

CHANCES FOR THE CONSERVATION AND RE-CULTIVATION OF CENTRAL EUROPEAN CLUB WHEAT (BINKEL) THROUGH A NUTRITIONAL AND GENETIC DIFFERENTIATION TOWARDS OTHER WHEAT SPECIES (BIDIFFERENT)

Rudolf Voegel, VERN
Albrecht Serfling, JKI

September 18, 2025



**Presentation by Rudolf Voegel, VERN
background of project work, collaboration, club
wheat documented in gene bank collection,
field trials and ongoing work**

**Presentation by Dr. Albrecht Serfling,
genetics of selected club wheat samples,
Trials and analysis of pathogene resistance and
tolerance**

Club wheat / *Triticum compactum* ssp.

- neglected,
- underutilized,
- extincted...

- a forgotten wheat species of history....
- out of formal interest of seed policies and breeding



Historic migration of club wheat



Black line: 10,000-4,000 BCE. Movement of hexaploid wheat from Turkey throughout Central Asia and into Europe.

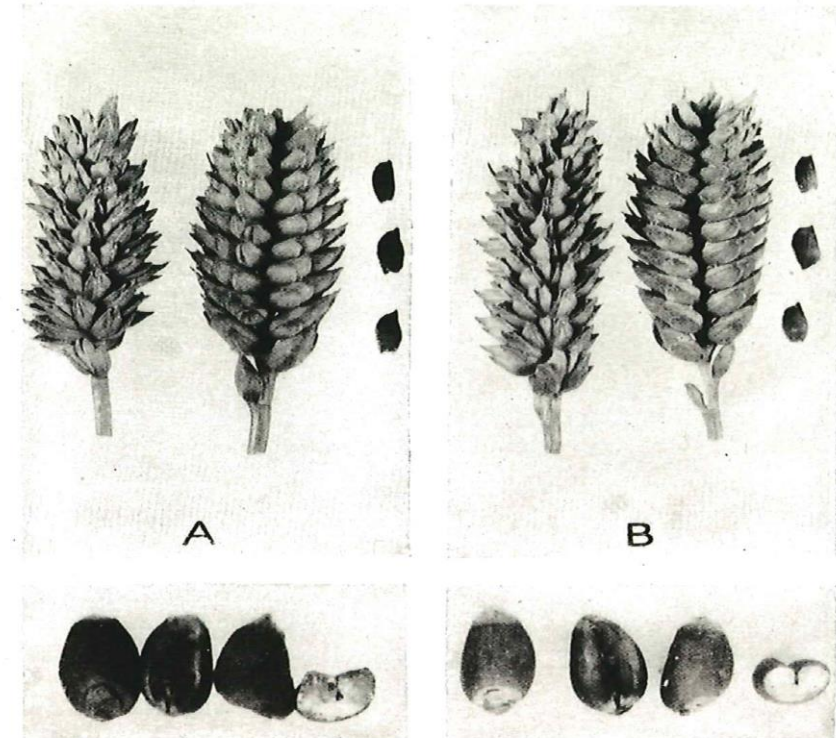
Red line: 4,000 BCE-1800. Wheat is tracked across Europe at archaeological sites in Romania, Catalonia, Iberia and the Black Sea to Budapest and through Spain to Portugal, then on to South America and Mexico.

Green line: 1800-1900. Shipping routes from Chile to California expedite wheat's progress to North America. By the 1830s, wheat finds its home in the Pacific Northwest.



Tech. Bul. 795 U. S. Dept. of Agriculture

PLATE 39



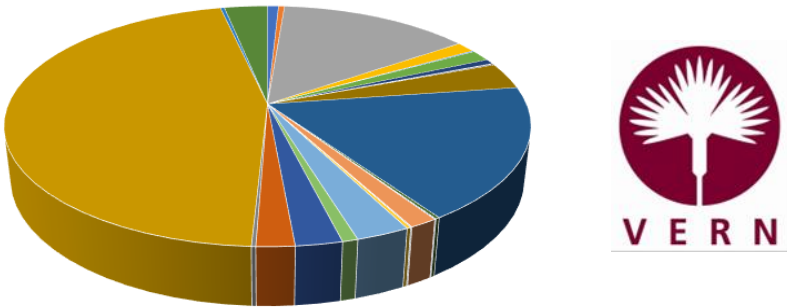
A, Hybrid 128 and B, Albit wheats; Spikes and glumes natural size; kernels $\times 3$.

Phenotypic/genetic heterogeneity?
Breeding in SWE, CH, A, Germany early 20th
Historic sources: Russia, Siberia 1795
Modern use and breeding: US/Oregon

Group of triticum compactum var. Part of Triticum collection:

Binkel/Igelweizen, Herisson, mocho, Kubbweisen, Teremok, club wheat

EURISCO-data:
total number of estimated accessions of triticum compactum ssp. 1362



- AUT AUT001
- AUT AUT005
- AZE AZE015
- BGR BGR001
- BGR BGR029
- BLR BLR011
- CHE CHE001
- CHE CHE094
- CHE CHE100
- CZE CZE122
- DEU DEU146
- ESP ESP004
- FRA FRA040
- GBR GBR247
- GEO GEO001
- GEO GEO013
- HUN HUN003
- NGB SWE054
- NLD NLD037
- POL POL003
- PRT PRT001
- RUS RUS001
- SVK SVK001
- UKR UKR001

241 selected accessions of Triticum compactum:

- european origin,
- taxonomy trit. comp.ssp.
- name of accession, description



- AUT
- BGR
- BLR
- CHE
- CZE
- DEU
- ESP
- FRA
- GBR
- HUN
- NGB
- NLD
- POL
- PRT
- RUS
- UKR

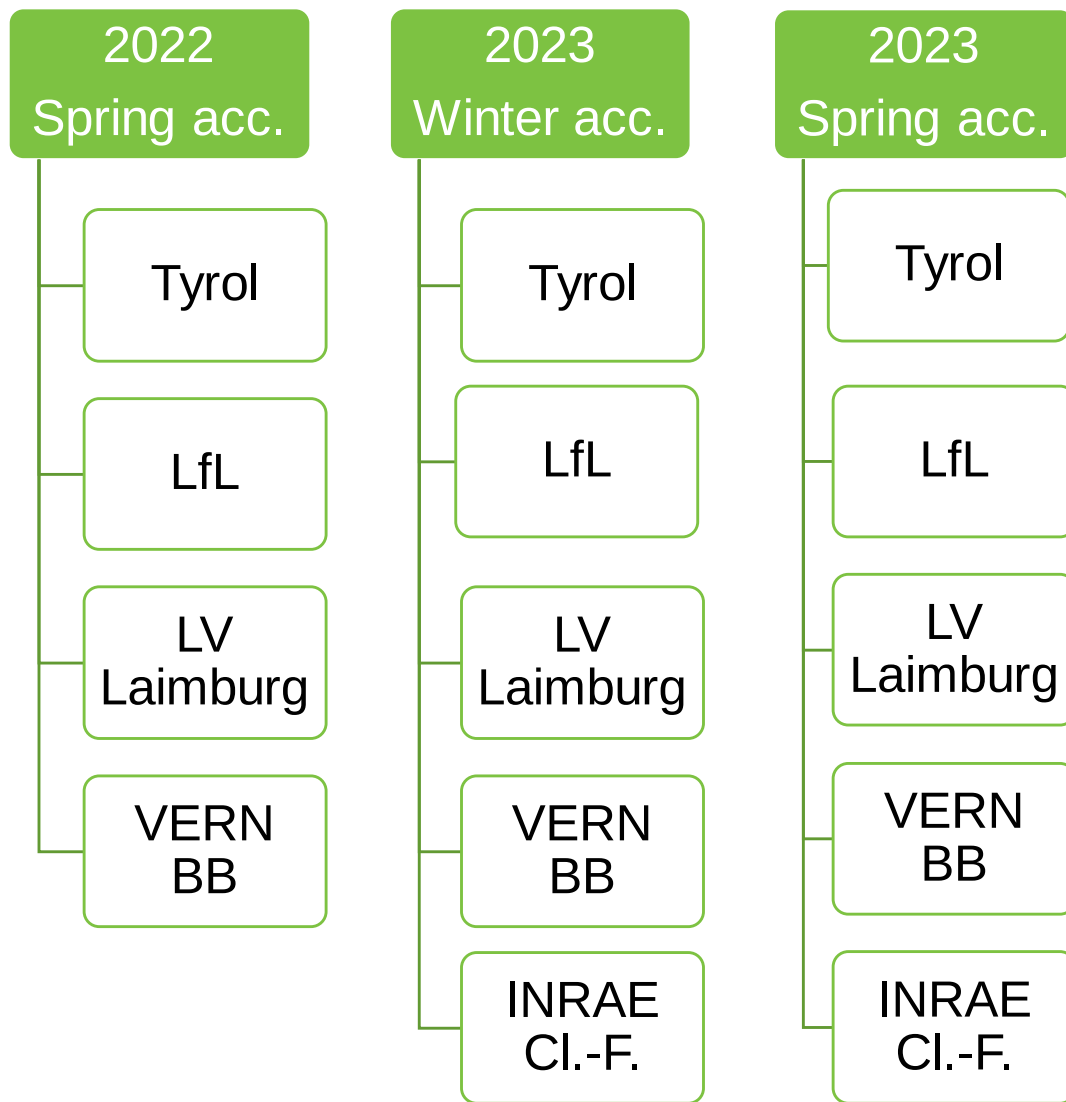
Triticum	aestivum	L.	var. creticum	(Mazz.) Mansf.	common v	TIROLLER I
Triticum	aestivum	L.	var. wernerianum	(Koern.) Mansf.	common v	TIROLLER I
Triticum	compactum	Host.	var. creticum			
Triticum	compactum	Host.	var. clava			BLAUROT!
Triticum	compactum	Host.	var. wernerianum			HYBRID 12
Triticum	compactum	Host.	var. clava			BBA1 0013
Triticum	compactum	Host.	var. clava			D.H.E.COL
Triticum	aestivum	L.	var. wernerianum	(Koern.) Mansf.	common v	Albit
Triticum	compactum	Host.	var. wernerianum			
Triticum	compactum	Host.				ROHDE
Triticum	aestivum	L.	var. compactum		common v	M 465
Triticum	aestivum	L.	var. compactum		common v	M 513
Triticum	aestivum	L.	rufulum			Omar C.J.
Triticum	aestivum	L.	erinaceum			ROTER IGE
Triticum	compactum	Host	rufulum		winter, w	Omar

