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Assessment of Phenological and Yield Characteristics of Apple (*Malus* × *domestica* Borkh) Varieties

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Phenology has gained recently a considerable emphasis as a method for assessing the impacts of changing climate on plant species. Shifting in phenological stages changes can have rippling impacts on environment. Quantifying the effects of these shifting changes on plants is therefore crucial. Knowledge of the dates and duration of particular phenological stages and their variations can be a valuable source of information for organizing, planning and implementation of some regular and special horticultural activities. The phenological study of apple is an essential component of the study as critical phenological stages of the apple are highly reliant on

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environment, they also have significant practical and scientific implications in the domain of selection. In particular, proper flowering and fruit ripening time are very critical to achieve optimum fruit yield and quality. Fruit yield is an important parameter that determines the acceptability of a cultivar by consumers. The present investigation was undertaken to evaluate the apple varieties for their phenology and yield under Kashmir conditions. Four varieties viz., Super Chief, Red Chief, Gala Redlum and Mitch Gala were used for study. Phenological characteristics revealed that Mitch Gala was earliest in all the phenological stages and Super Chief was late. The blooming period of the studied varieties indicated the synchronizing behaviour of the varieties, which is a prerequisite for effective pollination and adequate fruit set. As far as flowering is concerned, Mitch Gala was earliest to bloom and Gala Redlum was late. Fruit production characteristics revealed that Gala Redlum and Mitch Gala. In terms of yield characteristics, highest yield of *20.58* kg/tree was recorded in Gala Redlum followed by *19.40* kg/tree in Mitch Gala.

Keywords: Apple; flowering; fruit; phenology; variety; yield.

1. INTRODUCTION

Apples (*Malus* × *domestica* Borkh.) occupy an important position among temperate fruits all over the world. In India, apple is commercially cultivated in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. The proverb “An apple a day keeps the doctor away” addresses the beneficial effects of the fruit on human health. It belongs to the family Rosaceae and Sub-family Pomoidae. The primary centre of origin of apple is considered Asia Minor to Western Himalayas. Apple is one of the most important temperate fruit crops in India which accounts for about 10 % of the total fruit production of the country. Jammu and Kashmir have been pioneer in growing temperate fruits because of being endowed with natural advantages of climate, temperature, fertile land and with diversity of agro-climatic conditions, thus having vast scope for horticultural development. In India, UT of Jammu and Kashmir is known to be the den of apple production. It enjoys the share of 70.54% (Yousuf et al., 2023) contribution in apple produce in India.

As apple is the most popular and ubiquitous of all temperate fruits, therefore its production has received a great deal of attention. It is therefore important to focus on all the factors which govern the yield and quality of apple. Apple production is a result of series of physiological and phenological events including fruit set (Sanzol and Herrero 2001). Phenology is the study of periodical plant development events, how they are affected by environment, their correlation with plant morphology (Ali et al*.,* 2022). Studying the developmental stages of a given plant species elucidates the relationship between its morphological and physiological characteristics and environmental factors, especially climatic factors. Phenology has the potential to improve several scientific fields, including climate change, biodiversity, agriculture, forestry, and human health. Phenological observations would assist growers in understanding the dates of specific stages of crop development, allowing them to-plan, organize, and carry out timely schedules of agronomic practices such asirrigation, fertilization, and crop protection, as well as serve as a tool for monitoring the effects of climate change (Petri et al*.,* 2024; Rumi et al*.,* 2005).

As for most deciduous fruit trees, apple trees have a reproductive cycle in which they shift from vegetative to generative (floral) growth (Hanke et al., 2007). Generative growth involves the formation of flower buds, which is divided into the processes of floral induction, initiation and differentiation of the different organs in the flower cluster (Tromp et al*.,* 2005; Hanke et al*.,* 2007; Dadpour et al*.,* 2011). A manifold of internal and external cues promote the activation of floral induction genes involved in floral growth. This leads to cytochemical, histological and morphological changes in the shoot apical meristem, such as the appearance of floral primordia and later development of floral organs (floral initiation and differentiation) (Hanke et al*.,* 2007). Flowering in deciduous fruit trees has been an interesting subject for both growers and scientists for many years. For fruit growers, the importance of flowering lies in the fact that flowers are a prerequisite for the formation of the crop (Tromp et al*.,* 2005). The amount and quality of flowers are central factors determining the size of the crop, thus representing the potential yield in the orchard. For scientists, the interest for this subject lies not only in its economic importance, but also in its complexity and significance as a crucial step of the reproductive cycle of the tree and as a model for

other woody species in the Rosaceae (Riveroa et al*.,* 2017).

