ERRATUM

Erratum to: Evaluation of the best linear unbiased prediction method for breeding values of fruit-quality traits in citrus

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Unfortunately, all of the tables (Tables 1, 2, 3, 4, 5, and 6) in the original version of this article were misprinted in the process of proof reading. The correct tables are reprinted below with their legends.

Data Archiving Statement

All relevant data of the original article are presented in this errata and in the Supplementary Materials of the original article.

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Table 1 List of parental cultivars/genotypes and their usage frequencies in the Kuchinotsu Citrus Breeding Program at the National Institute of Fruit Tree Science (NIFTS-KCBP) from 2009 to 2012

Name ^a	Species or parentage ^b	Accession ^c	No. of crosses ^d
satsuma mandarin	<i>Citrus unshiu</i> Marcow.	‘Okitsu wase’(170630)	9
clementine	<i>Citrus clementina</i> hort. ex Tanaka	Stock strain (113161)	1
sweet orange	<i>Citrus sinensis</i> (L.) Osbeck	‘Trovita’(172154)	2
iyō	<i>Citrus iyo</i> hort. ex Tanaka	‘Miyauchi’(117374)	0
hyuga-natsu	<i>Citrus tamurana</i> hort. ex Tanaka	Stock strain (117317)	2
grapefruit	<i>Citrus paradisi</i> Macfad.	‘Duncan’(168864)	2
dancy tangerine	<i>Citrus tangerina</i> hort. ex Tanaka	Stock strain (117396)	0
king mandarin	<i>Citrus nobilis</i> Lour.	Stock strain (117386)	1
mediterranean mandarin	<i>Citrus deliciosa</i> Ten.	Stock strain (117393)	0
ponkan	<i>Citrus reticulata</i> Blanco	‘Yoshida’(113178)	5
kishu mandarin	<i>Citrus kinokuni</i> hort. ex Tanaka	‘Mukaku-kishu’(171490)	0
hassaku	<i>Citrus hassaku</i> hort. ex Tanaka	Stock strain (115524)	0
Tanikawa-buntan	unknown origin	Stock strain (117433)	0
San-jacinto	unknown origin	Stock strain (113350)	1
Soren-tangelo	unknown origin	Stock strain (113347)	1
tankan	<i>Citrus tankan</i> Hayata	‘Tarumizu 1 Gou’(113508)	7
Murcott	unknown origin	Stock strain (113374)	0
Nankou	satsuma mandarin × clementine	Stock strain (117160)	8
HF15	satsuma mandarin × sweet orange	Stock strain (n.a.)	0
HF17	satsuma mandarin × sweet orange	Stock strain (n.a.)	0
HF20	satsuma mandarin × sweet orange	Stock strain (n.a.)	0
HF21	satsuma mandarin × sweet orange	Stock strain (n.a.)	0
HF9	satsuma mandarin × sweet orange	Stock strain (n.a.)	1
Aki Tangor	satsuma mandarin × sweet orange	Stock strain (n.a.)	7
Kiyomi	satsuma mandarin × sweet orange	Stock strain (115521)	3
Minneola	grapefruit × dancy tangerine	Stock strain (113377)	0
Orlando	grapefruit × dancy tangerine	Stock strain (113327)	0
Encore	king mandarin × mediterranean mandarin	Stock strain (117421)	0
Wilking	king mandarin × mediterranean mandarin	Stock strain (117425)	1
Ariake	sweet orange × clementine	Stock strain (117158)	0
Sweet Spring	satsuma mandarin × hassaku	Stock strain (168866)	1
No. 1087	iyō × sweet orange	Stock strain (n.a.)	0
Awa Orange	hyuga-natsu × sweet orange	Stock strain (115757)	0
JHG	satsuma mandarin × hyuga-natsu	Stock strain (n.a.)	3
Kara	satsuma mandarin × king mandarin	Stock strain (113158)	4
Hayaka	satsuma mandarin × ponkan	Stock strain (117154)	0
Kankitsu Chukanbohon Nou 6 Gou	king mandarin × Mukaku-kishu	Stock strain (223661)	4
Southern Yellow	Tanikawa-buntan × Mukaku-kishu	Stock strain (117470)	3
Nishinokaori	Kiyomi × sweet orange	Stock strain (118841)	2
Osceola	clementine × Orlando	Stock strain (113329)	0
Lee	clementine × Orlando	Stock strain (113385)	0
Robinson	clementine × Orlando	Stock strain (113386)	0
KyOw14	Kiyomi × satsuma mandarin	Stock strain (n.a.)	4
KyOw21	Kiyomi × satsuma mandarin	Stock strain (n.a.)	0
EnOw20	Encore × satsuma mandarin	Stock strain (n.a.)	0
EnOw21	Encore × satsuma mandarin	Stock strain (n.a.)	1