Proposal	Tasks	Timetable	Responsible
3	baking tests and experiments, quality analysis 9 acc. spring, 2022 29 acc. winter acc. 2023	2022-2024	VERN 
3	disposal to interested farmers, bakers, groups	2023-2024	VERN, all, Slow Food
3	transformation, seed multiplying, establishing on farm conservation, Information and public	2023	VERN, all, Slow Food

Field survey 2022/2023

2022 4 locations, spring acc.

2023 5 locations, spring (second time) 2023 5 locations,
winter acc.



Parameters...

- Yield
- Agronomics
- Tolerance/resistance
- Cultivation value
- Phenotype description

Total:

field plots/5 locations

~10 acc. spring (2x),

~15 acc. Winter

Additional ~15 acc.

small plots by INRAE

Field trials VERN-Wilmersdorf 2023 Winter accessions club wheat



TOBIAS
Standard



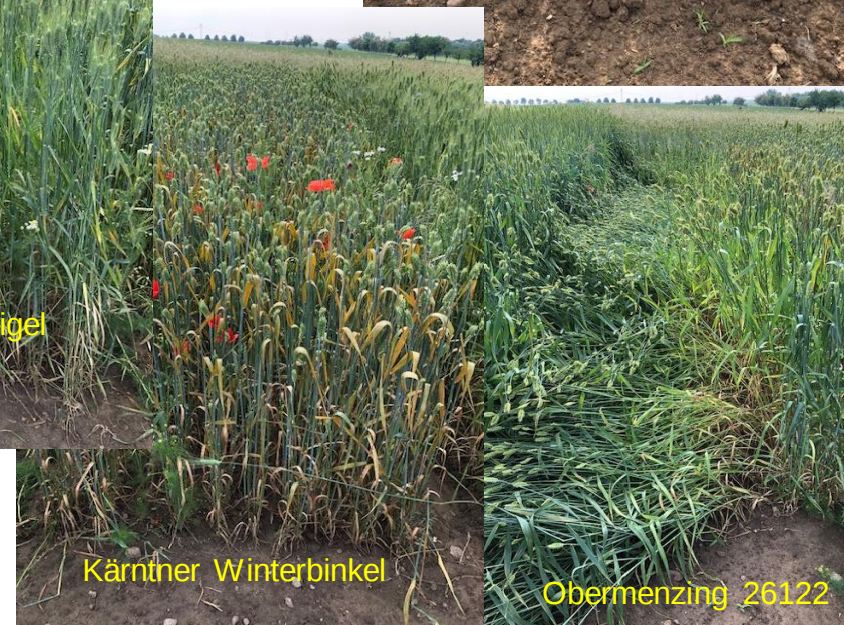
Binkel samtrot



Crescent Club wheat US



Weißspelziger Winterengel

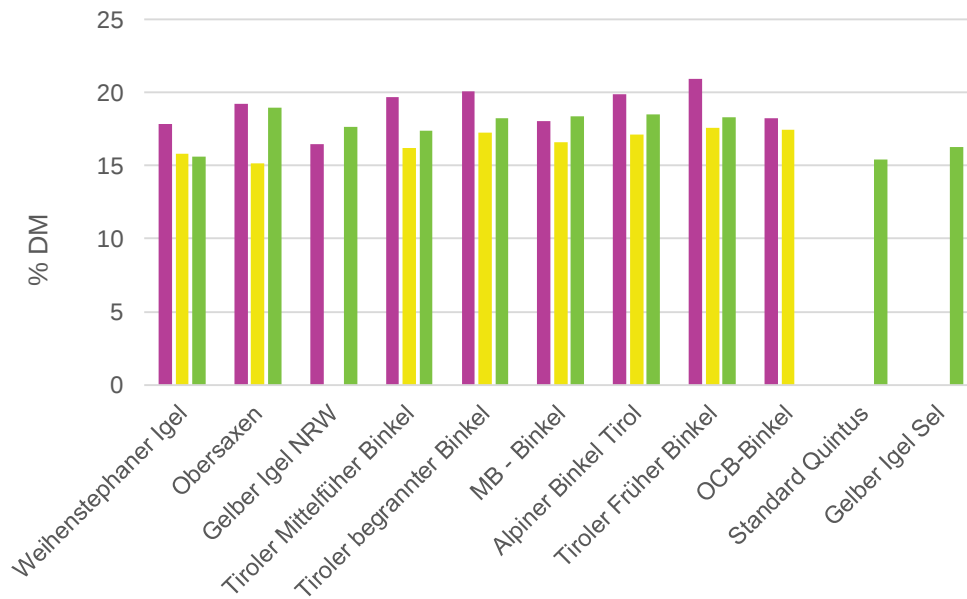


Kärntner Winterbinkel

Obermenzing 26122

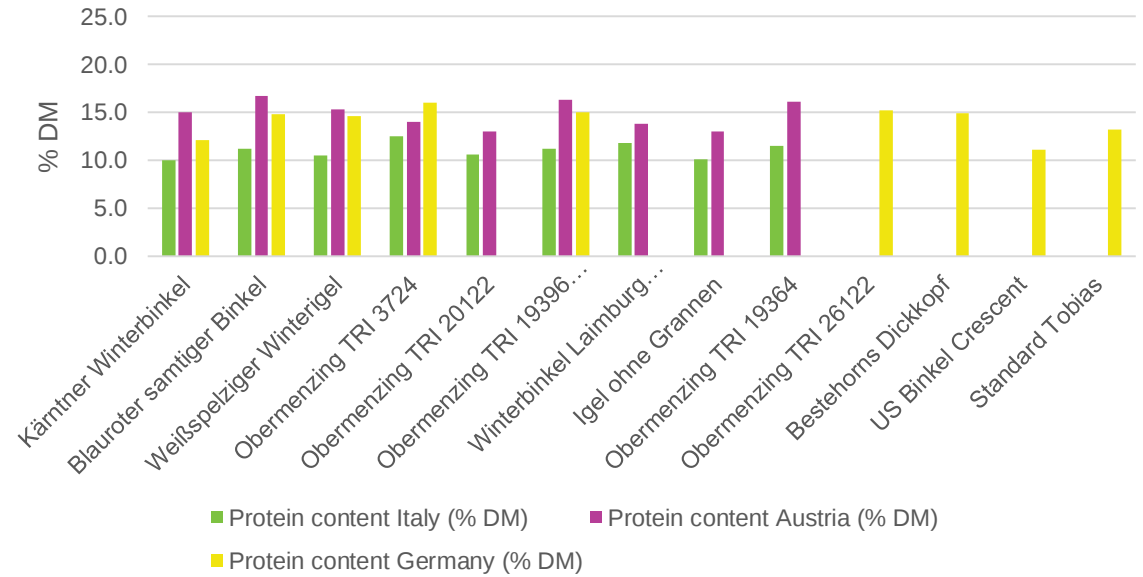
Quality of trial harvest

Protein content spring accessions
Italy - Austria - Germany 2022



■ Protein content Italy (% DM) ■ Protein content Austria (% DM)
■ Protein content Germany (% DM)

