イチジク品種の着果および果実生育特性

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Growing Characteristics of Second Crop Fruits of Various Fig (*Ficus carica* L.) Varieties

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Fig trees (*Ficus carica* L.) are cultivated worldwide, but little attention has been given to their varieties concerning proper classification and fruit-growth dynamics. In this study, we compared the fruit growth characteristics of fig varieties and explored how morphological traits might help with its identification. The selected fig trees were introduced under 37 names and cultivated in an open field at the Toyo Institute of Food Technology. After analysing the similarities between tree and fruit characteristics, they were consolidated into 25 varieties, and 24 were identified as representative variety names based on the literature. Shoot basal width, fruit set date, set rate, enlargement pattern, maturation date and rate, and size and weight at maturation were recorded. Our results showed that (1) the differences in fruit size and maturation time between varieties were primarily determined by the size of the young fruit at the end of enlargement-stage I and the length of enlargement-stage II, respectively; (2) fruit maturation was characterised by order of fruit set, i.e. sequential maturation from the base of the shoots to the tips, although this was disrupted in some varieties by the excessive growth of shoots; and (3) fruit size decreased from the base to the tip of shoots in all varieties, and this pattern was most marked in larger-fruit varieties.

Key words: cultivar name, fruit enlargement, fruit maturation, fruit set, growing stage, homonym, synonym.

1.Introduction

Fig trees (*Ficus carica* L.) have been valuable plants for humankind since ancient times [1]. They are cultivated worldwide, including in the Near and Middle East, the Mediterranean region, the United States, Brazil, China, India, and Japan. Still, the annual production of figs (1,264,943 t) is not as large as that of other relevant fruits, such as apples (86,442,716 t), grapes (78,034,332 t), and oranges (75,458,588 t)[2]. Therfore, despite their long history of cultivation, scientific research on fig trees and fruits remains limited compared to other fruit types.

As well as shedding light on how to better select varieties for cultivation, studying fruit growth is crucial for understanding fig-growing physiology and refining variety-specific cultivation methods, such as pollination timing, the correct period for applying pesticides and plant-growth regulators, controlling the nutrients condition of fruit-bearing shoots, and estimating harvest periods and yield size.

As one of the main characteristics of fig trees, fruit development happens progressively from the base to the apex of reproductive shoots[3] and undergoes three stages of enlargement: stage I (a rapid increase), stage II (almost no change in growth), and stage III (a marked increase) [4,5]. However, there is very limited information on the extent to which varieties share these growth characteristics or whether there are exceptions[6].

Some discrepancies in variety names complicate detailed studies on figs due to a plethora of synonyms and homonyms[7], and some authors attempted to resolve these issues based on morphological classification[7,8,9,10]. However, in numerous cases, one variety is still called by different synonyms[11].

In this study, we sought to characterise the second crop of different fig varieties based on key features, including fruit set, maturation, and enlargement. We also present our results of cross-checking representative variety names and their characteristics, hoping to

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Table 1 (1st half). List of the studied varieties of fig and a comparison of their morphological characteristics with referenced literatures.

Representative names of varieties				Archipel [w]	Barnissotte	Blanche	Bordeaux	Bourjassotte Grise	Bourjassotte Noire [v]	Brown Turkey	Brunswick	Conadria	Dottato	(Dreamy Sweet) [u]
Names of introduced to TIFT (underline indicates a match with one of the representative names, synonyms, homonyms, or misnomers in the referenceed literature).				Lisa	Negro Largo, Bellone	Athènes, White Marseilles	Negronne	Bourjassotte Grise	Violette de Solliès, Noire Sucre	Brown Turkey	Brunswick, Mission	Conadria	Kadota, Goutte d'Or	Dreamy Sweet
Planted year				2008	2008	2008	2008	2008	2008	2008	2008	2020	2008	2017
Number of test trees				2	4	2	4	2	4	2	4	2	4	2
Referenced literature [z]				[C]	[C]	[C]	[C]	[C]	[S]	[C]	[C]	[CW]	[C]	
Descriptors and its rank value by IPGRI and CIHEAM (2003)				Characteristic values of each variety [t]										
Tree	7.2.1	Tree growth habit	1 Erect, 2 Semi-erect, 3 Open, 4 Spreading, 5 Weeping	2 [2]	4	2	3	3	2	3	4	 [4]	2	1
	7.2.2	Vigour	3 Low, 5 Intermediate, 7 High	5	7 [7]	5 [3]	5 [5]	7 [7]	7	3	3 [3]	7 [7]	7 [7]	
	7.2.9	Terminal bud colour	1 Light green, 2 Green, 3 Pinkish brown, 4 Brown	2 [2]	4 [4]	1 [2]	3 [3–4]	3 [3]	3	1	1 [2]	1	1 [2]	2
Leaf	7.3.3	Number of lobes	0 Absent, 1 Three, 2 Five, 3 Seven, 4 More than seven	2 [1–2]	1–2 [2]	1–2 [1–2]	1–2 [1–2]	2	1–2 [1–2]	1 [1]	2 [2]	2 [3]	1 [0–2]	2
	7.3.4	Shape of lobes	1 Spatulate, 2 Linear, 3 Latate, 4 Lyrate, 99 Other	3	1 [1]	3–4	1–2 [2]	1, 3	3 [3]	3	1, 2 [2]	1	3	3
	7.3.6	Degree of leaf lobation / incision	0 No, 1 Slight, 2 Average, 3 Marked, 4 Very marked	3 [2]	3–4 [3–4]	2 [2]	3 4	2 [2]	2	2 [1]	4 [4]	3 [3]	2 [1]	3
	7.3.7	Shape of base	1 Truncate, 2 Cordate, 3 Calcarate, 4 Decurrent, 5 Open calcarate	2 [2]	2 [2]	2–3 [2–3]	1, 3 [1–2]	2 [2]	2–3	1–2 [2]	3 [2]	2	2 [2]	2
	7.3.10	Area	1 Small, 2 Medium, 3 Large, 4 Very large	2 [2]	3–4 [2–3]	2 [2]	2–3 [2]	2–3 [2]	3 [3–4]	1 [1]	1–2	2	1–2 [2]	1–2
	7.3.13	Margin	1 Crenate, 2 Dentate, 3 Serrate, 4 Double serrate, 6 Undulate	3 ** [1]	1,3 [1]	1 [1]	1,3 [1]	1 [1]	3 [1–3]	1 [1]	1 [1]	1,3 [1]	1, 3 [1–3]	1
Fruit (2nd crop)	7.1.3	Beginning of fruit maturation	1 Very early, 2 Early, 3 Mid-season, 4 Late, 5 Very late	3	3	2	3	4	4	3	3		3	4
	7.1.4.2	Full maturity	1 Very early, 2 Early, 3 Mid-season, 4 Late, 5 Very late	3	3–4	3	3–4	3–4	4	4	3–4		3	4
	7.4.1	Shape	1 Oblong, 2 Globose, 3 Oblate	1 [1]	1 [1–2]	2 [2–3]	1 [1–2]	2–3 [3]	2–3 [2–3]	1–2 [2–3]	1 [1]	2 [1]	1–2 [1–2]	1
	7.4.2	Shape according to the location of the max width [y]	1 Ovoid, 2 Bell shaped, 3 Pyriform	3 [2,3]	2, 3 [2,3]	1 [1]	1, 3 [1,3]	1, 3 [2–3]	1 [1–2]	2–3 [2]	2 [2]	1,3 [2–3]	1 [1]	1
	7.4.5	Weight [x]	(g)	34–52 [58]	37–54 [50]	34–44 [30]	28–39 [27]	35–58 [38]	46–64	33–54 [28]	57–78 [42]	52–74 [50]	35–55 [30–80]	53–72
	7.4.8	Neck length	0 Absent, 1 Short, 2 Medium, 3 Long	3 [3]	1 [variable]	1 [1]	0–1 [0–1]	2 [1]	2 [2–3]	0 [0]	0 [0]	0–1	0–1 [0–1]	1
	7.4.11	Ostiole width	1 Small, 2 Medium, 3 Large, 4 Very large	2 [2]	2 [2]	1 [2]	1 [2]	3 [2]	2 [1]	3 [2]	3 [2]	2 [2]	2 [2]	
	7.4.14.1	Scale size	3 Small, 5 Medium, 7 Large	5	5	5	5	7	7	7	3	3	5	
	7.4.14.2	Scale colour	1 Same as skin, 2 Different from skin	2 [2]	1 [chaffy]	1	1	1 [1]	1 [1]	1 [1]	2 [2]	2 [2]	1 [1]	1
	7.4.14.3	Scale adhesion	1 Detached, 3 Adhered, 5 Semi-adhered	1	1	3	5	5	1 [1]	3–5	5	1	1	
	7.4.15	Shape of the fruit stalk	1 Variously enlarged, 2 Long and slender, 3 Short and thick	3(J) [1–3]	3(J) [3]	2(H)	2(H) ** [1]	3(J) [3]	3(J) [3]	2(G), 3(J) ** [1]	3(J) [3]	3(J)	3(J)	3(J)
	7.4.20	Ribs	0 None, 3 Intermediate, 5 Prominent	0 [0–3]	5 [5]	3–5	3	3 [0–3]	3 [3]	5 [5]	0 [0]	3	0, 3 [0,5]	5
	7.4.21	Skin cracks	1 Cracked skin, 2 Scarce longitudinal cracks, 3 Minute cracks	3	2	3	3	3	3 [3]	3	3 [3]	1	3	2
	7.4.25	Bloom	0 Absent, 1 Present, 2 Abundant	1 [0–1]	0	0	1–2 [2]	2 [2]	2 [bluish]	0	0	1	0 [0–1]	1
	7.4.26	Skin ground colour	1 Black, 2 Purple, 3 Brown, 4 Green, 5 Light green, 6 Yellow green, 7 Yellow	3–4 [3]	1–2 [1–2]	5 [5]	1–2 [1–2]	2, 4 [2–4]	1 [1–2]	3 [3]	3 [3]	5 [4]	6 [4–6]	4
	7.4.28	Lenticels quantity	3 Scarce, 5 Intermediate, 7 Numerous	5 [3–5]	5	3 [3]	5 [5]	5–7 [7]	5	5 [5]	5–7 [7]	5 [5]	3	
	7.4.29	Lenticels colour	1 White, 2 Pink, 3 Green	1, 2 [1]	1 [1]	1	1–2 [1]	1 [1]	1	1 [1]	1 [1]	1 [1]	1	
	7.4.30	Lenticels size	3 Small, 5 Medium, 7 Large	3–5 ** [7]	7 [7]	3 [3]	5–7 [7]	7	3–5	7 [7]	7 [5]	5 [3]	3–5	
	7.4.32	Pulp internal colour	1 White, 2 Amber, 3 Pink, 4 Red, 5 Dark red	2 [2]	2, 3 [3]	1 [1]	4 [4]	5 [4]	4–5 ** [3]	2, 3 [2]	2 [2]	3 [3]	2 [2]	2
	7.4.35	Fruit cavity	0 None, 3 Very small, 5 Small, 7 Medium, 9 Large	0	5	0	0	7	3	5	7 [hollow]	0	0	5
Markedly mismatched characteristics between TIFT observations and references				Leaf: "margin", fruit: "lenticels size"	None	None	Fruit: "shape of the fruit stalk"	None	Fruit: "pulp internal colour"	Fruit: "sape of the fruit stalk"	None	None	None	