Table 1 (continued)

Name ^a	Species or parentage ^b	Accession ^c	No. of crosses ^d
EnOw7	Encore × satsuma mandarin	Stock strain (n.a.)	0
EnOw8	Encore × satsuma mandarin	Stock strain (n.a.)	0
Shiranuhi	Kiyomi × ponkan	Stock strain (117159)	14
Setomi	Kiyomi × ponkan	Stock strain (223670)	5
Harumi	Kiyomi × ponkan	Stock strain (117468)	6
Youkou	Kiyomi × ponkan	Stock strain (n.a.)	0
Page	clementine × Minneola	Stock strain (113370)	0
No. 2681	Kiyomi × iyo	Stock strain (n.a.)	0
Tsunonozomi	Kiyomi × Encore	Stock strain (n.a.)	6
KyEn4	Kiyomi × Encore	Stock strain (n.a.)	0
KyEn5	Kiyomi × Encore	Stock strain (n.a.)	1
Amaka	Kiyomi × Encore	Stock strain (118843)	0
Tamami	Kiyomi × Wilking	Stock strain (223657)	4
F118	Kiyomi × Wilking	Stock strain (n.a.)	0
Okitsu 45 Gou	Kiyomi × Wilking	Stock strain (n.a.)	0
Benibae	HF9 × Encore	Stock strain (n.a.)	10
HF9 · En29	HF9 × Encore	Stock strain (n.a.)	0
A7	Sweet Spring × sweet orange	Stock strain (n.a.)	0
Okitsu 46 Gou	Sweet Spring × sweet orange	Stock strain (n.a.)	2
Hareyaka	Encore × satsuma mandarin	Stock strain (117510)	0
M5	Kiyomi × dancy tangerine	Stock strain (n.a.)	0
2700 · Oly25	Nishinokaori × iyo	Stock strain (n.a.)	0
E647	Kiyomi × Osceola	Stock strain (n.a.)	6
KyOw21 · D4	KyOw21 × dancy tangerine	Stock strain (n.a.)	0
KyOw21 · D49	KyOw21 × dancy tangerine	Stock strain (n.a.)	0
Kuchinotsu 28 Gou	KyOw21 × dancy tangerine	Stock strain (n.a.)	0
Kuchinotsu 27 Gou	EnOw21 × Youkou	Stock strain (n.a.)	6
Seinannohikari	EnOw21 × Youkou	Stock strain (n.a.)	8
Amakusa	KyOw14 × Page	Stock strain (117161)	1
Kuchinotsu 33 Gou	KyOw14 × Encore	Stock strain (n.a.)	2
Tsunokagayaki	KyOw14 × Encore	Stock strain (n.a.)	12
Kuchinotsu 18 Gou	KyOw21 × Encore	Stock strain (n.a.)	0
Kuchinotsu 35 Gou	KyOw21 × Encore	Stock strain (n.a.)	3
Kuchinotsu 38 Gou	KyOw21 × Robinson	Stock strain (n.a.)	1
No. 1408	EnOw21 × No. 2681	Stock strain (n.a.)	1
Kankitsu Chukanbohon Nou 5 Gou	Lee × Mukaku-kishu	Stock strain (223660)	1
990343	Tsunonozomi × Benibae	Stock strain (n.a.)	2
Kanpei	Nishinokaori × Shiranuhi	Stock strain (n.a.)	5
Okitsu 57 Gou	Okitsu 46 Gou × Harumi	Stock strain (n.a.)	15
Asumi	Okitsu 46 Gou × Harumi	Stock strain (n.a.)	3
Okitsu 59 Gou	A7 × F118	Stock strain (n.a.)	1
Setoka	Tsunonozomi × Murcott	Stock strain (118842)	5
KyEn5 · En6	KyEn5 × Encore	Stock strain (n.a.)	0
Reikou	KyEn5 × Murcott	Stock strain (n.a.)	0
Kuchinotsu 36 Gou	KyEn5 × Murcott	Stock strain (n.a.)	3
KyOw21 · CC33	KyOw21 × clementine	Stock strain (n.a.)	0

