

Phenological features of four exotic apple cultivars on M9T337 rootstock under high density plantation in North Himalayan region of India

ABSTRACT

This study was conducted to define the phenology of flowering of four apple cultivars grafted on M9T337 rootstock and cultivated in the Experimental Orchard of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir, Shalimar, Srinagar, Jammu & Kashmir during the year 2014. In the study it was recorded days to bud break, silver tip stage, green tip stage, leafing out, pink bud, initial and final bloom, duration of flowering and days to petal fall of apple cultivars viz. Super Chief Sandidge, Gala Red Lum, Fuji Zhen Aztec and Golden Clone B. The results reveal that bud break, green tip, silver tip and leaf initiation showed significant differences for the different cultivars. Cv. Gala Red Lum took minimum number of days for starting bud break (15.27 days after reference date) and silver tip stage (20.20 DARD), while 'Golden Clone B' was the last to attain these different phenological stages. Full bloom was earliest (52.29 DARD) on 'Gala Red Lum' and later (58.79 DARD) on 'Golden Clone B'. The duration of flowering ranged from 12.28 days on 'Super Chief Sandidge' to 13.69 days on 'Golden Clone B'. Remarkable variations were thus observed in the phenology of flowering of the investigated varieties under temperate conditions of Jammu and Kashmir.

Key words: Apple varieties, phenological data, flowering, high density, temperate climate

26 INTRODUCTION:

27 Jammu and Kashmir States, as being endowed with natural advantages of topography
28 and climate with enormous diversity of agro-climatic conditions, has immense scope for
29 horticultural development. Horticulture industry in the J&K State made rapid strides during the last
30 few decades. Compared to 1954-1955, the area under fruits in the State has increased by 16
31 times and the production has shoot up to 60 times. Among the temperate fruits, apple ranks
32 first, covering 43.30 per cent in area and 80.18 per cent for production. Productivity of apple has
33 shown an increase from 4.12 to 10.60 MT/ha from 1975 to 2017. Though it appears to be the
34 principal
35 among the apple producing States in the country, yet it is far below the level achieved by
36 horticulturally advanced countries where productivity is in between 50-60 MT/ha [1]. The
reason behind which appears to be the use of inadequate rootstocks.

37 Almost entire apple plantation in the J&K State is on seedling rootstocks. The
excessive
38 vigor of this type of rootstock leads to larger trees and have long juvenility. Also there is more
39 competition between vegetative growth and fruit production within these king of trees and their
40 internal self-shading makes them more vulnerable to various diseases. When using vigorous
41 rootstocks, only few trees can be accommodated per hectare, making the productivity less
42 profitable. With stagnation in productivity, looming threat of imported fruits and land prices
43 touching new peaks in the State, it becomes imperative to invest on high-density plantation, for
44 which changing rootstock from vigorous to size controlling (dwarfing) rootstocks is a
prerequisite.

45 Orchards with new cultivars and on dwarfing rootstocks are also few in the State. The
46 number of orchard with new cultivars grafted on dwarf and semi-dwarf clonal rootstocks should
be
47 increased in order to increase yield and fruit quality, as these rootstocks are more effective.
Therefore, it is necessary to determine
48 suitable cultivars for the region. Otherwise apple shows gametophytic self and cross-
incompatibility, showing that at least two genetically distinct cultivars are necessary for stable
apple

49 production. SKUAST-K has recently introduced new apple cultivars from outside the country

50 which were grafted on the dwarfing clonal rootstock M9T337, a suitable combination for high density

51 plantation. However their features on flowering phenology under temperate conditions of
52 Kashmir remain to be studied. Thus this study was conducted to fill this gap.

