Identifying finger millet lines as a potential crop for acidic soils

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5/9/2023
Alnarp, Sweden

Morphological description

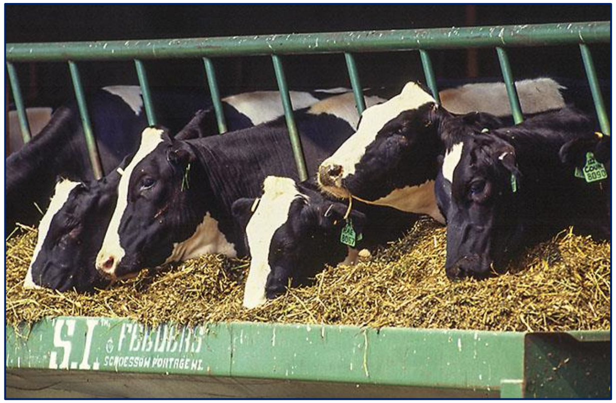
Fig 1. Finger millet

- 170 cm in height
- Shallow root system
- Curved, open and semi-curved
- Self-pollinated (~95%)

Economic importance

(Shobana *et al*., 2013)

INTERNATIONAL YEAR OF
MILLETS
2023

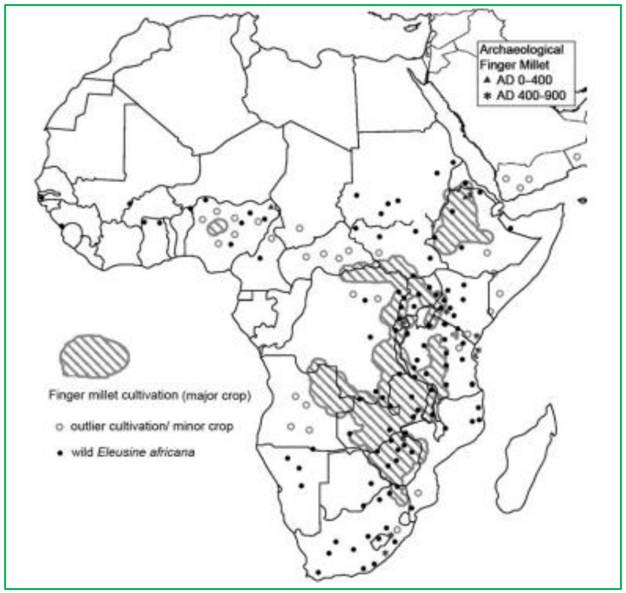


(USDA, 2016)

Yield and productivity constraints

- Blast
- **Soil acidity**
- Salinity
- Lodging
- Drought
- Poor attitude to the crop
- Little research emphasis

Distribution of acidic soil in Ethiopia



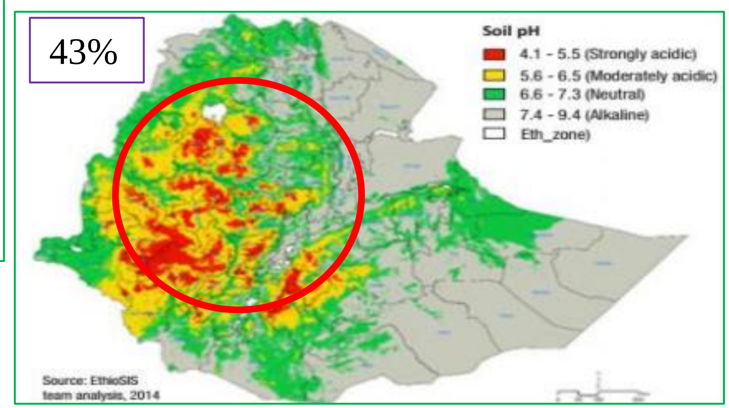


Fig 5. Distribution of acidic soil

Causes of acidic soil

Management practices

Liming

Organic fertilizer

Crop residues on the farm

Developing Al-tolerant cultivar --- Solution

Objectives

- To evaluate diverse finger millet accessions against Al-toxicity under hydroponic
- To evaluate genetic diversity of finger millet landraces using GBS-derived SNP markers
- To identify genomic regions through GWAS
- To perform transcriptomic analysis and marker development of finger millet genotypes using RNA sequencing