Table 1 (continued)

Name ^a	Species or parentage ^b	Accession ^c	No. of crosses ^d
KyOw21 · Ariake22	KyOw21 × Ariake	Stock strain (n.a.)	0
Kuchinotsu 40 Gou	KyOw21 × No. 1087	Stock strain (n.a.)	1
Haruhi	Okitsu 46 Gou × Awa Orange	Stock strain (n.a.)	1
LeeAo25	Lee × satsuma mandarinLee × satsuma mandarin	Stock strain (n.a.)	0
LeeAo35	Lee × satsuma mandarinLee × satsuma mandarin	Stock strain (n.a.)	0
LeeAo9	Lee × satsuma mandarinLee × satsuma mandarin	Stock strain (n.a.)	0
No. 1010	Nankou × 2700 · OIy 25	Stock strain (n.a.)	0
No. 1011	Nankou × 2700 · OIy 25	Stock strain (n.a.)	7
Harehime	E647 × satsuma mandarin	Stock strain (n.a.)	9
Kuchinotsu 51 Gou	KyOw21 · D4 × Kuchinotsu 27 Gou	Stock strain (n.a.)	1
No. 1051	HF9 × 2700 · OIy 25	Stock strain (n.a.)	0
Ehime Kashi No. 28	Nankou × Amakusa	Stock strain (n.a.)	5
Kuchinotsu 52 Gou	Tsunokagayaki × Ariake	Stock strain (n.a.)	0
960203	Kuchinotsu 18 Gou × Youkou	Stock strain (n.a.)	3
Kuchinotsu 49 Gou	Kuchinotsu 38 Gou × No. 1408	Stock strain (n.a.)	6
Mihaya	Tsunonozomi × No. 1408	Stock strain (n.a.)	8
980389	HF15 × No. 1408	Stock strain (n.a.)	7
Okitsu 56 Gou	Okitsu 45 Gou × Kankitsu Chukanbohon Nou 5 Gou	Stock strain (n.a.)	6
031060	Harehime × clementine	Stock strain (n.a.)	2

^a Names in bold represent founding genotypes of NIFTS-KCBP, consisting of 13 known species and four genotypes of unknown origin

^b Regarding 13 species in founding genotypes, we selected a representative cultivar within each species for phenotypic evaluation

^c Accessions used for phenotypic evaluation. Numbers in parentheses represent the accession ID (JP number) in the NIAS germplasm collection. Accessions with “n.a.” have not been registered in the collection

^d Number of crosses that the parent was involved in within 126 pair-cross families used in this study. “0” indicates their descendant genotypes were used as cross-parents

Table 2 The nine fruit-quality traits evaluated in this study

Trait	Data type	Measurement unit
Fruit weight	Continuous	Mean weight of mature fruits (g)
Fruit skin color	Ordinal	1:yellow, 2:orange, 3:red
Fruit surface texture	Ordinal	1:rough, 2:medium, 3:smooth
Peelability	Ordinal	1:difficult, 2:medium, 3:easy
Flesh color	Ordinal	1:yellow, 2:light-orange, 3:orange
Pulp firmness	Ordinal	1:firm, 2:medium, 3:soft
Segment firmness	Ordinal	1:firm, 2:medium, 3:soft
Sugar content	Continuous	Mean Brix of juice (Brix%)
Acid content	Continuous	Mean citric acid concentration of juice (%)