53 MATERIALS AND METHODS

54 The study was conducted in the Experimental Orchards of Division of Fruit Science, Sher-
55 e-Kashmir University of Agricultural Science & Technology of Kashmir, Srinagar, Jammu &
56 Kashmir, during the year 2014 (Figure 1). The orchard was established at a mean of 1500 meters
57 above sea level. The climate is cold temperate. Rainfall is about 800mm well distributed,
58 mostly in the form of snow during winter with the main rainfall during March-April .
59 Uniform plants of four exotic cultivars of apple viz. Super Chief Sandidge, Gala Red Lum,
60 Fuji Zhen Aztec and Golden Clone B grafted on M9T337 rootstock
61 were introduced by SKUAST-Kashmir in spring 2013 from the Italian nursery GRIBA.. The
selected trees for this study were planted at a spacing of 3 m x 1,5 m in the orchard. The
experiment was laid in Randomized Complete Block
62 Design (RCBD) with five replications and two trees per treatment as plot size. For this study it
was recorded the following
63 phenological characteristics: days to bud break, silver tip stage, green tip stage and leafing
64 outrecorded visually by observing peculiar stages of each parameter (Figure 2).
65 Flowering stages including initial and final bloom in each variety was recorded when
66 10 and 80 per cent of the flowers had opened, respectively (Figure 3). The period from the date
of flowering initiation
67 to the date of petal fall was calculated as duration of flowering. The date
68 for petal fall was recorded when 80% of petals were fallen. The dates thus recorded
69 were converted to days from day after reference date (DARD), 1st of March.

70 The data recorded during the course of investigation were subjected to statistical analysis
71 using the method of 'Analysis of Variance' [6]. The significance and non-significance of
72 treatment effects were judged with the help of software OPSTAT. The significant differences
73 of the means were tested against the critical difference at 5% level.

75 **RESULTS AND DISCUSSION**

76 Most of the phenological stages viz. bud break, green tip, silver tip and leaf initiation,
77 showed significant differences during the study (Table 1). The cv. Gala Red Lum took
78 minimum number of days to attain bud break (15.27 DARD), silver tip stage (20.20 DARD),
79 green tip stage (23.57 DARD) and leaf initiation (29.48 DARD), while ‘Golden Clone B’ was
80 the last to attain these different phenological stages i.e. bud break at 21.50 DARD, silver tip at
81 25.49 DARD, green tip at 28.36 DARD and leaf initiation at 36.66 DARD. The cv. Fuji Zhen Aztec
82 also showed longer DARD then cv. Gala Red Lum, the results being in accordance
83 with the findings of Baytekin, (2006). who stated that dates of bud break for ‘Fuji’/’M9’ were later
84 than for
85 ‘Gala’/’M9’.

86 Remarkable variations were observed in the flowering behaviour of the different
87 cultivars from the pink bud to complete petal fall (Table 2). Pink bud stage was first
88 noticed after 39.44 DARD for cv. Gala Red Lum followed by cv. Super Chief
89 Sandidge, that took 40.68 DARD. The last was ‘Golden Clone B’ with 44.86 DARD to get pink
90 buds.
91 Likewise, initial bloom was first (44.41 DARD) on cv. Gala Red Lum,
92 while ‘Golden Clone B’ reached at this stage much later (48.46 DARD). Full bloom stage was
93 observed first (52.29 DARD) on cv. Gala Red Lum and again much later (58.79 DARD) on
94 ‘Golden Clone B’. The differences in the phenological stages of different cultivars, certainly, are
95 due
96 to the differential chilling requirements of these varieties. Further,
97 these cultivars may be different in their photo sensitivity and response to temperature
98 resulting in these variations. These results are in accordance with the findings of Gasser (7)
99 who has reported that beginning of blooming depends highly on the site of cultivation.
100 Beginning of bloom can be observed with higher accuracy which indicates the genetic
101 differences among varieties. Bodor and Toth (4) reported that high spring temperature causes

- 98 shorter blooming period and main bloom takes only few days for the whole cultivar
- 99 assortment. Soltesz, (10) investigated the stability of the blooming order of 86 varieties

for 20 years and pointed out that beginning of blooming never shows the same trend even under similar circumstances.

The petal fall was observed first of all on the cv. Gala Red Lum (60.64 DARD) and last on 'Golden Clone B' (66.24 DARD). Usually these differential results are due to the different level of satisfaction of the buds on chilling requirement. These results are in conformity with the findings of Facticeau *et al.* (5) 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 early stage of vegetative development. Flowering date and period of blooming varies according to cultivar aptitude as well as ecological and cultural conditions [5].

Duration of flowering ranged from 12.28 days for cv. Super Chief Sandidge to 13.69 days for 'Golden Clone B'. The results are in accordance with the findings of Blazek *et al.* (3) who reported 17 days of flowering in different apple cultivars. Kumar (8) also recorded from 10 to 17 days for different apple cultivars. Sharma *et al.* (9) reported that duration of flowering in Himachal Pradesh ranged from 10 to 17 days in apple.

