Table S1. Soil conditions before establishing an experiment with winter oilseed rapeseed (2016–2018).

Location	Soil layer, cm	pH_{KCl}	SOC, %	mg kg^{-1}		Nmin, kg ha^{-1}	mg kg^{-1}							
				$N\text{-}NO_3$	$N\text{-}NH_4$		P	K	Mg	B	Cu	Fe	Mn	Zn
						2016								
Sahryń	0–30	7.5	4.39	20.76	5.17	101	14	42	83	6.60	5.8	730	138	7.4
	30–60	7.6	3.31	12.66	1.23	54	8	21	89	5.80	5.1	640	101	5.2
Pągów	0–30	7.0	1.18	8.54	3.49	54	52	112	153	4.20	2.7	1546	163	14.6
	30–60	6.7	0.95	6.55	3.49	46	49	95	137	4.00	2.6	1523	158	14.3
Nowiny	0–30	6.2	1.76	2.09	2.21	17	68	184	154	0.90	2.1	1545	130	8.0
	30–60	5.9	1.45	8.97	2.35	44	59	188	128	0.80	1.9	1309	99	6.4
						2017								
Sahryń	0–30	7.5	2.10	28.18	1.12	114	44	58	66	2.58	7.1	470	173	7.7
	30–60	7.8	1.28	19.45	3.43	89	4	25	68	1.71	6.2	520	107	4.9
Pągów	0–30	6.4	1.02	10.80	1.46	53	89	183	103	1.81	3.0	871	115	10.1
	30–60	6.5	0.32	7.66	1.07	38	30	85	90	6.53	2.2	729	46	4.3
						2018								
Sahryń	0–30	7.3	1.20	8.30	3.30	50	61	129	71	1.70	8.1	874	171	8.3
	30–60	7.4	0.79	5.56	2.67	35	21	52	59	1.43	7.1	1074	151	7.3
Pągów*	0–30	7.4	0.96	14.74	1.61	64	56	332	82	1.41	3.9	2011	195	17.0
	30–60	7.2	0.48	12.77	1.27	54	114	299	86	1.74	2.8	1496	112	5.8
Pągów**	0–30	7.1	0.77	9.00	2.08	43	98	246	87	1.27	3.2	1539	198	14.6
	30–60	7.3	0.61	7.84	1.59	37	155	214	86	0.84	2.6	1382	111	4.6
Nowiny	0–30	6.7	1.69	12.40	<1.00	52	107	188	145	0.69	3.5	1601	139	12.6
	30–60	6.8	1.40	12.20	<1.00	51	106	217	132	0.65	3.5	1670	136	9.6
Pityny	0–30	6.1	1.08	2.07	4.60	29	56	110	91	0.75	2.0	1424	156	4.0
	30–60	6.8	0.88	5.79	1.54	32	82	114	71	0.69	1.7	1222	122	3.8

*forecrop spring wheat; **forecrop winter wheat.

Table S2. Weather conditions during the growing spring season of winter oilseed rapeseed (2017–2019).

Location	Month	Precipitation, mm	Average temperature, °C	Hydrotermical coefficient, k
			2017	
Sahryń	March	49	6.8	-
	April	36	8.6	1.40
	May	45	13.5	1.08
	June	34	18.2	0.62
	July	95	18.9	1.62
	Sum	**259**	-	-
Pągów	March	70	6.0	-
	April	70	8.0	2.92
	May	31	14.0	0.71
	June	101	18.0	1.87
	July	88	19.0	1.49
	Sum	**360**	-	-
Nowiny	March	22	4.0	-
	April	72	5.7	4.21
	May	26	12.0	0.70
	June	68	15.5	1.46
	July	216	16.3	4.27
	Sum	**404**	-	-
			2018	
Sahryń	March	44	−0.6	-
	April	36	13.9	0.86
	May	47	17.0	0.89
	June	111	18.1	2.04
	July	181	20.4	2.86
	Sum	**419**	-	-
Pągów	March	12	−0.1	-
	April	16	14	0.38
	May	54	17	1.02
	June	73	19	1.28
	July	149	20	2.40
	Sum	**304**	-	-
			2019	
Sahryń	March	24	5.0	-
	April	19	9.5	0.67
	May	118	14.1	2.70
	June	59	21.8	0.90
	July	45	18.2	0.80
	Sum	**265**	-	-
Pągów	March	34	5.4	2.15
	April	30	10.0	1.00
	May	97	12.0	2.61
	June	7	22.0	0.11
	July	35	17.0	0.66
	Sum	**203**	-	-
Nowiny	March	49	4.5	-
	April	6	7.8	0.26
	May	94	11.0	2.76
	June	107	19.9	1.79
	July	78	16.5	1.52
	Sum	**334**	-	-
Pityny	March	54	4.3	-
	April	5	8.0	0.21
	May	75	11.8	2.05