Despite being the largest apple producing region in the country, the productivity is very less than the horticultural advanced countries (30-62 MT/ha) (Ali et al., 2019). There are many reasons behind this low productivity but one of the important factors is lack of knowledge and timing of phenological stages in varieties. Bloom synchronization and pollination is an important and inseparable component in respect of regular and consistent production. In a fruit crop like apple, pollination is of utmost significance and its proportion and magnitude is primarily based upon appropriate selection of varieties in orchard. Moreover, various orchard practices like spraying of pesticides, fungicides, growth regulators and foliar nutrients are effective at particular phenological stage (Ali et al*.,* 2019). Therefore, the investigation was undertaken to evaluate the apple varieties for phenological and blooming characteristics in Kashmir conditions.

2. MATERIALS AND METHODS

The present investigation entitled Assessment of Phenological and Yield characteristics of Apple varieties was carried out in the year 2022-2023 and 2023-2024 at the Experimental Field of the Division of Fruit Science at Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar campus, Srinagar (J&K).

Branches of selected tress of apple varieties were tagged and evaluated for blooming period prior to flowering and then the blooming dates were calculated accordingly.

2.1 Date of Silver Tip Stage

When the dormant buds started bursting, the silver tip stage was recorded visually. For each tagged branch of selected tree, the date of occurrence was recorded. The dates thus recorded were converted to days after reference date (DARD) fixed arbitrarily as 1stMarch.

2.2 Date of Green Tip Stage

When the vegetative buds started emerging, the green tip stage was recorded visually. For each tagged branch of selected tree, the date of occurrence was recorded. The dates thus recorded were converted to days after reference date (DARD) fixed arbitrarily as 1st March.

2.3 Date of Half Inch Green Stage

When the green tip was about ½ inches in size, half inch green tip stage was recorded visually. For each tagged branch of selected tree, the date of occurrence was recorded. The dates thus recorded were converted to days after reference date (DARD) fixed arbitrarily as 1st March.

2.4 Date of Tight Cluster Stage

When clusters of green buds started to open, tight cluster stage was observed visually. For each tagged branch of selected tree, the date of occurrence was recorded. The dates thus recorded were converted to days after reference date (DARD) fixed arbitrarily as 1st March.

2.5 Date of Pink Bud Stage

When about 50% of pink buds appeared, this stage was observed visually. For each tagged branch of selected tree, the date of occurrence was recorded. The dates thus recorded were converted to days after reference date (DARD) fixed arbitrarily as 1st March.

2.6 Date of Initial Bloom (10% flowering)

When about 10% of flowers were open and rest of the flowers were either in pink tip stage or in balloon stage, this stage was observed visually for each selected tree. The dates thus recorded were converted to days after taking reference date into consideration.

2.7 Date of Full Bloom (80% flowering)

When about 80% of flowers were open, this stage was observed visually for each selected tree. The dates thus recorded were converted to days after taking reference date into consideration.

2.8 Date of 80% Petal Fall

When about 80% of flowers exhibited petal fall, this stage was observed visually for each selected tree. The dates thus recorded were converted to days after taking reference date into consideration.

2.9 Fruit Set (%)

Fruit set was measured by counting number of flower buds during full blooming and mature number of fruits at pea stage of four pre-selected branches in four directions (N, E, S, and W) of the same tree. Fruit set was calculated from number of flowers and mature fruits on individual branches. Flowers werecounted during full bloom

and the number of fruits remaining on the same branches was recorded before harvest.

$$Fruit\ set\ (\%) = \frac{Number\ of\ fruitlets\ at\ pea\ stage}{Number\ of\ flowers\ pollinated} \times 100$$

2.10 Maturity Date (DAFD)

The maturity date was recorded from the reference date (1st March) when fruits attained proper maturity and was worked out as the period (days) between the full bloom and harvesting date in each tagged tree.

