ECPGR Activity Grant Scheme – Phase X, Fifth Call, 2022
Activity Report

Chances for the conservation and re-cultivation of central European club wheat (Binkel) through a nutritional and genetic differentiation towards other wheat species (BiDifferent)

Binkel wheat, survey and recultivation

February 2022 – December 2024

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BiDifferent
Activity Report

TITLE of AGREEMENT	5th call Grant Scheme Activities
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ABSTRACT (maximum 200 words)	More than 20 accessions of club wheat were investigated in 3 cycles of field tests at 5 locations. Additionally, 25 accessions of genebank collections were screened and described. The working collection includes a recent selection of useful samples adapted to modern farming practices. In order to compare modern soft wheat and commercial club wheat, samples were characterized by molecular genetics and described using UPOV phenotype guidelines and farming manure data (yielding, behaviour). Greenhouse experiments with a selection of these samples provided insight into resistance to pathogens and tolerance to abiotic stresses. Data on the product quality of the harvested samples were collected and could be compared between two trial years and five locations. Product testing and baking experiments were performed with ten spring samples in 2022, and all harvested grain samples from 2023. Events such as field days, presentations, conferences, and the creation of a dedicated website helped establish a network for farmers and other interested stakeholders. The first field tests, carried out by participating farmers, began in 2023. Scientific working groups from Austria, Italy and Germany were involved.
KEYWORDS	Central Europe, alpine/mountain agriculture, wheat subspecies *compactum*, phenotyping, genotyping, field trials, on-farm activities, agrobiodiversity, recultivation

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RESEARCH PROJECT HIGHLIGHTS

Overview of club wheat accessions (*Triticum aestivum* ssp. *compactum*) in genebank collections (EURISCO* inventories)

In cooperation with IPK Gatersleben (partner: Stephan Weise, IPK Gatersleben, Germany), the origins of *Triticum aestivum* ssp. *compactum* accessions within European genebanks were analyzed using their collection data. Passport data were evaluated for further information about origin, ancestry and phenotypic characteristics. This analysis identified 1,362 *T. compactum* accessions across 24 collections, of which about 241 are of European origin, listed as cultivars or landraces. Based on their names, many are probably of regional, predominantly mountainous European origin (Figures 1 and 2). Some of these collections contain duplicates, evident from identical names or occasionally differing names. These selected provenances integrate the already known basic collection of alpine/montane from Austria and Switzerland (Mayr collection 1920s within IPK genebank, Germany and Agroscope collection, Switzerland). Furthermore, collections include presumably early breeding lines and landraces from other European environments with regional names, especially from France (Herisson), Scandinavia (Kubbweisen), Spain, Portugal (Mocha), the United Kingdom and also the Eastern European area (Teremok). The earlier historical use of club wheat can be traced back without interruption to the Neolithic period (pile-dwelling finds in the northern Alpine region). However, more precise historical distribution data for Europe, derived from archaeological site data, cannot be verified with certainty. According to personal communication from state archaeological offices (South Tyrol, Brandenburg), wheat discovery data are not reliably differentiated into *T. aestivum* and *T. aestivum* ssp. *compactum*. Interestingly, the genebank collections also include accessions from non-European regions, such as the USA and Australia, likely introduced through early exchanges and grain exports, some of which have been historically documented. To prevent the analysis of duplicate accessions and ambiguous phenotypes, 241 accessions were selected (Figure 3).

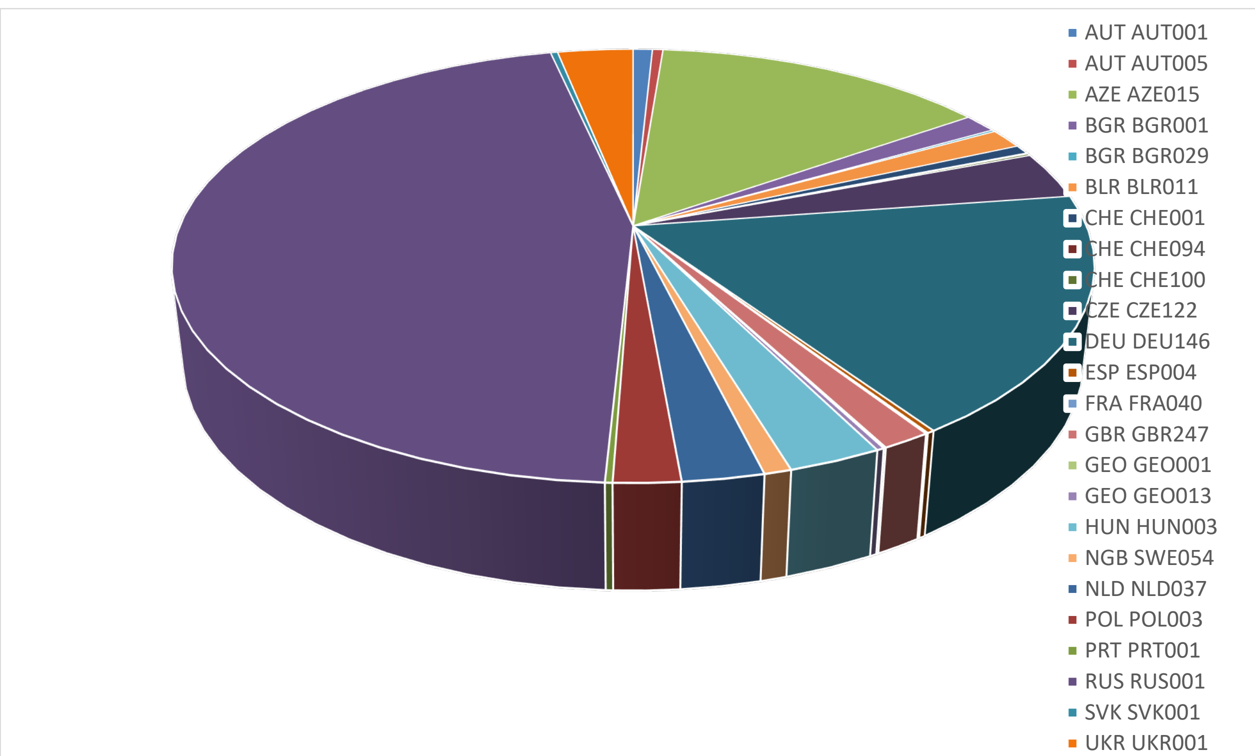

Fig.1. Genebank evaluation data of T. aestivum *ssp.* compactum*, EURISCO query 2022. EURISCO-data: Total number of 1,362 estimated accessions of* Triticum aestivum *ssp.* compactum*.*

*EURISCO: European Search Catalogue for Plant Genetic Resources

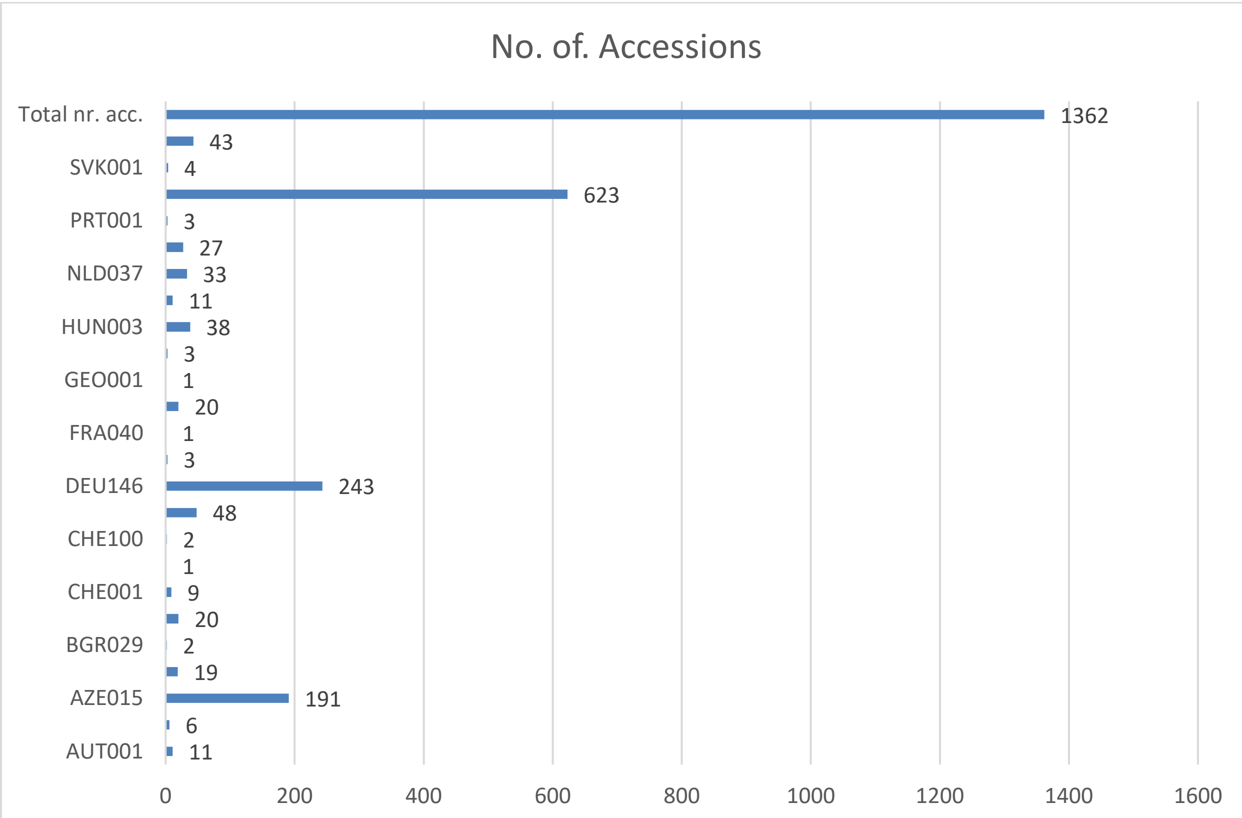

Fig. 2. Selected accessions of analyzed genebanks (EURISCO data query IPK, S. Weise 2022, pers. communication.

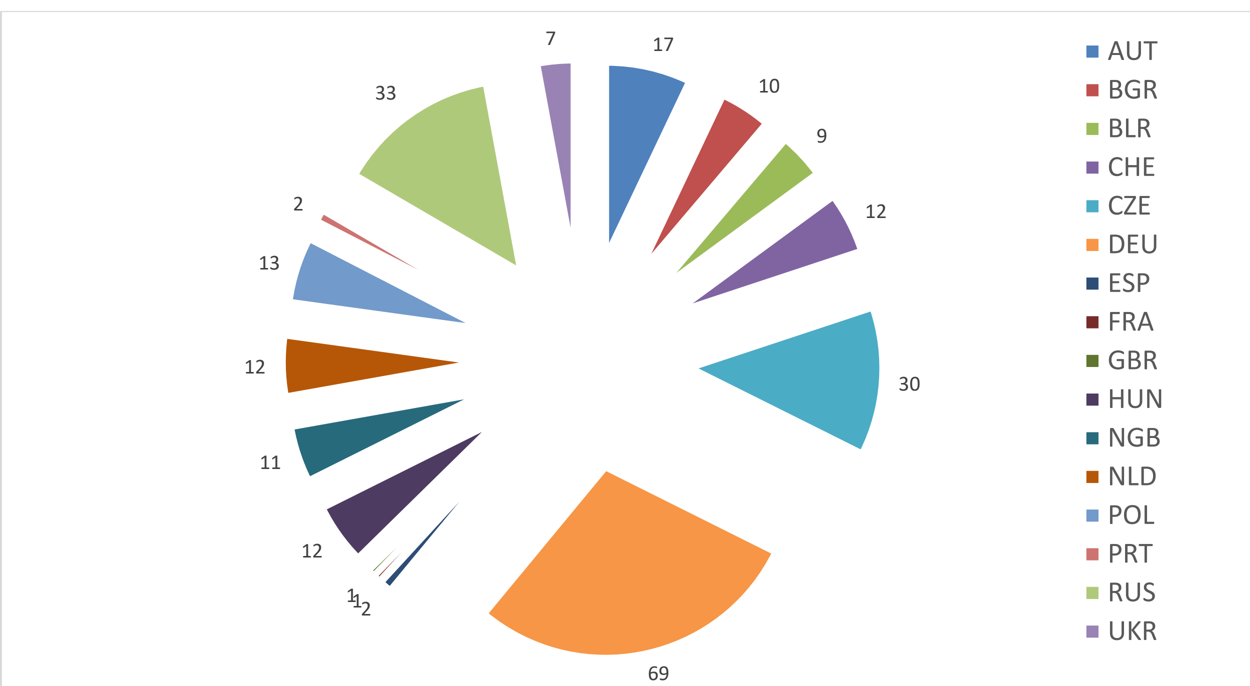

Fig.3. Collection of 241 T. compactum *accessions, selected according to European origin and further descriptive data.*

Genetic identification of selected club wheat origins and comparative classification in the genome of *T. aestivum* ssp. *compactum*

