and its variants is regularly planted in a staggered way with repeating sowing at three-month intervals to maintain adult-stage plants continuously in the field. The quick set is comprised of the wheat lines Morocco (no *Sr* gene), LMPG (no *Sr* gene), Seri–MACS 2496, Bacanora–WH 542, Attila–PBW 343, *Sr31*/LMPG, *Sr24* (Tr 380–14), *Sr36* (Cook-2), *Sr36* (Cook), and *Sr36* (LMPG).

In the month of November 2009, the quick set also was planted at all regional stations of IARI; Shimla (North Hill zone), the Wheat Division of IARI headquarters in Delhi (North Western Plain Zone), Indore (Central Zone), and Wellington (South Hill Zone). These station cover all the agro-ecological situations in India suitable for wheat cultivation. Uredosporic dust was collected from 146 leaf samples of stem rust from the premises of the IARI Regional Station, Wellington, between April 2009 and April 2010 from the regular winter (March–April 2009 and October 2009–April 2010) and the summer crops (July–November, 2009). Seedlings of the quick set were inoculated and seedling reactions recorded following Bahadur et al. (1985). These samples yielded only the existing Indian pathotypes and none resembled Ug99 or its reported variants. The adult-stage reactions recorded in the first week of April, 2010, following the scale of Roelfs et al. (1992) indicated that all lines of the quick set were free of stem rust except Morrocco, which was susceptible at Indore and Wellington. We have concluded that Ug99 has not yet reached in Nilgiri Hills or other parts of India so far.

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ITEMS FROM ITALY

CONSIGLIO PER LA RICERCA E LA SPERIMENTAZIONE IN AGRICOLTURA, Unità di ricerca per la valorizzazione qualitativa dei cereali (CRA–QCE), Via Cassia, 176, 00191 Rome, Italy.

Pyramiding of leaf rust-resistance genes in common wheat using marker-assisted selection.

F. Nocente, L. Gazza, L. Sereni, and M. Pasquini.

Foliar diseases, such as leaf rust caused by *Puccinia triticina* Eriks. (*Pt*), have been important factors limiting wheat production worldwide. This pathogen is regarded as potentially the most damaging causal agent of rust disease on wheat in Italy, where it is widespread and needs constant monitoring.

One strategy for increasing the durability of resistance in commercial cultivars is to pyramid multiple resistance genes into a single wheat genotype. Pyramiding two or more genes, irrespective of whether they are major or minor, with different modes of action can greatly delay or even prevent the breakdown of resistance. The introgression of two or more genes into the same genetic background is difficult to monitor by traditional phenotypic analysis alone because of the epistatic or dominance effects of some genes or the lack of pathotypes with virulences matching the corresponding resistance gene(s). The availability of specific molecular markers tightly linked to respective resistance genes makes the detection of multiple genes in one genotype possible; such markers are the basis for efficient marker-assisted selection (MAS) in breeding work to speed up the identification of lines carrying two or more resistance genes.

Several known genes for resistance to leaf rust, often derived from related species and genera, have confirmed their efficacy in Italy over a long period. Epidemiological field controls in different locations in Italy and greenhouse tests were carried out over 5 years on a set of 36 Thatcher NILs, each with one gene (*Lr*) for resistance to *P. triticina*. As a result, five *Lr* genes were selected as the most effective in Italy (Table 1): *Lr9* (from *Ae. umbellulata*), *Lr10* (from *T. aestivum* subsp. *aestivum*), *Lr47* (from *Ae. speltoides*), and the *Lr24-Sr24* (from *Th. ponticum*), and *Lr37-Yr17-Sr38* (from *Ae. ventricosa*) clusters. Molecular markers (STS, CAPS, and SCAR) closely linked to these genes were validated and used for MAS.

Table 1. Resistance genes and related introgression lines used for pyramiding experiments at the Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Roma, Italy.

Resistance gene	Chromosome location	Source	Introgression line
Lr9	6BL	*Ae. umbellulata*	Tc*6 / Transfer // Spada
Lr10	1AS	*T. aestivum* subsp. *aestivum*	Tc*6 / Exchange // Bolero Tc*6 / Exchange // Bilancia
Lr24–Sr24	3D	*Th. ponticum*	Tc*6 /Agent // Bolero Tc*6 /Agent // Spada
Lr47	7A	*Ae. speltoides*	T7AS-7S3#1S-7AS·7AL / Bilancia T7AS-7S3#1S-7AS·7AL / Colfiorito
Lr37–Yr17–Sr38	2AS	*Ae. ventricosa*	Tc8* / VPM1 // Bolero

The NILs carrying these genes were used as donor parents for a backcross program in order to introgress the selected genes in four susceptible, high-quality and locally adapted common wheat cultivars Bolero, Spada, Colfiorito, and Bilancia. Eight introgression lines were obtained (Table 1) and intercrossed in order to combine two or more resistance genes into the same wheat cultivar using a gene-pyramiding scheme (Table 2). The first gene combination was achieved by crossing 'Bolero+*Lr24*' with 'Bolero+*Lr9*' (Fig. 1) followed by selfing the progenies and then screening by MAS to identify individuals homozygous at both requested loci. The same breeding scheme was used for combining the other *Lr* genes into cultivars Spada, Colfiorito, and Bilancia. The introgression of the target genes was confirmed by both PCR amplification of molecular markers (STS, CAPS, and SCAR) linked to the genes and phytopatological tests to verify their phenotypic expression in the new genetic background. Further screening of *Lr24-Sr24+Lr9* cross combination was simplified and accelerated by the use of a high-throughput, multiplex PCR system that allows the simultaneous detection of both resistance gene (Fig. 2). Reaction conditions, such as annealing temperature, primer concentration, and type of polymerase, were optimized to obtain a robust amplification and reproducible genotype analysis. In addition, phytopathological analysis using specific rust pathotypes were performed in order to confirm the absence of suppressing or modifying effects due to the co-presence of the introgressed genes.

Table 2. Crosses for gene pyramiding through marker-assisted selection at the Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Roma, Italy.

Bolero + *Lr24–Sr24*	/ Spada + *Lr9*
Bolero + *Lr24–Sr24*	/ Bolero + *Lr9* (Fig. 1)
Bolero + *Lr24–Sr24*	/ Bolero + *Lr37–Yr17–Sr38*
Spada + *Lr9*	/ Spada + *Lr24–Sr24*
Spada + *Lr24–Sr24*	/ Colfiorito + *Lr47*
Bilancia + *Lr10*	/ Bilancia + *Lr47*

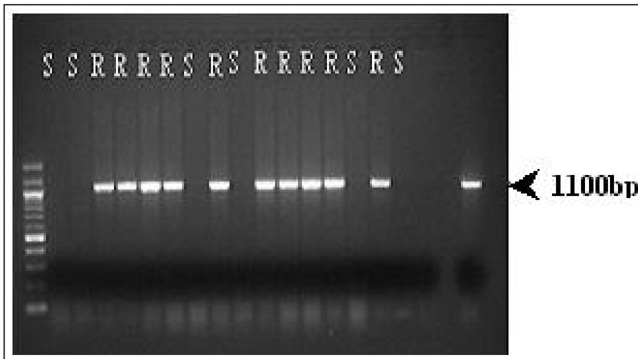

Fig. 1. STS marker-assisted screening of leaf rust resistance gene *Lr9* on the progny from a cross between the cultivar Bolero and a Thatcher NIL–*Lr9* (R = resistance and S = susceptible).

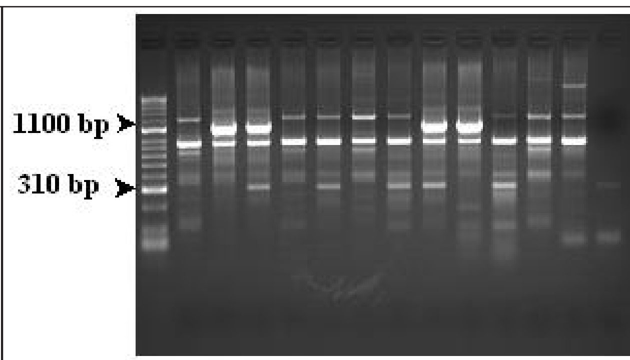

Fig. 2. Multiplex PCR on F_2 plants from a cross between Bolero+*Lr24* and Bolero+*Lr9*. A single, resolved band for each marker, 1,100 bp for *Lr9* and 310 bp for *Lr24*, was visualized on an ethidium bromide-stained agarose gel.

Different individuals were identified with favorable gene combinations: *Lr24-Sr24+Lr47*, *Lr24-Sr24+Lr37-Yr17-Sr38*, *Lr9+Lr24-Sr24*, and *Lr10+Lr47*. These combinations can prevent the breakdown and enhance the durability of resistance, expressed both in seedling and adult-plant stages, and possibly to more than one pathogen, as in the case of gene clusters *Lr24-Sr24* and *Lr37-Yr17-Sr38*, conferring resistance to leaf (adult-plant resistance), stripe, and stem rust.

Novel, selected genotypes are now available that could be useful as cultivars or for further breeding work. In conclusion, the pyramiding of relevant resistant genes in an agronomically superior genotype offers real solutions for a longer period of protection and for a shorter breeding time.

Table 3. Field behavior to natural powdery mildew infections of 6V disomic substitution and addition lines in different regions of Italy during 2007–08 and at Martonvásár, Hungary, in 2008–09. For infection type, the first digit gives the relative height of disease (1–9, a value of 5 corresponds to the midpoint of the plant), the second digit shows the disease severity as a percentage but in terms of 0–9 following the modified Cobb's scale (0–100%), Tr = trace, — = no data, and an * indicates symptoms on the susceptible line CS/V58 derived from CS lacking of chromosome 6V#4.

Line/cultivar	Lonigo (VC)		S. Angelo (LO)		S. Lazzaro (BO)		Viterbo (VT)		Foggia (FG)		Libertinia (CT)	Caltagirone (CT)	Martonvásár, Hungary	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2008	2007	2008	2009
CS/V32	0	1–2	8–3	0	0	0	0	0	0	0	1–Tr	1–3	Tr	Tr
CS/V63	0	0	8–1	8–1	1–1	0	0	0	0	0	Tr	1–3	—	—
Chinese Spring (CS)	—	7–6	—	7–6	—	1–Tr	6–6	6–5	—	0	0	—	8–5*	8–5*
Fortunato (check)	6–4	6–6	8–4	8–3	9–6	7–4	7–6	7–5	0	5–3	1–Tr	5–3	—	—
Novosadska (check)	8–5	7–7	8–5	8–5	9–4	7–5	8–4	8–5	5–1	5–3	5–3	1–2	—	—
Irnerio (check)	8–7	7–7	8–5	8–4	9–7	7–7	—	8–6	1–2	7–5	7–8	1–4	—	—

Resistance to Blumeria graminis tritici and Puccinia triticina in aneuploid wheat lines with chromatin introgressed from Dasypyrum villosum.

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Leaf rust and powdery mildew are important fungal diseases affecting wheat cultivation in Italy. National pathogenicity surveys and virulence determinations are annually performed in the most important wheat-growing areas to obtain data on disease severity and virulence composition of the pathogen population. The incorporation of effective and durable resistance is a valuable breeding strategy for wheat improvement, and the wild species prove to be a useful source for this character. *Dasypyrum villosum* Candargy (syn. *Haynaldia villosa*) (*Dv*) is an annual, diploid (2n=14), allogamous grass species, belonging to the tribe Triticeae. This species is widespread in the Mediterranean region and has been reported as carrying different genes conditioning useful characters, including resistance to several pathogens. One gene for resistance to *B. graminis* f.sp. *tritici* was reported to be located at locus *Pm21* on the short arm of chromosome 6V#2 introgressed in *T. astivum* subsp. *aestivum* from *D. villosum*. A study was made on the disomic addition (DA) (CS/V63) and substitution (CS/V32) (DS) lines of chromosome 6V#4 introgressed, by Prof. De Pace, into the Chinese Spring (CS) wheat chromosome complement from a *D. villosum* population collected in Latium. The disomic addition line (DA) CS/V63 was completely resistant to powdery mildew at adult-plant and seedling stages, in comparison with the disomic substitution line (DS) CS/V32, which was genetically unstable at the seedling stage (Tables 3 and 4). As matter of fact, monosomic and nullisomic

Table 4. Seedling inoculation with *B. graminis* pathotypes of control and wheat introgression lines. Infection type scoring was a 0–4 scale.

