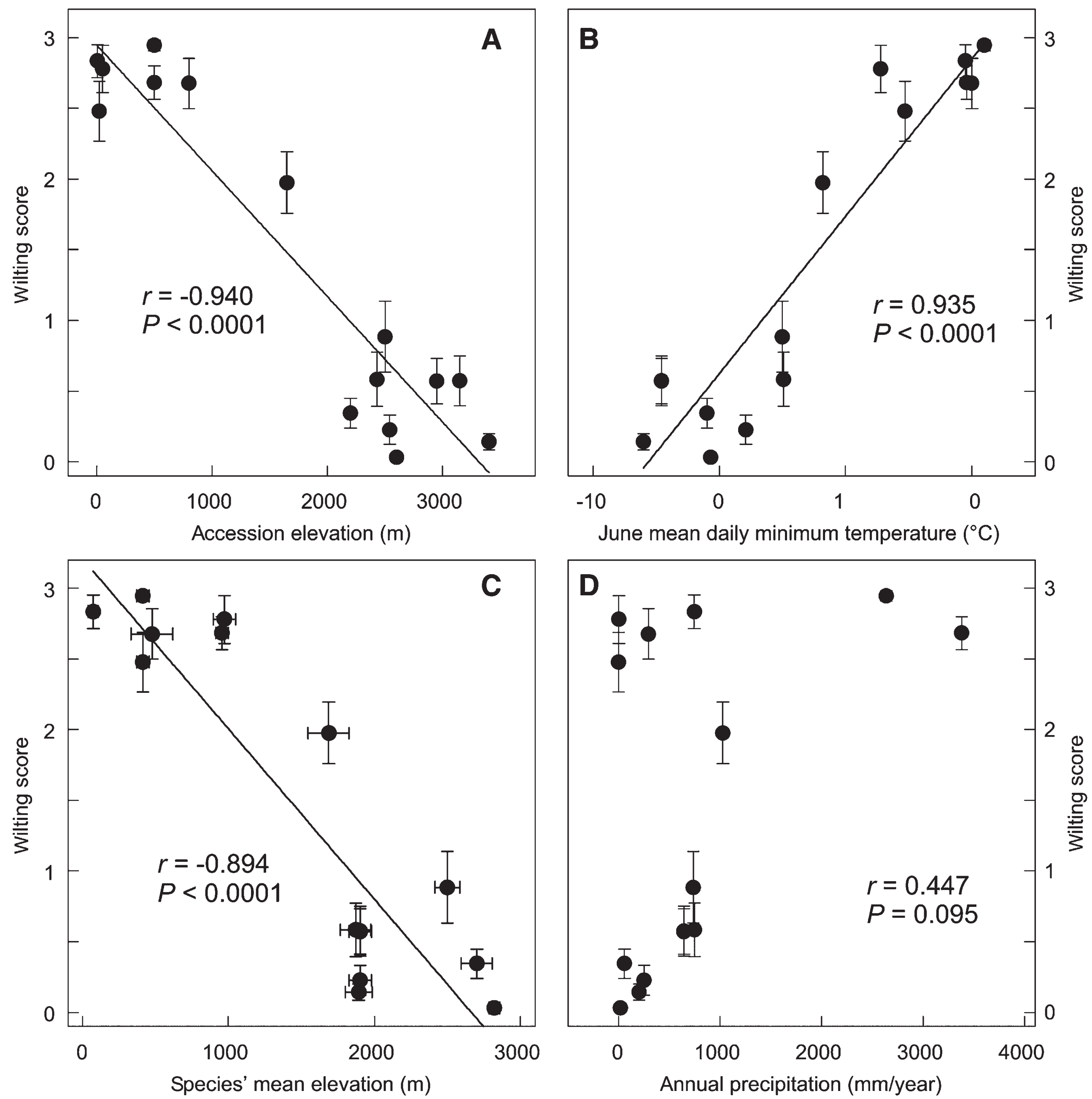

Fig. 2. Correlations between shoot wilting score (±SE) during root chilling and (A) native source population elevation, (B) winter minimum temperature (C) mean species elevation (±SE), and (D) annual precipitation for accessions in the genus *Solanum* sect. *Lycopersicon* and allies *S. lycopersicoides* and *S. sitiens* (see Table 1). Shoots were scored for wilting on a 0 to 3 scale (0 = completely turgid shoot, 1 = leaflet tips were flaccid, 2 = more that 50% of the leaf area was flaccid and 3 = completely wilted). Linear regressions fitted to data.