	June	84	20.0	1.40
	July	55	16.8	1.06
	Sum	**273**	-	-
		Average from multiyear*		
Location	Month	Precipitation, mm	Average temperature, °C	Hydrotermical coefficient, k
Sahryń	March	36	2.9	-
	April	40	9.3	1.43
	May	73	14.3	1.65
	June	73	17.7	1.37
	July	100	19.7	1.64
	Sum	**322**	-	-
Pągów	March	43	2.9	-
	April	37	9.5	1.30
	May	64	14.4	1.43
	June	64	17.9	1.19
	July	89	19.7	1.46
	Sum	**297**	-	-
Nowiny	March	36	1.9	-
	April	28	7.8	1.20
	May	49	12.9	1.23
	June	61	16.0	1.27
	July	87	18.5	1.52
	Sum	**261**	-	-
Pityny	March	37	1.9	-
	April	32	7.8	1.37
	May	52	13.1	1.28
	June	67	16.2	1.38
	July	98	18.7	1.69
	Sum	**286**	-	-

*Precipitation: Sahryń (1991–2019), Pągów (1998–2019), Nowiny and Pityny (2001–2019).
Temperature: Sahryń (2002–2019), Pągów, Nowiny and Pityny (2001–2019).
Source: own study based on data from IMGW-PIB, „Pagro" farm, Strzyżów Sugar Factory.

Table S3. Characteristics of winter oilseed rape production technology in the experiment (2016/2017–2018/2019).

Location	Forecrop	Straw yield of forecrop, dt ha^{-1}	Cultivar of winter oilseed rape	Mineral fertlization, kg ha^{-1}	Sowing date	Harvest date
			2016/2017			
Sahryń	Winter wheat	45	Trezor	N–230 (treatment No 0) and 161 (treatments No 1 and No 2); P–55; K–104; S–62	13.08	19.07
Pągów	Winter wheat	60	DK Exquisite	N–186 (treatment No 0) and 130 (treatments No 1 and No 2); P–13; K–46; S–72	27.08	30.07
Nowiny	Winter wheat	50	Atora	N–233 (treatment No 0) and 163 (treatments No 1 and No 2); P–30; K–100, S–54	28.08	12.07
			2017/2018			
Sahryń	Winter wheat	50	Trezor	N–226 (treatment No 0) and 158 (treatments No 1 and No 2); P–44; K–125; S–66	10.08	04.07
Pągów	Winter wheat	53	Florida	N–245 (treatment No 0) and 172 (treatments No 1 and No 2); P–10; K–56; S–68	28.08	07.07
			2018/2019			
Sahryń	Winter wheat	35	Trezor	N–258 (treatment No 0) and 181(treatments No 1 and No 2); P–44; K–125; S–64	11.08	05.07
Pągów*	Spring wheat	50	KWS Umberto	N–219 (treatment No 0) and 154 (treatments No 1 and No 2); P–19; K–22; S–29	26.08	18.07
Pągów**	Winter wheat		DK Expiro	N–182 (treatment No 0) and 127 (treatments No 1 and No 2); P–12; K–43; S–34	21.08	16.07
Nowiny	Spring wheat	35	Umberto KWS	N–139 (treatment No 0) and 97 (treatments No 1 and No 2); P–69; K–125; S–3	21.08	18.07
Pityny	Spring barley	21	Rumba	N–139 (treatment No 0) and 97 (treatments No 1 and No 2); P–20; K–120 ; S–18	25.08	16.07

0—control; 1—Penergetic (K + P); 2—Penergetic (K + P) + Azoter.