Line	Pathotype	
	O1	O2
CS / V63 95-97 2n=44	0	0
CS / V63 1.95 2n=44	0	0
CS / V32 v616-1 2n=42	0/3	0/3-
CS / V32 v623-3 2n=42	0/1++3=	0/3-
Chinese Spring (CS)	3/3+	3+
CS+6V (Sears)	3+	3+
Dv T v330	0	0
Dv 200 v346	0	0

plants for 6V#4 were observed in the progenies of CS/V32. In nursery plots designed for disease scoring under air-borne inoculum and grown in two-year field experiments in several Italian localities and at Martonvàsàr (Hungary), the two lines carrying chromosome 6V#4 confirmed their resistance in many environments (Table 5).

Table 5. Segregation for resistance to powdery mildew pathotype O2 in F_2 plants (* non significant).

Cross combination	Number of F_2 plants	Resistant	Susceptible	χ^2 (3:1)
CS / V63 // CS + 6V	356	270	86	0.284 *

The DA CS/V63 line was crossed to the susceptible DA line 6V#1, obtained by Prof. E.R. Sears. A suitable mapping population, segregating for powdery mildew resistance coming from chromosome 6V#4 of *D. villosum*, was obtained. The $F_{2:3}$ progenies were studied both by phytopathological (with a selected pathotype of *B. graminis*) and molecular (PCR marker) analyses in order to assess the genetic basis of resistance. The segregation for powdery mildew resistance indicated the presence of one dominant gene (called *PmVt*) controlling resistance, presumably located on 6VS (Table 5). Molecular analyses using the marker $OPH17_{1900}$, reported as linked to the *Pm21* gene, were used to confirm the location of this gene on 6VS and to verify its relationship with the *Pm21* locus. The preliminary analyses on resistant and susceptible F_3 progenies seem to confirm the location of *PmVt* on 6VS, but the marker and the resistance gene do not seem to be closely linked (Fig. 3).

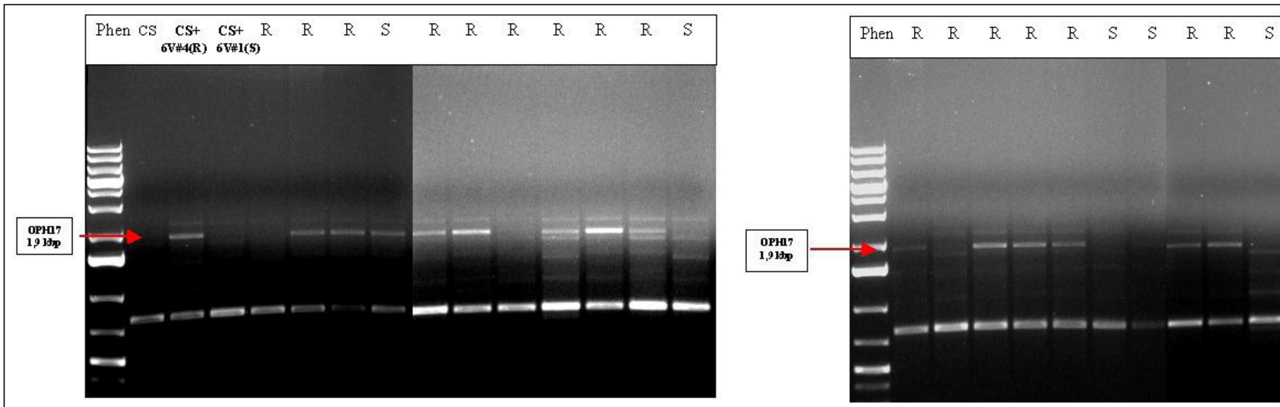

Fig. 3. Preliminary analysis on resistant and susceptible F_3 progeniew from the cross 'CS/V63//CS/6V' using the molecular marker $OPH17_{1900}$.

The lines also were tested for resistance to *P. triticina*. All lines were susceptible in experiments with different selected pathotypes at the seedling stage. When tested in the field in multilocation epidemiological trials, they showed adult-plant resistance (APR) to *P. triticina* (Tables 6 and 7, p. 99). The genetic basis of APR was studied in the same $F_{2:3}$ progenies, and the resistance surveyed in the 6V#4-introgression line could be controlled by a single resistance gene, different from those already present in Chinese Spring (*Lr12*, *Lr34*).

In conclusion, the *D. villosum* ecotypes coming from Latium resulted in resistance to *B. graminis*. A suitable mapping population, segregating for powdery mildew resistance on chromosome 6V of *D. villosum*, was obtained. One dominant gene (*PmVt*) controlling resistance to *B. graminis* was identified; adult plant resistance (probably under simple genetic control) to *P. triticina*, derived from *D. villosum*, was observed

Table 6. Seedling inoculation with *P. triticina* pathotypes of control and wheat introgression lines. Infection type scoring was a 0–4 scale.

Line	Pathotype		
	B-1	B-2	B-3
Chinese Spring (CS)	3+	3+	4
CS / V63 A (2n=44)	3+	3+ 4	4
CS / V32 S (2n=42)	3+ 4	3	4
CS 1BL/1VS	3+	3+	3+ 4
CS+6V (Sears)	3+	3+	3+ 4
Dv T	1–	0	0; 1=
Dv 200	1=	1–	1–
CS / V58 (2n=42)	3+	3+	3+
CS / V59 (2n=42)	3+	3+	3+
CS / V60 (2n=42)	3+	3+	3+

Table 7. Field behavior to natural leaf rust infections of 6V disomic substitution and addition lines in different regions of Italy during 2007–08 and at Martonvásár, Hungary, in 2008–09. For infection type, the first digit gives the relative height of disease (1–9, a value of 5 corresponds to the midpoint of the plant), the second digit shows the disease severity as a percentage but in terms of 0–9 following the modified Cobb's scale (0–100%), Tr = trace, — = no data, and an * indicates symptoms on the susceptible line CS/V58 derived from CS lacking of chromosome 6V#4.

Line/cultivar	S. Angelo (LO)		Grosseto (GR)	Montelibretti (RM)		Ussana (CA)		Foggia (FG)		Gela (CL)		Marton-vásár, Hungary	
	2007	2008	2007	2007	2008	2007	2008	2007	2008	2007	2008	2008	2009
CS/V32	—	0	3	0	5–1	0	0	—	0	7–3	1–3	Tr	Tr
CS/V63	—	8–2	3	Tr	Tr	0	0	—	0	—	8–2	—	—
Chinese Spring (CS)	—	8–4	—	—	8–4	—	8–4	—	0	—	8–4	8–5*	8–5*
Fortunato (check)	7–3	8–7	8	8–5	8–4	8–6	8–5	8–3	5–2	7–5	7–4	—	—
Novosadska (check)	7–2	8–5	2	1–1	5–1	0	8–Tr	0	0	1–1	5–4	—	—
Irnerio (check)	8–3	8–8	8	8–2	8–5	8–6	8–3	8–2	0	8–6	8–7	—	—

in the wheat introgression lines; new bread wheat genotypes were selected carrying useful genes controlling different characters.

Septoria disease complex on durum wheat in Italy.

A. Iori, A. L'Aurora, A. Matere, L. Sereni, F. Casini, and M. Pasquini.

The Septoria disease complex, caused by *M. graminicola* (anamorph *S. tritici*) and *Phaeosphaeria nodorum* (anamorph *St. nodorum*), has been observed on durum wheat during the last few years and an increase in its diffusion has been recorded (Fig. 4). The presence of the disease has been detected not only in northern regions of Italy but outside its typical area of spread as well (central and southern Italy).

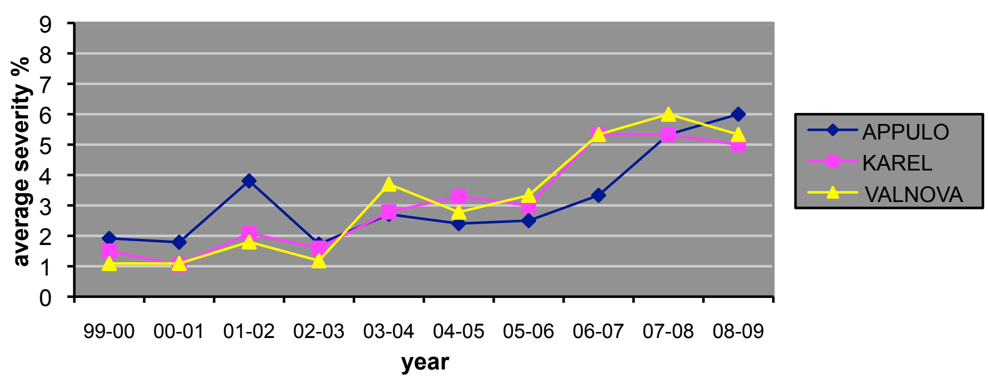

Fig. 4. Average severity of the Septoria disease complex on durum wheat check cultivars from 2000 to 2009.

National pathogenicity surveys and virulence determinations were conducted by organizing field nurseries in the most important durum wheat-growing areas. Twenty-three wheat genotypes, included in the National Durum Wheat Network, were grown in experimental fields situated in central and southern Italy, during a 4-year period. Data on disease severity were recorded using a double-digit scale, representing the vertical disease progress (first digit) and disease severity as a percentage (second digit). Naturally infected leaf samples were collected from the field; leaf segments were put in humidity chamber or on water agar medium at 20°C for 48 h and then analyzed with stereoscopic and compound microscopes for pathogen identification.

Climatic conditions favored the spread of Septoria disease complex on wheat plants in 2007 and 2009; moderate disease infections were observed in 2008 but not present on plants in 2006 (Table 8, p. 100). All genotypes were moderately or completely susceptible in the field to *S. tritici* and/or *S. nodorum* in the location/year where heavy infections of these pathogens were detected, such as in Sardinia in 2009. Microscopic analyses on infected leaf samples showed

Table 8. Behavior of durum wheat cultivars to the Septoria disease complex in central and southern Italy from 2006 to 2009 (R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, and — = missing data).

	2006			2007			2008			2009		
Culitvar	**Puglia (FG)**	**Sardinia (CA)**	**Lazio (RM)**	**Puglia (FG)**	**Sardinia (CA)**	**Lazio (RM)**	**Puglia (FG)**	**Sardinia (CA)**	**Lazio (RM)**	**Puglia (FG)**	**Sardinia (CA)**	**Lazio (RM)**
Anco Marzio	R	R	R	R	MR	MS	MR	R	R	R	MS	MR
Canyon	R	R	R	MS	R	MS	MR	R	R	R	MS	MS
Casanova	R	R	MR	MR	MR	MS	MR	MR	R	R	MS	MR
Ciccio	R	R	R	MR	R	MS	R	MR	R	R	S	S
Claudio	R	R	R	MS	R	MS	R	R	R	R	S	MR
Creso	R	R	MR	R	MS	MR	R	MR	R	R	MR	MS
Duilio	R	R	MR	MS	R	R	MR	MR	MR	R	S	MR
Dylan	R	R	R	MS	R	—	MR	MR	R	R	S	MS
Grecale	R	R	R	R	MS	MS	R	R	MR	R	MS	MR
Iride	R	R	MR	MS	—	—	R	MR	R	R	S	MR
Levante	R	R	MR	MR	MR	MR	MS	R	MS	R	MR	MS
Maestrale	R	R	R	MS	R	—	R	—	MR	R	MS	MS
Meridiano	R	R	R	MS	R	—	R	MR	MR	R	S	MS
Neolatino	R	R	R	MR	MS	S	R	R	MR	R	S	MR
Normanno	R	R	R	R	MS	MR	MS	R	MR	R	S	MR
PR22D89	R	R	MS	R	MS	—	MS	R	MR	R	S	R
Sant Agata	R	R	R	MR	MS	MS	MS	MS	R	R	S	R
Saragolla	R	R	R	R	MS	MR	R	R	R	R	S	MS
Simeto	R	R	MS	MS	R	MS	R	MS	R	R	S	S
Solex	R	R	MR	MR	MR	MS	R	MR	MS	R	S	R
Svevo	R	R	MR	MS	R	MS	MS	MS	MR	R	S	S
Valerio	R	R	MR	MS	R	MS	R	MR	MS	R	S	MR
Virgilio	R	R	MS	R	MR	MS	R	MR	S	R	S	MR

that *S. tritici* and *S. nodorum* sometimes occur together and with other pathogens on durum wheat cultivars. *S. tritici* was isolated most during the last four years, whereas *S. nodorum* was identified only in 2008 and 2009 (Table 9).

Table 9. Isolation frequency (%) of fungal pathogens on infected leaf samples from field experiments.

