Root traits differ between wet- and dry-adapted sets of faba bean accessions selected by FIGS

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Faba bean genetic resources

ICARDA Internati

ICGR-CAAS Insti

ATFCC Australian

al Sciences (China)

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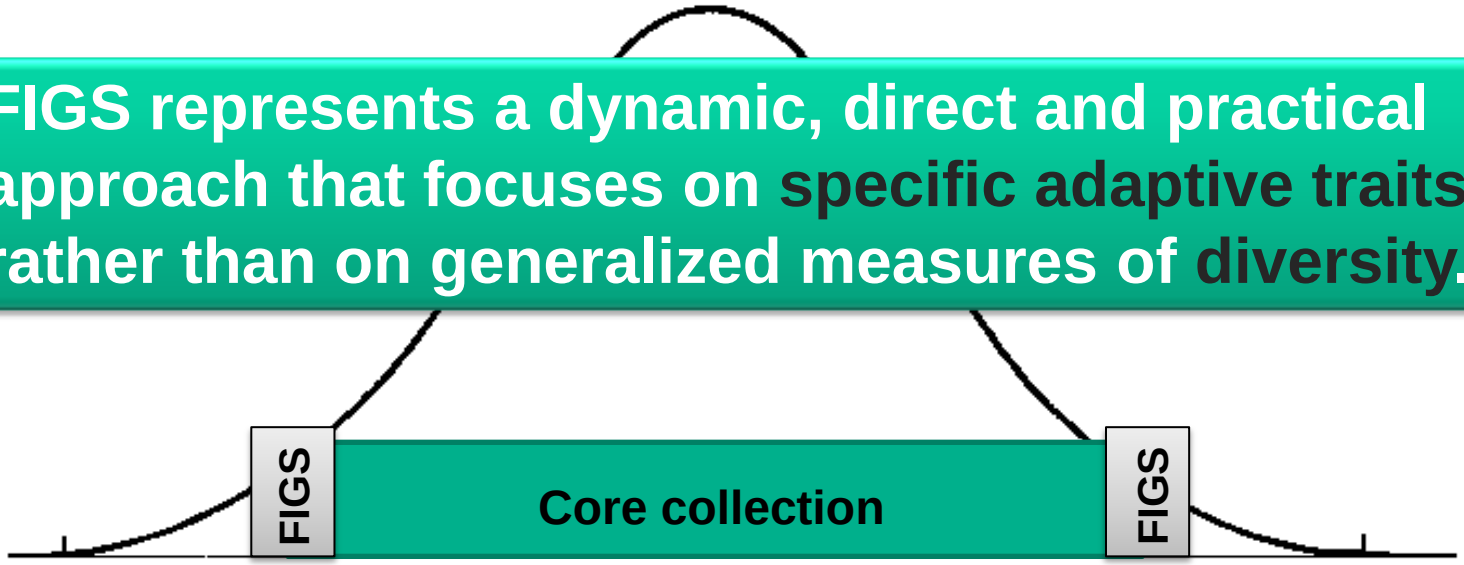
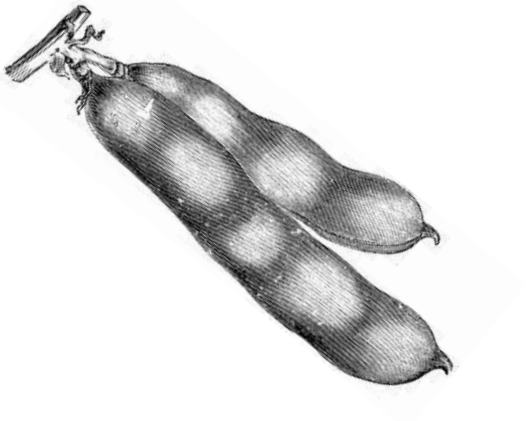
ws.

Core collection / FIGS

FIGS represents a dynamic, direct and practical approach that focuses on specific adaptive traits rather than on generalized measures of diversity.

