

Supplementary material

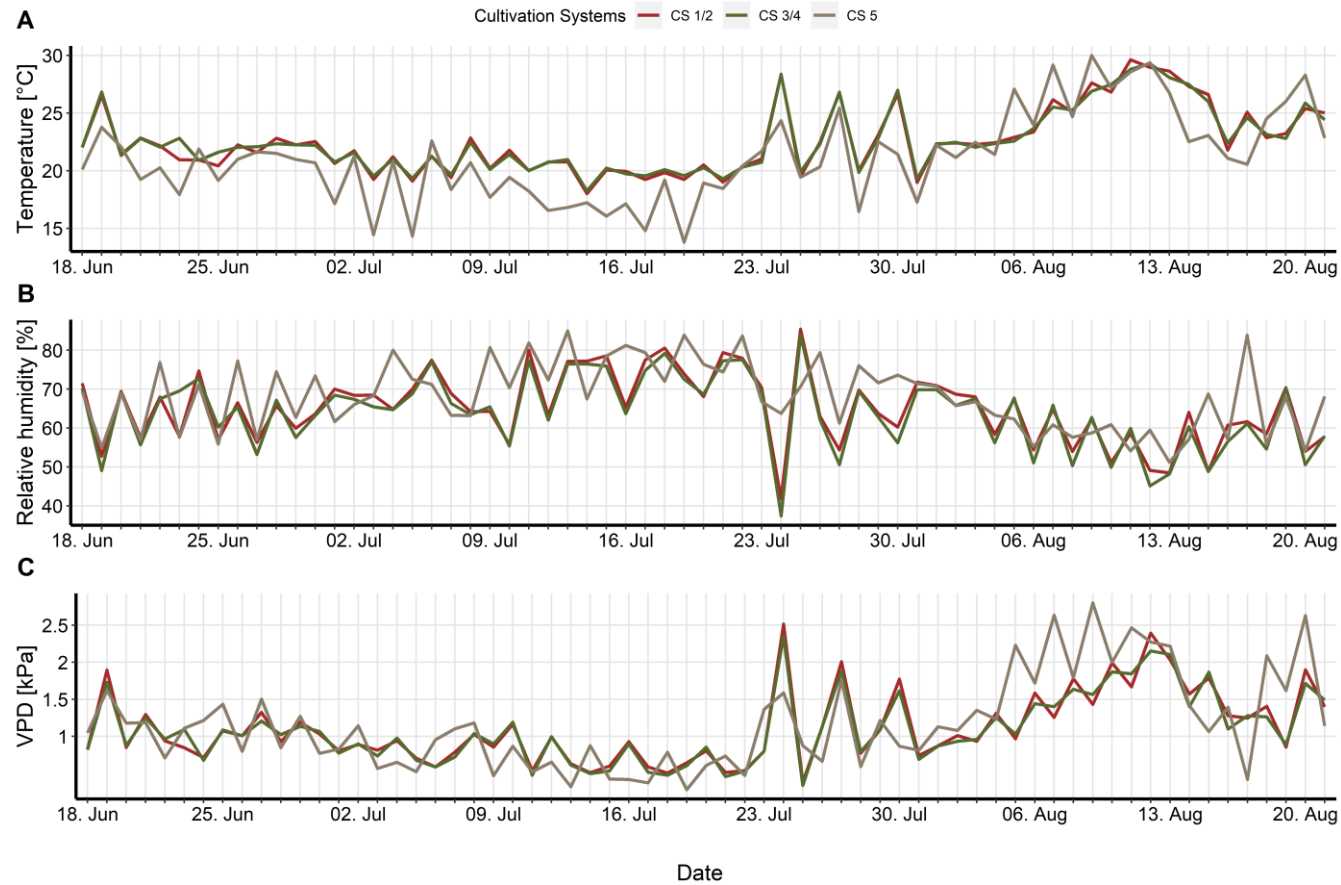


Figure S1. Mean daily values in the five cultivation systems of (A) temperature [°C], (B) relative humidity [%], and (C) vapor pressure deficit (VPD) [kPa] over the entire period of fruit growth.

Table S1. Mean values of yield parameters \pm standard deviation in different cultivation systems of five breeding lines and Lyterno F1.

