Supplementary Material

Biomass Estimation of Apple and Citrus Trees Using Terrestrial Laser Scanning and Drone-mounted RGB Sensor

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Table S1. Biomass of trees and remote sensing measurements for apple 'Fuji'/M.9 variety were measured in this study. Abbreviations: TLS, terrestrial laser scanning; Drone, drone-mounted RGB sensor; AGB, aboveground biomass; BGB, belowground biomass; AGV, aboveground volume; BGV, belowground volume.

Tree code	Total biomass (kg)	AGB (kg)	BGB (kg)	TLS measurement			Drone measurement
				AGV (m^3)	BGV (m^3)	Crown_area (m^2)	Crown_area (m^2)
AP_4_1	2.06	1.73	0.33	3.37	0.24	1.53	3.92
AP_4_2	2.56	2.07	0.48	3.17	0.18	1.40	4.01
AP_4_3	2.42	2.01	0.41	2.85	0.19	0.83	3.43
AP_6_1	7.764	5.743	2.021	2.75	0.38	1.99	6.66
AP_6_2	8.284	5.433	2.851	1.91	0.29	2.45	6.63
AP_6_3	7.293	5.08	2.213	1.03	0.48	1.89	6.05
AP_10_1	23.64	18.87	4.77	6.24	0.75	3.50	10.95
AP_10_2	18.32	14.31	4.02	6.82	0.51	4.62	9.31
AP_10_3	10.2	7.23	2.97	5.19	0.51	4.05	6.72
AP_10_4	17.602	11.263	6.339	4.43	0.39	3.35	8.83
AP_10_5	17.075	12.318	4.757	4.60	0.16	3.24	11.36
AP_10_6	17.591	11.959	5.632	4.33	0.26	2.70	8.13
AP_14_1	22.957	16.537	6.42	7.53	0.24	2.90	6.78
AP_14_2	24.032	18.572	5.46	7.34	0.02	3.74	8.70
AP_14_3	21.55	15.57	5.98	6.34	0.15	3.44	10.72

Table S2. Biomass of trees and remote sensing measurements for citrus 'Miyagawa-wase' satsuma mandarin variety were measured in this study. Abbreviations are shown in Table S1.

Tree code	Total biomass (kg)	AGB (kg)	BGB (kg)	TLS Measurement			Drone measurement
				AGV(m^3)	BGV (m^3)	Crown_area (m^2)	Crown_area (m^2)
CT_10_1	33.8	22.63	11.17	8.01	0.17	7.70	11.82
CT_10_2	26.33	17.17	9.16	3.14	0.39	5.11	8.78
CT_10_3	27.23	19.39	7.84	5.12	0.07	4.14	6.08
CT_18_1	61.76	41	20.76	8.56	0.64	7.07	10.16
CT_18_2	41.88	32.11	9.77	6.88	0.25	5.71	7.75
CT_18_3	38.76	32.96	5.80	8.13	0.33	6.71	6.77
CT_19_1	39.41	27.00	12.41	1.98	0.80	7.58	17.15
CT_19_2	44.45	32.00	12.45	3.65	0.90	9.74	18.50
CT_30_1	62.85	44.14	18.71	8.43	0.76	16.21	22.75
CT_30_2	48.02	32.08	15.94	6.29	1.09	11.75	17.91
CT_35_1	51.8	40.8	11.00	6.08	0.72	9.02	29.54
CT_35_2	50.36	38.36	12.00	4.26	0.72	12.35	29.36
CT_40_1	48.27	31.46	16.81	8.47	1.31	13.43	8.43
CT_40_2	50.18	39.79	10.39	8.79	0.501	15.30	9.43
CT_45_1	81.95	54.77	27.17	10.73	0.21	12.27	23.28
CT_45_2	100.73	67.90	32.84	11.69	0.46	11.53	21.12
CT_45_3	110.18	74.92	35.26	15.97	0.24	11.60	21.68
CT_45_4	132.28	98.50	33.77	17.51	0.28	14.91	26.55
CT_45_5	87.06	67.49	19.58	13.67	0.26	9.59	15.66
CT_45_6	84.03	56.37	27.64	12.79	0.25	10.17	18.64