[z] [C]: Condit (1955)[10], [CW]:Condit and Warner (1956)[13], [S]: Simonet, et al. (1945)[9].
[y] "Ovoid" (in the middle), "Bell shaped" (nearer to the neck) and "Pyriform" (nearer to the ostiole-end) correspond to "Spherical", "Tarbinate", and "Pyriform", respectively, as referred to by Condit (1941)[15].
[x] Fruit weight (at the TIFT) is the interquartile range of the weight of all mature fruits on shoots (four per tree) in 2021.
[w] 'Lisa' is not listed by Condit (1955)[10], although its characteristics are similar to the fig trees cultivated under the name 'Archipel' that has been cultivated in the same field of TIFT in the past.
[v] 'Violette de Solliès' is not listed by Simonet, et. al., (1945)[9], but Khadari et al. (1995)[28] reported a genomic match between this variety and 'Bourjassotte Noire'.
[u] As no matching names could be found. Therefore, the name introduced in TIFT was adopted in this study.
[t] The values observed in TIFT (upper row). Red notation with ** indicates a clear deviation from the values shown in the reference denoted within [ ] at the bottom.

Table 1 (2nd half). List of the studied varieties of fig and a comparison of their morphological characteristics with referenced literatures.

Representative names of varieties			Drap d'Or [v]	Du Japon [u]	Franciscana	Genoa	Houraishi [t]	Ischia	Ischia Black	Longue d'Août [s]	Malta	Panachée [r]	Précoce de Barcelona [q]	Saint Jean	San Piero	Verdone
Names of introduced to TIFT (underline indicates a match with one of the representative names, synonyms, homonyms, or misnomers in the referenceed literature).			Peau Dure, Daw Low	Dalmatie	California Black, Black Mission, Noire de Caromb	White Genoa	Houraishi (Horaigaki)	White Ischia, Sugar	Ischia Black	Banane	Celeste	Zebra Sweet, TEMARI ICHIJIKU	Précoce Ronde de Bordeaux	Grisé de Saint Jean, Grisé Bifère	MASUI Dauphine, WASE Dauphine	White Adriatic
Planted year			2008	2008	2008	2008	2008	2008	2020	2020	2008	2008	2008	2008	2008	2009
Number of test trees			4	4	6	2	2	4	1	2	2	4	4	4	4	2
Referenced literature [z]			[C]	[S]	[C]	[C]	[C]	[C]	[C]	[S]	[C]	[C]	[C]	[C]	[C]	[C]
Descriptors by IPGRI and CIHEAM (2003) [y]			Characteristic values of each variety [p]													
Tree	7.2.1	Tree growth habit	4 [3]	4	4 [5]	2 ** [4]	2	2	[2,4]		3	1 [1]	3	4	3	4 [4]
	7.2.2	Vigour	5	5	5	7 [5]	7	3–5	[5–7]		5 [5–7]	7 [7]	7 [7]	5 [5]	5	5 [7]
	7.2.9	Terminal bud colour	1 [2]	4	3 [3]	2 [2,4]	1	1 [2]	3 [3]	2	1 [2]	4 ** [2]	3 [3]	2	3–4 [3]	1 [2]
Leaf	7.3.3	Number of lobes	1–2 [2]	2–3 [2–3]	2 [2]	1–2 [1–2]	1	1 [1]	0–1 [0–1]	2–3	2 [1–2]	2 [2]	2 [2]	2 [1–2]	1–2 [1–2]	2 [2]
	7.3.4	Shape of lobes	4	2 [2]	3	4	3	1, 3	3	1	3	3–4	2	3	3–4	1 [1]
	7.3.6	Degree of leaf lobation / incision	3 [2]	4 [3]	3	2–3 [2]	2	1 [1]	1–3 [2]	3	3 [2]	3	3–4 ** [2]	1–2 [1]	2 [1–2]	2 [2]
	7.3.7	Shape of base	2 [1–2]	3	3	2 [2–3]	2	1, 4 [1, 4]	1 [1:2]	3	2 [2]	2–3 [3]	2–3 [2–3]	2 [2–3]	3 [3]	2 [1–2]
	7.3.10	Area	2–3 [2]	2 [3]	3 [3]	3 [2–3]	4	1 [1]	1–2 [1:2]	2	2–3 [1–2]	2 [2–3]	2–3 [2]	2 [1–2]	2 [2–3]	2 [2]
	7.3.13	Margin	1 [1]	1 [1]	1	1 [1]	1	1 [1]	1,3 [1]	1,3	1 [1]	1 [1]	1 [1]	1 [1]	1 [1]	1 [1]
Fruit (2nd crop)	7.1.3	Beginning of fruit maturation	3	2	3	3	4	3			2		2	3	2	4
	7.1.4.2	Full maturity	3	3	3	3	5	3			3		3	3	3	4
	7.4.1	Shape	1 [1]	1 [1]	1 [1]	1 [1]	2	2–3 [2–3]	1–2	1 [1]	1 [1]	1–2 [1]	1–2 [2]	1 [1]	1 [1]	1 [1]
	7.4.2	Shape according to the location of the max width [x]	3 [3]	3 [2–3]	2–3 [3]	2–3 [2]	3 [3]	1 [1]	2–3 [2–3]	3 [1,3]	3 [3]	1, 3 [3]	1 [1]	1–2 [2–3]	3 [3]	2–3 [2]
	7.4.5	Weight [w]	59–79 [medium]	58–81 [40–60]	30–46 [25–41]	54–72 [60]	50–69 [>medium]	19–27 [18]	22–33 [30]	54–70 [30–60]	11–33 [14]	41–52 [40]	20–39 [25]	27–38 [31]	69–96 [70]	41–63 [50]
	7.4.8	Neck length	3 [3]	0	0–1 [0–1]	1 [0–1]	3 [thick]	0–1 [0–1]	0–1 [0–1]	1 [0–1]	3 [3]	2 [2–3]	0 [0]	1–2 [0–1]	0–3 [1–3]	2 ** [0–1]
	7.4.11	Ostiole width	3 [3]	1	2 [1–2]	3	3 [2–3]	1 [2]	2	1 [2]	1 [2]	3 [2–3]	2	2 [3]	3 [3]	1 [2]
	7.4.14.1	Scale size	5	3	5	7	3	7	3	5	3	7	5	5	7	3
	7.4.14.2	Scale colour	2 [2]	1, 2	1 [1]	1,2	1	2 [2]	1	2 [2]	1 [1]	2 [2]	1	2 [2]	1 [1]	2 [2]
	7.4.14.3	Scale adhesion	1	1	5	3	1	3	1	3 [3]	3 [5]	5	1	3–5	5	3
	7.4.15	Shape of the fruit stalk	3(J) [3]	3(J)	3(J) [3]	3(J) [3]	2(G)	2(G) [2–3]	3(J)	3(J)	2(G) [2]	3(J)	3(J)	2(H),3(J)	3(J)	3(J) [somewhat
	7.4.20	Ribs	5 [5]	0	0 [0–1]	5 [5]	3	3 [3]	0–3	5 [5]	3–5 [3]	0 [0]	3	0 [0–3]	3 [3]	0 [0]
	7.4.21	Skin cracks	2	3	2 [3]	3	3	3 ** [1]	3	2–3	3 ** [1]	3	1 [1–2]	1 [1]	3	2
	7.4.25	Bloom	0	1	0–1 ** [2]	1 [0]	2	1 [0–1]	2 [2]	1	2 [2]	0 [0–1]	1 [2]	2 [2]	1 [2]	0 [0–1]
	7.4.26	Skin ground colour	3 [3]	5 [5–6]	1 [1]	5 [5]	3	2, 5 [2,5]	1	3–4 [2,4]	2–3 [2–3]	6 [6]	1 [1]	2–3 [2–3]	2–3 [2]	4 [4]
	7.4.28	Lenticels quantity	3	3	5	5	5	5–7 [5]	3–5 [5]	5	5 [5]	3	5–7	3	5 [5]	5 [7]
	7.4.29	Lenticels colour	1	1	1 [1–2]	3	3	1–3 [1]	2 [1]	1	1 [1]	1 [1]	1	1 [1]	1 [1–2]	1, 3 [1]
	7.4.30	Lenticels size	5	7	3	5	3–5	3	3	7	3 [5–7]	3 [3]	3	3 [3]	7 [7]	7 [7]
	7.4.32	Pulp internal colour	2, 3 [3]	4, 5 [4]	2–3 [2–3]	2–3 [2–3]	3	2–3 [2–3]	4 [3–4]	4 [3]	4 [3–4]	3 [3–4]	4 [3–4]	3 [3–4]	3 [3]	3 [3]
	7.4.35	Fruit cavity	5 [hollow]	7	3	9 [hollow]	5	0	5	5	7	5	0	5	7 [hollow]	5 [somewhat]
Markedly mismatched characteristics between TIFT observations and references			None	None	Fruit: "bloom"	Tree: "growth habit"	None	Fruit: "skin cracks"	None	None	Fruit: "skin cracks"	Tree: "terminal bud colour" of shoot	Leaf: "degree of leaf lobation"	None	None	Fruit: "neck length"

z, x, w, p See Table 1 (1st half).

