BAY KLIMAFIT 2
Projektverbund · Starke Pflanzen im Klimawandel

Identification of interlinked Boron deficiency and drought stress mechanisms and their underlying genes in *Brassica napus*

Jiline B. Tölle, Thomas D. Alcock, Gerd Patrick Bienert
Technical University of Munich, Professorship of Crop Physiology

Boron deficiency and drought stress: a vicious circle

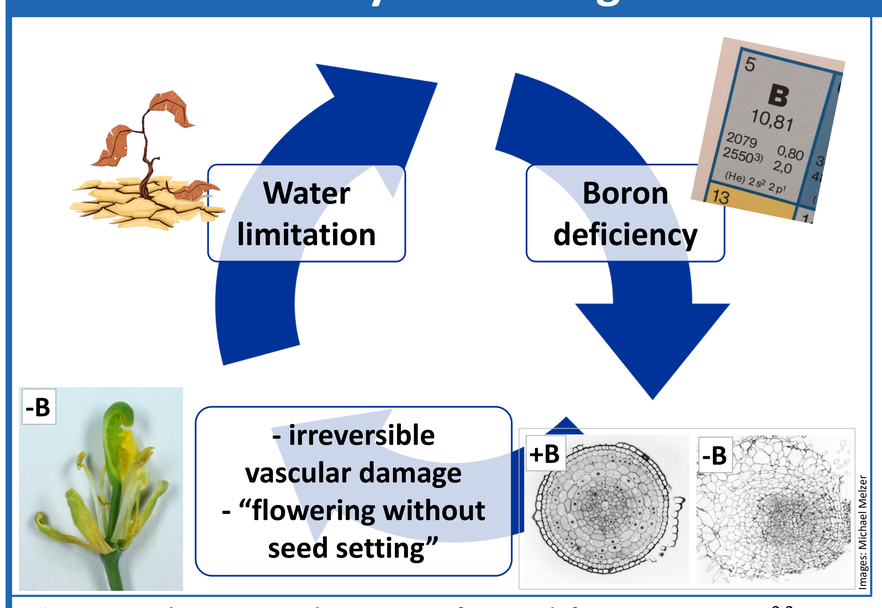

Fig. 1: Drought increases the severity of Boron deficiency symptoms[2,3]

Brassica napus is Boron (B) deficiency sensitive. Typical B deficiency symptoms are an inhibited cell elongation and at the flowering stage a necrotic flower buds or a "flowering without seed setting" phenotype (Fig.1, 2)[1,2]

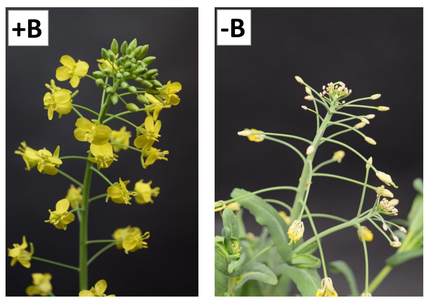

Fig. 2: *B. napus* inflorescence phenotype on +B and -B conditions.

Project aim **Identification of molecular and physiological interlinked Boron deficiency and drought stress mechanisms and their underlying genes/QTLs in two *B. napus* genotypes contrasting in B efficiency and their derived DH population**

Materials and Methods

- 198 double-haploid *B. napus* lines, segregating for B efficiency, and their parental accessions[4] (Fig. 3) were phenotyped during flowering on -B and drought stress conditions

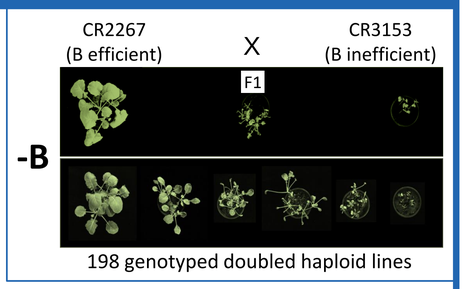

Fig. 3: Top: *CR2267*, *CR3153* and F1 on -B; Bottom: DH population on -B.

- In the glasshouse (Fig. 4), plants were grown on B deficient substrate (< 0.08 mg B/kg substrate; Fruhstorfer Nullerde)[4] supplemented with 0.02 mg B/kg substrate, sufficient supply of other essential nutrients. *CR3153* and *CR2267* were additionally grown on B sufficient substrate (2.5 mg B/kg substrate)
- At BBCH 50 (bud formation), plants were divided into well-watered (WW) and water-limited (WL) treatments (> / < 10 % volumetric water content) and phenotyped during flowering and at harvest (111 days after sowing)

Fig. 4: *B. napus* plants grown on -B.

