Table S1. Effects of growing season, irrigation and fertilizer type on spelt wheat (variety Rubiota) harvest index (HI), tillers and ears per m^2, grain to hull ratio, thousand grain weight (TGW) and estimated leaf chlorophyll content (SPAD-meter readings)

Factor	HI	Tillers/	Ears/	Grain/ hull	TGW	estimated leaf chlorophyll content (SPAD)		
	%	m^2	m^2	ratio	g	GS39*	GS50	GS62*
Season (n=24)								
2014/15	19 ±1 **a**	434 ±10 **a**	339 ±10 **a**	2.35 ±0.04 **a**	43.4 ±0.7 **a**	42.0 ±0.3	41.9 ±0.2 **a**	39.4 ±0.3
2015/16	11 ±1 **b**	307 ±20 **b**	173 ±13 **c**	1.52 ±0.11 **c**	35.8 ±0.6 **c**	ND	38.5 ±1.0 **b**	ND
2016/17	22 ±1 **a**	332 ±12 **b**	264 ±14 **b**	2.05 ±0.05 **b**	38.7 ±0.9 **b**	39.8 ±1.0	42.8 ±0.6 **a**	43.6 ±0.8
Fertilizer type (n=24)								
Chicken manure	18 ±1 **ab**	355 ±21	267 ±20	1.95 ±0.10 **ab**	38.7 ±1.0 **ab**	39.8 ±0.9 **b**	40.6 ±0.5 **b**	40.8 ±0.7 **b**
Mineral NPK	15 ±1 **b**	363 ±20	252 ±23	1.87 ±0.12 **b**	38.3 ±1.0 **b**	43.4 ±0.7 **a**	43.1 ±0.7 **a**	42.9 ±1.2 **a**
Sheep manure	19 ±1 **a**	355 ±15	257 ±12	2.11 ±0.07 **a**	40.9 ±0.8 **a**	39.4 ±0.7 **b**	39.4 ±0.9 **b**	40.8 ±0.7 **b**
Irrigation (n=36)								
With	18 ±1	383 ±13	277 ±14	2.11 ±0.07	40.6 ±0.7	40.0 ±0.7	40.2 ±0.7	41.0 ±0.6
Without	16 ±1	333 ±16	240 ±16	1.84 ±0.09	38.0 ±0.9	41.7 ±0.8	41.9 ±0.5	42.0 ±0.9
ANOVA (*p*-value)								
Main effects								
Season (YR)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	ns	**0.039**	**0.009**
Fertilizer type (FT)	**0.034**	ns	ns	**0.026**	**0.044**	**<0.001**	**0.004**	0.050
Irrigation (IR)	0.054	**<0.001**	**0.008**	**<0.001**	**0.003**	**0.013**	**<0.001**	ns
Interactions#								
YR x FT	ns	**0.005**	**0.021**	**0.047**	ns	**0.003**	ns	**0.006**
YR x IR	**0.027**	**0.004**	0.052	ns	ns	0.073	**<0.001**	**0.004**
FT x IR	ns	ns	ns	ns	ns	ns	ns	ns
YR x FT x IR	ns	ns	ns	ns	ns	ns	ns	ns

HI, harvest index; Means that are followed by the same letter within each column are not significant different (General Linear Hypothesis test *p*<0.05);
[1]See Table 2 for interaction means ±SE; [2]See Table 3 for interaction means ±SE;

Table S2. Effects of growing season, irrigation, fertilizer type and variety choice on spelt wheat harvest index (HI), tillers and ears per m^2, grain to hull ratio, thousand grain weight (TGW) and estimated leaf chlorophyll content (SPAD-meter readings)