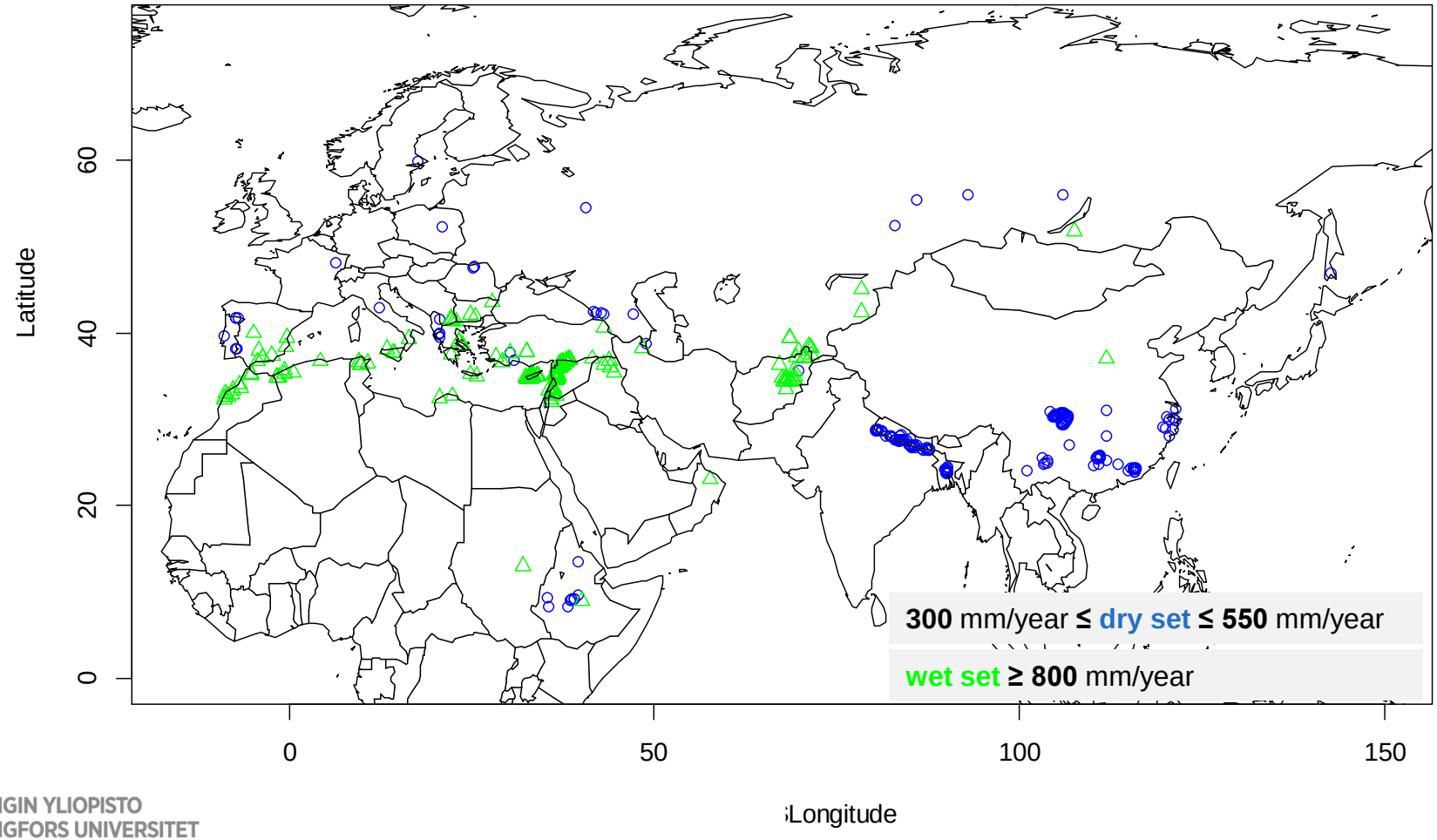


Why faba bean (*Vicia faba* L.)?



During 2010-2011

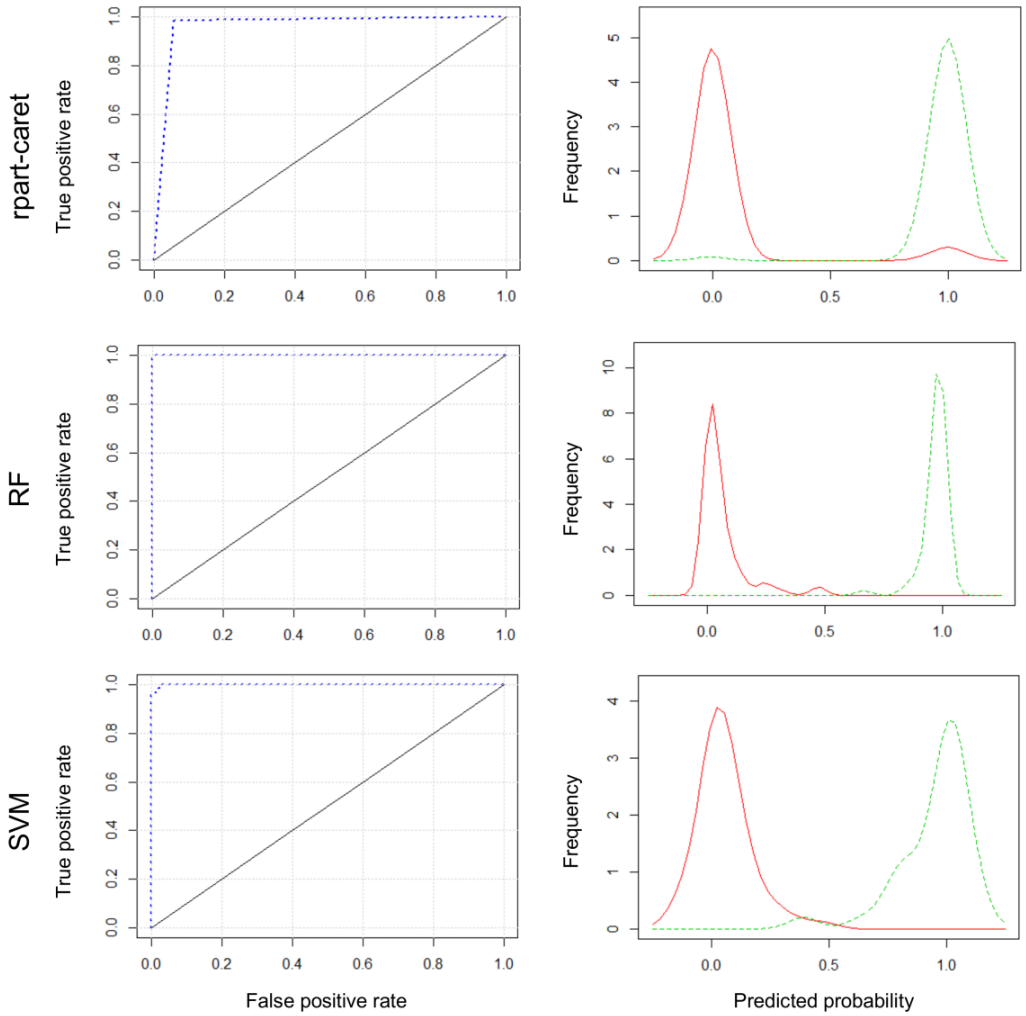
201 accessions of faba bean from **wet** and **201** from **dry** region of the world, were chosen according to principals of the FIGS.



Measurements

- Stomatal morphology
- Stomatal function
- Relative Water Content
- Days to flowering
- Number of tillers
- Seed size (*major*, *equina, minor*)

ROC plots (left) and density plots class prediction (right) for dry and wet sets using the three models.