Figure 3

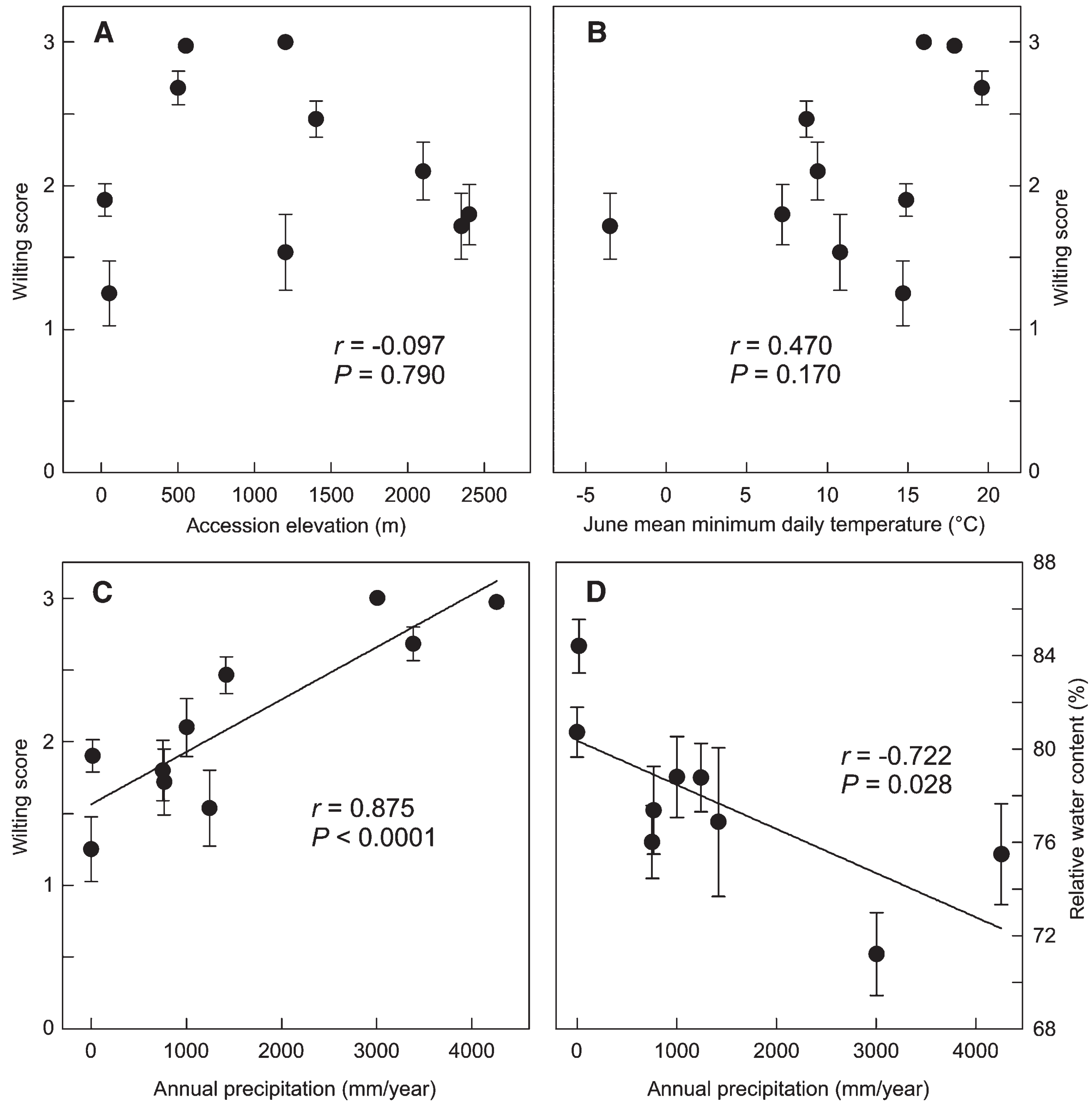

Fig. 3. Correlations between shoot wilting score (±SE) during root chilling and (A) native source population elevation, (B) winter minimum temperature, (C) annual precipitation, and (D) leaf relative water content and annual precipitation for accessions of *Solanum lycopersicum* var. *cerasiforme* (see Table 2). Shoots were scored for wilting on a 0 to 3 scale (0 = completely turgid shoot, 1 = leaflet tips were flaccid, 2 = more that 50% of the leaf area was flaccid and 3 = completely wilted). Linear regressions fitted to data.