2.11 Number of Fruits / Tree

Total number of fruits were recorded from each tagged tree at harvest or at the end of season..

2.12 Yield (kg/tree)

The crop harvested from each tagged tree was recorded and average yield was expressed in kilograms per tree.

3. RESULTS AND DISCUSSION

The average number of days taken to reach different phenological stages is presented in Table 1. The values represent the average number of days taken to reach the particular phenological stage from 1st March that was taken as reference date (DARD).

3.1 Days Taken to Silver Tip Stage

It is evident from the perusal of data (Table 1) that significant differences were recorded with respect to silver tip stage among all the varieties. Mitch Gala exhibited silver tip stage 15.33 and 18.33 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Mitch Gala for both the seasons was 16.83 DARD. Gala Redlum exhibited this stage 17.67 and 20.67 DARD for the season 2022/23 and 2023/ 24respectively. Overall mean of Gala Redlum was 19.17 DARD for both the seasons. In Red Chief silver tip stage was recorded 20.33 and 23.33 DARD for the season 2022/23 and 2023/24 respectively whereas it was recorded 22.67 and 25.67 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 21.83 and 24.17 DARD in Red Chief and Super Chief respectively.

3.2 Days Taken to Green Tip Stage

Perusal of the data presented in Table 1 reveals that Mitch Gala exhibited green tip stage 19.33 and 22.33 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 20.83 DARD. Gala Redlum exhibited this stage 20.67 and 23.67 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 22.17 DARD for both the seasons. In Red Chief green tip stage was recorded 24.00 and 27.00 DARD for the season 2022/23 and 2023/24respectively whereas it was recorded 25.67 and 28.67 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 25.50 and 27.17 DARD in Red Chief and Super Chief respectively.

3.3 Days taken to Half Inch Green Stage

The data presented in Table 1 reveals that Mitch Gala exhibited half inch green stage 22.33 and 25.33 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 23.83 DARD. Gala Redlum exhibited this stage 24.67 and 27.67 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 26.17 DARD for both the seasons. In Red Chief half inch green stage was recorded 27.67 and 30.67 DARD for the season 2022/23 and 2023/24respectively whereas it was recorded 30.33 and 33.33 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 29.17 and 31.83 DARD in Red Chief and Super Chief respectively.

3.4 Days Taken to Tight Cluster Stage

It is evident from the data presented in Table 1 that Mitch Gala exhibited tight cluster stage 27.67 and 30.67 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 29.17 DARD. Gala Redlum exhibited this stage 29.33 and 32.33 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 30.83 DARD for both the seasons. In Red Chief tight cluster stage was recorded 32.00 and 35.00 DARD for the season 2022/23 and 2023/24respectively whereas it was recorded 34.33 and 37.33 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 33.50 and 35.83 DARD in Red Chief and Super Chief respectively.

3.5 Days Taken to Pink Bud Stage

Perusal of the data presented in Table 1 reveals that Mitch Gala exhibited pink bud stage 30.33

and 33.33DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 31.83 DARD. Gala Redlum exhibited this stage 33.33 and 36.33 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 34.83 DARD for both the seasons. In Red Chief pink bud stage was recorded 36.67 and 39.67 DARD for the season 2022/23 and 2023/24respectively whereas it was recorded 39.00 and 42.00 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 38.17 and 40.50 DARD in Red Chief and Super Chief respectively.

3.6 Flowering Behaviour of Apple Varieties in Open Field Conditions

3.6.1 Days taken to initial bloom (10% flowering)

The observations related to initial bloom stage of apple varieties are inscribed in Table 2. It is apprehended from the data that Mitch Gala exhibited initial bloom 36.33 and 39.33 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Mitch Gala for both the seasons was 37.83 DARD. Gala Redlum exhibited this stage 37.67 and 40.67 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Gala Redlum was 39.17 DARD for both the seasons. In Red Chief initial bloom was recorded 41.33 and 44.33 DARD for the season 2022/23 and 2023/24 respectively whereas it was recorded 42.67 and 45.67 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 42.83 and 44.17 DARD in Red Chief and Super Chief respectively.

