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Abiotic Stress Response in Ryegrasses: Old Problems and New Opportunities

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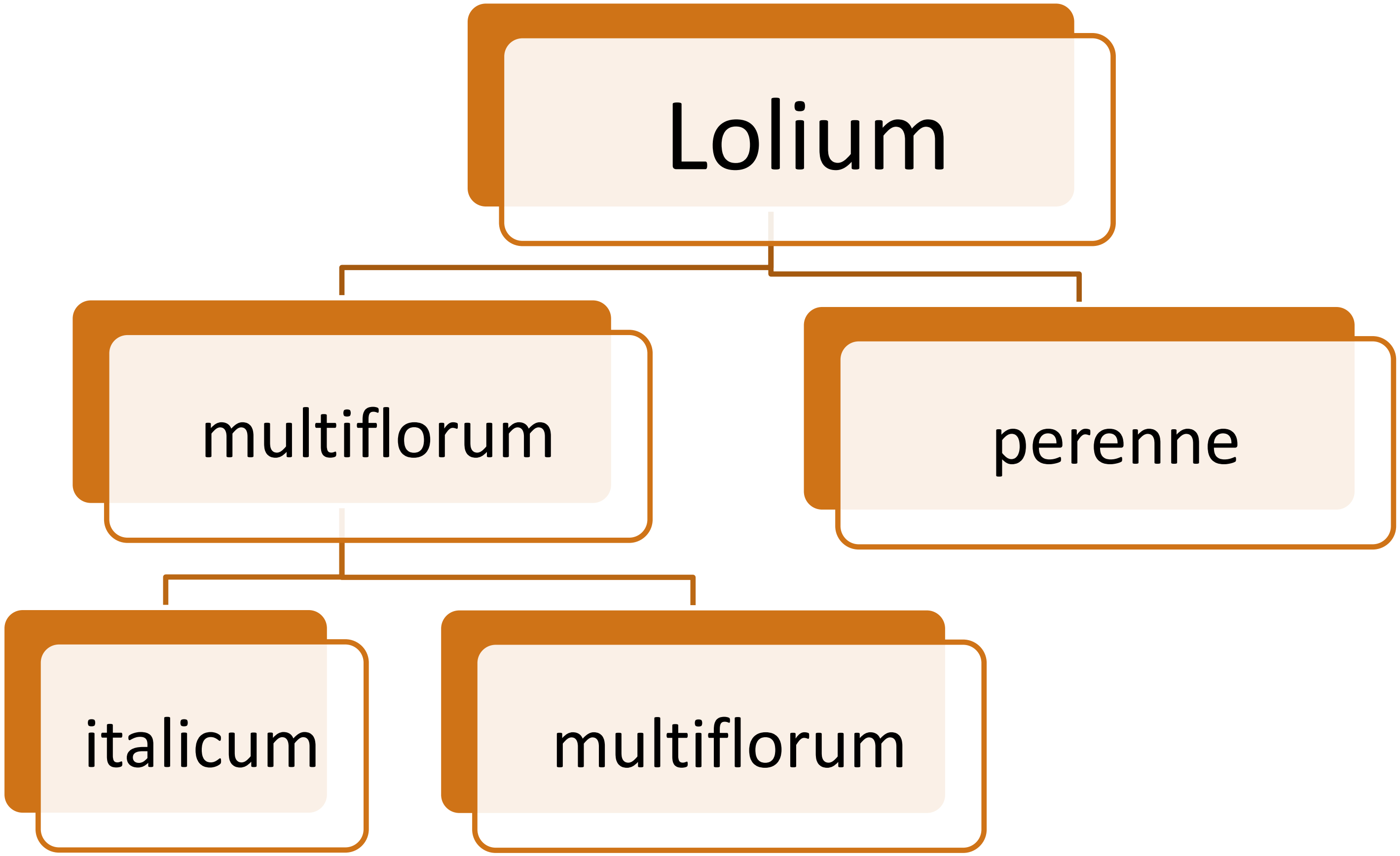
LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

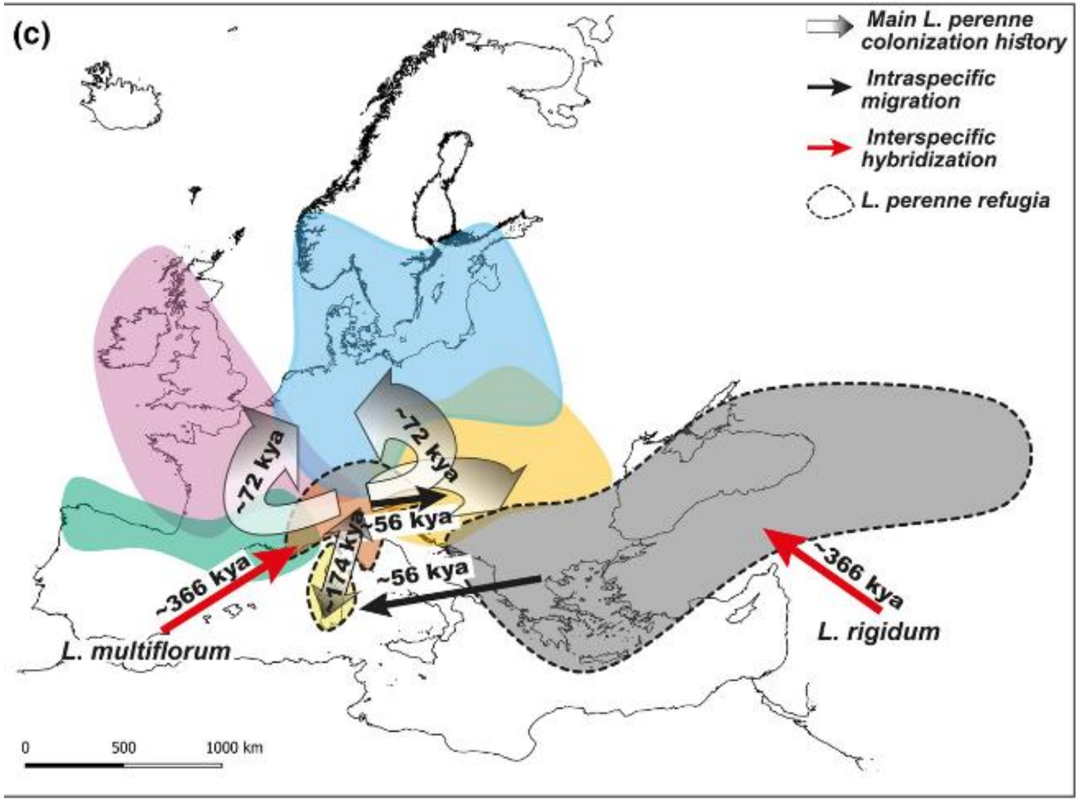
Gražina Statkevičiūtė
Akademija 2023 10 26


