

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

ABSTRACT

Study was conducted to define phenological and flowering characteristics of four apple cultivars raised on M9T337 rootstock 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, days to bud break, silver tip stage, green tip stage, leafing out, pink bud, initial bloom, 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 were recorded. The results reveal that various phenological stages viz. bud break, green tip, silver tip and leaf initiation showed significant differences. During the study, cultivar Gala Red Lum took minimum number of days to attain bud break (15.27 days after reference date), silver tip stage (20.20 DARD) while as Golden Clone B was last to attain different phenological stages. Full bloom was earliest (52.29 DARD) in Gala Red Lum and was late (58.79 DARD) in Golden Clone B. The duration of flowering ranged from 12.28 days in Super Chief Sandidge to 13.69 days in Golden Clone B. Remarkable variations were thus observed in the phenological and flowering behaviour of investigated varieties under temperate conditions of Jammu and Kashmir.

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

26 INTRODUCTION:

27 Jammu and Kashmir state 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 state made rapid strides during the last
30 few decades._Compared to 1954-55, 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 area and 80.18 per cent production. Productivity of apple has
33 shown an increase from 4.12 to 10.60 MT/ha (1975-2017). Though it appears to be highest
34 among the apple producing states in the country, yet it is far below the level achieved by
35 horticulturally advanced countries where productivity is between 50-60 MT/ha [1].

36 Almost entire apple plantation in the state is on seedling origin rootstock. The
37 vigorous seedling rootstock leads to larger trees, which have long juvenility. There is more
38 competition between vegetative growth and fruit production within these trees and their
39 internal self-shading makes them more vulnerable to various diseases. By using vigorous
40 rootstocks, only few trees can be accommodated per hectare making the productivity less
41 profitable. With stagnation in productivity, looming threat of imported fruits and land prices
42 touching new peaks in the state, it becomes imperative to go for high-density plantation for
43 which change in rootstock from vigorous to size controlling rootstock is a prerequisite.
44 Orchard numbers with new cultivars and on dwarfing rootstocks are also few in the state. The
45 number of orchard with new cultivars and on dwarf and semi-dwarf rootstocks should be
46 increased in order to increase yield and quality. Therefore, it is necessary to determine
47 suitable cultivars for the region. Besides apple shows gametophytic self and cross-
48 incompatibility, and 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 are raised on dwarf clonal rootstock M9T337 and are suitable for high density

51 plantation. However their phenological and flowering features under temperate conditions of
52 Kashmir are still to be studied. Thus the study was conducted to fill the 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 is located at an altitude of 1500 meters
57 above mean sea level. The climate is cold temperate. Rainfall is about 80cm, well distributed
58 and is mostly in the form of snow during winter and main rainfall is during March-April. The
59 uniform plants of four exotic cultivars of apple viz. Super Chief Sandidge, Gala Red Lum,
60 Fuji Zhen Aztec and Golden Clone B raised on M9T337 rootstock at a spacing of 3×1.5m
61 that were introduced by SKUAST-Kashmir in spring 2013 from an Italian nursery, GRIBA,
62 Italy were selected for the study. The experiment was laid in Randomized Complete Block
63 Design (RCBD) with five replications and two trees per treatment as plot size. Various
64 phenological characteristics (days to bud break, silver tip stage, green tip stage and leafing
65 out) were recorded visually by observing peculiar stages of respective parameter (figure 2).
66 Flowering stages including initial bloom and final bloom in each variety was recorded when
67 10 and 80 per cent flowers had opened (figure 3). The duration from the date of initiation of
68 flowering to the date of start of petal fall was calculated as duration of flowering. The date of
69 occurrence of petal fall was recorded when 80% petal fall occurred. The dates thus recorded
70 were converted to days with respect to days after reference date (DARD).