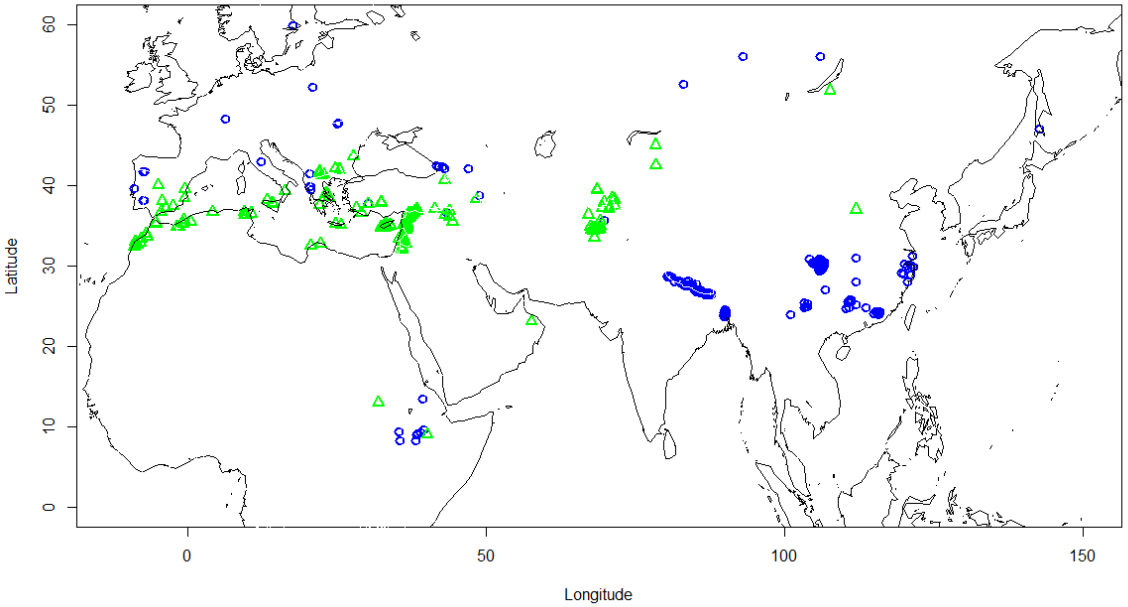
rpart - caret: Classification and Regression Training
RF: Random Forests
SVM: Support Vector Machines

Khazaei *et al.* (2013) PLoS ONE 8(5): e63107.

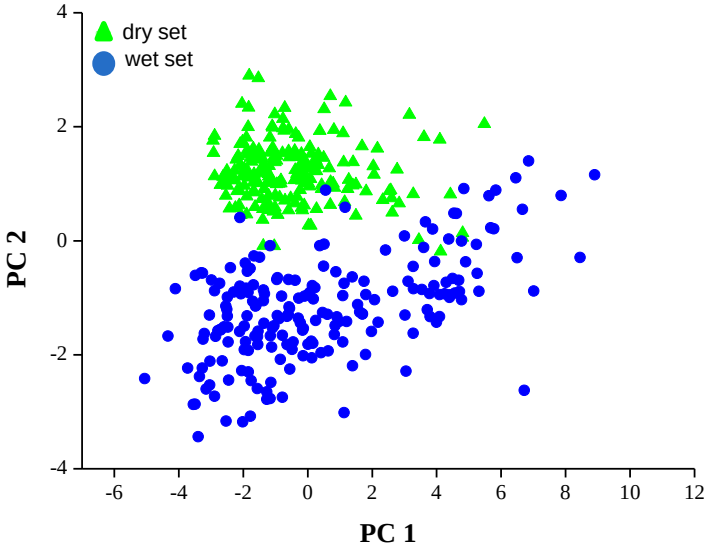
Rank of measurements that contribute the most to discriminate the sets.

Rank	drought related parameter	model
		rpart-caret
1	**Leaflet temperature**	**34.91**
2	**Canopy temperature**	**13.68**
3	**Relative water content**	**12.46**
4	Leaflet area	9.95
5	Stomatal length	6.70
6	Fertile tillers	4.72
7	Stomatal area	4.13
8	Transpiration rate	3.61
9	Stomatal area per unit area of leaflet	2.75
10	Photosynthetic rate	2.34
11	Days to flowering	2.21
12	Intercellular CO_2	1.64
13	Stomatal density	1.26
14	Water use efficiency	1.21
15	Stomatal conductance	0.86
16	Stomatal width	0.14

Distribution of FIGS sets before and after evaluation



Geographical distribution of the two sets based on *a priori* information (climate data)



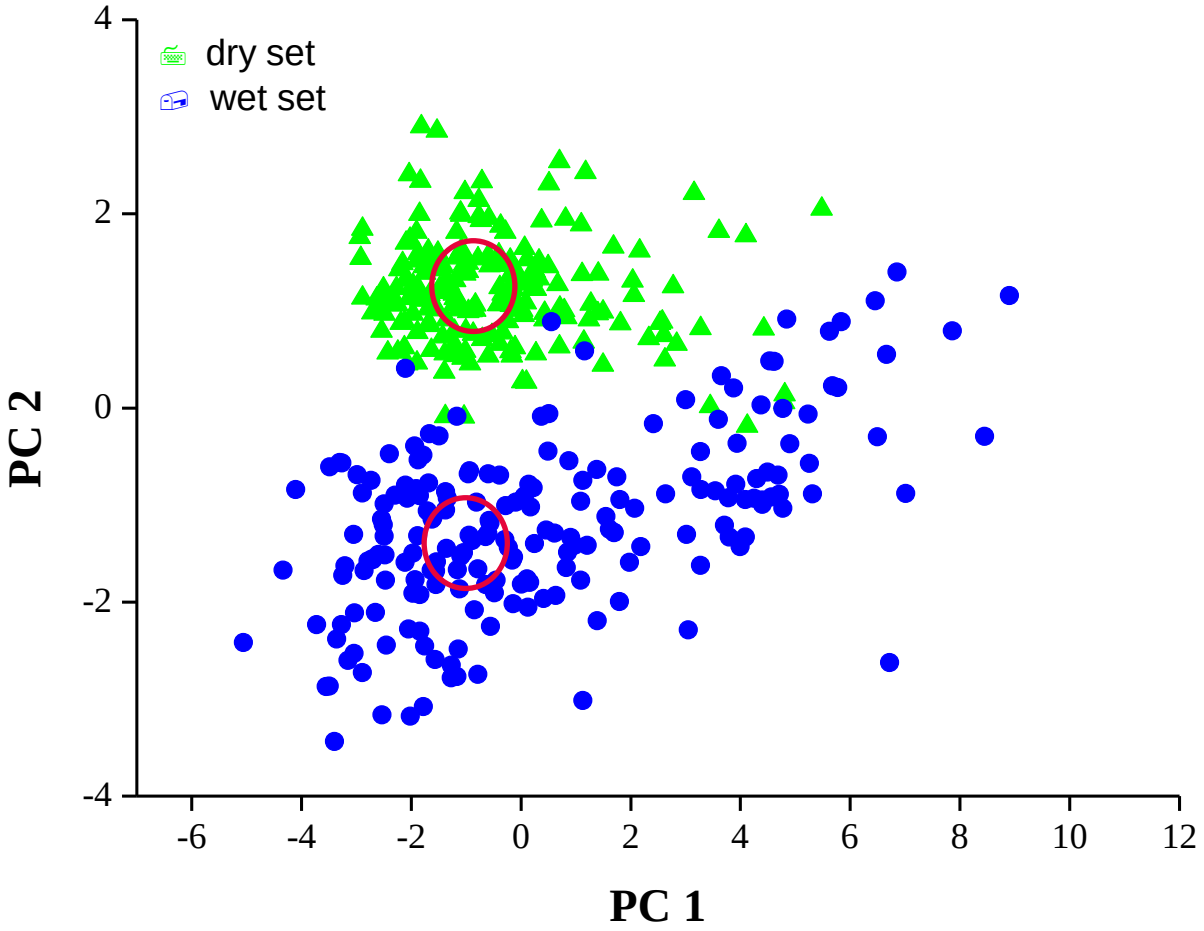
Distribution of the two sets based on **PCA** of evaluation data