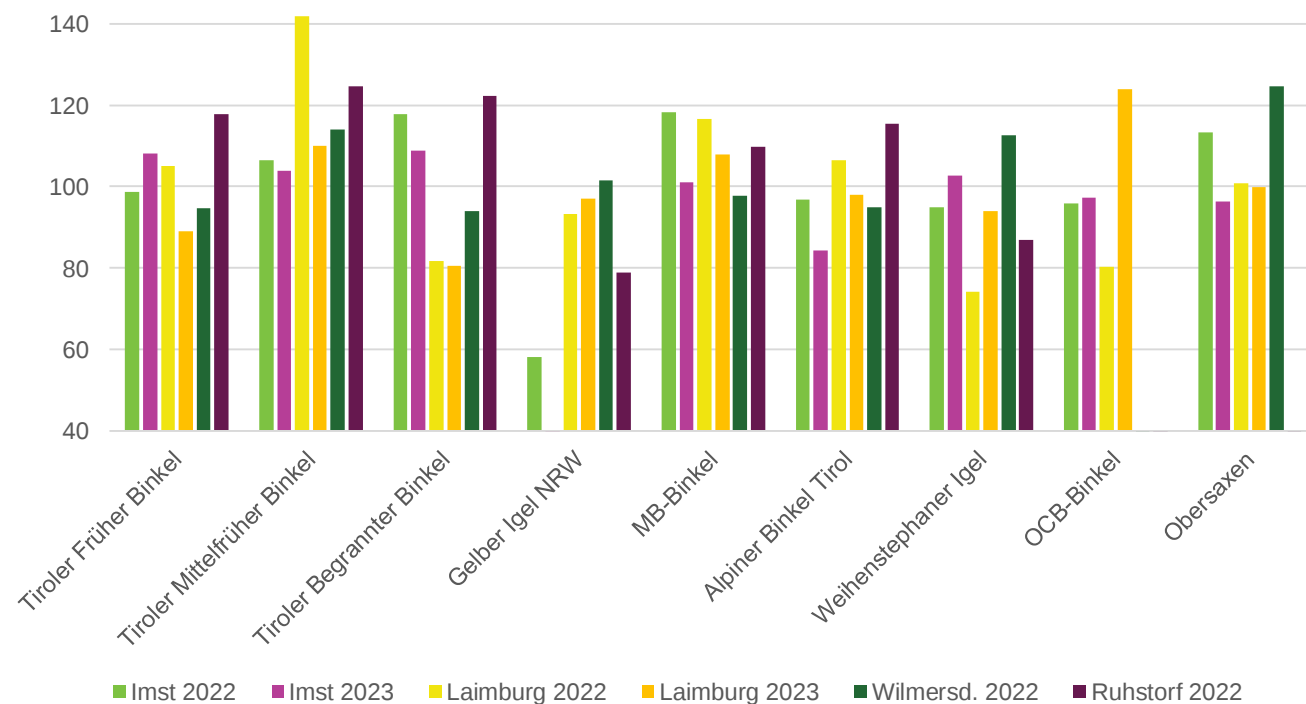
Protein content winter accessions
Italy - Austria - Germany 2023



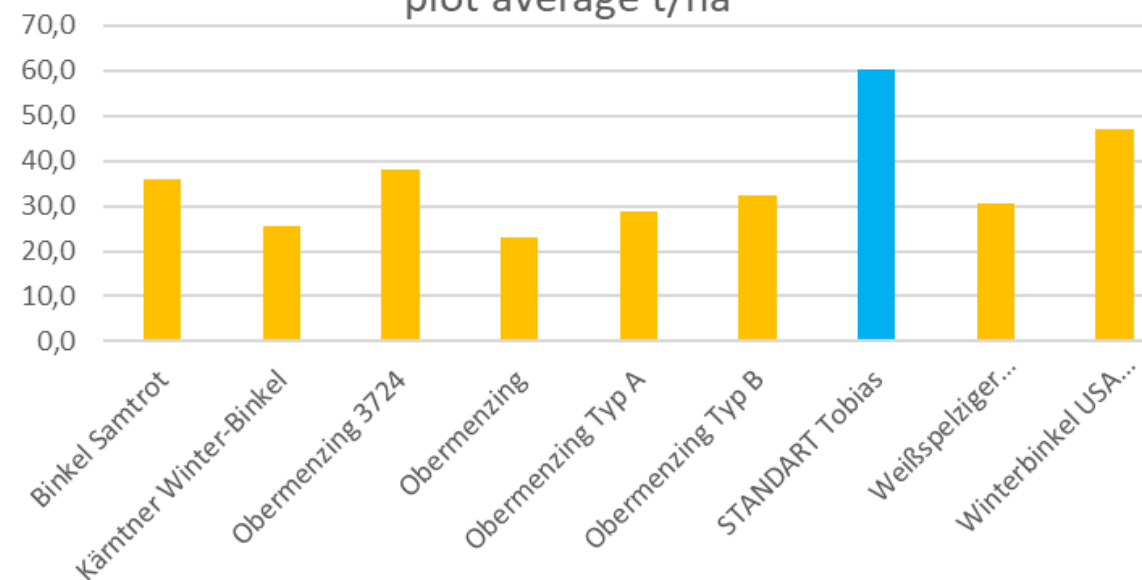
■ Protein content Italy (% DM) ■ Protein content Austria (% DM)
■ Protein content Germany (% DM)

Trial yield of sites

Spring club wheat: relative yield (rel. % VD) all sites, 2022-2023



field trial club wheat WIL-BB 2022/2023
plot average t/ha

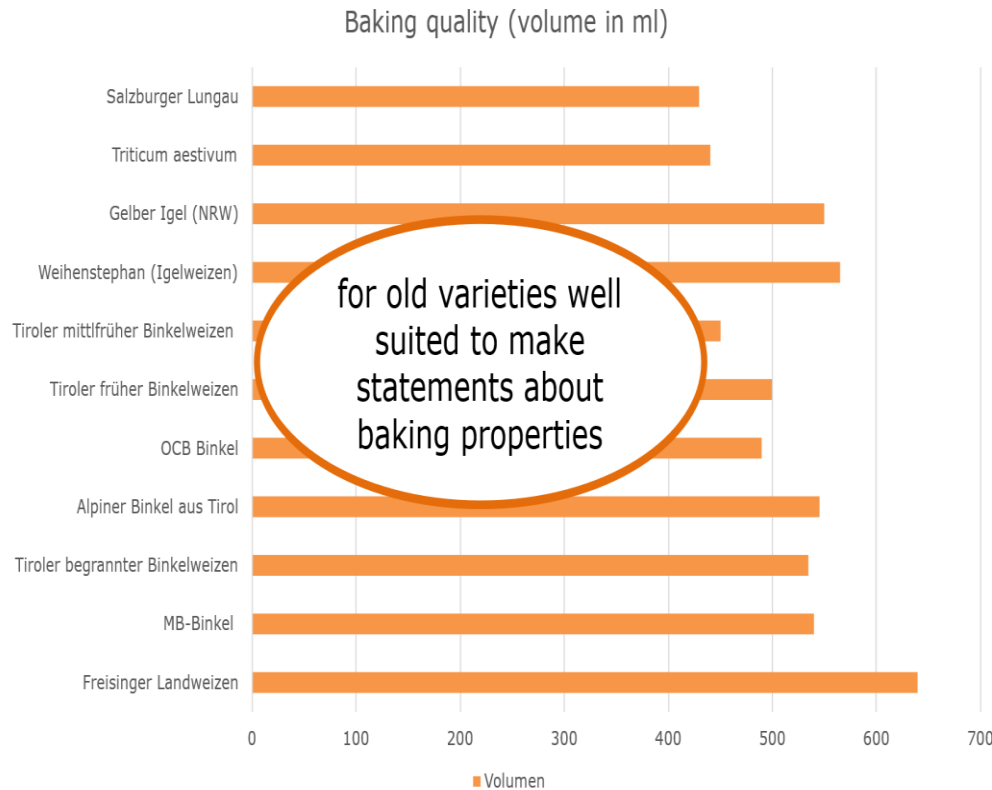


Baking quality of club wheat

analysis-baking laboratory

Checked parameters:

- Water absorption
- Sedimentation
- Ash
- Falling number
- Crude protein
- Wet glue
- Gluten index
- Crumb elasticity
- Dough elasticity
- Dough surface
- Volume



CHOPIN

AlveoLab

INRAE
5 CHEMIN DE BEAULIEU
63000, CLERMONT FERRAND, FRANCE

IVD-bié
.. ..

Protocole : Alvéographe HC
Nom du fichier : 2404160507[1110]
Nom du test : WB E23-8
Commentaires :

Date et heure du test : 16/04/2024 13:50:23
Nom du partenaire : IVD-bié
Produit : Farine de blé de laboratoire
S/N : 594
A : 1.4.0

Température

Eau : 19,9 °C
Pétrin : 24 °C
Chambre de repos : 25 °C
Chambre Alveo : 20,7 °C

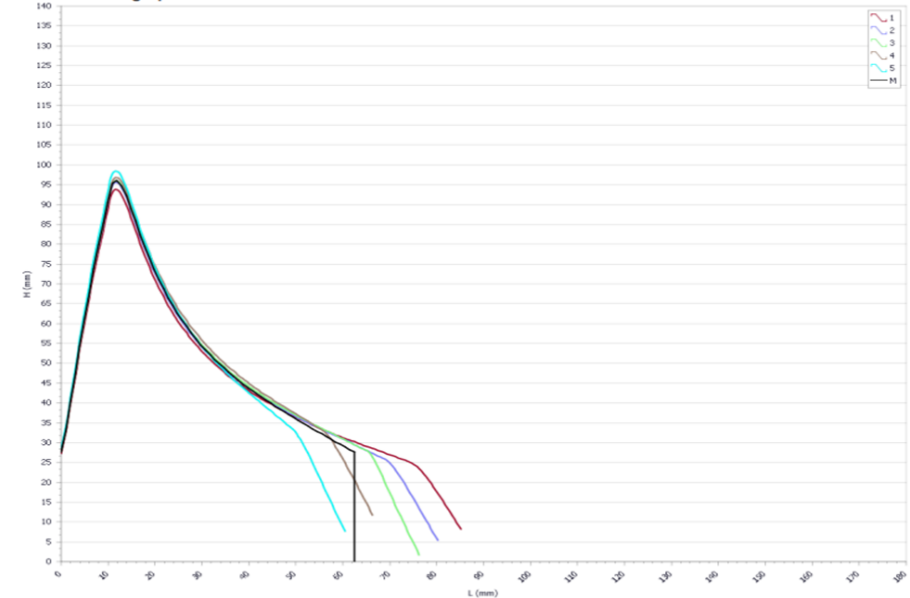
Paramètres

Hygrométrie : 60,8 %
Humidité : 15,2 %
Hydratation : 50 %
Base d'hydratation : B15% H2O
Quantité d'eau : 124,12 mL
Masse de farine : 250 g

Résultats standards

P : 106 mmH2O
L : 62 mm
G : 17,5
W : 223 10-4J
P/L : 1,71
le : 45,8 %

Courbe Alvéographe



v : 1.1.2.4

1 / 1

BiDifferent- Genetic differentiation of Binkel accessions and identification of possible resistances

Albrecht Serfling
JKI- Institute for Resistance Research and Stress Tolerance



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Are there genetic differences between binkel and common wheat?

