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Phenological growth and development stages of common fig (*Ficus carica* L.) under arid climate of India

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ABSTRACT

Arid region is characterised by extreme climatic condition, poor soil health and over-exploitation of natural resources. Under prevailing conditions of arid India, *Ficus carica* is an emerging fruit crop with high commercial value and nutritional significance. Phenological study plays an important role in ensuring efficient crop management practices, but such studies in fig have not yet been conducted in India. The present study was conducted with an aim to define and describe phenological stages of common fig cultivar 'Diana' in arid regions according to the Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie (BBCH)-scale using two-digit numerical system. The BBCH scale markedly explains various developmental stages of crops. Seven principal growth stages, viz. bud development (0), leaf development (1), shoot development (3), inflorescence development (5), flower development (6), syconium (fig receptacle) development (7) and fruit maturation (8), and 25 secondary growth stages of fig have been described. The sequential progression of principal growth stages of fig indicated temporal variation in growth pattern as well as overlapping of secondary growth stages. Phenological description will act as a pragmatic approach to define growth stages in order to facilitate timely agronomic practices such as canopy management, nutrient management and irrigation scheduling, pest and disease management. Since fig is considered one of the important minor fruits of India, a detailed phenological description will be instrumental in enhancing its potential in arid and semi-arid regions.

Keywords: BBCH-scale, common fig, fruit development, syconium, vegetative growth

INTRODUCTION

Arid regions of India are constrained by low and erratic precipitation (100–420 mm · year^{-1}), high solar radiation and high wind velocity resulting in high evapotranspiration (1500–2000 mm · year^{-1}), and high mean aridity index (Rao, 2009). The soils are poor in fertility and have poor water holding capacity with high infiltration rate. The soils are generally shallow with subsoil underlain with carbonaceous hard pan (Narain, 2008). The groundwater resources are scares and mostly saline in nature. Under such constraints, fig (*Ficus carica* L.) (Moraceae) exhibits adaptive features like extensive root system, thick and coarse leaves, hairiness, sunken and covered stomata in leaves, mucilaginous latex in twigs and branches,

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tolerance capacity to salinity and alkalinity and ability to synchronise flowering and fruiting as per ideal growing condition by crop regulation. Fig performs well in arid and semi-arid climates, with cool winters and hot–dry summers, extremely drought tolerant once established, and commercial production is preferred in dry hot summers. In India, area under fig cultivation has increased, is increasing more rapidly and is now cultivated in 5900 hectares (FAOSTAT, 2022). Genus ficus comprised of around 37–40 genera and 800–1100 species; most of the species are found in the tropics and subtropics and only a few species produce edible fruits (Ferguson et al., 1990). Among them, *Ficus carica* is the most important species. Fig is said to have originated in western Asia, particularly in southern Arabia.

World fig production is about 1.26 million MT, of which 70% is contributed by Turkey (25.3%), Egypt (15.9%), Morocco (11.4%), Algeria (9.2%) and Iran (FAOSTAT, 2022). Fig is a deciduous subtropical fruit species, which is cultivated in the Mediterranean regions of the world in mild-temperate to tropical and subtropical conditions (Botti et al., 2003). Low humidity (<25%), intense solar radiation, high summer temperatures (up to 39°C) and frost-free winter (Botti et al., 2003) are ideal for successful cultivation of fig. Figs are divided into four groups depending on their sex and pollination—caprifig (*F. carica* var. *sylvestris* Shinn.), common fig (*F. carica* var. *hortensis* Shinn.), Smyrna (*F. carica* var. *smyrnica* Shinn.) and San Pedro (*F. carica* var. *intermedia* Shinn.). Among which, Smyrna and San Pedro types produce edible fruit. These contain only long-styled female flowers producing more succulent fruitlets, and act as females, while caprifig contains staminate and short-styled female flowers, and acts as males to pollinate the other female figs (Hong and Chen, 2003). The common fig (*Ficus carica* L; 2n = 2x = 26), commonly grown in India is parthenocarpic in nature. Whereas, Smyrna fig has completely non-parthenocarpic flowers (i.e. need pollination to produce fruit) and the San Pedro type needs pollination for the main crop, while the *breba* crop is parthenocarpic (Hong and Chen, 2003; Stover et al., 2007). In recent years, the area under fig cultivation has been substantially increased in arid and semi-arid regions of India due to the availability of micro-propagated dwarf cultivars such as Diana. Fig is a bush or small tree (1–10 m), bearing specialised fruits (syconia) singly or in pairs in the axils of leaves of the current season's growth (Hussain et al., 2021). Fig is an aggregate fruit composed of individual small drupes; each termed drupelets (Lisei and Pacini, 1994). True fruits are the tiny drupelets inside the cavity of the fused peduncle. Fig fruit development follows a double sigmoid curve with three defined growth periods (Panchai and Boonplod, 2021). Figs are climacteric fruits exhibiting their climacteric peak at the beginning of the third stage of growth (Ferguson et al., 1990). Figs can be eaten fresh, dried or canned, and are often used in the preparation of jam. Fig fruit is highly nutritious and rich in dietary fibre, iron, calcium, proteins and calories (Sedaghat and Rahemi, 2018). Dried figs are rich in polyphenols, such as anthocyanins and flavonoids (Piga et al., 2008), containing higher concentrations of proteins, fibre, carbohydrates and minerals especially calcium, phosphorus and iron (Sedaghat and Rahemi, 2018).

