Salinity stress-mediated phenotypic, biochemical and microscopic assessment of two flaxseed cultivars having contrasting lignan content

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INTRODUCTION & AIM

On the verge of the United Nations' predicted upcoming food scarcity, research regarding plants' potentiality to withstand environmental stresses to provide better yield has immense importance. Salinity is one of the major abiotic stresses (UN 2022). Presently, salinity affects around 20% of total cultivated and 33% of irrigated lands that includes more than 424 million hectares of topsoil (0-30 cm) and 833 million hectares of subsoil (30-100 cm) spanning 73% of the global land area. By 2050, around 50% of total arable land may be affected by salinity (FAO 2021). In this context, plant lignans are such substances of great potential that possess multifunctional roles towards different organisms including plants and humans. Lignans accumulate in plants and primarily act as defence substances during abiotic stresses (Ražná et al. 2021). Flaxseed (*Linum usitatissimum* L.) is a rich source of lignans. However, the lignan contents are dependent on plant genotypes. Therefore, this report searched for the answer to the question – "**under salinity stress, how much better a high lignan-containing flaxseed genotype adapt than a low lignan-containing flaxseed genotype?**".

MATERIALS & METHOD

3-week-old Flaxseed plant + 1 week 100 mM NaCl stress
Flanders (higher lignan) and Astella (lower lignan)

Shoot
Length measurement
Using ruler scale

Leaf
Relative water content
measurement

Root
Phenotyping
Length, diameter, volume, tips and forks number
Epson Expression 11000XL + WinRHIZO Pro 2013e

Biochemical analyses
Radical scavenging activity (DPPH method);
Total polyphenol content (Folin-Ciocalteu reagent);
Total phenolic acids content (Arnova reagent)

Fluorescence Microscopy
FDA-PI co-staining

RESULTS & DISCUSSION

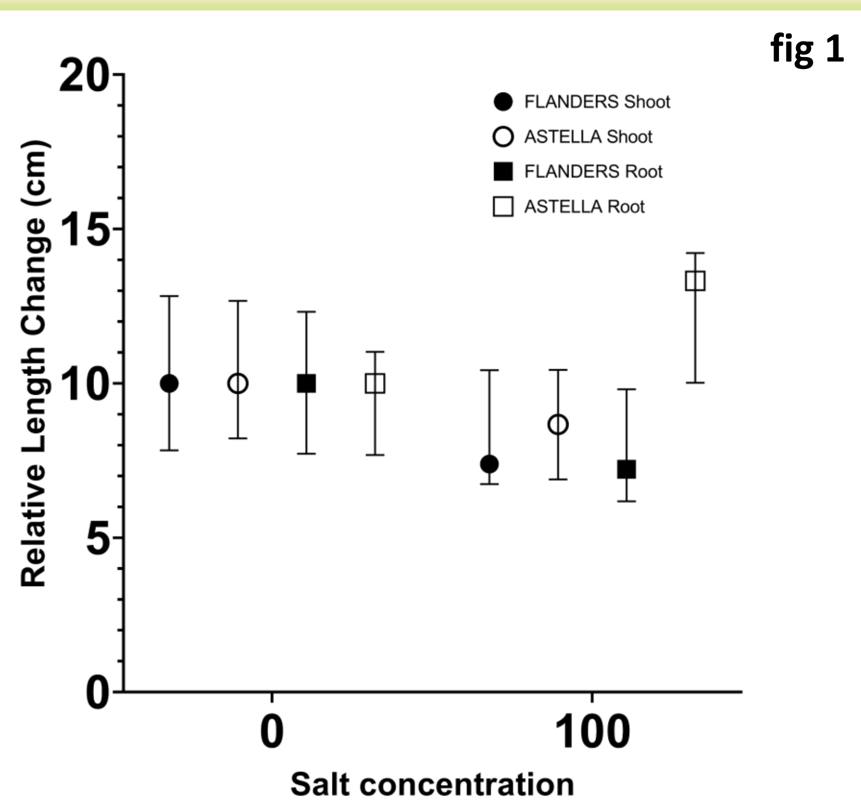

fig 1

Phenotypic/ morphological assessments

Under stress, compared to Astella, **Flanders roots are**

- **Shorter** (fig 1)
- **Thicker** (fig 2)
- **Less voluminous** (fig 3)
- **Less branched** (fig 4)

It signify a **growth inhibition in Flanders** root system.