	2006	2007	2008	2009
Number of samples	19	29	16	25
Septoria tritici	16	41	19	54
Stagonospora nodorum	0	0	6	29
Fusarium spp.	11	7	0	23
Helminthosporium spp.	63	66	19	29
Alternaria spp.	84	100	94	91
Cladosporium spp.	84	83	88	77
Epicoccum spp.	16	31	56	40
Stemphylium boryosum	26	38	31	40
Phoma spp.	5	3	0	6

Monitoring of powdery mildew and leaf rust infections in Italy: behavior of durum wheat cultivars.

A. Matere, F. Nocente, L. Sereni, A. L'Aurora, F. Casini, and M. Pasquini.

Fungal diseases affect wheat cultivation in Italy with economic consequences because of their influence on yield, grain quality, and healthiness. National pathogenicity surveys and virulence determinations are conducted annually, both in organic and conventional farming systems, to provide timely information about the structure of pathogen populations, which are relevant to breeding programs and resistance deployment.

Data on disease severity are recorded in the field, and artificial inoculations, at the seedling stage, are conducted in greenhouse by testing single pathotypes of the different pathogens on durum and common wheat cultivars and lines. For field evaluation, a double-digit scale, representing vertical disease progress (the relative height of the disease based on a 1–9 scale, with the value of 5 corresponding to the mid-point of the plant) and severity estimate (disease severity as a percentage following a modified Cobb's scale 0–100%) was used.

Among epigeous wheat diseases, powdery mildew and leaf rust occur annually throughout most Italian wheat-growing areas. Powdery mildew has shown a decrease in its frequency and severity over time, probably because of the cultivation of more resistant cultivars and the occurrence of climatic conditions unfavourable for fungal growth. The mean percentage of powdery mildew infections on the susceptible check cultivars Appulo (durum wheat) and Fortunato (common wheat) has not exceeded 44% during the last decade. Durum wheats appear to be more susceptible than bread wheat (Fig. 5)

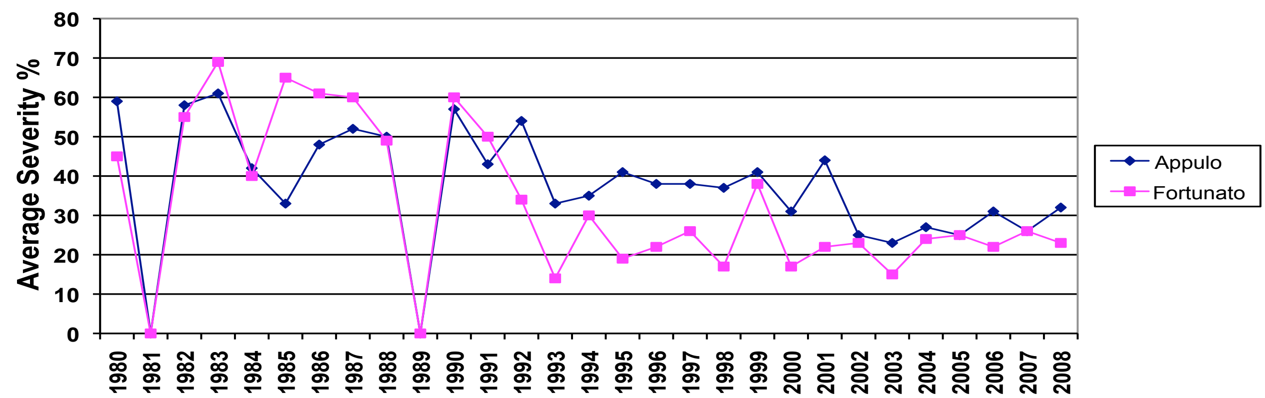

Fig. 5. Average powdery mildew severity in the field on durum (Appulo) and bread (Fortunato) wheat check cultivars from 1980 to 2008.

From 1981 to 1991, the mean percentage of leaf rust infections was generally over 50% on susceptible wheat cultivars; in the last years the disease has shown a moderate decrease in its frequency and severity (Fig. 6). The disease severity frequently appeared slightly higher on bread wheat than on durum cultivars. Durum wheat showed slightly higher percentages of infection in central and southern Italy than in the north.

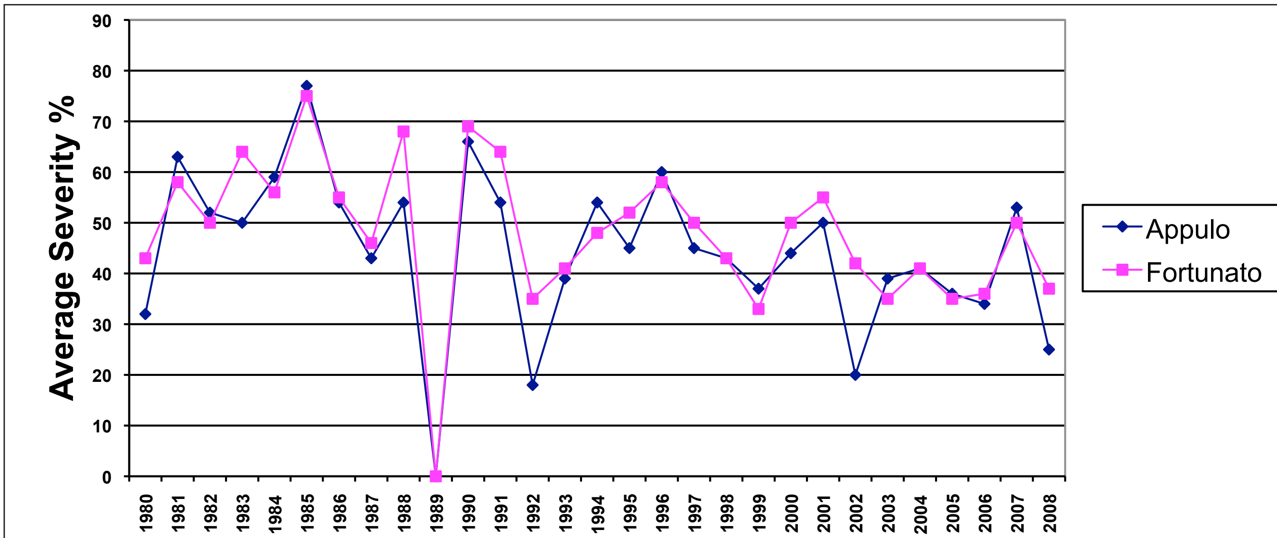

Fig. 6. Average leaf rust severity in the field on durum (Appulo) and bread (Fortunato) wheat check cultivars from 1980 to 2008.

During the last four years, data on field infections by powdery mildew and leaf rust on durum wheats have been recorded in central and southern Italy (typical durum wheat-growing areas) and included in the National Durum Wheat Network. Field nurseries were organized in different locations in Italy; in some, disease infections allowed a comparison of the varietal behavior.

Many durum wheats grown in Italy resulted resistant to powdery mildew in almost all the locations tested (Table 10, p. 103). With respect to leaf rust none of the cultivars was found completely resistant in the years/locations considered, but several genotypes (Casanova, Levante, Normanno, PR22D89 and Saragolla) showed only a moderate susceptibility in some wheat growing areas (Table 10).

Table 10. Field behavior to powdery mildew in central and southern Italy of durum wheat cultivars included in the National Wheat Network (R = resistant; MR = moderately resistant; MS = moderately susceptible; s = Susceptible; and — = missing data).

	Locality												
	2005–06				2006–07					2007–08		2008–09	
Cultivar	Sicily (CL)	Calabria (CS)	Puglia (FG)	Basilicata (MT)	Sicily (CL)	Sardinia (CA)	Calabria (CS)	Puglia (FG)	Basilicata (MT)	Sicily (CT)	Puglia (FG)	Sicily (CL)	Puglia (FG)
Anco Marzio	R	MS	R	R	R	R	R	R	R	MS	MS	R	R
Canyon	R	R	R	R	MR	R	R	R	R	R	R	—	R
Casanova	R	R	R	R	MR	R	R	R	R	R	R	R	R
Ciccio	R	MR	R	R	R	R	R	R	R	MR	MS	R	R
Claudio	R	R	R	R	R	R	R	R	R	R	R	R	R
Creso	R	R	R	R	R	R	R	R	R	R	R	—	R
Duilio	R	R	R	R	R	R	R	R	R	R	R	R	R
Dylan	R	MR	R	R	MR	R	R	R	R	R	MS	R	R
Grecale	R	MR	R	R	R	R	R	R	R	MS	R	R	R
Iride	R	R	R	R	—	R	R	R	R	R	R	R	R
Levante	R	MS	R	R	R	R	R	R	R	R	R	R	R
Maestrale	R	R	R	R	R	R	—	R	R	R	R	R	R
Meridiano	R	R	R	R	R	R	R	R	R	R	R	R	R
Neolatino	R	R	R	R	R	R	R	R	R	R	R	—	R
Normanno	R	R	R	R	R	R	R	R	R	R	MS	R	R
PR22D89	R	R	R	R	R	R	R	R	R	R	MR	—	R
Sant'Agata	R	R	R	R	MR	R	R	R	R	MR	MS	R	R
Saragolla	R	R	R	R	MR	R	-	R	R	MR	R	R	R
Simeto	R	R	R	R	R	R	R	R	R	MS	MR	R	R
Solex	R	R	R	R	R	R	—	R	R	R	R	—	R
Svevo	R	R	R	R	MR	R	—	R	R	R	R	R	R
Valerio	R	R	R	R	MR	R	—	R	R	R	R	R	R
Virgilio	R	R	R	R	MR	R	R	R	R	R	R	—	R

The same durum wheat cultivars were artificially inoculated in greenhouse, at the seedling stage, with different pathotypes of *B. graminis* and *P. triticina*, identified within the pathogen populations during the 2005–06 to 2008–09 crop seasons. Infection types were scored on a 0–4 scale. The reaction of genotypes to the different pathotypes anually identified has been reported (Table 11, p. 103). The cultivars Canyon, Dylan, Grecale, Iride, Levante, Maestrale, Meridiano, Normanno, Saragolla, and Svevo had a resistant or variable behavior with respect to both pathogens between 2005 and 2009 (Table 12, p. 103).

In conclusion, the risk of heavy epidemics is potentially in Italy high because of the selection of new virulent variants within the pathogen populations; increased cultivation of susceptible cultivars, often from foreign countries;

Table 11. Field behavior to leaf rust in Central and Southern Italy of durum wheat cultivars included in the National Wheat Network (R = resistant; MR = moderately resistant; MS = moderately susceptible; s = Susceptible; and — = missing data).

	Locality																
	2005–06			2006–07						2007–08				2008–09			
Cultivar	Calabria (CS)	Puglia (FG)	Basilicata (MT)	Sicily (CL)	Sardinia (CA)	Calabria (CS)	Puglia (FG)	Basilicata (MT)	Lazio (RM)	Sicily (CL)	Puglia (FG)	Sardinia (CA)	Lazio (RM)	Sicily (CL)	Puglia (FG)	Sardinia (CA)	Lazio (RM)
Anco Marzio	R	R	R	MS	R	R	R	R	S	MS	R	R	R	R	R	R	R
Canyon	MR	MR	MS	MS	S	MR	MS	R	MS	MR	R	R	R	—	R	MS	MR
Casanova	R	R	R	MS	MR	R	MR	R	MR	R	R	—	R	R	R	MS	R
Ciccio	MS	MR	R	S	S	MR	MS	MS	MS	MR	R	R	R	MR	MR	R	MR
Claudio	R	R	R	S	S	R	MS	MS	S	R	R	—	R	R	MR	MS	R
Creso	MR	R	MS	MS	S	R	R	MR	MR	R	R	MR	R	—	R	R	MS
Duilio	MS	MR	R	S	S	R	MS	MR	MS	R	MR	MR	R	R	R	R	R
Dylan	R	R	MS	MS	S	R	MS	R	S	MR	R	MR	R	R	R	R	MS
Grecale	MR	R	R	MS	S	R	R	R	R	R	R	R	R	R	R	R	R
Iride	MR	MR	R	—	S	R	MS	R	S	MR	R	R	R	R	R	R	MS
Levante	R	R	R	MS	R	R	MR	R	MS	R	R	R	R	R	R	R	MS
Maestrale	R	R	R	MR	S	R	MS	R	MS	MS	R	R	R	R	R	MR	MR
Meridiano	MS	MR	MR	MR	S	MR	S	R	MS	R	R	R	R	R	R	R	MS
Neolatino	MR	MR	MR	MR	S	MR	MS	MR	MS	MS	R	R	R	—	R	MS	R
Normanno	R	R	R	MS	MR	R	R	R	MS	MS	R	R	R	R	R	MS	R
PR22D89	MR	R	MS	MS	MR	MR	MR	MR	MS	MR	MR	R	R	—	R	R	R
Sant'Agata	MS	MS	R	MS	S	MR	MS	MR	S	MS	R	MR	R	R	MR	MR	MR
Saragolla	MR	R	R	MS	MR	R	R	R	R	MS	R	R	R	MR	R	R	MR
Simeto	MS	MR	R	MR	S	MR	MR	MR	S	R	R	MR	R	R	MR	R	MS
Solex	MS	R	R	MS	MR	R	MR	R	S	R	R	R	R	—	R	MR	R
Svevo	MS	MR	MR	MS	S	MR	MS	R	S	MR	R	R	R	R	R	MR	S
Valerio	MS	MS	MR	MS	S	MR	MS	R	S	MR	R	MR	R	MS	R	MR	MS
Virgilio	MS	R	R	S	MS	MR	MS	R	S	R	R	R	R	—	R	R	MR

Table 12. Seedling behavior of durum wheat cultivars artificially inoculated with different, annually identified pathotypes (R = resistant to the whole spectrum of virulence tested; S = susceptible to the whole spectrum of virulence tested; V = variable, the genotype is carrying some gene for resistance; and — = missing data).