3.6.2 Days taken to final bloom (80% flowering)

The data presented in Table 2 reveals that Mitch Gala exhibited final bloom 40.00 and 43.00 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Mitch Gala for both the seasons was 41.50 DARD. Gala Redlum exhibited this stage 42.33 and 45.33 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Gala Redlum was 43.83 DARD for both the seasons. In Red Chief final bloom was recorded 45.67 and 48.67 DARD for the season 2022/23 and 2023/24 respectively whereas it was recorded 48.33 and 51.33 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 47.17 and 49.83 DARD in Red Chief and Super Chief respectively.

Fig. 1. Dormant bud stage, b. silver tip stage, c. green tip stage, d. half inch green stage, e. tight cluster stage, f. pink bud stage, g. initial bloom, h. final bloom, i. petal fall

Table 1. Phenological stages of Apple varieties in open field conditions

Variety	Days taken to silver tip (DARD)			Days taken to green tip (DARD)			Days taken to half inch green (DARD)			Days taken to tight cluster (DARD)			Days taken to pink bud (DARD)		
	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled
Mitch gala	15.33	18.33	16.83	19.33	22.33	20.83	22.33	25.33	23.83	27.67	30.67	29.17	30.33	33.33	31.83
Gala redlum	17.67	20.67	19.17	20.67	23.67	22.17	24.67	27.67	26.17	29.33	32.33	30.83	33.33	36.33	34.83
Red chief	20.33	23.33	21.83	24.00	27.00	25.50	27.67	30.67	29.17	32.00	35.00	33.5	36.67	39.67	38.17
Super chief	22.67	25.67	24.17	25.67	28.67	27.17	30.33	33.33	31.83	34.33	37.33	35.83	39.00	42.00	40.50

DARD: Days after reference date
Reference date: 1st March

Table 2. Flowering behaviour of Apple varieties in open field conditions

Variety	Days taken to initial bloom (10%) (DARD)			Days taken to final bloom (80%) (DARD)			Days taken to petal fall (DARD)			Days taken to fruit maturity (DAFB)		
	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled
Mitch gala	36.33	39.33	37.83	40.00	43.00	41.5	45.33	48.33	46.83	122.33	122.63	122.48
Gala Redlum	37.67	40.67	39.17	42.33	45.33	43.83	47.67	50.67	49.17	122.67	122.88	122.77
Red chief	41.33	44.33	42.83	45.67	48.67	47.17	50.33	53.33	51.83	137.00	137.33	137.16
Super chief	42.67	45.67	44.17	48.33	51.33	49.83	51.00	54.00	52.5	137.33	137.66	137.49

DARD: Days after reference date
DAFB: Days after full bloom
Reference date: 1st March

Table 3. Yield characteristics of Apple varieties in open field conditions

Variety	Fruit set (%)			Number of fruits per tree			Yield (kg/tree)		
	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled
Mitch gala	40.03	40.13	40.08	107.6	105.8	106.7	19.57	19.23	19.40
Gala Redlum	39.93	40.37	40.15	113.7	112.8	113.21	20.67	20.50	20.58
Red chief	30.47	30.43	30.45	78.91	76.95	77.92	17.53	17.10	17.31
Super chief	29.73	29.63	29.68	77.93	76.33	77.13	15.60	15.27	15.43

3.6.3 Days taken to petal fall

The observations recorded in Table 2 pertaining to petal fall depicts that Mitch Gala exhibited petal fall 45.33 and 48.33 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Mitch Gala for both the seasons was 46.83 DARD. Gala Redlum exhibited this stage 47.67 and 50.67 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 49.17 DARD for both the seasons. In Red Chief petal fall was recorded 50.33 and 53.33 DARD for the season 2022/23 and 2023/24respectively whereas it was recorded 51.00 and 54.00 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 51.83 and 52.50 DARD in Red Chief and Super Chief respectively.