Figure 4

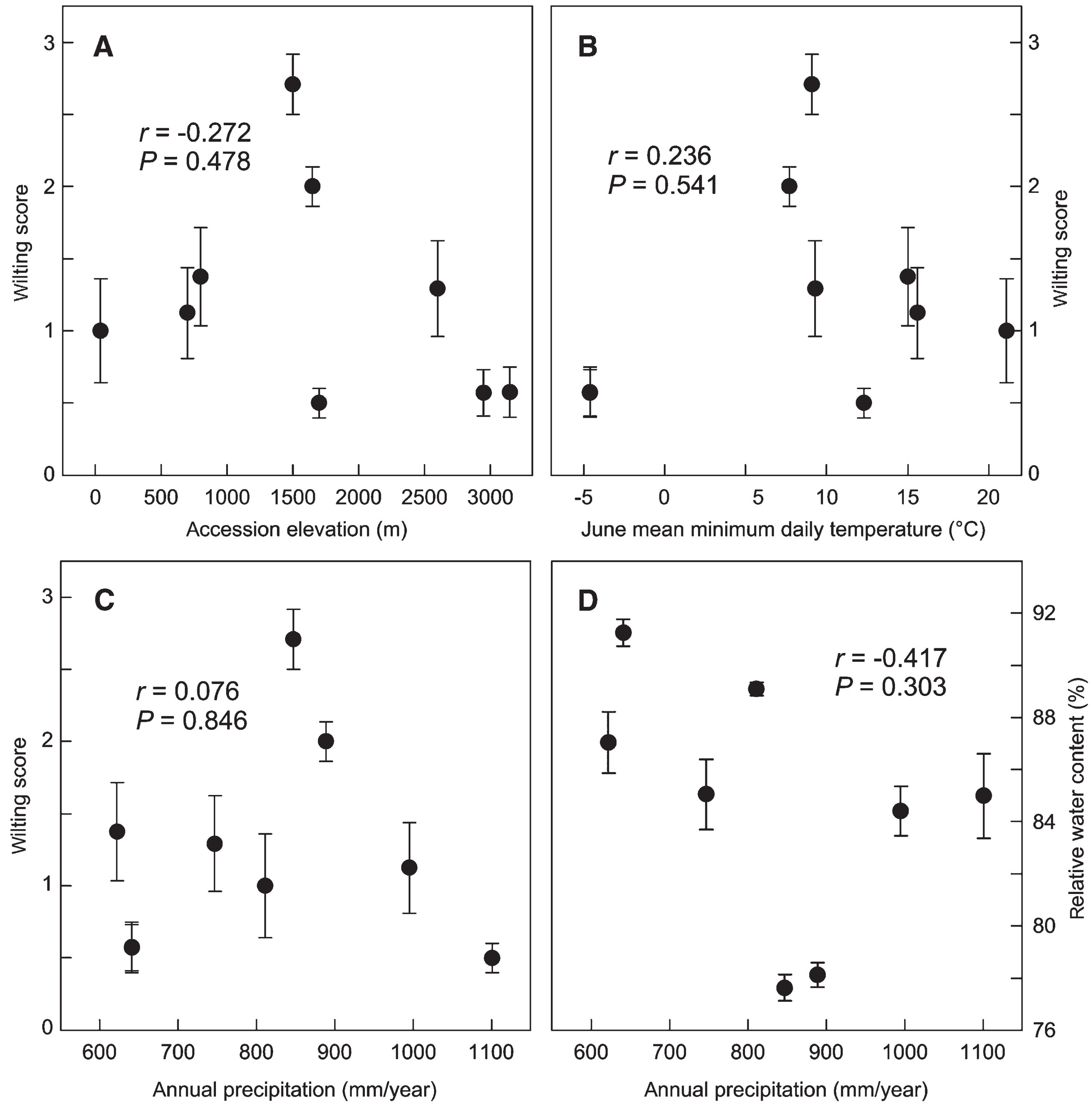

Fig. 4. Correlations between shoot wilting score (±SE) during root chilling and (A) native source population elevation, (B) winter minimum temperature, (C) annual precipitation, and (D) leaf relative water content and annual precipitation for accessions of *Solanum habrochaites* (see Table 2). Shoots were scored for wilting on 0 to 3 scale (0 = completely turgid shoot, 1 = leaflet tips were flaccid, 2 = more that 50% of the leaf area was flaccid and 3 = completely wilted). Linear regressions fitted to data.

Figure 1

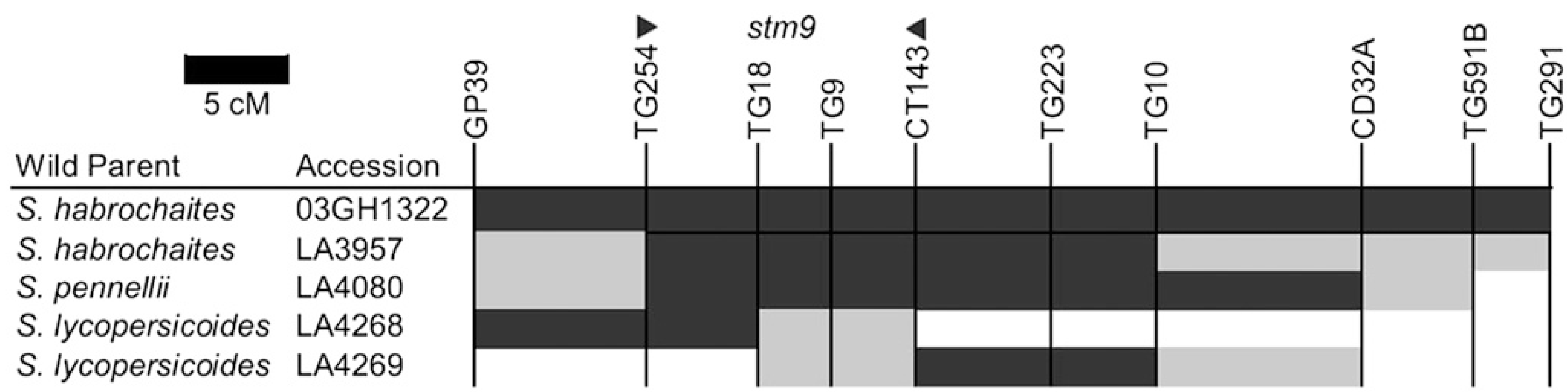

Fig. 1. Graphical scheme of genotypes of the chromosome 9 region in introgression lines obtained from C. M. Rick Tomato Genetics Resource Center (http://tgrc.ucdavis.edu) and for a chromosome 9 NIL (03GH1322) derived from *Solanum habrochaites* acc. LA1778 (Goodstal et al., 2005). Arrows indicate the major QTL, *stm9.* White bars indicate *S. lycopersicum* alleles, black bars indicate wild species alleles, and gray bars indicate regions of recombination breakpoints. Genetic distances (in cM) estimated from the *S. lycopersicum* × *S. pennellii* LA0716 mapping population (http://solgenomics.net).