	Blumeria graminis				*Puccinia triticina*			
Cultivar	(2 pathotypes) 2006	(3 pathotypes) 2007	(2 pathotypes) 2008	(2 pathotypes) 2009	(4 pathotypes) 2006	(5 pathotypes) 2007	(4 pathotypes) 2008	(4 pathotypes) 2009
Anco Marzio	S	S	R	V	R	V	V	R
Canyon	V	V	V	V	V	V	V	V
Casanova	S	S	R	R	V	R	R	V
Ciccio	S	S	V	V	V	R	R	V
Claudio	S	S	V	V	V	V	S	V
Creso	S	V	R	R	R	R	R	R
Duilio	S	S	S	V	V	V	V	R
Dylan	R	R	R	R	R	V	—	R
Grecale	V	V	R	V	V	V	—	R
Iride	R	V	V	V	R	V	R	R
Levante	R	R	R	R	R	R	R	R
Maestrale	R	R	R	V	R	R	R	R
Meridiano	R	V	R	V	R	V	R	R
Neolatino	V	S	S	V	R	V	R	V
Normanno	R	V	R	R	R	V	R	R
PR22D89	S	S	S	V	V	V	R	V
Sant'Agata	V	V	S	V	V	V	R	R
Saragolla	R	V	R	R	R	R	—	R
Simeto	S	V	V	V	V	V	—	V
Solex	V	V	S	V	R	V	R	V
Svevo	V	R	R	R	V	V	V	R
Valerio	V	S	V	S	R	R	R	V
Virgilio	S	S	S	S	V	V	S	V

inoculum migration from adjacent wheat-producing regions; and modified cultural practices. Selecting new wheat genotypes, characterized by multiple and durable resistance to different pathogens, by classic and nonconventional breeding is important.

2007–09 national network of conventional durum wheat cultivar trials.

Andreina Belocchi, Maria Grazia D'Egidio, Mauro Fornara, Ester Gosparini, Valerio Mazzon, and Fabrizio Quaranta.

Since 1972, the Research Unit for the Qualitative Valorization of Cereals of the Italian Council for Research in Agriculture (CRA–QCE, Rome) has coördinated the national network for the evaluation of the performance of conventionally managed durum wheat cultivars. The aim of this network is to provide useful information about the qualitative and quantitative traits of durum wheat cultivars managed conventionally, testing at the same time their suitability to specific agroclimatic conditions. Field trials are kept in diverse locations, in collaboration with some important national and local agencies involved in agricultural research. Between 2007 and 2009, field experiments were carried out in 54 locations, grouped into six main geographical and pedoclimatic areas (Sicily, Southern Italy, Sardinia, Thyrrenic–Central Italy, Adriatic–Central Italy, and Northern Italy). Several cultivars were evaluated; some were tested in all the environments, whereas others were considered suitable only for a part. Three replicate trials were grown in each field. The agronomic performance of ten genotypes evaluated in all the areas between 2007 and 2009 are given in Table 13. Such cultivars represent a considerable amount of the durum wheat commercialized seed in Italy. For all the observed parameters and all growing areas, the mean data of the cultivars equalled the values obtained considering all the tested genotypes.

Table 13. Yield, grain protein content, and test weight of ten Italian durum wheat cultivars tested during a three- year period (2007–09) in six areas of Italy (for length of growing cycle, E = early, ME = medium early, M = medium, ML = medium late, and L = late).

Cultivar	Length of growing cycle	Sicily	Sardinia	South	Thyrrenic–Central	Adriatic–Central	North	Mean	Mean
		Yield							
		Index (yield / column mean * 100)							**t/ha**
Anco Marzio	E	106	100	101	104	102	104	**103**	**5.28**
Ciccio	E	95	95	92	87	92	90	**92**	**4.73**
Duilio	E	106	97	99	98	97	99	**99**	**5.11**
Saragolla	E	109	112	107	107	109	107	**109**	**5.60**
Iride	ME	104	108	103	104	101	102	**104**	**5.34**
Simeto	ME	86	93	97	94	97	93	**94**	**4.81**
Claudio	M	105	104	104	100	103	105	**104**	**5.32**
Normanno	M	97	104	105	107	105	103	**104**	**5.34**
Dylan	ML	105	94	103	107	99	108	**103**	**5.27**
Creso	L	87	91	89	91	93	88	**90**	**4.63**
Mean (t/ha)		**4.46**	**5.81**	**4.13**	**4.76**	**6.24**	**5.47**	**100**	**5.14**
		Grain protein content							
		Index (grain protein content / column mean * 100)							**% D.M.**
Anco Marzio	E	101	105	100	100	100	98	101	**13.4**
Ciccio	E	97	95	97	97	98	99	97	**13.0**
Duilio	E	98	102	100	100	100	101	100	**13.4**
Saragolla	E	98	101	98	98	98	98	98	**13.1**
Iride	ME	97	96	96	96	97	98	97	**12.9**
Simeto	ME	104	101	102	103	104	104	103	**13.8**
Claudio	M	100	99	100	100	100	101	100	**13.4**
Normanno	M	101	101	102	101	100	101	101	**13.5**
Dylan	ML	101	98	1011	100	99	99	100	**13.3**
Creso	L	103	103	105	104	103	101	103	**13.8**
Mean (% D.M)		**80.5**	**80.6**	**80.5**	**78.8**	**78.9**	**75.4**	**100**	**79.1**
		Test weight							
		Index (test weight / column mean * 100)							**kg/hl**
Anco Marzio	E	102	102	102	102	102	103	102	**80.7**
Ciccio	E	100	101	101	99	100	100	100	**79.1**
Duilio	E	99	99	100	99	100	100	99	**78.7**
Saragolla	E	99	99	98	99	99	98	99	**78.2**
Iride	ME	100	99	99	99	99	98	99	**78.3**
Simeto	ME	97	97	98	97	97	96	97	**76.8**
Claudio	M	102	103	102	103	103	104	103	**81.3**
Normanno	M	98	99	99	99	100	99	99	**78.5**
Dylan	ML	101	100	100	102	100	102	101	**79.7**
Creso	L	101	101	101	102	101	101	101	**79.9**
Mean (kg/hl)		**80.5**	**80.6**	**80.5**	**78.8**	**78.9**	**75.4**	**100**	**79.1**

The average national yield for the period reached 5.14 t/ha; the highest production was achieved in Adriatic–Central Italy, whereas the lowest was from Southern Italy (6.24 t/ha and 4.13 t/ha, respectively). Four of the cultivars (the early cultivars Anco Marzio, Saragolla, and Iride, and the medium Claudio) reached yield indexes higher than 100 in all six environments. On the contrary, Creso, Ciccio, and Simeto were clearly below the average in every area.

Grain protein content was the highest in Northern Italy (14.0%, the nationwide average was 13.4 %) and lowest in Sardinia (12.7 %). The cultivars Creso, Normanno, and Simeto were above average in every area, and Ciccio and Iride were characterized by at all locations as lower than the national average. No genotype was high for both yield and protein content, but Dylan and Normanno showed a satisfactory compromise between high yield and good protein level .

Test weight values were not much different from each other, with the exception of northern Italy, where the aveage (75.4 kg/hl) was clearly below the others. The national mean value was 79.1 kg/hl with the best results in Sardinia (80.6 kg/hl) and Sicily and southern Italy (80.5 kg/hl). No great differences were detected between the cultivars if Simeto is excluded. The average test weight for Simeto during the period was 76.8 kg/hl; other values ranged from 81.3 kg/hl (Claudio) to 78.2 kg/hl (Saragolla). Claudio, Anco Marzio, Creso, and Dylan exceeded the local average in every area, Duilio, Iride and Saragolla were slightly under average, and Simeto was the only cultivar whose test weight was remarkably under the mean data in every growing area.

2007–09 national network of organic durum wheat cultivar trials.

Fabrizio Quaranta, Andreina Belocchi, Maria Grazia D'Egidio, Mauro Fornara, Sahara Melloni, Massimiliano Camerini (University of Molise, Dip. to S.A:V.A), and Stefano Pucciarmati.

In 2003, Italian Ministry of Agriculture established a national network in order to supply to farmers useful information concerning the qualitative and quantitative performance and suitability of durum wheat cultivars to specific agrosystems managed by organic farming. The Research Unit for Qualitative Valorization of Cereals of the Italian Council for Research in Agriculture (CRA–QCE, Cereal Quality Research Unit in Rome) coördinated this network, which was carried out in collaboration with diverse national agencies and universities. In the period between 2007 and 2009, 16 durum wheat cultivars (representing about 70% of the commercialized seed) were evaluated in 18 experimental fields, representative of three Italian geographical macroareas (Southern, Thyrrenic Central, and Adriatic Central–Northern Italy). Three replicate trials were grown in each field.

The agronomic performance of the tested genotypes are given in Table 14 (pp. 105-106). The average national yield for the period 2007–09 reached 3.72 t/ha.

Table 14. Yield, grain protein content, and test weight of 16 organically managed, Italian durum wheat cultivars tested during a three-year period (2007–09) in three main cropping areas of Italy (for length of growing cycle, E = early, ME = medium early, M = medium, ML = medium late, and L = late).

		Yield				
		Index (yield / column mean * 100)				t/ha
Cultivar	Cycle	South	Thyrrenic Central	Adriatic Central and North	Mean	Mean
Ciccio	E	104	100	93	**99**	**3.67**
Duilio	E	106	101	104	**104**	**3.86**
Karalis	E	96	101	104	**100**	**3.75**
Saragolla	E	108	105	111	**108**	**4.02**
Svevo	E	105	97	103	**102**	**3.80**
Meridiano	ME	111	101	109	**107**	**3.99**
Simeto	ME	106	98	100	**101**	**3.76**
Claudio	M	112	106	112	**110**	**4.10**
Colosseo	M	101	101	98	**100**	**3.73**
Normanno	M	99	111	110	**106**	**3.97**
San Carlo	M	88	90	100	**93**	**3.48**
Vinci	M	97	110	102	**103**	**3.83**
Dylan	ML	104	111	103	**106**	**3.94**
Grazia	ML	94	94	99	**96**	**3.56**
Cappelli	L	76	71	58	**68**	**2.52**
Mean (t/ha)		**3.53**	**3.62**	**4.02**	**3.72**	**3.72**
	Grain protein content					
	Index (grain protein content / column mean * 100)					%D.M.
Ciccio	E	95	100	99	98	**12.3**
Duilio	E	98	99	98	99	**12.4**
Karalis	E	104	102	101	102	**12.8**
Saragolla	E	95	95	94	95	**11.9**
Svevo	E	103	104	104	104	**13.0**
Meridiano	ME	98	97	96	97	**12.2**
Simeto	ME	101	104	103	103	**12.9**
Claudio	M	97	97	99	98	**12.3**
Colosseo	M	95	96	96	96	**12.0**
Normanno	M	99	96	97	97	**12.2**
San Carlo	M	104	101	102	102	**12.9**
Vinci	M	98	97	95	97	**12.2**
Dylan	ML	98	96	96	97	**12.2**
Grazia	ML	103	101	101	102	**12.8**
Cappelli	L	110	113	118	114	**14.3**
Mean (t/ha)		**12.6**	**12.4**	**12.8**	**12.6**	**12.6**

The highest value was recorded in the Adriatic Central–Northern Italy region (4.02 t/ha), however, yields in the Southern and Thyrrenic–Central Italy were close (3.53 t/ha and 3.62 t/ha, respectively). Five cultivars, Claudio, Duilio, Dylan, Meridiano, and Saragolla, had yield indexes greater than 100 in all three areas. The cultivars Claudio and Saragolla had indexes that were remarkably above the average value in every growing area. To the contrary, generally negative results were given by the old cultivar Cappelli, basically because of intense lodging to which this tall genotype is subject, even when managed organically.