Lolium
multiflorum
perenne
italicum
multiflorum

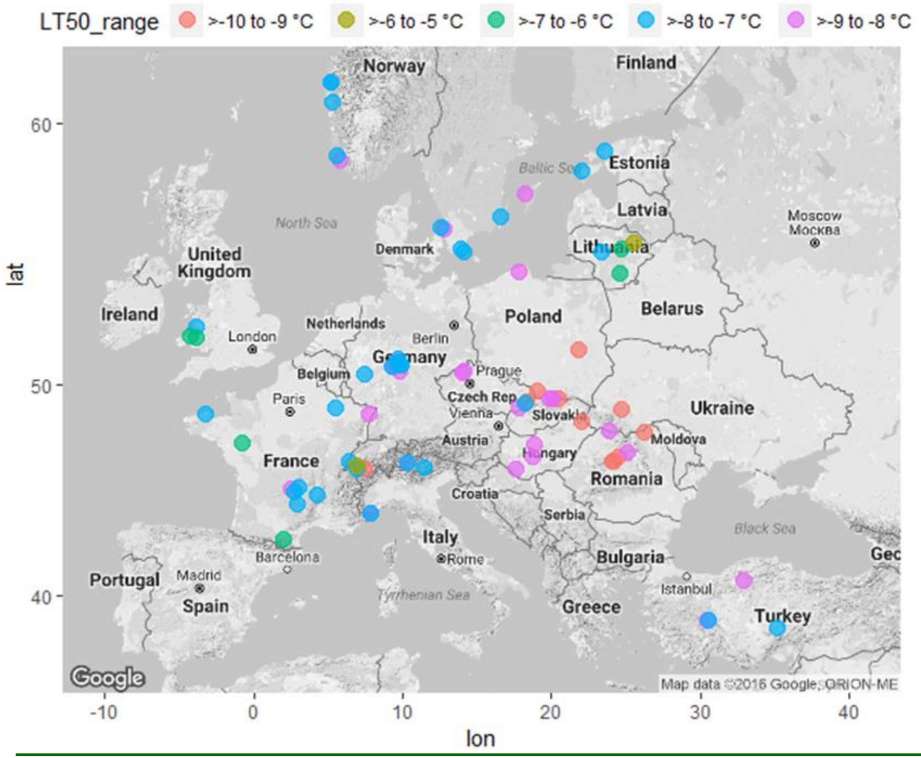
Lolium perenne

Natural populations maintain a wide genomic variability at continental scale that has been minimally exploited by recent breeding activities. This variability constitutes valuable standing genetic variation for future adaptation of grasslands to climate change, safeguarding the agricultural services they provide.

Blanco-Pastor et al 2019



Abiotic stresses: freezing resistance



The locations of origin and the distribution of freezing tolerance among wild-growing perennial ryegrass populations

A. Aleliūnas, PhD thesis

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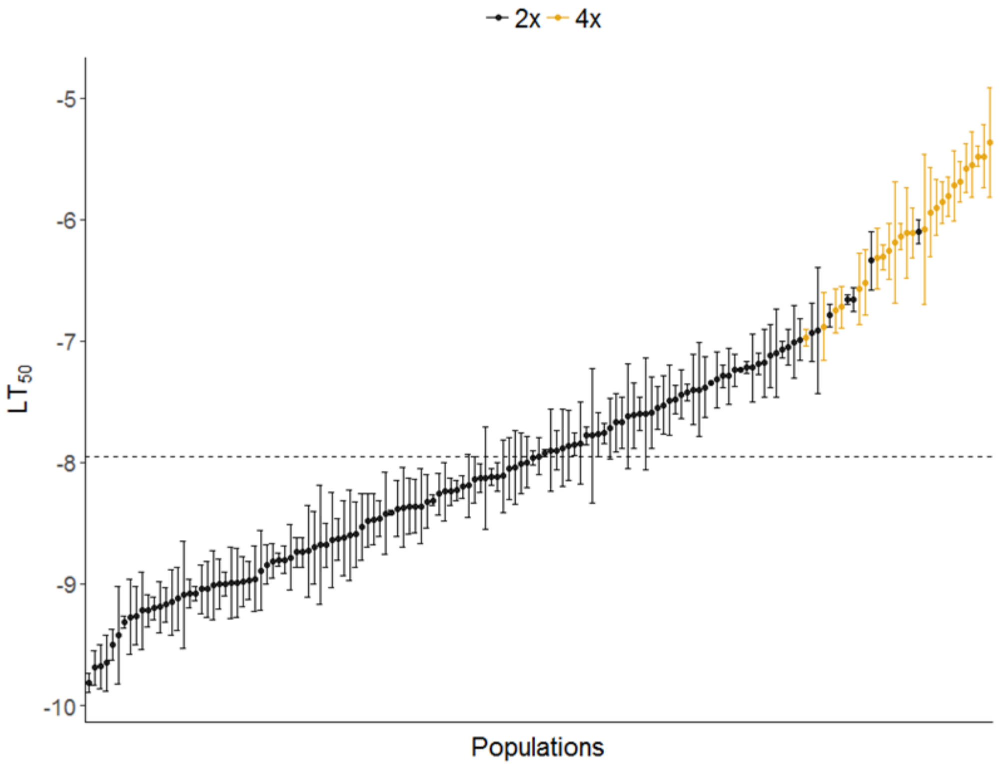
Spearman rank correlation between electrolyte leakage (EL), percentage of tiller survival (PTS), cold-acclimated plant proline content (PC) and field winter survival (FWS)

