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Hydroponic kale: effects of row spacing and number of plants per cell on yield and quality

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Supplementary material

Table S.1. Regression models, coefficient of determination (R2) and coefficient of variation (CV) of the evaluated agronomic characteristics.

Plant height	Regression models	R^2	CV (%)
Spacing	$f(x) = -44.412x + 31.183$	0.9638	6.57
Number of plants per cell	$f(x) = -1.2423x + 28.404$	0.9631	6.90
Leaf length			
Spacing	$f(x) = -60.853x^2 + 7.7594x + 10.66$	0.8995	8.91
Number of plants per cell	$f(x) = 0.5193x^2 - 4.0716x + 16.764$	0.9932	8.14
Petiole length			
Spacing	$f(x) = -25.507x + 12.374$	0.9613	13.56
Number of plants per cell	$\bar{x}$ = 8.99 (non-significant)		11.88
Number of leaves			
Spacing: 1 plant per cell	$\bar{x}$ = 14.41 (non-significant)		
Spacing: 2 plants per cell	$f(x) = 20.182x + 21.607$	0.6252	8.27
Spacing: 3 plants per cell	$f(x) = 39.185x + 27.589$	0.9467	
Spacing: 4 plants per cell	$f(x) = 659.48x^2 - 121.29x + 42.464$	0.9625	
Number of plants per cell: 0.07 m	$f(x) = 7.9125x + 6.4375$	0.9942	
Number of plants per cell: 0.11 m	$f(x) = -1.5625x^2 + 15.313x - 10^{-13}$	1	8.24
Number of plants per cell: 0.15 m	$f(x) = 8.5125x + 6.375$	0.997	
Number of plants per cell: 0.20 m	$f(x) = 9.5875x + 6.5625$	0.9975	
Leaf width			
Spacing: 1 plant per cell	$f(x) = -258.55x^2 + 68.473x + 5.0128$	0.6263	
Spacing: 2 plants per cell	$\bar{x}$ = 7.45 (non-significant)		13.57
Spacing: 3 plants per cell	$\bar{x}$ = 6.73 (non-significant)		
Spacing: 4 plants per cell	$\bar{x}$ = 6.25 (non-significant)		
Number of plants per cell: 0.07 m	$f(x) = -0.6522x + 8.9453$	0.9629	
Number of plants per cell: 0.11 m	$f(x) = 0.6182x^2 - 4.3759x + 13.813$	0.9827	13.92
Number of plants per cell: 0.15 m	$f(x) = -0.8274x + 9.5422$	0.9257	
Number of plants per cell: 0.20 m	$f(x) = -0.7558x + 8.9688$	0.9122	
Total chlorophyll index			
Spacing: 1 plant per cell	$f(x) = 33.887x + 39.48$	0.8072	
Spacing: 2 plants per cell	$f(x) = 546.25x^2 - 107.66x + 46.522$	0.9175	11.05
Spacing: 3 plants per cell	$f(x) = 44.889x + 37.28$	0.9655	
Spacing: 4 plants per cell	$f(x) = 34.315x + 37.985$	0.7354	
Number of plants per cell: 0.07 m	$\bar{x}$ = 41.53 (non-significant)		5.77
Number of plants per cell: 0.11 m	$f(x) = -0.6908x + 43.175$	0.4161	