Phenology is the annual sequence of biological development phases of plant species. The Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie (BBCH) numerical scale is a system for uniform coding of growth stages and has been widely used for describing phenological stages of plants. The basic BBCH-scale, represented by two digits, consists of primary and secondary scales, each of which is subdivided into 10 (0–9) clearly recognisable and distinguishable developmental phases. The primary scale describes the principal stages associated with the developmental cycle of the plants, whereas the secondary scale is a subsequent division of the principal stages into 10 developmental stages (Fin et al., 2007). On the other hand, the extended BBCH-scale provides a more detailed description of crops by considering meso levels (1–n), which are incorporated between the primary and secondary stages, resulting in a three-digit scale (Hack et al., 1992). Climate and other associated factors govern the phenology of crops and fig being a new introduction in the arid parts of western India, the precise and standardised description of phenological stages is essential for effective crop management practices, breeding programmes, characterisation and conservation of germplasm. Since the phenology of fig has not yet been defined and described, the aim of the present study is to define phenological growth stages to enable the growers and researchers for efficient crop management practices and crop improvement programmes.

MATERIALS AND METHODS

The present study was conducted at the ICAR-Central Arid Zone Research Institute, Jodhpur (elevation: 216 m above mean sea level; and 45 m amsl; latitude: 26°18′ N; longitude: 73°04′ E), Rajasthan, India for two consecutive seasons during 2020–2021 and 2021–2022. The climate of the site is subtropical hot arid with an average annual rainfall of 340 mm, mean annual, average minimum and maximum temperatures of 34.4°C, 12.2°C and 38.7°C, respectively, and average relative humidity of 50.5% (ranging from 35% to 70%) along with a very high rate of evaporation throughout the year with the peak during summer (3.5–13.5 mm $\cdot$ day^{-1}). The soil of the experimental site contains high percentage of fine and coarse sand, the pH varies from 8.2 to 8.4 having average organic carbon (0.217%), available N (kg $\cdot$ ha^{-1}), available P_2O_5

(23.8 kg · ha^{-1}) and available K_2O (359 kg · ha^{-1}). The fig cultivar 'Diana' raised through tissue culture planted at 4 m · 3.5 m (715 plants · ha^{-1}) in a 0.35–ha area was undertaken for experimentation. Plants were maintained in the open field under a drip irrigation system, trained with multistem system having 4–5 primary branches with well-spaced 4–5 secondary branches on each primary branch. Since fig cultivar 'Diana' bears fruits on current season growth, severe annual pruning leaving 4–5 basal nodes was performed in June–July. Nutrients were applied both as basal application and fertigation through water-soluble fertilizer grades in the ratio of 40:60. Well-decomposed farm yard manures along with humic acid and bioformulation (*Trichoderma viride* and *Vesicular Arbuscular Mycorrhizae*) was applied during the rainy season just after annual pruning.

Out of 260 plants in the experimental orchard, 45 uniform plants were selected for recording various observations for different phenological stages at weekly intervals, starting from July. The development of shoot and fruit was recorded twice per month from 90 tagged branches located in randomly selected plants.

In the two-digit code of the BBCH-scale, the first digit represents the principal growth stage and the second digit specifies secondary growth stages (Hack et al., 1992; Meier et al., 2009). The proposed BBCH phenological scale is represented by various primary growth stages starting with stage 0 (vegetative bud development), stages 1 (leaf development), 3 (shoot development), 5 (reproductive bud development), 6 (flower development), 7 (fruit development) and ending with stage 8 (fruit maturity). The stages 2 (tillering and side shoots) and 4 (development of vegetatively propagated organs) were not described because it is not applicable in fig. Principal growth stages were further divided into 10 secondary stages (0–9) corresponding to intermediate developmental stages linked to specific stages. For example, value 5 of principal stage 1 (leaf development) is assigned when the leaf attains about 50% of the final leaf length and its identification would be 15. Likewise, code 79 identifies as secondary stage 9 of the principal stage 7 (fruit development), which defines fruit at about 90% of its final size. The phenological growth stages and syconium development were sequentially characterised and photographed with a digital camera (Nikon D3200 USA). In order to characterise the development of druplets, five reproductive buds were collected at different stages during October–November and photographed under a stereoscopic microscope (LeicaS8APO, Germany).