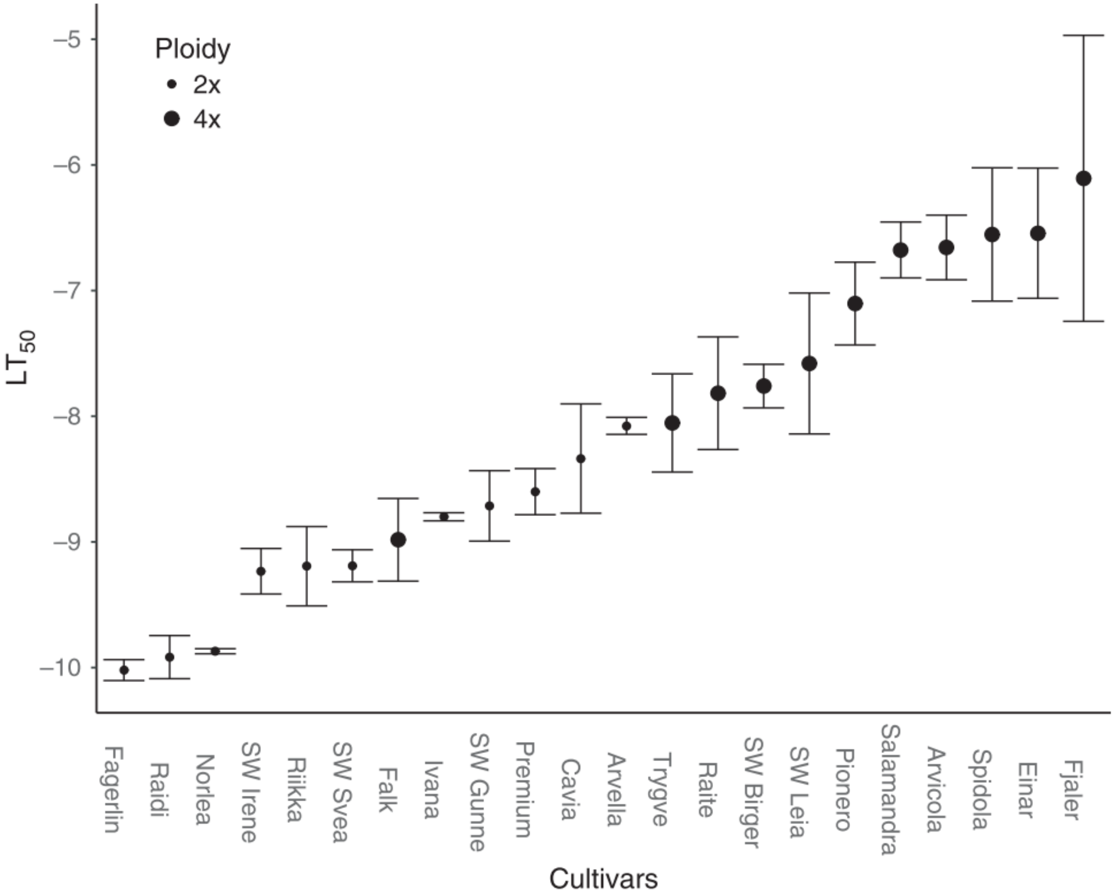
Trait	EL -8 °C	EL -12 °C	PTS -8 °C	PTS -12 °C	PC
EL -8 °C (%)	-				
EL -12 °C (%)	0.49***	-			
PTS -8 °C (%)	-0.39***	-0.15 NS	-		
PTS -12 °C (%)	-0.17 NS	-0.47***	0.41***	-	
PC (µg g $^{-1}$)	-0.15 NS	-0.03 NS	-0.12 NS	0.05 NS	-
FWS (score)	-0.20 NS	-0.47***	-0.06 NS	-0.003 NS	0.02 NS

Diploid vs Tetraploid



Variation of the freezing tolerance within the perennial ryegrass population panel. The dashed line represents median LT_{50} value.