y See Table 1 for the respective class values.

v Condit (1955)[10] classified this variety as "San Pedro" type. However, this is questionable, as his same paragraph shown as "Common" type characteristics (= second-crop maturation without caprification). 'Daw Low' is probably coined to facilitate the pronunciation of 'Drap d'Or'.

u The observed characteristics also matched well with those of 'San Pietro', listed by Condit (1955)[10] as a variety imported to the USA from Dalmatia, but the observed number of lobes was markedly different from that described for 'San Pietro'.

t This variety is unique to Japan, which Condit (1955)[10] lists as 'Horaigaki', but the alternative modern pronunciation "Houraishi" is common in Japan.

s 'Banane' is not listed by Simonet, et. al. (1945)[9], but 'Banane', a synonym of 'Longue d'Août', is shown with similar fruits is listed on many nursery websites, e.g., "Pepinieres.quissac" https://www.jardin-ecologique.fr/produit/figuier-longue-daout-ficus-carica-longue-daout/.

r 'Zebra Sweet' and 'TEMARI ICHIJIKU' are probably uniquely Japanese names and are not shown in Condit (1955)[10], although the distinctive fruit appearance is unmistakably 'Panachée'.

q 'Précoce Ronde de Bordeaux' is not shown in Condit (1955)[10] but 'Ronde de Bordeaux', a synonym of 'Précoce de Barcelona', is shown with similar fruits on some websites, e.g., "La Figue du Salagou" https://lafiguedusalagou.fr/liste-varietes-figuiers/ronde-de-bordeaux/.

collaborate for the global disclosure of relevant scientific information about the fig.

2.Materials and Methods

2.1. Sampled trees

We conducted all observations between 2019 and 2021 at the Toyo Institute of Food Technology (TIFT) experimental field in Hyogo, Japan (34°81′N; 135°40′E). The field site is 38 m above sea level and dressed by decomposed granite soils on a "Lowland paddy soil". As shown in **Table 1**, 77 trees with 37 introductory names planted in 2008, 2009, 2017, or 2020 at a density of 95 trees per 1,000 m^2 were studied. All of the trees were base-form trained, but only two trees each of 'Bordeaux', 'Du Japon', or 'Précoce de Barcelona' were trained by straight line training[12]. We selected 30 to 35 shoots from each tree to be elongated as fruit-bearing shoots and removed the others. The shoots were allowed to elongate to more than approximately 180 cm before being pinched. Other cultivation details, such as irrigation, fertilisation, and pest management, followed standard practices for fig orchard management.

The 'Conadria', 'Ischia Black', and 'Longue d'Août' (**Table 1**) were excluded from the fruit set and growth measurements for being considered too immature.

2.2. Representative variety names

Prior to this study, we cross-checked the most representative names of the studied fig varieties against the lists of significant varietal characteristics as given by Condit (1955)[10], Simonet *et al*. (1945)[9], and Condit and Warner (1956)[13].

The selected varieties were purchased from nurseries or transferred from other research institutions to the TIFT and arrived labelled with Japanese trade names and synonyms. Therefore, we grouped those varieties with similar morphological and agronomic characteristics and, subsequently, sought to identify a representative name from those listed by Condit (1955)[10]. The representative name of studied varieties was determined by confirming that the label names matched with the representative names, synonyms, homonyms, or misnomers given by Condit (1955)[10] and that the morphological characteristics of labelled varieties also agreed with his descriptions. We compared morphological characteristics based on current fig descriptors (IPGRI and CIHEAM, 2003)[14]. Since this descriptors and that of Condit (1955)[10] do not necessarily match, the characteristics described by Condit (1955) were replaced to the descriptors of IPGRI and CIHEAM (2003)[14] referring to his explanation of fig characteristic[15]. The characteristics of studied varieties were determined from observations in 2020 and 2021, while "fruit weight" was determined as the interquartile range of fruit weights on the tested shoots described in the following Section 2.3 in 2021. When the labelled varieties could not be identified by Condit (1955)[10], we performed the same matching process using Simonet *et al*. (1945)[9] and Condit and Warner (1956)[13]. In addition, we also considered relevant literature and the information available online on the plant nursery website.

2.3. Growth and fruit production of individual shoots

At the beginning of the fruit-set period, six and four medium-growing shoots were selected from each tree in 2020 and 2021, respectively, to investigate the overall main (second) crop fruit production per shoot. The following information was recorded for each shoot: the first day of fruit set and maturation, the fruit set date on each node (in 2021), the fruit maturation date, and the mature fruit weight (fruit weight) on each node. The basal diameter (between the second and third nodes from the base) of dormant shoots was recorded during winter (post-harvest). The fruit set date was defined as when the diameter of a flower bud was around 3 mm[16], and the fruit maturation date was defined as when the fruit was soft and easily indented when pressured by finger touch. Fruit weight (± 0.1 g) was measured with a digital scale (EW-300G, A&D, Tokyo) and basal diameter of shoot (± 0.01 mm) with a digital calliper (AD-5765A-150, A&D, Tokyo). Using the records of up to 20 nodes on each shoot, we then determined the following: (i) the percentage of nodes with fruit set ("fruit set rate") and, in 2021, multiple fruit set ("multiple fruit set rate"), and (ii) the percentage of nodes with set fruit showing mature fruit ("fruit maturation rate"). The polyserial correlation coefficient (PCC) for node order and fruit set date in 2021, node order and fruit maturation date, and node order and fruit weight were also calculated using R (Ver. 4.1.2, R Foundation for Statistical Computing, Vienna, Austria). Standard score (SS) values were calculated (for data from the same year) using Microsoft Excel (ver. 2016, Microsoft Corp., Redmond, WA, USA) to assess the specificity of those characteristics between the different varieties.

2.4. Growth of individual fruit at the bases of shoots

Six and four medium-growing shoots from each tree

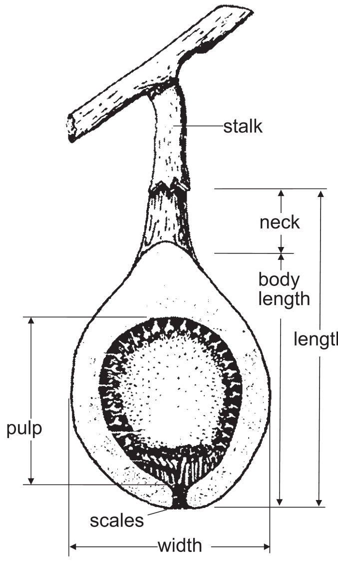

Figure 1. Measured parts of fig fruits adopting Storey (1975)[29] as reference and IPGRI and CIHEAM (2003)[14].

were selected at the beginning of the fruit set period in 2019 and 2021, respectively, to investigate individual fruit growth. The shoots selected in 2021 were the ones described in Section 2.3. The earliest or second-earliest young fruit was marked on each candidate shoot, and the diameter of its equatorial plane ("fruit width", **Figure 1**) was measured from approximately 5 mm until maturity using a calliper (AD-5765A-150). This approach followed the method described by Crane (1948)[4] but with shorter measurement intervals of 3–4 days. The resulting data were plotted over time alongside the length of distinct enlargement stages (as described in Section 3) and fruit width. The fruit weight, fruit length and body length (**Figure 1**) were also measured at the maturity stage. For the characteristic enlargement stages, the expansion ratio was determined. To assess the variability and specificity of these different growth characteristics between the varieties (in the same year), the mean, coefficient of variation (CV), and SS were calculated using Microsoft Excel (ver. 2016, Microsoft).

3.Results and Discussion

3.1. Representative names of the studied varieties

The figs introduced to the TIFT experimental field under 37 different names were grouped into 25 different varieties, 24 of which correspond to the representative names given by Condit (1955)[10], Condit and Warner (1956)[13], and Simonet *et al*. (1945)[9]. The morphological characteristics of the studied varieties and their conformity with reference reports are shown in **Table 1** and **Figures 2** and **3**. Specific descriptors of some varieties were distinctly different from the reference reports, such as "leaf margin" and "fruit lenticels size" in 'Archipel', "shape of the fruit stalk" in 'Bordeaux' , "pulp internal colour" in 'Bourjassotte Noire', "shape of the fruit stalk" in 'Brown Turkey', "fruit bloom" in 'Franciscana', "tree growth habit" in 'Genoa', "skin cracks of fruit" in 'Ischia' and 'Malta', "terminal bud colour" of the shoot in 'Panachée', "degree of leaf lobation" in 'Précoce de Barcelona', and "neck length of fruit" in 'Verdone'. However, like most other plants, morphological characteristics are markedly affected by environmental conditions[15] and minor mutations. Therefore, some of these discrepancies do not necessarily reflect different varieties. When the designation in the referenced reports conferred with most of the traits in the studied specimens, the reported representative name was treated as the name of the studied variety, even if there were some discrepancies. Only 'Dreamy Sweet' could not be matched in this way, and, therefore, this name was retained.

3.2. Growth and fruit production of individual shoots

The characteristics of shoot growth, fruit set and maturation of each variety are shown in **Table 2**, and the results of the analysis of the relationships between these metrics are shown in **Figures 4–6**. The basal width of shoots ranged from 18.0 to 31.6 mm between varieties. 'Houraishi' and 'Précoce de Barcelona' were larger, and 'Brown Turkey', 'Ischia', and 'Dreamy Sweet' were smaller (**Table 2**). As all specimens were managed in such a way that the number of shoots per tree did not vary significantly, this variation seems to be a direct reflection of the varying vigour of the varieties.

Fruit set began earlier on the shoots of 'Ischia' and later on 'Bourjassotte Noire', and the fruit set rate was >70% for many varieties but was notably low for 'Panachée', 'Genoa', and 'Verdone'. Some of the varieties with higher set rate, such as 'Ischia', 'Malta', 'Brunswick', 'Brown Turkey', and 'Dottato', had more than one fruit on the same node (**Table 2**). This result agree with the view that figs have two flower bud inflorescences in each leaf axil, and only one of them grows in 'Mission' (probably a synonym for 'Fransiscana'), 'Brown Turkey' (probably a synonym for 'San Piero') and many other varieties, whereas in 'Kadota (probably a synonym for 'Dottato')' both inflorescences grow[3,7,18]. The correlation between the fruit set and node order was higher than 0.86 in the PCC values, and no varieties deviated from the base-to-apex fruit set habit [3] (**Table 2**).