Objectives

- To test whether faba bean germplasm from drought-prone (dry) and drought-free environments (wet) differed in root traits.

- The initial findings were then tested in a subset of materials to examine response of wet and dry set accessions under drought conditions.

How the subsets chosen (6+6)



Accessions used for root traits screening

Set	Accession number[a]	Country	Province	Altitude (m)	Latitude	Longitude	Seed size
Wet set	Aurora/2	Sweden	-	-	-	-	*minor*
	IG 114476	Bangladesh	Dhaka	50	23.8167	90.0833	*paucijuga*
	IG 99501	China	Zhejiang	299	28.8167	121.1	*equina*
	IG 114985	Nepal	Kosi	140	26.4664	87.4469	*paucijuga*
	IG 132238	China	Guangdong	200	24.36	115.59	*equina*
	IG 117833	China	Yunnan	1680	24.8594	103.278	*major*
Dry set	IG 13987 (ILB 938)	Ecuador	-	-	-	-	*equina*
	Mélodie/2	France	-	-	-	-	*minor*
	IG 11689	Afghanistan	Baghlan	1640	35.6	69.1667	*minor*
	IG 131708	Tajikistan	Khudzhand	2000	39.378	68.591	*minor*
	IG 72309	Syria	Damascus	931	33.4333	36.0833	*major*
	IG 13505	Cyprus	Nicosia	320	35.0667	33.0667	*major*

[a] more information on accessions available at: https://www.genesys-pgr.org/

Evaluating 12 accessions
(6 wet and 6 dry set)

- Well watered conditions
- Randomized complete block with 4 replicates

Germplasm survey
Exp . 1

(4 accessions, 2+2 wet \ dry)
response to drought stress

- Completely randomized factorial design with 4 replicates

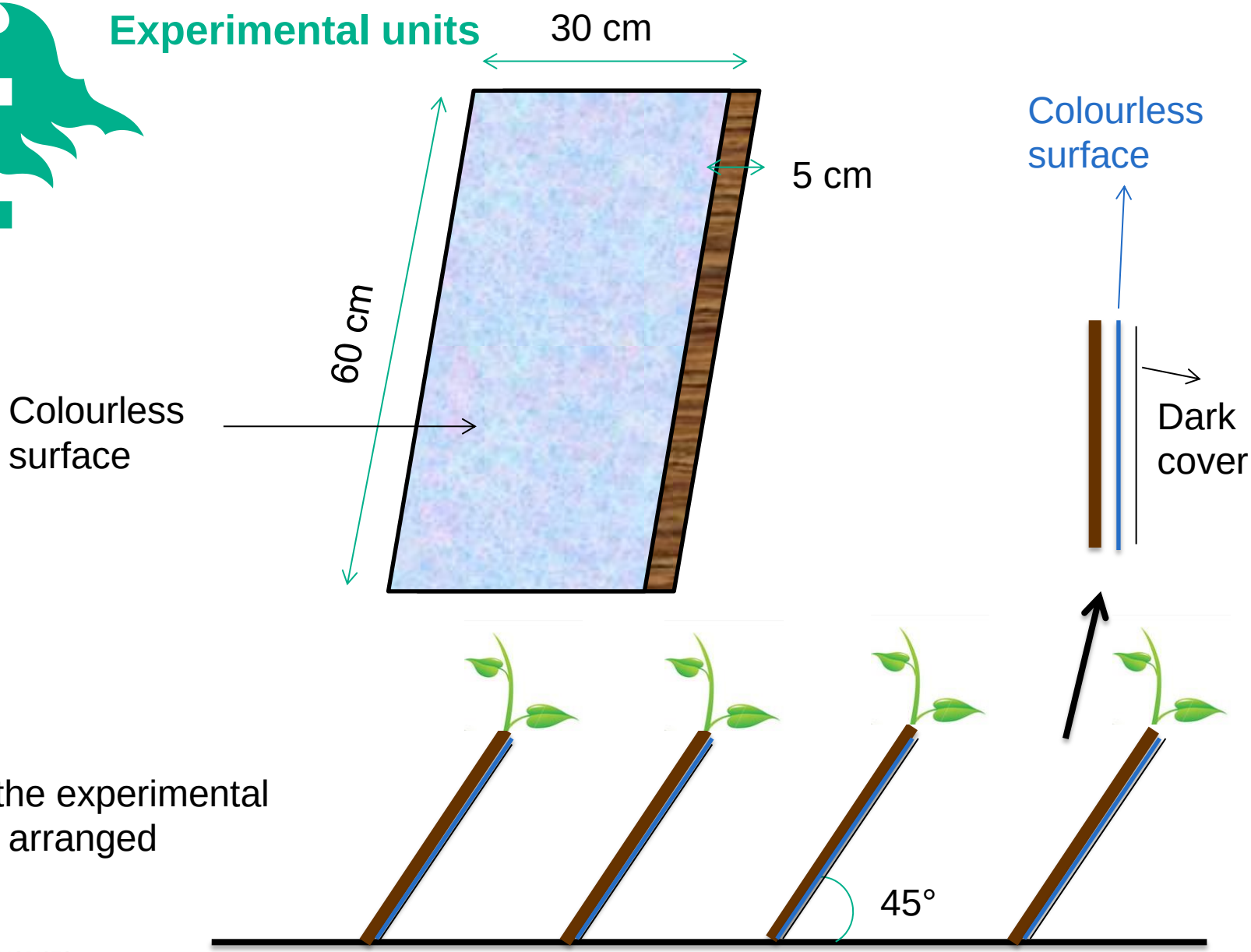
Water holding capacity = **18%** (*w/w*)
Each box (**7.72 kg)** brought to WHC by adding **1400** ml of water