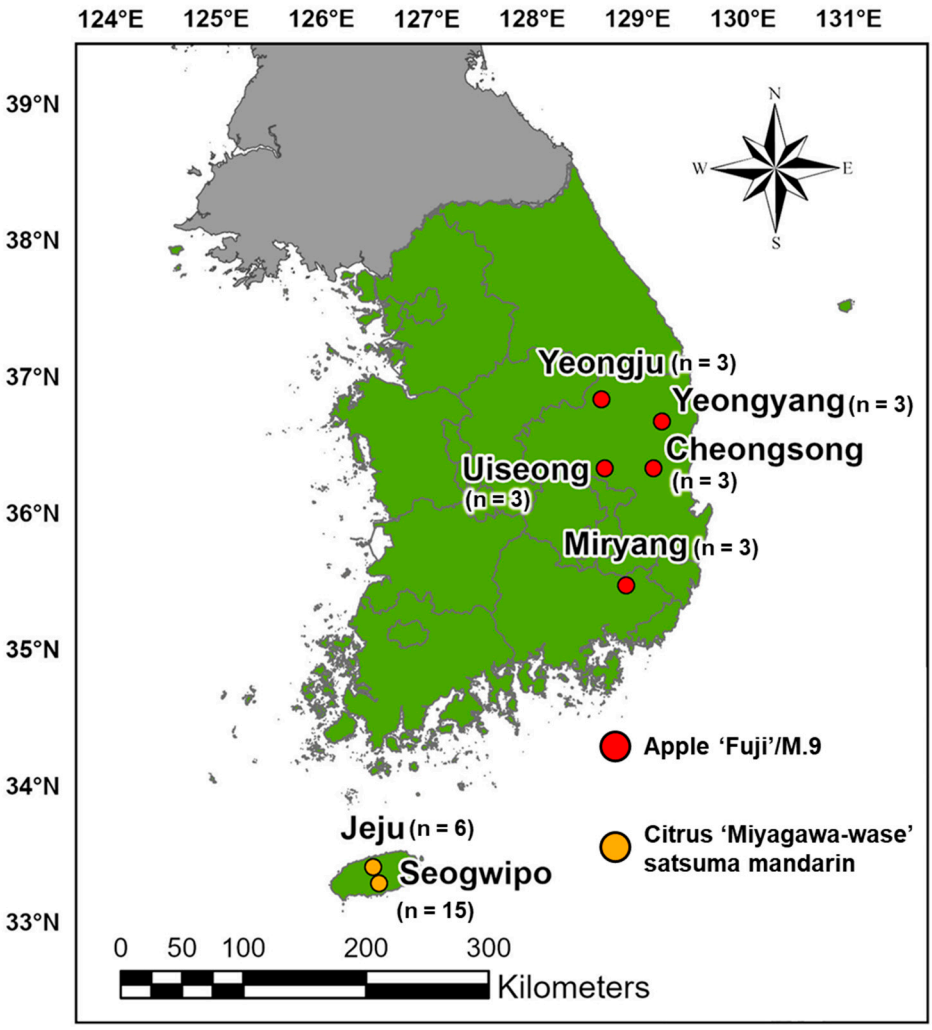


Figure S1. Geographic locations where tree excavation was performed.