Figure 5

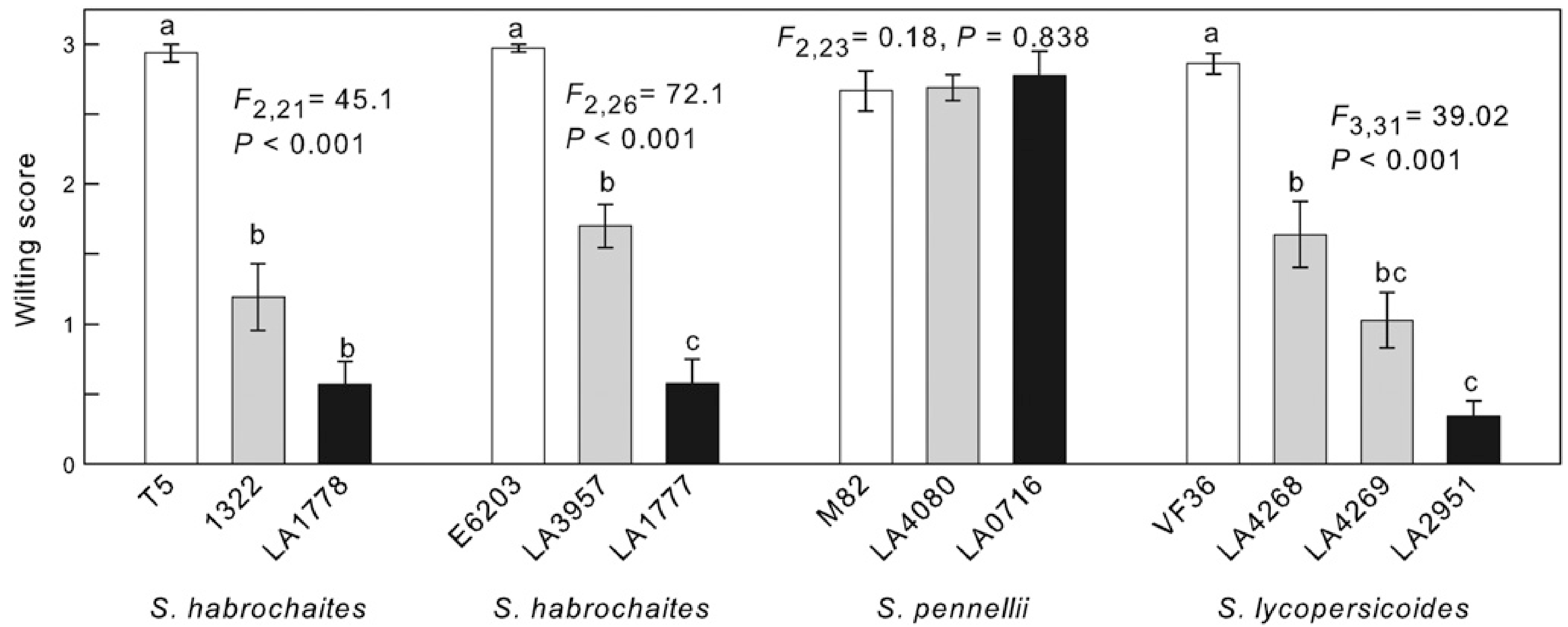

Fig. 5. Shoot wilting scores (±SE) during root chilling in tomato chromosome 9 introgression lines or NIL 03GH1322 (gray) and their wild accession (black) and cultivated variety (white) parents. A score of 3 indicates that the shoots were fully flaccid; a score of 0 indicates that they were fully turgid. Letters indicate significant differences within groups according to Tukey's tests ($P < 0.05$).