- Stress treatment plants got 50 % of field capacity.

Drought response
Exp. 2

Soil :sandy soil with organic matter 3-6 % (m). pH 6.7, Ca 1300, P 21 , K 130, Mg 113

Experimental units



How the experimental units arranged

Experiment 1

Root profile after 32 days

Wet set

Dry set

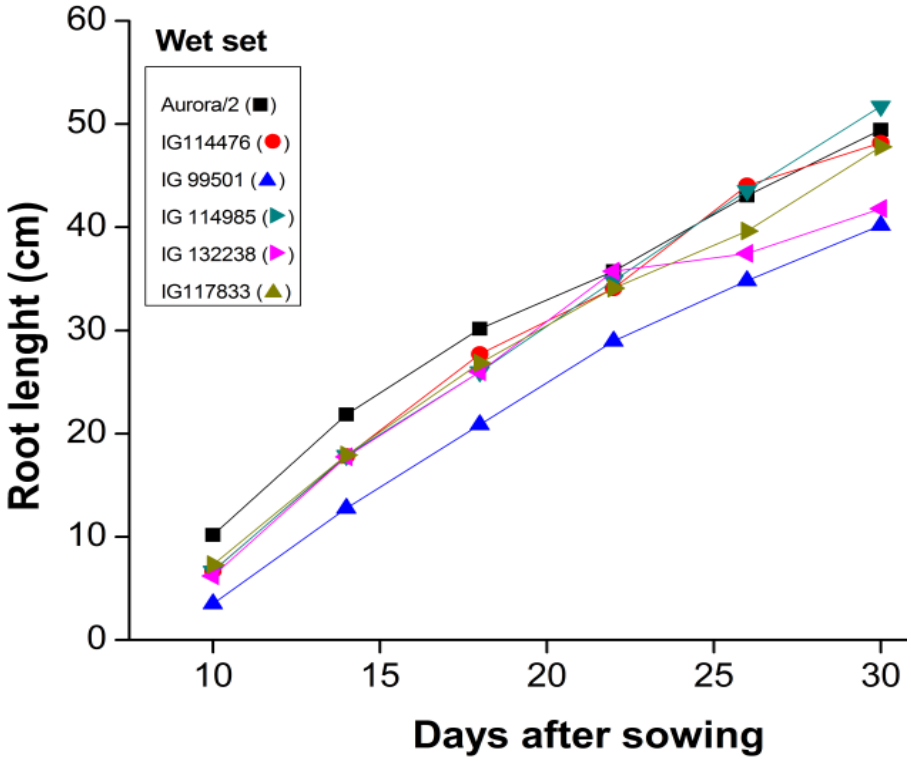
Characteristics of the roots and shoot of faba bean accessions (32-day-old seedlings)

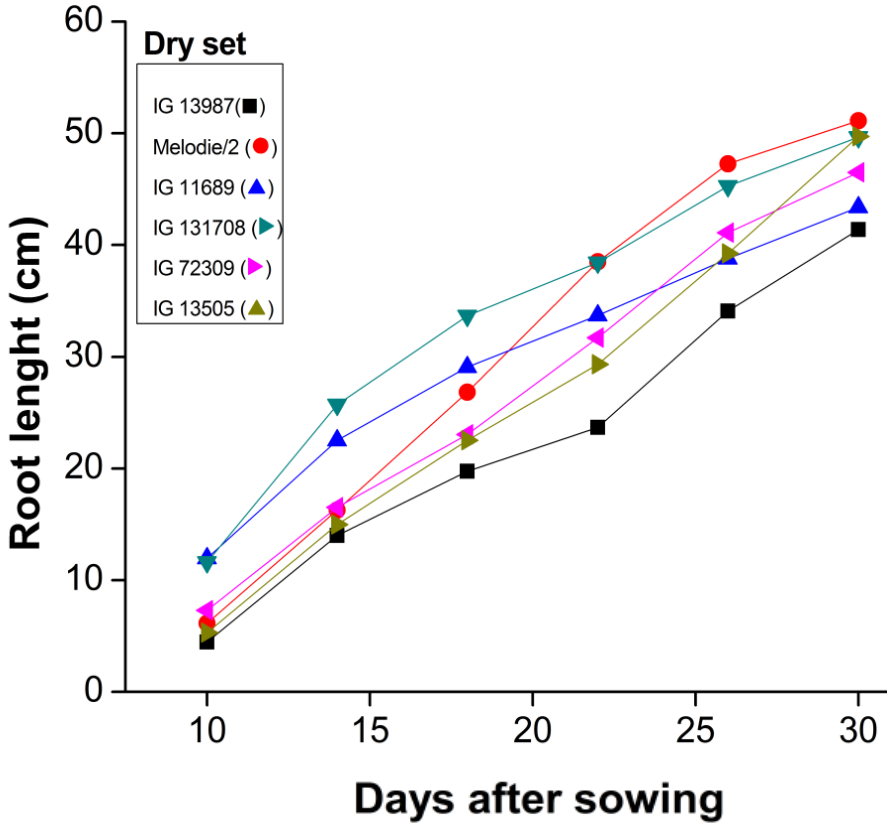
Accessions	Root length (cm)	Shoot length (cm)	Root DM (g)	Shoot DM (g)	Root / Shoot
Aurora/2	49.43	22.67	0.679	0.649	1.05
IG 114476	48.17	21.27	0.256	0.305	0.84
IG 99501	40.20	25.60	0.524	0.607	0.86
IG 114985	51.73	19.60	0.372	0.314	1.18
IG 132238	41.80	28.37	0.469	0.913	0.51
IG 117833	47.80	24.90	0.462	0.542	0.85
mean	**46.52**	**23.73**	**0.460**	**0.555**	**0.88**
SEM	*1.85*	*1.30*	*0.058*	*0.093*	*0.10*
ILB 938	41.37	26.03	0.524	0.729	0.72
Mélodie/2	51.13	25.07	0.551	0.820	0.67
IG 11689	43.37	26.20	0.518	0.526	0.98
IG 131708	49.67	26.07	0.640	0.845	0.76
IG 72309	46.50	34.10	0.831	1.256	0.66
IG 13505	49.73	30.90	0.847	1.209	0.70
mean	**46.96**	**28.06**	**0.652**	**0.897**	**0.75**
SEM	*1.60*	*1.47*	*0.062*	*0.115*	*0.05*