A. Aleliūnas, PhD thesis



Freezing tolerance of the 22 tested perennial ryegrass cultivars

A. Helgadottir et al, J Agro Crop Sci. 2018;204:493–504.

Correlation between LT_{50} and spring cover

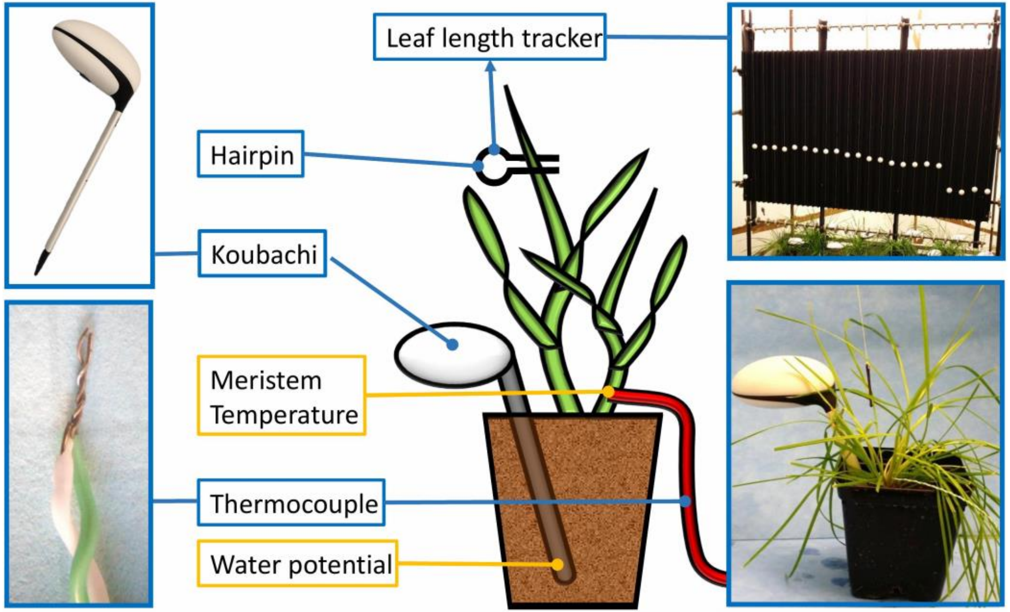
	Year 1	Year 2	Year 3
Estonia	0.23^{ns}	-0.21^{ns}	0.73^{**}
Finland	-0.13^{ns}	-0.13^{ns}	-0.49^{*}
Iceland	-0.71^{**}	-0.73^{**}	
Norway	-0.34^{ns}	-0.35^{ns}	-0.07^{ns}
Sweden	0.11^{ns}		

Winterkill and drought damage of perennial ryegrass, 2015–2016

Trait	Ploidy group	Winter kill 2015	Winter kill 2016	Drought damage 2015
Mean	diploid	1.12	3.19	4.87
	tetraploid	1.09	2.90	4.05
Min	diploid	1.00	2.00	2.00
	tetraploid	1.00	2.00	2.00
Max	diploid	5.00	8.50	8.50
	tetraploid	2.50	6.00	8.50

Kemesyte et al Crop Sci. 57:1–6 (2017)

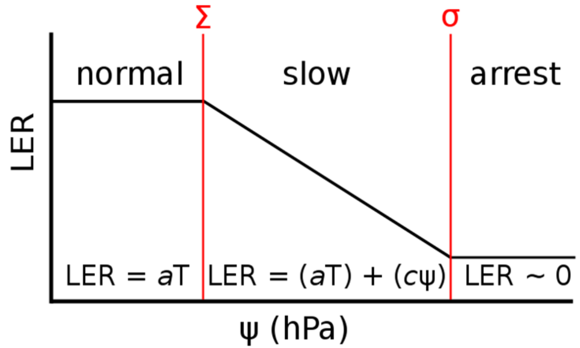
Abiotic stresses: **drought** resistance

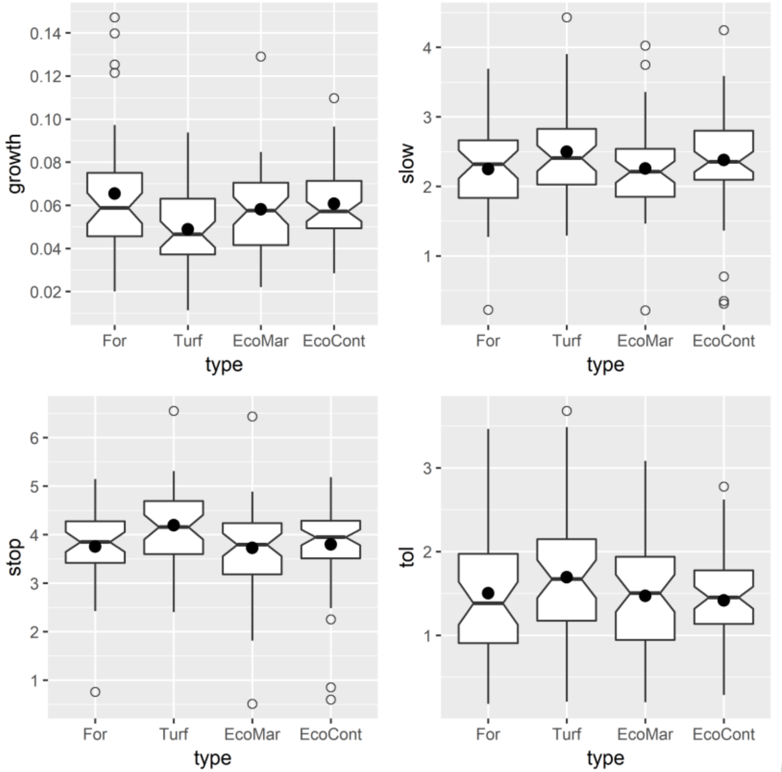


Phenotyping platform for chronological profiling of the leaf elongation rate (LER), the soil water potential and micrometeorological variables.