RESULTS

The principal growth stages of fig are divided into seven stages; three for vegetative growth (bud, leaf and shoot development) and four for reproductive stages (inflorescence emergence, flowering, fruit development and fruit maturation). Within the principal growth stages, a total of 25 secondary growth stages are described (Table 1).

Table 1. Description of phenological growth stages of common fig (*Ficus carrica* L.) according to BBCH-scale.

BBCH code	Description
Principal growth stage 0: vegetative bud development	
01	Beginning of bud swelling
05	Beginning of bud elongation
07	Advance bud elongation
09	Beginning of bud break
Principal growth stage 1: leaf development	
11	Separation of leaves
15	Leaf development continues
17	Advance leaf development
19	All leaves unfolded
Principal growth stage 3: shoot development	
31	Beginning of shoot elongation
33	Advance shoot elongation
37	Shoots about 70% of final length
39	Shoots about 90% of final length
Principal growth stage 5: inflorescence development	
51	Emergence of reproductive bud from the shoot
53	Beginning of bud elongation
55	Initiation of syconium development
59	Maturation of inflorescence bud
Principal growth stage 6: flower development	
61	Beginning of flower maturation
65	Peak flowering
69	End of flower maturation
Principal growth stage 7: syconium development	
71	Fruit set
75	Syconium at 50% of final size
79	Syconium at 70% or more of final size
Principal growth stage 8: fruit maturity	
81	Beginning of syconium maturation
85	Advance colour development
87	Syconium ripe for picking
89	Fruit over mature

BBCH, Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie.

Principal growth stage 0: Vegetative bud development

01. Beginning of bud swelling: dull brown buds start emerging from leaf axil (Figure 1).
05. Beginning of bud elongation: buds become prominent, leaf primordia start emerging, bracts attached at the base (Figure 1).
07. Advance bud elongation: growth of leaf primordia continues leaf primordia in advance growth stage (Figure 1).

09. Beginning of bud break: leaf primodia start separating, leaf tips visible (Figure 1).

Principal growth stage 1: Leaf development

11. Separation of leaves: light green leaf primordia are visible, leaf primordia starts separating (Figure 1).
15. Leaf development continues: lamina formation begins; three to five prominent lobes of leaf are visible (Figure 1).
17. Advance leaf development: first leaves open, leaf turns dark green, leaf development completed (Figure 1).
19. All leaves unfolded: first leaves attain full size, leaves appear green.

Principal growth stage 3: Shoot development

31. Beginning of shoot elongation: axes of developing shoots elongate, developing green leaves visible (Figure 1).
33. Advance shoot elongation: shoots about 30% of final length: central axis starts elongating (Figure 1).
37. Shoots about 70% of final length: most of the leaves fully expanded and light green in colour (Figure 1).
39. Shoots about 90% of final length: all leaves fully developed, shoots completely developed, most of the leaves dark green in colour (Figure 1).

Principal growth stage 5: Inflorescence development

51. Emergence of reproductive bud from the shoot (Figure 2).
53. Beginning of bud elongation: main axis of inflorescence (syconium) starts elongating (Figure 2).
55. Initiation of syconium development: syconium developed in advance stage; reproductive parts inconspicuously developed (Figure 2).
59. Maturation of inflorescence bud: development of pistillate and sterile male flowers completed (Figure 2).

Principal growth stage 6: Flower development

61. Beginning of flower maturation: small pistillate flowers along with style and pedicel start elongating, ovary development continue, elongation of sterile staminate flowers continues (Figure 2).
65. Peak flowering: elongation of most of the pistillate flowers complete; elongation of sterile staminate flowers complete; style attains its maximum size; stigmas are at peak receptivity (Figure 2).
69. End of flower maturation: initiation of fruit set, pistillate flowers exhibit parthenocarpic fruit set; degeneration of staminate flowers begins (Figure 2).

Principal growth stage 7: Syconium development

71. Fruit set: beginning of ovary growth and druplets; degeneration of staminate flowers (Figure 2).
75. Syconium at 50% of final size: development of drupelets and receptacle at advance stage; skin hardening begins (Figure 2).