Table 14 (continued). Yield, grain protein content, and test weight of 16 organically managed, Italian durum wheat cultivars tested during a three-year period (2007–09) in three main cropping areas of Italy (for length of growing cycle, E = early, ME = medium early, M = medium, ML = medium late, and L = late).

		Yield				
		Index (yield / column mean * 100)				t/ha
Cultivar	Cycle	South	Thyrrenic Central	Adriatic Central and North	Mean	Mean
Ciccio	E	101	100	100	**100**	**79.7**
Duilio	E	99	99	100	**99**	**79.0**
Karalis	E	100	102	101	**101**	**80.3**
Saragolla	E	98	98	98	**98**	**78.0**
Svevo	E	100	101	101	**100**	**79.8**
Meridiano	ME	97	96	98	**97**	**77.0**
Simeto	ME	98	97	97	**98**	**77.5**
Claudio	M	102	102	103	**102**	**81.2**
Colosseo	M	101	101	100	**101**	**80.1**
Normanno	M	99	100	100	**100**	**79.2**
San Carlo	M	100	100	103	**101**	**80.2**
Vinci	M	98	98	98	**98**	**77.9**
Dylan	ML	100	101	101	**101**	**80.0**
Grazia	ML	102	102	103	**102**	**81.1**
Cappelli	L	102	100	98	**100**	**79.3**
Mean (t/ha)		**80.4**	**80.2**	**77.7**	**79.4**	**79.4**

Grain protein content had an average value of 12.6%. Once again, production from the Adriatic Central–Northern Italy region were the best (12.8%) but even in this case, no large differences were observed between this region and those from Southern (12.6%) and Thyrrenic–Central Italy (12.4%). Overall, protein content seems to be negatively related to yield. The highest percentages were obtained by the cultivar Cappelli, whereas lower values were recorded in the most productive cultivars. Eight genotypes, Cappelli, Creso, Duilio, Grazia, Karalis, San Carlo, Simeto, and Svevo, reached the important commercial value of 12.0% in every environment and, among these, Svevo obtained a good protein content level (13.0%), brilliant from a productive point of view. The protein content of Saragolla was below 12.0%.

The nationwide average test weight was 79.4 kg/hl. The highest value was recorded in Southern Italy (80.4 kg/hl). Data from Thyrrenic–Central Italy were not much different, with an average value of 80.2 kg/hl. However, production from Adriatic–Northern Italy were the worst (77.7 kg/hl). The cultivars Claudio and Grazia gave above average test weights in all the environments, with a mean greater than 81.0 kg/hl. Meridiano, Simeto, and Vinci were clearly below average in all areas (< 78.0 kg/hl).

Weed control and nitrogen supply in organic durum wheat in Italy.

Sahara Melloni, Andreina Belocchi, Massimiliano Camerini (University of Molise, Dip. to S.A:V.A), Valerio Mazzon, and Fabrizio Quaranta.

Weed control and nitrogen supply are two crucial factors in organic farming (Hansen 2000). In Mediterranean areas, winter-grown cereals are heavily affected by low temperatures and high autumn–spring rainfall causing low nitrogen availability in the soil rooting layer. Weed control is possible only with crop rotation and mechanical methods. Intercropping is used widely to enhance the efficiency of the cropping systems, basically using species exhibiting complementary use of nitrogen, water, and other resources. Cereal–legume temporary intercropping, aimed only at increasing nitrogen supply for the former crop, is a less used practice (Vandermeer 1989; Pristeri 2006). Our effort was to evaluate the effect of durum wheat–legume temporary intercropping and mechanical weeding on grain yield, weed control, nitrogen availability, and protein content.

Field experiments were carried out in 2004–05 and 2005–06 in Rome using a randomized split-plot design with three replicates. Three Italian, durum wheat cultivars (Cappelli, Creso, and Duilio) were grown with three cropping techniques: i) no weeding (control), ii) mechanical weeding (harrowing) at tillering (weeded), and iii) with a temporary intercrop of field bean. No N fertilizers were added. The intercrop was made by sowing single wheat rows 45-cm apart and a legume species was sown in the 45-cm interrow. Weed density was determined at wheat harvest by counting the weedy plants in a 1-m^2 sample area. At harvest, grain yield and grain protein content were measured. Means for each cultivar and technique were compared using a Fisher LSD at P = 0.05. No significant differences were found for the 'cultivar x technique' interaction.

Intercropping and harrowing were effective in reducing weed density, but no significant differences were detected between treatments and between cultivars (Fig. 7). For yield, intercropping was a less effective tool and no difference was found between the weeded and control treatments. Between cultivars, Duilio had the higher yield.

Grain protein content was higher in the intercrop-managed field even with lower yields, whereas no significant differences were found between weeded and untreated plots. In particular, we emphasize that intercropping increased the amount of protein in all cultivars above the market-required standards. Cappelli had a higher protein level content even if due to low yields.

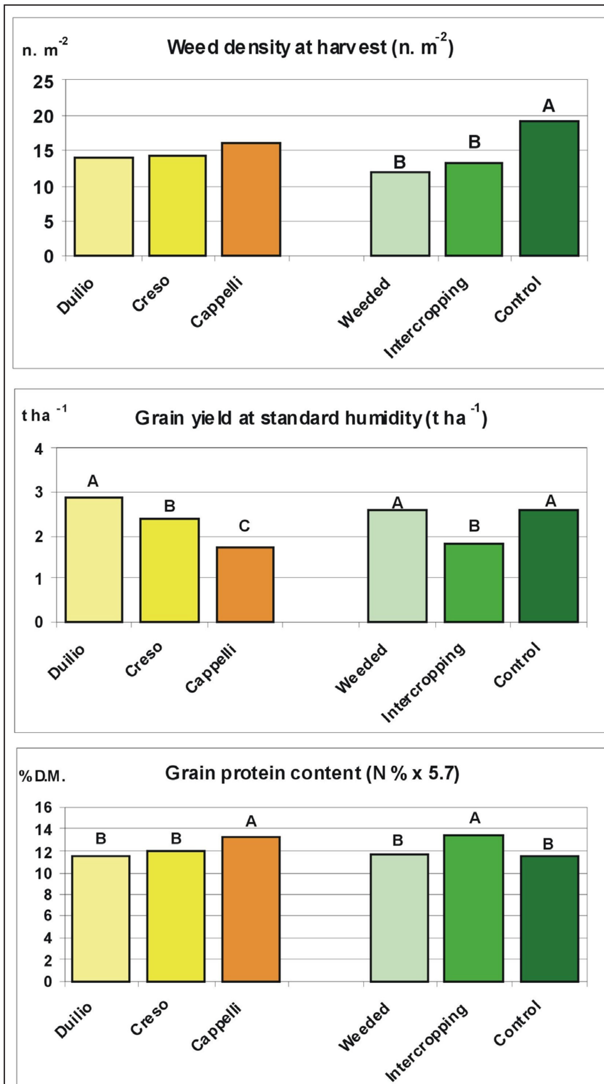

Fig. 7. Weed density, grain yield, and protein content of three durum wheat varieties under three different weed management techniques during 2004–05 and 2005–06 in Rome, Italy.

The main advantage of temporary intercropping certainly is related to the direct effect of nitrogen derived from the atmosphere and supplied to the system with biomass incorporation, although positive effects also may come from nitrogen transfer from legume roots before incorporation, the modification of wheat root development, and improved efficiency in the use of resources other than nitrogen. Our results indicate that temporary intercropping may supply an important amount of nitrogen to cereals, leading to an increase of grain quality traits. This technique and harrowing also give positive effects in controlling weeds. Temporary intercropping may be considered an environmentally sustainable technique that can improve organic wheat production in Mediterranean areas. Further studies are needed concerning the feasibility of this agronomic practice and to confirm that harrowing is convenient for improving yield and reducing the number of weeds.

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The quality of organic durum wheat grown in Italy.

Maria Grazia D'Egidio, Cristina Cecchini, Sahara Melloni, Salvatore Moscaritolo, Valeria Scla, and Fabrizio Quaranta.

Cereal-based products play a primary role in the growing attention by consumers and producers about organic farming products. Durum wheat is the choice raw material for pasta production and, consequently, its quality characteristics are related strictly to requirements of the milling and pasta-making industries. This study investigated the quality aspects of durum wheat grown in an organic cropping system in experimental fields in Italy . The survey was carried out within the 'BIOCER' National Project with financial support from the Italian Agriculture Ministry.

Nine durum wheat cultivars (Ciccio, Duilio, Simeto, Iride, San Carlo, Claudio, Grazia, Creso, and Cappelli) from among the most widely grown in Italy, and differing from each other for the length of the growth cycle (early, medium-early, medium, medium-late, and late), were grown over four years (2004–07) under controlled, organic, crop-management conditions in experimental fields located in the most representative regions for durum wheat cultivation in Italy. A randomized block design with three or four replicates was used in all environments. Diverse parameters were used to characterize the quality of raw materials: test weight, protein content (Dumas-Leco combustion method), gluten Index (UNI 10690 method), alveographic test (UNI 10453 method), and yellow index (Minolta Chromameter CR-300). Semolina flour obtained by a pilot milling plant (Buhler MLU 202) also was used to produce pasta samples (spaghetti shape, Ø = 1.65 mm) employing a low temperature drying diagram (Tmax 50°C). Pasta cooking quality was evaluated by sensory analysis according to D'Egidio et al. (1993). Analytical data for the mean of repeated analyses and differences between replicates were included within the specific ranges of each method. Results related to quality aspects were expressed as average values in the three main macroclimactic areas considered (north, center, and south).

Yield data are reported in Fig. 8. The highest yield was in the northern area (4.48 t/ha) and the lowest in the south (3.33 t/ha). Among the cultivars, Claudio had the best production; Iride was a highlight, especially in the north. Production by the old cultivar Cappelli was quite poor because of the plant height and frequent lodging. Average test weight values were quite similar in all environments; San Carlo, Claudio, and Grazia were the highest; however, all the cultivars presented levels above 80 kg/hl, considered a good value for the durum wheat grading (UNI 10709). Protein content (Fig. 9), a critical parameter in organic conditions because of absorption and the availability of nitrogen, is considered an essential factor for organic crops. An average value above 12.0% was found for all three environments. The best protein content (average value 12.7%), even if associated with lower yield, was in southern Italy, a suitable agroclimatic area for durum wheat. Relevant differences were detected among the genotypes: Cappelli had the highest protein content, owing to the lowest production level, San Carlo, Creso, and Simeto had levels equal to or higher than the average value of the environment, and Iride had the lowest levels in all trials.

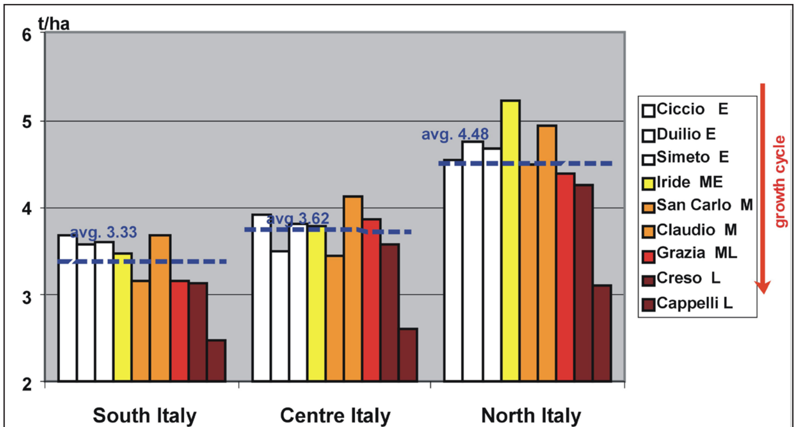

Fig. 8. Production (t/ha) of nine durum wheat cultivars grown between 2004–07 in controlled organic crop-management condition at three locations in Italy (E = early, ME = medium early, M = medum, ML = medium late, and L = late cultivars).