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1. Hydroponic optimization and screening of Al-tolerance on finger millet (*Eleusine coracana* (L.) Gaertn.) accessions and cultivars

https://doi.org/10.3390/agronomy13061596

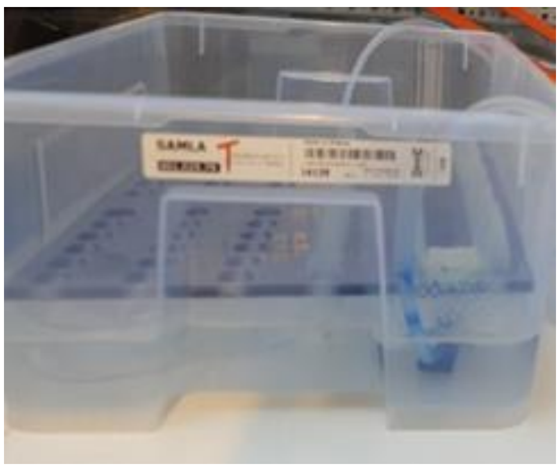

Fig 6. Hydroponic setup

Plant materials = 400 accessions

Different Al conc.

Treatment/control

RL/SL measured after 10 days

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Results

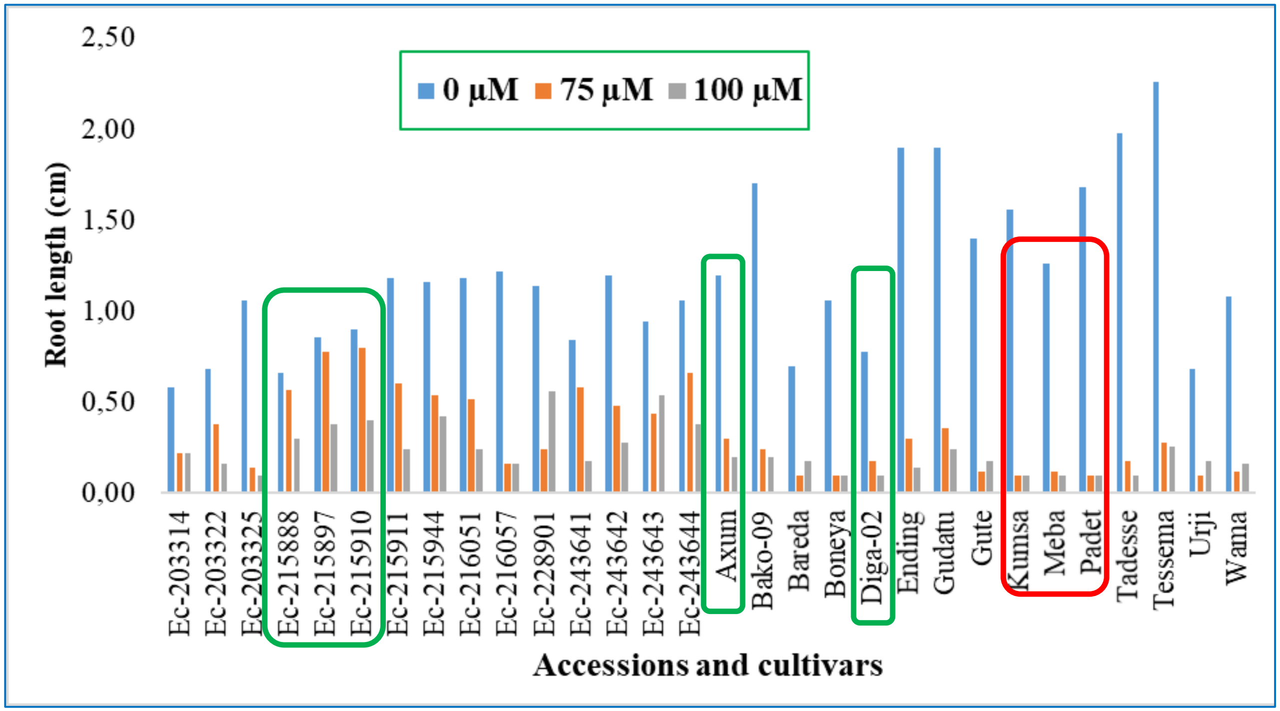

Fig 7. Root length (cm) of accessions and cultivars grown under different Al-conc