An existing selection of field-tested and pre-propagated club wheat accessions from earlier work (INTERREG-Tamsweg), on-farm conservation VERN, utilization projects Niederrhein (EIP-agri), Blauroter Samtiger Binkel in Baden-Württemberg (Backhaus Veit, Owen/T.) served as the primary test material. The existing assortment was supplemented by breeding material from an Austrian breeder (Saatbaugenossenschaft Graz), a commercial club wheat origin CRESCENT from the USA/Oregon and new propagations of genebank origins from Switzerland (Agroscope) and France (INRAE). During the project period, further test material was obtained from the American Germplasm Resources Information Network (GRIN). A total of 299 Binkel accessions were genotyped using the 25k Illumina Infinium array SNP chip (SGS Institut Fresenius GmbH), optimized for wheat. Genebank material already in cultivation with the same name such as 'MB Dinkel', 'Gelber Igel' or 'Alpiner Binkel aus Tirol' were included. The genotype data were supplemented by previous SNP analyses of more than 200 wheat accessions from the IPK Gatersleben genebank, which could then be used for comparisons of club wheat-specific phenotypes. The genotype data were initially filtered according to the quality of the marker information, so that 13,756 of the original 24,145 markers were initially available. Marker information was removed if no allele information was available for more than 10% of the analyzed genotypes, if less than 10% showed a different allele, if more than 5% showed heterozygous signals and if these could not be clearly assigned to the wheat reference genome (reference variety ‘Chinese Spring’). The remaining 9,557 markers were physically mapped using the available reference genome based on the positions published by Sun et al. (2020) and used for further analyses and genome-wide association studies (GWAS). Initially, missing marker data were supplemented by imputation (Money et al. 2015) and a principal component analysis was performed. With this, relationships within the selected set of Binkel origins but also with *T. aestivum* accessions that do not have compact spikes could be detected. The comparison with *T. aestivum* clearly showed that there are no significant genome-wide differences. *T. compactum* accessions do not form any clusters within the *T. aestivum* gene pool (Fig. 4A). If analyses are carried out within the *compactum* phenotype (not exclusively on the basis of information available from genebanks), it is possible to assign them to regions of origin. This could be illustrated by mapping the principal component analysis based on clustering (Fig. 4B). If the differences are visualized dendrographically, the genotypic data can be reliably assigned to the place of origin. For example, Tyrolean Binkel could be distinguished from Turkish landraces (Fig. 4C). Accessions from Germany, Italy, Switzerland and France are more closely related, but clusters can also be observed on the basis of origin, especially in Swiss provenances (Fig. 4D).

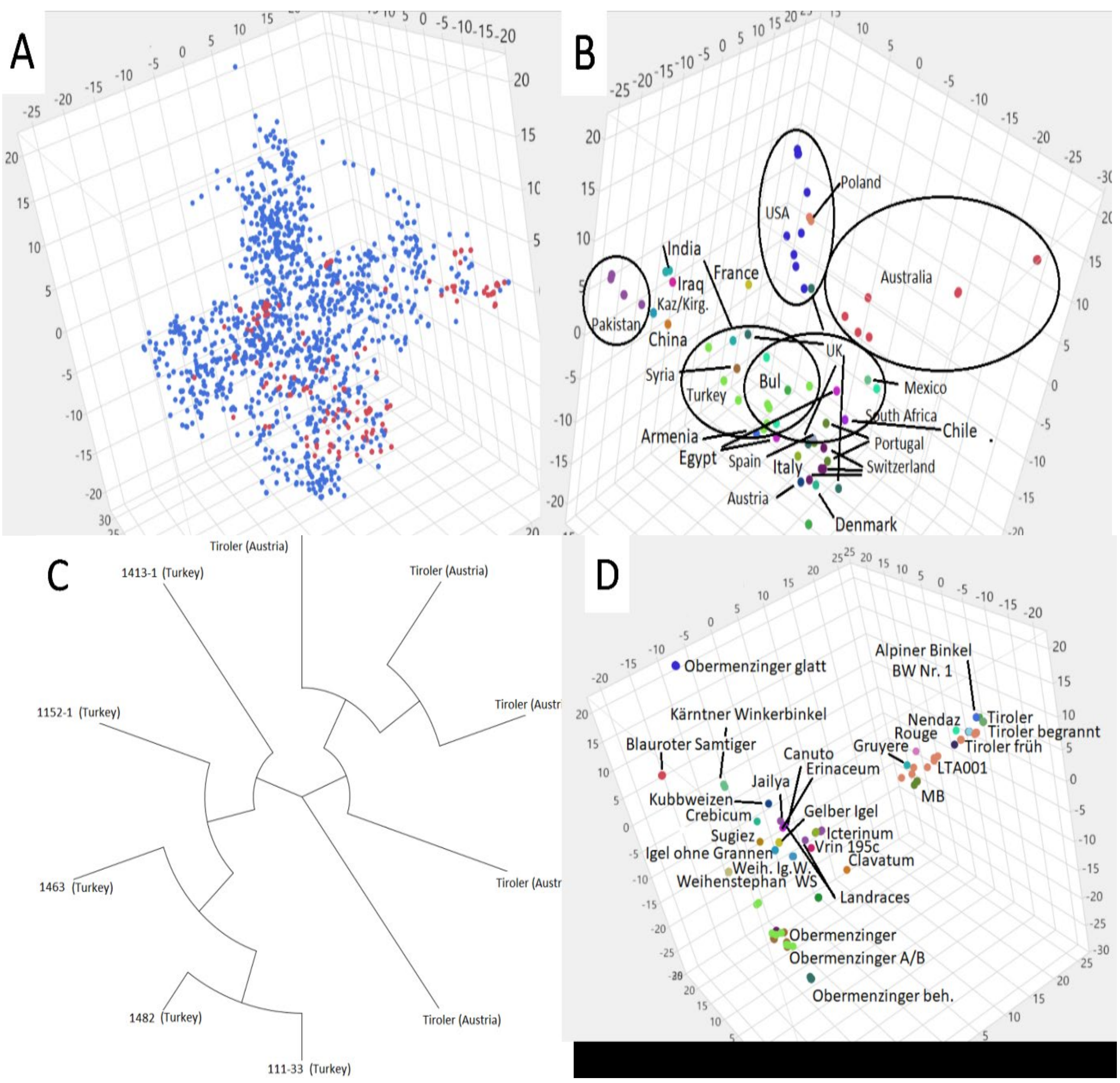

Figure 4. Principal component analysis of 262 T. aestivum *ssp.* compactum *genotypes and 1,188* T. aestivum *genotypes (A), reduced number of* T. compactum *genotypes from different world regions (B), dendrogram to differentiate* T. compactum *accessions by their origin (C), differentiation of European accessions from different countries around the Alps (D).*

Regional accessions such as ‘Teremok’ (Kazakhstan), ‘Termok’ (Kyrgyzstan) and ‘Kozha Bidai’ (Kazakhstan) show a high degree of relationship. They can be clearly assigned geographically and differentiated from other accessions on the basis of genotypic data. In addition to genotyping to distinguish landraces and their origins and verify homogeneity within landraces, genotypic data could also be used to genetically differentiate the *compactum* phenotype from other *aestivum* accessions. For this purpose, 188 winter wheat genotypes from the BRIWECS winter wheat assortment (Voss-Fels et al. 2019) were included,

all of which displayed ear phenotypes distinctly different from the Binkel phenotype. In a GWAS, this trait was offset against marker data to identify genome regions associated with a compact ear type. The LOD value, indicating a significant marker-trait association, was calculated to be 5.28. Based on these calculations, the compact ear type is determined by several loci; the QTL on chromosomes 1A, 1B, 2D, 3D, 4B, 5D and 6D have the greatest impact on the phenotypic variance.
The loci on 1A, 1B, 4B, 5D (Takenaka et al. 2018), 2D (Wen et al. 2022), 3D (Faris et al. 2014) are already known, while others, especially the QTL on 6D, have not yet been described (Fig. 5, Tab. 1).

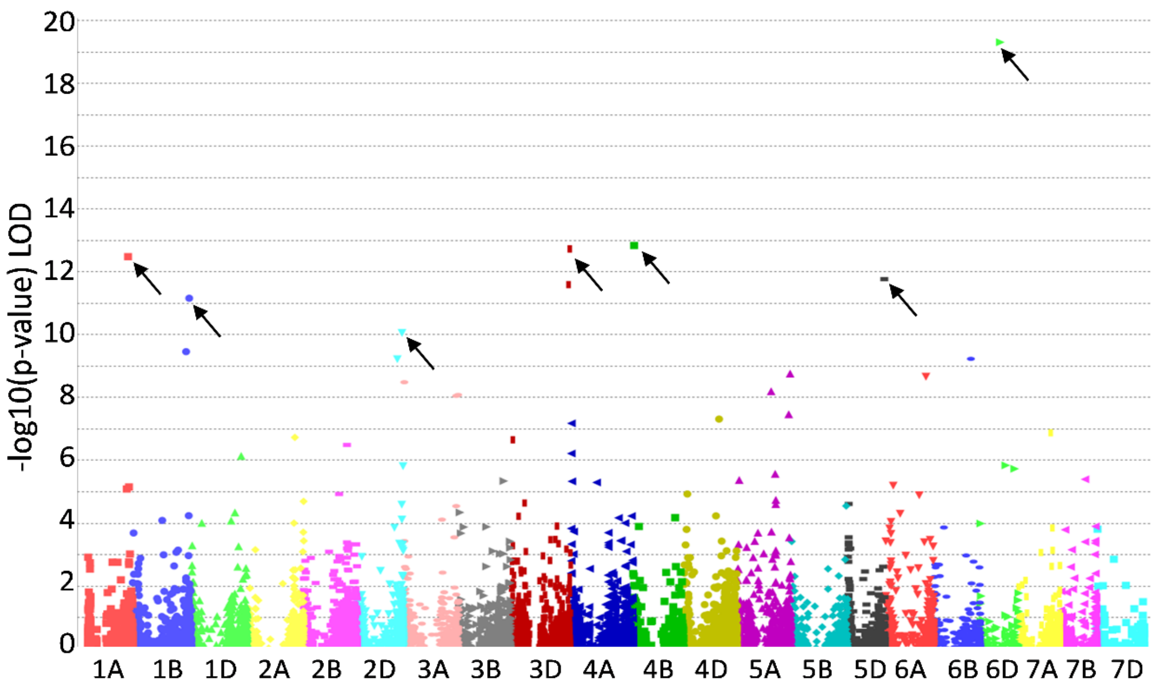

Figure 5. GWAS to detect loci associated with the T. aestivum compactum *type. The significance level was calculated at 5.28 with p < 0,05. Arrows indicate the most significant markers associated with the T.* compactum *type.*

Table 1. SNP-marker, significantly associated with compact ears after calculation of a GWAS ordered by the level of significance. Explained phenotypic variance is displayed by Rí.

Marker	Chromosomes	Position	F	p	LOD	R^2
RAC875_c60218_63	6D	263948709	32.02	4.94E-20	19.31	0.066
tplb0045c06_1675	4B	13052722	21.40	1.46E-13	12.84	0.044
RAC875_c16993_196	3D	786105639	21.23	1.86E-13	12.73	0.044
BobWhite_c96_170	1A	531682521	20.83	3.30E-13	12.48	0.043
Excalibur_c8161_1443	5D	486066869	19.66	1.71E-12	11.77	0.041
RAC875_c24205_110	3D	769076503	19.38	2.56E-12	11.59	0.040
BS00023202_51	1B	751422366	18.68	6.93E-12	11.16	0.039

Results of greenhouse experiments

Older indications of special tolerance and resistance properties of club wheat to fungal pathogens compared to (then) modern breeding material have been known for a long time and were demonstrably already described by Mayr (1920) and Rümker (1907). However, information on resistance to the most frequently occurring leaf rust (*Puccinia triticina*) is hardly available. Klaus (2005) demonstrated a high susceptibility of the accessions analyzed (rating 8 out of a maximum susceptibility of 9). However, an overview of the resistance properties of a larger spelt assortment is not yet available. Therefore, the 299 club wheat genotypes were tested for resistance against leaf rust with four to five replicates each at the seedling stage, and the most resistant genotypes were determined by high-throughput phenotyping with two leaf rust isolates. In an association study based on resistance data, two significant associations were identified on chromosomes 2B and 6D (LOD threshold set as 3, Figure 6). However, the effectiveness of the resistances is low, so it can be assumed that although known resistance genes are expressed, the majority of rust races have overcome them. The leaf rust resistance genes (Lr-genes) *Lr13*, *Lr16*, *Lr23* and *Lr35* (2B) as well as *Lr38* (6D) were expected to be carried by *T. compactum* accessions. With regard to improved resistance, further genotypes should be identified, for example from genebank material, in order to achieve long-term yield stability without using fungicides. Significant differences were found between different origins, as demonstrated by a mean value comparison (Tukey, α = 0.05) (Table 2). Based on these data, it is possible to select the most resistant genotypes, i.e. with an infestation < 10% of the leaf area, ‘Aus Weihenstephan’, ‘Type A Obermenzing’, ‘Igel ohne Grannen’ and ’Obermenzing Spelze glatt’.