Yates et al Front. Plant Sci., 2019

Leaf elongation rate in response to mild drought





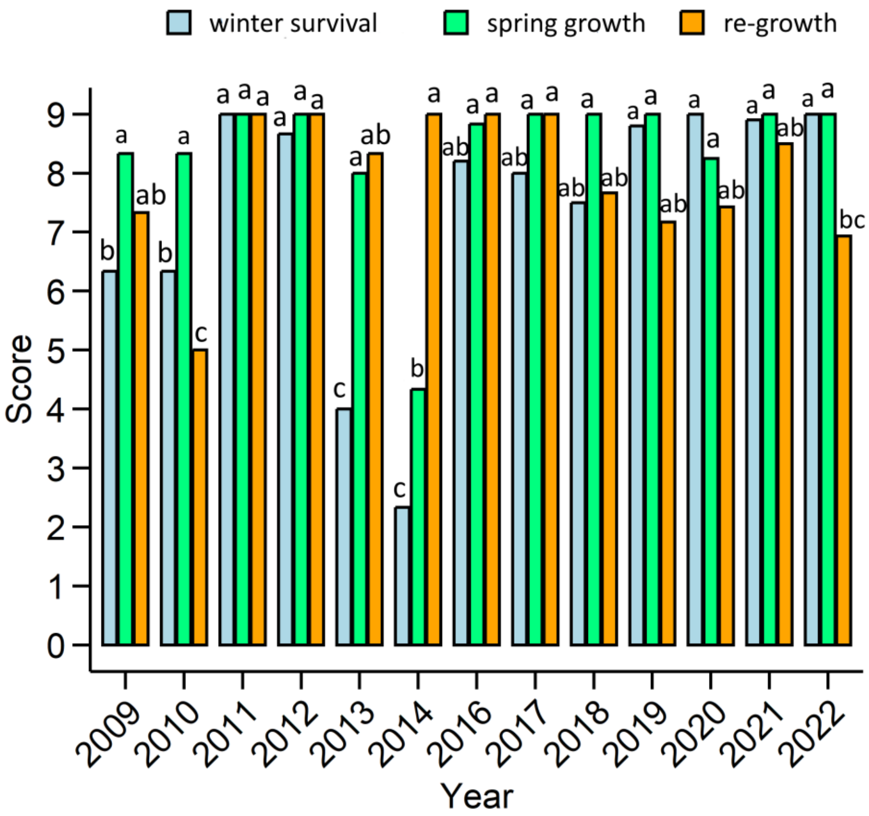
Jaškūnė et al. Front. Plant Sci.2020

Significant marker trait associations for the growth decrease trait on genomic scaffolds

Scaffold	Position	Gene prediction (blastn)	Location	Scaffold position in barley genome	GWAS method	SNP effect	MAF	*P*-value	*P*-values FDR	*P*-values (Bonferron correction
scaffold_20866|ref0045961	1878	Transcription factor MYB41 (XM_003573090.4)	Outside gene (708 bp)	Hv_chr6H	FarmCPU	−0.548	0.091	4.19E-07	0.009	0.009
					BLINK	NA	0.091	4.15E-07	0.009	NA
					MLMM	NA	0.091	8.16E-07	0.009	0.018
scaffold_4484|ref0039062	32616	Phytochrome B (XM_020328926.1)	Intron	Hv_chr4H	FarmCPU	0.739	0.054	1.79E-07	0.019	0.039

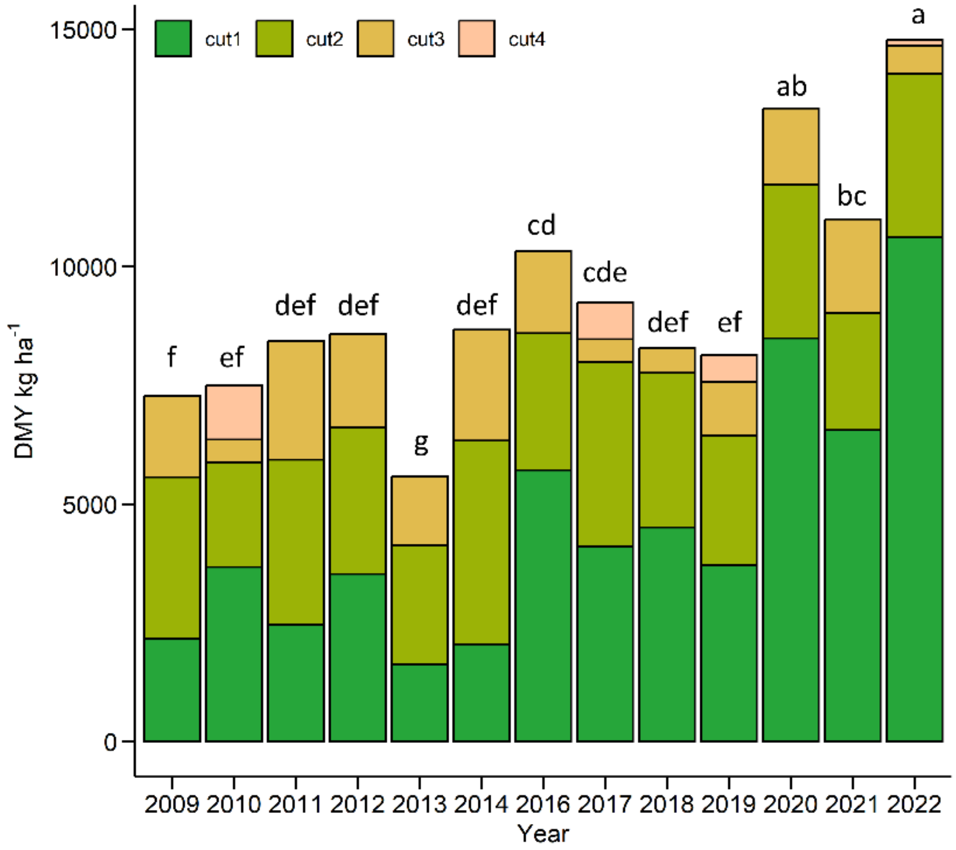
Jaškūnė et al. Front. Plant Sci.2020

L. multiflorum ssp. italicum



Winter survival, spring growth and re-growth after cuts

Kemešytė et al 2023 (hopefully)