	HI %	Tillers/ m^2	Ears/ m^2	grain/hull ratio	TGW G	estimated leaf chlorophyll content (SPAD)		
						GS39*	GS50	GS62*
Season (n=96)								
2015/16	11 ±1	317 ±9	189 ±8	1.4±0.06	36.2 ±0.4	ND	40.1 ±0.6	ND
2016/17	23 ±1	335 ±7	284 ±8	2.1±0.03	40.2 ±0.5	41.4 ±0.5	45.2 ±0.4	45.3 ±0.4
Fertility type (n=64)								
Chicken manure	18 ±1 **a**	330 ±9	249 ±11 **a**	1.8±0.07 **a**	38.8 ±0.6 **a**	40.2 ±0.7 **b**	41.9 ±0.5 **b**	43.8 ±0.7 **b**
Mineral NPK	13 ±1 **b**	328 ±11	217 ±14 **b**	1.6±0.08 **b**	35.9 ±0.6 **b**	45.2 ±0.7 **a**	44.9 ±0.7 **a**	48.4 ±0.8 **a**
Sheep manure	20 ±1 **a**	321 ±9	244 ± 9 **a**	1.9±0.05 **a**	39.8 ±0.6 **a**	38.9 ±0.6 **b**	41.2 ±0.8 **b**	43.8 ±0.5 **b**
Irrigation (n=96)								
With	20 ±1	363 ±7	280 ±9	1.9±0.05	40.2 ±0.5	39.6 ±0.6	41.6 ±0.6	44.3 ±0.6
Without	14 ±1	289 ±7	193 ±8	1.6±0.06	36.1 ±0.5	43.2 ±0.7	43.7 ±0.5	46.3 ±0.7
Variety (n=48)								
Filderstolz	19 ±1 **a**	320 ±11	258 ±11 **a**	1.6±0.07 **b**	36.1 ±0.7 **b**	44.0 ±1.0 **a**	45.0 ±0.8 **a**	47.0 ±0.8 **a**
Oberkulmer	15 ±1 **b**	322 ±13	229 ±14 **ab**	1.7±0.08 **b**	39.8 ±0.8 **a**	40.5 ±0.9 **bc**	42.3 ±0.7 **bc**	45.3 ±0.7 **bc**
Rubiota	16 ±1 **b**	320 ±12	218 ±12 **b**	1.8±0.07 **ab**	37.3 ±0.6 **b**	39.8 ±0.9 **c**	40.6 ±0.7 **c**	43.6 ±0.8 **c**
ZOR	17 ±2 **ab**	343 ±10	241 ±17 **ab**	1.9±0.10 **a**	39.5 ±0.6 **a**	41.6 ±0.8 **b**	42.8 ±0.9 **b**	45.5 ±1.0 **ab**
ANOVA								
Main effects								
Season (YR)	**0.0012**	ns	**0.0022**	**0.0020**	**0.0132**	-	0.085	-
Fertility type (FT)	**0.0001**	ns	**0.0405**	**0.0015**	**0.0031**	**0.0001**	**0.003**	**0.0016**
Irrigation (IR)	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**0.0352**	**0.0001**	ns
Variety (SV)	**0.0025**		**0.0043**	**0.0001**	**<0.0001**	**0.0001**	**0.0001**	**0.0031**
Interactions								
YR x FT		**0.0094**	**0.0388**	**0.0085**	ns	-	ns	-
YR x IR		**0.0086**		**0.0082**	ns	-	**0.0465**	-
FT x IR	0.0897		0.0792		ns	-	ns	-
YR x SV	**0.0013**	0.0879	**0.0000**	**0.0036**	ns	-	ns	-
FT x SV					ns	-	ns	-
IR x SV					ns	-	ns	-
YR x FT x IR	**0.0287**		0.0860		ns	-	ns	-
YR x FT x IR x VR				**0.0386**		-	ns	-

HI, harvest index; TGW; thousand grain weight; means that are followed by the same letter within each column are not significant different (general linear hypothesis test *p*<0.05); [1]See Table S3 for interaction means ±SE; [2]See Table S4 for interaction means ±SE; [3]See Table 6 for interaction means ±SE; [4]See Table 8 for interaction means ±SE; [5]See Table S5 for interaction means ±SE; *, SPAD data for GS 39 and GS 62 were not available in 2016;

Table S3. Interaction means ± SE for the effects of growing season (2015/16, 2016/17) and supplementary irrigation (with and without) on spelt wheat grain yield and yield related growth parameters