Number of plants per cell: 0.15 m	$\bar{x}$ = 43.64 (non-significant)		
Number of plants per cell: 0.20 m	f(x) = -0.7387x + 48.075	0.7252	
Fresh weight of the shoot			
Spacing: 1 plant per cell	f(x) = 99.739x + 29.922	0.8304	
Spacing: 2 plants per cell	$\bar{x}$ = 47.54 (non-significant)		18.29
Spacing: 3 plants per cell	$\bar{x}$ = 49.28 (non-significant)		
Spacing: 4 plants per cell	$\bar{x}$ = 50.44 (non-significant)		
Number of plants per cell: 0.07 m	f(x) = 4.2474x + 34.09	0.7317	
Number of plants per cell: 0.11 m	f(x) = $-1.5655x^2 + 9.493x + 34.979$	0.1798	17.90
Number of plants per cell: 0.15 m	$\bar{x}$ = 48.95 (non-significant)		
Number of plants per cell: 0.20 m	$\bar{x}$ = 49.77 (non-significant)		
Dry weight of the shoot			
Spacing: 1 plant per cell	f(x) = 12.636x + 2.4041	0.8081	
Spacing: 2 plants per cell	$\bar{x}$ = 4.46 (non-significant)		22.17
Spacing: 3 plants per cell	f(x) = $73.974x^2 - 10.774x + 4.5478$	0.5873	
Spacing: 4 plants per cell	$\bar{x}$ = 4.69 (non-significant)		
Number of plants per cell: 0.07 m	f(x) = 0.3557x + 3.0623	0.7055	
Number of plants per cell: 0.11 m	f(x) = $-0.1075x^2 + 0.6296x + 3.4033$	0.0929	17.70
Number of plants per cell: 0.15 m	$\bar{x}$ = 4.83 (non-significant)		
Number of plants per cell: 0.20 m	$\bar{x}$ = 4.87 (non-significant)		
Productivity			
Spacing: 1 plant per cell	f(x) = -13252x + 4158.2	0.9448	
Spacing: 2 plants per cell	f(x) = -21873x + 5672.9	0.9529	26.07
Spacing: 3 plants per cell	f(x) = $247797x^2 - 88520x + 9656.8$	0.9548	
Spacing: 4 plants per cell	f(x) = $156759x^2 - 63740x + 8239.2$	0.9972	
Number of plants per cell: 0.07 m	f(x) = $-269.5x^2 + 1752x + 1899.2$	0.9915	
Number of plants per cell: 0.11 m	f(x) = $-94.881x^2 + 575.33x + 2119.9$	0.1798	20.20
Number of plants per cell: 0.15 m	$\bar{x}$ = 2175.41 (non-significant)		
Number of plants per cell: 0.20 m	$\bar{x}$ = 1659.13 (non-significant)		

Table S.2. Mean values of bromatological and nutrient composition of kale cultivated in NFT hydroponic system in bunches of young plants as a function of different row spacings and number of plants per cell (NPC), 27 days after transplanting. UFSCar, Araras (SP), 2020.

Spacing	Ashes		Lipids		P		K		S		Fe		Mn		Zn		B	
0,07	1,84	ns	0,60	ns	77,41	ns	355,21	ns	109,49	ns	1,386	ns	0,761	ns	0,346	ns	0,372	ns
0,11	1,84	ns	0,62	ns	76,61	ns	387,69	ns	107,63	ns	1,291	ns	0,771	ns	0,338	ns	0,373	ns
0,15	1,86	ns	0,53	ns	77,01	ns	384,32	ns	104,90	ns	1,385	ns	0,770	ns	0,362	ns	0,387	ns
0,20	1,89	ns	0,56	ns	78,79	ns	393,04	ns	106,53	ns	1,457	ns	0,775	ns	0,381	ns	0,404	ns
Number of plants per cell																		
1	1,87	ns	0,55	ns	77,38	ns	392,65	ns	103,20	ns	1,407	ns	0,793	ns	0,355	ns	0,377	ns
2	1,87	ns	0,58	ns	77,69	ns	378,17	ns	106,22	ns	1,350	ns	0,775	ns	0,361	ns	0,386	ns
3	1,84	ns	0,57	ns	77,62	ns	388,01	ns	108,73	ns	1,408	ns	0,765	ns	0,359	ns	0,388	ns
4	1,84	ns	0,61	ns	77,13	ns	361,43	ns	110,40	ns	1,355	ns	0,744	ns	0,352	ns	0,386	ns
CV Main plot (%)	4,87		16,48		20,24		18,83		15,20		18,21		17,81		26,72		18,47	
CV Sub-plot (%)	4,20		14,13		7,97		11,67		7,89		15,08		10,26		9,20		7,48	

Means within a column with similar letter are not significantly different ($p<0.05$) by the Tukey's test; ns: non-significant; CV: coefficient of variation.

