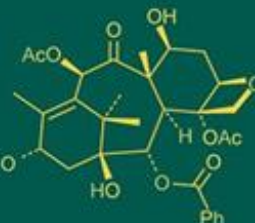
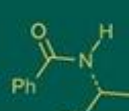
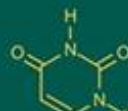
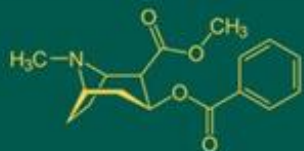


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Varietal difference in mango for phenological responses under Konkan condition

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Abstract

Phenological studies are important for understanding the influence of weather dynamics on vegetative growth, flowering and fruiting on mango. BBCH (Biologische Bundesantalt, Bundessortenamt und Chemische Industrie) scale was used for data recording and to assess utility of the scale in mango phenological studies. Phenological stages of the mango were recorded at one month intervals throughout the year, during 2019-20, on 20-25 years old mango trees. The field experiment was conducted in plot No. 9,11,12 and centre of excellence on 25 trees at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Existing BBCH scale was modified on the basis of data recorded for mango in which seven out of 10 principal stages were used, starting with bud development (stage 0) and ending with maturity of fruit (stage 8). Alphonso had early vegetative flush emergence stage (115-319), flowering stage (611-630) and fruit development stage (701-809) followed by Tommy Atkins and Kesar. However, all these stages were delayed on Ratna and late on Amrapali. Maturity stage (800-809) for harvest was achieved early by Tommy Atkins followed by Alphonso. However, Kesar and Ratna had matured late followed last by Amrapali.

Keywords: Bbch scale, biologische bundesantalt, bundessortenamt und chemische industrie, mango, phenology, phenophase, flowering, growth

Introduction

Konkan region in west coast of India is known worldwide for commercial cultivation of prime Indian export mango variety “Alphonso”. Red lateritic, slightly acidic soil with annual rainfall ranging from 3000-3500 mm during June to September, followed by bright sunny days period of over 7 months from October to May, render this region as one of the best regions in the world for commercial cultivation of mango (Burondkar *et al.* 2012) ^[1]. In this region, mango is cultivated in an area of 1,03,960 ha. Which is about 10 per cent of the total area under mango in the country. However, the productivity of mango in Konkan is about 2.69 t/ha., which is about three times less than the average productivity of the country (Anon., 2019 d) ^[2].

During recent years, climatic conditions in Konkan region are experiencing drastic changes such as unseasonal rains especially during flowering and fruit development, delayed monsoon, prevalence of low temperature (<17°C) for prolonged periods and sudden rise in maximum temperature during February-March. These climatic events made greater influence on phenology in mango which resulted in an extended profound effect on vegetative growth immediately after harvest, irregular flowering, severe fruit drop due to temperature variation etc.

However, the work pertaining to the effect of seasonal variation on physiological behaviour leading to biochemical changes associated with growth and yield of different mango varieties viz. Alphonso, Kesar, Ratna, Amrapali and Tommy Atkins are very meager hence the present study on “Varietal difference in mango for physiological responses under Konkan condition.”

Material and Methods

Location and plant material: The experiment was conducted during 2019-2020 with an objective to study the weather association with phenology of different mango cultivars in Konkan. Field experiment was conducted in plot No. 9,11,12 and centre of excellence on 25 trees at College of Horticulture, Dapoli. Healthy and vigorous 25-30 years old plants were selected for the present studies, adopting randomized block design.

Scale: Developmental stages and morphological characteristics were recorded as per BBCH scale.

Representative shoot parts were coded as per primary and secondary phenological growth stages and photographed for recorded information. Due to inclusion of the mesostages between the principal and secondary growth stages, three digit scale was used to study the mango phenology.

The existing BBCH scale (Hernández *et al.*, 2010) [3] was used for the entire developmental cycle of mango and was subdivided into seven clearly recognisable and distinguishable principal growth stages out of 10 of general BBCH scale. Each principal growth stage was classified into secondary stages which described points in time or shorter developmental intervals in the major growth stage. This scale started with bud development (stage 0) and terminated at maturity of fruit (stage 8). The secondary stages were numbered 0 to 9 that described related percentile stages of growth. Several mesostages (1 to n) were used to describe the different vegetative and floral flushes during season for coding bud, leaf and shoot development. A list of phenological stages of mango, made in ascending order by sorting codes into numerical order and A photo guide (Fig. 1) with codes was developed and used for uniform data recording at different cultivars.

Results and Discussion

Phenological stages of different mango cultivars were given in Table 1 and depicted in Plate 2, 3, 4, 5 and 6. It was observed that, the bud emergence phase started with stage 011 *i.e.* beginning of leaf bud swelling, bud scales begin to separate, which was observed early in Alphonso mango during 2nd week of August, Tommy Atkins during 3rd week of August, Kesar during 2nd week of September, Ratna during 3rd week of September and late in Amrapali during 2nd week of October. Bud emergence phase stopped with stage 019 *i.e.* Bud break: light green to dark coppery tan leaf tips, visible 5 to 10 mm above bud scales which was completed faster in Alphonso during 4th week of September, in Tommy Atkins and Kesar during 1st week of October, Ratna during 2nd of October and late in Amrapali during 1st week of November.

The leaf development phase started with stage 110 *i.e.* leaf tips more than 10 mm above bud scales, this was observed early in Alphonso during 1st week of October, in Tommy Atkins and Kesar during 2nd week of October, in Ratna during 3rd week of October and late in Amrapali during 2nd week of November. The leaf development phase ended with stage 119 *i.e.* all leaves completely unfolded and expanded which was completed earlier in Alphonso during 1st week of November, in Kesar and Ratna during 2nd week of November, in Tommy Atkins during 3rd week of November and late in Amrapali during 1st week of December.

The shoot development phase started with stage 311 *i.e.* beginning of shoot growth axes of developing shoots visible about 10% of final length, this was observed in Alphonso during 2nd week of November, Kesar and Ratna during 3rd week of November, in Tommy Atkins during 4th week of November and late in Amrapali during 2nd week of December; whereas shoot development phase ended with stage 319 *i.e.* Shoots about 90% of final length which was completed earlier in Alphonso during 3rd week of December, Tommy Atkins during 4th week of January, Kesar during 1st week of February, Ratna during 4th week of February and late in Amrapali in 3rd week of March.