Table S4. Soil conditions after the harvest winter oilseed rape (2017–2019).

Location	Treat-ment	Soil layer, cm	pH_{KCl}	SOC, %	mg kg^{-1}		Nmin, kg ha^{-1}	mg kg^{-1}							
					N-NO_3	N-NH_4		P	K	Mg	B	Cu	Fe	Mn	Zn
							2017								
Sahryń	0	0–30	7.5	1.66	36.24	1.58	147	87	62	69	2.23	7.3	490	167	5.9
		30–60	7.8	1.02	6.55	3.60	40	6	21	70	1.49	5.7	520	110	4.8
	1	0–30	7.5	2.58	24.13	1.56	100	45	79	70	2.76	6.8	480	173	7.1
		30–60	7.8	1.52	6.96	2.67	38	5	29	68	1.85	6.4	470	120	6.6
	2	0–30	7.5	2.64	26.16	1.93	110	44	83	61	2.60	7.9	500	184	7.0
		30–60	7.7	1.16	5.16	2.23	29	4	25	52	1.20	7.0	700	123	5.5
Pągów	0	0–30	6.7	1.21	12.36	3.29	67	68	217	108	1.49	3.2	834	115	9.9
		30–60	6.5	0.35	6.57	2.12	37	18	53	110	0.51	1.4	511	46	5.2
	1	0–30	6.9	1.18	9.61	2.08	50	62	139	116	1.67	2.7	753	92	13.0
		30–60	6.9	0.40	6.48	2.25	38	17	55	108	0.84	1.7	928	55	7.7
	2	0–30	6.7	1.39	17.30	2.57	85	77	190	97	2.03	2.9	1039	117	13.9
		30–60	6.7	0.90	7.64	2.57	44	23	66	87	0.69	1.5	897	44	6.4
Nowiny	0	0–30	6.2	0.73	7.50	1.34	35	44	188	44	0.98	1.8	1412	115	5.4
		30–60	6.0	0.53	13.40	<1.00	56	36	147	31	0.75	1.9	1468	113	6.0
	1	0–30	6.0	0.95	7.80	<1.00	38	32	152	70	0.40	1.6	1353	102	6.6
		30–60	6.1	1.38	12.00	<1.00	56	37	144	58	0.91	1.8	1474	109	7.6
	2	0–30	7.0	1.54	7.55	<1.00	37	54	160	44	1.08	2.0	1420	111	8.0
		30–60	6.2	0.73	7.50	1.34	35	44	188	44	0.98	1.8	1412	115	5.4
							2018								
Sahryń	0	0–30	7.3	2.76	18.43	3.11	93	91	133	99	5.57	8.8	630	157	8.0
		30–60	7.4	2.22	13.15	2.47	67	49	62	123	4.54	9.2	700	125	7.6
	1	0–30	7.3	1.56	18.01	2.35	88	52	141	67	4.89	8.8	621	158	8.0
		30–60	7.6	1.04	15.87	5.17	91	4	46	64	3.22	6.3	616	131	7.5
	2	0–30	7.3	1.74	33.98	2.61	157	32	83	72	5.45	8.3	644	156	7.9
		30–60	7.5	1.12	17.32	3.81	91	4	37	71	3.78	6.9	630	130	7.3
Pagów	0	0–30	6.4	0.78	14.80	2.02	72	78	184	88	0.37	3.6	1873	122	9.7
		30–60	6.2	0.20	62.50	1.33	33	16	81	102	1.51	3.1	1496	57	5.5
	1	0–30	6.4	0.81	17.20	3.16	88	70	266	125	0.86	3.7	1460	130	11.0
		30–60	6.2	0.36	7.56	2.01	41	19	75	112	0.36	3.1	1673	53	8.8
	2	0–30	6.4	1.17	15.67	2.33	70	68	224	128	0.36	5.3	1530	137	14.8
		30–60	6.5	0.70	16.96	2.35	75	24	51	114	0.36	4.3	1693	98	10.8
							2019								
Sahryń	0	0–30	7.2	1.37	52.40	3.33	217	44	116	60	2.34	6.9	735	192	6.4
		30–60	7.4	0.71	18.20	1.55	77	8	25	60	2.12	6.3	875	179	6.8
	1	0–30	6.2	1.02	20.00	1.85	85	45	75	70	0.68	4.4	702	161	4.4
		30–60	5.8	0.52	5.84	1.69	29	33	37	53	<0.50	5.0	826	95	3.2
	2	0–30	6.9	1.02	21.60	1.08	89	88	125	66	1.25	4.8	720	160	4.8
		30–60	7.0	0.48	15.40	2.08	68	31	42	57	0.52	5.0	788	114	3.2
Pągów*	0	0–30	7.4	1.09	17.22	2.37	76	201	340	80	2.74	4.7	1630	232	37.0
		30–60	7.6	0.68	10.93	2.47	52	158	390	77	1.91	3.0	1430	186	21.6
	1	0–30	7.2	1.11	19.90	2.57	88	214	564	118	2.57	3.2	1196	192	21.1
		30–60	7.2	0.61	5.60	1.26	27	55	531	84	1.38	1.8	1121	153	3.7
	2	0–30	7.3	1.59	12.02	9.08	82	170	473	87	2.80	4.0	1128	180	17.0
		30–60	7.0	0.63	8.84	2.79	45	41	506	65	1.34	3.1	1473	111	5.9
Pągów**	0	0–30	7.3	0.99	35.35	14.03	193	129	249	80	2.09	3.2	970	196	17.8
		30–60	7.5	0.60	8.89	1.46	40	52	197	80	1.17	2.2	959	152	7.9
	1	0–30	7.0	1.59	44.66	2.84	185	235	415	87	3.08	6.2	1284	203	25.2
		30–60	7.2	1.09	16.54	2.47	84	162	311	85	1.78	5.9	1612	185	14.4
	2	0–30	6.5	1.25	24.24	6.38	119	122	282	121	2.88	2.8	845	174	21.9
		30–60	6.4	0.99	12.02	2.39	56	105	197	96	1.86	1.9	924	178	6.4
Nowiny	0	0–30	7.0	1.77	23.70	<1.00	102	285	327	190	2.34	3.8	1850	171	20.3