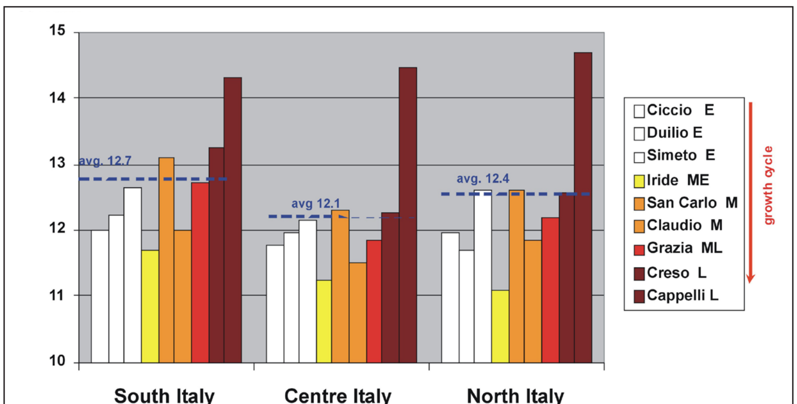

Fig. 9. Protein content (% D.M.) of nine durum wheat cultivars grown between 2004–07 in controlled organic crop-management condition at three locations in Italy (E = early, ME = medium early, M = medum, ML = medium late, and L = late cultivar).

Rheological characteristics were evaluated by different methods (SDS, gluten index, and alveographic test). Results of the SDS tests (Fig. 10) showed similar average values in all environments; the highest value was detected in southern Italy. The cultivars maintained the same order of sedimentation levels in all the areas, even if with different values. San Carlo was the highest. For gluten index, no statistical differences were observed between the environments, and all the cultivars except Cappelli had good values. However, because a low gluten content can provide an overestimate of the gluten index (D'Egidio et al. 2008), data from different methods should be integrated to correctly estimate cultivar performance. Average levels for the alveographic parameter (W) were not particularly high in any environment (Fig. 11); the highest values were recorded in southern Italy (140) and for San Carlo among the cultivars. Quality traits (gluten quality and color) are characterized by a high genotypic effect. The response of each cultivar in different environments can change in magnitude, but the rank of cultivars does not significantly change among the environments (Mariani et al. 1995). Therefore, the choice of cultivars suitable for specific agroclimatic environments represents an effective tool for obtaining raw materials having a suitable qualitative levels for the industrial requirements.

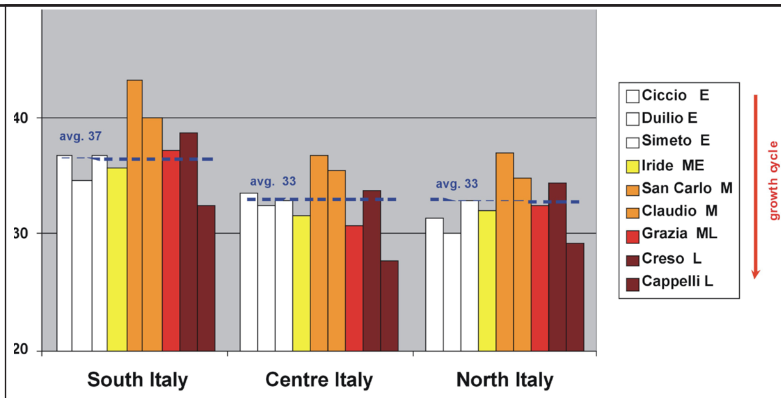

Fig. 10. Average SDS sedimentation rates (mL) of nine durum wheat cultivars grown between 2004–07 in controlled organic crop-management condition at three locations in Italy (E = early, ME = medium early, M = medum, ML = medium late, and L = late cultivars).

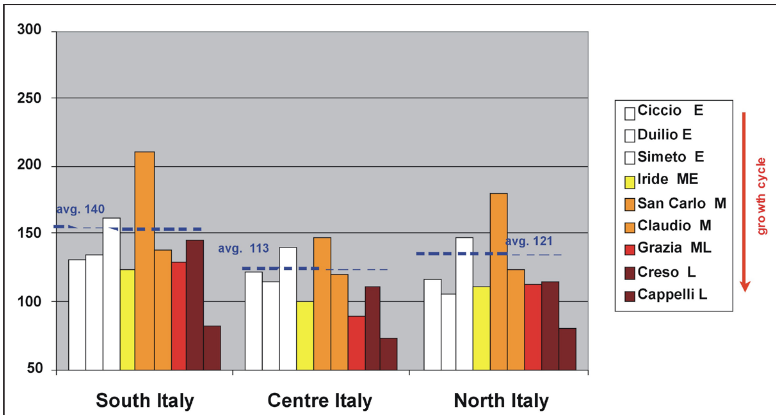

Fig. 11. Average levels of Alveographic parameter (W (J x 10^{-4})) of nine durum wheat cultivars grown between 2004–07 in controlled organic crop-management condition at three locations in Italy (E = early, ME = medium early, M = medum, ML = medium late, and L = late cultivars).

Semolina flour color, expressed as a yellow index, showed significant differences between the cultivars as expected because of the strong genetic inheritance of this character. The cultivar San Carlo had the highest values in all environments. Considering the levels required by pasta-making industry, average values in the agroclimatic areas were not high, however, until recently, colour was not considered in breeding programs. Consequentely, several old genotypes are characterized by low yellow index values. Better results were generally recorded in the southern area over those in the center and north, confirming the findings of Johnston et al. (1983) that the positive influence of warm, droughty conditions on the synthesis and accumulation of carotenoid pigments. Evaluations for pasta cooking quality were not significantly different, always medium quality.

Protein level is the main factor to be improved for durum wheat grown in an organic cropping system. However, a suitable choice of cultivars can provide higher guarantees, without added costs, in order to meet industrial requirements for products of high quality. Cultivating organic durum wheat in suitable agroclimatic areas will produce raw material meeting the criteria for health and quality. Not using chemical products causes production to be unsatisfactory only in some unfavorable years and environments. Although it is more difficult to ensure regularly good protein levels, the use of good quality, modern cultivars can provide raw material suitable for the requirements of pasta-making industry when good agronomic practices are applied. The demand for food with high quality and safety levels is increasing all the time. In this context, enhancing the traceability along the entire production chain could make organic products appreciated more and more.

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Grain yield, quality, and deoxynivalenol (DON) contamination of organic and conventional durum wheat.

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Durum wheat has the most widespread cultivation in Italy (approximately 1.60 x 10^6 ha) with an important and growing quota in the organic cropping system. The increasing area of the wheat grown in the organic cropping system could mean a greater presence of deoxinivalenol (DON) in foodstuffs because of the ban on the use of synthetic pesticides. In addition, lower grain yields and protein contents created uncertainty about the use of organic agricultural techniques for durum wheat. Recent studies concerning the particular safety practices adopted in organic farming systems show a lower incidence of *Fusarium* spp. than in conventional systems (Edwards 2009; Vànovà et al. 2008; Pussemier et al. 2006). We evaluated the incidence of the sources of variability for yield, protein content, and DON contamination in raw durum wheat grown in comparable environments under both organic and conventional cropping systems in south-central Italy.

Six cultivars (Ciccio (early), Simeto (early), Duilio (early), Iride (medium-early), Claudio (medium), and Creso (late)) with different biological cycles were used. Samples were collected from several experimental fields in both conventional and organic cropping systems during a three-year period between 2006 and 2008. The following fields were selected as representative of the durum wheat-growing areas in Italy: Jesi, Pollenza, and Papiano in central Italy and Campobasso, Foggia, and S.Stefano Quisquina in southern Italy. Agronomic data were collected throughout the course of the experiment. Whole-meal samples were extracted in distilled water, and the filtered extract was employed for DON analysis using the enzyme-linked immunosorbent assay (ELISA). Statistical analysis were used to elucidate the influence of cultivar, cropping system, year, and field location on grain yield, protein content (having a normal distribution), and DON contamination (using a generalized linear model).

For yield, the cropping system factor was highly significant; its contribution to explain variability was 73% also taking into account the interaction with location. This result confirms that the most important factor in explaining the differences in production is the cropping system, with a grain yield significantly greater in the conventional. The average grain yields obtained in the three years at the six locations reflected the production expectations for the different areas of Italy, both for conventional (5.85 t/ha) and organic (4.91 t/ha) cropping systems. Years were not significant for grain yield, explaining only 1% of the total variability. No significant differences were recorded among the six cultivars. Higher yields were obtained from Iride, Claudio, and Duilio in both cropping systems, and Creso had the lowest (Fig. 12, p. 111).

Cropping system, location, and year significantly affected grain protein content; the cultivar factor was negligible. Location and cropping system had the same weight (their contribution to the explanation of variability was 35% (location) and 37% (cropping system); year was slightly lower (24%). No interactions were significant.

Protein content was inversely affected by the lower yields obtained in the organic system and by climatic conditions that influenced the absorption of available nitrogen. Widespread variability between locations and years was

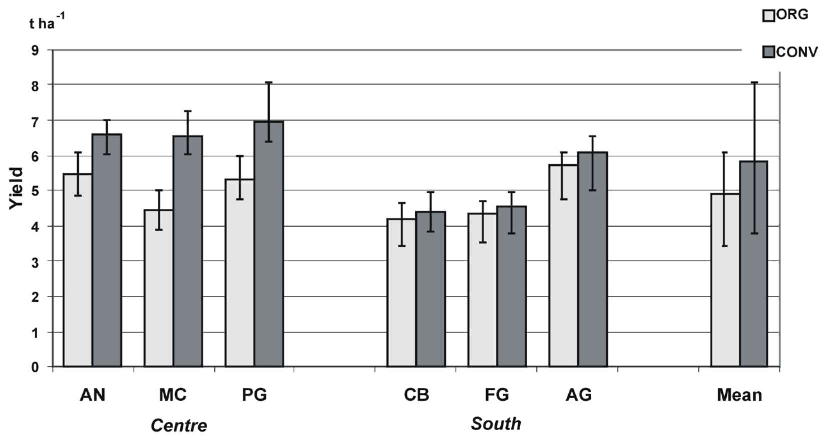

Fig 12. Comparison for grain yield (t/ha at 13% moisture) of the national networks in the organic and conventional cropping systems. Means are for six cultivars (Ciccio (early), Simeto (early), Duilio (early), Iride (medium-early), Claudio (medium), and Creso (late)) in two different agroclimatic areas of Italy (Jesi–AN, Pollenza–MC, and Papiano–PG (central Italy) and Campobasso–CB, Foggia–FG, and S.Stefano Quisquina-AG (southern Italy)). Vertical bars are the maximum and minimum values.

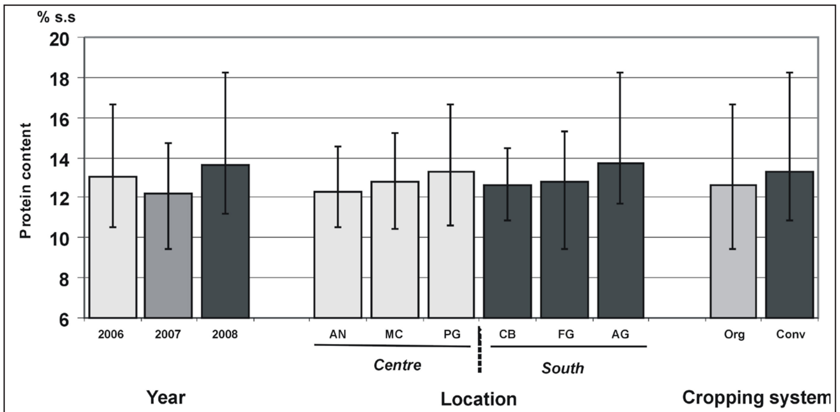

Fig 13. Grain protein content (13% DM) of the national networks in the organic and conventional cropping systems in Italy. Means are for year, location (see Fig. 12 for abbreviations), and cropping system. Vertical bars are the maximum and minimum values.