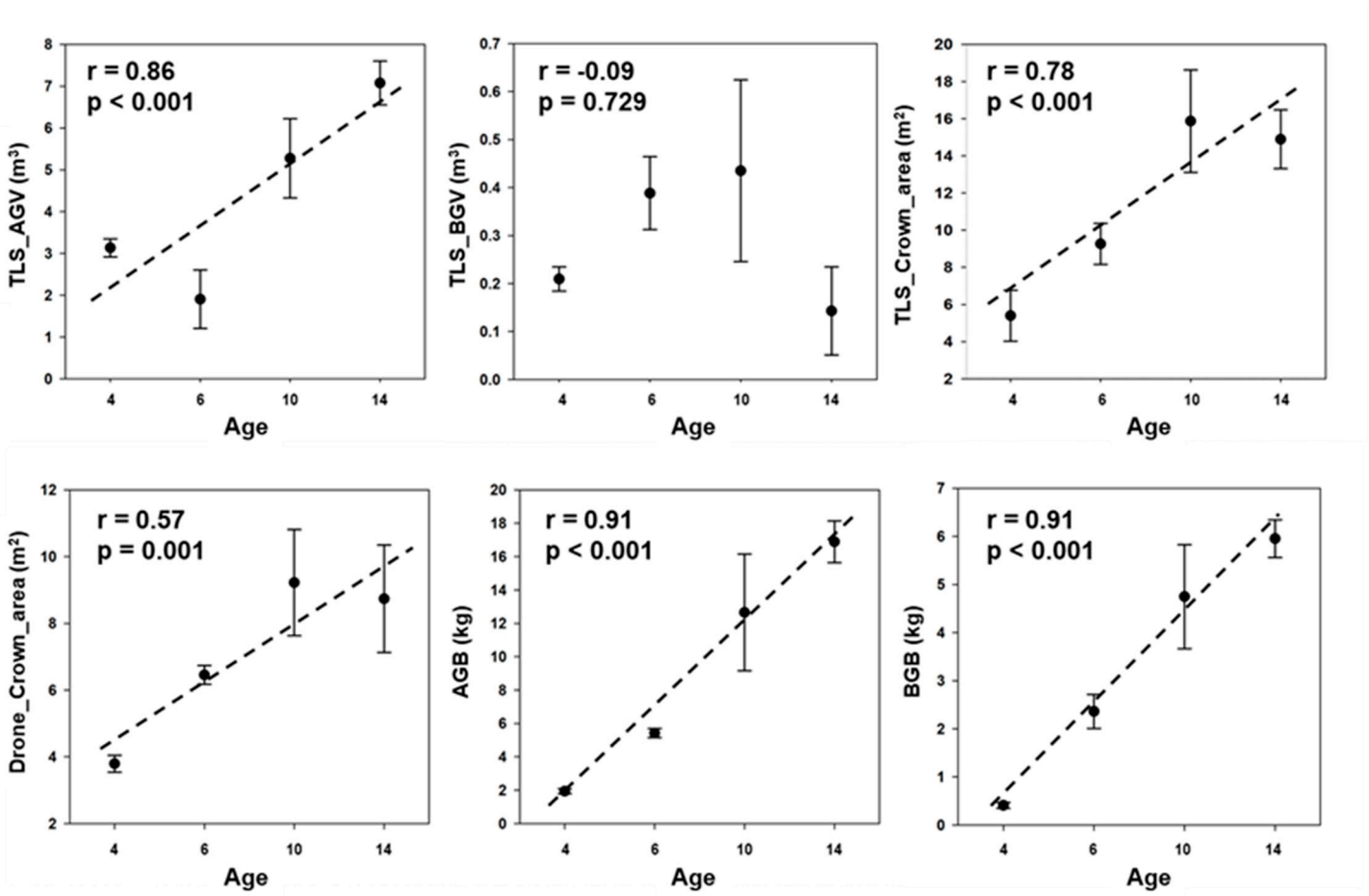


Figure S2. Relationships of six dependent variables with age for apple trees, 'Fuji'/M.9 variety. There is the correlation coefficient (r) in each plot, and the plot without the dotted line indicates the statistical nonsignificance of the correlation analysis ($P > 0.05$). Abbreviations: AGB, aboveground biomass; AGV, aboveground volume; BGB, belowground biomass; BGV, belowground volume; TLS, terrestrial laser scanning; Drone, drone-mounted RGB sensor.