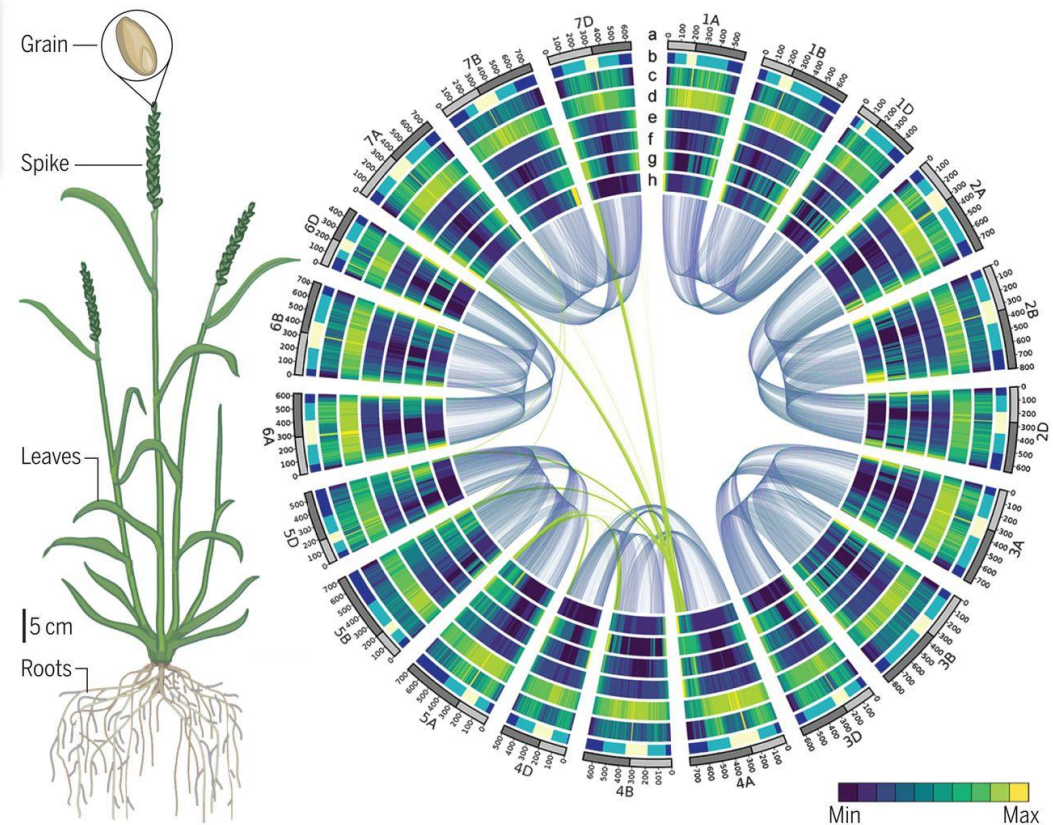
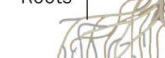
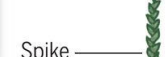
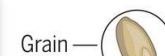
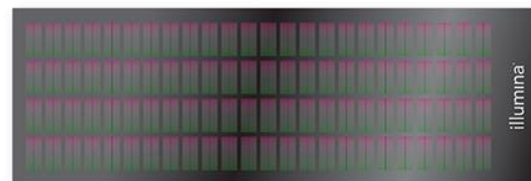
Analysis of genotypic variability in previous projects

Material: 2458 wheat genotypes

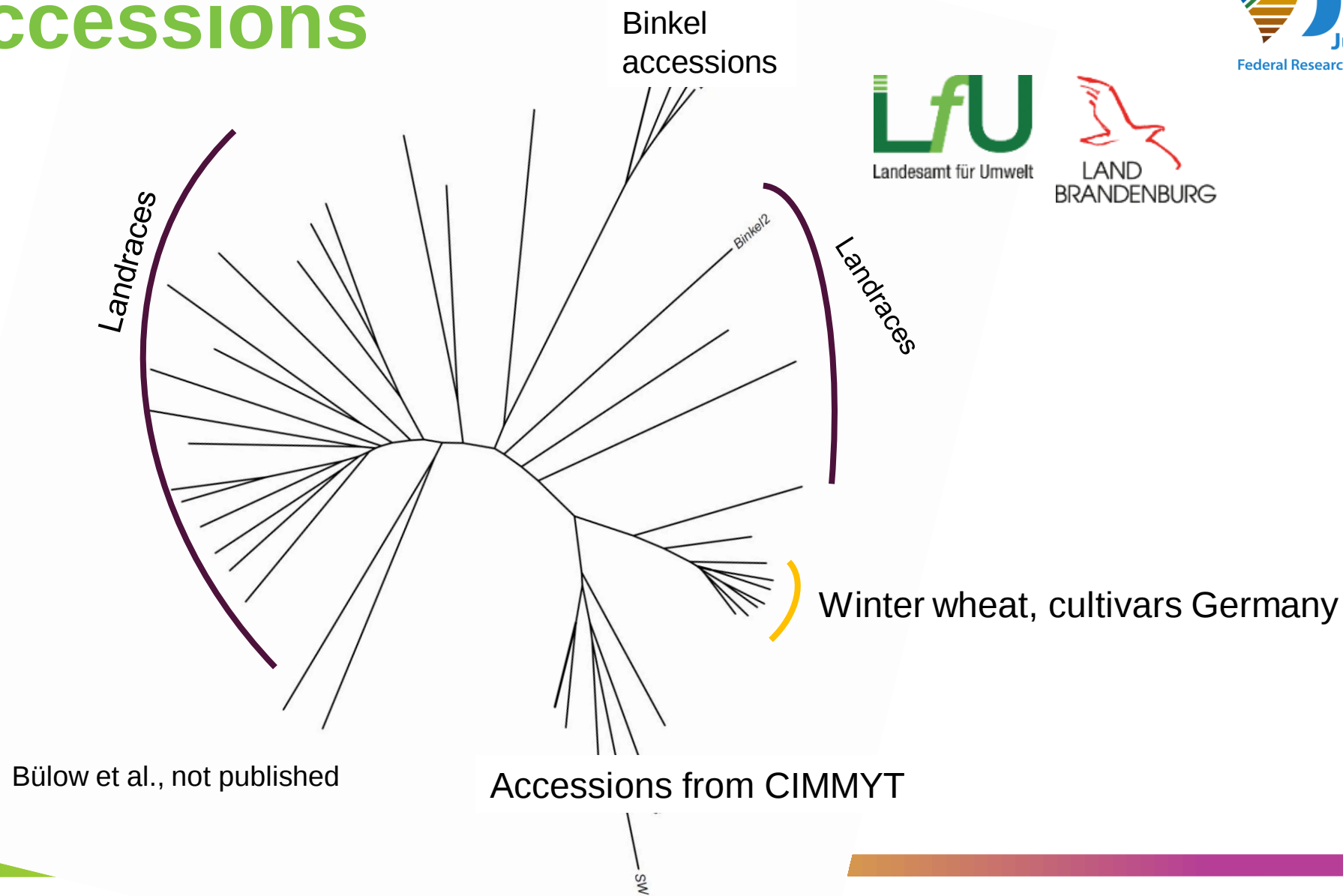
- ✓ Winter wheat (Germany)
- ✓ Winter wheat, F, RUS, SVK
- ✓ Spring wheat, D
- ✓ Spring wheat CIMMYT
- ✓ Watkins core collection
- ✓ PGR (LflL, GRIN)
- ✓ Landraces (VERN e.V.)
- ✓ Club wheat accessions (IPK genebank):

- 1 TRI 28234 Alpiner Binkel Tirol
- 2 TRI 853/TRI 24327 Gelber Igel Germany
- 3 TRI 9237 Landrace Austria before 1930
- 4 TRI 8857 Landrace Austria before 1930
- 5 TRI 7769 Tiroler Mittelfrüher Binkel
-Landrace before 1930