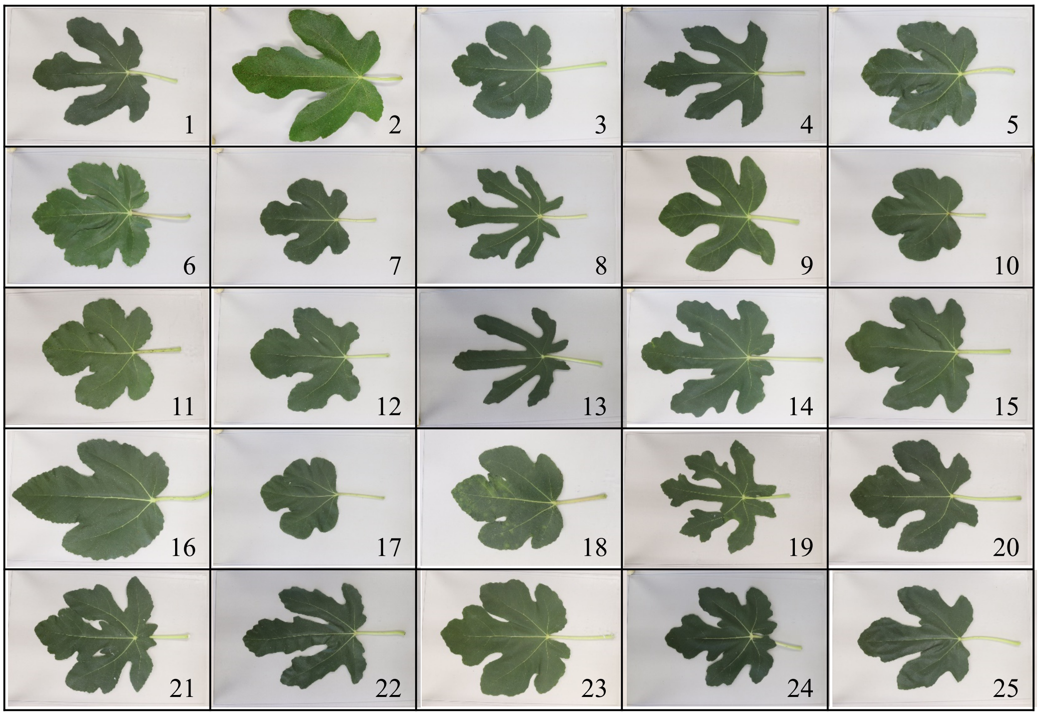

Figure 2. Appearance of mature leaves of tested varieties, 1: Archipel, 2: Barnissotte, 3:Blanche , 4: Bordeaux, 5: Bourjassotte Grise, 6: Bourjassotte Noire, 7: Brown Turkey, 8: Brunswick, 9: Conadria, 10: Dottato, 11: Dreamy Sweet, 12: Drap d'Or, 13: Du Japon, 14: Franciscana, 15: Genoa, 16: Houraishi, 17: Ischia, 18: Ischia Black, 19: Longue d'Août, 20: Malta, 21: Panachée, 22: Précoce de Barcelona, 23: Saint Jean, 24: San Piero, 25: Verdone.

Figure 3. Appearance of mature fruits of tested varieties, 1: Archipel, 2: Barnissotte, 3:Blanche , 4: Bordeaux, 5: Bourjassotte Grise, 6: Bourjassotte Noire, 7: Brown Turkey, 8: Brunswick, 9: Conadria, 10: Dottato, 11: Dreamy Sweet, 12: Drap d'Or, 13: Du Japon, 14: Franciscana, 15: Genoa, 16: Houraishi, 17: Ischia, 18: Ischia Black, 19: Longue d'Août, 20: Malta, 21: Panachée, 22: Précoce de Barcelona, 23: Saint Jean, 24: San Piero, 25: Verdone.

Table 2. Growth and fruit production of individual shoots.

Variety [z]	Shoot vigour		Fruit set						Fruit maturation							
	Basal diameter of shoot [z]		Date of fruit set beginning [y]		Fruit set rate [x]		Multiple fruit set rate [x]	Fruit set and node order relationship [w]	Date of fruit maturation beginning [y]		Fruit maturation rate [v]		Fruit maturation date and node order relationship [w]		Fruit weight and node order relationship [w]	
	2020	2021	2020	2021	2020	2021	2021	2021	2020	2021	2020	2021	2020	2021	2020	2021
Archipel	—	26.4 [u]	—	29-May	—	84.4	0.7	0.97	—	9-Aug	—	72.6	—	0.61	—	-0.74
Barnissotte	25.3	24.7	8-Jun	5-Jun	73.9	84.1	8.7	0.95	22-Aug	15-Aug	78.8	85.3	0.82	0.86	-0.42	-0.24
Blanche	24.8	25.7	29-May	25-May	72.3	80.0	1.7	0.99	4-Aug	30-Jul	86.5	87.5	0.88	0.98	-0.18	-0.28
Bordeaux	21.4	24.1	30-May	2-Jun	80.8	91.3	3.3	0.98	20-Aug	16-Aug	82.5	91.9	0.92	0.95	-0.34	-0.44
Bourjassotte Grise	27.0	27.8	31-May	5-Jun	92.1	91.9	0.0	0.98	26-Aug	21-Aug	83.7	96.6	0.80	0.82	-0.82	-0.78
Bourjassotte Noire	24.0	26.7	6-Jun	9-Jun	57.8	63.8	0.0	0.96	18-Sep	9-Sep	86.8	94.9	0.36	0.33	-0.57	-0.70
Brown Turkey	20.7	20.1	31-May	5-Jun	91.7	91.3	19.8	0.92	21-Aug	27-Aug	67.7	72.0	0.86	0.71	-0.71	-0.70
Brunswick	20.5	22.8	30-May	1-Jun	90.6	93.5	20.3	1.00	13-Aug	15-Aug	78.9	98.0	0.94	0.67	-0.79	-0.62
Dottato	25.1	25.9	26-May	29-May	91.7	88.8	13.1	0.99	8-Aug	9-Aug	81.0	95.6	0.95	0.99	-0.48	-0.64
Drap d'Or	26.2	27.1	31-May	30-May	74.3	75.6	3.2	0.97	19-Aug	10-Aug	75.3	61.6	0.27	0.69	-0.84	-0.48
(Dreamy Sweet)	—	18.6	—	3-Jun	—	54.4	0.0	0.96	—	5-Sep	—	82.7	—	0.94	—	-0.28
Du Japon	22.9	24.7	2-Jun	4-Jun	74.1	80.4	0.4	0.99	1-Aug	10-Aug	56.9	80.8	0.89	0.94	-0.34	-0.64
Franciscana	24.6	25.7	3-Jun	5-Jun	48.4	78.7	0.8	0.98	16-Aug	15-Aug	65.5	86.3	0.84	0.91	-0.71	-0.74
Genoa	24.8	26.5	—	9-Jun	48.7	53.8	1.0	1.00	—	16-Aug	—	65.9	—	0.80	—	-0.62
Houraishi	31.4	31.6	1-Jun	6-Jun	90.8	93.1	1.3	0.98	3-Sep	5-Sep	94.9	97.3	-0.28	0.61	-0.80	-0.64
Ischia	18.4	18.0	23-May	19-May	89.9	96.6	30.7	0.98	12-Aug	13-Aug	94.4	97.4	0.96	0.92	-0.54	-0.53
Malta	—	29.0	—	26-May	—	92.6	28.9	0.98	—	2-Aug	—	29.5	—	0.76	—	-0.42
Panachée	—	25.1	—	5-Jun	—	12.5	0.0	—	—	2-Sep	—	57.9	—	—	—	—
Précoce de Barcelona	30.6	29.2	30-May	3-Jun	87.8	85.4	2.7	0.95	2-Aug	9-Aug	83.1	93.0	0.89	0.86	-0.64	-0.61
San Piero	24.9	25.2	30-May	28-May	88.1	84.1	1.1	0.96	4-Aug	3-Aug	80.0	94.1	0.92	0.89	-0.63	-0.59
Saint Jean	—	25.5	—	30-May	—	71.9	2.7	0.94	—	15-Aug	—	94.0	—	0.79	—	-0.72
Verdone	20.9	22.9	8-Jun	2-Jun	29.9	57.5	0.0	0.86	20-Sep	1-Sep	74.7	93.1	0.25	0.77	-0.34	-0.59
Mean	24.3	25.2	31-May	1-Jun	75.5	77.5	6.38	0.97	18-Aug	17-Aug	79.4	83.1	0.70	0.80	-0.57	-0.57

[z] Diameter between the second and third node from the base of the shoot.
[y] The first day of fruit set and maturation on each shoot.
[x] Percentage of nodes with fruits or multiple fruits out of a maximum of 20 nodes on each shoot.
[w] Polyserial correlation coefficient of node order (up to 20 nodes) and fruit set date, maturation date and mature weight for each shoot.
[v] Percentage of nodes with mature fruit among those nodes with set fruit out of a maximum of 20 nodes on each shoot.
[u] Means of characteristic values on tested shoots in each variety. Each value is colour-coded depending on the standard scores among test varieties for each year, as red (>1.5), orange (>1.0), black (=<1.0, >=-1.0), light blue (<-1.0) and blue (<-1.5).

Fruit maturation rates were high for most varieties, ranging from approximately 70% to 90%. However, fruit drop before maturity resulted in low maturation rates for some varieties, such as 'Malta', 'Du Japon', and 'Panachée' (**Table 2**). Among these, 'Du Japon' was observed to have a low resistance to diseases, which probably explained its high fruit-drop rate.