3.7 Days Taken to Fruit Maturity

The observed data related to the number of days required by apple varieties for fruit maturity under study is presented in Table 2. The data revealed significant differences between all the varieties under study with respect to the number of days taken to reach the harvestable stage. The perusal of data reveals that Mitch Gala and Gala Redlum took significantly less number of days to reach the harvestable stage. Mitch Gala exhibited this stage 122.33 and 122.63 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Mitch Gala for both the seasons was 122.48 DARD. Gala Redlum exhibited this stage 122.67 and 122.88 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 122.77 DARD for both the seasons. In Red Chief fruit maturity was recorded 137.00 and 137.33 DARD for the season 2022/23 and 2023/24 respectively whereas it was recorded 137.33 and 137.66 DARD for the season 2022/23 and 2023/24 in Super Chief. Overall mean of two seasons was 137.16 and 137.49 DARD in Red Chief and Super Chief respectively.

3.8 Yield Characteristics of Apple Varieties in Open Field Conditions

3.8.1 Fruit set (%)

The data pertaining to fruit set of all the varieties is presented in Table 3. Fruit set of 40.03% and 40.13% was recorded in Mitch Gala for the season 2022/23 and 2023/24 respectively whereas in Gala Redlum 39.93% and 40.37% of fruit set was recorded for the season 2022/23 and 2023/24 respectively. Overall mean of two seasons recorded was 40.08% and 40.15% in Mitch Gala and Gala Redlum respectively. Fruit set of 30.47% and 30.43% was recorded in Red Chief for the season 2022/23 and 2023/24 respectively whereas in Super Chief 29.73% and 29.63% of fruit set was recorded for the season 2022/23 and 2023/24 respectively. Overall mean of two seasons recorded was 30.45% and 29.68% in Red Chief and Super Chief respectively.

3.8.2 Number of fruits per tree

The observations related to the number of fruits per tree are inscribed in Table 3. In Mitch Gala 107.6 and 105.8 fruits per tree were recorded for the season 2022/23 and 2023/24 respectively whereas in Gala Redlum, 113.7 and 112.8 fruits per tree were recorded for the season 2022/23 and 2023/24. Overall mean of two seasons was 106.7 and 113.2 fruits per tree in Mitch Gala and Gala Redlum respectively. In Red Chief 78.91 and 76.95 fruits per tree were recorded for the season 2022/23 and 2023/24respectively whereas in Super Chief, 77.93 and 76.33 fruits per tree were recorded for the season 2022/23 and 2023/24. Overall mean of two seasons was 77.92 and 77.13 fruits per tree in Red Chief and Super Chief respectively.

3.8.3 Yield (Kg/tree)

The data related to yield per tree are recorded in Table 3. In Mitch Gala yield of 19.57 and 19.23 kg/tree was recorded for the season 2022/23 and 2023/24 respectively whereas in Gala Redlum, 20.67 and 20.50 kg/tree was recorded for the season 2022/23 and 2023/24. Overall mean of two seasons was 19.40 and 20.58 kg/tree in Mitch Gala and Gala Redlum respectively. In Red Chief yield of 17.53 and 17.10 kg/tree was recorded for the season 2022/23 and 2023/24 respectively whereas in Super Chief 15.60 and 15.27 kg/tree was recorded for the season 2022/23 and 2023/24. Overall mean of two seasons was 17.31 and 15.43 kg/tree in Red Chief and Super Chief respectively.

3.9 DISCUSSION

3.9.1 Phenological characteristics

Considerable variations were exhibited by all the varieties in attaining the different phenological stages *viz*, silver tip, green tip, half inch green, tight cluster and pink bud. Phenological

characteristics revealed that Mitch Gala was earliest in all the phenological stages and Super Chief was late. Mitch Gala exhibited silver tip stage 15.33 and 18.33 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 16.83 DARD. Gala Redlum exhibited this stage 17.67 and 20.67 DARD for the season 2022/23 and 2023/24respectively. Mitch Gala and Gala Redlum took significantly less number of days to reach the harvestable stage. Mitch Gala exhibited this stage 122.33 and 122.63 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 122.48 DARD. Overall mean of two seasons was 137.16 and 137.49 DARD in Red Chief and Super Chief respectively. The difference in phenological characteristics is important in orchard planning regarding pollination and varietal suitability. The differences in the phenological stages of different cultivars, certainty, are due to the differential chilling requirements of these varieties. Further, these variations are also due to different management practices (Mushtaq et al*.,* 2018). Cultivar and climate type are the important parameters that affect phenological stages (Ganjiet al*.,* 2013). Phenological stages depend on environmental conditions (temperature, altitude, rainfall etc.) and may change every year (Liveraniet al*.,* 2010).