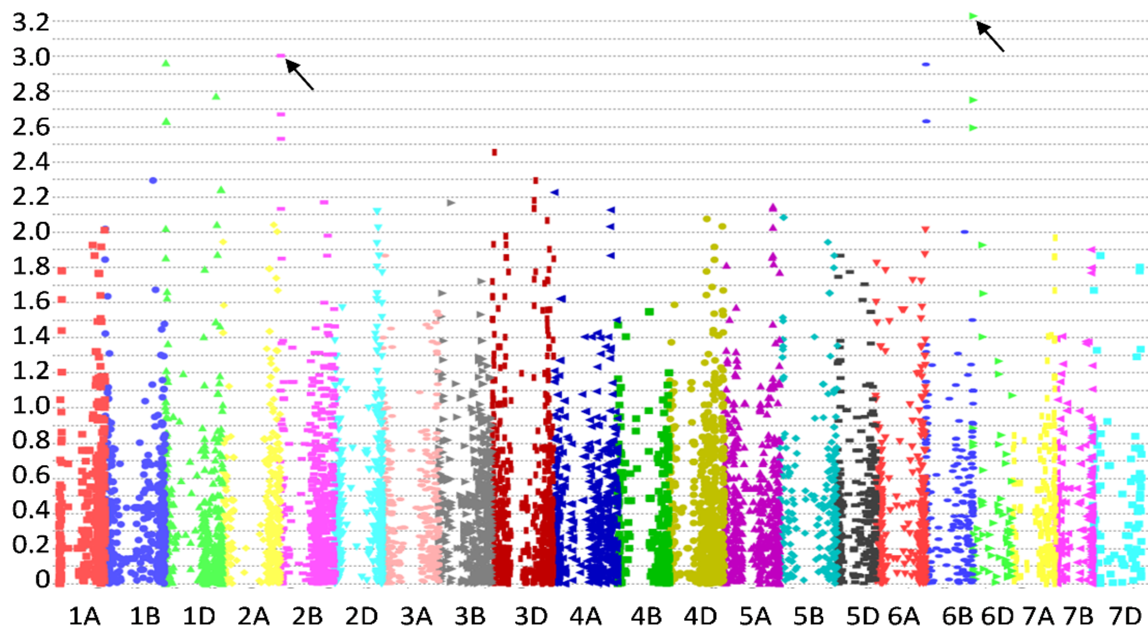

Figure 6. GWAS of leaf rust resistance. LOD threshold was set to 3. Arrows indicate significant marker-trait (leaf rust resistance) associations.

Table 2. Leaf rust infestation on leaves of different Binkel accessions. Averages of infected leaf area (%) are shown in column ‚Infection (%)'. Homogenic groups are defined by letters, significant differences between the averages are shown by separate letters. Differences between averages were defined by using Tukey's HSD (honestly significant difference) at a level of = 0.05.

Genotypes	Homogenic groups							Infection (%)
CP. clavatum 73V	A	B	C					34.0
Landrace	A	B	C					32.0
Binkelweizen Nr.1	A	B	C	D				31.0
Canuto	A	B	C	D				31.0
Obermenzing R18	A							26.6
MB-Binkel	A	B						25.8
Weißspelziger Winterigel	A	B	C					24.3
Tiroler mittelfrüher Binkel	A	B						24.3
Weihenstephaner Igelweizen	A	B	C					23.8
Alpiner Binkel Tirol	A	B	C					23.4
LTAae001	A	B						22.6
Tiroler Begrannter Binkel	A	B	C					22.2
CP. crebicum 72V	A	B	C	D	E	F	G	22.0
Kaerntner Winterbinkel	A	B	C	D	E		G	22.0
Obersaxener	A	B	C					22.0
Landrace (24122)	A	B	C	D	E	F	G	22.0
Tiroler früher Binkel	A	B	C					21.8
LTA001	A	B	C					21.5
CP. erinaceum 75V	A	B	C	D	E	F	G	21.0
Obermenzing Spelze behaart	A	B	C					20.9
Alpiner Binkel aus Tirol	A	B	C					20.5
CP. icterinum 74V	A	B	C	D	E	F	G	20.0
Landrace (24120)	A	B	C	D	E	F	G	20.0
Kubbweisen	A	B	C	D	E	F	G	19.0
Gelber Igel		B	C	D			G	18.2
Tiroler Binkel	A	B	C	D	E	F	G	18.0
Jailya-Bugdai	A	B	C	D	E	F	G	16.0
Landrace (24140)	A	B	C	D	E	F	G	13.0
Typ B Obermenzing			C	D	E	F	G	12.9
Blauroter samtiger Winterbinkel				D	E	F	G	10.6
Aus Weihenstephan					E	F		9.6
Typ A Obermenzing						F		7.7
Igel ohne Grannen					E	F	G	5.7
Obermenzing Spelze glatt						F		5.3

Field trial cultivation of selected varieties of club wheat

Cultivated genotypes

In 2022 and 2023, spring and winter forms were cultivated in five locations (Austria, 2x Germany, Italy, France) to determine agronomic characteristics, yield potential, quality and suitability for cultivation in a total of three cultivation cycles (2 x summer forms with 9 origins, 1x winter forms with 10 accessions, Table 3). In addition, 'Bestehorns Dickkopf' and the US Binkel 'Crescent' were grown in Wilmersdorf; 'Quintus', an elite wheat cultivar, served as a comparison variety. At the Imst site (Austria), Binkel was grown alongside modern common wheat varieties, which served as a control. Due to severe lodging caused by extreme weather conditions, the yields at the Theix/Clermont-Ferrand site (France) could not be analyzed (locations summarized in Table 4). In Crouel/F, UPOV descriptions were prepared for 25 *T. aestivum* accessions. In all trials, agronomic characteristics (emergence, tillering, winter hardiness, number of ears, growth height, lodging, various diseases and pests, time to heading, flowering, maturity, yield) were recorded as standard. In addition, various quality parameters were recorded after harvest (thousand-grain mass, hl-weight, grading, protein content, falling numbers, etc.). Trial design: Randomized block design with three replicates.

Table 3. Accessions used for field trials

Spring accessions of club wheat in field trials		**Winter accessions of club wheat in field trials**	
Name of accession	**Genebank number**	**Name of accession**	**Genebank number**
Gelber Igel NRW	TRI 24327	Kärntner Winterbinkel	
Weihenstephaner Igelweizen	TRI 25390	Blauroter samtiger Binkel	
Alpiner Binkel Tirol	TRI 28234	Igel ohne Grannen	
MB-Binkel	TRI 7778	Obermenzing Typ A	TRI 19396
Tiroler begrannter Binkel	TRI 7771	Obermenzing	TRI 19364
Tiroler Mittelfrüher Binkel	TRI 7769	Obermenzing	TRI 3724
Tiroler Früher Binkel	TRI 7770	Obermenzing	TRI 20122
OCB-Binkel		Obermenzing Typ B	TRI 19396
Obersaxen		Winterbinkel Laimburg	LTA001

Table 4. Field sites, description and characteristics

Site	Height m a.s.l.	Average temperature °C	Average precipitation mm	Soil type	remarks
Crouel/F	335	12,0	572	lessive	UPOV-descr. 25 acc.
Dietenheim/I	890	8,5	751	Loamy sand	9 spring acc. 2022 nd 2023, 10 winter acc. 2022/2023
Imst/A	720	9,4	787	Calcic fluvisoils	9 spring acc. 2022 nd 2023, 10 winter acc. 2022/2023
Ruhstorf/G	330	8,5	743	Cambisol	11 spring acc. 2022, 9 winter acc. 2022/2023
Theix/F	825	8,6	766	Brown soil	No harvest, lodging
Wilmersdorf/G	70	8,9	521	lessive	9 spring acc. 2022, 8 winter acc. 2022/2023, 10 spring acc. 2023

Results of the field trials

The trials are presented individually; the final summaries for spring and winter Binkel are intended to provide an overview of the cumulative results with brief descriptions of the individual varieties. Only the relevant data are listed within the following tables. Surveys and assessments with minimal effects and minor differences in the characteristics are available but are not included in the tables for clarity. The following traits are shown from trials in Imst (A, 2022, Table 5), Imst (A, 2023, Table 6), Dietenheim (I; 2022, Table 7), Dietenheim (I, 2023, Table 8), Wilmersdorf (G, 2022, Table 9), Ruhstorf (G, 2022, Table 10) and summarized in Table 11:

KOER (14%)	Grain yield in dt/ha with 14 % water content
KOER rel %	Grain yield relative to the trial average
H2OF	Harvest moisture in %
>2.0 (%)	Grain content in % greater than 2.0mm (slotted sieve)
VLG	¼-l weight in g: bulk weight for calculating the hl weight
TGK	Thousand grain weight in g
DTBAE Date	start of ear emergence (1 = 01.05., days then consecutive)
DTAE	Date middle of ear emergence (1 = 01.05., days then consecutive)

DTMR	Date of milk maturity (1 = 01.05., days then consecutive)
DTGR	Date of yellow ripening (1 = 01.05., days then consecutive)
BEST	Crop density (1 - very good, 9 - very poor)
ZWIE	Twining/re-shoots (1 - none, 9 - very many)
LAGR	Storage (1 - none, 9 - complete storage)
WHOE	Growth height in cm; plant erect, without awns
LEMA	Feeding damage by cereal weevils (1 - none, 9 - complete)
GE	Overall impression (1 - perfect, 9 - miserable)
HOM	Stand homogeneity (1 - very homogeneous, 9 - very inhomogeneous)
Missing	plants, proportion in area %

Table 5. Spring club wheat trial Imst/A 2022

Imst/A	Sowing	Accessions	Kernel/sqm	Size of plot (m²)	precrop	Fertilising	Care	Harvest time
	29.3.2022	9	440	8.244	potato	N/P/K 60/55/80kg	Rollers, herbicide	25.7.2022

Variety	KOER dt/ha	KOER rel. %	H2OF	>2,0 (%)	VLG (g)	TKG (g)	BEST	HOW	LAGR	WHOE (cm)	GE	HOM
Tiroler Früher Binkel	24.4	**98.7**	10.3	94.9	193.2	32.0	4.0	3.0	5.7	124	5.3	6.0
Tiroler Begrannter Binkel	29.0	**117.7**	10.7	95.3	190.3	30.3	4.0	3.0	4.7	111	4.0	4.3
Tiroler Mittelfrueher Binkel	26.3	**106.4**	10.7	94.9	191.4	30.6	4.3	3.0	5.0	119	5.0	6.8
Gelber Igel NRW	14.3	**58.1**	14.2	96.2	174.6	32.2	5.3	6.0	1.0	86	7.3	8.7
MB-Binkel	29.2	**118.3**	10.8	94.4	192.8	32.0	3.3	3.0	1.8	112	4.0	4.8
Alpiner Binkel Tirol	23.9	**96.8**	10.3	96.1	193.9	31.3	4.0	3.3	3.7	124	4.7	4.7
Weihenstephaner Igel	23.4	**94.9**	11.3	94.7	194.2	28.9	3.7	3.0	3.8	106	4.8	5.7
OCB-Binkel	23.7	**95.8**	11.0	94.0	190.3	31.8	4.0	3.3	2.2	118	5.0	6.0
Obersaxen	28.0	**113.4**	11.3	95.6	189.7	31.5	4.0	3.0	3.2	118	4.0	4.8
Mean value	**24.7**	**100.0**	**11.2**	**95.1**	**190.1**	**31.1**	**4.07**	**3.41**	**3.44**	**113**	**4.91**	**5.76**
Max.	29.2	118.3	14.2	96.2	194.2	32.2	5.3	6.0	5.7	124.0	7.3	8.7
Min.	14.3	58.1	10.3	94.0	174.6	28.9	3.3	3.0	1.0	86.0	4.0	4.3
Diff.	14.9	60.2	3.8	2.2	19.7	3.4	2.0	3.0	4.7	38.0	3.3	4.3

Table 6. Spring club wheat trial Imst/A 2023.

Imst/A	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	6.4.2023	9	440	8.2	potato	N/P/K 60/60/85kg	Rollers, herbicide	31.7.2023

Variety	KOER dt/ha	KOER rel. %	H2OF	>2,0 (%)	VLG	TKG	DTGR	JUET	BEST	LEMA	WHOE	GE	HOM
Tiroler Früher Binkel	14.7	108.0	17.2	92.9	163.8	22.6	76	1.5	4.7	3.7	86	6.0	3.7
Tirolem Mittelfrueher Binkel	14.1	103.8	17.5	94.9	160.2	23.2	76	1.5	4.7	3.3	80	7.5	4.7
Tiroler Begrannter Binkel	14.8	108.9	17.3	95.4	162.7	23.4	76	1.2	4.8	3.7	87	6.7	4.8
Bs Binkel x Amber	13.3	97.7	18.4	93.7	160.5	23.7	73	3.3	6.5	6.0	84	6.8	5.7
MB-Binkel	13.8	101.1	16.3	86.8	160.2	20.5	78	1.7	4.8	4.0	76	6.7	4.0
Alpiner Binkel aus Tirol	11.5	84.4	17.6	94.7	162.3	22.6	76	1.3	4.5	3.0	83	8.2	4.0
Weihenstephan Igel	14.0	102.7	18.4	90.4	161.7	19.6	77	1.7	4.2	4.3	84	7.8	5.8
OCB-Binkel	13.2	97.3	16.7	85.7	158.7	20.1	77	1.2	4.2	5.0	81	7.5	5.0
Obersaxen	13.1	96.2	17.7	91.9	156.5	21.9	77	1.2	5.0	3.7	80	7.8	4.7
Mean value	**13.6**	**100.0**	**17.7**	**92.8**	**161.3**	**22.6**	**76**	**1.8**	**5.1**	**3.9**	**83**	**7.2**	**4.9**
Max.	14.8	108.9	18.4	95.4	162.7	23.7	77.7	3.3	6.5	6.0	87	8.2	5.8
Min.	11.5	84.4	16.3	85.7	156.5	19.6	73.3	1.2	4.2	3.0	76	6.7	4.0
Diff.	3.3	24.5	2.1	9.7	6.2	4.1	4.3	2.2	2.3	3.0	10	1.5	1.8

Table 7. Spring club wheat trial Dietenheim/I 2022.