Figure 6

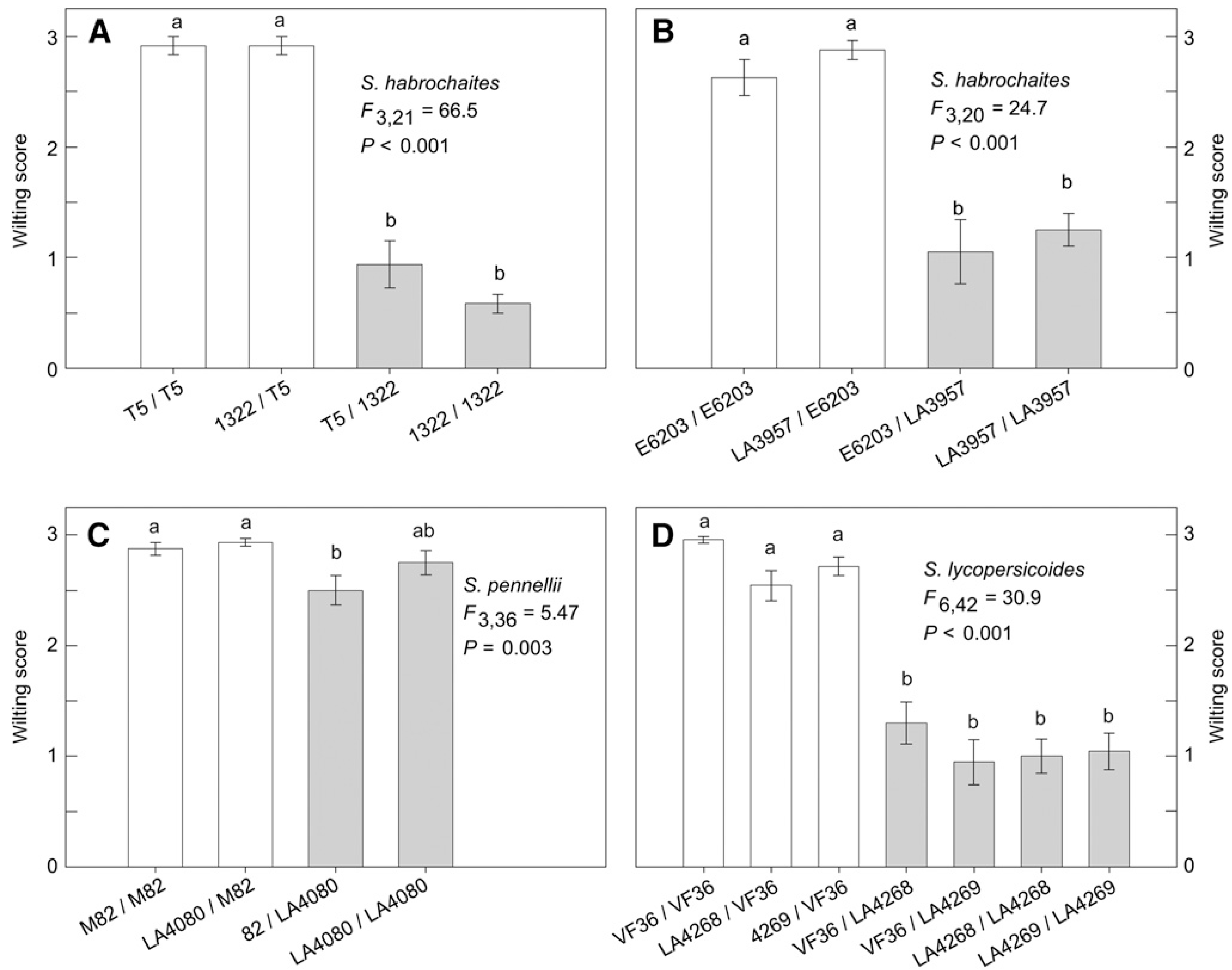

Fig. 6. Shoot wilting scores (±SE) during root chilling in grafts of tomato chromosome 9 introgression lines or NIL 03GH1322 and cultivated variety parents (denoted as shoot genotype / root genotype). Gray bars indicate roots have wild alleles at regions collinear to *stm9*. A score of 3 indicates that the shoots were fully flaccid; a score of 0 indicates that they were fully turgid. Letters indicate significant differences according to Tukey's tests ($P < 0.05$).