Drought stress and B deficiency limit biomass accumulation

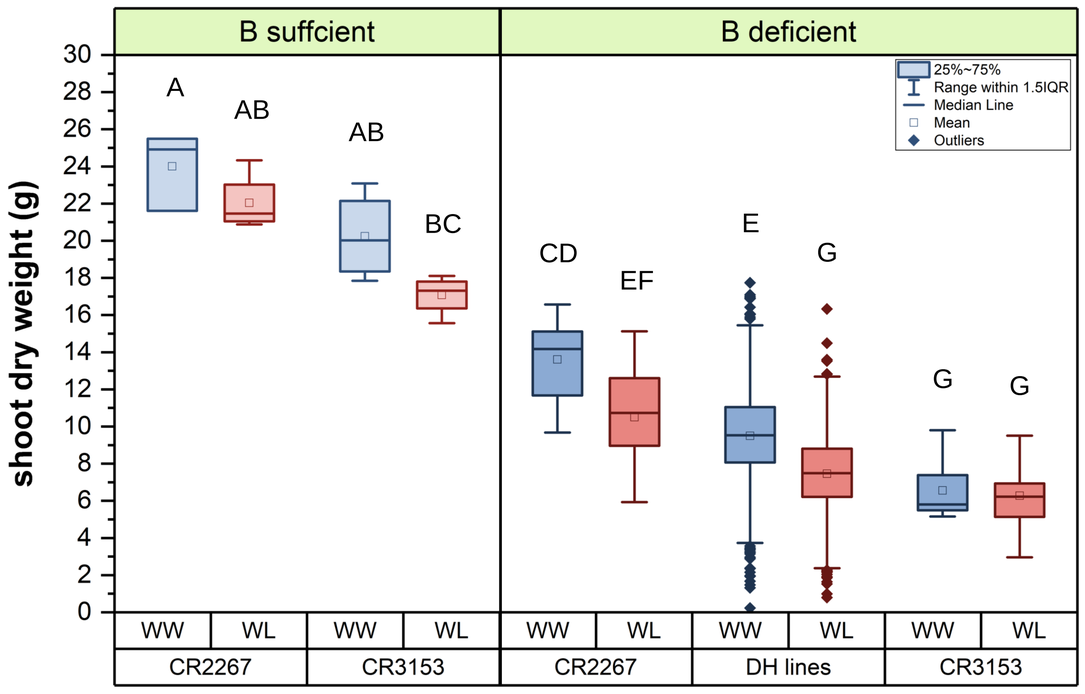

Fig. 5: Shoot dry weight of *B. napus* parental accessions *CR2267* (B-efficient) and *CR3153* (B-inefficient) and 198 DH lines under B sufficient and B deficient conditions comparing well-watered (WW) and water-limited (WL) treatments. Upper case letters indicate significance between genotypes, B conditions and water treatments ($p < 0.05$, ANOVA, post hoc Tukey test). (B sufficient: *CR2267*, *CR3153*: n = 3-4 plants, per treatment; B deficient: *CR2267*, *CR3153*: n = 15 plants, per treatment, DH lines: WW n = 989 and WL n = 988 plants).