Dietenheim/I	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	12.4.2022	9	440	4.8	change meadow	no	Rolling, 1x grooming	4.8.2022

ariety	KOER dt/ha	KOER rel %	Missing parts	Culms/m²	DTAE	LAGR	WHOE (cm)
Tiroler Früher Binkel	21.7	**105.0**	17	392	47	5.3	118
Tiroler Mittelfrueher Binkel	29.3	**141.7**	3	424	45	6.7	127
Tiroler Begrannter Binkel	16.9	**81.7**	38	302	49	5.7	111
Gelber Igel NRW	19.3	**93.1**	15	319	48	2.3	108
MB-Binkel	24.1	**116.6**	10	316	47	3.7	118
Alpine Binkel Tirol	22.0	**106.5**	10	407	46	5.7	127
Weihenstephan Igel	15.3	**74.2**	20	282	48	5.7	104
OCB-Binkel	16.6	**80.4**	28	256	47	3.7	113
Obersaxen	20.8	**100.7**	32	334	46	5.0	114
Mean value	**20.7**	**100.0**	**19**	**337**	**47**	**4.9**	**116**
Max.	29.3	141.7	38	424	49	6.7	127
Min.	15.3	74.2	3	256	45	2.3	104
Diff.	14.0	67.6	35	169	4	4.3	24

Table 8. Spring club wheat trial Dietenheim/I 2023

Dietenheim/I	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	18.4.2023	9	440	4.8	Winter rye	no	Rollers	17.8.2023

Variety	KOER dt/ha	KOER rel %	LAGR	WHOE (cm)
Tiroler Früher Binkel	34,2	**89,0**	5,0	68
Tiroler Mittelfrueher Binkel	42,3	**110,0**	6,7	65
Tiroler Begrannter Binkel	31,0	**80,6**	4,7	72
Gelber Igel NRW	37,3	**97,0**	1,0	104
MB-Binkel	41,5	**107,9**	2,7	85
Alpine Binkel Tirol	37,7	**98,0**	4,0	89
Weihenstephan Igel	36,1	**93,9**	4,0	70
OCB-Binkel	47,6	**123,8**	2,3	88
Obersaxen	38,4	**99,9**	6,7	62
Mean value	**38,5**	**100,0**	**4,1**	**78**
Max.	47,6	123,8	6,7	104
Min.	31,0	80,6	1,0	62
Diff.	16,6	43,2	5,7	42

Table 9. Spring club wheat trial Wilmersdorf/G 2022

Wilmersdorf/D	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	10.4.2022	9	440	12,0	clovergrass	no	Groom 2x	July 2022

Variety	KOER dt/ha	KOER rel. %	H2OF	Plants/ m²	Culms/m ²	Stalks/ plant	DTBAE	DTMR	WHOE
Tiroler Früher Binkel	13.1	**94.6**	14.0	224	315	1.41	59	77	85
Tiroler Mittelfrueher Binkel	15.8	**114.1**	14.0	247	261	1.06	65	77	100
Tiroler Begrannter Binkel	13.0	**94.0**	13.9	299	278	0.93	61	77	95
Gelber Igel NRW	9.1	**66.0**	13.4	273	220	0.81	54	77	70
MB-Binkel	13.5	**97.8**	14.6	268	177	0.66	57	77	85
Alpiner Binkel Tirol	13.1	**94.8**	13.5	273	296	1.08	61	87	95
Weihenstephan Igel	15.5	**112.5**	13.9	268	275	1.03	59	89	90
Gelber Igel NRW (Sel.)	14.0	**101.6**	14.2	245	231	0.94	59	83	70
Obersaxen	17.2	**124.7**	13.8	224	196	0.88	58	75	80
Mean value	**13.8**	**100.0**	**13.9**	**258**	**250**	**0.90**	**59**	**80**	**86**
Max.	17.2	124.7	14.6	299	315	1.41	65	89	100
Min.	9.1	66.0	13.4	224	177	0.66	54	75	70
Diff.	8.1	58.8	1.2	75	138	0.75	11	14	30

Table 10. Spring club wheat trial Ruhstorf/G 2022

Ruhstorf/D	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	14.3.2023	11	330	13,5	spelt	no	1x grooming	1.8.2022

Variety	KOER (dt/ha)	KOER (rel. %)	LAGR 1	LAGR 2	LAGR	WHOE (cm)
Alpiner Binkel aus Tirol	24.6	**115.4**	6.0	4.7	5.3	128
Gelber Igel NRW	16.8	**78.9**	2.7	1.3	2.0	113
MB-Binkel	23.4	**109.7**	1.0	1.7	1.3	120
T. ae. L. var. lutescenscompactoides, TRI 8857	9.5	**44.6**	3.7	3.5	3.6	100
T. ae. L. var. lutescenscompactoides, TRI 8674	18.9	**88.8**	3.0	3.7	3.3	117
T. ae. L. var. milturocompactoides, TRI 8858	26.3	**123.1**	6.7	4.7	5.7	97
T. aestivum L. var. creticum, TRI 9237	18.8	**88.2**	6.3	6.0	6.2	117
Tiroler Begrannter Binkel	26.1	**122.2**	7.3	6.5	6.9	125
Tiroler Früher Binkel	25.1	**117.8**	8.7	6.7	7.7	122
Tiroler Mittelfrüher Binkel	26.6	**124.5**	8.7	5.7	7.2	118
Weihenstephan Igel	18.5	**86.8**	9.0	6.3	7.7	118
Mean value	**21.3**	**100.0**	**5.7**	**4.6**	**5.2**	**116**
Max.	26.6	124.5	9.0	6.7	7.7	128
Min.	9.5	44.6	1.0	1.3	1.3	97
Diff.	17.0	79.9	8.0	5.3	6.4	32

Summary of field trial yield (relevant data)

Table 11. Relative yields of the spring club wheat accessions (locations/years)

Variety	Imst 2022	Imst 2023	Dietenheim 2022	Dietenheim 2023	Wilmersd. 2022	Ruhstorf 2022	MW	Number of attempts	Diff. to VI
Tiroler Früher Binkel	98.7	108.0	105.0	89.0	94.6	117.8	**102.2**	**6**	**2.2**
Tiroler Mittelfrueher Binkel	106.4	103.8	141.7	110.0	114.1	124.5	**116.8**	**6**	**16.8**
Tiroler Begrannter Binkel	117.7	108.9	81.7	80.6	94.0	122.2	**100.9**	**6**	**0.9**
Früher Binkel x Amber	-	97.7	-	-	-	-	**97.7**	**1**	**-2.3**
Gelber Igel NRW	58.1	-	93.1	97.0	101.6	78.9	**85.7**	**5**	**-14.3**
MB-Binkel	118.3	101.1	116.6	107.9	97.8	109.7	**108.6**	**6**	**8.6**
Alpiner Binkel Tirol	96.8	84.4	106.5	98.0	94.8	115.4	**99.3**	**6**	**-0.7**
Weihenstephan Igel	94.9	102.7	74.2	93.9	112.5	86.8	**94.2**	**6**	**-5.8**
OCB-Binkel	95.8	97.3	80.4	123.8	-	-	**99.3**	**4**	**-0.7**
Obersaxen	113.4	96.2	100.7	99.9	124.7	-	**107.0**	**5**	**7.0**
Mean value (rel. %)	**100.0**	**100.0**	**100.0**	**100.0**	**104.3**	**107.9**	**101.2**	**6**	-
Average value (dt/ha)	**24.7**	**13.6**	**20.7**	**38.5**	**13.8**	**21.3**	**22.1**	**6**	-
Max (%)	118.3	108.9	141.7	123.8	124.7	124.5	116.8	**6**	**16.8**
Min (%)	58.1	84.4	74.2	80.6	94.0	78.9	85.7	**6**	**-14.3**
Diff. (%)	60.2	24.5	67.6	43.2	30.7	45.6	31.0	**6**	**-69.0**

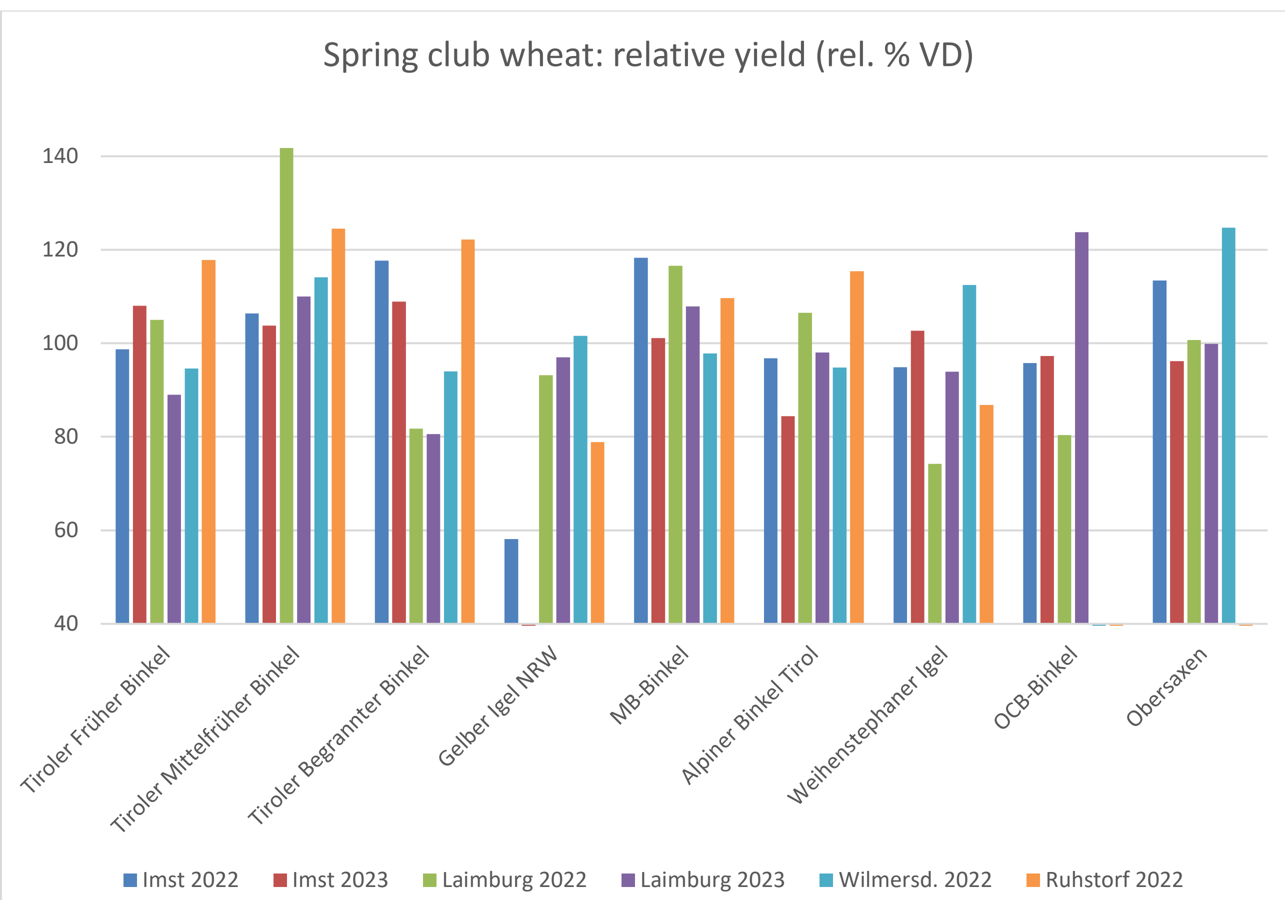

Figure 7. Relative yields of spring club wheat (individual locations) in % of the trial average

Brief characteristics of the tested spring club wheat accessions (Figure 7)

1. Tiroler Früher Binkel: Slightly above average in terms of yield. Also in terms of height; clear tendency to lodging; medium ripening period. Medium TKW. High hl weight of grains.
2. Tiroler Mittelfrüher Binkel: Highest yielding variety (117% to VD). Clearly above average in every trial; rather susceptible to lodging due to its height; ripening time medium to slightly later.
3. Tiroler Begrannter Binkel: Average yields. Long and corresponding lodging tendency; ripening medium–late.
4. Gelber Igel NRW: Lowest yielding Binkel in the trials (79% to VD); lower height and very good vigour; ripening times not uniform; somewhat low hl weight of grains.
5. MB-Binkel: Second best-yielding accession in the trials (109% to VD); average growth height and very good vigour; medium ripening time.
6. Alpiner Binkel Tirol: Average yields and tendency to lodging. Clearly the tallest height; ripening rather late. Results not uniform.
7. Weihenstephaner Igel: Below-average yields. Low growth height. Medium susceptibility to lodging; later ripening; low TKM. Rather weak screening.
8. OCB-Binkel: Average yields and growth height. Rather low storage tendency; medium maturity.
9. Obersaxen: Good yields (107% to VD); medium growth height and storage tendency; slightly earlier ripening.