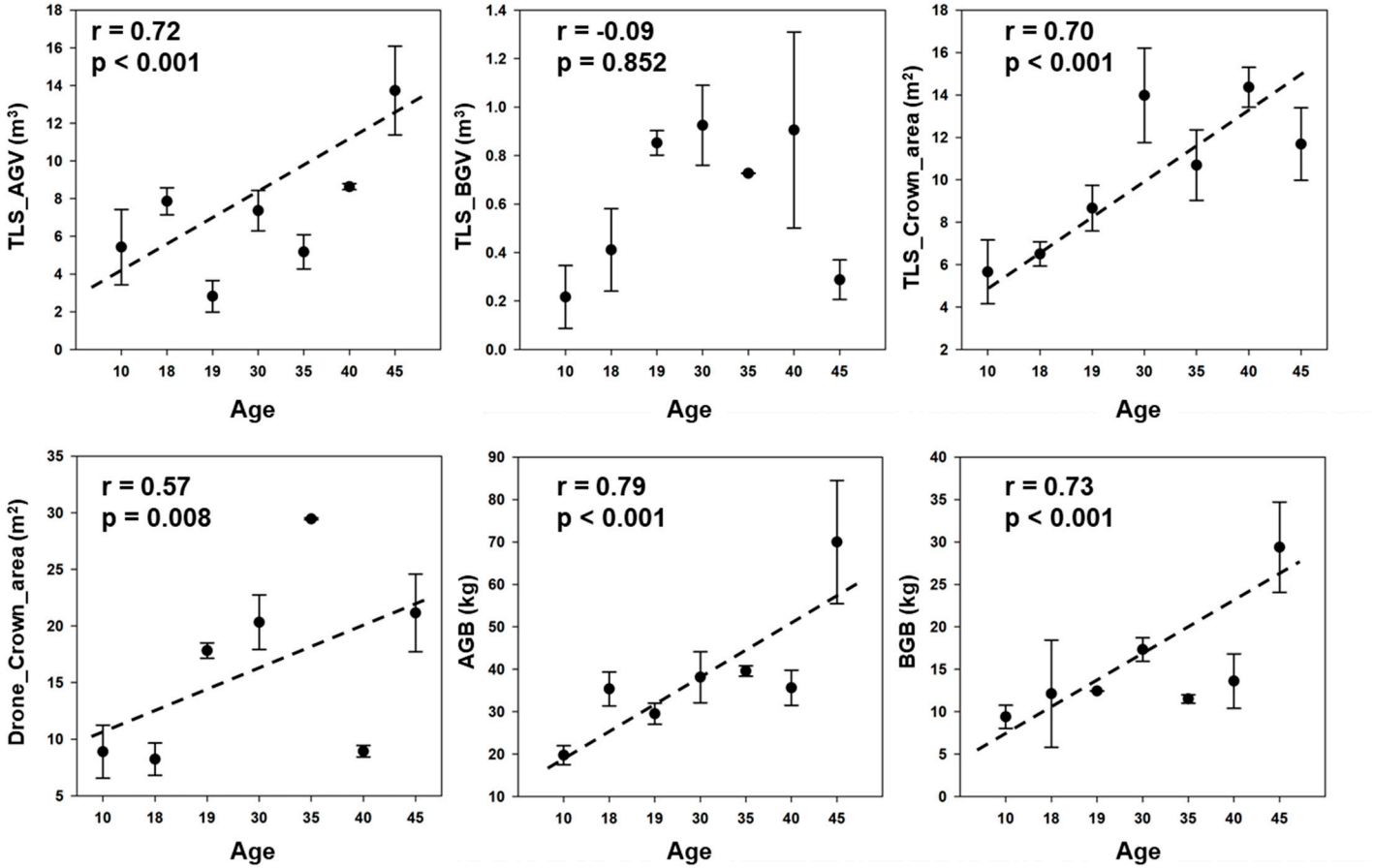


Figure S3. Relationships between six dependent variables with age for citrus trees, 'Miyagawa-wase' satsuma mandarin variety. There is the correlation coefficient (r) in each plot, and the plot without the dotted line indicates the statistical nonsignificance of the correlation analysis ($P > 0.05$). Abbreviations are shown in Figure S2.