Experiment 1

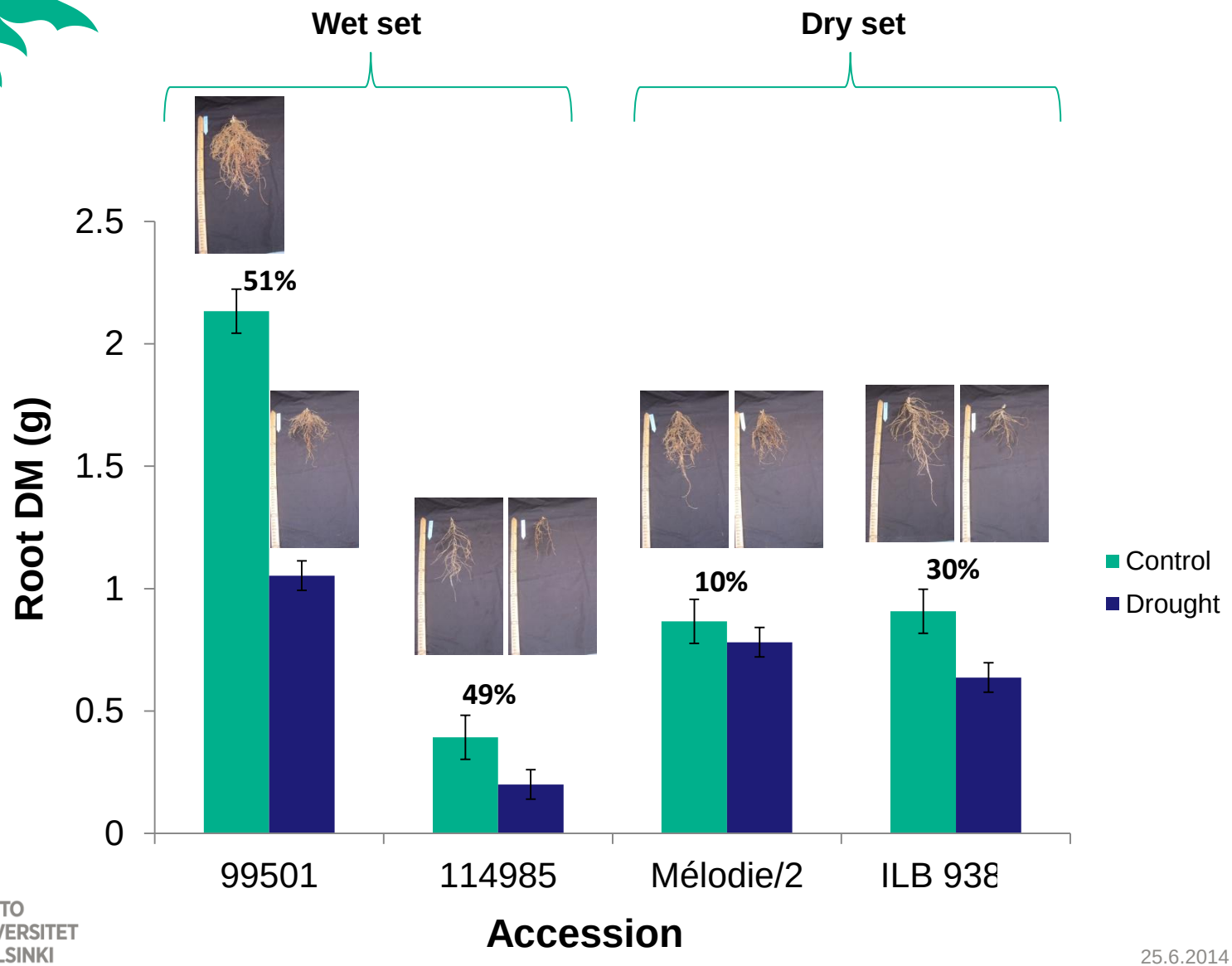
Root growth in wet and dry set under well watered conditions (6+6)