Winter club wheat
Winter club wheat results from trials in Imst (A, 2022/23, Table 12), Dietenheim (I 2022/23, Table 13), Wilmersdorf (G 2022/23, Table 14), Ruhstorf (G, 2022/23, Table 15). The relative yields are shown in summary in Figure 8.

Table 12. Winter club wheat trial Imst/A 2022/23 incl. No. 4. Obermenzing TRI 19396 Type A (biotype mixture, hardly any bark types included).

Imst/A	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	19.10.2022	10	370	8.2	clovergrass	60/55/80 N/P/K kg	Rollers, herbicide	11.7.2023

SORT	KOERdt/ha	KOER rel. %	>2.0	VLGN	TKGN	DTAE	DTGR	VWNT	JUET	WHOE	HOM
Blauroter samtiger Binkel	26.7	**97.1**	88.2	192.1	24.5	35	64	3.8	4.3	123	7.0
Igel ohne Grannen	31.7	**115.0**	85.0	197.4	20.7	32	65	3.7	3.3	146	5.7
Kärntner Winterbinkel	31.3	**113.9**	89.5	182.7	28.2	33	64	2.8	4.8	125	5.3
Obermenzing TRI 19364	22.5	**81.6**	77.9	181.7	23.4	30	65	3.3	3.7	151	5.5
Obermenzing TRI 19396 Type A	30.8	**112.0**	97.3	189.1	30.0	34	66	2.8	2.8	125	5.3
Obermenzing TRI 19396 Type B	28.5	**103.7**	93.5	183.7	24.3	37	66	3.5	3.5	132	5.8
Obermenzing TRI 20122	26.1	**94.9**	86.1	178.5	22.9	35	68	3.0	3.2	132	5.0
Obermenzing TRI 3724	20.3	**73.8**	96.7	205.0	27.8	36	67	4.2	4.7	128	6.0
Weißspelziger Winterigel	25.0	**90.7**	54.6	187.8	19.6	35	65	4.3	3.8	141	4.0
Winterbinkel Laimburg LTA001	32.3	**117.3**	81.3	194.4	23.0	29	64	2.2	2.0	150	5.0
Mean value	27.5	100.0	85.0	189.2	24.4	33	65	3.4	3.6	135	5.5
Trial average	**27.5**	**100.0**	**85.0**	**189.2**	**24.4**	**33**	**65**	**3.4**	**3.6**	**135**	**5.5**
Max	32.3	117.3	97.3	205.0	30.0	37	68	4.3	4.8	151	7.0
Min	20.3	73.8	54.6	178.5	19.6	29	64	2.2	2.0	123	4.0
Diff.	12.0	43.5	42.7	26.5	10.4	8	4	2.2	2.8	28	3.0

Table 13. Winter club wheat trial Dietenheim/I 2022/23

Dietenheim/I	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	12.10.2022	10	370	4.8	oat	no	no	27.7.2023

Variety	KOERN dt/ha	KOER rel. %	VLG (g)	TKG (g)	LAGR	WHOE (cm)
Blauroter samtiger Binkel	31.7	**90.0**	195.0	29.2	1.3	111
Igel ohne Grannen	38.0	**108.2**	190.1	33.1	4.0	139
Kärntner Winterbinkel	33.9	**96.4**	185.9	25.1	2.7	153
Obermenzing TRI 19364	33.4	**94.9**	189.4	27.8	3.7	141
Obermenzing TRI 19396 Type A	38.4	**109.0**	190.4	26.3	5.7	141
Obermenzing TRI 19396 Type B	37.3	**106.0**	190.5	30.3	3.3	131
Obermenzing TRI 20122	42.1	**119.7**	189.0	31.2	7.7	140
Obermenzing TRI 3724	32.5	**92.3**	201.3	28.6	1.3	132
Weißspelziger Winterigel	36.6	**104.1**	193.5	32.8	5.3	141
Winterbinkel Laimburg (LTA001)	27.9	**79.4**	195.6	34.1	3.3	131
Mean value	**35.2**	**100.0**	**192.1**	**29.8**	**3.8**	**136**
Max.	42.1	119.7	201.3	34.1	7.7	153
Min.	27.9	79.4	185.9	25.1	1.3	111
Diff.	14.2	40.4	15.4	9.0	6.3	42

Table 14. Wilmersdorf/G 2022/23 winter club wheat trial

Wilmersdorf/D	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	19.10.2022	9	400	12.0	clovergrass	no	Groom 2x	July 2022

Variety	KOER dt/ha	KOER rel. %	TKM (g)	HLG (kg)	Remarks
Blauroter samtiger Binkel	35.8	100.3	36.1	79.3	
Kärntner Winterbinkel	25.4	71.2	39.3	74.7	
Obermenzing TRI 20122	23.2	65.1	32.4	73.1	
Obermenzing 3724	37.9	106.2	38.4	78.2	
Obermenzing TRI 19396 Type A	28.7	80.4	42.5	75.3	mixture!
Obermenzing TRI 19396 Type B	32.2	90.4	37.2	78.2	
Tobias (Standard)	60.2	168.7	45.5	85.0	
Weißspelziger Winterigel	30.6	85.9	29.4	74.2	
Winterbinkel USA (CRESCENT)	47.0	131.8	38.2	78.0	
Mean value	**35.7**	**100.0**	**37.7**	**77.3**	
Max.	60.2	168.7	45.5	85.0	
Min.	23.2	65.1	29.4	73.1	
Diff.	37.0	103.6	16.1	11.9	

Table 15. Winter club wheat trial Ruhstorf/G 2022/23

Ruhstorf/D	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	24.10.2022	9	300	13.5	spelt	no	no	28.8.2023

Variety	KOER dt/ha	KOER rel. %	TKG (g)	hl weight (kg/hl)	WHOE (cm)	LAGR
Blauroter samtiger Binkel	29.1	107.8	34.3	73.4	127	1.7
Kärntner Winterbinkel	25.5	94.4	41.6	73.7	121	2.7
Obermenzing TRI 19364	20.2	75.0	39.5	73.3	154	3.7
Obermenzing TRI 19396 Type B	29.9	110.8	36.6	76.8	138	2.5
Obermenzing TRI 20122	30.3	112.5	36.8	75.0	137	6.3
Obermenzing TRI 3724	26.9	99.8	40.1	74.7	146	1.8
Weihenstephan TRI 28351	21.7	80.5	30.2	78.6	138	1.7
Weißspelziger Winterigel	32.2	119.3	32.3	79.4	141	6.8
Mean value	**27.0**	**100.0**	**36.4**	**75.6**	**138**	**3.4**
Max.	32.2	119.3	41.6	79.4	154	6.8
Min.	20.2	75.0	30.2	73.3	121	1.7
Diff.	11.9	44.3	11.4	6.1	33	5.2

Summary (relevant data)

Table 16. Relative yields of the winter club wheat accessions on the trial varieties 2022/2023

Ruhstorf/D	Sowing	Accessions	Kernel/sqm	Size of plot	precrop	Fertilising	Care	Harvest time
	24.10.2022	9	300	13.5	spelt	no	no	28.8.2023

Variety	KOER dt/ha	KOER rel. %	TKG (g)	hl weight (kg/hl)	WHOE (cm)	LAGR
Blauroter samtiger Binkel	29.1	107.8	34.3	73.4	127	1.7
Kärntner Winterbinkel	25.5	94.4	41.6	73.7	121	2.7
Obermenzing TRI 19364	20.2	75.0	39.5	73.3	154	3.7
Obermenzing TRI 19396 Type B	29.9	110.8	36.6	76.8	138	2.5
Obermenzing TRI 20122	30.3	112.5	36.8	75.0	137	6.3
Obermenzing TRI 3724	26.9	99.8	40.1	74.7	146	1.8
Weihenstephan TRI 28351	21.7	80.5	30.2	78.6	138	1.7
Weißspelziger Winterigel	32.2	119.3	32.3	79.4	141	6.8
Mean value	**27.0**	**100.0**	**36.4**	**75.6**	**138**	**3.4**
Max.	32.2	119.3	41.6	79.4	154	6.8
Min.	20.2	75.0	30.2	73.3	121	1.7
Diff.	11.9	44.3	11.4	6.1	33	5.2

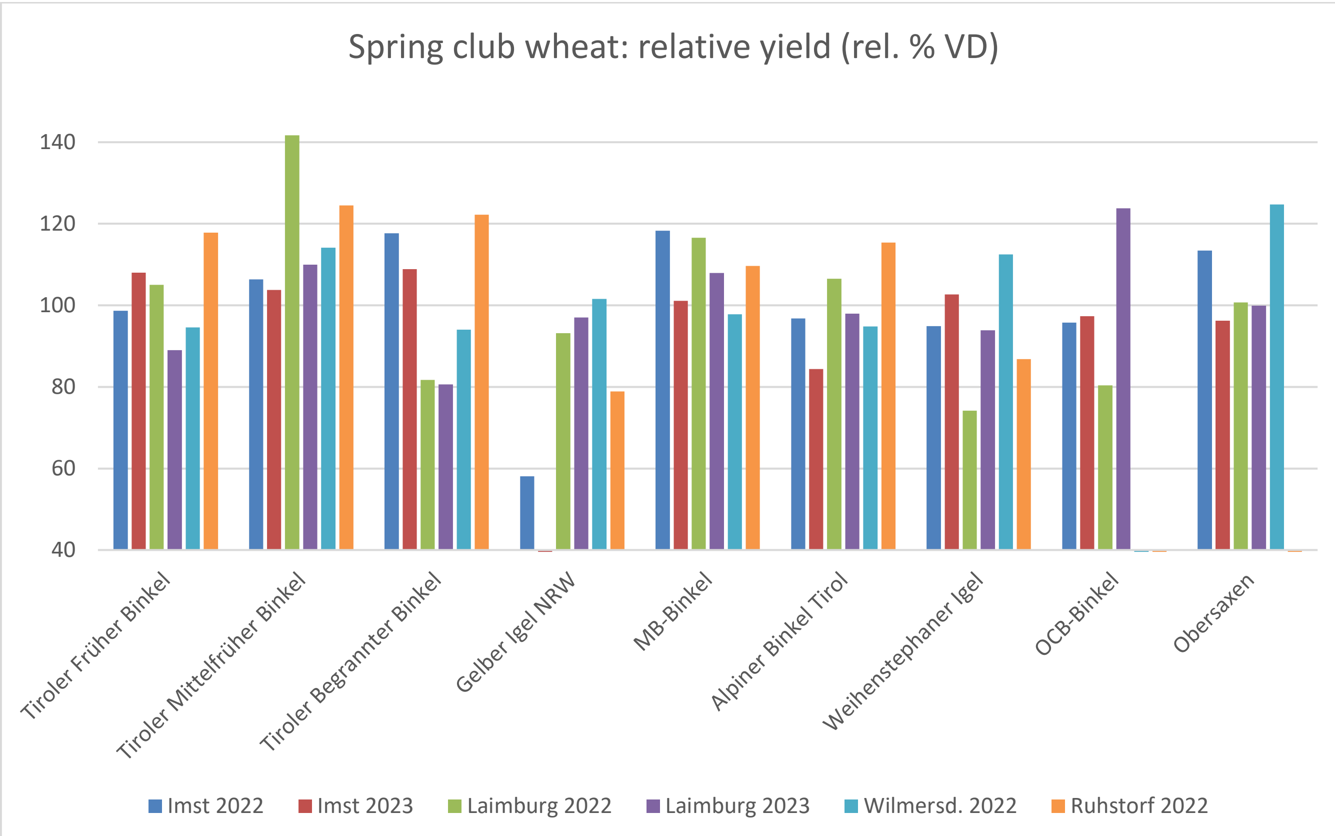

Figure 8. Relative yields of winter club wheat (individual locations) 2022/2023 in % of the trial average