Cultivation system (CS)					Breeding line (BL)/Cultivar (CV)						BL/CV x CS		
1	2	3	4	5		1	2	3	4	5	6		
trusses up to 2.5 m													
9.43	8.90	9.12	8.28	10.39	***	8.47	8.05	10.16	10.9	9.23	8.54	***	*
± 1.39 b	± 1.25 b	± 1.30 b	± 1.06 c	± 1.31 a		± 1.02 d	± 1.09 d	± 0.76 b	± 1.50 a	± 0.86 c	± 0.73 d		
trusses per week since planting													
0.92	0.89	0.93	0.83	0.72	***	0.73	0.75	0.88	1.00	0.87	0.91	***	*
± 0.13 a	± 0.14 a	± 0.12 a	± 0.13 b	± 0.10 c		± 0.09 c	± 0.09 c	± 0.15 b	± 0.13 a	± 0.09 b	± 0.12 b		
time from planting to 2.5 m plant height [weeks]													
10.3	10.1	9.89	9.92	14.73	***	11.93	10.89	11.63	11.09	10.7	9.67	***	ns
± 0.80 b	± 1.06 b	± 0.96 b	± 0.92 b	± 1.49 a		± 2.27 a	± 2.08 c	± 2.09 ab	± 2.27 bc	± 1.48 c	± 2.17 d		
single fruit weight [g]													
62.82	53.4	52.3	51.88	68.71	***	59.47	68.47	61.6	18.47	34.87	104.05	***	***
± 32.46 a	± 25.30 b	± 25.67 b	± 26.29 b	± 34.87 a		± 13.73 c	± 10.98 b	± 13.13 bc	± 3.55 e	± 4.95 d	± 18.85 a		
yield [g per week and plant since planting]													
359.43	295.28	295.89	269.07	297.4	***	262.61	305.56	327.15	186.92	184.39	553.84	***	*
± 166.11 a	± 127.94 b	± 132.75 b	± 131.42 b	± 128.17 b		± 56.03 c	± 57.52 bc	± 62.29 b	± 43.26 d	± 36.97 d	± 99.33 a		
calculated yield [kg per plant]													
3.56	2.91	2.77	2.6	4.29	***	3.00	3.28	3.78	2.03	1.94	5.30	***	***
± 1.47 b	± 1.12 c	± 0.99 c	± 1.05 c	± 1.72 a		± 0.88 c	± 0.71 c	± 0.92 b	± 0.56 d	± 0.36 d	± 1.40 a		

ns ≥ 0.05 , * < 0.05 , ** ≤ 0.01 , *** ≤ 0.001 . Small letters indicate significant differences between either the cultivation systems or the breeding lines/cultivar and their interaction (Tukey's HSD, $p \leq 0.05$).

Table S2. Soil analyses in the low-input cultivation system (CS 5) before and after the experimental setup.

soil sample	soil depth [cm]	Use	Soil texture (Group)	Calcium carbonate pH-value		Phosphorus [mg/100g]	Potassium [mg/100g]	Magnesium [mg/100g]
				to target CaCl ₂	determined CaCl ₂	CAL	CAL	CaCl ₂
03.06.2019 start of experiment	0 – 30	Agricultural use	(h) ttU	6.3-7.0	7.0 C	4.6 C	11.7 C	13.6 D
08.10.2019 end of experiment	0 – 30	Agricultural use	(h) ttU	6.3-7.0	7.0 C	4.4 B	9.1 B	13.3 D

A = very low, B = low, C = to target, D = high, E = very high, F = extremely high; results were measured and provided by the LUFA Nord-West (Germany). (h) = low humus to humous, ttU = strong clayey silt.

Table S3. Mean values ± standard deviation of 18 aroma compounds in different cultivation systems of five breeding lines and Lyterno F1.

	Cultivation system (CS)						Breeding Line (BL)/ Cultivar (CV)							CS × BL/CV
	1	2	3	4	5		1	2	3	4	5	6		
[ng/ml sample]														
1-Penten-3-one	0.006 ±0.00 ab	0.006 ±0.00 ab	0.006 ±0.00 a	0.005 ±0.00 ab	0.004 ±0.00 b	*	0.005 ±0.00 b	0.005 ±0.00 b	0.006 ±0.00 ab	0.003 ±0.00 c	0.005 ±0.00 b	0.008 ±0.00 a	***	ns
Hexanal*	6.54 ±3.60 ab	5.93 ±3.87 b	7.31 ±6.12 ab	7.88 ±3.46 a	8.19 ±4.41 a	**	14.25 ±5.14 a	5.17 ±1.76 c	6.57 ±2.48 bc	7.47 ±2.22 b	6.62 ±2.77 bc	3.34 ±1.82 d	***	ns
Z-3-Hexenal*	1.91 ±0.64 a	1.25 ±0.59 b	1.64 ±0.81 ab	1.28 ±0.52 b	1.51 ±0.72 ab	***	1.79 ±0.63 a	1.66 ±0.63 ab	1.2 ±0.35 b	1.93 ±0.68 a	1.71 ±0.79 ab	0.86 ±0.38 c	***	ns
E-2-Hexenal*	4.75 ±2.20 a	3.18 ±1.39 b	4.7 ±2.13 a	4.51 ±1.81 a	4.30 ±1.58 a	***	6.43 ±1.61 a	4.65 ±1.05 b	3.97 ±0.99 b	6.05 ±1.06 a	2.93 ±0.66 c	1.86 ±0.55 d	***	ns
6-Methyl-5-hepten-2-one*	2.72 ±1.21 a	3.02 ±1.36 a	3.09 ±1.31 a	2.39 ±0.86 a	4.00 ±2.55 a	ns	3.61 ±2.00 ab	3.20 ±2.40 ab	3.79 ±1.38 a	2.50 ±0.90 ab	2.31 ±1.09 b	2.88 ±1.15 ab	**	ns