Experiment 1



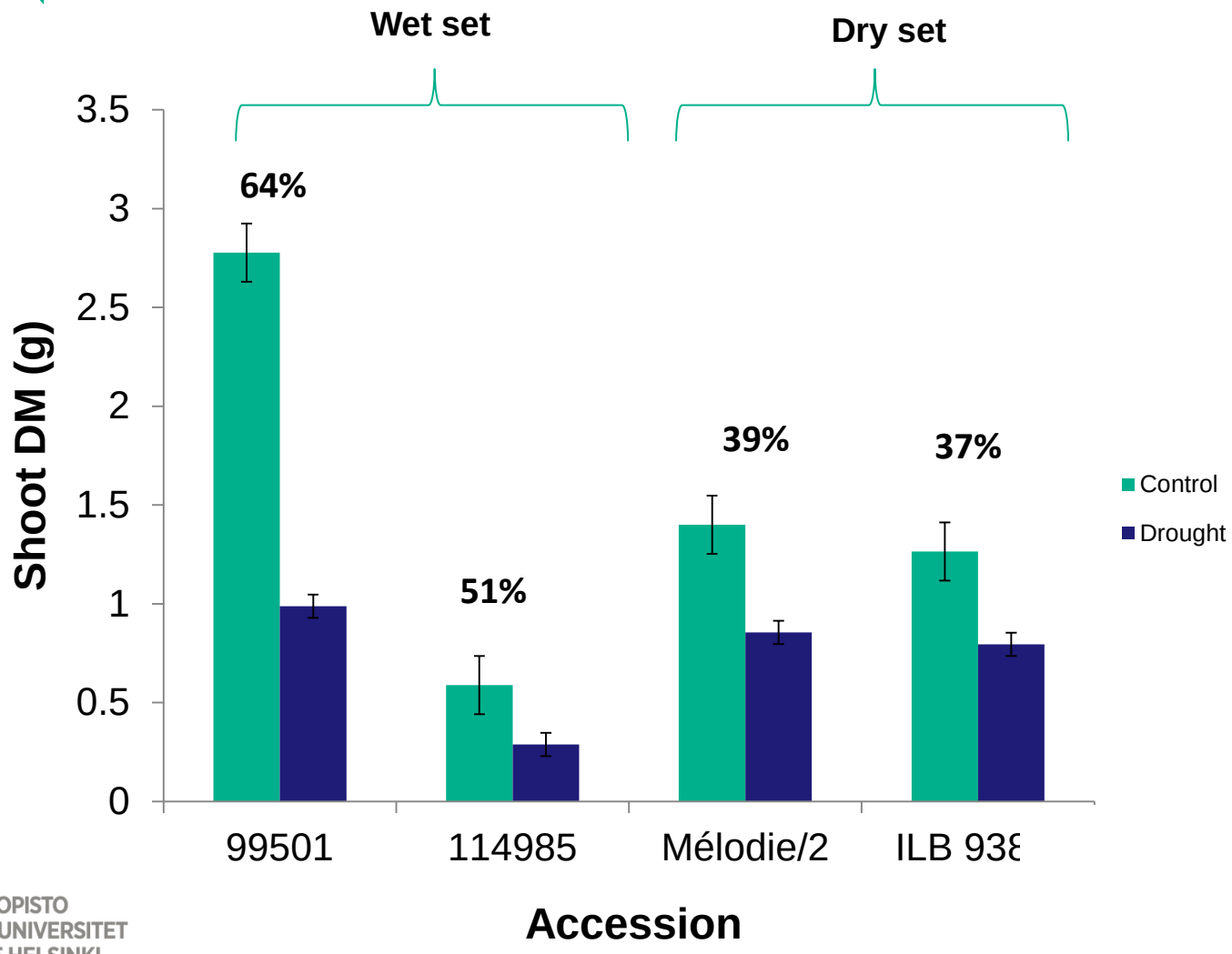


Effects of water treatments on the root dry weight in dry and wet set accessions (2+2).