Table 3 Summary statistics based on yearly means of individual genotypes of the nine fruit-quality traits evaluated in this study

Year	Descriptive statistics ^a	Traits								
		FW (g)	FSC	FST	PE	FC	PF	SF	SC (Brix%)	AC (%)
2009	Mean	139.3	2.12	2.47	2.60	2.94	2.69	2.64	11.9	1.20
	S.D.	61.7	0.46	0.61	0.61	0.26	0.62	0.60	1.6	0.55
	Min	29.7	1	1	1	1	1	1	8.4	0.46
	Max	626.0	3	3	3	3	3	3	16.6	3.37
	Records	422	418	421	421	421	346	346	421	421
2010	Mean	152.9	2.13	2.53	2.57	2.95	2.67	2.62	12.0	1.29
	S.D.	66.3	0.39	0.66	0.65	0.25	0.57	0.61	1.5	0.55
	Min	30.6	1	1	1	1	1	1	8.2	0.54
	Max	621.5	3	3	3	3	3	3	18.3	4.16
	Records	619	618	618	618	618	618	617	617	614
2011	Mean	190.2	2.13	2.46	2.48	2.92	2.59	2.54	10.9	1.22
	S.D.	81.4	0.43	0.68	0.72	0.28	0.62	0.63	1.4	0.54
	Min	38.2	1	1	1	1	1	1	7.4	0.41
	Max	949.5	3	3	3	3	3	3	16.2	3.83
	Records	640	639	639	640	640	637	639	640	640
2012	Mean	154.1	2.01	2.34	2.38	2.84	2.58	2.52	11.6	1.47
	S.D.	59.7	0.51	0.71	0.78	0.41	0.66	0.62	1.3	0.66
	Min	32.8	1	1	1	1	1	1	7.7	0.58
	Max	541.0	3	3	3	3	3	3	16.2	4.48
	Records	1782	1780	1781	1781	1781	1781	1780	1777	1778

FW fruit weight, FSC fruit skin color, FST fruit surface texture, PE peelability, FC flesh color, PF pulp firmness, SF segment firmness, SC sugar content, AC acid content

^a The means represent raw means unadjusted for the combination of remaining effects and are different in genotype for each year.

The other summary statistics also differ with genotype for each year.

Table 4 Best linear unbiased estimator (BLUE) values of intercepts and year effects for nine fruit-quality traits

Traits	Best linear unbiased estimator (BLUE)				
	Intercept ^a	2009	2010	2011	2012
Fruit weight (g)	178.9 ± 17.6 ^b	0	11.9 ± 2.8	50.3 ± 2.8	13.2 ± 2.5
Fruit skin color	1.85 ± 0.11	0	0.06 ± 0.02	0.07 ± 0.02	-0.04 ± 0.02
Fruit surface texture	2.54 ± 0.14	0	0.04 ± 0.04	-0.01 ± 0.04	-0.12 ± 0.03
Peelability	2.23 ± 0.16	0	-0.12 ± 0.04	-0.20 ± 0.04	-0.30 ± 0.03
Flesh color	2.48 ± 0.08	0	0.02 ± 0.02	0.01 ± 0.02	-0.07 ± 0.01
Pulp firmness	2.72 ± 0.15	0	-0.05 ± 0.04	-0.15 ± 0.04	-0.14 ± 0.03
Segment firmness	2.37 ± 0.13	0	-0.02 ± 0.04	-0.13 ± 0.04	-0.15 ± 0.03
Sugar content (Brix%)	11.4 ± 0.4	0	0.0 ± 0.1	-1.2 ± 0.1	-0.4 ± 0.1
Acid content (%)	1.79 ± 0.18	0	0.03 ± 0.02	-0.03 ± 0.02	0.19 ± 0.02

^a The BLUE of each intercept includes the year effect of 2009

^b The number following the plus-minus sign (±) relates to the standard error of each estimate