Table S.3. Correlations among the plant height (PH), number of leaves (NL), leaf width (LW) and length (LL), petiole length (PL), fresh (FMS) and dry (DMS) weight of the shoot, productivity (PDR), total chlorophyll index (TCI), moisture (MS), ashes, protein (PT), fibre (FB), lipids, total carbohydrates (TC) and nutrients (N, P, K, Ca, Mg, S, Fe, Mn, Cu, Zn, B) of kale cultivated in NFT hydroponic system in bunches of young plants as a function of different row spacings and number of plants per cell (NPC), 27 days after transplanting. UFSCar, Araras (SP), 2020.

	PH	NL	LW	LL	PL	FMS	DMS	PDR	TCI	MS	Ashes	PT	FB	Lipids	TC	N	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn	B
PH	1.00	-0.65	0.64	0.71	0.78	-0.50	-0.67	0.62	-0.63	0.59	-0.28	-0.61	-0.58	0.22	-0.55	-0.67	-0.19	-0.06	-0.58	-0.60	-0.10	-0.26	0.24	-0.80	-0.67	-0.63
NL	-0.65	1.00	-0.91	-0.93	-0.09	0.61	0.50	0.04	-0.06	0.12	-0.21	-0.06	0.02	0.30	-0.15	0.00	0.03	-0.24	0.01	0.01	0.63	-0.02	-0.52	0.57	0.12	0.36
LW	0.64	-0.91	1.00	0.92	0.08	-0.42	-0.31	-0.09	0.10	-0.20	0.27	0.16	0.06	-0.34	0.23	0.07	0.06	0.45	-0.01	0.14	-0.58	0.05	0.55	-0.43	-0.13	-0.18
LL	0.71	-0.93	0.92	1.00	0.13	-0.56	-0.47	0.03	-0.02	-0.04	0.05	-0.01	-0.08	-0.35	0.09	-0.07	-0.08	0.25	-0.08	-0.08	-0.57	0.13	0.55	-0.53	-0.13	-0.36
PL	0.78	-0.09	0.08	0.13	1.00	-0.21	-0.51	0.86	-0.90	0.88	-0.47	-0.87	-0.81	0.56	-0.86	-0.90	-0.26	-0.32	-0.74	-0.79	0.34	-0.48	-0.16	-0.63	-0.80	-0.59
FMS	-0.50	0.61	-0.42	-0.56	-0.21	1.00	0.91	-0.10	0.05	-0.22	0.12	0.29	0.36	-0.21	0.20	0.20	0.11	0.26	0.09	0.29	0.32	0.14	0.15	0.32	0.34	0.44
DMS	-0.67	0.50	-0.31	-0.47	-0.51	0.91	1.00	-0.43	0.39	-0.54	0.32	0.60	0.55	-0.48	0.52	0.53	0.18	0.37	0.34	0.58	0.06	0.26	0.17	0.52	0.58	0.61
PDR	0.62	0.04	-0.09	0.03	0.86	-0.10	-0.43	1.00	-0.80	0.86	-0.40	-0.84	-0.77	0.51	-0.85	-0.92	-0.14	-0.45	-0.75	-0.75	0.51	-0.25	-0.15	-0.57	-0.61	-0.51
TCI	-0.63	-0.06	0.10	-0.02	-0.90	0.05	0.39	-0.80	1.00	-0.91	0.63	0.88	0.79	-0.52	0.88	0.91	0.46	0.28	0.70	0.86	-0.37	0.56	0.21	0.52	0.74	0.64
Moisture	0.59	0.12	-0.20	-0.04	0.88	-0.22	-0.54	0.86	-0.91	1.00	-0.60	-0.95	-0.85	0.61	-0.99	-0.95	-0.41	-0.61	-0.77	-0.95	0.44	-0.51	-0.37	-0.58	-0.79	-0.69
Ashes	-0.28	-0.21	0.27	0.05	-0.47	0.12	0.32	-0.40	0.63	-0.60	1.00	0.60	0.52	-0.33	0.52	0.47	0.20	0.21	0.47	0.63	-0.39	0.12	0.14	0.18	0.35	0.37