Genotyping using 25k wheat chip



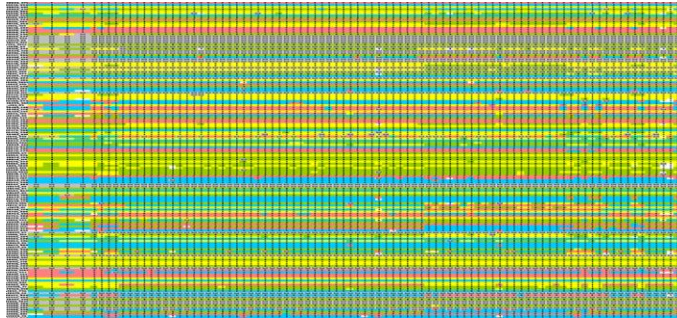
Preliminary results- Differentiation of wheat accessions



BiDifferent-Detection of Binkel by genotyping

Analysis of 227 Binkel genotypes and comparison to > 100 wheat accessions using 25k chip (>24,000 markers)

Filtering and
selection of SNP-
markers



Identification
of polymorphic markers

**Reference genomes
of wheat available!**

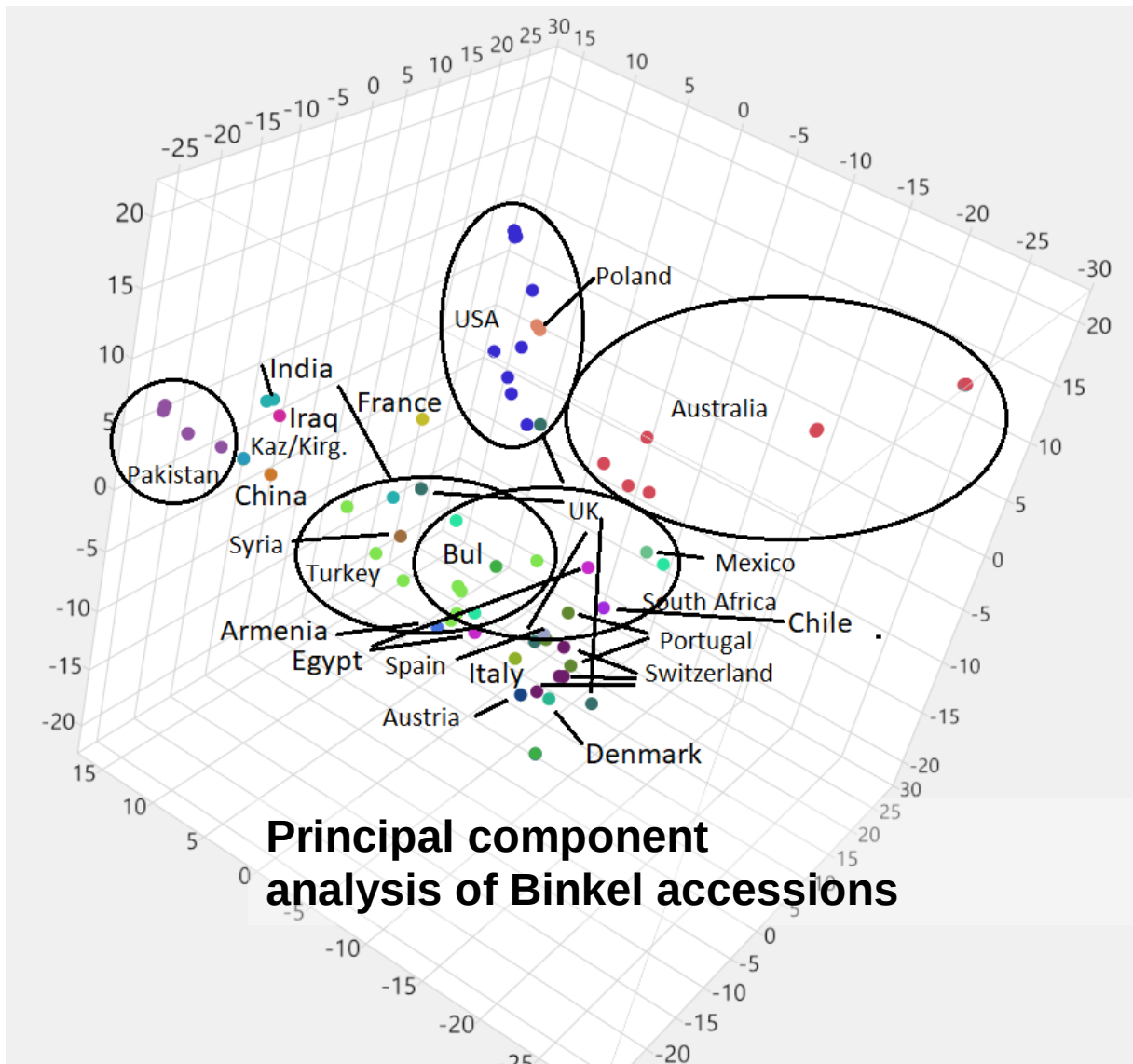
Mapping of SNP-markers (Wang et al. 2014, Wen et al. 2017, Sun et al. 2022)

Identification of Binkel specific introgressions/ translocations/ SNPs

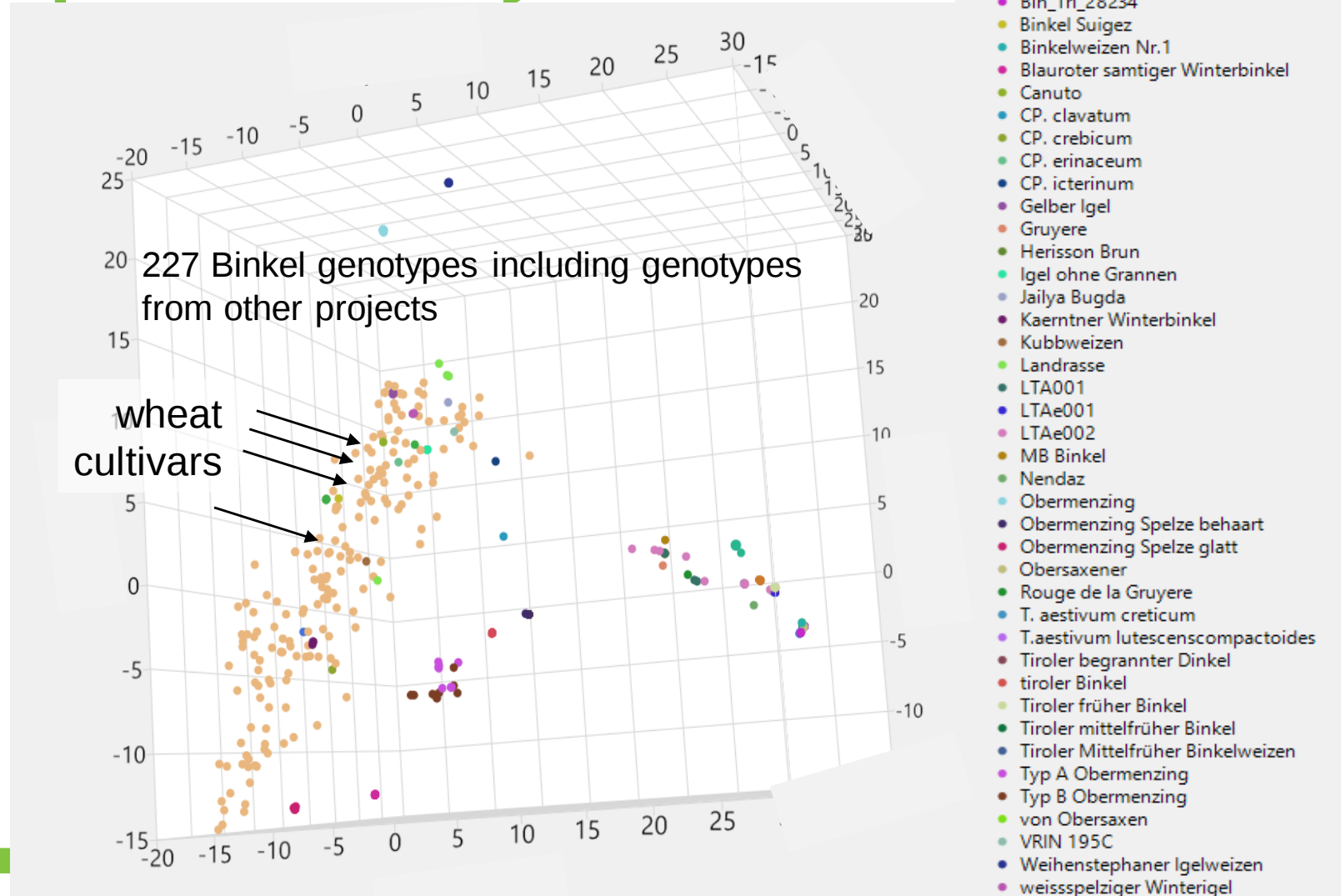
Comparison of polymorphic SNP markers with wheat accessions

Blast to publicly available databases and derivation of KASP-markers for differentiation of Binkel accessions/ varieties and comparison to common wheat cultivars