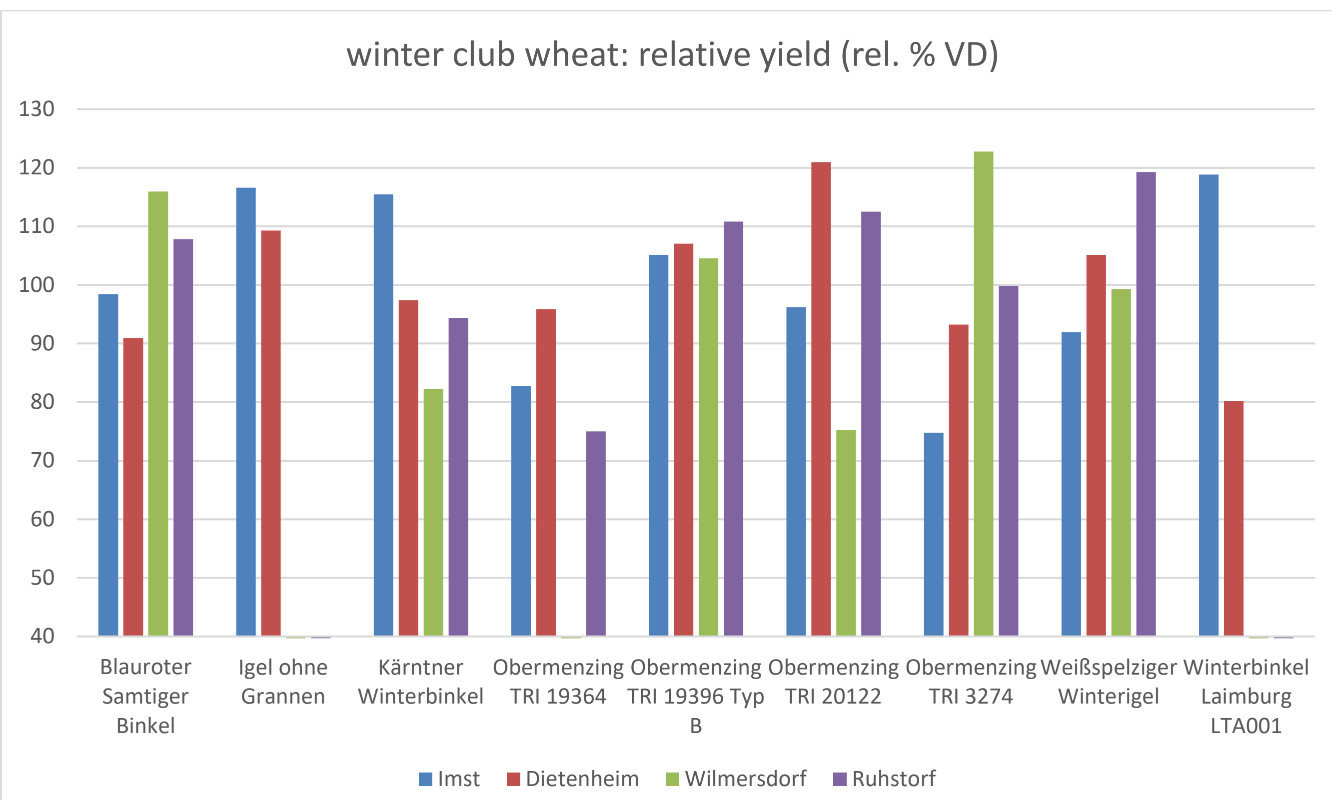

Figure 9. Relative yields of the winter club wheat 2022/2023 (mean value; all locations; in %)

Brief characteristics of the tested winter Binkel accessions including averages of yield (Figure 8):

1. Blauroter Samtiger Binkel: slightly above average yield. Lowest height of all accessions tested and fairly stable; medium maturity; high hectolitre and average thousand-grain weight.
2. Igel ohne Grannen: Highest relative yields (113%), but was only tested at two locations. Long stalk and therefore susceptible to lodging.
3. Kärntner Winterbinkel: About average yield. Wide variation between locations! TKM above average. Medium growth height, otherwise unremarkable.

4. Obermenzing TRI 19364: Low-yielding and highest-growing accession. Grain characteristics below average.
5. Obermenzing TRI 19396 Type B: Yield well above 100% at every location. Grain quality also good.
6. Obermenzing TRI 20122: Average yields. Not reliable between locations; very susceptible to lodging. Below-average grain quality.
7. Obermenzing TRI 3274: Average yields. Not reliable between locations (75–123%!). Medium plant height. Low lodging tendency. Good grain quality. Especially high in hl weight.
8. Weißspelziger Winterigel: Rather good yields, but not reliable between locations; tall growth. Highly susceptible to lodging and weak grain development.
9. Winterbinkel Laimburg LTA001: Tested at two locations. Very different results; hl weight high. TKM satisfactory.
10. Weihenstephan TRI 28351: Only tested at one location; low yield and low TKM there.

QUALITY OF HARVEST FOR CLUB WHEAT ACCESSIONS 2022/2023

The following accessions of winter club wheat were studied. One cycle of field tests in the year 2022/23 at four locations (Dietenheim (Italy), Imst (Austria), Wilmersdorf (Germany), INRAE (France)) was carried out. Due to extreme lodging, the field site at INRAE could not be harvested (Table 17).

Table 17. Studied accessions of winter club wheat

No.	Accessions	Italy	Austria	Germany
1	Kärntner Winterbinkel	x	x	x
2	Blauroter samtigerBinkel	x	x	x
3	Weißspelziger Winterigel	x	x	x
4	Obermenzing TRI 3724	x	x	x
5	Obermenzing TRI 20122	x	x	x *
6	Obermenzing TRI 19396 TypeB	x	x	x
7	Winterbinkel Laimburg LTA001	x	x	
8	Igel ohne Grannen	x	x	
10	Obermenzing TRI 19364	x	x	
11	Obermenzing TRI 26122			x **
12	Bestehorn's Dickkopf			x
13	US Binkel Crescent			x
14	Standard Tobias			x

*only falling number

**only protein content

The following accessions of spring club wheat were studied. For the spring types, two growing cycles in the years 2022 and 2023 at three field sites (Italy, Germany, Austria) were performed (Table 18).

Table 18. Studied accessions of spring club wheat

No.	Accessions	Italy 2022	Austria 2022	Germany 2022	Italy 2023	Austria 2023	Germany 2023
1	Weihenstephan Igel	x	x	x	x	x	
2	Obersaxen	x	x	x	x	x	
3	Gelber Igel NRW	x		x	x		
4	Tiroler Mittelfrueher Binkel	x	x	x	x	x	
5	Tiroler Begrannter Binkel	x	x	x	x	x	
6	MB-Binkel	x	x	x	x	x	
7	Alpiner Binkel Tyrol	x	x	x	x	x	
8	Tiroler Früher Binkel	x	x	x	x	x	
9	OCB-Binkel	x	x	x *	x	x	
10	Gelber Igel Sel.			x **			
11	Standard Quintus			x **			
12	MB Binkel x Amber					x	
13	Tiroler Früher Binkel (Verm.)					x	
14	Tiroler ;Mittelfrüher Binkel (Verm.)					x	

* only falling number
** only protein content

Results – Quality parameters of winter club wheat

Falling Numbers (FN) were measured according to the ICC standard 107/1. A mixed grain sample from three field repetitions was analyzed. Clear differences between the three field sites were evident (Figure 10). Differences are related to weather conditions prior to the harvest period. However, also differences between the studied accessions were evident.

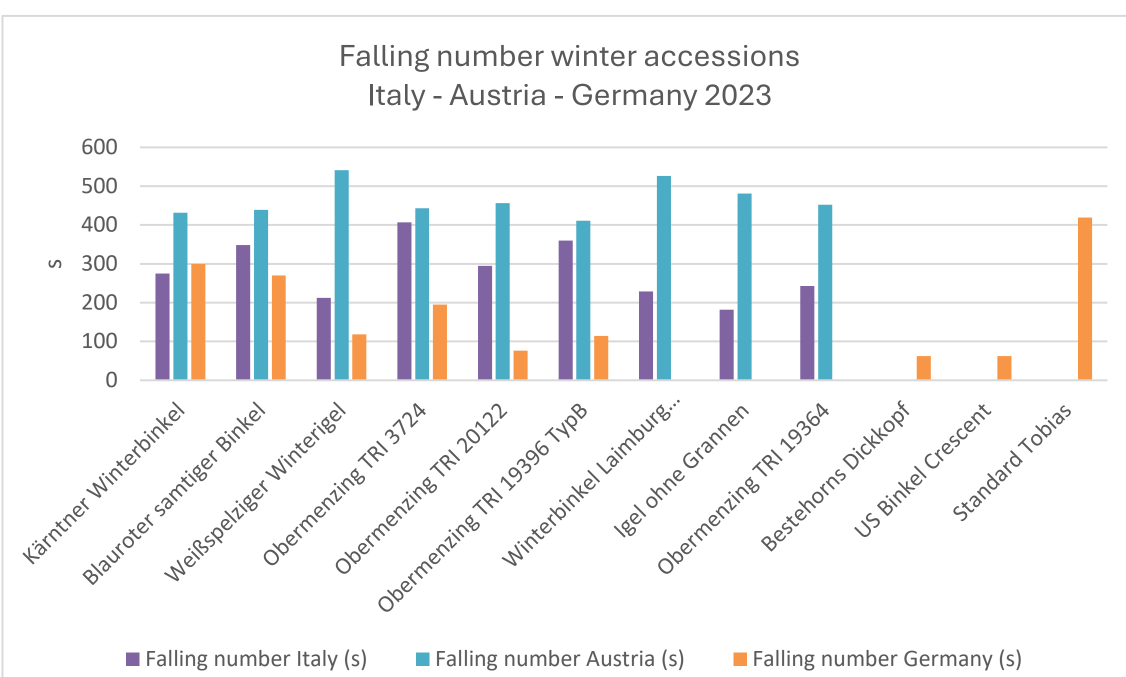

Figure 10. Falling numbers (s) of winter club wheat accessions, year 2022/23

Protein content of the grain was determined using the Dumas method. A mixed sample of three field repetitions was used. Differences between field sites are probably due to different soil nitrate concentrations. Clear difference between accessions were noted and should be further studied (Figure 11).

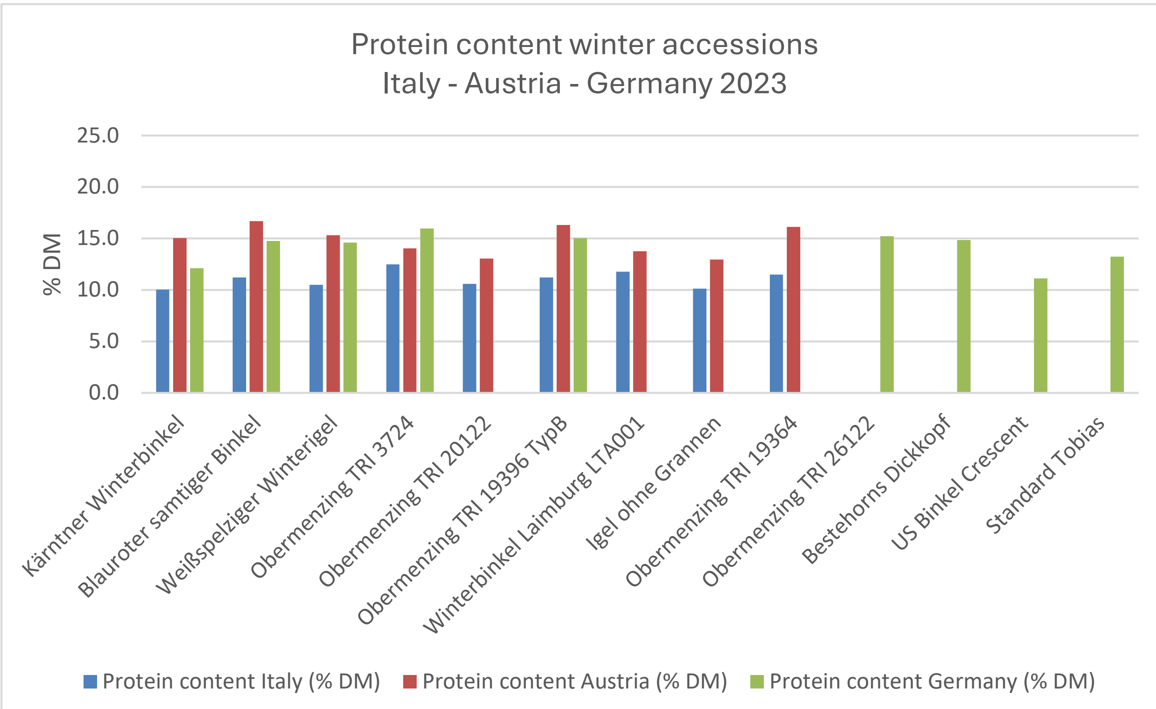

Figure 11. Protein content (% DM) of winter club wheat accessions year 2022/23

Results – Quality parameters of spring club wheat

Falling Numbers (FN) were measured according to the ICC standard 107/1. A mixed grain sample from the three field repetitions was analyzed. Also for the spring form (see data for years 2022 and 2023), clear differences between the three field sites were evident. Differences are related to weather conditions prior to the harvest period. However, also differences between the studied accessions were evident. Differences in the year 2023 were more pronounced due to lodging of some accessions and frequent rain prior to harvesting (Figures 12, 13).