Protein	-0.61	-0.06	0.16	-0.01	-0.87	0.29	0.60	-0.84	0.88	-0.95	0.60	1.00	0.87	-0.63	0.90	0.93	0.45	0.51	0.68	0.91	-0.36	0.50	0.30	0.53	0.75	0.71
Fibre	-0.58	0.02	0.06	-0.08	-0.81	0.36	0.55	-0.77	0.79	-0.85	0.52	0.87	1.00	-0.40	0.80	0.82	0.44	0.49	0.64	0.79	-0.23	0.51	0.43	0.41	0.64	0.62
Lipids	0.22	0.30	-0.34	-0.35	0.56	-0.21	-0.48	0.51	-0.52	0.61	-0.33	-0.63	-0.40	1.00	-0.66	-0.55	-0.11	-0.42	-0.42	-0.54	0.48	-0.45	-0.48	-0.22	-0.68	-0.34
TC	-0.55	-0.15	0.23	0.09	-0.86	0.20	0.52	-0.85	0.88	-0.99	0.52	0.90	0.80	-0.66	1.00	0.93	0.37	0.64	0.77	0.92	-0.46	0.53	0.42	0.57	0.81	0.66
N	-0.67	0.00	0.07	-0.07	-0.90	0.20	0.53	-0.92	0.91	-0.95	0.47	0.93	0.82	-0.55	0.93	1.00	0.43	0.44	0.69	0.89	-0.36	0.48	0.28	0.59	0.76	0.69
P	-0.19	0.03	0.06	-0.08	-0.26	0.11	0.18	-0.14	0.46	-0.41	0.20	0.45	0.44	-0.11	0.37	0.43	1.00	0.22	0.00	0.57	0.44	0.56	0.40	0.23	0.45	0.73
K	-0.06	-0.24	0.45	0.25	-0.32	0.26	0.37	-0.45	0.28	-0.61	0.21	0.51	0.49	-0.42	0.64	0.44	0.22	1.00	0.44	0.63	-0.26	0.19	0.47	0.34	0.37	0.42
Ca	-0.58	0.01	-0.01	-0.08	-0.74	0.09	0.34	-0.75	0.70	-0.77	0.47	0.68	0.64	-0.42	0.77	0.69	0.00	0.44	1.00	0.65	-0.50	0.44	0.05	0.59	0.55	0.43
Mg	-0.60	0.01	0.14	-0.08	-0.79	0.29	0.58	-0.75	0.86	-0.95	0.63	0.91	0.79	-0.54	0.92	0.89	0.57	0.63	0.65	1.00	-0.20	0.48	0.32	0.67	0.79	0.84
S	-0.10	0.63	-0.58	-0.57	0.34	0.32	0.06	0.51	-0.37	0.44	-0.39	-0.36	-0.23	0.48	-0.46	-0.36	0.44	-0.26	-0.50	-0.20	1.00	0.00	-0.17	0.12	-0.08	0.27
Fe	-0.26	-0.02	0.05	0.13	-0.48	0.14	0.26	-0.25	0.56	-0.51	0.12	0.50	0.51	-0.45	0.53	0.48	0.56	0.19	0.44	0.48	0.00	1.00	0.49	0.26	0.60	0.53
Mn	0.24	-0.52	0.55	0.55	-0.16	0.15	0.17	-0.15	0.21	-0.37	0.14	0.30	0.43	-0.48	0.42	0.28	0.40	0.47	0.05	0.32	-0.17	0.49	1.00	-0.27	0.35	0.19
Cu	-0.80	0.57	-0.43	-0.53	-0.63	0.32	0.52	-0.57	0.52	-0.58	0.18	0.53	0.41	-0.22	0.57	0.59	0.23	0.34	0.59	0.67	0.12	0.26	-0.27	1.00	0.65	0.75
Zn	-0.67	0.12	-0.13	-0.13	-0.80	0.34	0.58	-0.61	0.74	-0.79	0.35	0.75	0.64	-0.68	0.81	0.76	0.45	0.37	0.55	0.79	-0.08	0.60	0.35	0.65	1.00	0.76
B	-0.63	0.36	-0.18	-0.36	-0.59	0.44	0.61	-0.51	0.64	-0.69	0.37	0.71	0.62	-0.34	0.66	0.69	0.73	0.42	0.43	0.84	0.27	0.53	0.19	0.75	0.76	1.00