Under stress
- **Shoot growth is more arrested in Flanders** compared to Astella (fig 1).
- Compared to unstressed plants, an **overall growth inhibition in Flanders** is observed, which is a **stress adaptive phenomenon** (Li et al. 2022).
- Salinity stress creates **physiologic drought**. As an adaptive response, **plants try to hold more water** primarily via stomata closure (Kiani et al. 2020).
- **Flanders leaves hold higher amount of water** than Astella (fig 5).

RESULTS & DISCUSSION (CONTD.)

Phenotypic/morphological assessments (contd.)

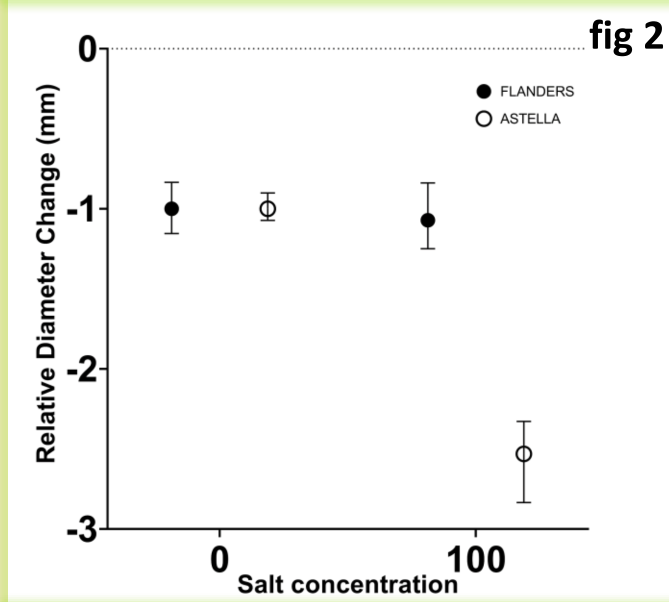

fig 2

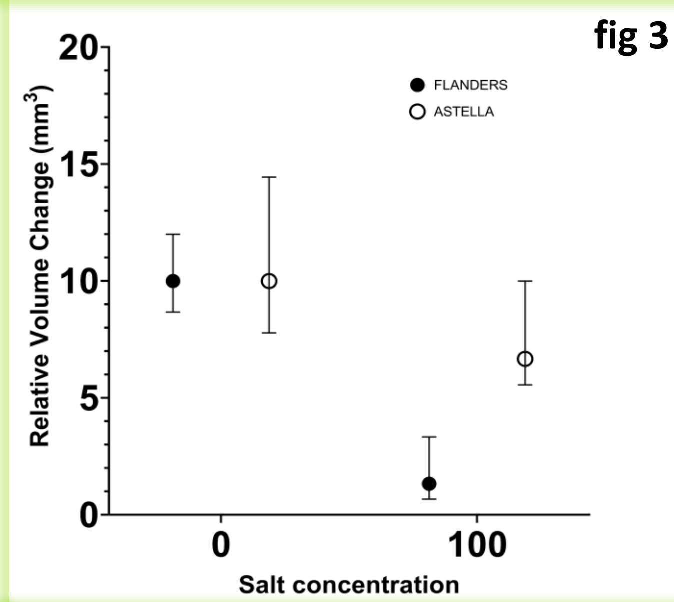

fig 3

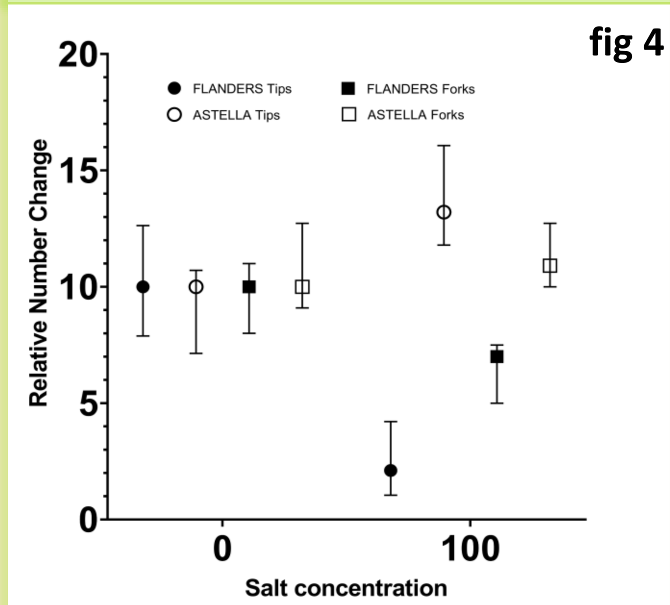

fig 4

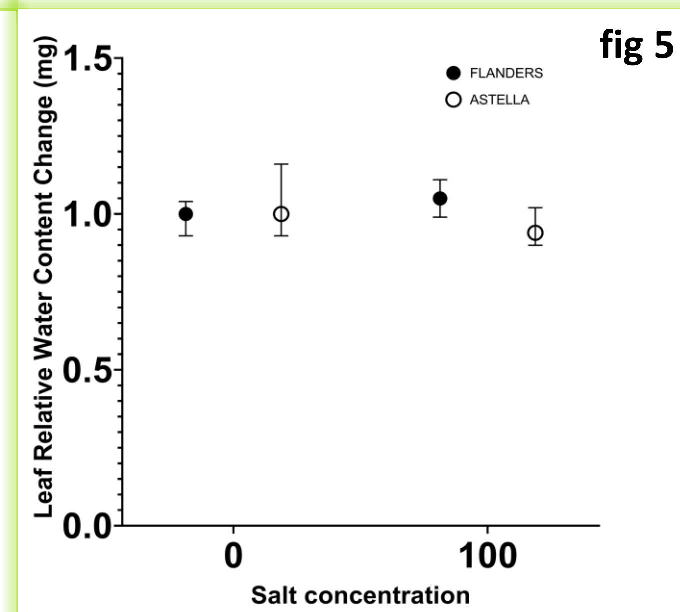

fig 5