In many varieties, fruit maturation progressed sequentially from near the base of the shoots to the apex, again following the known habit of fig trees[3]. This habit was reflected in the high correlation values for fruit maturation and node order, which was >0.8 in PCC for many varieties. However, the PCC values for varieties such as 'Bourjassotte Noire', 'Houraishi', and 'Drap d'Or' were notably low (**Table 2**), varieties that showed excessive shoot growth. Therefore, we plotted the basal width of each shoot (in 2020) against each PCC result in these three varieties alongside 'San Piero' as a reference, as shown in **Figure 4**. This figure shows that PCC values were always high regardless of basal shoot width in 'San Piero', whereas PCC values decreased with increasing shoot basal width in the other three varieties. Thus, while fruit maturation from the base up is a fundamental characteristic of figs, our observations show that in some varieties, the excessive growth of shoots disrupts this pattern.

The fruit weights varied widely among the varieties, as shown in **Table 1**. **Figure 5** shows the transition of fruit weight according to the node position in 'San Piero' as an example. The fruit weight peaked at approximately the 3rd to 4th node positions as previously reported[19]; the basal-most fruits were not the largest, but the apical fruits were overall smaller than the rest. This difference in size is a typical pattern observed in other varieties. The PCC values for fruit weight and node order were also highly negative for most varieties, except for a few, such as ‘Blanche’ (**Table 2**). For ‘Bourjassotte Noire’, ‘Houraishi’, and ‘Drap d'Or’, PCC values were also not particularly low, indicating the disruption of fruit maturation in node order, as previously described, does not affect the typical pattern of fruit weight. Hosomi (2021)[20] reported that in ‘Houraishi’, larger shoots had smaller fruit weights, especially during the early harvest period. While Hosomi (2021) did not report from which nodes fruits were taken, it is possible that the order of maturation was disrupted and the lower-weight apical fruits ripened earlier, thereby reducing the mean weight of fruits on the larger shoots of ‘Houraishi’ during the early harvesting period.

Notably, for some varieties, there was not much difference in fruit size between those developing at the bases and tips of shoots. **Figure 6** shows the mean of single regression coefficient (explanatory variable: node position; response variable: fruit weight) plotted alongside the mean fruit weight for each variety. This result shows that the negative regression coefficients tended to approach 0 with decreasing mean fruit weight, and this was also the case for measurements made in 2021 (data not shown). It can also be assumed that smaller-fruiting varieties show less variation in fruit weight according to shoot node position.

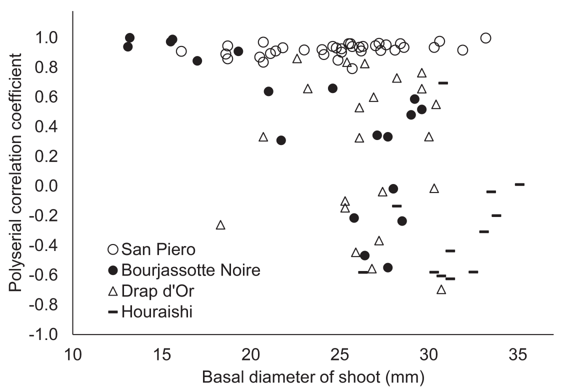

Figure 4. Polyserial correlation coefficients between node order and fruit maturation date on various sizes of shoots in 2020 for the example varieties ‘San Piero’, ‘Bourjassotte Noire’, ‘Drap d'Or’ and ‘Houraishi’.

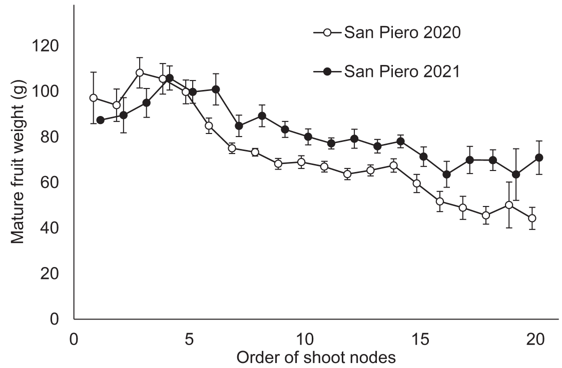

Figure 5. Mean weight of mature fruits at each shoot node in 2020 and 2021 for the example variety ‘San Piero’. Vertical bar indicate SE.

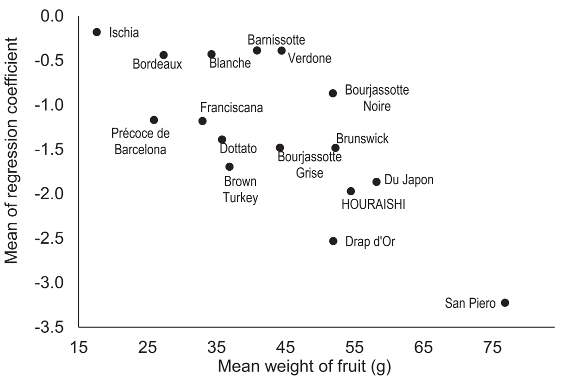

Figure 6. Relationship between the mean weight of fruits and the mean of regression coefficient of fruit weight on each shoot node order for various fig varieties in 2020.

3.3. Growth of individual fruits at the shoot base

We measured the fruit enlargement for fruits near the base of each shoot, and the results are shown in **Figure 7** and **Table 3**. It is well known that fig fruit enlargement follows a double sigmoid curve, i.e., after the fruit set there is a short period of steadiness followed by rapid enlargement (stage I), followed by a period of stagnation (stage II) and then another rapid enlargement period (stage III) until maturity[4, 5] However, as we observed, these varieties did not always strictly follow this pattern. **Figure 7** shows an example of enlargement in the widths of ‘Brunswick’ fruits. In this example, shortly after fruit set, the fruit enlarged rapidly, but intersecting point 1 soon appeared indicating that enlargement slowed. After a gradual increase (after intersecting point 2), the fruits continued to enlarge only very slightly—almost stopping entirely—and then immediately after rsecting point 3, rapidly re-enlarged and reached maturity. For some varieties, the intersecting points 1 and 2 were less clear or absent, although this general growth pattern was common. Sasou (1936)[5] and Marei and Crane (1971)[21] identify intersecting point 1 as the boundary between stages I and II, while Crane (1986)[17] and Hirai (1966)[22] suggest this boundary lines around intersecting point 2. Hence, there is no clear definition of the boundary between stage I and stage II, but in this study, intersecting point 2 was used as the boundary between both stages. Baskaya and Crane (1950)[23] and Hirai (1966)[22] reported that the increase in cell layers and the number of cells in fig fruits are either terminated and the flowering of fruitlets inside the syconium occurs halfway from fruit set until the end of stage I. Although there is no current clear evidence, the patterns observed in our study may indicate similar physiological changes. Thus, we consider that intersecting point 1 is a significant turning point in fruit development, and we distinguish the following stages: stage Ie - from fruit set to the intersecting point 1; stage I - from fruit set to the intersecting point 2; stage II - from the intersecting points 2 to 3; and stage III - from the intersecting point 3 to maturation.

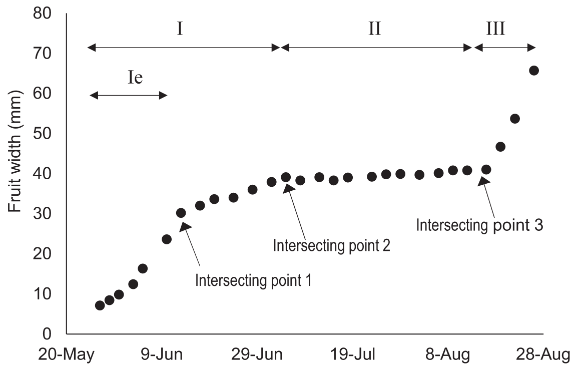

Figure 7. Expansion of basal width of fruits in an example of ‘Brunswick’ in 2019. The growth curve is divided into stages I, II and III according to intersecting points 2 and 3, and further divided into stage Ie up to the intersection with point 1 in Stage I.

Table 3 Growth characteristics of individual fruits at the shoot base.