The inflorescence emergence phase started with stage 511 *i.e.* beginning of bud swelling: scales begin to separate, this was observed early in Alphonso during 4th week of December, Tommy Atkins during 1st week of February, Kesar during 2nd week of February, Ratna during 1st week of March and late in Amrapali during 4th week of March whereas inflorescence emergence phase end with stage 519 *i.e.* End of panicle development: fully developed secondary axes, many flowers with green to crimson petal tips visible and some opened. Leaves fully developed in case of mixed panicles which was completed earlier in Alphonso mango during 1st week of February, Tommy Atkins during 3rd week of February, Kesar during 1st week of March; Ratna during 3rd week of March and late in Amrapali during 1st week of April.

Table 1: Performance of mango varieties under different phenological stages.

Treatment	Bud development stage (011-019)	Leaf development stage (110-119)	Shoot development stage (311-319)	Inflorescence emergences (501-519)	Flowering (610-619)	Fruit development stage (701-709)	Maturity of fruits (800-809)
Alphonso	2 nd week of August to 4 th week of September	1 st week of October to 1 st week of November	2 nd week of November to 3 rd week of December	4 th week of December to 1 st week of February	2 nd week of February to 2 nd week of March	3 rd week of March to 1 st week of May	2 nd week of May to 3 rd week of May
Kesar	2 nd week of September to 1 st week of October	2 nd week of October to 2 nd week of November	3 rd week of November to 1 st week of February	2 nd week of February to 1 st week of March	2 nd week of March to 1 st week of April	2 nd week of April to 2 nd week of May	3 rd week of May to 4 th week of May
Ratna	3 rd week of September to 2 nd week of October	3 rd week of October to 2 nd week of November	3 rd week of November to 4 th week of February	1 st week of March to 3 rd week of March	4 th week of March to 3 rd week of April	4 th week of April to 3 rd week of May	4 th week of May to 1 st week of June
Amrapali	2 nd week of October to 1 st week of November	2 nd week of November to 1 st week of December	2 nd week of December to 3 rd week of March	4 th week of March to 1 st week of April	2 nd week of April to 4 th week of April	1 st week of May to 4 th week of May	1 st week of June to 2 nd week of June
	November 3 rd week of August to 1 st week of October	December 2 nd week of October to 3 rd week of November	4 th week of November to 4 th week of January	1 st week of February to 3 rd week of February	4 th week of February to 3 rd week of March	4 th week of March to 4 th week of April	1 st week of May to 4 th week of May

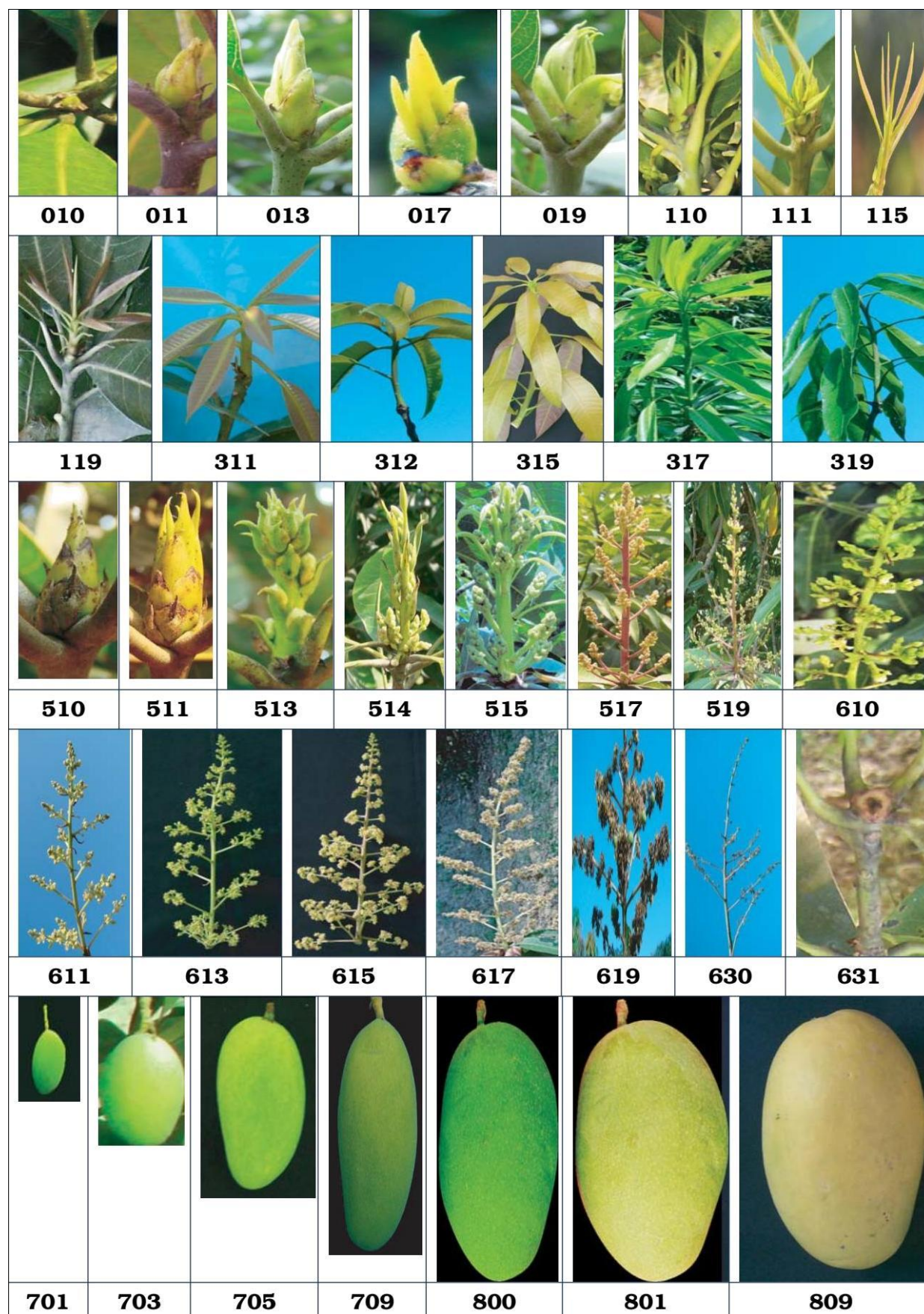


Plate 1: Recording of important phenophases in mango with corresponding codes as described by [Rajan et al. \(2011\)](#)^[4]