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

75 **RESULTS AND DISCUSSION**

76 Various phenological stages viz. bud break, green tip, silver tip and leaf initiation
77 showed significant differences during the study (Table 1). Cultivar 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 as Golden Clone B was
80 last to attain different phenological stages i.e. bud break at 21.50 DARD, silver tip at 25.49
81 DARD, green tip at 28.36 DARD and leaf initiation at 36.66 DARD. The results are in line
82 with the findings of (Baytekin, 2) who stated that dates of bud break in Fuji/M9 were late than
83 Gala/M9.

84 Remarkable variations were observed in the flowering behaviour of different
85 cultivars from the date of pink bud to complete petal fall (Table 2). Pink bud stage was first
86 noticed after 39.44 days of reference date in cultivar Gala Red Lum followed by Super Chief
87 Sandidge that took 40.68 days and last (44.86 DARD) in the cultivar Golden Clone B.
88 Likewise, date of initial bloom was attained first (44.41 DARD) by cultivar Gala Red Lum
89 while Golden Clone B reached at this stage very late (48.46 DARD). Full bloom stage was
90 observed first (52.29 DARD) in cultivar Gala Red Lum and very late (58.79 DARD) in
91 Golden Clone B. The differences in the phenological stages of different cultivars may be due
92 to their genetic differences or the differential chilling requirements of these varieties. Further
93 these cultivars may be different in their photo sensitivity and response to temperature
94 resulting in these variations. These results are in consequence with the findings of Gasser (7)
95 who has reported that beginning of blooming depends highly on the site of cultivation.
96 Beginning of bloom can be observed with highest accuracy which indicates the genetic
97 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 varieties in the

case of 86 varieties for 20 years and pointed out that beginning of blooming never shows same trend even under similar circumstances.

The petal fall was recorded first of all in the cultivar Gala Red Lum (60.64 DARD) and last in Golden Clone B (66.24 DARD). These differential results may be due to the different requirements of temperature and average temperature during bloom period. These results are in conformity with the findings of Facteau *et al.* (5) who reported that beginning of flowering, full bloom and end of flowering were different for 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 varies according to cultivar aptitude as well as ecological and cultural conditions [5].

Duration of flowering ranged from 12.28 days in cultivar Super Chief Sandidge to 13.69 days in 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 10 to 17 days difference in different apple cultivars. Sharma *et al.* (9) reported that duration of flowering in Himachal Pradesh ranged from 10-17 days in apple.

From the above study, it was concluded that different exotic cultivars had varied phenological and flowering features which will be beneficial for devising proper varietal combinations for profitable high density apple orcharding.

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Table 1. Phenological stages of exotic apple cultivars under high density plantation.

Variety	Days to bud break (DARD)	Days to sliver tip stage (DARD)	Days to green tip stage (DARD)	Days to leafing out (DARD)
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

DARD: Days after reference date (1st March).

Table 2. Flowering behavior of exotic apple cultivars under high density plantation.

Variety	Days to pink bud stage (DARD)	Initial bloom (10%) (DARD)	Full bloom (85-90%) (DARD)	Duration of flowering (days)	Days to petal fall (DARD)
Super Chief Sandidge	40.68 ±0.40	45.35 ±0.11	55.54 ±0.08	12.28 ±0.11	65.05 ±0.43
Gala Red Lum	39.44 ±0.13	44.41 ±0.14	52.29 ±0.06	13.51 ±0.18	60.64 ±0.19
Fuji Zhen Aztec	43.69 ±0.09	47.85 ±0.04	56.50 ±0.15	12.36 ±0.10	65.88 ±0.25
Golden Clone B	44.86 ±0.06	48.46 ±0.17	58.79 ±0.08	13.69 ±0.34	66.24 ±0.34
CD (p≤ 0.05)	0.70	0.40	0.32	0.64	0.84

DARD: Days after reference date (1st March).



Figure 1: A view of an experimental orchard at SKUAST-Kashmir



Figure 2: different phenological stages



(a) Initial bloom

(b) Full bloom

189 **Figure 3: Flowering stages at initial bloom and final bloom were recorded**