Location	Treatment	Soil layer, cm	pH_{KCl}	SOC, %	mg kg^{-1}		Nmin, kg ha^{-1}	mg kg^{-1}							
					N-NO_3	N-NH_4		P	K	Mg	B	Cu	Fe	Mn	Zn
Pityny		30–60	7.1	1.95	25.40	<1.00	109	307	365	174	2.13	3.9	2026	164	19.6
	1	0–30	6.5	1.69	16.80	1.40	78	51	160	177	1.54	2.7	1704	133	8.2
		30–60	6.5	1.57	13.10	2.00	65	56	184	150	1.26	2.8	1692	123	8.0
	2	0–30	6.6	0.29	13.90	<1.00	60	130	242	191	1.65	3.6	1841	133	11.7
		30–60	6.5	2.05	14.70	<1.00	63	116	305	190	1.36	3.0	1645	121	11.7
	0	0–30	5.7	<0.29	5.50	4.30	44	47	134	77	<0.40	1.6	1417	121	3.2
		30–60	5.8	0.66	7.30	2.10	42	43	110	75	<0.40	1.6	1355	137	3.1
	1	0–30	6.3	0.54	5.00	5.90	49	83	93	95	0.41	1.3	1029	113	3.4
		30–60	6.3	0.45	13.00	1.80	67	80	115	73	<0.40	1.4	1098	121	3.4
	2	0–30	7.1	<0.29	6.10	2.50	37	76	105	63	0.78	1.8	1303	146	3.6
		30–60	7.1	<0.29	9.40	1.80	48	73	99	63	0.70	2.0	1430	148	3.1

*forecrop spring wheat; **forecrop winter wheat; 0—control; 1—Penergetic (K + P); 2—Penergetic (K + P) + Azoter.