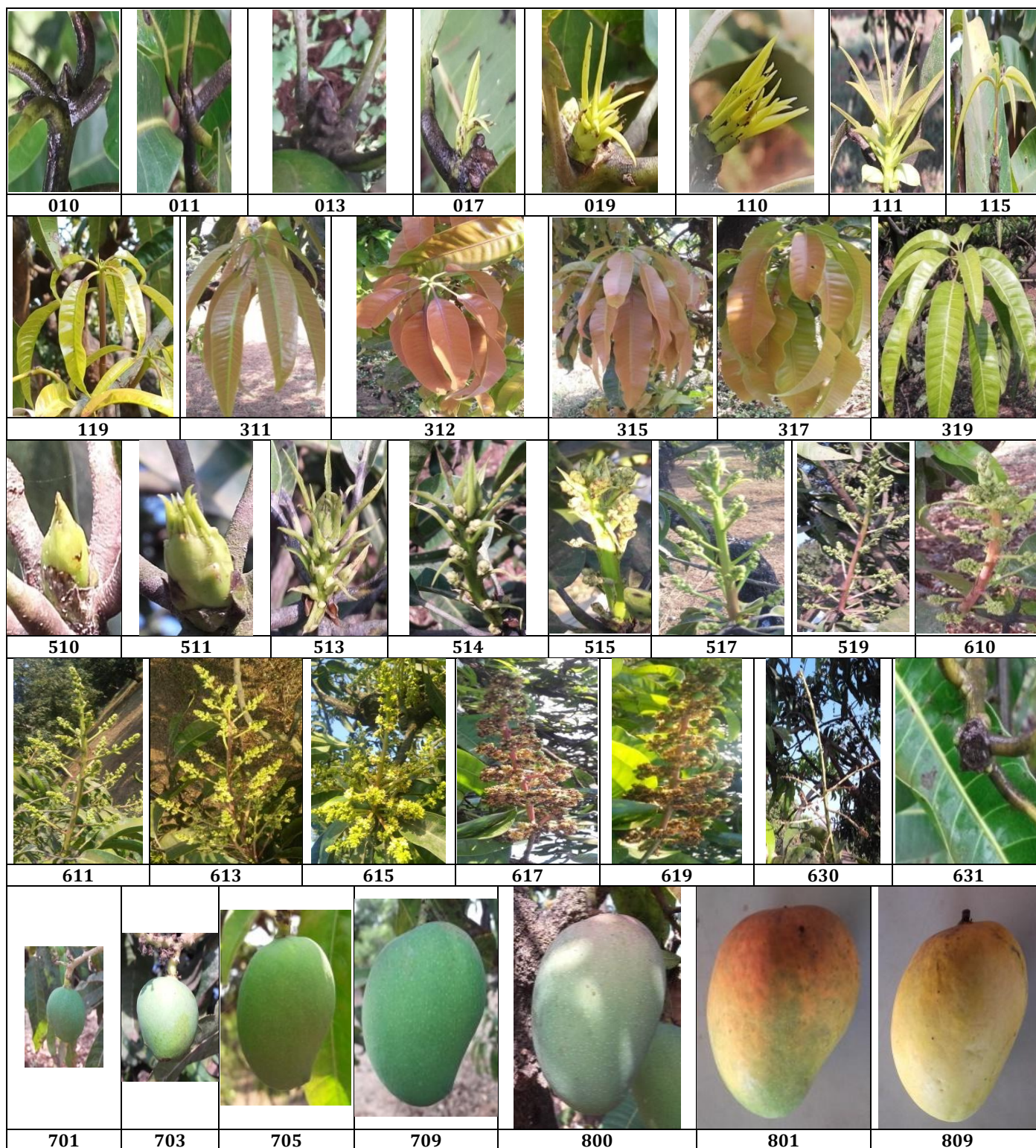


Plate 2: Important phenophases for cv. Alphonso with corresponding codes (BBCH scale, by Rajan *et al.*, 2011) [4].