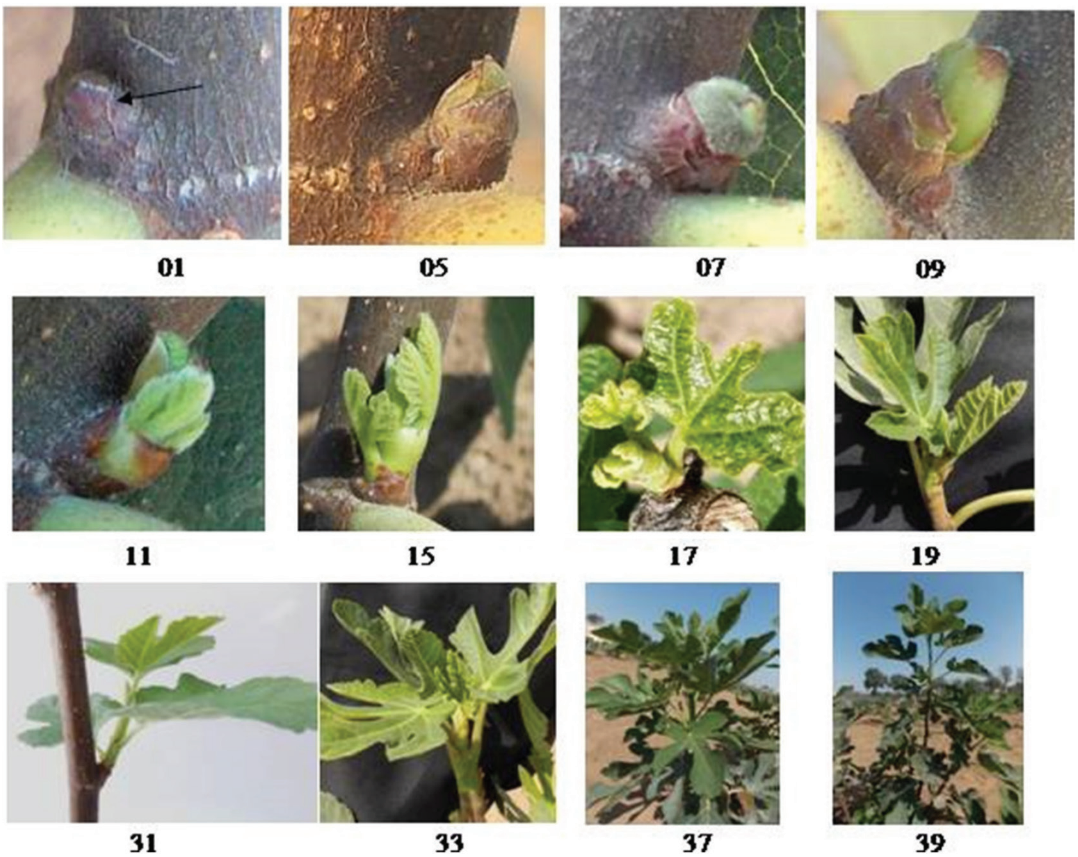

Figure 1. Illustrations of vegetative development of common fig (*Ficus carica* L.) according to BBCH-scale. BBCH, Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie.