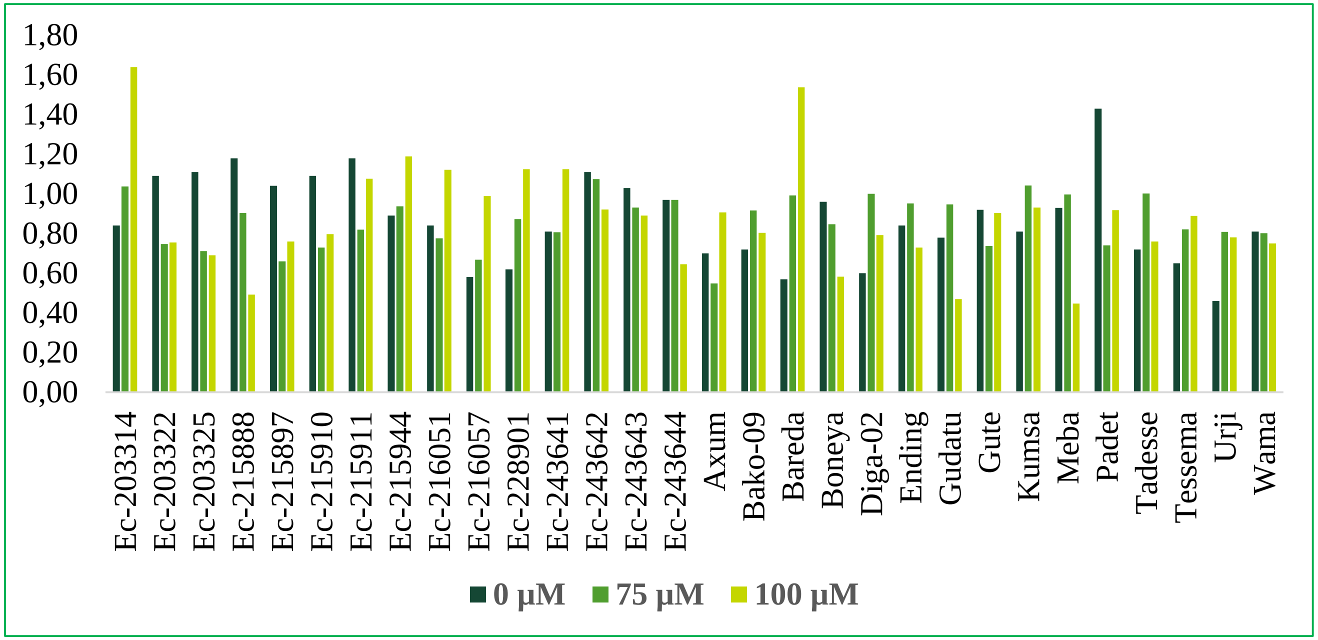

Fig 8. Shoot length (cm) of accessions and cultivars grown under d/t Al-conc

Table 1. ANOVA of the accessions and cultivars grown at d/t Al-con

		MS	
Source	**DF[Z]**	**Root length**	**shoot length**
Concentration	2	8.5***	0.003ns
Residuals	87	0.08	0.04
Environmental variance	2.00	42.03**	0.02ns
Replication variance	12.00	0.15**	0.04ns
Genotypic variance	29.00	0.37**	0.18**
Genotypic X Environment	58.00	0.46**	0.26**
Residuals	348.0	0.05	0.10

➔➔**288 samples ... Selected for further analysis**

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2. Novel GBS based SNP markers for finger millet and their use in genetic diversity analyses

(https://doi.org/10.3389/fgene.2022.848627)