The total dry matter yield over the period of 2009 – 2022

Winter period average temperature and total precipitation during 1st cut growth period had a significant effect on the 1st cut DMY ($R^2 = 0.51$)

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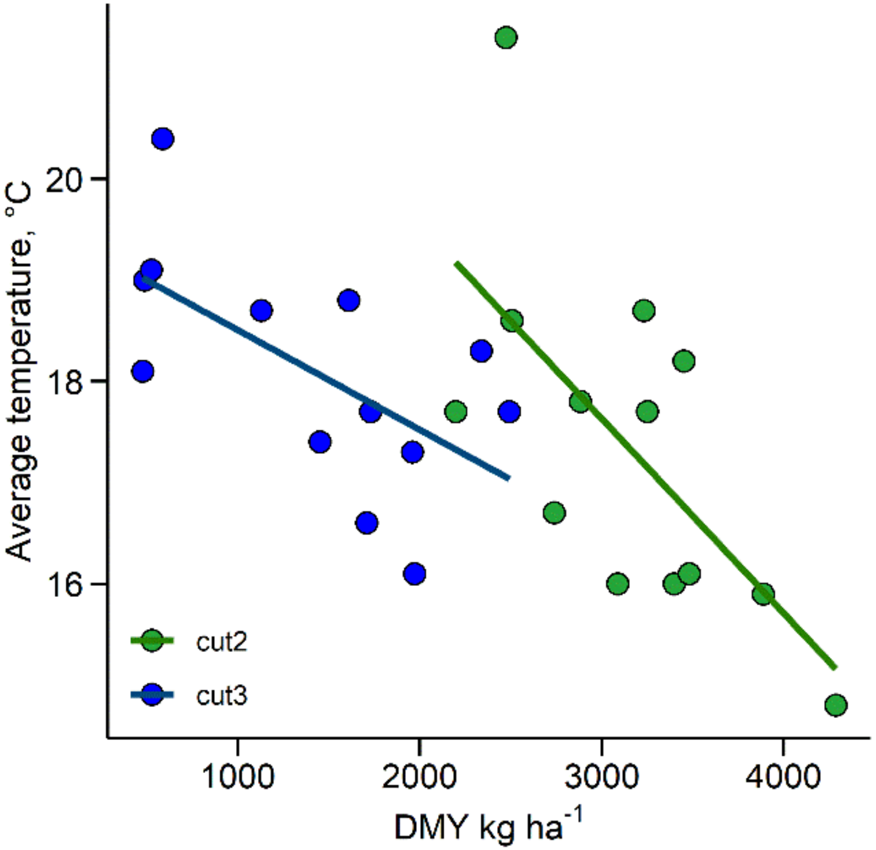
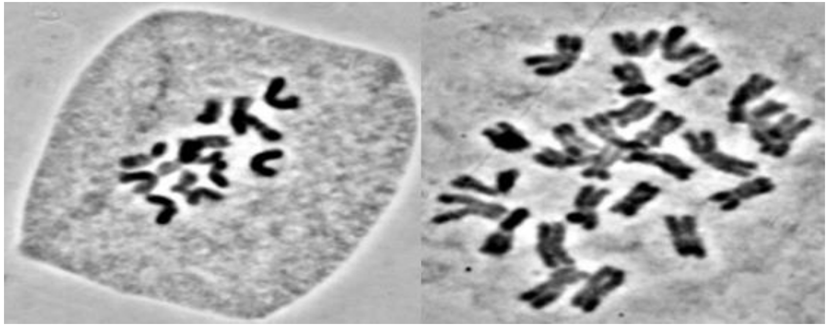


The relationship between dry matter yield (DMY) of 2nd and 3rd cuts and average temperature of corresponding growing period. The lines represent linear regression