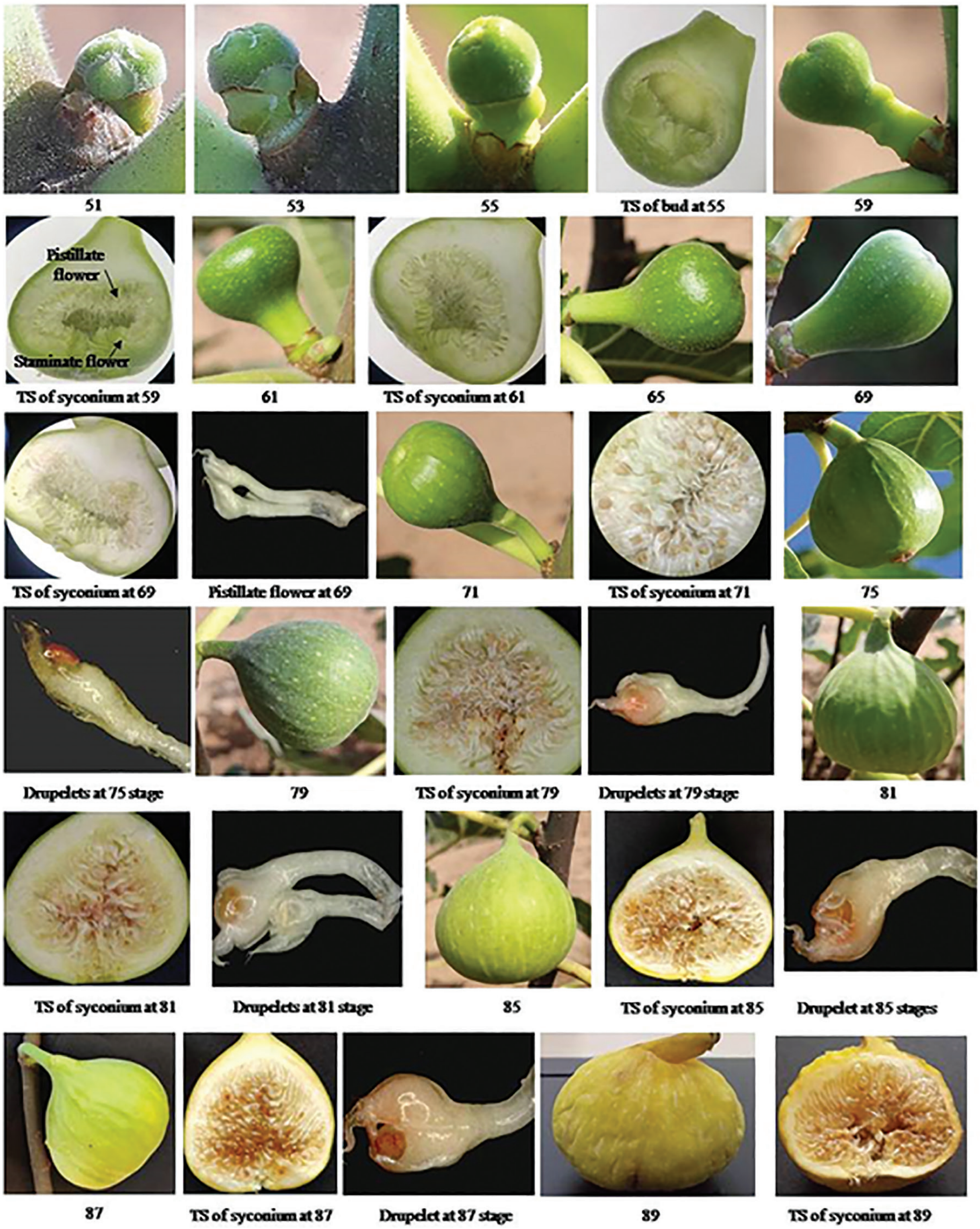

Figure 2. Illustrations of reproductive development, fruit development and maturation of common fig (*Ficus carica* L.) according to BBCH-scale. BBCH, Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie.

79. Syconium at 90% or more of final size: skin hardening complete; change in the colour of skin and pulp begins; drupelets development is completed (Figure 2).

Principal growth stage 8: Fruit maturity

81. Beginning of syconium maturation: skin colour turns light green; pulp colour begins to change to light yellow (Figure 2).

85. Advance colour development: fruit skin turns light yellow; softening of skin begins, increase in the juice content of drupelets; pulp content increases (Figure 2).

87. Syconium ripe for picking: skin and pulp turn yellow; fruit becomes lustrous and adequately soft, juiciness in drupelets substantially increases (Figure 2).