Parameters	Season	Supplementary Irrigation	
		Irrigation + (n=48)	Irrigation – (n=48)
Grain Yield	**2015/16**	1.6 ±0.1 **A b**	0.6 ±0.1 **B b**
t ha⁻¹	**2016/17**	3.9 ±0.2 **A a**	1.6 ±0.1 **B a**
SPAD	**2015/16**	38.6±0.9 **B b**	41.7±0.8 **A b**
	2016/17	44.7±0.5 **A a**	45.8±0.5 **A a**
Grain/hull	**2015/16**	1.7 ±0.07 **A b**	1.2 ±0.07 **B b**
%	**2016/17**	2.2 ±0.04 **A a**	2.0 ±0.05 **B a**
Tillers m²	**2015/16**	367 ±12 **A a**	267 ±10 **B b**
	2016/17	359 ±8 **A a**	311 ±10 **B a**

For each parameter means labelled with capital letter within the same row or the same lower-case letter within the same column are not significant different (General Linear Hypothesis test $p<0.05$)

Table S4. Interaction means ± SE for the effects of growing season (2015/16, 2016/17) and fertilizer type (chicken manure, mineral NPK, sheep manure) on spelt wheat grain crude protein content and yield related growth parameters

Parameters	Season	Fertilizer type		
		Chicken manure (n=32)	Mineral NPK (n=32)	Sheep manure (n=32)
Plant height (cm)	**2015/16**	85 ±3 **A b**	82 ±3 **A b**	86 ±3 **A b**
at GS62	**2016/17**	104 ±3 **B a**	114 ±4 **A a**	103 ±3 **B a**
Tillers m²	**2015/16**	326 ±16 **A a**	289 ±16 **B b**	337 ±15 **A a**
	2016/17	334 ±11 **B a**	367 ±12 **A a**	304 ±10 **B b**
Ears m²	**2015/16**	201 ±14 **A b**	151 ±14 **B b**	214 ±12 **A b**
	2016/17	297 ±14 **A a**	282 ±19 **A a**	274 ±10 **A a**
Grain /hull ratio	**2015/16**	1.4 ±0.10 **B b**	1.1 ±0.09 **C b**	1.7 ±0.08 **A b**
	2016/17	2.1 ±0.05 **A a**	2.0 ±0.07 **A a**	2.1 ±0.04 **A a**

For each parameter means labelled with capital letter within the same row or the same lower case letter within the same column are not significant different (General Linear Hypothesis test $p<0.05$)

Table S5. Interaction means ± SE for the effects of growing season (2015/16, 2016/17), supplementary irrigation (with or without) and fertilizer type (chicken manure, mineral NPK, sheep manure) on spelt wheat grain yield and harvest index

Mean ± SE

Parameter	Season	Irrigation	Fertilizer Type		
			Chicken manure (n=16)	Mineral NPK (n=16)	Sheep manure (n=16)
Harvest Index	**2015/16**	Irrigation +	15.2 ±1.4 **A c**	9.9 ±1.1 **B b**	15.2 ±1.3 **A b**
%		Irrigation -	8.8 ±1.5 **AB d**	5.8 ±1.1 **B c**	10.4 ±1.0 **A c**
	2015/17	Irrigation +	27.3 ±0.8 **A a**	24.9 ±0.8 **A a**	27.7 ±0.7 **A a**
		Irrigation -	21.6 ±1.9 **A b**	11.7 ±1.4 **B b**	24.7 ±0.8 **A a**

For each parameter assessed means labelled with capital letter within the same row or the same lower case letter within the same column are not significantly different (General Linear Hypothesis test $p<0.05$)

Table S6. Interaction means ± SE for the effects of growing season (2015/16, 2016/17), supplementary irrigation (with or without) and fertilizer type (chicken manure, mineral NPK, sheep manure) and variety choice (Filderstolz, Oberkulmer, Rubiota, ZOR) on spelt wheat grain/hull ratio and crude protein content