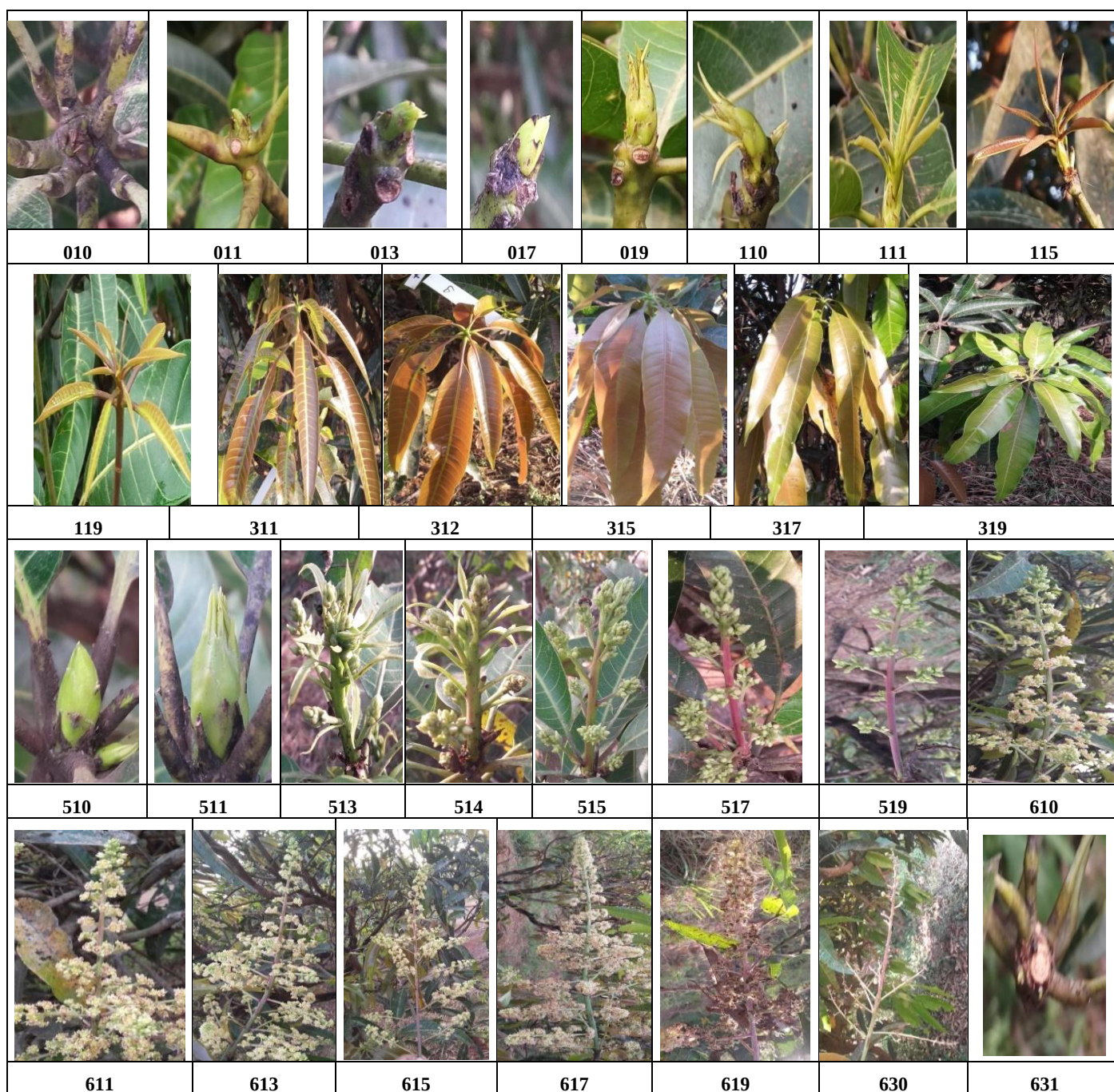
The flowering emergences phase started with stage 610 *i.e.* First flower opened, this was observed early in Alphonso during 2nd week of February, Tommy Atkins during 4th week of February, Kesar during 2nd week of March, Ratna during 4th week of March and late in Amrapali during 2nd week of April, whereas, flowering emergences phase end with stage 619 *i.e.* end of flowering: all petals fallen or dry, fruit set, which was completed earlier in Alphonso during 2nd week of March, Tommy Atkins during 3rd week of March, Kesar during 1st week of April, Ratna during 3rd week of April and late in Amrapali during 4th week of April.

The fruit development phase started with stage 701 *i.e.* Fruits at 10% of final size, style still visible. Beginning of physiological fruit drop was observed early in Alphonso during 3rd week of March, Tommy Atkins during 4th week of March, Kesar during 2nd week of April and Ratna during 4th week of April and late in Amrapali during 1st week of May. Fruit development phase ends with stage 709 *i.e.* Fruits at standard cultivar size, shoulders fully developed which was completed earlier in Tommy Atkins during 4th week of April, Alphonso during 1st week of May, Kesar during 2nd of May, Ratna during 3rd week of May and late in Amrapali during 4th week of May.

The fruit development phase started with stage 800 *i.e.* physiological maturity: fruit fully developed. Pulp creamy green in colour, this was observed early in Tommy Atkins during 1st week of May, Alphonso during 2nd week of May, Kesar during 3rd week of May, in Ratna during 4th week of May and late in Amrapali during 1st week of June. Fruit development phase ended with harvesting the fruits in Alphonso during 3rd week of May, in Tommy Atkins and Kesar during 4th week of May, in Ratna during 1st week of June and in Amrapali during 2nd of June.

Data revealed that the earliest emergence of bud phase,

vegetative flush, flowering, fruiting stage and harvesting was observed in cultivar Alphonso, followed by Tommy Atkins, Kesar and Ratna; however, the late emergence of bud phase, vegetative flush, flowering and fruiting stage was observed in Amrapali. The days required for maturation of mango cultivars *viz.* Alphonso, Kesar and Ratna fruits showed different periods due to the heat units requirement. Alphonso fruits mature early than Kesar and Ratna due to smaller fruit size and requirement of less heat units than other varieties (Shinde *et al.*, 2001) [5] location differences in phenological behaviour in mango are widely reported.