Huevelink 2006, Fig. 1

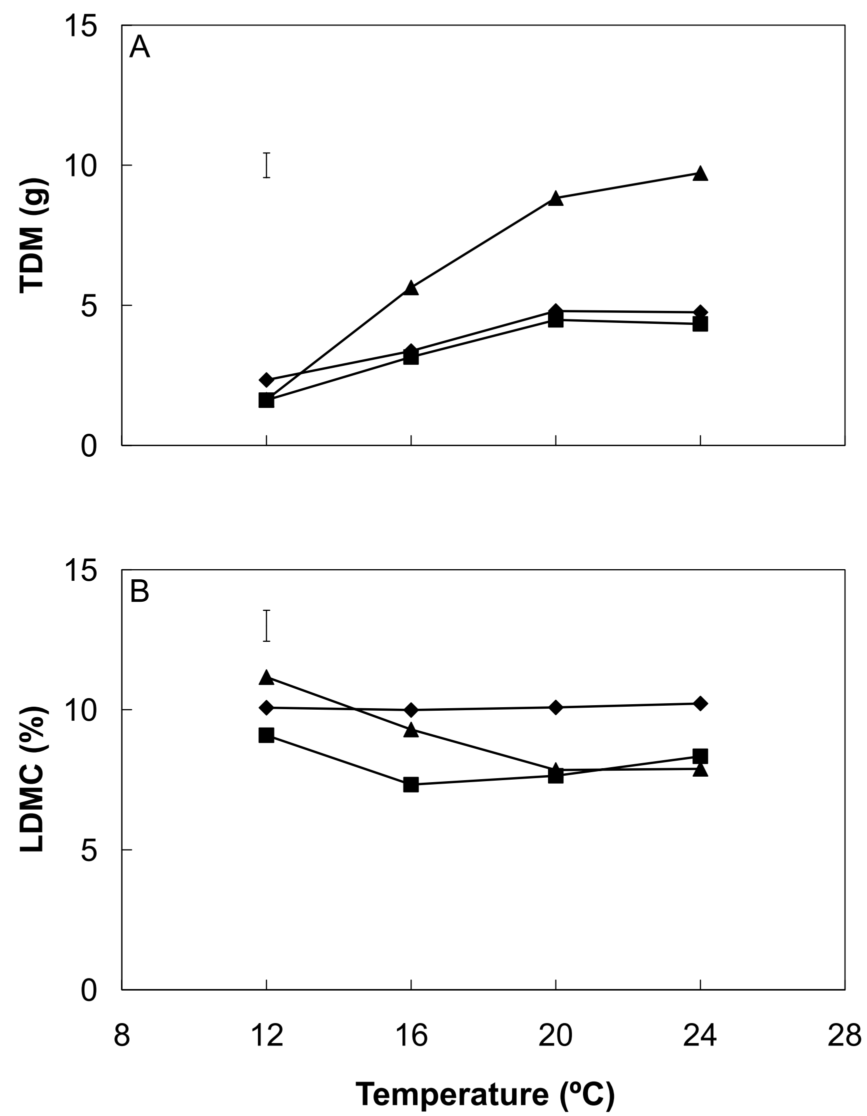

Fig. 1. The effect of temperature on total dry mass (TDM) (A) and leaf dry matter content (LDMC) (B) of *L. esculentum* cv. Moneymaker (▲), *L. pennellii* (■) and *L. hirsutum* (♦) after four weeks of temperature treatment. Vertical bars indicate LSD = 0.87 (A) and LSD = 1.1 (B).