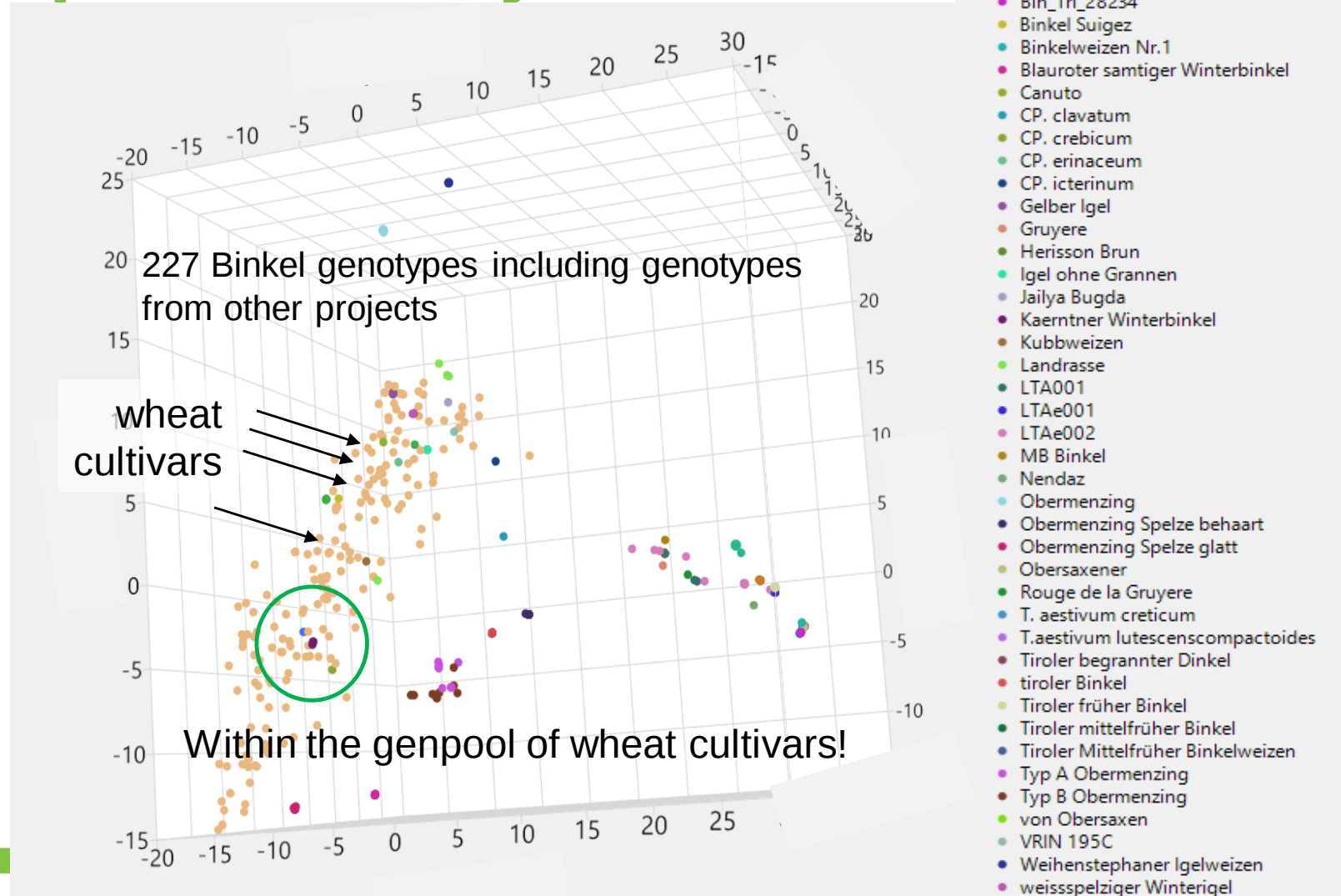
Allocation of the regions of origin of Binkel



Comparison of Binkel and winter wheat accessions by principal component analysis



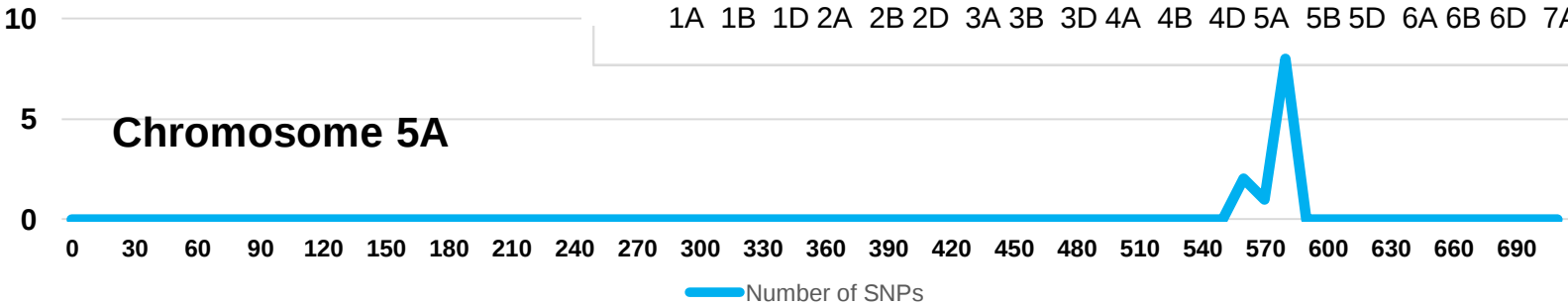
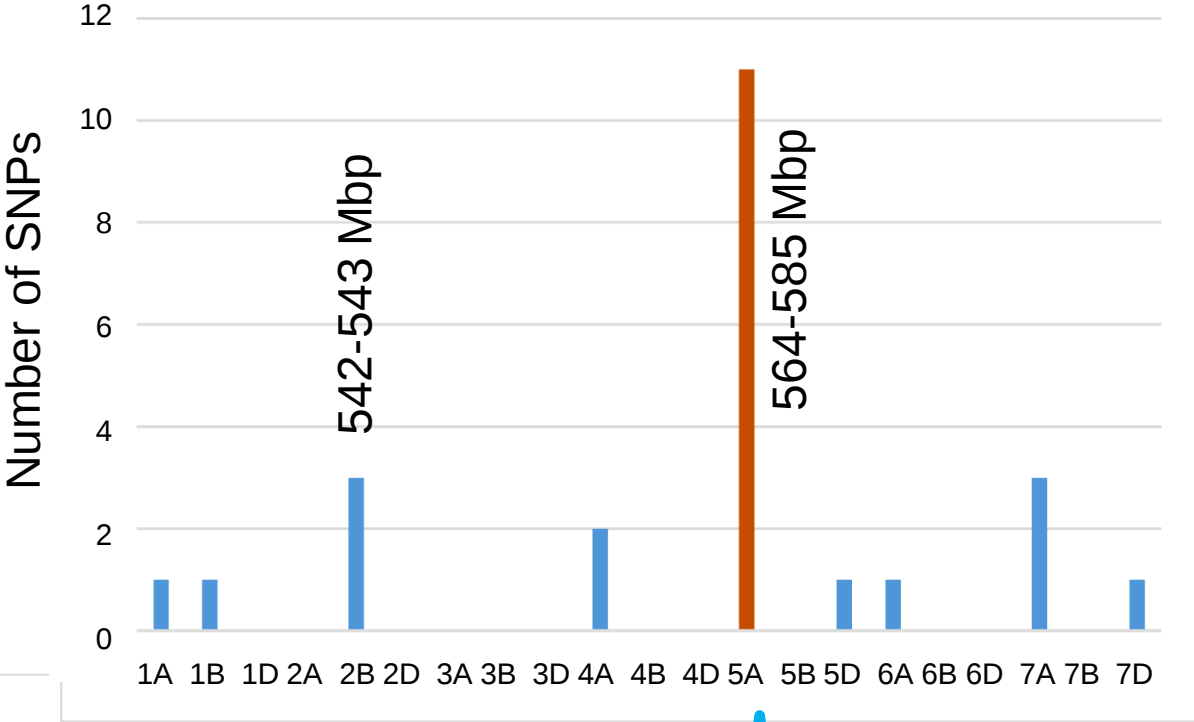
Comparison of Binkel and winter wheat accessions by principal component analysis