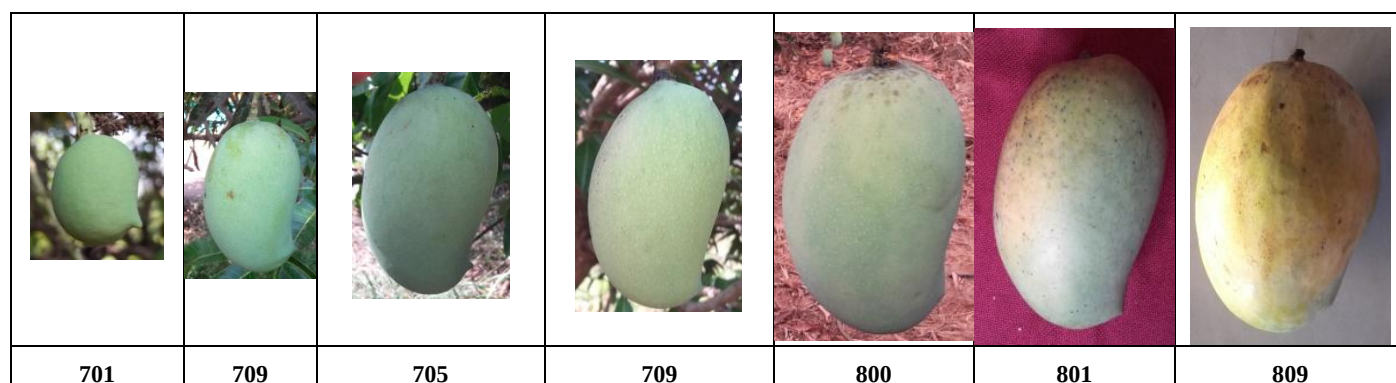
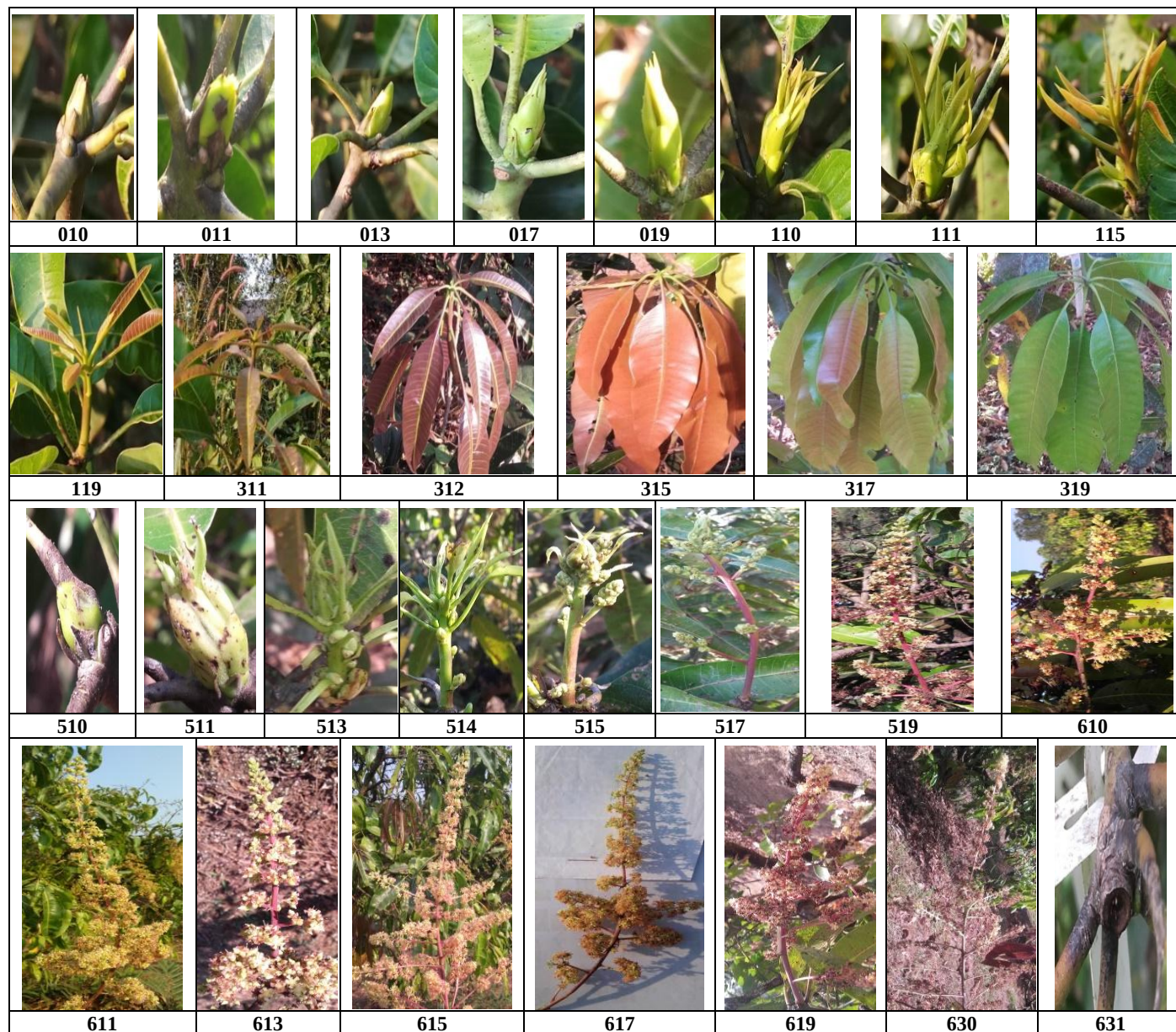


Plate 3: Important phenophases for Cv. Kesar with corresponding codes (BBCH scale, by Rajan *et al.*, 2011) ^[4].



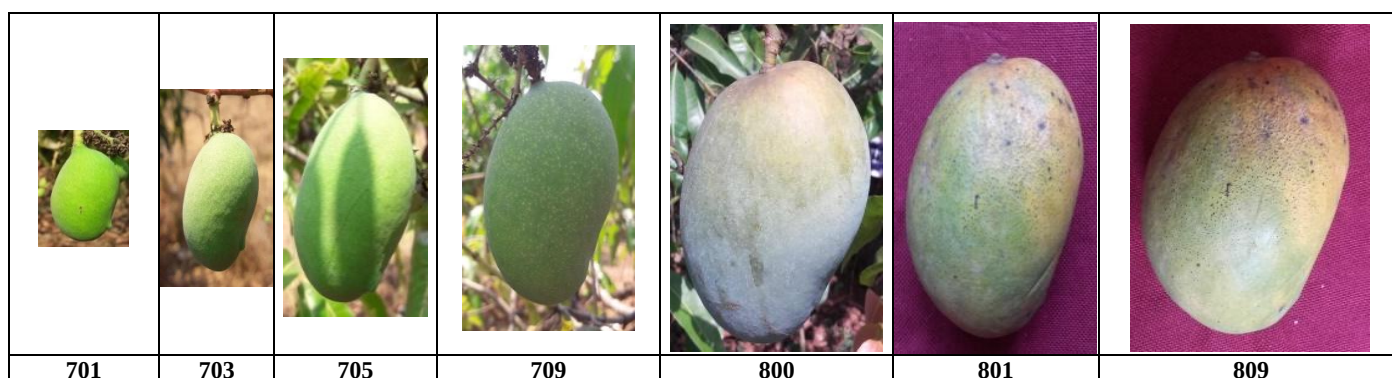


Plate 4: Important phenophases for Cv. Ratna with corresponding codes (BBCH scale, by Rajan *et al.*, 2011) ^[4].