		With Supplementary Irrigation						Without Supplementary Irrigation					
		Fertilizer type						Fertilizer type					
		Chicken manure (n=4)			Mineral NPK (n=4)			Sheep manure (n=4)			Chicken manure (n=4)			Mineral NPK (n=4)			Sheep manure (n=4)		
Season																				
Grain/hull ratio																				
2015/16	**Filderstolz**	1.5 ±0.17	AB	d	1.7 ±0.11	A	cd	1.9 ±0.14	A	bc	1.1 ±0.12	BC	d	0.7 ±0.21	C	c	1.2 ±0.15	B	b
	Oberkulmer	1.8 ±0.16	A	cd	1.1 ±0.24	B	e	1.7 ±0.23	A	c	1.1 ±0.36	B	d	1.1 ±0.37	B	c	1.5 ±0.14	A	cd
	Rubiota	1.7 ±0.23	A	cd	1.5 ±0.24	AB	d	1.9 ±0.16	A	bc	1.2 ±0.30	BC	cd	1.0 ±0.15	C	c	1.8 ±0.22	A	bc
	ZOR	2.2 ±0.07	A	ab	1.2 ±0.31	B	e	2.1 ±0.28	A	abc	1.0 ±0.19	BC	d	0.8 ±0.22	C	c	1.3 ±0.28	B	d
2016/17	**Filderstolz**	2.2 ±0.07	A	bc	1.9 ±0.23	AB	bcd	2.0 ±0.11	AB	bc	1.7 ±0.04	B	bc	1.9 ±0.13	AB	ab	1.9 ±0.07	AB	abc
	Oberkulmer	2.0 ±0.03	AB	bc	2.0 ±0.05	AB	bc	2.2 ±0.14	A	ab	2.0 ±0.13	AB	ab	1.7 ±0.26	B	b	2.0 ±0.08	AB	ab
	Rubiota	2.2 ±0.03	A	ab	2.2 ±0.05	A	ab	2.1 ±0.04	AB	abc	2.0 ±0.06	AB	ab	1.8 ±0.18	B	b	2.0 ±0.03	AB	ab
	ZOR	2.5 ±0.02	A	a	2.7 ±0.08	A	a	2.5 ±0.15	A	a	2.3 ±0.07	A	a	2.3 ±0.09	A	a	2.4 ±0.05	A	a
Crude protein (%)																				
2015/16	**Filderstolz**	10.1 ±0.5	B	a	10.8 ±0.6	AB	a	10.1 ±0.3	AB	a	12.3 ±0.5	AB	a	13.3 ±0.5	A	a	12.4 ±0.6	AB	a
	Oberkulmer	11.4 ±0.7	B	a	12.6 ±0.3	AB	a	12.3 ±0.6	AB	a	14.3 ±0.2	A	a	14.9 ±0.8	A	a	13.3 ±0.6	AB	a
	Rubiota	12.3 ±0.4	B	a	13.3 ±0.7	AB	a	11.8 ±0.4	B	a	13.9 ±0.9	AB	a	15.7 ±0.8	A	a	13.9 ±0.7	AB	a
	ZOR	10.1 ±0.2	B	a	12.4 ±1.0	A	a	10.3 ±0.5	B	a	11.9 ±0.2	AB	a	14.1 ±0.4	A	a	12.3 ±0.7	AB	a
2016/17	**Filderstolz**	9.3 ±0.3	B	b	12.2 ±0.9	A	a	9.7 ±0.4	AB	b	11.8 ±0.7	AB	b	13.2 ±1.4	A	c	12.0 ±0.4	AB	a
	Oberkulmer	11.6 ±0.4	B	ab	13.9 ±0.2	AB	a	12.9 ±1.2	AB	a	14.3 ±0.9	AB	a	15.3 ±1.1	A	bc	13.5 ±0.9	AB	a
	Rubiota	12.5 ±0.6	BC	a	14.9 ±0.9	B	a	11.6 ±0.4	C	ab	14.0 ±1.3	B	ab	17.1 ±0.5	A	b	13.9 ±0.8	B	a
	ZOR	9.9 ±0.1	C	ab	13.6 ±0.5	B	a	9.9 ±0.4	C	ab	12.5 ±0.9	BC	ab	20.1 ±5.1	A	a	13.1 ±1.3	B	a

For each parameter assessed means labelled with capital letter within the same row or the same lower case letter within the same column are not significant different (General Linear Hypothesis test $p<0.05$)