3.9.2 Flowering behaviour

Remarkable variations were observed in the flowering behaviour of all the Varieties. Mitch Gala exhibited initial bloom 36.33 and 39.33 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 37.83 DARD. Gala Redlum exhibited this stage 37.67 and 40.67 DARD for the season 2022/23 and 2023/24respectively. Overall mean of two seasons was 42.83 and 44.17 DARD in Red Chief and Super Chief respectively. Gala Redlum exhibited petal fall stage 47.67 and 50.67 DARD for the season 2022/23 and 2023/24 respectively. Overall mean of Gala Redlum was 49.17 DARD for both the seasons. The perusal of data reveals that Mitch Gala and Gala Redlum took significantly less number of days to reach the harvestable stage. Mitch Gala exhibited this stage 122.33 and 122.63 DARD for the season 2022/23 and 2023/24respectively. Overall mean of Mitch Gala for both the seasons was 122.48 DARD. Genetic differences or the differential chilling requirements of these varieties may be the reason for difference in flowering. Further temperature response and photosensitivity may also result in such variations (Ganjiet al*.,* 2013). These results are in conformity with the findings of Mushtaq et al*.* (2018) who reported that beginning of flowering, full bloom and end of flowering were different for the different cultivars under study.Such divergent results might be due to the difference between the temperatures during an early stage of vegetative development. Flowering date and period of blooming varies according to cultivar as well as ecological and cultural conditions (Mushtaq et al*.,* 2018).

3.9.3 Fruit set and Yield

The variations in fruit set and yield among different varieties may be because of their genetic differences. Besides genetic differences, there could be an array of reasons for such differences in fruit set among the varieties like temperature, weather conditions, the atmosphere which is conducive for bee flight, pollen compatibility etc (Beyhan and Karaks, 2009). In present study, fruit set of 40.03% and 40.13% was recorded in Mitch Gala for the season 2022/23 and 2023/24respectively whereas in Gala Redlum 39.93% and 40.37% of fruit set was recorded for the season 2022/23 and 2023/24respectively. Overall mean of two seasons recorded was 30.45% and 29.68% in Red Chief and Super Chief respectively. In Mitch Gala yield of 19.57 and 19.23 kg/tree was recorded for the season 2022/23 and 2023/24respectively whereas in Gala Redlum, 20.67 and 20.50 kg/tree was recorded for the season 2022/23 and 2023/24. Overall mean of two seasons was 19.40 and 20.58 kg/tree in Mitch Gala and Gala Redlum respectively. Overall mean of two seasons was 17.31 and 15.43 kg/tree in Red Chief and Super Chief respectively. The variation in fruit set has been reported by several workers and is mainly attributed to several factors like genetic make-up of a variety i.e. self-compatible or self-incompatible, placement of pollinizer in an orchard and the prevailing climatic conditions at the time of flowering (Verma and Thakur, 2019). Our research results were in conformity with the findings of Mushtaq et al*.* (2018) and Sharma et al*.* (2017).

4. CONCLUSION

Considerable variations were exhibited by the different apple varieties in attaining the different phenological stages *viz,* silver tip, green tip, half

inch green, tight cluster and pink bud. All these stages were observed earlier in variety Mitch Gala and late in Super Chief. The blooming period of the studied varieties indicated the synchronizing behaviour of the varieties, which is a prerequisite for effective pollination and adequate fruit set. As far as flowering is concerned, Mitch Gala was earliest to bloom and Gala Redlum was late. The study revealed that all the four varieties performed well under Kashmir conditions, however highest yield was recorded in Gala Redlum followed by Mitch Gala.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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