CONCLUSIONS

From the obtained results, it was concluded that the different exotic cultivars studied had different flowering phenological features which will permit to establish proper varietal combinations for pollination to improve profitability of high density apple orchards.

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151 **Table 1.** Phenological stages of exotic apple cultivars under high density plantation for the 2014
season at the Experimental Orchards of Division of Fruit Science, Sher-e-Kashmir University of
Agricultural Science & Technology of Kashmir, Srinagar, Jammu & Kashmir - North Himalayan
region of India

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Variety	Days after reference date (DARD) (1 st March)			
	Days to bud break	Days to silver tip stage	Days to green tip stage	Days to leafing out
Super Chief Sandidge	16.42 ±0.17	21.36 ±0.16	25.92 ±0.66	32.26 ±0.09
Gala Red Lum	15.27 ±0.21	20.20 ±0.10	23.57 ±0.05	29.48 ±0.15
Fuji Zhen Aztec	18.49 ±0.18	23.50 ±0.50	27.60 ±0.16	34.52 ±0.13
Golden Clone B	21.50 ±0.20	25.49 ±0.20	28.36 ±0.16	36.66 ±0.18
CD (p≤ 0.05)	0.59	0.45	0.57	0.43

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Table 2. Flowering behavior of exotic apple cultivars under high density plantation at the Experimental Orchards of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir, Srinagar, Jammu & Kashmir during the 2014 season - North Himalayan region of India.

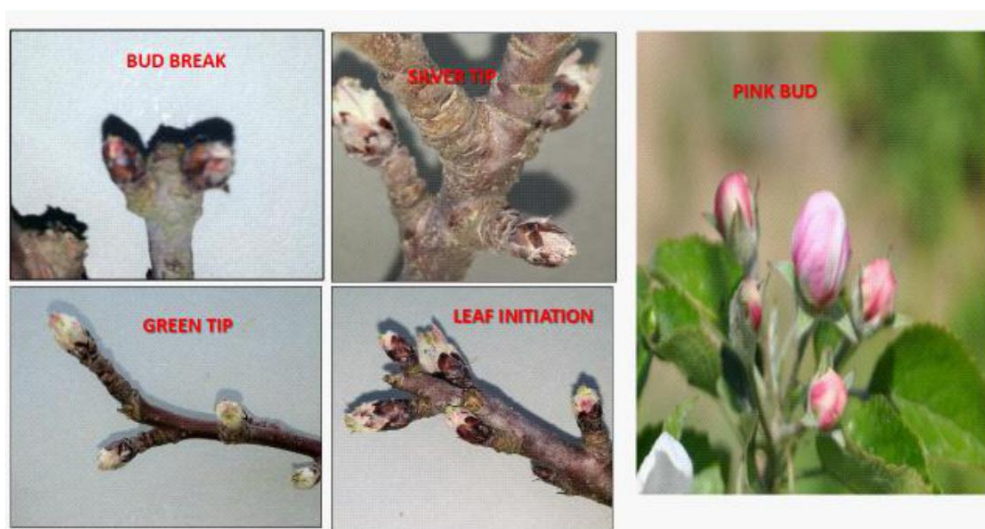
Variety	Days after reference date (DARD) (1 st March)				Duration of flowering (days)
	Days to pink bud stage	Days to Initial bloom (10%) ^{1/}	Days to Full bloom (85-90%) ^{1/}	Days to petal fall (80%) ^{2/}	
Super Chief Sandidge	40.68 ±0.40	45.35 ±0.11	55.54±0,08	65.05±0.43	12.28±0,11
Gala Red Lum	39.44 ±0.13	44.41 ±0.14	52.29±0,06	60.64±0.19	13.51±0,18
Fuji Zhen Aztec	43.69 ±0.09	47.85 ±0.04	56.50±0,15	65.88±0.25	12.36±0,10
Golden Clone B	44.86 ±0.06	48.46 ±0.17	58.79±0,08	66.24±0.34	13.69±0,34
CD (p≤ 0.05)	0.70	0.40	0.32	0.84	0,64

^{1/} Refers to the percentage of opened flowers. ^{2/} Refers to the percentage of fallen petals



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181 **Figure 1: A view of the experimental orchard at SKUAST-Kashmir**



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184 **Figure 2: Different phenological stages of bud break on apple**



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(a) Initial bloom

(b) Full bloom

188 **Figure 3: Flowering stages of initial bloom and final bloom of apple**