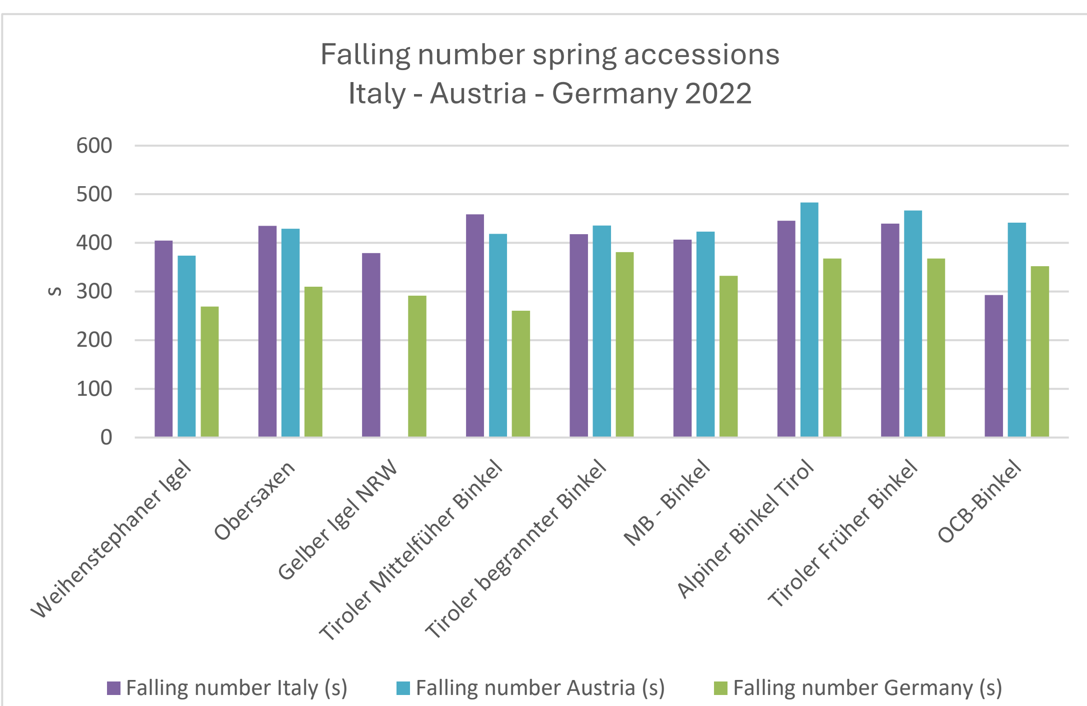

Figure 12. Falling numbers (s) of spring club wheat accessions year 2022

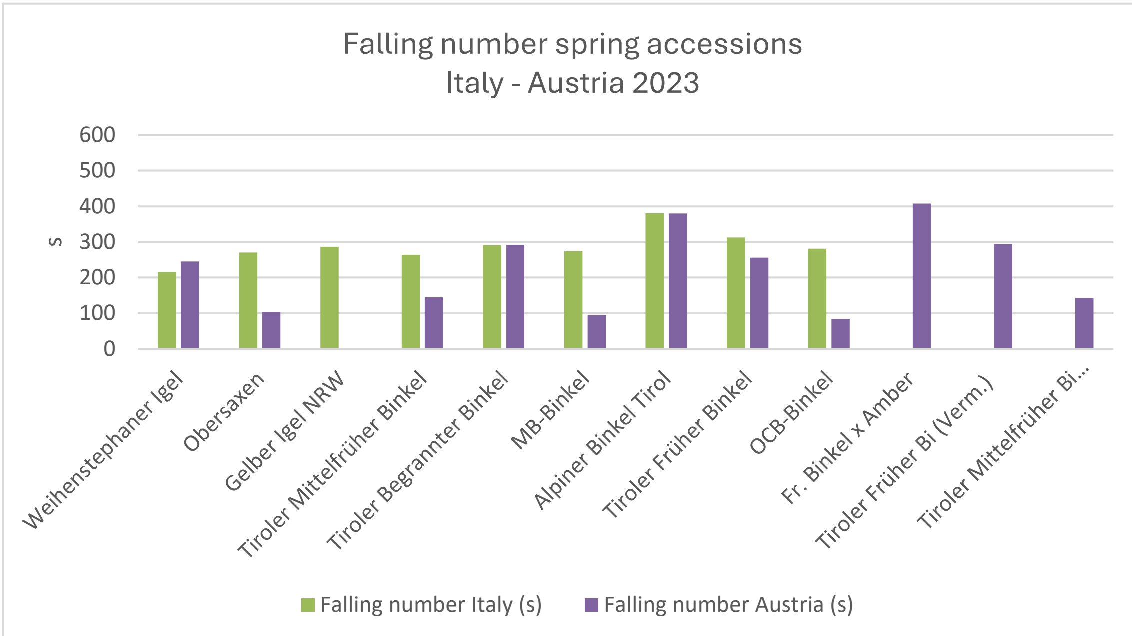

Figure 13. Falling numbers (s) of spring club wheat accessions year 2023

Protein content of the grain was determined using the Dumas method. A mixed sample of the three field repetitions was used. As expected, spring-type accessions showed higher protein values than the winter types. Differences between field sites are probably due to different soil nitrate concentrations (Figures 14, 15). Clear differences between accessions were noted and should be studied further.

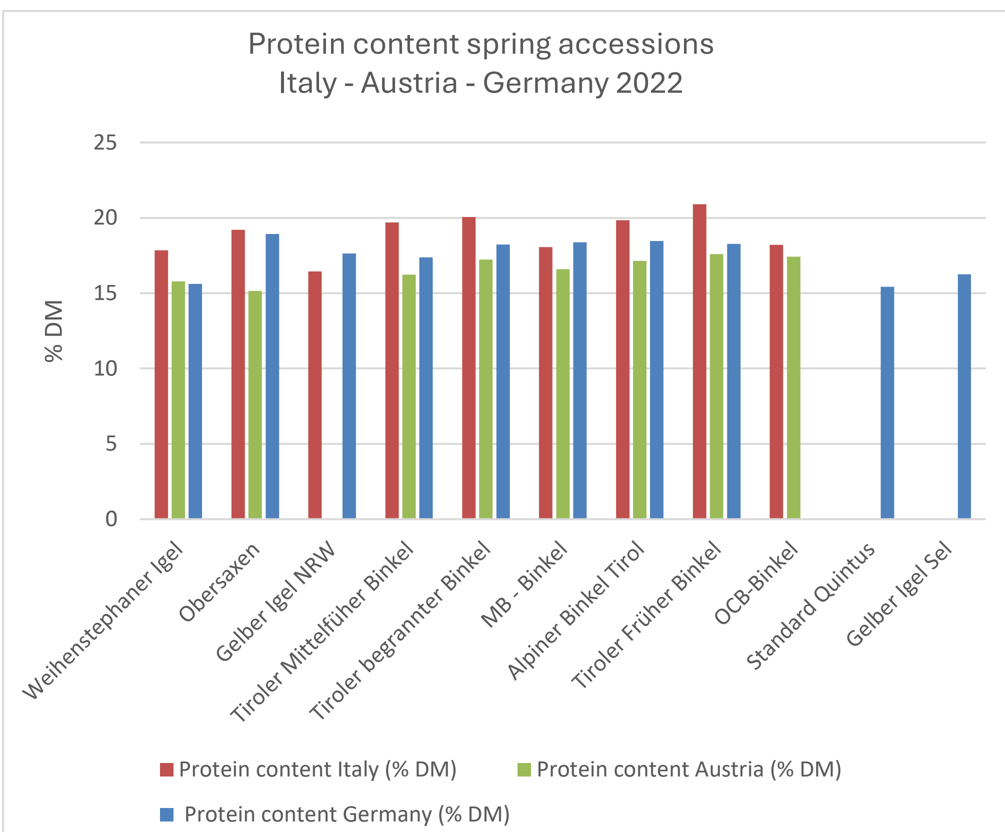

Figure 14. Protein content (% DM) of spring club wheat accessions year 2022

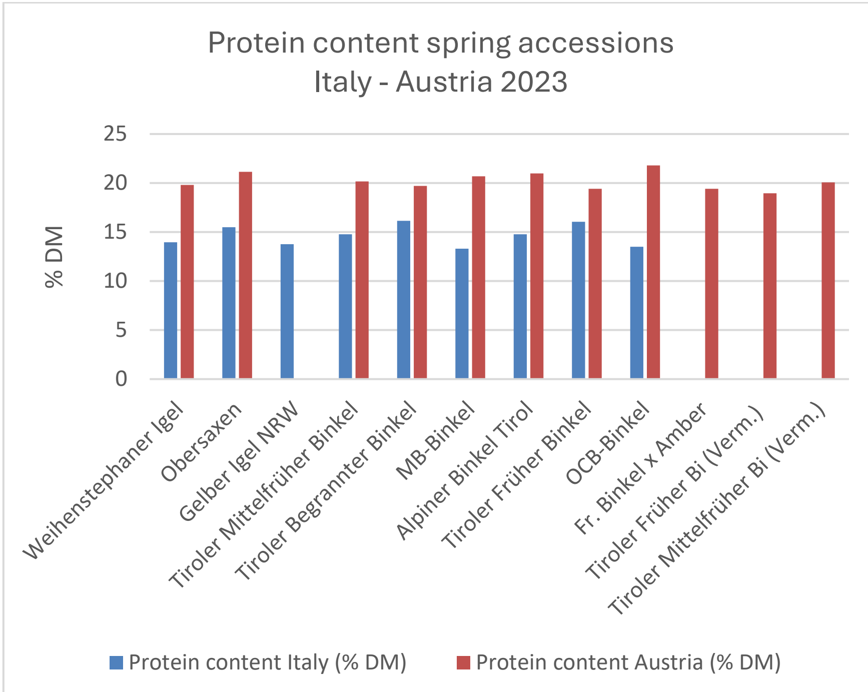

Figure 15. Protein content (% DM) of spring club wheat accessions year 2023

Phenotype description of the field assortments (France, Germany, Italy)

The tested field assortment was also phenotypically described according to UPOV descriptors. In total, the description and scoring data of the 20 field test accessions (Germany) are available. Another set of 10 samples (winter accessions, France) as well as additional descriptions of 24 samples (narrowed to *T. compactum*, including 22 genebank accessions (France, small plots)) are also available. The common characteristics recognized were predominantly the distinctive spike shape and in some cases, especially in the summer forms, a significantly shorter, rigid stem. Many accessions were found to be less homogeneously balanced in phenotype, which can be attributed to a broader genetic background. A high proportion of heterozygosity, which was also confirmed by molecular genetic analyses could be detected. Therefore, Binkel's landrace accessions in particular have a pronounced population character. This was evident, for example, in ‘Gelber Igel’, which was genotyped several times and exhibited a non-uniform phenotype in all trials. Differences were clearly recognizable in some genome regions, for example on chromosome 5 (Table 19). In individual cases, a mixture with other varieties was also seen in field provenances.

Table 19. Heterogenic genotypes within ˛Gelber Igel˝ accessions on chromosome 5 showing different alleles in specific chromosomal regions. This explains phenotypic variation within ˛Gelber Igel˝ accessions.

Chromosomes	Position (bp)	"Gelber Igel" accessions						
5	19272838	A	A	A	A	A	A	A
5	19667864	T	T	T	C	C	C	C
5	19977033	A	A	A	C	C	C	C
5	19979291	T	T	T	C	C	C	C
5	20816395	A	A	A	G	G	G	G
5	20816430	T	T	T	C	C	C	C
5	20817897	C	C	C	A	A	A	A
5	20822105	C	C	C	T	T	T	T
5	20993327	C	C	C	A	A	A	A
5	20994259	C	C	C	T	T	T	T
5	21411719	C	C	C	T	T	T	T
5	26441681	C	C	C	A	A	A	A
5	26462416	T	T	T	G	G	G	G
5	28104282	C	C	C	T	T	T	T

QUALITY EVALUATION: BAKING TESTS AND LABORATORY BAKING EXPERIMENTS

Extensive baking tests for suitability for artisanal processing were carried out on the harvest samples from all locations (with the exception of the non-harvested samples from INRAE's field station). For this purpose, samples were processed into wholemeal flour using a standard household flour mill and made into small loaves using sourdough. In total, 70 tests of spring and winter-type accessions were carried out. All field-grown samples from several locations and from both trial harvest years were tested. A modern standard (1x spring type, 1x winter type) was included for comparison. Without exception, all samples demonstrated good baking properties; parameters such as dough volume, baking volume, sliceability and flavour were examined. In addition to the wholegrain baking trials (without bran separation), standardized small-scale baking trials were carried out at the Bavarian LfL on ten harvest samples of winter types of the harvest from Imst in 2023. Results are available of similar small-scale baking tests (see parameters in Figure 16) on selected spring types from samples, harvested by LfL in 2022.