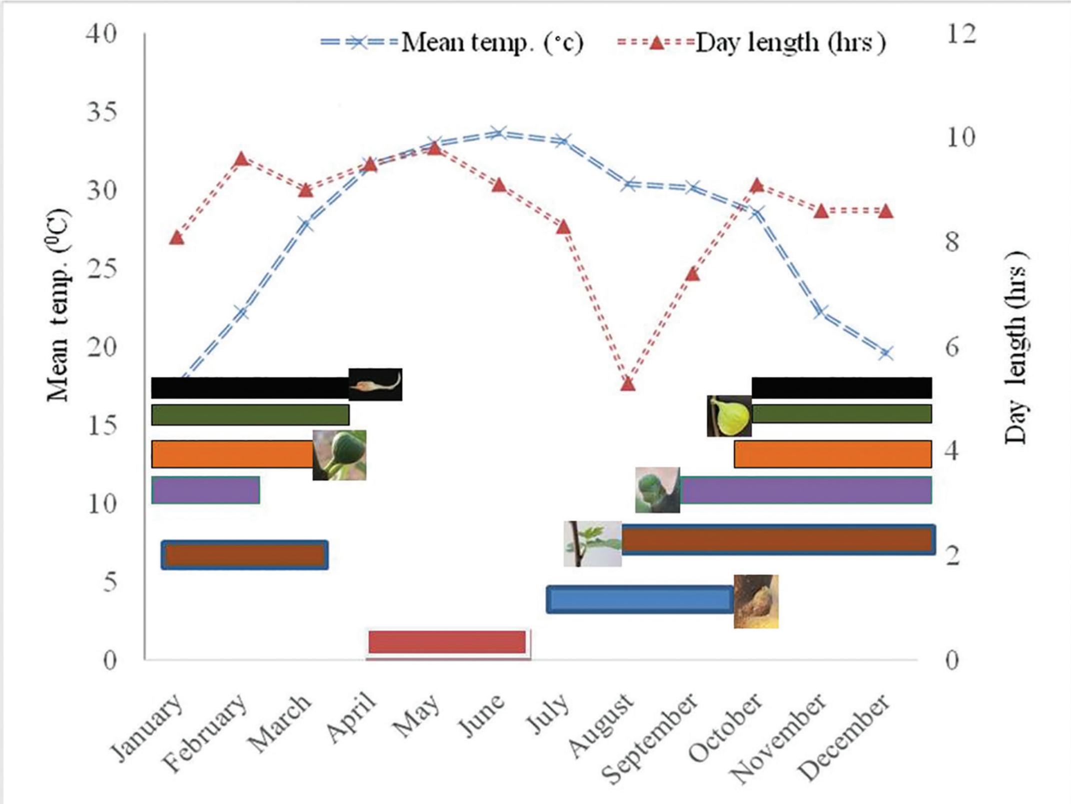

Figure 3. Sequential progression of principal growth stages of common fig (*Ficus carica*). Time elapsed in each stage (horizontal bars), monthly mean temperature (ºC) and day length (2020–21).

89. Fruit over mature: loss of fruit cluster, fruit colour is lost, excessive softening of peel and pulp, reduction in the sweetness of drupelets (Figure 2).

DISCUSSION

Under the arid region of India, fig produced multiple flushes of reproductive and vegetative buds throughout the year, however July–August and October–January were the major episodes for vegetative and reproductive development, respectively. The sequential progression of principal growth stages indicated overlapping of phases since vegetative growth phases preceded in parallel with the reproductive stages (Figure 3). In fig, third—fourth order branches served as fruiting shoots. Since the main crop of fig bears fruit on current season growth, the successful development of leaves (11–19) and shoots directly influence subsequent reproductive bud induction (51–59) and fruit set (71). Hence, this phase of plant growth is very crucial and requires utmost attention on time annual pruning of secondary branches and subsequent protection of vegetative growth from various biotic and abiotic stresses for producing high marketable fruit yield. Development of vegetative phenophases in July–August is indicative of the physiological adaptation of fig in arid conditions since during this period, the weather is characterised by mild temperature and light intensity, which in turn facilitates higher synthesis of photo-assimilates. Can et al. (2008) reported that fig cultivars were stressed at high temperatures, which in turn reduced stomatal conductance, net photosynthetic rate and photochemical efficiency. Ammar et al. (2020) also reported higher photosynthetic performance of fig in spring than in summer. They attributed the prevalence of optimum leaf temperature (~30°C) during spring to higher net photosynthesis, gas exchange and chlorophyll content index.

Fig exhibits indeterminate growth habit after pruning (July–September). However, the intensity of bud emergence varies with climatic conditions and nutrient management practices. The development of buds is followed by leaf development which is completed within 2–3 weeks after bud emergence. The events of bud, leaf and shoot growth go together and reach physiological maturity after 6–7 weeks and begin reproductive bud development. Major reproductive flush period in fig starts from mid-September and continues till January, however, October–November is the major reproductive flush period. Emergence of reproductive phase in the autumn season may be indicative of adaptive behaviour of fig to cope with stressful situations such as high temperature and light intensity, which affect reproductive success in fruit crops. Fruit set and fruit development in perennial fruit crops is highly influenced by the supply of photosynthates (Vasconcelos et al., 2009; Gundesli et al., 2020).

Reproductive buds emerged from the axil of leaves singly, which continuously grow and transform into syconium within 10–15 days. The growth pattern of reproductive buds indicated an initial phase of slow growth followed by rapid growth attributed to the elongation of syconium (75). It is reported that overall syconia developed over a period of 12–16 weeks (Bremer 2008, Crisosto et al., 2010) but the length of growth periods within different stages may vary depending on variety, climatic conditions and season of crop (Hussain et al., 2021). Similarly, in arid climatic conditions of India, prevalence of mild temperature (25–30°C), bright sunshine (7–9 h) and low humidity (25–35%) favour reproductive events in fig (Figure 3), which is overlapped by fruit development and maturation.

Botti et al. (2003) also observed that the fruit quality deteriorates beyond 39ºC. Though the mature plant can withstand low temperatures up to 4ºC, it makes good growth when the temperature is in the range of 15–21ºC. High humidity coupled with low temperature usually results in fruit splitting and low fruit quality. Similarly, Soby (1997) also stated that figs perform best under mild winter, hot summer, low relative humidity and intenseness solar radiation.