Huevelink 2006, Fig. 2

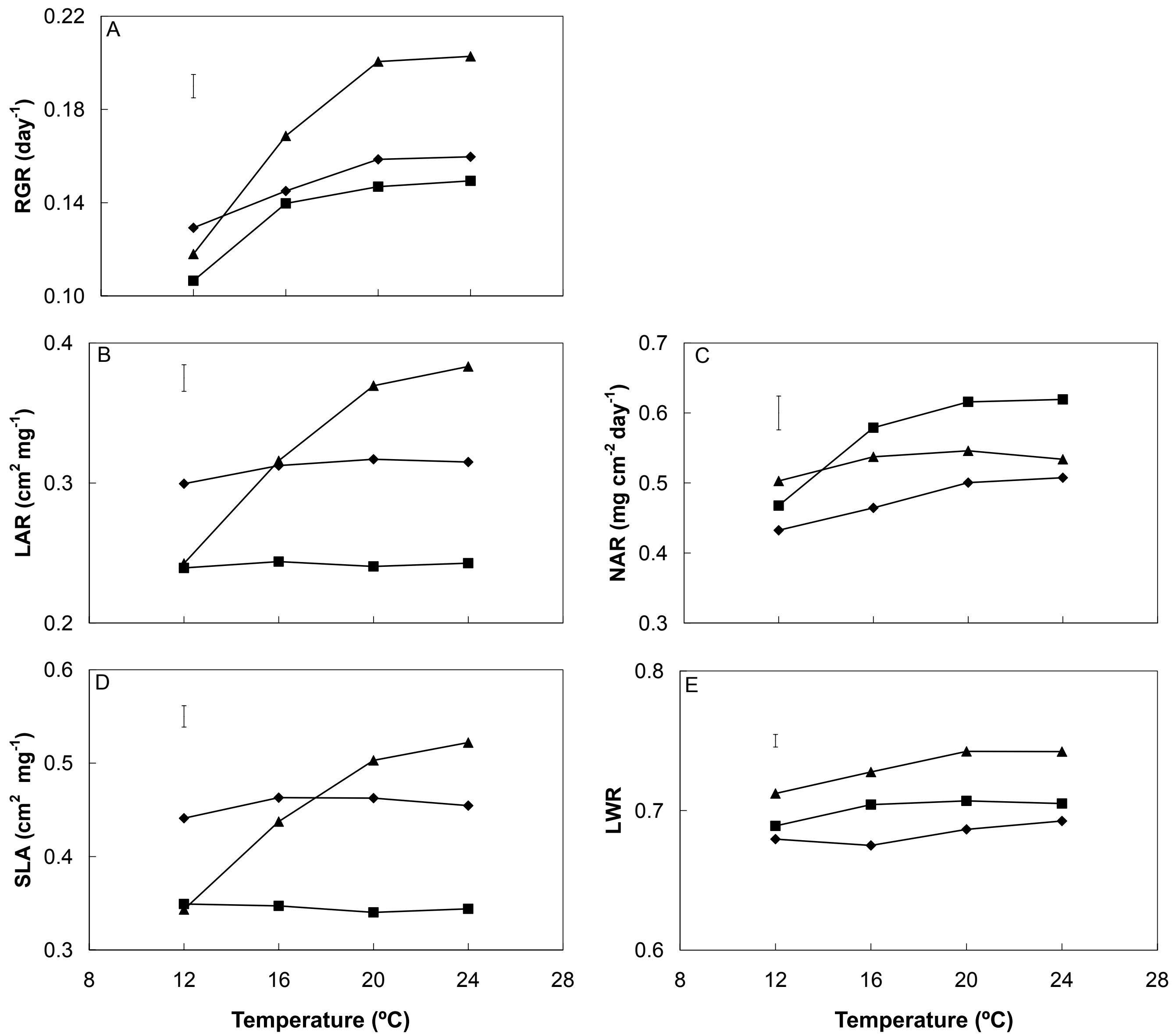

Fig. 2. The effect of temperature on RGR (A), LAR (B), NAR (C), SLA (D) and LWR (E) of *L. esculentum* cv. Moneymaker (▲), *L. pennellii* (■) and *L. hirsutum* (♦). Vertical bars indicate LSD = 0.010 (A), LSD = 0.019 (B), LSD = 0.048 (C), LSD = 0.023 (D) and LSD = 0.009 (E).

RGR: Relative Growth Rate
LAR: Leaf Area Ratio
NAR: Net Assimilation Rate
SLA: Specific Leaf Area
LWR: Leaf Weight Ratio

Compared based on a TDM interval of 20.5 - 92.5 TDM

Huevelink 2006, Fig. 3