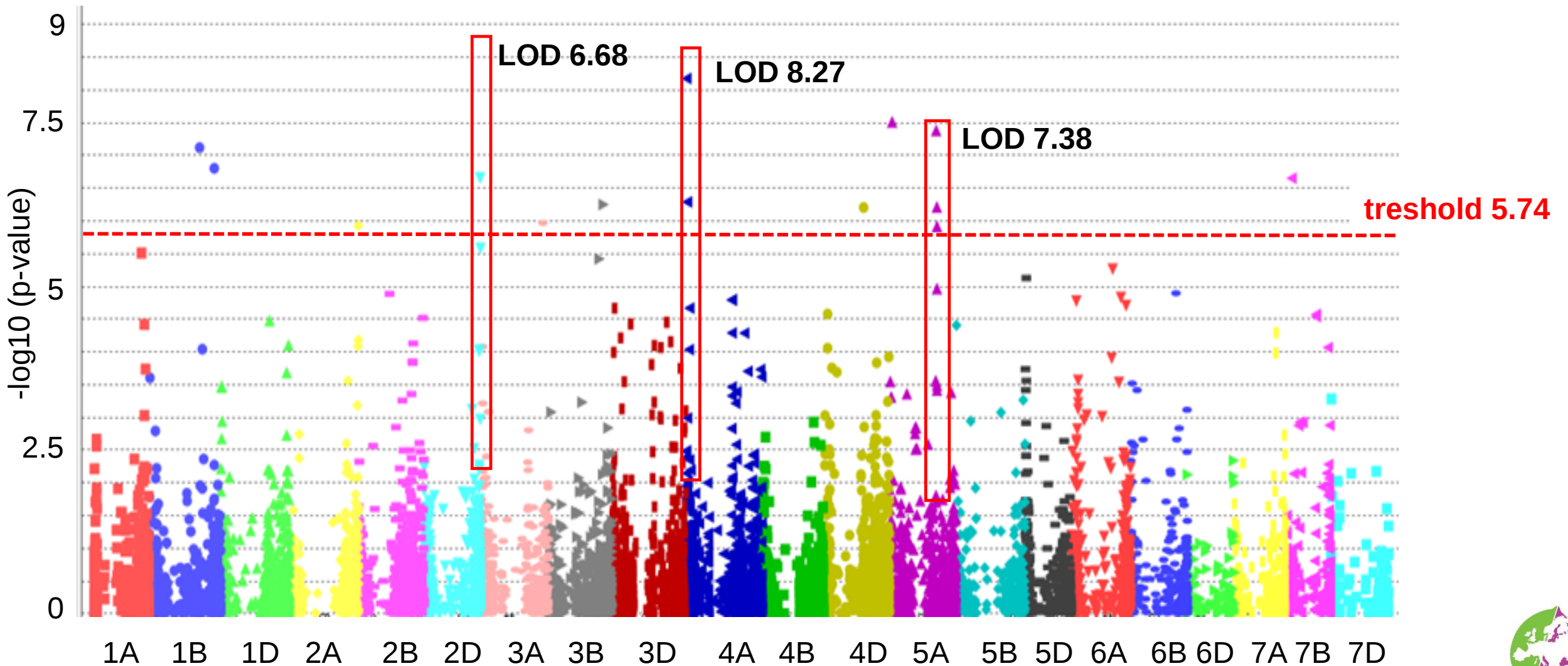
How to differentiate wheat phenotypes genetically?

A simple comparison:
Number of different alleles on
chromosomes between wheat phenotypes

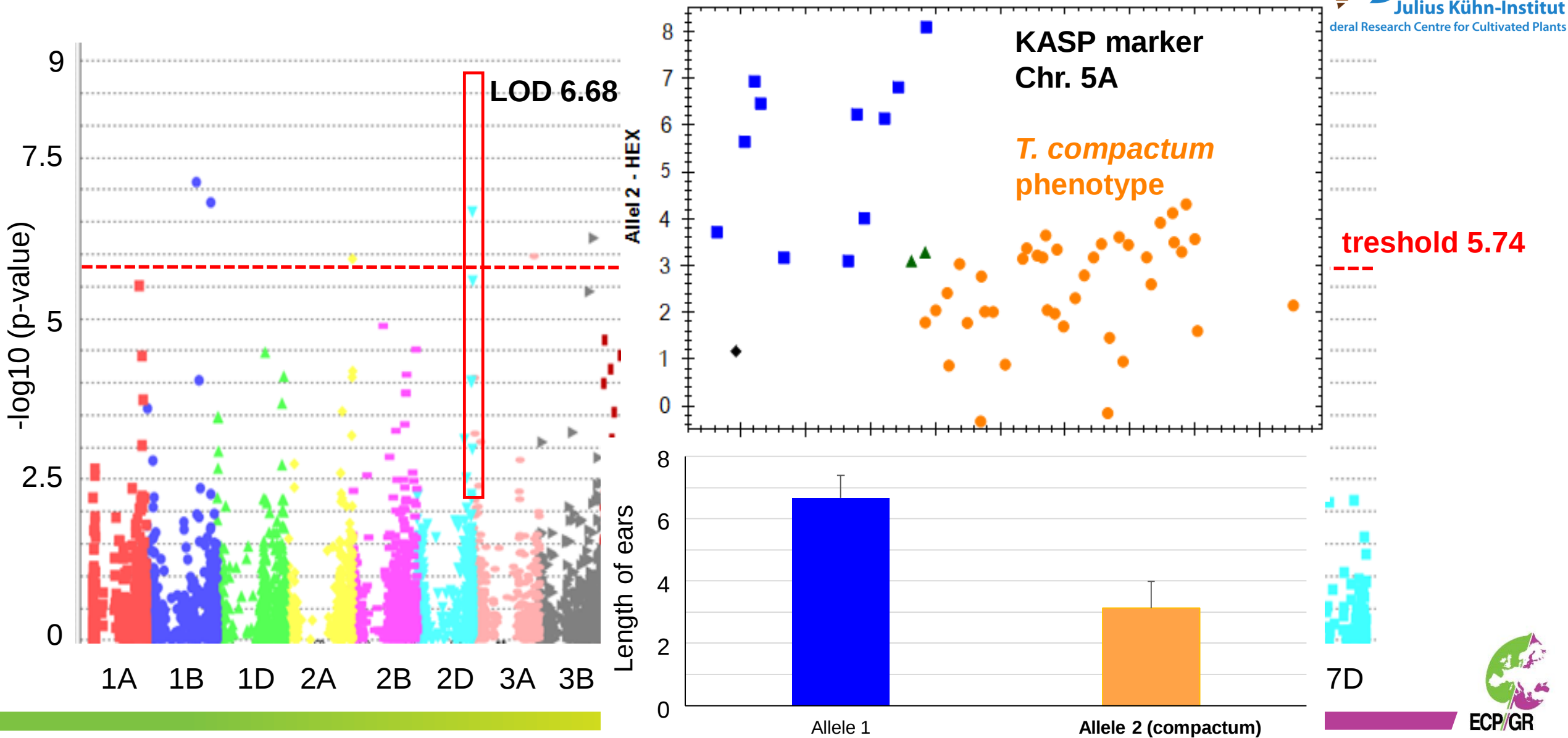
Chromosome	Markers	Lowest	Highest (bp)
1A	609	7184499	593550661
1B	531	1203935	689000691
1D	219	216813	493936055
2A	654	259213	780714971
2B	799	1251459	801253577
2D	238	5086803	749278574
3A	520	1306410	749278574
3B	647	337188	827042743
3D	125	773182	614367136
4A	352	2791040	744515299
4B	297	537211	670438383
4D	52	1242201	509666790
5A	636	13858	708442531
5B	662	6648543	712905690
5D	157	1613079	563854980
6A	646	287373	617689725
6B	549	164066	720952203
6D	110	1415350	472890118
7A	358	653444	736690246
7B	240	114913	750604135
7D	60	378699	630528147



Detection of *T. compactum* alleles



Detection of *T. compactum* alleles



What is known about QTL, associated with a *compactum* phenotype?

- „It was evident that the loci affecting compact spikes in *T. aestivum* mutants were located on chromosome **5AL** distal from *Q* locus.”-Kosuge et al. 2011
- “In hexaploid wheat, spike morphology is regulated by three major genes, namely *Q*, *C* (*Compactum*), and *S* (*Sphaerococcum*) located on chromosomes **5A**, **2D**, and 3D, respectively”- Fan et al. 2019
- “Other QTL that were significantly associated with spike morphology-related traits, in at least one environment, were localized on chromosomes 2B, 3A, 3D, 4D, and **5A**.” –Jantasuriyarat et al. 2009

Resistance to rusts

Wheat rusts, a plague that accompanies the cultivation of wheat



Stripe rust (*Puccinia striiformis*)

Yield losses up to 60%

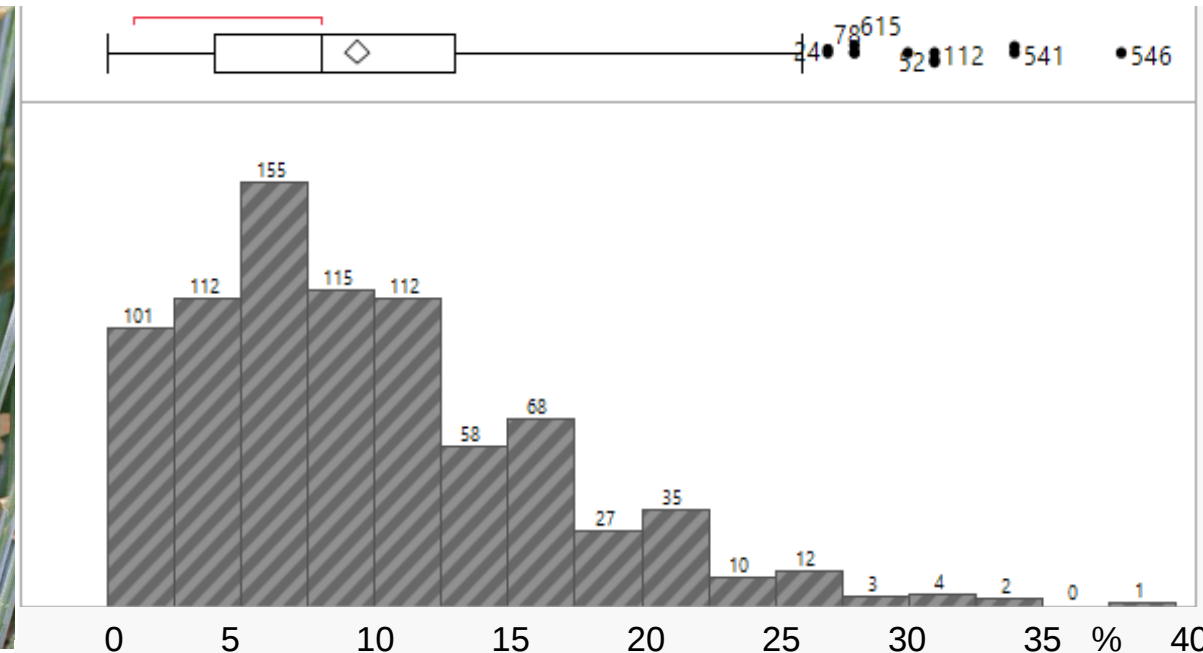
Races „Warrior“
overcome important resistances