Intensity and time of pruning followed by nutrient management have been observed as key operations in fig for ensuring higher yield and fruit quality. Soil and foliar application of macro and micro-nutrients at vegetative bud (01), shoot growth (31) and reproductive growth stages (51) ensures high marketable yield and fruit quality. Foliar sprays of micro-nutrients at syconium elongation (79) are important for reducing fruit splitting in fig (Hussain et al., 2021; Sedaghat and Rahemi, 2018; Morton, 2000). Since parallel vegetative (shoots) growth and reproductive growth occur in figs, the application of nutrients in split doses would be more beneficial in obtaining higher and quality produce. Fruit skin turns yellow from green (85) after around 8–10 days, which occurs 30–35 days after syconium development. Similar pattern of fruit growth and maturation in fig fruit was also reported by Flaishman et al. (2008) and Hong and Chen (2003). The stage of maturation of fruit at harvest affects postharvest development and influences the overall quality of fruits. Fig is a climacteric fruit that reaches the best eating quality when harvested at optimum maturity (Flaishman et al., 2008; Sedaghat and Rahemi, 2018). Fruits that have been harvested prematurely (81) are prone to cellular disorganisation, whereas fruits harvested overripe (819) are likely to have high moisture content, poor pulp texture and fruit quality (Crisosto et al., 2010; Dogan et al., 2020; Jusoh et al., 2020). Being highly perishable with a short shelf life, identifying the optimal stage of harvest is prerequisite for ensuring better fruit quality. Fig fruit should be harvested either at the colour turning stage (85) for distant markets or at the fully mature stage (87) for local consumption for harnessing maximum nutritional quality. Under arid climate of western India, fruit attains optimum maturity after 7–8 weeks after syconium development. If harvesting is delayed by 5–7 days, fruit splitting and rotting can occur (89).

CONCLUSIONS

Phenological events of crop species are highly regulated by weather parameters such as temperature, relative humidity, light intensity and soil moisture conditions. Hence, alteration in critical developmental stages (phenology) gives an indication of climate change which has a negative impact on crop production. Scientific reports clearly indicate the impact of climate change on agriculture production and under such conditions, phenological studies of potential minor fruit crop such as *Ficus carica* has great significance. The detailed description of phenology of fig will not only be helpful in ensuring efficient agronomic practices (canopy management, nutrient management, irrigation scheduling, pest and disease management) but also provide a better understanding of the interaction between weather parameters and phonological events. The study will also be helpful in the development of a climate-resilient variety of fig.

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AUTHOR CONTRIBUTIONS

A.S. – conceptualisation, data collection and writing. K.K. – coding, interpretation and editing. P.K. – manuscript drafting and editing. P.S. – graphical representation. D.S.M. – editing, revising and figures plotting. D.S. – data collection and analysis. H.S. – experimental field management.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Ammar, A., Ben Aissa, I., Mars, M., and Gouiaa, M. (2020). Seasonal variation of fig tree (*Ficus carica* L.) physiological characteristics reveals its adaptation performance. *South African Journal of Botany*, *132*, 30–37, https://doi.org/10.1016/j.sajb.2020.04.020.

Botti, C., Franck, N., Prat, L., Ioannidis, D., and Morales, B. (2003). The effect of climatic conditions on fresh fig fruit yield, quality and type of crop. *Acta Horticulturae*, *605*, 37–44.

Bremer, V. (2008). Use of preharvest ethephon applications to reduce breba crop load and postharvest performance evaluation of fresh fig (*Ficus carica*) varieties/selection. MSc Thesis, California State University, Fresno, CA, USA.

Can, H. Z., Meyyaci, K. B., and Balci, B. (2008). Determination of gas exchange capacity of some breba fig cultivars. *Acta Horticulturae*, *798*, 112–117, https://doi.org/10.17660/ActaHortic.2008.798.14.

Crisosto, C. H., Bremer, V., Ferguson, L., and Crisosto, G. M. (2010). Evaluating quality attributes of four fresh fig (*Ficus carica*) cultivars harvested at two maturity stages. *HortScience*, *45*(4), 707–710.

Dogan, A., Ali, Q., Erkan, M. (2020). Comparison of quality attributes of fig fruit ('Bursa Siyahi') harvested at two different maturity stages. *Acta Horticulturae*, *1275*, 311–316, https://doi.org/10.17660/ActaHortic.2020.1275.42.

FAOSTAT (2022). Food and agricultural statistics. Retrieved from https://www.fao.org/faostat/en/#data/QCL. (accessed on August 6, 2022).

Ferguson, L., Michailides, T. J., and Shorey, H. H. (1990). The Californian fig industry. *Horticulture Review*, *12*, 409–490, https://doi.org/10.1002/9781118060858.ch9

Fin, G. A., Straszewski, V., and Peterson, V. (2007). A general growth stage key for describing trees and woody plants. *Annals of Applied Biology*, *151*, 127–131, https://doi.org/10.1111/j.1744-7348.2007.00159.x.