Variety	Growing time[z]										Fruit size[y]													
	Fruit set date		Number of days in stage Ie		Number of days in stage I		Number of days in stage II		Number of days in stage III		Fruit width at end of stage Ie		Fruit width at end of stage I		Fruit width at end of stage II		Fruit length at maturation		Fruit body length at maturation		Fruit width at maturation		Width expansion ratio from end of stage I to maturation	
	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021
Archipel	—	31-May[x]	—	20.1	—	27.9	—	45.9	—	8.5	—	29.4	—	31.8	—	33.0	—	64.4	—	45.4	—	49.0	—	1.5
Barnissotte	5-Jun	5-Jun	18.2	20.1	34.3	35.0	38.7	36.2	5.0	6.2	28.1	28.7	32.8	34.0	34.6	36.1	61.1	65.4	48.7	52.4	49.1	48.4	1.5	1.4
Blanche	29-May	26-May	21.8	18.9	32.9	29.1	28.8	31.9	5.1	5.9	28.3	29.1	35.4	34.7	36.7	36.4	48.7	51.5	39.8	44.1	48.0	46.4	1.4	1.3
Bordeaux	30-May	3-Jun	20.3	19.0	38.1	33.4	34.8	38.3	5.8	6.2	24.0	23.5	28.4	26.6	30.4	28.5	60.7	58.8	43.5	46.8	43.5	42.3	1.5	1.6
Bourjassotte Grise	29-May	5-Jun	20.6	20.1	38.0	34.0	38.8	44.4	5.3	7.1	31.7	31.2	37.8	39.3	39.6	41.9	65.4	51.9	43.3	41.1	55.3	57.2	1.5	1.5
Bourjassotte Noire	10-Jun	10-Jun	19.4	22.2	35.6	37.5	56.3	55.9	4.6	11.8	31.0	31.3	37.4	38.8	41.1	43.1	57.8	55.7	42.9	43.3	54.3	57.8	1.5	1.5
Brown Turkey	13-Jun	6-Jun	18.8	20.0	28.1	27.8	47.8	46.7	5.6	7.3	25.4	28.8	28.1	32.5	29.7	34.2	43.7	58.8	38.0	47.3	44.3	49.2	1.6	1.5
Brunswick	28-May	1-Jun	20.6	18.9	31.8	33.6	47.0	46.2	5.9	9.8	30.2	28.3	35.0	32.5	37.2	34.9	73.5	71.5	62.0	62.0	57.8	52.5	1.6	1.6
Dottato	2-Jun	31-May	19.2	18.1	34.1	34.5	33.3	31.3	6.5	7.1	28.7	28.4	32.1	32.3	32.2	33.0	59.2	59.6	40.8	44.7	45.6	49.4	1.4	1.5
Drap d'Or	3-Jun	31-May	18.1	18.6	29.9	32.3	47.7	34.6	6.1	7.7	29.4	28.1	33.7	32.9	35.8	33.8	74.5	80.3	53.8	57.6	52.7	50.3	1.6	1.5
(Dreamy Sweet)	—	3-Jun	—	25.4	—	41.9	—	46.3	—	8.9	—	26.9	—	30.8	—	32.9	—	57.7	—	49.0	—	46.2	—	1.5
Du Japon	7-Jun	4-Jun	21.7	19.5	38.5	35.4	22.3	27.4	6.7	6.3	28.8	27.1	34.1	34.4	35.1	35.5	78.4	82.1	67.1	71.7	49.1	53.3	1.4	1.6
Franciscana	12-Jun	7-Jun	18.1	20.9	31.7	33.1	31.9	32.3	4.6	7.1	23.4	24.3	29.3	30.8	30.2	32.1	59.5	65.0	45.8	52.3	43.9	45.8	1.5	1.5
Genoa	2-Jun	9-Jun	18.5	17.5	30.0	31.0	36.8	35.6	6.3	6.3	27.5	28.7	34.1	34.8	35.8	35.7	66.0	67.3	55.0	57.0	56.1	54.5	1.7	1.6
Houraishi	—	7-Jun	—	19.0	—	28.9	—	82.8	—	10.3	—	31.9	—	38.0	—	42.2	—	59.4	—	49.7	—	55.3	—	1.5
Ischia	22-May	21-May	18.8	21.4	34.8	37.3	43.5	43.1	4.6	6.1	21.6	24.4	24.8	27.5	25.7	28.4	44.1	42.4	29.0	34.6	35.0	43.0	1.4	1.6
Malta	—	28-May	—	17.8	—	27.3	—	35.5	—	6.9	—	24.3	—	25.9	—	26.4	—	55.0	—	35.4	—	36.9	—	1.4
Panachée	—	5-Jun	—	20.7	—	36.4	—	47.3	—	7.7	—	27.1	—	31.5	—	32.9	—	53.5	—	40.5	—	43.5	—	1.5
Précoce de Barcelona	30-May	5-Jun	16.4	16.4	30.0	28.6	28.5	35.5	4.3	5.4	22.7	22.7	28.6	28.5	29.7	30.6	48.5	46.6	39.9	39.8	40.7	41.2	1.4	1.5
San Piero	30-May	29-May	24.2	24.0	35.6	36.9	24.2	27.9	5.2	6.0	38.2	36.0	44.1	41.6	45.9	42.5	88.2	79.5	63.7	59.9	66.3	59.5	1.5	1.4
Saint Jean	—	31-May	—	19.6	—	33.8	—	42.5	—	5.9	—	24.3	—	29.0	—	30.3	—	54.5	—	43.6	—	43.0	—	1.5
Verdone	—	3-Jun	—	20.8	—	38.0	—	49.5	—	6.4	—	25.8	—	34.5	—	38.4	—	73.2	—	55.3	—	49.8	—	1.4
Mean	2-Jun	2-Jun	19.6	20.0	33.6	33.4	37.4	41.7	5.4	7.3	27.9	27.7	33.0	32.9	34.6	34.7	62.0	61.6	47.6	48.8	49.4	48.8	1.5	1.5
CV	—	—	0.10	0.10	0.10	0.12	0.26	0.29	0.14	0.22	0.15	0.12	0.15	0.13	0.15	0.14	0.21	0.17	0.23	0.19	0.16	0.12	0.06	0.05

[z] See Figure 7 for growing stages Ie, I, II and III.

[y] See Figure 1.

[x] Means of characteristic values on tested shoots in each variety. Each value is colour-coded depending on the standard scores among test varieties for each year, as red (>1.5), orange (>1.0), black (=<1.0, >=-1.0), light blue (<-1.0) and blue (<-1.5).

Table 3 shows the aggregated results for the duration of each growth stage and fruit size. We focussed on the mean, and CV. The mean durations of stage Ie were 19.6 d (2019) and 20.0 d (2021), which is, overall, in agreement with Sasou (1936)[5]. These durations were similar to most varieties and had a relatively small CV, although this stage was slightly longer for ‘San Piero’ and ‘Dreamy Sweet’, and shorter for ‘Précoce de Barcelona’.

The mean durations of stage I were 33.6 d (2019) and 33.4 d (2021), with some differences between varieties, but the CV was also relatively low.

In contrast, the durations of stage II were 37.4 d (2019) and 41.7 d (2021), the longest among the different stages, and the CV between varieties was high. Stage III also had a slightly higher CV between the varieties than stage Ie and stage I, but the actual duration was as short as 5.4 d (2019) and 7.3 d (2021). In other words, the length of stage II significantly influenced the differences in the maturation dates of the fig varieties, which is consistent with the review of Flaishman *et al*. (2008)[3].

Regarding fruit size, the mean fruit widths in 2019 and 2021 were 27.9 and 27.7 mm at the end of stage Ie, 33.0 and 32.9 mm at the end of stage I, 34.6 and 34.7 mm at the end of stage II, and 49.4 and 48.8 mm at maturation (the end of stage III). For comparison, in the two years of measurement, the respective mean fruit lengths were 62.0 and 61.6 mm, and the mean body lengths were 47.6 and 48.8 mm at maturation. The ratio of fruit width at the end of stage I to fruit width at maturity ranged from 1.3 to 1.6, with minor differences between the varieties, and the same was true for the ratio between the fruit width at the end of stage Ie to fruit width at maturation (data not shown). The mature fruit size of varieties was determined before reaching Stage II, and then enlarged at the same rate until maturity. It is known for individual fig fruits of the same variety that size at maturity is determined at the end of Stage I [24]. Our results indicate that the same relationship applies to fruit size differences among varieties. As previously mentioned, Hirai (1966)[22] states that the capacity of the cellular tissue of ‘Masui Dauphine (San Piero)’ fruit is determined during stage I and that expansion of intercellular spaces causes subsequent fruit enlargement. It is, therefore, presumed that the cellular tissue capacity has a decisive influence on the size of fig fruits, regardless of the variety or individual specimen.

The fruit-enlargement patterns described here reflect fruit set at the base of trees, whereas Hirai (1966)[22] and Yahata and Nogata (2001)[25] found that in ‘Masui Dauphine (San Piero)’, the durations of stages I, II, and III were constant regardless of the fruiting node position; and Crane (1948)[4] observed the same trend in ‘Kadota (Dottato)’. Thus, the fruit set trends described here likely apply to fruits developing from higher nodes.

4.Conclusions

The production of more and larger fruits at an earlier period is advantageous in fruit cultivation, enabling increases in yields earlier in the season when the selling price is typically higher. While qualitative characteristics such as eating quality are essential when selecting a variety, quantitative characteristics are also relevant. Maturation time, fruit set rate, and fruit size should be considered for good yield management, and the fruit productivity characteristics described in this study can help to make a better selection of fig varieties.

We found that the date of fig fruit maturation is influenced mainly by the length of the stage II development period, suggesting that actions that shorten stage II might accelerate fruit maturation under the same fruit-set conditions for a given variety. For example, oleification, the most classic and groundbreaking cultivation technique for figs, accelerates fruit maturation as it is known to shorten stage II[26].

Compared to the enlargement ratio, the size of mature figs is mainly determined at the end of stage I, indicating the importance of promoting cellular tissue formaion during this stage. For example, mitigating nutrient competition through fruit thinning treatments[25] and managing low temperatures[19,27], which increase fig fruit size, are both effective when applied early during fruit growth. Thus, further research is required to determine whether such enlargement effects can be achieved by promoting cellular tissue formation during Stage I.

Our observations also indicate that fig shoot lengthening disrupts the order of fruit maturation in the order of fruiting node position and reduces mean fruit weight during the early harvesting period. Thus, the excessive growth of shoots is an obstacle to the early production of large fruits in some fig varieties. The relationship between shoot growth and stage I fruit development should be further investigated. Notably, many fig varieties remain unpopular due to their relatively small-sized fruits despite their high eating quality. Thus, by developing the techniques and technologies to control fruit size better, a range of fig varieties could be brought into broader cultivation.

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人類の貴重な食物として，古代より栽培されてきたイチジク（*Ficus carica* L.）は，その発祥の地とされる中近東[1]をはじめ，地中海沿岸，アメリカ，ブラジル，中国，インド，日本など多くの国々で栽培されている．しかしながら，イチジクの世界の年間生産量（1,264,943 t）は，リンゴ（86,442,716 t），ブドウ（78,034,332 t），オレンジ（75,458,588 t）といった主要な果樹に比べると少ない[2]．そのため，長い栽培の歴史にもかかわらず，イチジクの生理・生態に関する科学的な知見は比較的限られているのが現状である．

イチジクの果実生育の基本的な特徴としては，例えば，伸長の途上にある新梢の下位節から順次着生する[3]，着生した個々の果実が，急速な肥大（第 I 期），肥大の停滞（第 II 期），再度の急速な肥大（第 III 期）の 3 段階を経て生育し[4, 5]，多くがその年の夏～秋に成熟する，といったことが挙げられる．しかし，これらの特性が品種間でどの程度共通しているのか，例外があるのかといった情報はごく限られている[6]．果実生育特性の品種比較は，非常に基盤的なテーマであり，栽培に適した品種選択とともに，受粉時期，農薬や植物成長調節剤の施用時期，結果枝の栄養状態の管理，収穫時期や収量の推定など，品種の生理的特性に応じた合理的な栽培に直結する知見となり得る．本研究では，こういった観点のもと，イチジクの様々な品種の秋果（second crop）について，その着果，肥大，成熟といった果実生育の基本的特性を明らかにすることを目的に調査を実施した．

