Responses of leaf expansion and plant transpiration of different soybean genotypes to soil water deficit

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Background & Aims

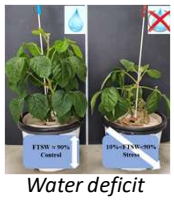
The responses of ecophysiological processes such as leaf expansion and plant transpiration to soil water deficit have been reported to be genotype-dependent. To study such responses in soybean, a two-year (2017 and 2021) outdoor pot experiment was carried out on the Heliaphen automated phenotyping platform at INRAE in Toulouse (France). The purpose is to develop a non-destructive phenotyping method which could bring new information to variety testing process and provide paths for integrating genotypic variability into crop growth models used for simulating soybean responses to water deficit at a plant, field, or regional level.

Materials & Methods

Auzeville, France (43°31'41.8"N, 1°29'58.6"E)

Cultivars	Breeder	Maturity group
Sultana	RAGT 2N	000
ES Pallador	EURALIS SEMENCES	I
Isidor	EURALIS SEMENCES	I
Santana	RAGT 2N	I/II
Blancas	CAUSSADE SEMENCES	II
Ecudor	EURALIS SEMENCES	II

Heliaphen automated phenotyping platform



Water deficit

Non-linear regression

Leaf expansion: NLE

Plant transpiration: NTP

FTSW Indicator of water deficit

(Casadebaig et al., 2008)

$$y = \frac{2}{1 + exp(a \times FTSW)} - 1$$

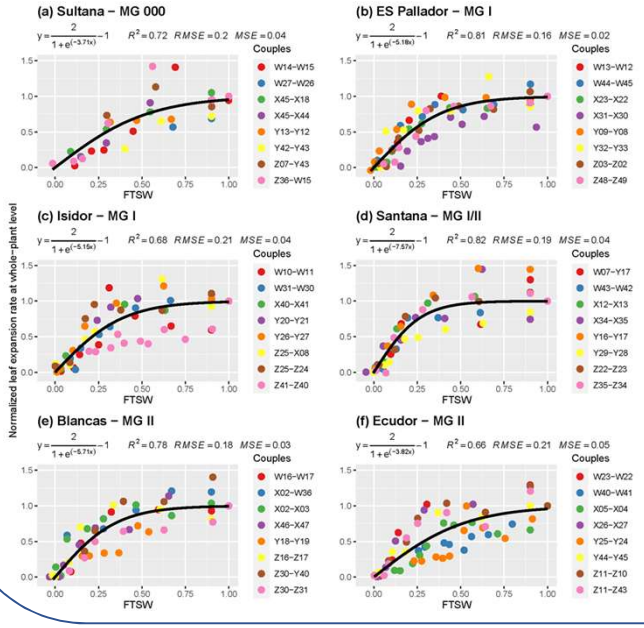
$$y = \frac{1}{1 + 4.5 \times exp(a \times FTSW)}$$

Results

2017 & 2021: NLE and NTP performed by **R**

Example: **NLE in 2021**.

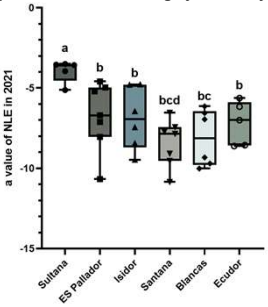
**The same non-linear fitting operation is also implemented on NLE of 2017, NTP of 2017, and NTP of 2021.*



2017 & 2021: **a** value of NLE and NTP performed by **GraphPad Prism**

NLE: $y = \frac{2}{1+exp(a \times FTSW)} - 1$ NTP: $y = \frac{1}{1+4.5 \times exp(a \times FTSW)}$

**FTSWt, the FTSW threshold for which the rate of the ecophysiological process in stressed plants starts to diverge from a reference value.*

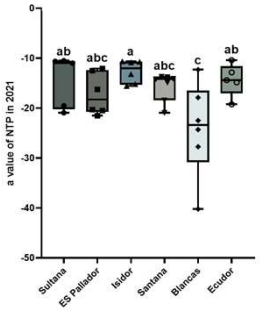


NLE MG	Variety	EXP1-2017 FTSWt	Group	EXP2-2021 FTSWt	Group
000	Sultana	0.80	ab	0.93	a
I	ES Pallador	0.65	ab	0.54	b
I	Isidor	0.92	a	0.53	b
I/II	Santana	0.60	ab	0.43	bcd
II	Blancas	0.55	ab	0.45	bc
II	Ecudor	0.38	b	0.51	b

*assuming that FTSWt was achieved when maximum normalized leaf expansion was reduced by 5%.

◆Genotypic differences are presented in both EXPs.

◆More noticeable in EXP1, as the MG gets later, the NLE sensitivity to water deficit becomes weaker.



NTP MG	Variety	EXP1-2017 FTSWt	Group	EXP2-2021 FTSWt	Group
000	Sultana	0.53	a	0.31	ab
I	ES Pallador	0.36	ab	0.26	abc
I	Isidor	0.41	ab	0.35	a
I/II	Santana	0.15	cd	0.28	abc
II	Blancas	0.24	abc	0.18	c
II	Ecudor	0.17	c	0.31	ab

*assuming that FTSWt was achieved when maximum normalized plant transpiration was reduced by 5%.

☐ Genotypic differences are presented in both EXPs.

☐ NTP sensitivity to water deficit and MG is not obvious.

Conclusion

- ✓ A non-destructive phenotyping method was developed for simulating soybean ecophysiological responses to water deficit.
- ✓ Genotypic differences were presented in both leaf expansion and plant transpiration.
- ✓ For NLE, the earlier MGs were more sensitive to water deficit, but the performance of NTP to water deficit was not consistent.

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