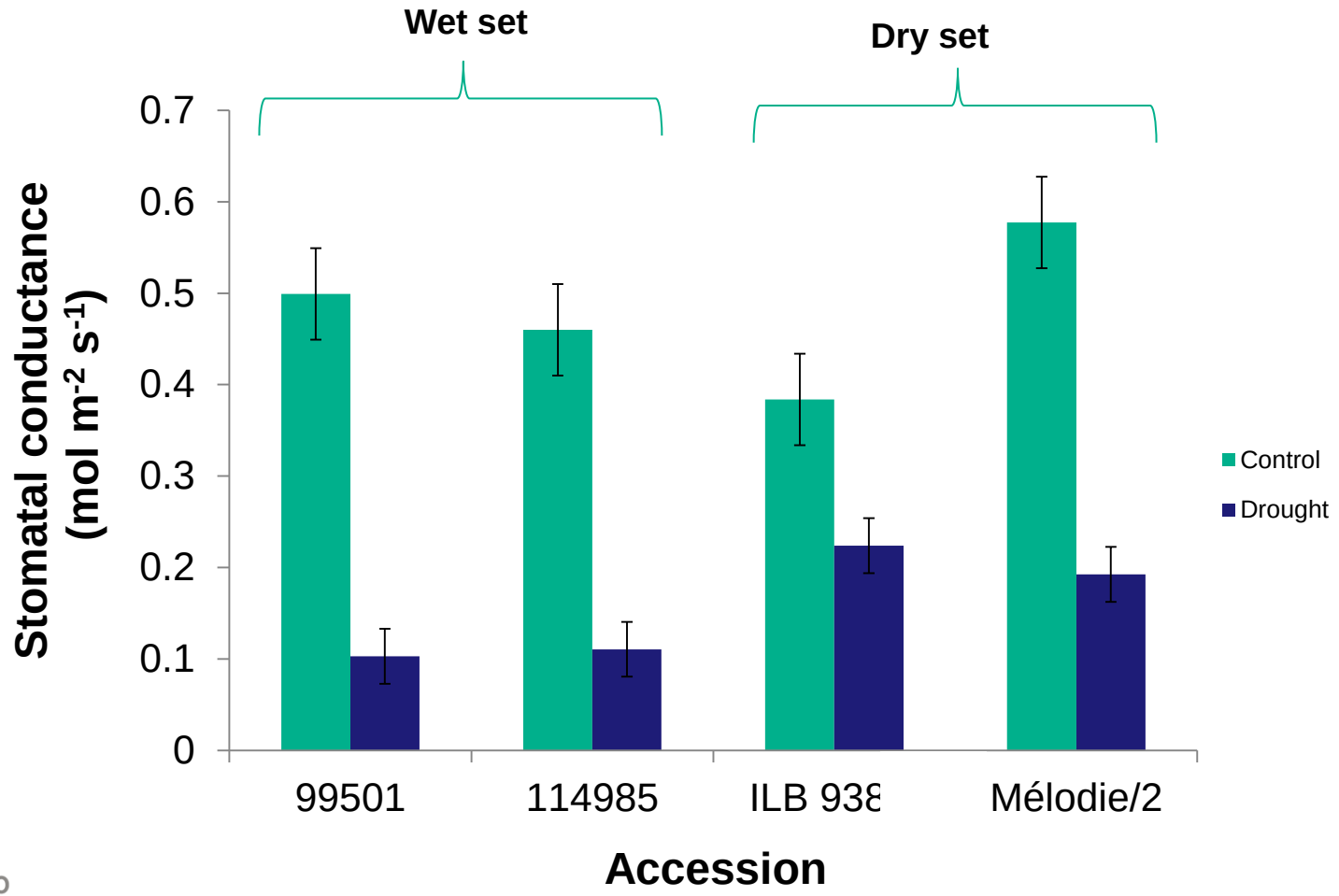
Experiment 2

Effects of water treatments on the shoot dry weight in dry and wet set accessions (2+2).



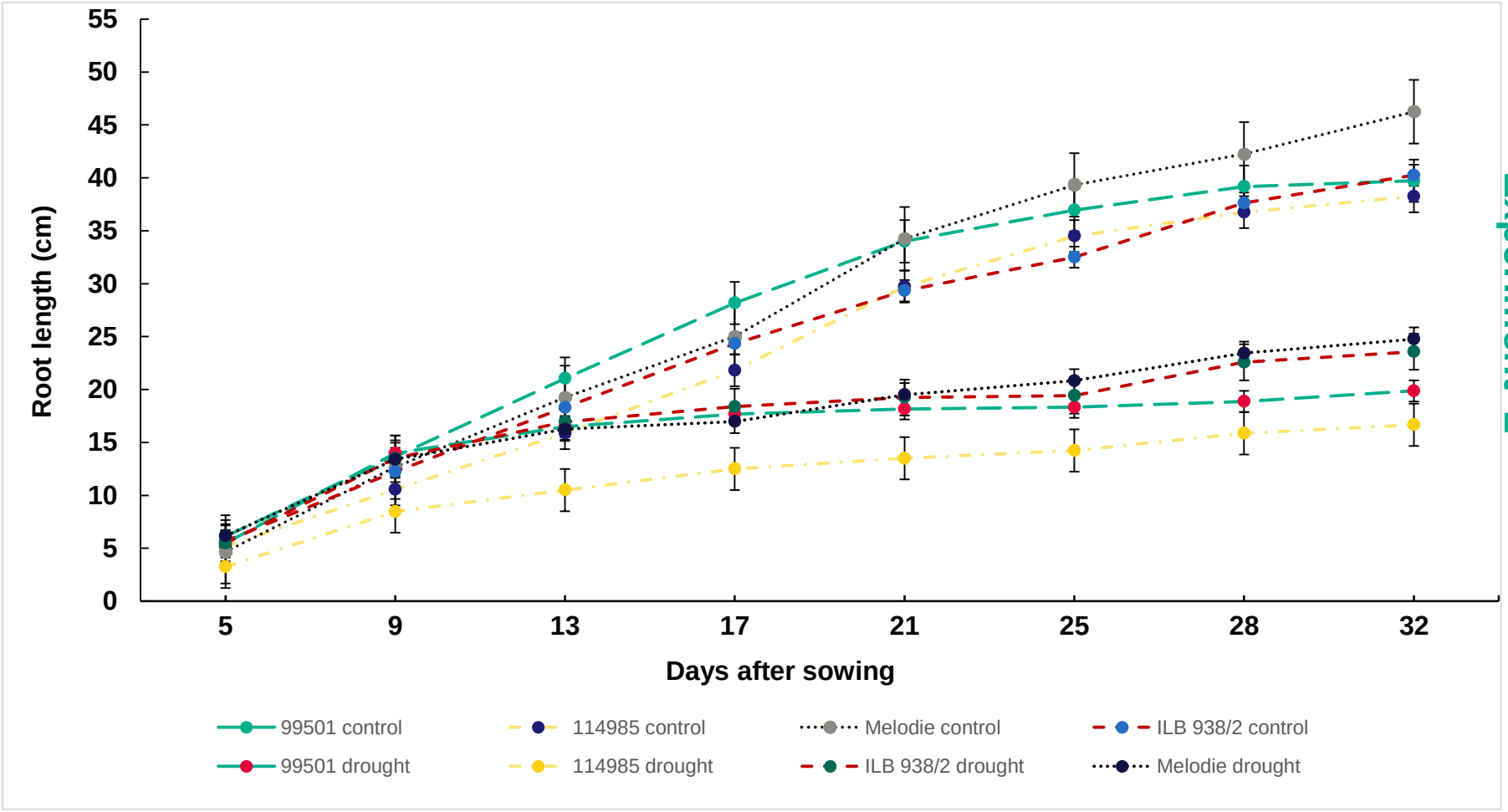
Experiment 2

Effects of water treatments on the stomatal conductance in dry and wet set accessions (2+2).



Experiment 2

Root length in response to water deficit



Conclusions

- The results supported that germplasm sets originating from environments with contrasting seasonal water availability will display **root traits differences** when they exposed under water stress.

- **FIGS** can reduce the cost and increase efficientness of germplasm evaluation by reducing the number of accessions screened while providing a higher probability of identifying sought-after traits.

- Further studies should be conducted under conditions where taproot expansion is not restricted.

Acknowledgments

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Thank you for your attention

Climate change and crop production