1-Hexanol	0.11 ±0.06 b	0.17 ±0.11 a	0.10 ±0.07 b	0.13 ±0.09 ab	0.18 ±0.12 a	***	0.17 ±0.11 ab	0.07 ±0.04 c	0.11 ±0.06 b	0.15 ±0.06 ab	0.23 ±0.13 a	0.11 ±0.07 b	***	ns
Z-3-Hexenol*	0.21 ±0.05 b	0.23 ±0.05 ab	0.22 ±0.05 ab	0.25 ±0.03 a	0.24 ±0.05 a	**	0.29 ±0.05 a	0.22 ±0.03 bc	0.20 ±0.04 c	0.21 ±0.03 bc	0.23 ±0.04 bc	0.23 ±0.03 b	***	ns
2-Isobutylthiazole*	2.17 ±1.89 b	2.20 ±2.43 b	2.10 ±1.38 b	2.18 ±1.53 b	3.23 ±2.26 a	**	0.53 ±0.33 d	2.53 ±1.70 b	4.47 ±2.45 a	1.04 ±0.53 c	2.23 ±0.95 b	3.38 ±1.59 ab	***	*
Benzaldehyde	0.13 ±0.04 b	0.17 ±0.05 a	0.13 ±0.05 b	0.14 ±0.06 b	0.09 ±0.03 c	***	0.09 ±0.04 b	0.15 ±0.06 a	0.15 ±0.07 a	0.15 ±0.04 a	0.16 ±0.03 a	0.10 ±0.05 b	***	***
Phenyl acetaldehyde*	0.08 ±0.03 a	0.09 ±0.04 a	0.09 ±0.04 a	0.07 ±0.03 a	0.09 ±0.04 a	ns	0.13 ±0.06 a	0.07 ±0.02 c	0.08 ±0.02 bc	0.07 ±0.02 bc	0.08 ±0.02 b	0.08 ±0.02 bc	***	ns
Neral	0.05 ±0.04 ab	0.06 ±0.04 a	0.04 ±0.03 ab	0.04 ±0.03 b	0.05 ±0.04 ab	*	0.03 ±0.02 c	0.04 ±0.03 ab	0.04 ±0.02 b	0.03 ±0.01 bc	0.11 ±0.03 a	0.03 ±0.02 bc	***	ns
Geranial	0.33 ±0.19 a	0.29 ±0.11 a	0.32 ±0.15 a	0.14 ±0.04 b	0.23 ±0.09 a	***	0.24 ±0.13 a	0.28 ±0.22 a	0.31 ±0.14 a	0.24 ±0.12 a	0.25 ±0.09 a	0.26 ±0.13 a	ns	ns
Methyl salicylate*	0.10 ±0.15 a	0.19 ±0.35 a	0.10 ±0.13 a	0.09 ±0.12 a	0.17 ±0.23 a	ns	0.15 ±0.21 b	0.23 ±0.21 a	0.34 ±0.33 a	0.04 ±0.01 bc	0.02 ±0.02 c	0.01 ±0.01 d	***	ns
β-Damascenone	0.17 ±0.12 a	0.14 ±0.06 a	0.19 ±0.16 a	0.22 ±0.19 a	0.14 ±0.06 a	ns	0.14 ±0.04 b	0.1 ±0.03 b	0.11 ±0.03 b	0.31 ±0.22 a	0.23 ±0.13 a	0.13 ±0.05 b	***	*
Z-Geranylacetone*	0.020 ±0.01 ab	0.018 ±0.01 ab	0.025 ±0.01 a	0.017 ±0.01 b	0.018 ±0.01 ab	*	0.028 ±0.01 a	0.022 ±0.01 ab	0.018 ±0.01 b	0.019 ±0.01 b	0.019 ±0.01 b	0.012 ±0.00 c	***	ns
E-Geranylacetone*	2.18 ±1.02 ab	2.07 ±1.20 ab	2.36 ±1.38 a	1.77 ±0.61 ab	1.70 ±0.93 b	*	3.30 ±1.52 a	2.22 ±1.03 b	2.07 ±0.44 b	1.37 ±0.51 c	1.84 ±0.70 bc	1.35 ±0.54 c	***	ns
2-Phenylethanol*	0.38 ±0.14 bc	0.47 ±0.21 a	0.35 ±0.14 c	0.44 ±0.21 abc	0.45 ±0.24 ab	**	0.19 ±0.13 d	0.26 ±0.11 c	0.62 ±0.16 a	0.49 ±0.08 ab	0.53 ±0.16 ab	0.40 ±0.08 b	***	ns
β-Ionone*	0.38 ±0.22 ab	0.29 ±0.17 bc	0.40 ±0.24 ab	0.27 ±0.12 c	0.29 ±0.17 bc	**	0.64 ±0.25 a	0.28 ±0.08 b	0.27 ±0.07 b	0.34 ±0.10 b	0.27 ±0.09 b	0.18 ±0.05 c	***	ns