研究に先立ち，供試したイチジクの形態的特性を既往の品種リスト[9, 10, 13]と照合することによって，その代表的な品種名の整理を試みた．イチジクは育種も古くから行われ，少なくとも 600 を超える品種が誕生している[10]．そして，他の地域や国に伝搬する過程で，多くの異名（シノニム）や同名（ホモニム）が生まれ，品種名をめぐる混乱を生じさせてきた[7]．この混乱については，以前から形態学的分類に基づく解決の努力がなされてきたが[7, 8, 9, 10]，今なお，同じ品種が様々な名称で呼ばれるのが現状である[11]．本研究で供試した様々なイチジク品種の代表名と，その照合過程で得た特性値は，イチジクに関する学術的情報を広く共有する要と考え，併せて報告を行うものである．

材料および方法

供試樹

調査は（公財）東洋食品研究所（以下，当所），附属農場（北緯 34 度 81 分，東経 135 度 40 分，海抜 38 m，低地水田土の地盤にマサ土を客土して造成）のイチジク樹を用いて 2019 ～ 2021 年に実施した．供試樹は**表 1** に示すとおり，2008 年，2009 年，2017 年，2020 年に 95 樹 / 1000 m^2 の密度で栽植された 77 本で，当所には 37 種類の名称で導入された．樹の仕立ては杯状型としたが，‘Bordeaux’，‘Du Japon’，‘Précoce de Barcelona’ の各 4 樹のうちの 2 樹は一文字整枝[12]とした．芽かきを行って，樹あたり 30 ～ 35 本の新梢を結果枝として伸長させ，過度に伸びた場合は，地上 180 cm 程度の位置で摘芯した．灌漑，施肥，病害虫防除などの栽培管理は慣行に従った．なお，定植から年数が浅く成木に達していないと思われた ‘Conadria’，‘Ischia Black’，‘Longue d'Août’ は，果実生育特性の調査（調査 2 および 3）の対象からは除外した．

調査 1．代表的な品種名の検索

供試樹は，国内の苗木業者から購入したり，他の研究機関から譲渡されたりしたもので，業者の商標や同種でありながら別名（シノニム）で導入されたと思われる樹が複数存在した．そこで，形態学的・栽培学的に類似した樹をグループ化し，学術的な品種の参照リストから代表的な品種名を検索した．検索では，まず Condit（1955）[10]を参照リストとし，当所への導入名，もしくは他の文献や苗木業者の情報で，その導入名のシノニムとされている名称が，Condit（1955）が示す品種の代表名, シノニム, ホモニム，誤称のいずれかと一致することを第一の手掛かりとし，そこに記述されている形態的特性が，当所での観察結果と大きく矛盾しないことをもって，その代表名を対応させた．この際，形態学的特性の基準は，現在広く使われている Descriptors for Fig（IPGRI and CIHEAM, 2003）[14]に準じた．ただし，これと Condit（1955）[10]の基準は，必ずしも一致しないため, Condit（1955）が示す特性は，同氏の基準の解説[15]を参考に，Descriptors for Fig[14]に置き換えて比較した．なお，当所の供試樹の特徴は 2020 年と 2021 年に目視で評定した．ただし，果重については次に示す調査 2 の 2021 年のデータを用い，サンプリングした新梢の 20 節までに成熟した果実重量の四分位範囲をあてた．Condit（1955）に一致する代表名が見当たらない場合は，Simonet ら（1945）[9]，Condit and Warner（1956）[13]を参照リストとして同様の検索を行った．

調査 2．新梢の生育と果実生産

新梢を単位とした果実の生産性を調べるため，2020 年と 2021 年の着果開始期に，各供試樹から中庸な新梢をそれぞれ 6 本と 4 本選定した．選定した新梢での着果開始日と果実成熟開始日，各節の着果日（2021 年のみ），各節の果実成熟日および各節の果重を記録した．収穫を終えた冬季には各新梢の基部から 2 ～ 3 節間の直径（以下，基部径）を記録した．なお，着果日は花序の直径が 3 mm 程度になった時[16]とし，成熟日は果実が指の表面で容易にくぼむ程度に軟化した時とした．また，果重（± 0.1 g）と新梢径（± 0.01 mm）はそれぞれデジタル天秤（EW-300G，A&D，東京）およびデジタルノギス（AD-5765A -150，A&D，東京）を用いて測定した．また，各新梢の

基部から 20 節までの範囲で，(i) 果実が着生した節の割合（以下，着果割合），(ii) 2 果以上が併存して着生した節の割合（以下，複果割合）(2021 年のみ)，(iii) 果実が着生した節のうち成熟果が得られた節の割合（以下，成熟果割合）を求めた．同じく (iv) 新梢各 20 までの節での，着果日と節順（2021 年のみ），果実成熟日と節順，果重と節順それぞれのポリシリアル相関係数（以下，PCC）を統計解析ソフト R（Ver. 4.1.2, R Foundation for Statistical Computing, Vienna, Austria）を用いて算出した. また, (v) 供試品種間での特異度を評点するため，Microsoft Excel (ver. 2016, Microsoft Corp., Redmond, WA, USA）を用いて各特性値の標準得点（standard score，以下，SS）を年度ごとに算出した.

調査 3．新梢基部の果実生育

個々の果実の生育プロセスを調べるため，2019 年と 2021 年の着果開始期に，各供試樹から中庸な新梢をそれぞれ 6 本と 4 本選んで調査新梢とした．なお，2021 年の調査新梢は，調査 2 で用いたものと同じである．各調査新梢で 1 番目もしくは 2 番目に着生した果実を選び，その赤道面の直径（以下，果実幅）を約 5 mm の時期から成熟までデジタルノギス（AD-5765A-150）で測定した．測定法は Crane（1948）[4] と同様だが，測定間隔はより短い 3 ～ 4 日とした．得られたデータは経時的にプロットし，段階的に区分された肥大期間（**図 7** 参照，以下，生育ステージ）の日数と，各生育ステージ終了時の果実幅を読み取った．なお，成熟時には果重と，**図 1** に示す果実長，胴体長も測定した．各特性は調査 2 と同様，年度ごとに SS を求めて供試品種間での特異度を評点するとともに, 各特性値の品種間の変動係数（以下, CV）を算出した.

結果および考察

調査 1．代表的な品種名の検索

観察された供試品種の形態的特性と既往の文献との整合性を**表 1** および**図 2**，**図 3** に示した．結果として，当所が 37 の異なる名称で導入したイチジクは，25 種に集約され，このうちの 24 種については，参照リスト［Condit (1955) [10]，Simonet ら（1945）[9]，Condit and Warner (1956) [13]］が示した代表的な品種名に対応させることができた．もっとも，いくつかの代表名の特性の一部には，供試樹と差異の大きいものがあった．例えば，‘Archipel’ での leaf margin（葉縁の形）と fruit lenticels size（果点サイズ），‘Bordeaux’ や ‘Brown Turkey’ での shape of the fruit stalk（果梗の形），‘Bourjassotte Noire’ での pulp internal colour（小果の色），‘Franciscana’ での fruit bloom（果粉の多少），‘Genoa’ での tree growth habit（樹姿），‘Ischia’ および ‘Malta’ での skin cracks of fruit（裂皮），‘Panachée’ での terminal bud colour（頂芽の色），‘Précoce de Barcelona’ での degree of leaf lobation（裂片切れ込み），‘Verdone’ での neck length of fruit（くび部の長さ），である．しかし，形態学的特徴は，環境条件や [15]，若干の遺伝的な変異によって変化するため，こうした部分的な差異が，必ずしも別品種を示すことにはならない．また名称に関して，3 種の導入名である，‘ビオレソリエス’ もしくは ‘ヌアールシュクレ’，‘バナーネ’，‘プレコスロンデドボルドー’ はいずれも参照リストになかったが，**表 1** の脚注のとおり，名称の関連づけが他の文献や苗木業者の情報に見出され，特性に矛盾もないことから, 代表名に ‘Bourjassotte Noire’, ‘Longue d'Août’，‘Précoce de Barcelona’ を対応させ得た．また，‘ゼブラ・スイート’ もしくは ‘てまりいちじく’ は，参照リストにも他の文献にも見いだせなかったが，明瞭な縦縞を呈する果皮の特徴は他に類がなく，観察される他の特性も参照リストと一致したことから，代表名 ‘Panachée’ で問題ないと思われた．以上，供試品種に参照リストから当てはめた代表名は概ね妥当とし，以下，本調査ではこの代表名を用いた. 導入名 ‘ドリーミースイート’ は唯一代表名を見つけられず，そのまま ‘Dreamy Sweet’ を用いた．また参照リスト [10] では, ‘桝井ドーフィン’ の代表名は ‘San Piero’，‘蓬莱柿’ は ‘Horaigaki’ とあるが, 我が国の主要な品種である前者は国内の呼称 ‘桝井ドーフィン’ を併記し，代表名が日本語由来である後者は漢字の ‘蓬莱柿’ のみで以下に示した.