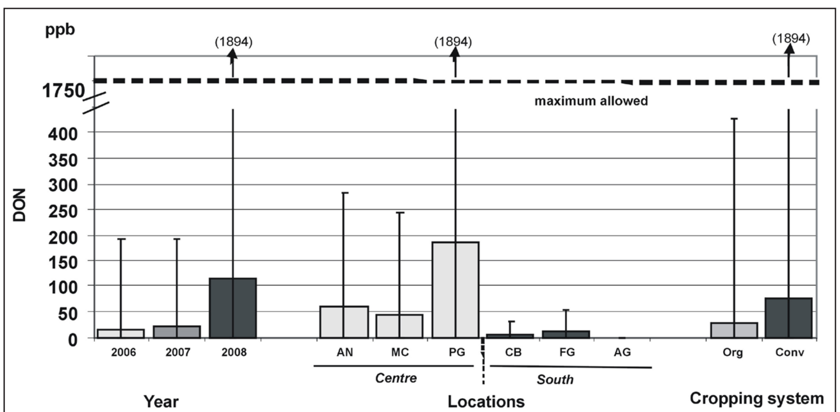

Fig 14. DON concentration (ppb) of the national networks in the organic and conventional cropping systems in Italy. Means are for year, location (see Fig. 12 for abbreviations), and cropping system. Vertical bars are the maximum and minimum values.

observed, whereas the tested cultivars showed greater homogeneity, the differences between organically and conventionally cropped plots for any cultivar were never significant for both central and southern Italy (Fig. 13).

Most of the variability in DON contamination was due to location. Considering only the simple effects, over 35% of the variability may be attributed to location. DON concentration at the locations in central Italy were higher than those in the south. The variability increased considerably for the interaction with year (almost 70%).

Cropping system and cultivar, although significant, had a low influence, however, their interaction accounted for 13% of the total variation. The 'cropping system x location' interaction accounted for 5% of the total variability. Mean levels of DON contamination were generally lower with only one sample during the three year-period exceeding the legal limit of 1,750 ppb (Reg. CE 1881/2006). In organic durum wheat, contamination during both 2006 and 2007 was characterized by lower contamination with *Fusarium* spp. than in 2008. The levels of DON contamination in the six fields had higher mean values in the central locations than in the south, where climatic conditions are characterized by lower rainfall and low atmospheric relative humidity (Fig. 14).

These results point out clearly the absence of a significant correlation between DON levels and type of cultivar cycle (0.090 n.s). No correlation was observed between production and DON concentration. Particularly interesting is the positive correlation between DON values and number of spikes/m^2 (r = 0.210**). We confirmed the known positive correlation with protein content (r = 0.179**) and number of spikes/m^2 (r = 0.210**). A negative, highly significant correlation exists between 1,000-kernel weight (–0.243 ***) and test weight (–0.476***), both probably due to the direct effects of damage from *Fusarium* fungi on the kernel.

The results of this study revealed some interesting issues. A low DON presence was confirmed in each location in southern Italy; in some there was a complete absence of contamination in all the years of trials for both conventional and organic cropping systems. Lower DON concentrations were detected in organic wheat samples, both in less favorable years for the occurrence of *Fusarium* (2006 and 2007) and in the more favorable one (2008). The organic cropping system allowed good results not only in the locations where fungal infections was limited (southern Italy) but even in locations in central Italy, which are more exposed to the risks of fungal pathogens attacks. The hypothesis of higher levels of DON in durum wheat grown under organic cropping system, based mainly on the consideration that chemical plant-protection is banned, does not seem supported by evidence. Although the choice of cultivar has a reduced influence on the possibility of contamination, some cultivars appear more susceptible to contamination by DON, likely due to the fact that they are more suitable to southern Italy, where the selective pressure for Fusarium is less. Our results largely confirm the importance of the southern vocational areas for growing durum wheat, which is a important primary crop for the economy and typical of such areas.

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2007–2009 conventional bread wheat cultivar trials in central Italy.

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The Research Unit for the Qualitative Valorization of Cereals of the Italian Council for Research in Agriculture (CRA–QCE, Rome) has field trials to evaluate the performance of conventionally managed bread wheat cultivars in central Italy. The aim of these trials is to provide useful informations about the qualitative and quantitative traits of bread wheat cultivars managed conventionally, testing at the same time their suitability to specific agroclimatic conditions. In the period between 2007 and 2009, field experiments at four locations, grouped into two regions (two in Latium and two in Molise). The agronomic performance of the 12 genotypes was evaluated in all the regions in the period between 2007 and 2009 (Table 15). The trials

Table 15. Yield and test weight of 12 Italian bread wheat cultivars tested during a three-year period (2007–09) in two regions of Italy (Latium and Molise) (for ISQ class, FF = Frumento di Forza (improver wheat, strongest), FB = Frumento da Biscotto (wheat for biscuits, weakest), FPS = Frumento Panificabile Superiore (superior bread-making wheat), and FP = Frumento Panificabile (ordinary bread-making wheat); yield index = yield/column mean*100; test weight index = test weight/column mean*100).

		Yield			Test weight		
		Index		Mean	Index		Mean
Cultivar	ISQ class	Latium	Molise	(t/ha)	Latium	Molise	(kg/ha)
Bologna	FF	96	90	5.46	103	102	81.1
Apache	FPS	95	104	5.85	99	98	78.5
Blasco	FPS	100	103	5.97	105	105	83.4
Egizio	FPS	97	95	5.62	104	103	82.1
Aubusson	FP	103	99	5.95	98	99	78.2
Azzorre	FP	100	97	5.79	97	97	76.8
Exotic	FP	112	114	6.63	97	98	77.1
Isengrain	FP	101	107	6.10	100	99	79.2
Mieti	FP	84	87	5.04	99	99	78.6
PR22R58	FP	113	103	6.34	99	99	78.7
Profeta	FP	101	97	5.80	102	102	80.8
Artico	FB	98	104	5.93	96	98	77.1
		Mean (t/ha)			Mean (kg/ha)		
		5.95	5.80	5.87	77.7	80.9	79.3

were replicated three times in each field. These cultivars represent a considerable amount of the commercialized bread wheat seed in Italy.

The tested cultivars are catalogued according with the Synthetic Quality Index method (Indice Sintetico di Qualità, ISQ), from the strongest type FF (Frumento di Forza, improver wheat), particularly used for manufacturing products with a strong and well leavened structure, to the weakest type FB (Frumento da Biscotto, qheat for biscuits), more appropriate to lend friableness to the products. The intermediate categories are FPS (Frumento Panificabile Superiore, superior bread-making wheat) and FP (Frumento Panificabile, ordinary bread-making wheat).

The average yield during the three-year period reached 5.87 t/ha. The production of both regions were quite similar (Latium: 5.95 t/ha; Molise: 5.80 t/ha). Three of cultivars (Exotic, PR22R58, and Isengrain, each of the FP class), reached yields exceeding 6.0 t /ha with indicies higher than 100 in every region. Blasco (class FPS) had satisfactory indicies in both regions associated to the best test weight (83.4 kg/hl), whereas most of the other cultivars were characterized by test weights not optimal for the requirements of the milling industry.

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2007–08 triticale cultivar trials in central Italy.

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The Research Unit for the qualitative valorization of Cereals of the Italian Council for Research in Agriculture (CRA–QCE, Rome) carries out field trials for the evaluation of the performance of triticale cultivars in central Italy. The aim of these trials is to provide useful information about the qualitative and quantitative traits of triticale cultivars, testing at the same time their suitability to specific agroclimatic conditions. Between 2007 and 2008, field experiments were carried out in two locations in central Italy (Leonessa, RI, 42°33'59" N, an inner mountain environment), and Rome, 41°58'04" N, where fields are in a tight river plain). The trials were replicated three times in each field.

The agronomic performance of nine genotypes evaluated in the period between 2007 and 2008 is given in Table 16. The average yield of the period was 3.84 t/hda. Two of the cultivars (Bienvenue and Wilfried), both with medium growth cycles, reached yields remarkably exceeding the average in every location. These cultivars also exhibited the best test weights.

Table 16. Growth cycle, grain yield, and test weight of nine Italian triticale cultivars tested during a two-year period (2007–08). Mean data are from two locations of central Italy.

	Heading date	Grain yield		Test weight
Cultivar	(days after 1 April)	t/ha	index	kg/hl
Rigel	30	3.43	89	66.9
Oceania	32	3.86	100	65.8
Catria	34	3.53	92	64.0
Mizar	34	3.67	95	70.4
Bienvenue	38	4.77	124	71.9
Wilfried	39	4.50	117	71.3
Frontera	44	3.73	97	70.5
Magistral	45	3.45	90	65.5
Talentro	49	3.65	95	71.3
Mean	38	3.84	100	68.6

2006–08 barley cultivars for livestock feeding in the Molise Region of Italy.

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The Research Unit for the Qualitative Valorization of Cereals of the Italian Council for Research in Agriculture (CRA-QCE, Rome) carries out field trials to provide useful informations about the qualitative and quantitative traits of barley cultivars for livestock feeding, testing at the same time their suitability to specific agroclimatic conditions. In the period between 2006 and 2008, field experiments were carried out in Colletorto (CB), a location in the Molise region (41°40' N, an inner hill environment, 515 msl, surrounded by the Central Apennine Mountain Range). The trials were replicated in triplicate.

Agronomic performance of 14 genotypes were evaluated during the two-year period between 2006 and 2008 (Table 17). The average yield of the period was 4.91 t/ha. Four of the cultivars, Ninfa and Sixtine (early-medium and medium growth cycle) and Ketos and Mattina (both with late growth cycles), reached yields that exceeded the average. At the same time, these cultivars also exhibited the best test weights. For plant height, the cultivar Sixtine, with an average height of about 1 m, appears to be more subject to lodging; conversely the cultivar Ninfa has a fairly low average height.

Table 17. Growth cycle, height plant, grain yield and test weight of 14 Italian barley cultivars for livestock feeding tested at Colletorto during a three-year period (2006–08).

	Heading date	Height	Yield		Test weight
Cultivar	(days after 1 April)	cm	t/ha	index	Kg/hl
Vega	30	85	4.66	95	70.6
Nure	33	93	4.79	98	73.2
Amillis	33	94	4.77	97	73.0
Ninfa	33	82	5.08	104	74.3
Lutece	34	95	5.37	109	69.9
Aliseo	34	87	4.55	93	71.0
Sixtine	35	101	5.11	104	72.3
Baraka	35	91	4.69	96	73.4
Sonora	36	91	4.91	100	71.0
Dasio	36	66	3.63	74	69.2
Siberia	37	87	5.11	104	70.3
Aldebaran	38	91	5.37	109	68.0
Ketos	38	90	5.44	111	73.2
Mattina	40	94	5.20	106	71.8
Mean	35	89	4.91	100	71.5

Valorization of the emmer wheat crop in marginal environments of central Italy.

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Emmer wheat was one of the first crops domesticated in the Near East. Widely cultivated in the ancient world, emmer wheat is now a relict crop in mountainous regions of Europe and Asia. The mounting interest for organic food in Italy has brought an increasing demand fur such hulled cereals. In 2001–02, the Experimental Institute for Cereals (currently Research Unit for the Qualitative Valorization of Cereals of the Italian Council for Research in Agriculture, CRA–QCE) carried out agronomic trials in two different environments of Central Italy.

At Leonessa (42°34' N, 969 masl), situated in a small plain at the foot of Mt. Terminillo, one of the highest mountains of the Apennine range, two different emmer genotypes were compared; a local one, Leonessa, and a recent cultivar, Farvento, patented by the former Institute of Germplasm of the National Council for Research. Trials dealt with the effects of seeding rate and nitrogen fertilization. Three different seeding rate were used (250, 300, and 350 germinating seeds/m^2), and nitrogen was supplied in six combinations, varying dose and supply date. Both genotypes were sown at the same date (14 March). The main results of the trial comparing Leonessa and Farvento indicated a delayed heading date (+13 days) and a taller height (+14 cm) (Table 18). Leonessa had a higher yield (1.13 t/ha) than that of Farvento (0.74 t/ha). A significant, posi-

Table 18. Growth cycle, plant height, and grain yield of two different emmer genotypes, six combination of nitrogen supply, and three seeding rates (seeds/m^2) in a field trial at Leonessa, Italy, 2001.

		Heading date	Plant height	Yield	
Treatment		(days after 1 April)	(cm)	(t/ha)	index
Nitrogen dose	0	89	80	0.76	81
	0 + 30	87	87	0.95	101
	30 + 30	87	88	0.79	84
	0 + 60	87	94	1.10	117
	30 + 60	87	89	0.88	94
	0 + 90	88	90	1.14	121
Genotype	Farvento	94	95	0.74	79
	Leonessa	81	81	1.13	120
Seeding rate	250	87	88	0.86	91
	300	88	88	0.95	101
	350	87	87	0.97	103
Mean		87	88	0.94	100

tive effect from nitrogen fertilization was recorded shen nitrogen was supplied at the beginning of stem elongation.