Flaishman, M. A., Rover, V., and Stover, E. (2008). The fig: Botany, horticulture, and breeding. *Horticulture Review*, *34*, 113–197, https://doi.org/10.1002/9780470380147.ch2.

Gundesli, M. A., Kafkas, N. E., Okatan, V., and Usanmaz, S. (2020). Identification and characterisatıon of volatile compounds determined by Hs/Gc-Ms technique in pulp of 'Abbas' fig (*Ficus carica* L.) variety. *Pakistan Journal of Agricultural Science*, *57*(3), 623–629.

Hack, H., Bleiholder, H., Buhr, L., Meier, U., Schnock-Fricke, U., Weber, E., and Witzenberger, A. (1992). Einheitliche Codierung der phanologischen Entwicklungsstadien mono und dikotyler Pflanzen-Erweiterte BBCH skala, Allgemein. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes*, *44*, 265–270.

Hong, P., and Chen, I. (2003). Pollination and syconium set in fig (*Ficus carica* L.). *Journal of Chinese Society of Horticulture Science*, *49*, 151–163.

Hussain, S. Z., Naseer, B., Qadri, T., Fatima, T., and Bhat, T. A. (2021). Fig (*Ficus carica*) – morphology, taxonomy, composition and health benefits. In S. Z. Hussain, B. Naseer, T. Qadri, T. Fatima, and T. A. Bhat (Eds), *Fruits Grown in Highland Regions of the Himalayas* (pp. 77–90). Cham. Switzerland: Springer. https://doi.org/10.1007/978-3-030-75502-7_6.

Jusoh, N. A. M., Ding, P., and Yeat, C. S. (2020). Extending post-harvest quality of fresh fig (*Ficus carica* L.) fruit through manipulation of pre and postharvest practices: A review. *Sains Malaysiana*, *49*(3), 553–560, https://doi.org/10.17576/jsm-2020-4903-10.

Lisci, M., and Pacini, E. (1994). Germination ecology of drupelets of the fig (*Ficus carica* L.). *Botanical Journal of Linnaean Society*, *114*(2), 133–146, https://doi.org/10.1006/bojl.1994.1008.

Meier, U., Bleiholder, H., Buhr, L., Feller, C., Hack, H., Hess, M., Lancashire, P.d., Schnock, U., Staub, R., Van Den Boom, T., Weber, E., Zwerger, P. (2009). The BBCH system to coding the phenological growth stages of plants – history and publications. *Journal für Kulturpflanzen*, *61*, 41–52.

Morton, J. F. (2000). Fruits of warm climates. Fig *Ficus carica*. Purdue University.

New Crop. Retrieved from http://www.hort.purdue.edu/newcrop/default.html.

Narain, P. (2008). Dryland management in arid ecosystem. *Journal of the Indian Society Soil Science*, *56*, 337–347.

Panchai, W. and Boonplod, N. (2021). Growth and development of fig fruit cv. Black Genoa grown in Chiang Mai. *Journal of Agricultural Research and Extension*, *38*(1), 1–11, https://doi.org/10.6084/m9.figshare.14483367.v2.

Piga, A., Del Caro, A., Milella, G., Pinna, I., Vacca, V., and Schirru, S. (2008). HPLC analysis of polyphenols in peel and pulp of fresh figs. *Acta Horticulturae*, *798*, 301–306, https://doi.org/10.17660/ActaHortic.2008.798.43.

Rao, A. S. (2009). Climate variability and crop production in arid western Rajasthan. In A. Kar. (Ed.), *Trends in Arid Zone Research in India* (p. 481). Jodhpur, India: Central Arid Zone Research Institute.

Sedaghat, S., Rahemi, M. (2018). Effects of physio-chemical changes during fruit development on nutritional quality of fig (*Ficus carica* L. var. 'Sabz') under rainfed condition. *Scientia Horticulturae*, *237*, 44–50.

Soby, S. (1997). Fig fact sheet. Fruit & Nut Research & Information Center, CA, USA. Retrieved from http://fruitsandnuts.ucdavis.edu/index.html.

Stover, E., Aradhya, M., Crisosto, C., and Ferguson, L. (2007). The fig: Overview of an ancient fruit. *HortScience horts*, *42*(5), 1083–1087.

Vasconcelos, M. C., Greven, M., Winefield, C. S., Trought, M. C. T., and Raw, V. (2009). The flowering process of *Vitis vinifera*: A review. *American Journal of Enology Viticulture*, *60*, 411–434, https://doi.org/10.5344/ajev.2009.60.4.411.

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