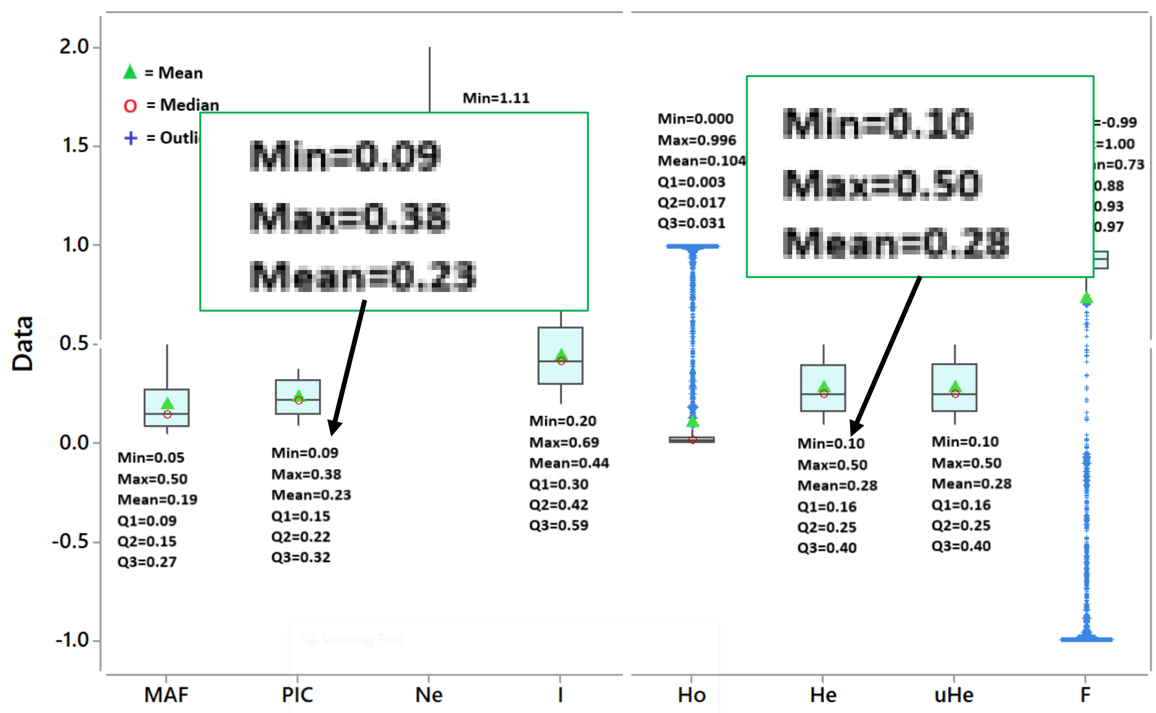
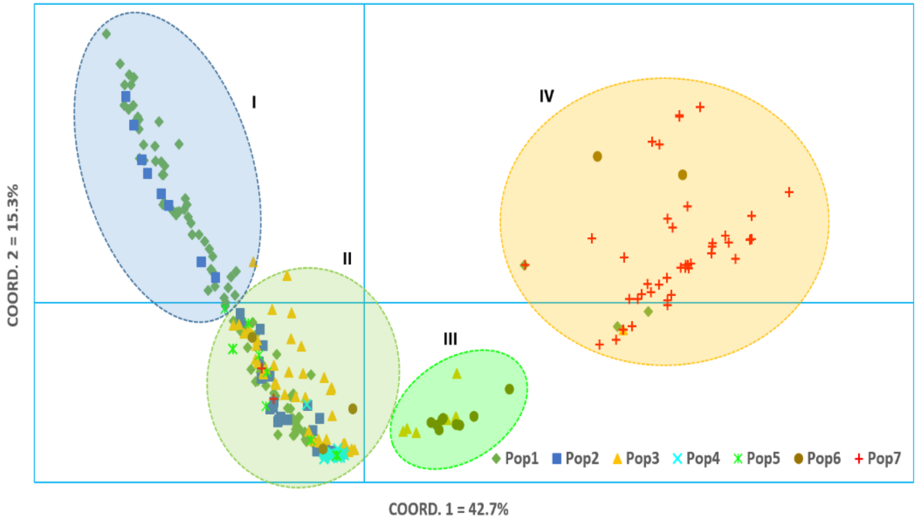


Fig 9. Genetic diversity of the markers



Geographic origin

- Pop-1 ➔ Agew-Awi, Gojam, Bahrdar and Metekel
- Pop-2 ➔ Western Tigray and Gonder
- Pop-3 ➔ Wellega and Illuababora
- Pop-4 ➔ central, eastern and southern Tigray, and northern Wello
- Pop-5 ➔ unknown sampling location
- Pop-6 ➔ improved cultivars
- Pop-7 ➔ Zimbabwea