Leaf rust (*Puccinia triticina*)

Yield losses up to 40%

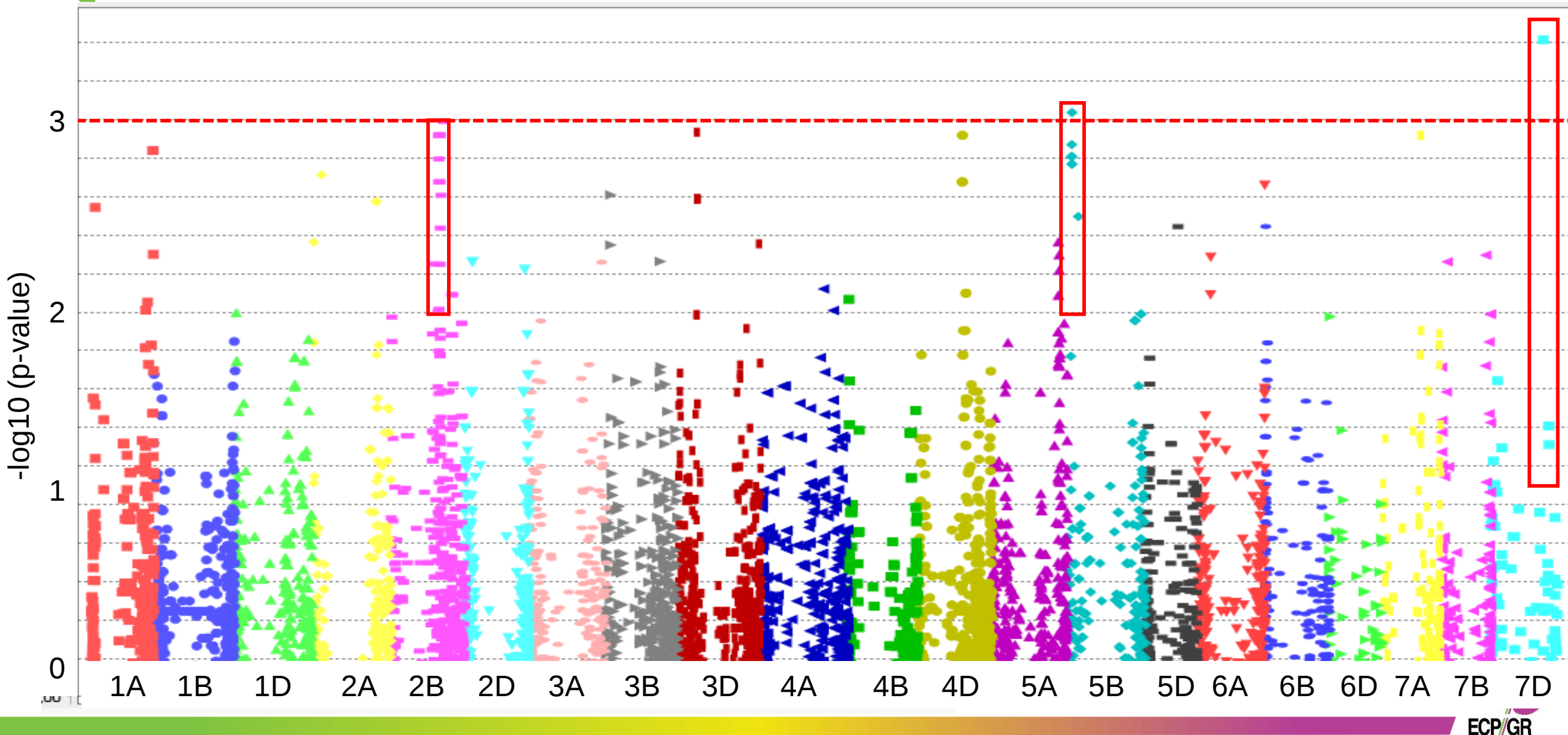
High diversity of races with different virulences
overcome important resistances, e.g. *Lr37*



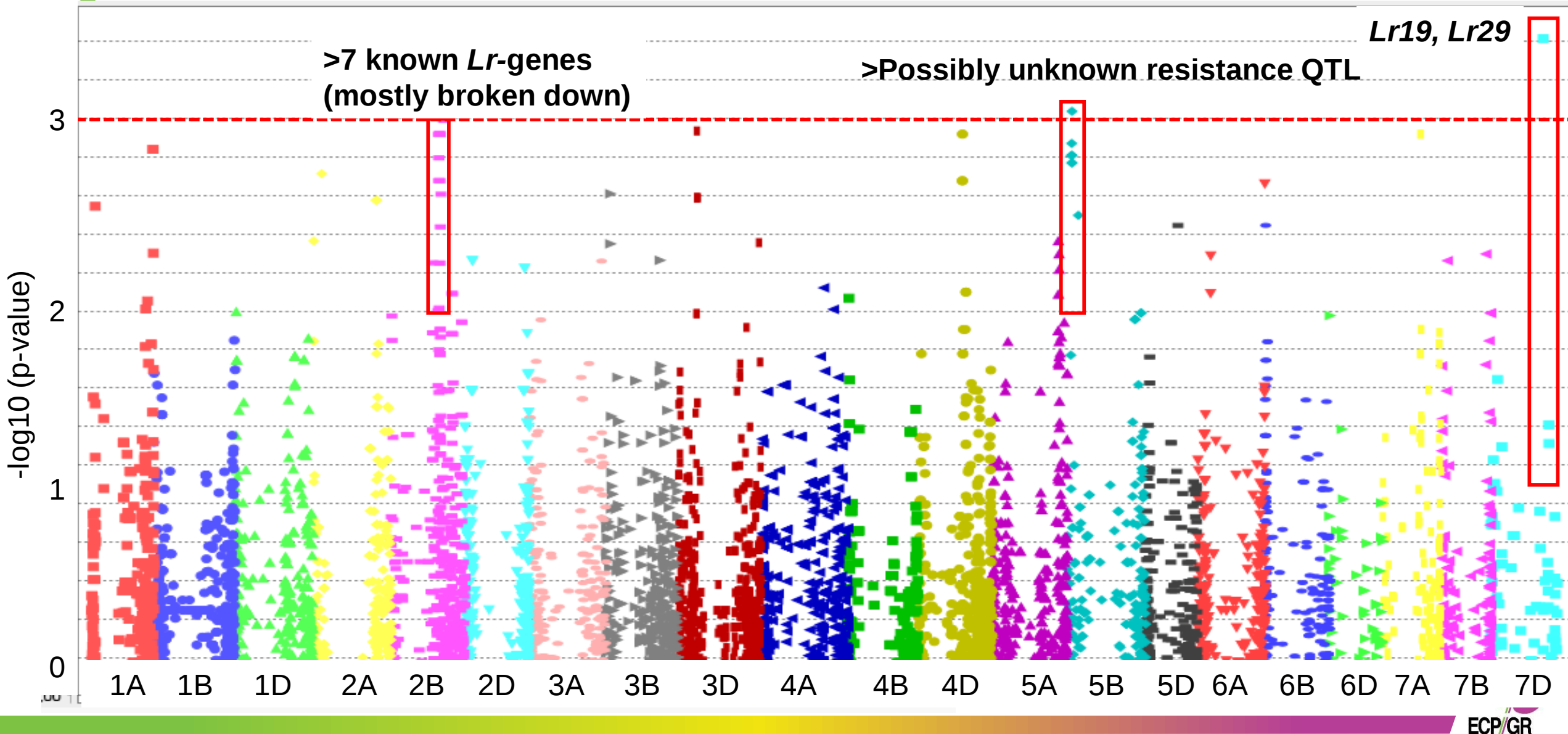
Analysis of variance (trait leaf rust)

Source	dF	SQ	AQ	F value	F (sign.)
Genotypes	194	6646.65	174.912	5.00256	0.0001*
Error	620	27007.78	34.804		
Sum	814	33654.43			

QTL for leaf rust resistance



QTL for leaf rust resistance



Summary

- Differentiation between *T. compactum* accessions and common wheat is possible by using molecular markers
- Origins and relations of *T. compactum* accessions could be identified by PCA
- Leaf rust resistant *T. compactum* accessions could be identified
- One QTL on chromosome 5B could be an unknown resistance to leaf rust
- Genotype data for many *T. compactum* genebank accessions are now available and can be used for GWAS after phenotyping of further traits

Thank you for your attention

Special thanks for the project collaboration to
Clement Debiton, INRAE,
Chr. Partl, Innsbruck,
M. Pramsohler, Laimburg Italy,
H. Steiner, Slowfood,
Klaus Fleissner, U. Konradl LfL
and all farmers, bakers and
external colleagues involved...



Selection of SNP-markers

Markers excluded

- >10% missing data
 - <10% minor allele frequency
 - >5% heterocycosity
 - More than one hit to the reference genome of wheat
-
- 8461 from more than 24.000 SNP markers selected