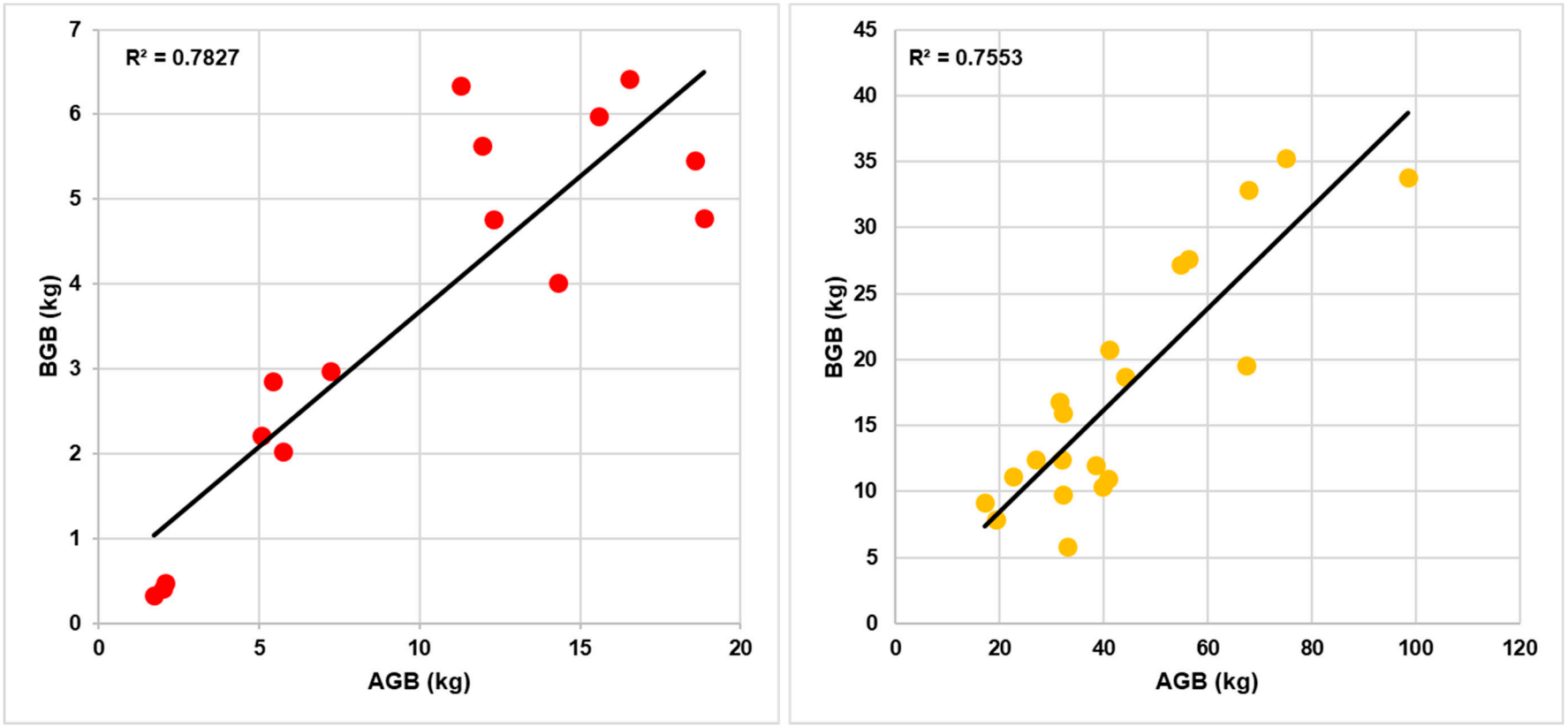


Figure S4. Bivariate graph comparing the relationship between aboveground and belowground biomass of apple and citrus trees. Abbreviations are shown in Figure S2.