Fig 10. PCoA depicting genetic relationship of accessions

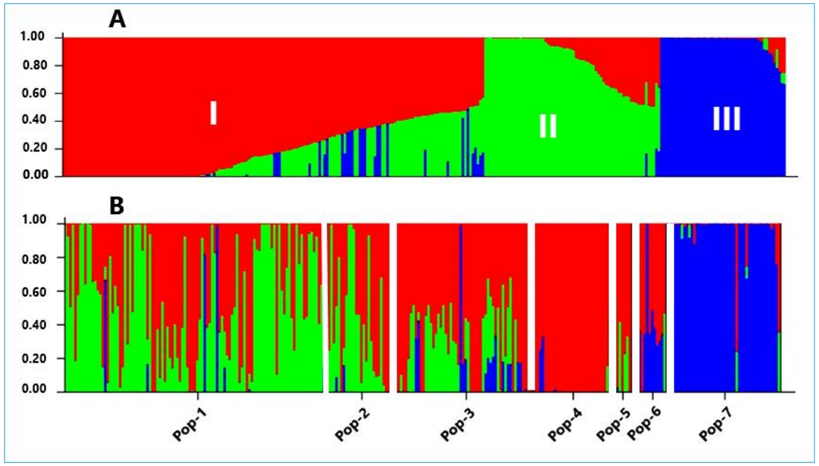


Fig 11. Genetic structure of 288 accessions

3. Genome-wide association analysis identifies genomic regions and candidate genes governing aluminum tolerance traits

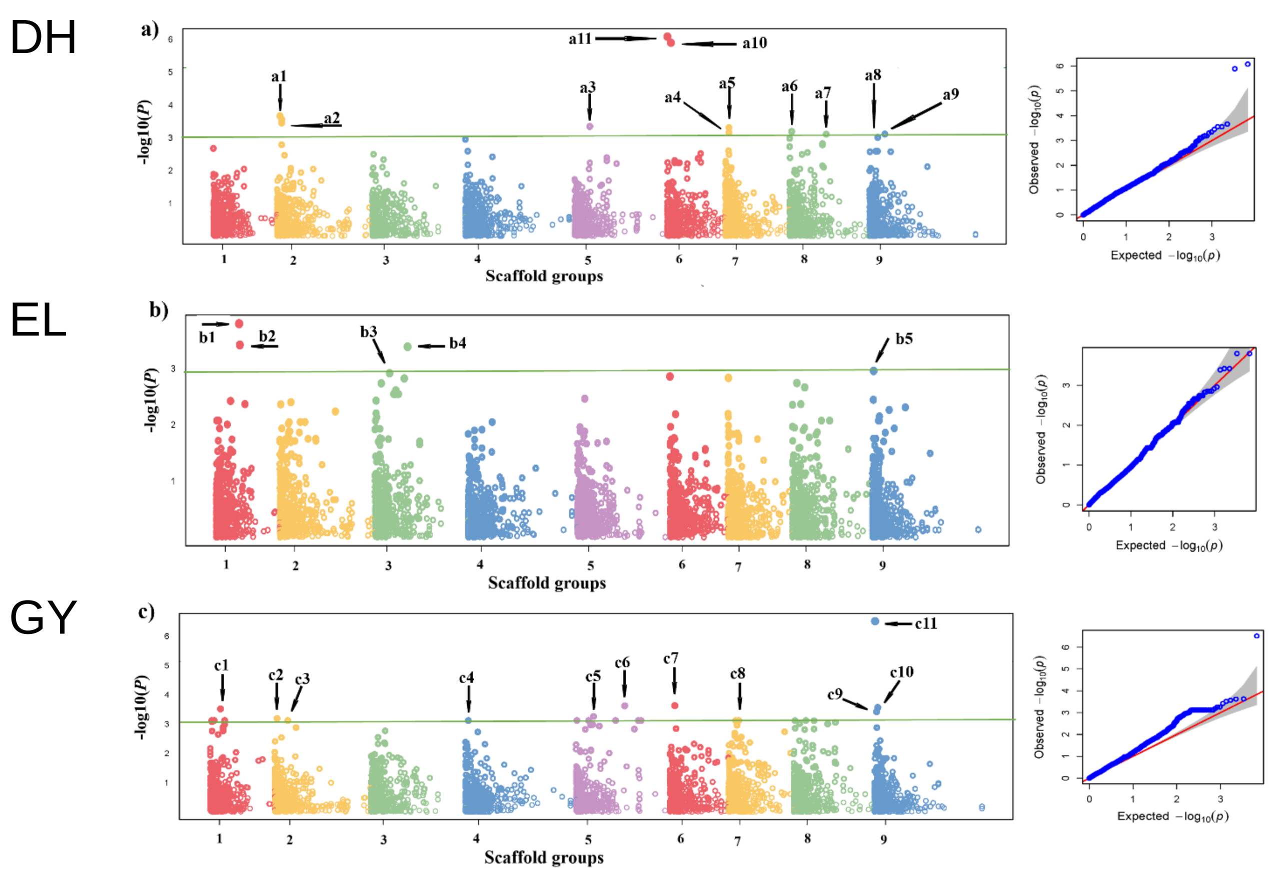


Fig 12. Manhattan's and quantile-quantile plots produced from GWAS analysis in **a)** days to heading, **b)** ear length, and **c)** grain yield traits