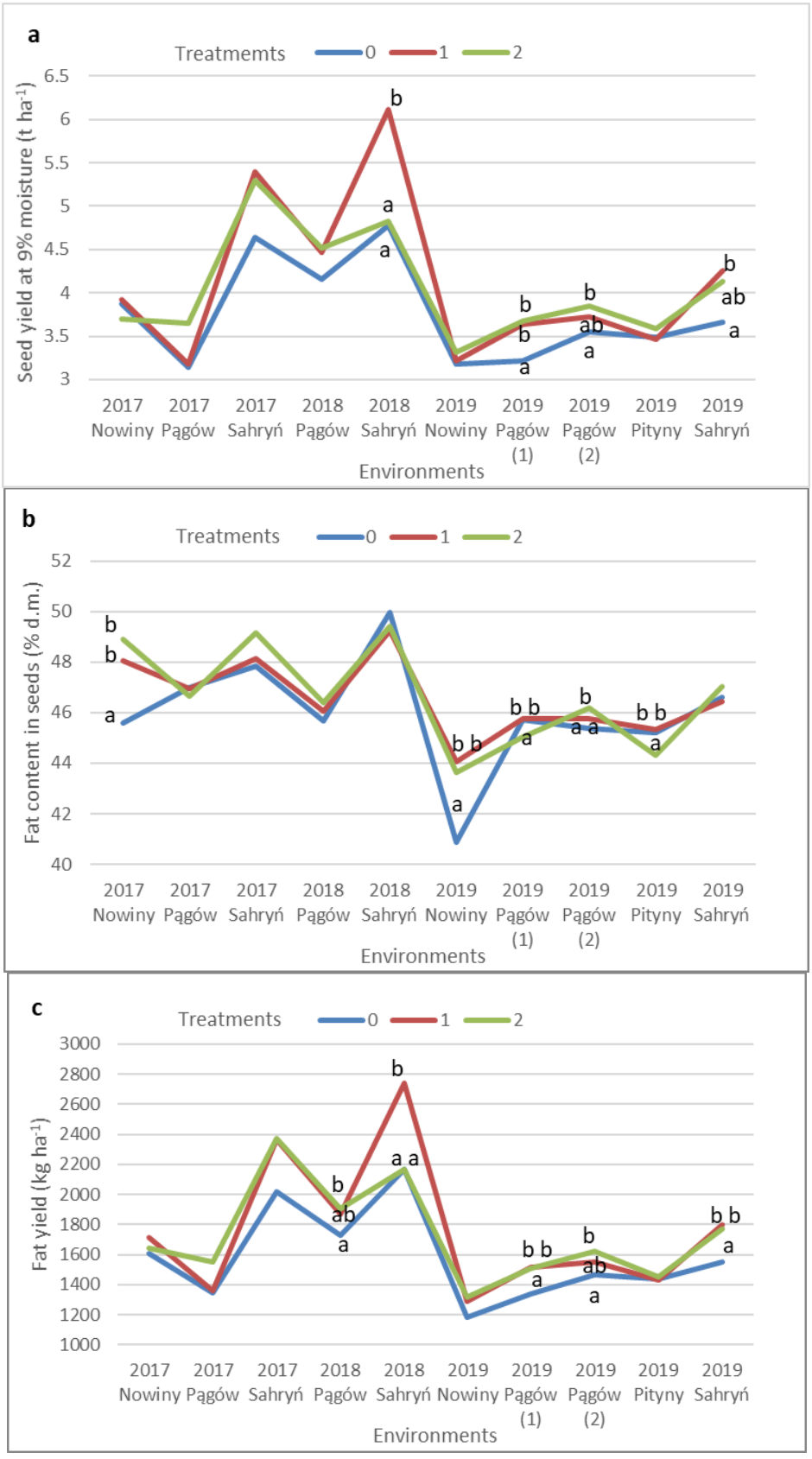

Figure S1. Means of seed yield (a), fat content (b) and fat yield (c) of variants of winter oilseed rape in different years and locations (environments). Different letters indicate significant differences between means for variants at $\alpha = 0.05$, lack of letters indicate lack differences between variants. Pągów (1)—forecrop: spring wheat; Pągów (2)—forecrop: winter wheat