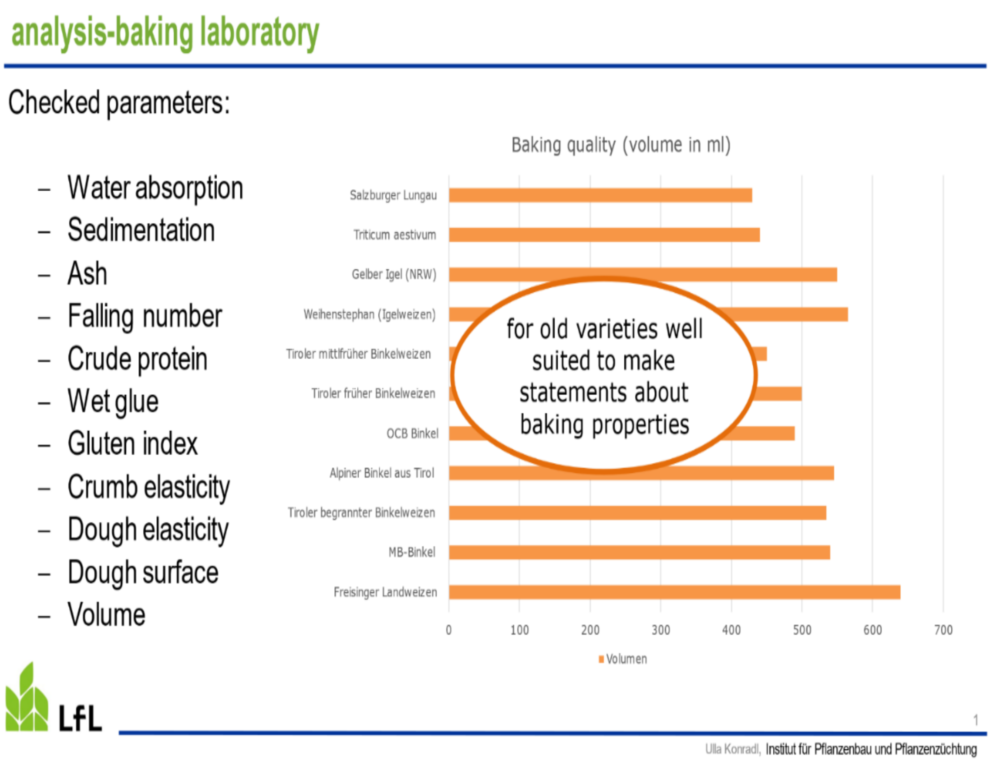

Figure 16. Small-scale baking trials (LfL). Baking volume spring club wheat. Samples were taken from Ruhstorf/G. 2022

As a result of the evaluation, baking samples also differed only slightly. In all parameters, samples proved to be easy to process and bake under the specified conditions simulating artisanal baking. This confirms the results already achieved in the wholemeal baking tests. INRAE also subjected the material to a technical test procedure (alveographic examination, CHOPIN test, https://www.arvalis.fr/infos-techniques/le-w-et-le-pl-deux-criteres-majeurs-pour-la-panification, Figure 17). This revealed clearer differences in terms of suitability for processing. Only two samples showed good values of toughness, elasticity and elongation in line with modern standards. As a result, a large part of the test range will not be suitable for modern baking and processing (Tables 20 and 21).

Table 20. Standard baking trial winter club wheat accessions, harvest 2023, Imst/A, LfL baking laboratory 2024

			falling number flour	Water absorption	Durchg.	Verbl.	Moist Gluten	Gluten Index	Sedimentation	Crude Protein in TM	Crumb Elasticity	Dough Elasticity	Dough Surface	Box Baking Test Volume	RMT Volumen	pastry ausbund
				%						%	--	--	--	ml	ml	
1	GK2438492	TRI 3724 Obermenzing	503	55,5	1,48	2,47	39,5	63	34	13,7	3	3	3	675	700	31
2	GK2438493	TRI 20122 Obermenzing	474	57,5	2,11	1,42	35,3	40	23	13,7	3	3	3	655	615	12
3	GK2438494	TRI 19364 Obermenzing	460	52,0	0,91	2,91	38,2	76	43	15,9	3	4	3	710	685	40
4	GK2438495	TRI 19396 Typ A Obermenzing	421	55,0	1,21	2,41	36,2	67	31	13,0	3	2	2	645	675	12
5	GK2438496	TRI 19396 Typ B Obermenzing	483	52,0	2,69	2,65	53,4	50	35	15,7	3	3	3	625	620	12
6	GK2438497	Blauroter Samtiger Binkel (HTri 4969)	462	54,0	2,74	1,81	45,5	40	25	16,2	3	2	2	565	525	22
7	GK2438498	Igel ohne Grannen (HTri 5011)	474	55,0	0,59	2,49	30,8	81	33	12,3	3	3	2	740	685	21
8	GK2438499	Kärntner Winterbinkel	517	57,5	0,9	2,64	35,4	75	23	13,9	3	4	3	670	655	40
9	GK2438500	Weißspelziger Winterigel (HTri 1792)	678	53,5	2,38	2,2	45,8	48	32	14,7	3	4	3	550	600	21
10	GK2438501	Winterbinkel Laimburg LTA001	509	55,0	1,1	2,35	34,5	68	26	13,5	3	3	3	735	730	12

Table 21. Lab tests alveograph INRAE. winter club wheat. harvest Imst 2023

										Alvéographe					
N° Sac	Quantity	Grain Humidity	Specific Weight	TKW	Flour after milling (first flour)	Flour after "convertissage" (second flour)	Total flour	Flour Humidity	protein content Flour (percon	W	P	L	P/L	Ie	Comment
WB E'23 - 1	450 g	12,1	73,7	28	113,47	181,25	294,72	15,5	10,3	137	53	115	0,46	39,1	sticky
WB E'23 - 2	450 g	11,8	71,9	21,4	91,25	173,64	264,89	15,5	10,3	119	58	78	0,74	35,9	sticky
WB E'23 - 3	450 g	12,3	67,7	21,7	99,85	161,22	261,07	14,3	11,3	214	68	101	0,67	54,2	sticky
WB E'23 - 4	450 g	12,8	73,5	27,7	143,24	116,82	260,06	14,5	9,1	114	43	114	0,38	40,9	sticky
WB E'23 - 5	450 g	12	71,6	24,4	158,17	128,97	287,14	15,2	10,4	125	42	139	0,3	41,6	sticky
WB E'23 - 6	450 g	12,7	72,3	24	106,91	159,97	266,88	15	11,2	90	64	49	1,31	21,8	very sticky
WB E'23 - 7	450 g	12,6	75,2	19,9	109,22	172,35	281,57	14,9	9,3	95	31	165	0,19	38,4	sticky
WB E'23 - 8	450 g	12,5	69,6	27,8	95,69	167,6	263,29	15,2	10,1	223	106	62	1,71	45,8	good texture
WB E'23 - 9	450 g	12,8	70,8	18,6	88,01	158,42	246,43	14,6	11	140	52	141	0,37	37,6	sticky
WB E'23 - 10	450 g	12,9	74,3	22,6	89,8	169,7	259,5	14,9	9,7	106	51	83	0,61	38	sticky

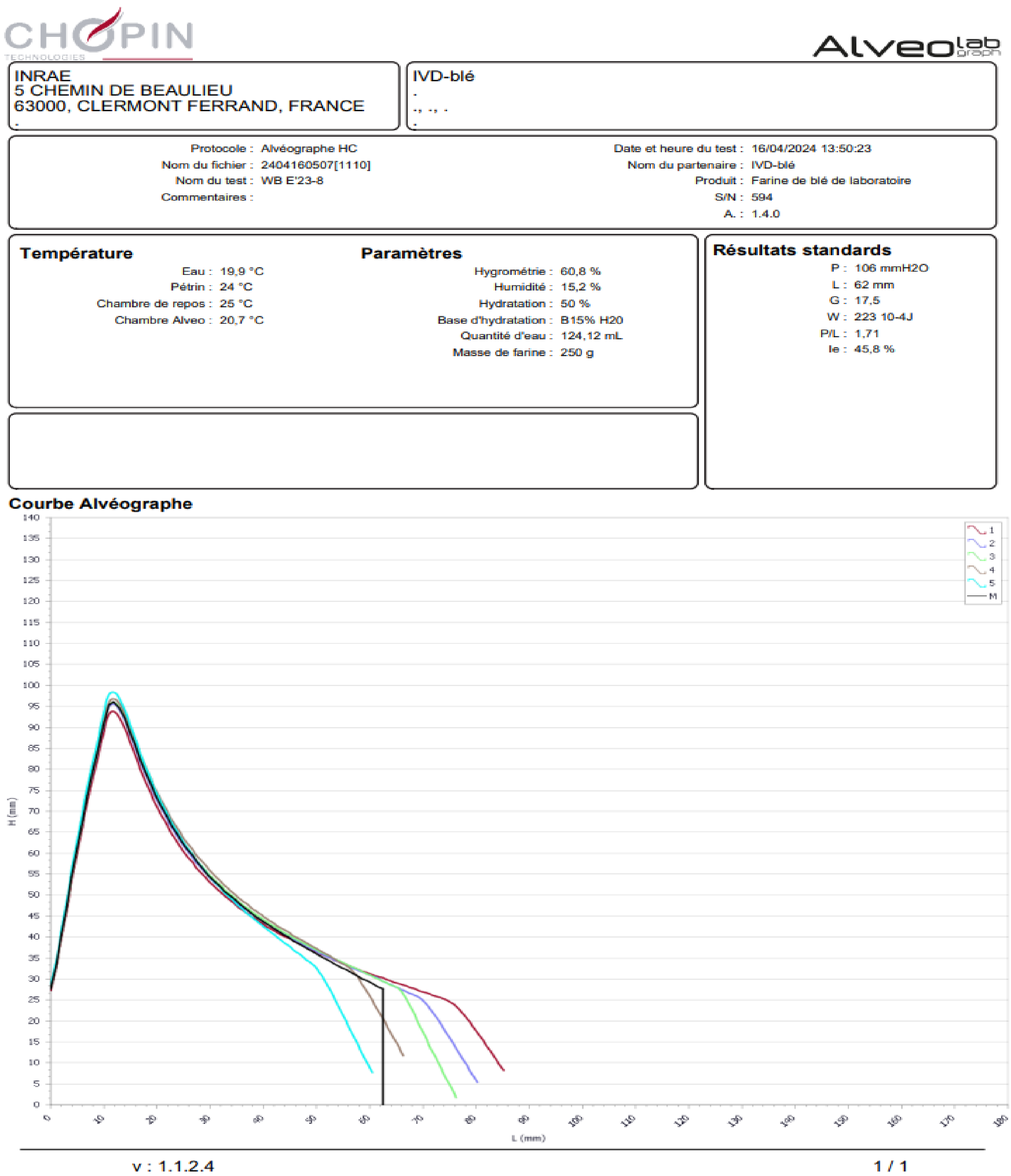

Figure 17. CHOPIN-test, alveograph results of club wheat test samples. INRAE 2024

CURRENT AND FUTURE ACTIVITIES WITHIN THE PROJECT PERIOD

A total of three working meetings were held during the project period. The kick-off meeting took place in July 2022 in Imst, Austria (Fig.18), the mid-term meeting in June 2023 in Clermont-Ferrand, INRAE, France and the final meeting in March 2024 in Merano/Laimburg, Italy. An important aspect of the project involved evaluating the suitability and viability for cultivation and thus the potential possibility of returning to practical farming. A wide range of efforts were made to attract interested parties, inform them, provide seeds and establish contacts with processors and end customers. Existing uses of club wheat were also analyzed and observed. Accompanying the test cultivation, publicity campaigns were organized at all locations in the form of field days and guided tours.

Partners made smaller and larger seed assortments available to several interested parties for their own test cultivation and use. Distribution could also be established for farmers and institutions in France, Austria, Germany and Italy. As a result, several groups were formed in Salzburg/Berchtesgaden (D) and South Tyrol (I, Villnöss, Vinschgau). The first field trials by farmers started in 2023 and intensified in 2024. Two information events were also held in South Tyrol (Laimburg, Meraner Mühle) with farmers, bakers and the local Slow Food Presidium (November 2023 and March 2024, 10 to 20 participants) (Fig. 18). In each case, available test results and prepared baking samples were shown. In order to improve resistance and thus ensure reliable yields in organic farming, the set of accessions is being expanded and field trials are being carried out. In addition to leaf rust, other fungal pathogens such as yellow rust, powdery mildew, Zymoseptoria and Fusarium sp.. will also be included in the investigations.

Figure 18. Project partner meeting at Imst/A in 2022

Figure 19. Farmers meeting 2023 at Meraner Mill, public information.

Outlook and running activities

In Germany, Italy and Austria, various smaller groups of farmers and processors have now established themselves with a particular interest in Binkel wheat. Active cultivation is currently established in South Tyrol (Villnöss Valley and Reschen Pass area), Austria (Salzburg area Salzburg Federal State) and Germany (Berchtesgaden region, Chiemgau). Various processors (mills, bakers) in the vicinity of this extension are also integrated. Seed requests are mainly limited to the direct Alpine region and suburbs in the case of larger levies. Conservation breeding of the origins identified as advantageous in the project by VERN e.V. and other partners (especially Laimburg, Tyrol) is guaranteed, as is advisory support for the reintroduction of Binkel wheat. Through relevant public relations work (lectures, publications, tests), the project partners are working on further consolidation and expansion.

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Running activities using club wheat for bakery/processing

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Annex

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- Fig. 18, Farmers meeting, Meraner Mill, H. Steiner 11/2023
- Fig. 19, Chr. Partl, Innsbruck, meeting at field site Imst/T. 6/2022