NET

NF

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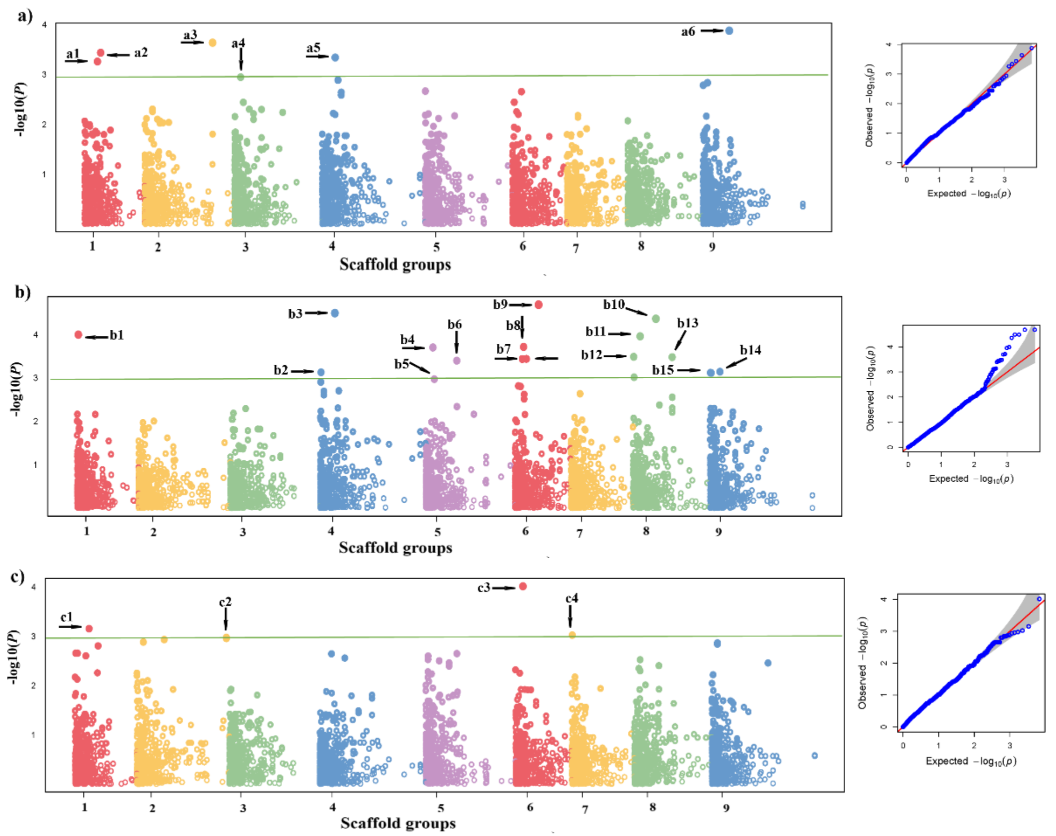
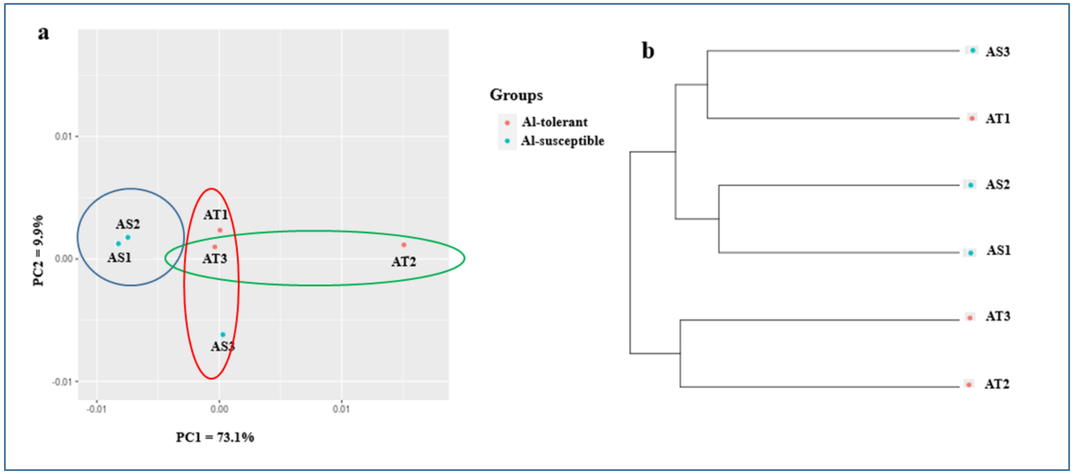