Phenological characteristics of different mango cultivars

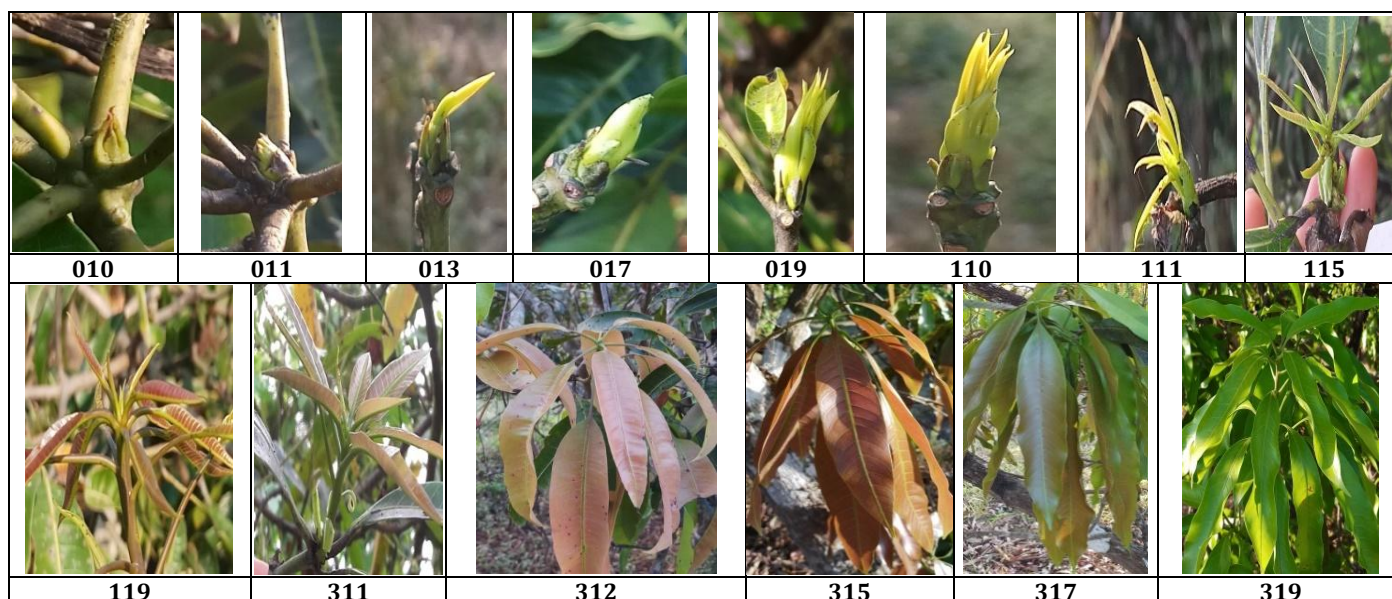
Phenological studies aim on the periodicity in the life-cycle events of plants are influenced by seasonal variations owing to weather factors mainly temperature and precipitation. In fact, changes in the time of phenophases of fruit trees are of great economical importance because they have direct impact on factors influencing final fruit yield (Kushwaha and Singh, 2008) ^[6]. Phenological studies in mango are also important for planned management of orchards and alerting mango cropping against environmental conditions. It is also useful for understanding the phenological impacts during the flowering phase which is the most sensitive and yield determining phenophase.

Under Konkan conditions, mango plant should give new vegetative flush (as an apparatus for photosynthesis) immediately after harvest of crop in May or at least on the onset of monsoon in June in order to rebuild the CHO stock, depleted with the harvest of previous seasons fruit yield. This flush should get physiologically matured in next four months by the end of September and remains dormant for next 3-4 months to have maximum accumulation of moveable reserve carbohydrate needed subsequently for resumption of reproductive phase by the end of November - December followed by flowering and fruiting towards the end of May, thus completing all the three phenophases (vegetative growth, quiescent and reproductive phase) in single calendar year (Burondkar *et al.*, 2018) ^[7].

In the present experiment, data revealed that earliest emergence

of bud phase, vegetative flush, flowering, fruiting stage and harvesting was observed in cultivar Alphonso, followed by Tommy Atkins, Kesar and Ratna; however, the late emergence of bud phase, vegetative flush, flowering and fruiting stage was observed in Amrapali. The days required for maturation of mango cultivars viz. Alphonso, Kesar and Ratna fruits showed different periods due to the heat units requirement. Alphonso fruits mature early than Kesar and Ratna due to smaller fruit size and requirement of less heat units than other varieties (Shinde *et al.*, 2001) ^[5] location differences in phenological behaviour in mango are widely reported.

Alphonso reported to put forth 3 to 4 vegetative flushes, generally in the month of January, February, September and November respectively (Patil, 1999) ^[8]. In the Konkan region, vegetative flush during October-November *i.e.* immediately after rainy season is major and very common. The large extent of this vegetative flush decides the fate of the mango crop in a particular year. In fact, occurrence of this flush considered untimely as it does more harm than good, as far as initiation of FBD or flowering is considered, particularly in Cv. Alphonso (Rao, 1981) ^[9]. Chandra *et al.*, (2001) ^[10] reported early flowering in Prabhashankar, Arka Puneet, Mallika and Alphonso. They further observed early panicle emergence in Kesar, Bombai, Banglora, Baneshan, Langra and Mallika under Sabour (Bihar) condition. Yadav and Singh, (1995) ^[11] reported that South Indian varieties showed earlier emergence of panicles compared to those of North Indian varieties.