調査 2．新梢の生育と果実生産

各新梢を単位に，その生育，果実の着生および成熟の状況を品種ごとに集計した結果を**表 2** に，各特性間の関連性について分析した結果を**図 4 ～ 6** に示した．まず**表 2** を見ると，新梢の基部径の平均は 18.0 ～ 31.6 mm の範囲にあり, ‘蓬莱柿’ や ‘Précoce de Barcelona’ が大きく，‘Brown Turkey’ や ‘Ischia’ が小さいなど，品種によるバリエーションがあった．いずれの個体も樹あたりの新梢数に大きな差がないよう管理したので，このバリエーションは各樹勢の違いを直接反映していると思われる．

着果開始は ‘Ischia’ が早く ‘Bourjassotte Noire’ が遅かった．着果割合は，大半の品種が 70 %を超えたが ‘Panachée’，‘Genoa’，‘Verdone’ などは目立って小さかった．また複果割合は多くが 4 %未満と小さかったのに対して，‘Ischia’，‘Malta’，‘Brunswick’，‘Brown Turkey’ は大きく，‘Dottato’ も比較的大きく，同一節に複数の幼果（双子果）が着生した．これは，イチジクは葉腋に着生する 2 個の花芽のうち，‘Fransiscana’（著者は ‘Mission’ で表記）や ‘San Piero’（著者は ‘Brown Turkey’ で表記）など，多くは 1 個の花芽だけが生育するのに対し，‘Dottato’（著者は ‘Kadota’ と表記）ではしばしば花芽が 2 個とも生育するとした見解 [3, 17, 18] と一致した．また，着果日と新梢節順との PCC は，0.86

以上と大きく，新梢の基部から先端に順次に着果するという，イチジクの基本的な習性[3]から逸脱する品種はなかった．

着果した果実のうち，約 70 ～ 90 %の果実は成熟したが，'Malta'，'Du Japon'，'Panachée' などは，成熟前に落果する割合が大きかった（**表 2**）．このうち 'Du Japon' は黒葉枯病やさび病の発生が多く，これらの罹病が落果を助長した可能性が考えられた．成熟日と節順との PCC は大半の品種で 0.8 を超えていた．これは果実の成熟が新梢の基部から先端にかけて順序正しく進んだことを示して，これもイチジクの基本的な習性[3]通りであった．しかしながら，'Bourjassotte Noire'，'蓬莱柿'，'Drap d'Or' などは PCC が目立って小さく，成熟の序列が乱れたことを示していた．序列の乱れた品種には，旺盛すぎる新梢が目立ったことから，これら 3 品種に参考の '桝井ドーフィン（San Piero）' を加え，2020 年に調査した新梢の基部径と PCC との関係をプロットした（**図 4**）．その結果，参考とした '桝井ドーフィン（San Piero）' での PCC は，新梢の基部径に関わらず常に大きかったのに対し，他の 3 品種では新梢基部径が大きいほど PCC が低下する傾向があった．基部から順次成熟するのがイチジクの基本特性であるものの，品種によっては，新梢の徒長がこの序列を乱すことを示していた．

成熟果の果重は**表 1** のとおりで，品種によるバリエーションは大きかった．同じく節順と果重との関係を '桝井ドーフィン（San Piero）' を例に，プロットしてみると（**図 5**），3 ～ 4 節あたりにピークがあり，最基部が最大とはならないものの，果重についても先端のほど小さくなるというイチジクの基本的な特性[19]が観察された．他の多くの品種も同様の傾向で，果重と節順との PCC は 'Blanche' など一部の品種を除いて大きい負の値を示していた（**表 2**）．また，節順と成熟日との PCC が小さかった，'Bourjassotte Noire'，'蓬莱柿'，'Drap d'Or' の 3 品種についても，果重と節順との PCC は小さくなく，このことは，新梢の徒長で節順に伴う成熟日の序列が乱れても，果重の序列は影響を受けないことを示していた．Hosomi（2021）[20]は '蓬莱柿' の場合，長大な新梢ほど，特に成熟初期の果重が小さかったことを報告している．Hosomi（2021）が調査した果実をどの節位から採果していたか不明だが，本研究と同じく成熟日の序列が乱れ，果重の小さい先端果が早期に成熟してしまうことで，長大な新梢での収穫初期の平均果重を押し下げた可能性も考えられる．

もっとも，品種によっては基部と先端との果実に目立った大きさの違いが感じられない例も見受けられた．そこで品種ごとに着果節位を説明変数，果重を目的変数とした単回帰係数と，全果の平均果重を求め，これらの関係をプロットしたのが**図 6** である．この図が示すとおり，負の値をとる回帰係数は平均果重が小さいほど 0 に近づき，この傾向は 2021 年も同様であった（図略）．すなわち，小果の品種ほど着果節位による果重の変化が少ない傾向があると言えた．

調査 3．新梢基部の果実生育

各品種の基部付近の果実を対象に，果実の肥大プロセスについて調査した結果を，**図 7** と**表 3** に示した．緒言で述べたとおり，イチジクの果実の肥大については，ダブルシグモイドカーブ，すなわち，着果後しばらくして急速に肥大し（Stage I），その後，停滞期（Stage II）を経てから，再び急速に肥大（Stage III）して成熟することが知られている[4, 5]．しかしながら，本研究の結果を見ると，実際はこの論理的な曲線に完全にフィットするケースは稀であった．**図 7** には例として 'Brunswick' の果実幅の変化を示した．着果後まもなく急速に肥大するが，やがて肥大が明瞭に減速する折曲点 1 が現れる．その後漸増したあと，折曲点 2 を経て，ほぼ停止に近いものの，ごくわずかに肥大する状態が続き，折曲点 3 の直後から急速に再肥大して成熟に至る．折曲点 1，2 が不明確なケースもあったが，多くが類似したパターンであった．このうち，例えば佐宗（1936）[5]や MAREI & CRANE（1971）[21]は折曲点 1 を，Crane（1986）[17]や平井（1966）[22]は折曲点 2 を Stage I と Stage II の境目とした図を示している．Stage I と Stage II の境目には明確な定義が見当たらず判断は難しいが，本研究では果実の生育を詳しく調査した後者に従うこととした．ただし，Baskaya and Crane（1950）[23]や平井（1966）[22]によると，イチジクは着果から果実の肥大がほぼ停止するまでの途中で，それまでの細胞層や細胞数の増加が終了したり，果のう内部の小花が開花したりする．今のところ明確な根拠はないが，本研究で確認した折曲点 1 については，こういった生理変化のサインの可能性もある．そこで，本研究ではこの折曲点 1 についても果実生育上の重要なターニングポイントと考え，着果から折曲点 1 までを Stage Ie，着果から折曲点 2 までを Stage I，その後の肥大停滞期間を Stage II，その後の成熟までの再急増期間を Stage III と定義して，以後の集計を行った．

各生育段階の日数に関する結果は**表 3** に示したとおりである．2019 年（16 品種）と 2021 年（22 品種）の各特性の平均や CV に着目すると，Stage Ie の平均日数は 19.6 日と 20.0 日で佐宗（1936）[5]と概ね一致し，'桝井ドーフィン（San Piero）' や 'Dreamy Sweet' でやや長く，'Précoce de Barcelona' でやや短かったものの CV は比較的小さく，品種間での大きな差異はなかった．Stage I の平均日数は 33.6 日と 33.4 日で，同じく CV は比較的小さかった．一方，Stage II の平均日数は 37.4 日と 41.7 日で，生育ステージの中では最も長く，品種間の CV も大きかった．Stage III も品種間の CV は Stage Ie や Stage I よりはやや大きかったが，平均日数自体は 5.4 日と 7.3 日と短かった．すなわち，イチジク品種の成熟期

の差にはStage IIの長さが最も影響すると言え，‘Bourjassotte Noire’‘蓬莱柿’などの成熟期の遅さは，その長いStage IIの日数に由来していた．これらのことはStage IIの日数に品種によるバリエーションが大きいとしたFlaishmanら（2008）[3]の見解とも一致していた．

表3には各生育段階の果実のサイズに関する結果も示した．2019年（16品種）と2021年（22品種）の各生育段階での果実幅を見ると，Stage Ieの終わりで27.9 mmと27.7 mm，Stage Iの終わりで33.0 mmと32.9 mm，Stage IIの終わりで34.6 mmと34.7 mm，成熟時（＝Stage IIIの終わり）で49.4 mmと48.8 mmであった．参考までに，それぞれの年の，成熟の果実長の平均は62.0 mmと61.6 mm，胴体長の平均は47.6 mmと48.8 mmであった．このうち，果実幅のStage Iの終わりと成熟時の比は，1.3から1.6の範囲にあって，品種による差は小さかった．Stage Ieの終わりと成熟時の比についても同様のことが言えた（データ略）．すなわち，いずれの品種もStage IIに入る段階で果実サイズが決しており，その後は成熟まで同じ比率で肥大することを示している．イチジク果実の成熟時の大きさの違いがStage Iの終わり決することは，同一品種の個々の果実については知られているが[24]，本結果は，品種による果実サイズの違いにも同様のことが当てはまることを示している．前述のとおり，平井（1966）[22]は，‘桝井ドーフィン（San Piero）’の果実の細胞の数と大きさがStage Iのうちに決定し，その後の肥大は細胞間隙の拡大によるとしている．したがって，イチジク果実の大きさには，品種，個体を問わず，細胞の数と大きさが決定的な影響をもつと推定される．

なお，今回示した生育特性は，基部付近に着生した果実についての結果であるが，平井（1966）[22]や八羽田・野方（2001）[25]は‘桝井ドーフィン（San Piero）’において，Crane（1948）[4]は‘Kadota (Dottato)’において第I，第II，第IIIの期間は着果節位に関わりなく一定としており，より上位節の果実についても同様の傾向が当てはまるものと推定される．

まとめ

イチジク栽培に限らず，より早い時期により大きな果実を数多く得ることは，売価の高い早期に生産物の収量を高め経営的に有利となる．栽培品種の選定には，果皮の色や食味などの質的特性が重要だが，成熟期，着果割合，果実サイズなどの量的特性の優秀性も重要である．本研究で示した果実生産性に関する諸特性の結果は後者の意味において品種選択の参考となろう．

一方，調査した果実の生育パターンから，果実の成熟期の早晩はStage IIの長短に大きく支配されていることが分かった．このことは，同じ着果条件の果実の成熟を促進するには，Stage IIの期間をいかに短縮するかが重要なことを示している．例えば，油処理はStage IIの期間を縮めることが知られており[26]，この目的を達成する最も古典的かつ画期的な手段と言えよう．

また，成熟果のサイズはStage Iの終わりにはほぼ運命づけられていると考えられ，より大きな果実を得るには，Stage I，すなわち細胞の数と大きさをいかに促進するかが重要なことを示している．例えば，摘果処理による養分競合の改善や[25]，果実を大きくする低温での管理[19, 27]は，いずれも，果実生育の初期に処理することで効果を発揮する．現時点では不明だが，この肥大効果が推定どおりStage Iでの細胞の数と大きさを促すことによって得られているかどうか，興味深いところである．さらに，本研究では，新梢の徒長が，着果節位順に熟する序列を乱し，収穫初期の平均果重を低下させる例を示した．早い時期に大きな果実を得る上で，品種によっては，新梢の伸び方が大きく関わってくることを考慮すべきで，今後は，新梢生育とStage I期の果実生育の関係についても究明を進める必要があろう．多くのイチジク品種の中には，高食味ながら果実が小さいために普及していない品種も多い，こういった潜在的価値をもった品種を発掘する上でも，果実の大きさを制御できる技術開発に期待が持たれるところである．