R^2 = 0.435

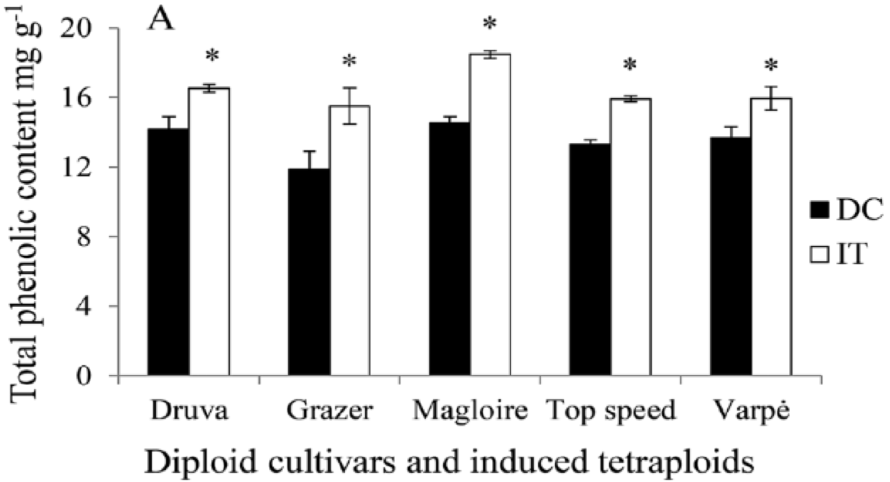
R^2 = 0.38

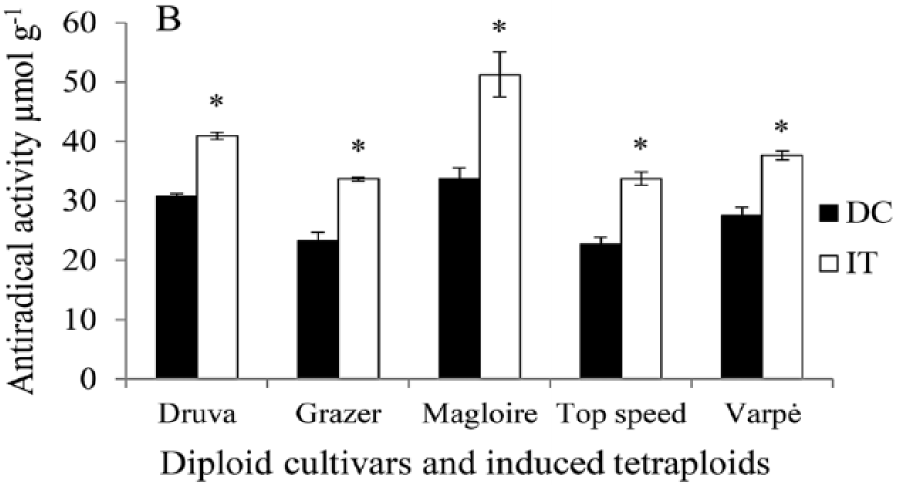
L. multiflorum ssp. multiflorum



O. K. Akinroluyo PhD thesis, 2019

The total phenolic content (A) and antiradical activity (B) of diploid cultivars (DC) and induced tetraploids (IT) after 5 days of mild drought





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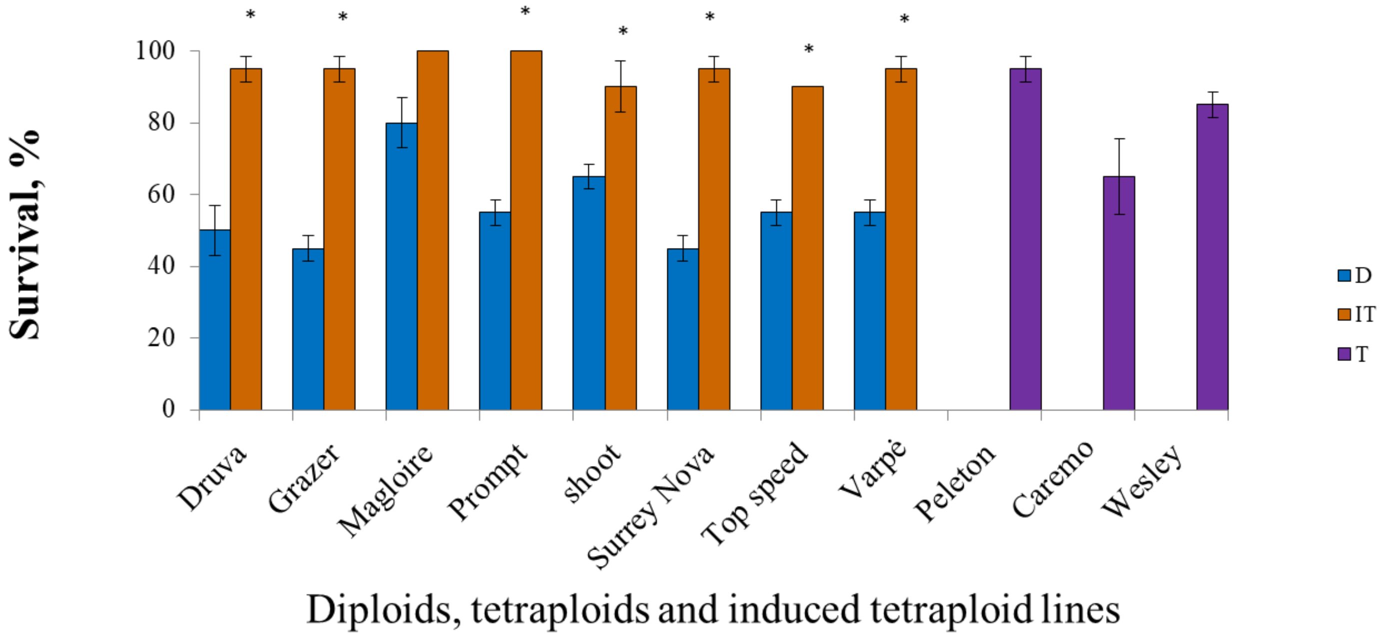
Akinroluyo et al Zemdirbyste-Agriculture, vol. 107, No. 2 (2020)