In Rome (41°58' N), trials were conducted on volcanic soils and dealt with the effect of a previous crop and fertilization on the emmer genotypes Leonessa and Garfagnana. All plots where sown on 18 January with a seeding rate of 300 germinating seeds/m^2. The effect of three different previous crops (emmer, sunflower, and chickpea) and three nitrogen supply levels (30, 60, and 90 kg/ha) supplied as inorganic (urea) and organic form (poultry manure, supplied prior to sowing) were measured (Talbe 19). A leguminous forecrop exerted a positive effect on yield, whereas no differences were ascribed to either of the two fertilizer types. Indeed, plots that received a greater dose of nitrogen gave, on average, higher yields. The genotype Garfagnana was slightly taller, later in heading, and more productive than Leonessa.

Table 19. Growth cycle, plant height, and grain yield of two different emmer genotypes, three different forecrops, two forms of fertilizer, and three different nitrogen supplies of two different emmer genotypes grown in the field in Rome, Italy, in 2001.

Treatment		Heading date (days after 1 April)	Plant height (cm)	Yield (t/ha)	Yield index
Previous crop	emmer	40	82	2.20	93
	chickpea	39	94	2.63	111
	sunflower	38	91	2.27	96
Fertilizer	poultry manure	39	90	2.36	100
	urea	39	88	2.36	100
Nitrogen dose	30 kg/ha	39	89	2.31	98
	60 kg/ha	39	88	2.33	99
	90 kg/ha	39	90	2.49	106
Genotype	Leonessa	39	87	2.32	98
	Garfagnana	40	91	2.41	102
Mean		39	89	2.36	100

Reactions of bread and durum wheat cultivars artificially inoculated at the seedling stage with Stagonospora nodorum.

A. Iori and A. L'Aurora.

Stagonospora nodorum (teleomorph *Phaeosphaeria nodorum*) is the fungal pathogen that causes Stagonospora nodorum blotch on wheat. In Italy, this fungus attacks seedlings and spikes causing yield losses of both durum and bread wheat. We evaluated 20 durum wheat and 18 bread wheat cultivars tested with *S. nodorum* isolates at the seedling stage in the greenhouse.

The pathogen was picked from naturally infected durum and bread wheat leaves collected in several Italian regions. Leaf segments with pycnidia were first washed with tap water, then with sterile distilled water, plated on water agar (15 g/L) in Petri dishes, and incubated at 20°C under a 12 h photoperiod. Single cirrhi of *S. nodorum* were isolated and tranferred to plates containing potato dextrose agar (PDA; 39 g/L) and kept at 20°C to develop colonies. Isolates were transferred to fresh plates every 7–10 days. Nine *S. nodorum* isolates collected from durum wheat and two isolates from bread wheat were used to inoculate durum wheats; whereas eight isolates gathered from durum wheat and four isolates from bread wheat were tested on bread wheats. Inoculum was prepared before inoculation. Cultures were washed with sterile distilled water, the spore suspension filtered, and the concentration was adjusted to 1 x 10^6 spores/mL with the aid of a hemacytometer. Finally, two drops of Tween 20 per 20 mL of inoculum were added. About 20 seeds for each bread or durum wheat cultivar were sown in pots in the greenhouse, and the seedlings were inoculated when the second leaf was emerging. Plants were maintained in a humid chamber for 72 h and returned to a greenhouse bench with a 12 h photoperiod at 20 °C. Disease severity was evaluated at 5, 8, and 10 days-after-inoculation using a 0 to 5 scale (Liu et al. 2004). Seedlings with two different lesion types were registered as an intermediate reaction type.

Artificial inoculations with different *S. nodorum* isolates showed that durum wheat genotypes were more susceptible than bread wheat cultivars at the seedling stage. The durum wheat cultivars Dylan, Meridiano, and Svevo were found to be resistant or moderately resistant with several isolates obtained from durum and bread wheat, whereas cultivars Anco Marzio, Ciccio, Claudio, Creso, Lesina, Solex, and Virgilio proved to be susceptible to all the isolates tested (Table 20, p. 116).

By contrast, many bread wheat cultivars showed resistance or moderate resistance to several isolates from both durum and bread wheat leaves. Cultivars Artico and Bologna tested with eight isolates from durum wheat and four isolates from bread wheat were resistant to all those isolates except Sn 15891. Cultivars Africa and Nomade were resistant as well; however, these cultivars were tested with a minor number of isolates (Table 21, p. 119). Unlike durum wheat, no bread wheat cultivars showed moderate or complete susceptibility to all the isolates used for artificial inoculation.

Table 20. Reaction of durum wheat cultivars artificially inoculated at the seedling stage with *Stagonospora nodorum* isolates collected from durum (*) and bread (^) wheat leaves collected in several Italian regions. Symptom severity was evaluated using a 0–5 scale (Liu et al. 2004), where 0 = highly resistant; 1 = resistant; 2 = moderately resistant; 3 = moderately susceptible; 4 = susceptible; 5 = highly susceptible. — = missing data. Average values based on repeated trials are reported.

Cultivar	AIND 1 (*)	Sn 15091 (*)	Sn 15147 (*)	Sn 15163 (*)	Sn 15465 (*)	Sn 15690 (*)	Sn 15570 (*)	Sn 15793 (*)	Sn 15891 (*)	Sn 15230 (^)	Sn 16037 (^)
Anco Marzio	3.0	4.0	3.5	3.0	4.5	4.3	3.5	4.5	4.5	4.0	3.5
Canyon	4.0	4.0	2.0	4.0	4.0	3.8	4.5	4.8	4.5	4.3	4.5
Ciccio	3.5	4.0	3.5	3.0	4.5	4.8	4.0	4.8	4.5	4.3	4.0
Claudio	4.0	4.0	3.5	3.5	4.5	4.8	4.5	4.5	4.5	4.5	4.0
Creso	4.0	4.0	4.0	4.0	4.5	4.5	4.3	4.5	4.5	4.5	4.5
Duilio	4.0	4.0	2.5	2.5	4.5	4.5	3.0	4.3	4.5	4.5	3.5
Dylan	2.0	1.0	3.5	2.5	4.0	4.0	0.0	2.5	3.0	2.0	0.0
Grecale	3.5	4.0	4.0	4.0	4.5	4.5	4.0	2.8	4.0	4.5	2.0
Iride	4.0	4.0	4.0	3.5	4.0	4.5	0.5	2.5	4.0	4.5	0.5
Lesina	4.0	4.0	4.0	4.0	4.5	4.5	4.0	3.5	4.5	—	4.5
Levante	4.0	3.8	4.0	4.0	4.0	4.0	0.5	2.5	4.5	4.5	2.5
Maestrale	—	—	—	—	4.0	4.0	0.5	1.8	2.5	4.5	0.5
Meridiano	3.0	2.8	2.5	2.0	2.5	—	1.0	2.3	3.5	4.5	0.5
Normanno	3.5	2.5	3.0	2.5	—	—	3.5	3.5	4.0	4.0	1.0
Simeto	3.0	1.8	2.0	3.5	4.5	—	4.3	4.3	4.5	4.5	2.5
Solex	3.8	3.8	3.0	4.0	4.0	—	4.0	4.3	4.5	4.5	4.0
Svevo	0.5	0.3	0.0	0.0	0.5	—	1.0	2.3	1.5	2.8	0.0
Valerio	2.5	2.3	3.5	3.5	4.0	—	3.5	3.5	4.5	4.5	3.0
Vinci	3.5	3.5	4.0	4.0	4.0	—	4.5	4.0	4.5	—	2.5
Virgilio	4.0	3.5	3.5	3.5	4.5	—	4.5	4.3	4.5	4.5	4.5

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Table 21. Reaction of bread wheat cultivars artificially inoculated at the seedling stage with *Stagonospora nodorum* isolates collected from durum (*) and bread (^) wheat leaves collected in several Italian regions. Symptom severity was evaluated using a 0–5 scale (Liu et al. 2004), where 0 = highly resistant; 1 = resistant; 2 = moderately resistant; 3 = moderately susceptible; 4 = susceptible; 5 = highly susceptible. — = missing data. Average values based on repeated trials are reported.

Cultivar	Sn 15091 (*)	Sn 15147 (*)	Sn 15163 (*)	Sn 15690 (*)	Sn 15570 (*)	Sn 15793 (*)	Sn 15891(*)	Sn 16268 (*)	Sn 15230 (^)	Sn 16037 (^)	Sn 16165 (^)	Sn 16357 (^)
A416	3.5	4.0	4.3	4.0	3.3	2.0	4.5	—	4.1	3.0	—	—
Africa	0.0	0.0	2.0	1.8	1.5	2.5	—	—	0.0	—	—	—
Albachiara	0.0	0.0	2.5	1.8	2.3	0.8	4.5	3.0	1.8	2.5	-	2.2
Artico	0.0	0.0	0.0	0.0	0.0	0.8	4.0	2.5	1.0	1.5	1.5	2.0
Aster	0.0	4.0	4.0	3.8	2.3	2.5	4.5	—	1.5	3.5	—	—
Aubusson	2.0	0.0	3.8	2.3	3.0	3.7	4.0	2.0	1.4	2.0	2.0	2.0
Avorio	0.0	0.0	3.0	2.5	0.0	0.0	—	—	0.0	—	—	—
Bilancia	2.0	3.0	4.0	2.0	2.0	1.5	—	—	1.8	—	—	—
Blasco	4.0	2.0	2.0	0.0	1.8	0.2	4.5	2.5	2.3	3.0	2.0	0.5
Bolero	2.0	2.0	4.3	1.8	2.0	1.5	5.0	2.0	3.1	2.3	—	4.0
Bologna	0.0	0.0	1.8	0.8	1.0	0.8	4.5	0.5	1.0	2.0	1.5	1.0
Bramante	0.0	3.0	4.0	1.8	2.0	1.7	4.5	1.5	2.3	3.5	—	—
Kalango	0.0	—	4.0	1.3	2.0	1.5	3.0	—	1.0	2.0	—	—
Mieti	0.0	2.0	3.5	2.5	2.8	2.7	4.5	2.0	3.1	2.5	—	3.0
Nomade	0.0	0.0	1.8	1.0	—	—	—	—	0.3	—	—	—
PR22R58	—	—	2.3	2.3	3.5	3.7	4.0	0.0	2.5	4.0	—	0.5
Sagittario	2.0	3.5	3.5	1.3	1.8	2.0	4.0	—	1.8	3.0	—	—
Serpico	0.0	—	4.0	1.0	0.0	0.5	—	—	0.5	—	—	—

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ITEMS FROM JAPAN

NATIONAL INSTITUTE OF CROP SCIENCE (NICS) – NATIONAL AGRICULTURE AND FOOD RESEARCH ORGANIZATION (NARO)
Tsukuba, Ibaraki 305-8518, Japan.

Kannon lines Nos. 1–51 with high flour yield, Japanese common wheat germ plasm for udon noodles.

Hiro Nakamura.

I report here the release of 51 germ plasm lines (Kannon No. 1–No. 51) of a Japanese common wheat used for udon noodle production. Kannon Nos. 1–51 are full-season, common wheat lines with a high grain and flour yields that have excellent milling and good udon noodle-making qualities. By using wheat flour particle size distribution measurements, I selected high flour yielding breeding materials among Japanese and Chinese wheat germ plasm, lines, and cultivars for breeding the udon-quality wheat lines with a high flour yield. The Kannon wheat lines were bred by crossing the selected Japanese and Chinese breeding materials with high flour yield with Japanese udon cultivars with high grain yield.

Japan produces about one million tons of wheat a year, maintaining ~15% self sufficiency in udon-quality wheat in a country of low overall food self-sufficiency, except for rice, which is near 100% self-sufficiency, or about 10 million tons/year. To improve the international competitiveness of the udon wheat grown in Japan, enhancing grain quality and developing cultivars with a higher flour yields are important in order to satisfy the demands of local milling companies. Therefore, breeding udon-quality wheat lines with excellent milling is the most important in the Japanese udon wheat-breeding program.

Wheat has been the staple food of Japan since ancient times, and it still makes frequent appearances on the dining table. The roots of a soft noodle such as udon lie in China, however, udon as we know it today developed independently in Japan. Of the many ways to eat wheat flour, it is the main ingredient in udon noodles. The kind of flour used has a great impact on the flavor and texture, therefore udon noodles are made of soft flour and not a hard bread flour. Each chef has his or her own unique formula; some blend several types of wheat flour, whereas others mix in other kinds of flour to give the udon noodles a chewier texture. Udon are popular with young and old alike, the cost of one bowl is low, and udon shops can be found nationwide. Some people in Japan eat udon almost every day.

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