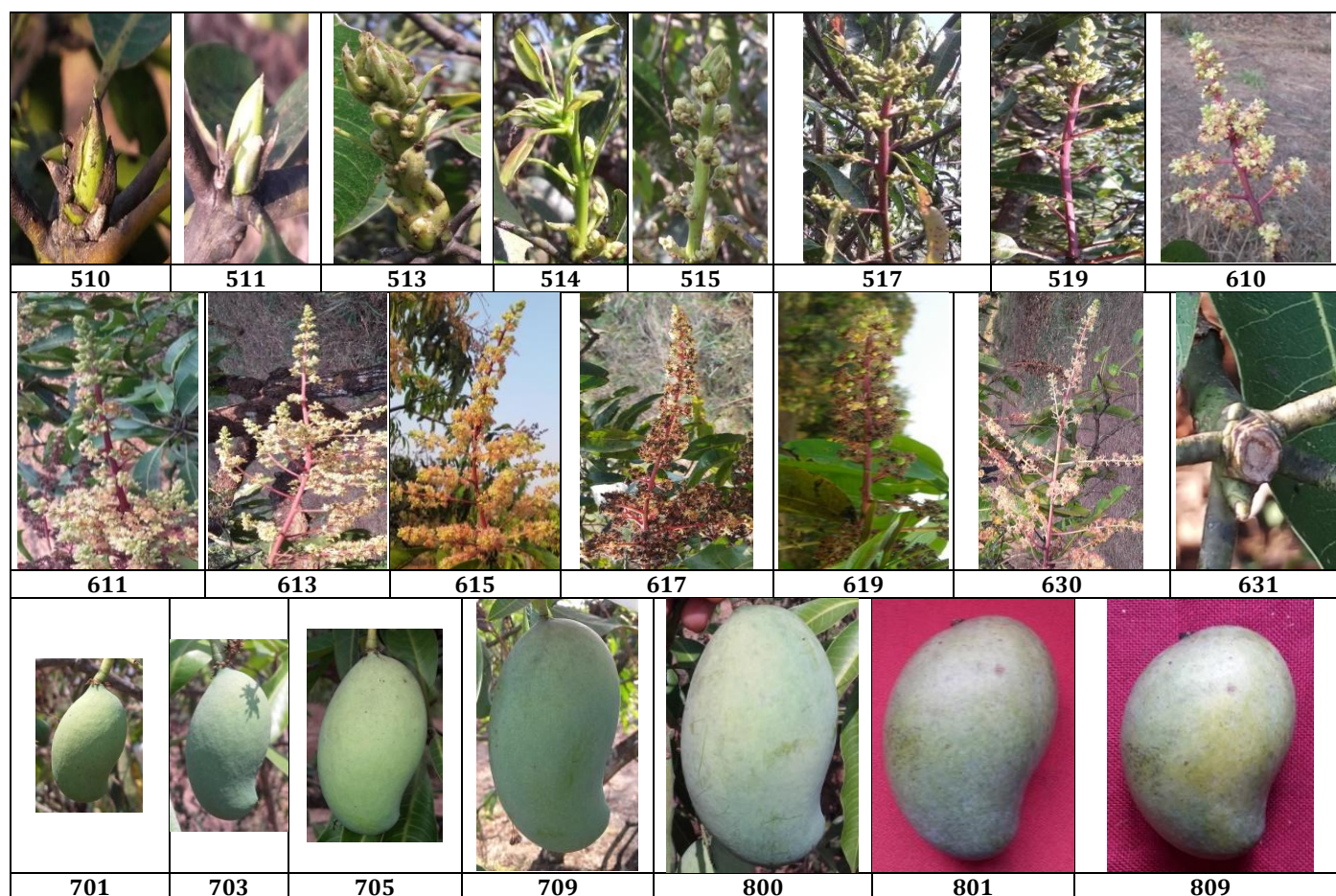
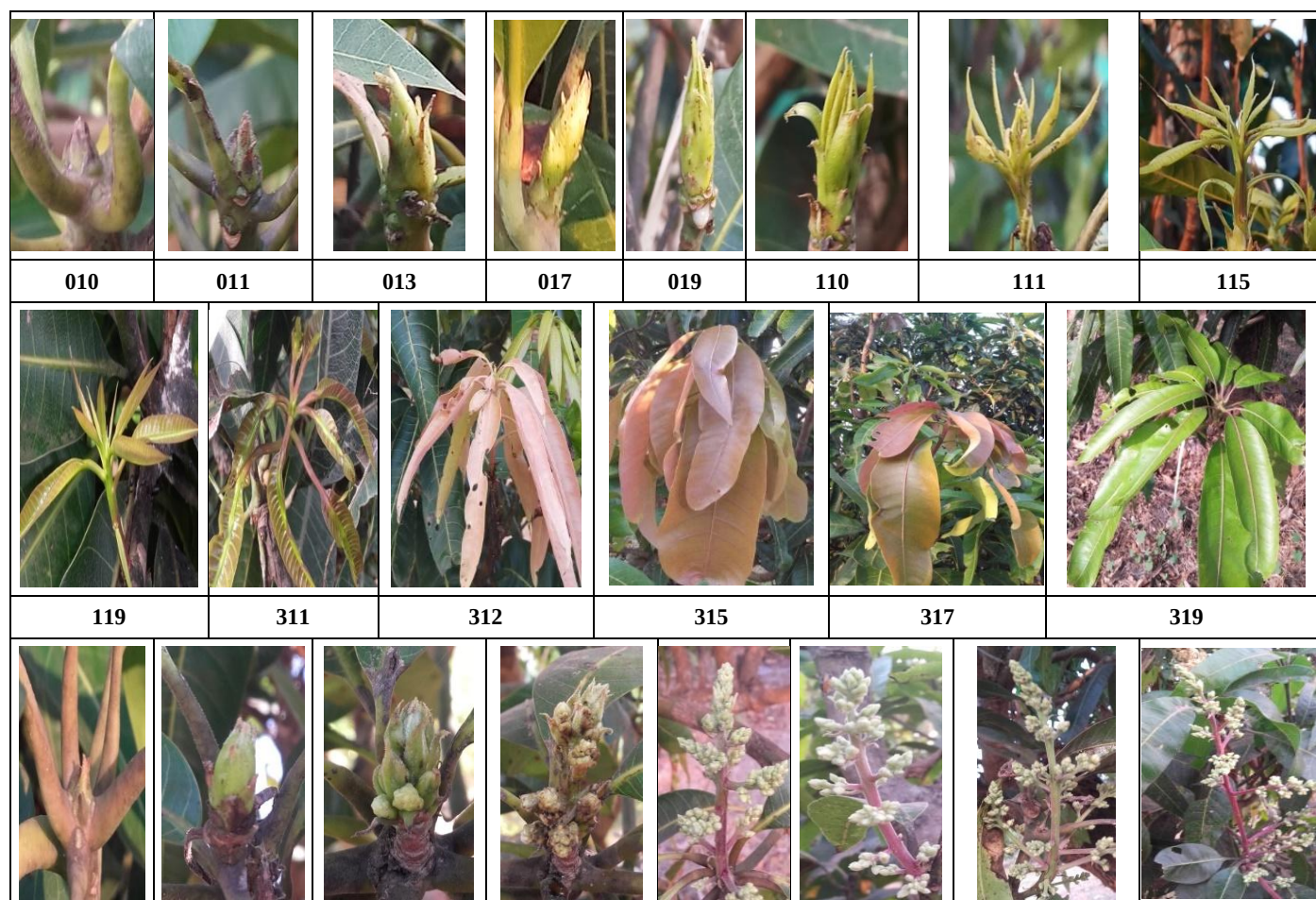


Plate 5: Important phenophases for Cv. Amrapali with corresponding codes (BBCH scale, by Rajan *et al.*, 2011) ^[4].