Flower development severely inhibited by B deficiency

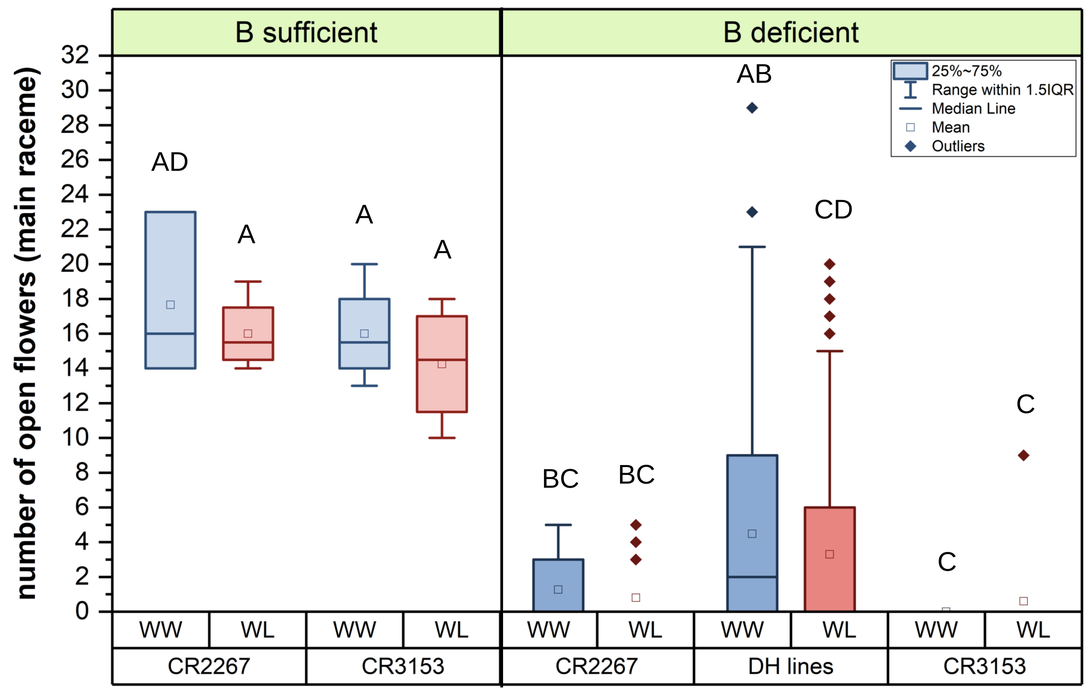

Fig. 6: Number of open flowers (main raceme) of *B. napus* parental accessions *CR2267* (B-efficient) and *CR3153* (B-inefficient) and 198 DH lines under B sufficient and B deficient conditions comparing well-watered (WW) and water-limited (WL) treatments, phenotyped 4 days after the first flowers opened. Upper case letters indicate significance between genotypes, B conditions and water treatments ($p < 0.05$, Kruskal-Wallis ANOVA, post hoc Dunn's test). (B sufficient: *CR2267*, *CR3153*: n = 3-4 plants, per treatment; B deficient: *CR2267*, *CR3153*: n = 15, DH lines: n = 990 plants, per treatment).

Chance of flowers opening predetermined by bud appearance on -B

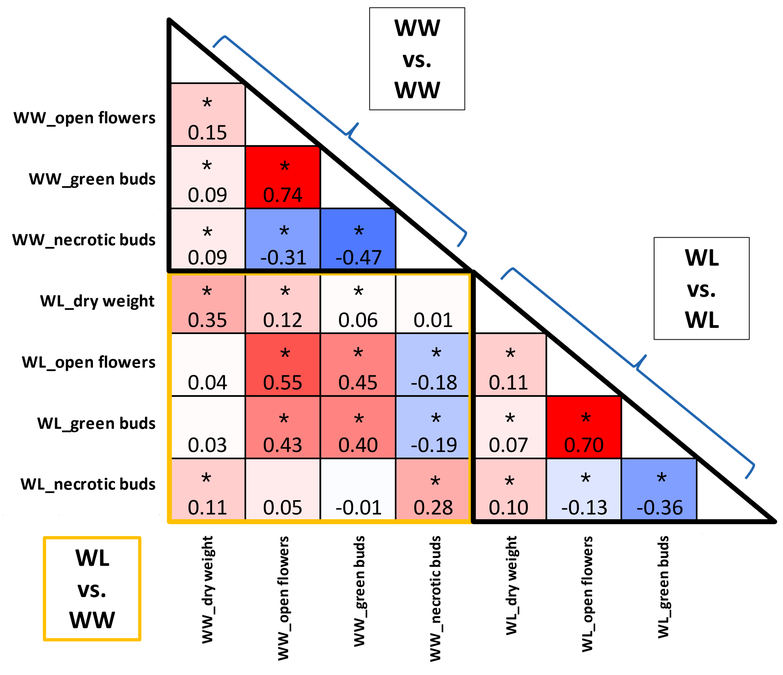

Fig. 7: Spearman's correlation table between phenotypic parameters of the main raceme (open flowers, green and necrotic flower buds), phenotyped 4 days after the first flowers opened, and dry weight of the whole plant for all *B. napus* plants (*CR2267, CR3153,* 198 DH lines) comparing well-watered (WW) and water-limited (WL) treatments under B deficient conditions.
Different colours represent positive (red) or negative correlations (blue), and colour intensity represents Spearman's correlation coefficient (*p<0.05; n = 1013-1020).

Flower malformation phenotypes caused by B deficiency

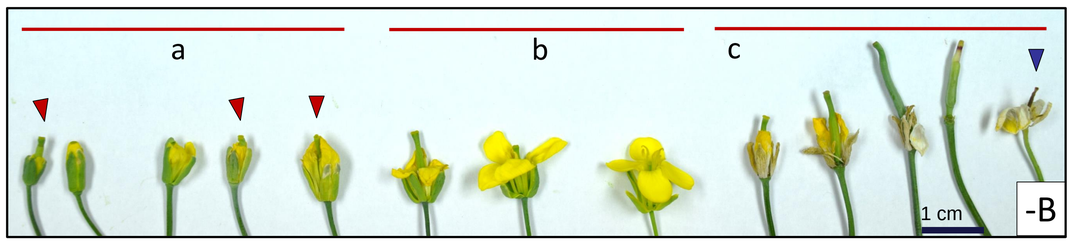

Fig. 8: Bud to flower to silique development on -B growth conditions. Left to right: a. various bud/open flower phenotypes with visible stigmas (red arrow head) above petals, b. open flower phenotypes from strongly wrinkled to fully turgid, c. senescent flowers with silique development and dried stigma (blue arrow head).

Conclusion

Genotype specific differences in biomass accumulation and fertility parameters detected between well-watered and water-limited treatments, indicating heritable variation in drought stress tolerance in low B conditions.

Next steps: elemental composition via ICP-MS analysis and QTL analysis

References
1: Marschner (2012): Marschner's Mineral Nutrition of Higher Plants, Academic Press.
2: Brdar-Jokanovic (2020), Int. J. Mol. Sci. 21: 1424.
3: Wimmer & Eichert (2013), Plant Science, 203-204, 25 – 32.
4: Pommerrenig et al. (2018), Front Plant Sci., 9, 1142.

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