Fig 13. Manhattan's and quantile-quantile plots produced from GWAS analysis in **a)** number of effective tillers, **b)** number of fingers, and **c)** plant height traits

4. Finger millet RNA-seq reveals differential gene expression associated with tolerance to aluminum toxicity and provides novel genomic resources

(https://doi.org/10.3389/fpls.2022.1068383)



AT1 = Ec-215836, **AT2** = Ec-215845, and **AT3** = Ec-229722

AS1 = Ec-212462, **AS2** = Ec-215804, and **AS3** = Ec-238323

Differentially expressed genes

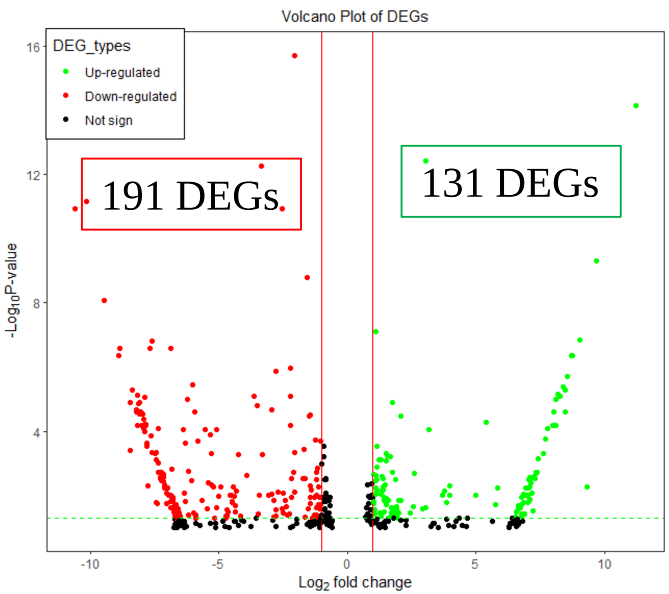


Fig 15. Volcano plots of DEGs between the two groups

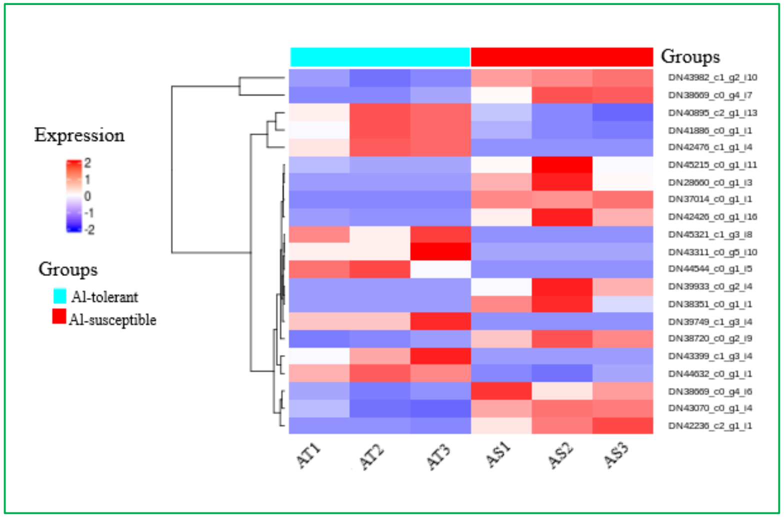


Fig 16. Selected sign. DEGs that have association with Al-tolerance

Summary

❑We have:-

- Identified tolerance level of finger millet against Al-toxicity (100 uM)
- Estimated the level of GD (high in Pop-1 and low in Pop-4)
- Identified genomic regions, DEGs, TFs
- Developed markers (SSR and SNP)
- Selected Al-tolerant and sucseptible accessions
- Uploaded genomic and transcriptomic data to NCBI to enrich finger millet database

➔➔➔ **input for breeders**

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Funded

Sida

SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

Thank you for listening!!!