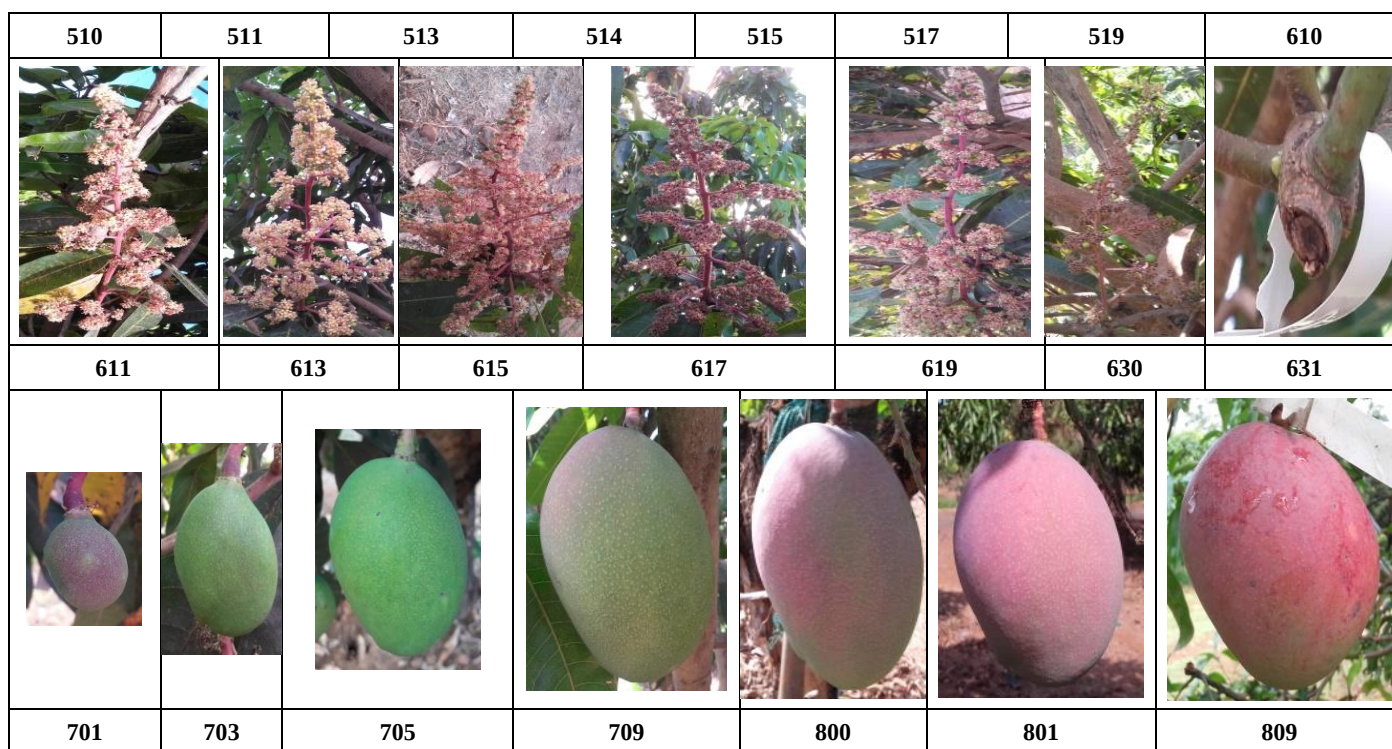


Plate 6: Important phenophases for Cv. Tommy Atkins with corresponding codes (BBCH scale, by Rajan *et al.*, 2011)^[4]

Conclusion

Alphonso had early vegetative flush emergence stage (115-319), flowering stage (611-630) and fruit development stage (701-809) followed by Tommy Atkins and Kesar. However, all these stages were delayed on Ratna and late on Amrapali. The maturity stage (800-809) for harvest was achieved early by Tommy Atkins followed by Alphonso. However, Kesar and Ratna had matured late followed last by Amrapali.

References

- Burondkar MM, Pujari KH, Shinde AK, Bhavne SG. Seasonal variation in physiological behavior of Alphonso mango under Konkan condition. *J. Agric. Res. Technol.* 2012;37(1):051-054.
- Anonymous. <http://nhb.gov.in/statistics/Publication/Horticulture>. 2019.
- Hernández Delgado PM, Agustí M, Aranguren M, Fernandez Galvan D, Galan Sauco V, Reig C. Phenological development stages of mango (*Mangifera indica* L.) according to the BBCH scale. In: 9th International Mango Symposium held during 8-12 April, Sanya, Hainan Island, China. 2010:72.
- Rajan S, Tiwari D, Singh VK, Saxena P, Singh S, Reddy YTN, *et al.* Application of extended BBCH scale for phenological studies in mango (*Mangifera indica* L.) *Journal of Applied Horticulture*. 2011;13(2):108-114.
- Shinde AK, Burondkar MM, Bhingarde RT, Waghmare GM, Rangwala AD, Wagh RG. Heat unit requirement for fruit maturity 71 in mango varieties. *Indian J. of Plant Physiol.* 2001;6(2):194-196.
- Kushwaha CP, Singh KP. India needs phenological stations network. *Current Science*. 2008;95(7):832-834.
- Burondkar MM, Kulkarni MM, Ambavane AR, Kelkar KD. Photosynthetic light response curve of mango (*Mangifera indica* L.) varieties grown in Konkan region of India. *Advances in mango production technology*. 2018.
- Patil DM. Phenological studies in some mango (*Mangifera indica* L.) Cvs. viz., Alphonso, Ratna, Kesar, Amrapali. M.Sc. (Agri.) Thesis submitted to Dr. Balasaheb Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.). 1999.
- Rao MM. Making mango regular bearer. *The Hindu*. 1981 Aug 5.
- Chandra A, Roy DP, Lenka PC. Studies on floral character of mango cultivar and hybrids under agroclimatic conditions of Orissa. *Orissa J. Hort.* 2001;29(1):29-33.
- Yadav IS, Singh HP. Evaluation of different ecological groups of mango cultivars for flowering and fruiting under subtropics. *Prog. Hort.* 1995;17:165-175.