ns ≥ 0.05, * < 0.05, ** ≤ 0.01, *** ≤ 0.001. Small letters indicate significant differences between either the cultivation systems or the breeding lines/cultivar (Tukey's HSD, p ≤ 0.05). Aroma volatiles marked with an asterisk [*] were considered as main aroma compounds according to Cebolla-Cornejo et al. [32].

Table S4. Mean values in percent \pm standard deviation of sensory panel results in the cultivation systems CS1 and CS2 of five breeding lines and Lyterno F1.

	Cultivation system (CS)			Breeding Line (BL)/Cultivar (CV)						CS \times BL/CV	
	1	2		1	2	3	4	5	6		
Overall odor	62.10	62.67	ns	60.42	62.70	65.24	61.74	63.08	61.13	ns	ns
	± 9.68	± 10.49		± 10.05	± 10.74	± 9.69	± 8.79	± 9.44	± 11.43		
Grassy green odor	51.66	50.49	ns	50.26	50.69	54.05	51.55	50.15	49.76	ns	ns
	± 8.93	± 9.44		± 9.59	± 10.43	± 7.72	± 7.59	± 8.31	± 10.86		
Tomato-typical odor	56.40	58.21	ns	55.70	59.53	58.69	57.41	58.01	54.53	ns	ns
	± 12.01	± 12.41		± 11.83	± 12.55	± 13.08	± 11.15	± 9.64	± 14.51		
Overall flavor	62.79	64.15	ns	60.51	60.19	61.41	67.86	69.68	61.19	***	ns
	± 10.33	± 10.90		± 9.81 b	± 10.26 b	± 10.59 b	± 10.04 a	± 9.49 a	± 9.86 b		
Tomato-typical flavor	58.73	60.59	ns	57.69	58.85	57.61	63.43	61.51	58.89	ns	ns
	± 12.02	± 13.21		± 10.61	± 10.50	± 15.14	± 12.13	± 13.30	± 13.22		
Fruity flavor	40.88	40.09	ns	40.54	38.81	35.81	45.91	46.77	35.08	***	ns
	± 13.69	± 13.93		± 11.99 ab	± 13.11 ab	± 11.65 b	± 12.72 a	± 13.82 a	± 15.31 b		
Sweetness	31.63	33.34	ns	32.65	34.47	28.60	36.25	37.50	25.42	***	ns
	± 12.33	± 11.36		± 10.36 ab	± 9.71 ab	± 10.90 bc	± 12.38 a	± 12.40 a	± 11.13 c		
Sourness	43.53	41.71	ns	39.80	36.76	38.35	46.51	47.09	47.20	***	ns
	± 13.35	± 12.87		± 13.43 ab	± 12.48 b	± 12.96 b	± 10.90 a	± 12.77 a	± 12.19 a		
Bitter	20.21	18.91	ns	18.22	18.29	20.15	19.07	19.73	21.91	ns	ns
	± 8.74	± 8.70		± 8.64	± 7.67	± 7.93	± 6.87	± 8.89	± 11.59		
Salty	21.19	23.04	ns	20.83	20.42	20.84	23.28	23.24	24.08	ns	ns
	± 10.33	± 11.49		± 11.47	± 10.39	± 10.69	± 10.86	± 10.70	± 11.60		
Umami	44.53	44.37	ns	43.68	43.66	42.24	48.80	46.51	41.82	ns	ns
	± 12.82	± 13.65		± 13.05	± 13.08	± 13.55	± 12.92	± 12.78	± 13.31		
Juiciness	62.20	63.75	ns	63.91	53.08	60.80	69.53	73.25	57.31	***	ns
	± 14.36	± 12.70		± 9.15 bc	± 14.85 d	± 12.21 c	± 8.88 ab	± 10.41 a	± 13.90 cd		
Skin firmness	56.14	53.63	ns	54.23	57.32	54.09	53.59	50.60	59.48	*	ns
	± 12.93	± 11.78		± 12.47 ab	± 8.61 ab	± 11.70 ab	± 11.98 ab	± 15.66 b	± 11.78 a		
Aftertaste	47.30	47.25	ns	44.90	44.75	46.83	49.45	51.79	45.95	*	ns