Regrowth after severe drought



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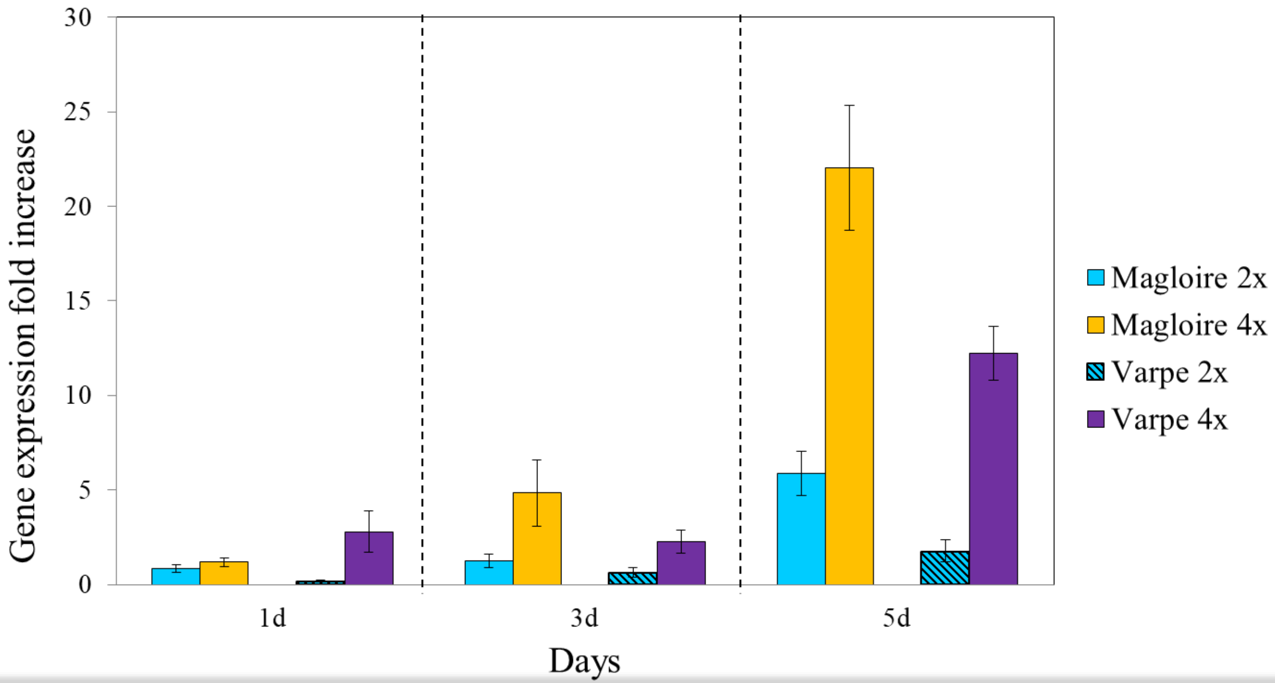
Catalase (CAT)



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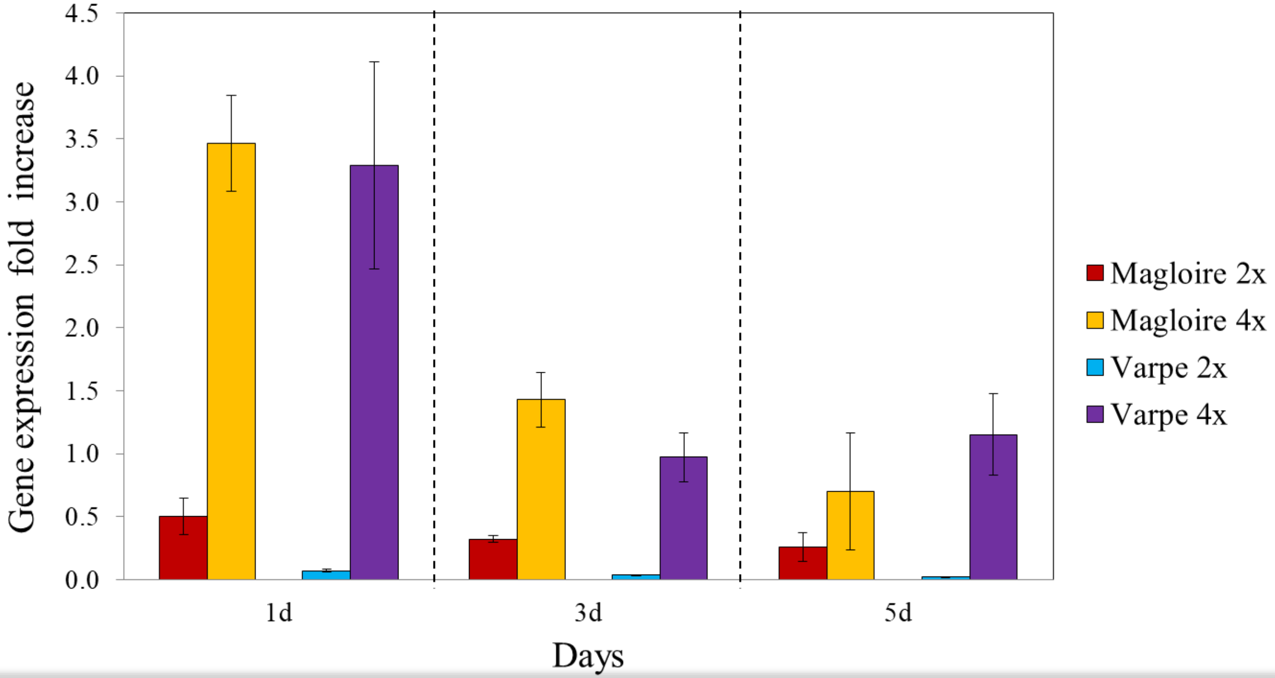
Guaiacol peroxidase(POD)



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Akinroluyo et al Zemdirbyste-Agriculture, 2021

So… do we still care about freezing?

Drought?

Water logging?

Heat?

Thank you