Table 5 Estimates of narrow-sense heritabilities (diagonal and in bold) and genetic (upper triangle) and phenotypic (lower triangle) correlations for the nine fruit-quality traits

	Fruit weight	Fruit skin color	Fruit surface texture	Peelability	Flesh color	Pulp firmness	Segment firmness	Sugar content	Acid content
Fruit weight	0.77 ± 0.01a	-0.09 ± 0.04	-0.07 ± 0.05	-0.18 ± 0.04	-0.17 ± 0.04	-0.08 ± 0.04	0.18 ± 0.05	-0.19 ± 0.03	0.12 ± 0.03
Fruit skin color	-0.06 ± 0.03	0.63 ± 0.02	-0.06 ± 0.05	0.12 ± 0.05	0.35 ± 0.04	0.03 ± 0.05	0.09 ± 0.05	0.08 ± 0.04	-0.08 ± 0.03
Fruit surface texture	-0.09 ± 0.03	-0.03 ± 0.03	0.46 ± 0.03	0.06 ± 0.06	-0.03 ± 0.06	0.03 ± 0.06	0.28 ± 0.06	-0.04 ± 0.05	0.00 ± 0.04
Peelability	-0.11 ± 0.02	0.04 ± 0.03	0.12 ± 0.03	0.54 ± 0.02	0.17 ± 0.05	0.38 ± 0.05	-0.04 ± 0.06	-0.07 ± 0.04	-0.13 ± 0.04
Flesh color	-0.13 ± 0.02	0.28 ± 0.02	-0.01 ± 0.03	0.08 ± 0.03	0.63 ± 0.02	0.17 ± 0.05	0.12 ± 0.06	0.09 ± 0.04	-0.17 ± 0.03
Pulp firmness	-0.09 ± 0.03	0.03 ± 0.03	0.07 ± 0.03	0.22 ± 0.02	0.17 ± 0.03	0.58 ± 0.02	0.02 ± 0.06	0.10 ± 0.04	0.01 ± 0.04
Segment firmness	0.08 ± 0.03	0.05 ± 0.03	0.15 ± 0.02	0.04 ± 0.03	0.07 ± 0.03	0.05 ± 0.03	0.45 ± 0.03	0.30 ± 0.05	-0.07 ± 0.04
Sugar content	-0.17 ± 0.02	0.08 ± 0.02	0.00 ± 0.03	-0.05 ± 0.03	0.08 ± 0.03	0.08 ± 0.03	0.16 ± 0.02	0.74 ± 0.01	0.02 ± 0.03
Acid content	0.06 ± 0.02	-0.06 ± 0.02	0.02 ± 0.02	-0.10 ± 0.02	-0.12 ± 0.02	0.01 ± 0.02	-0.04 ± 0.02	0.03 ± 0.02	0.91 ± 0.00

^a The number following the plus-minus sign (±) indicates the standard error of each estimate

Table 6 Illustration of best linear unbiased predictions (BLUPs) of breeding values for fruit weight in parental cultivars (upper) and F1 offspring (lower) evaluated in this study

Name	Number of relatives	Fruit weight (g)			
		GV ^a	BV ^b	Rank ^c	Accuracy ^d
satsuma mandarin	2057	155.6	-23.3	639	0.95
sweet orange	2015	161.2	-17.7	550	0.94
ponkan	1044	173.8	-5.1	414	0.96
Kiyomi	2061	197.9	19.0	221	0.95
Shiranuhi	2063	201.6	22.7	195	0.96
050317	2063	206.7	27.9	158	0.92
050473	2105	120.0	-58.9	1334	0.93
050847	2063	165.7	-13.1	490	0.89
060084	2114	156.0	-22.9	636	0.91
060710	2095	199.0	20.1	213	0.92

^a Estimated genotypic values, calculated as the sum of the intercept and the breeding value

^b Predicted breeding values

^c Ranking for favorable fruit quality among all 2122 genotypes evaluated in this study based on predicted breeding value

^d Accuracy, i.e., the reliability index of the predicted breeding values, was the inferred correlation between the true and predicted breeding values