	±10.56	±11.14	±10.55 ab	±11.74 b	±9.75 ab	±10.72 ab	±9.13 a	±11.68 ab
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ns ≥ 0.05, * < 0.05, ** ≤ 0.01, *** ≤ 0.001. Small letters indicate significant differences between the breeding lines/cultivar (Tukey's HSD, p ≤ 0.05).

Table S5. Mean values ± standard deviation of 38 metabolites detected in two breeding lines (2, 3) and Lyterno F1 (6), and the fold change (FC) from cultivation system 4 (double glazed greenhouse without LED) compared to cultivation system 2 (single glazed greenhouse without LED) are shown. Further, mean values ± standard deviation are shown for comparison of the 38 metabolites in the two breeding lines and Lyterno F1.

[mg/g DW]	CS2	CS4		FC
Amino acids				
Adenine	0.11±0.04	0.12±0.06	ns	1.08
Adenosine	0.49±0.18	0.48±0.20	ns	0.98
Alanine	0.9±0.37	0.7±0.13	ns	0.77
Asparagine	1.96±0.53	1.52±0.34	**	0.77
Aspartate	7.61±2.45	4.6±0.57	**	0.60
Glutamate	22.86±4.96	15.74±3.10	**	0.69
Glutamine	7.58±2.27	4.7±1.23	**	0.62
Guanosine	0.33±0.07	0.26±0.04	*	0.79
Isoleucine	0.72±0.21	0.53±0.19	**	0.74
Leucine	0.6±0.13	0.46±0.14	*	0.76
Lysine	0.5±0.18	0.34±0.06	*	0.69
Phenylalanine	1.8±0.46	1.46±0.39	ns	0.81
Proline	0.26±0.10	0.19±0.08	ns	0.73
Pyroglutamate	6.07±2.43	3.75±1.09	**	0.62
Serine	1.13±0.53	0.92±0.32	ns	0.82
Threonine	0.93±0.30	0.81±0.15	ns	0.87
Tryptophane	0.19±0.09	0.16±0.04	ns	0.82
Tyrosine	0.7±0.25	0.58±0.20	ns	0.83

Valine	0.43±0.12	0.31±0.10	*	0.72
γ-Amino-butyrate (GABA)	6.23±1.79	4.37±0.67	*	0.70
Sugars				
Arabinose	0.15±0.05	0.11±0.02	*	0.76
Fructose [#]	227.26±26.82	208.46±8.53	ns	0.92
Galactose	1.6±0.93	1.17±0.66	ns	0.73
Glucose [#]	208.68±24.78	188.08±12.02	*	0.90
Myo-inositol	1.45±0.32	1.16±0.45	*	0.80
Raffinose	0.29±0.24	0.3±0.20	ns	1.06
Ribose	0.16±0.04	0.19±0.08	ns	1.21
Organic acids				
Acetate	0.35±0.19	0.23±0.06	ns	0.66
Citrate	48.44±23.26	40.78±7.60	ns	0.84
Formate	0.11±0.02	0.1±0.02	ns	0.93
Fumarate	0.02±0.01	0.01±0.01	ns	0.76
Propionate	0.05±0.04	0.04±0.02	ns	0.69
Quinate	0.5±0.16	0.5±0.13	ns	1.00
Other organic compounds				
2,3-Butanediol	0.03±0.02	0.03±0.01	ns	0.92
Acetone	0.02±0.01	0.02±0.01	ns	1.27
Choline	1.2±0.24	1.01±0.26	ns	0.85
Ethanol	0.02±0.01	0.02±0.01	ns	1.17
Methanol	0.77±0.24	0.62±0.27	ns	0.80

ns ≥ 0.05, * < 0.05, ** ≤ 0.01, *** ≤ 0.001. Small letters indicate significant differences between either the cultivation systems or the breeding lines (Tukey's HSD, p ≤ 0.05). # Fructose and Glucose values are measured with HPLC.