Biochemical assessment of non-enzymatic antioxidants' activity

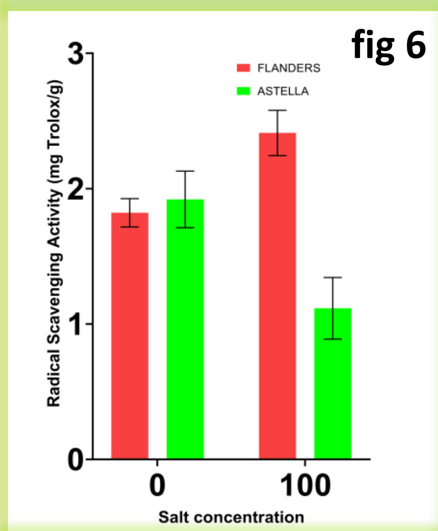

fig 6

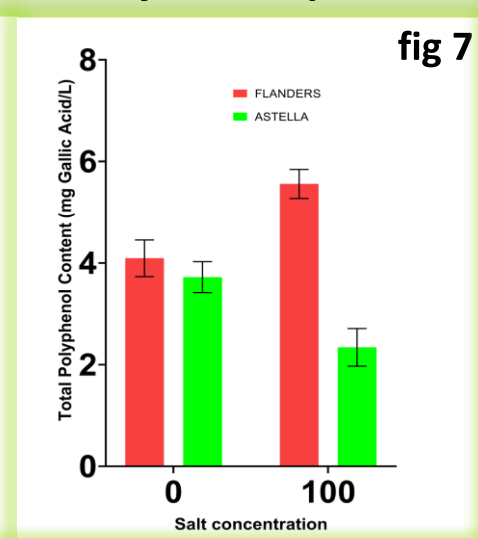

fig 7

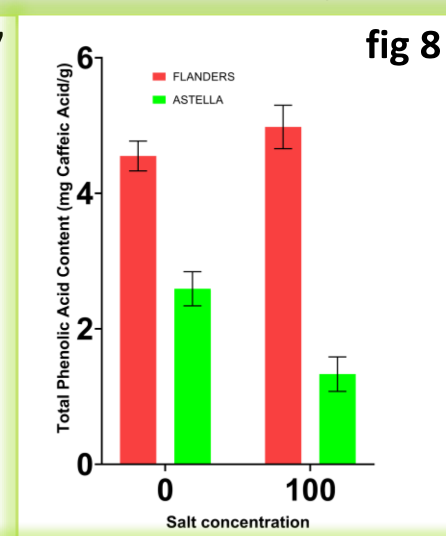

fig 8

- Under stress, **Radical scavenging activity** (fig 6), **total polyphenol** (fig 7) and **phenolic acid** (fig 8) contents are **higher in Flanders** than Astella.
- It indicates a **stress-adaptive hyperactive non-enzymatic antioxidant system in Flanders** mitigating stress (Šamec et al. 2021).

Microscopic assessment of roots of stressed plants

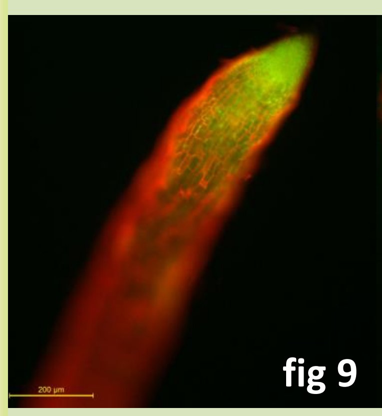
fig 9

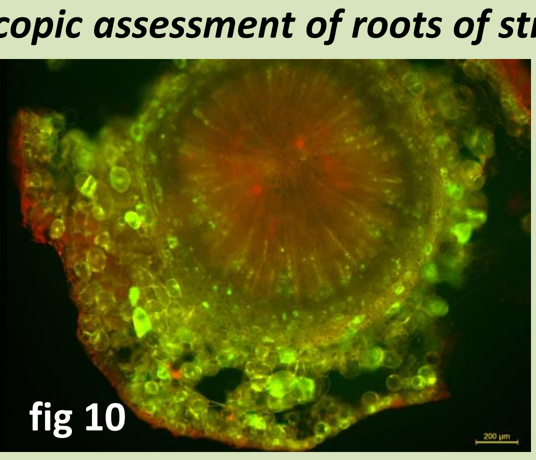
fig 10

Despite salt stress-induced cell death (primarily in epidermis), **root tip is alive**, possibly **to mitigate the harmful effect of salt stress** and **to search nutrients to keep the plant alive**.

The vascular bundle is semi-alive. Possibly, it is trying to transport nutrients.

CONCLUSION

Arrested morphological growth, **higher leaf relative water content** and **hyperactive non-enzymatic antioxidant system** of **Flanders** under stress indicates its **higher capability of salt stress mitigation** than Astella.

FUTURE WORK

Assessment of **biochemical antioxidant markers** and **lignan-related gene expression** could confirm the effectiveness of Flanders against salt stress.

REFERENCES
FAO. 2021. https://shorturl.at/jlUW4; Kiani et al. 2020. Agronomy. 10:1366; Li et al. 2022. Genes. 13:1904; Ražná et al. 2021. Cells. 11:2151; Šamec et al. 2021. Plants (Basel). 10:118; UN. 2002. https://shorturl.at/fqAJP