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Blooming behavior and pollen characteristics of exotic apple cultivars under high density planting systems of Kashmir

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Abstract

The present investigation entitled “Blooming behavior and pollen characteristics of exotic apple cultivars under High Density Planting System” was undertaken at experimental fields of Division of Fruit Science, SKUAST-Kashmir, during the year 2017. The productivity of apple in Jammu and Kashmir is 12 metric tons per hectare, when it is compared with the productivity of developed nations of the world this figure is very low and there is plenty of difference in the productivity. In order to curtail this gap, eight exotic apple cultivars introduced from Holland, of uniform age namely Mitch Gala, Elrosa, Wiltons Star, Golden Delicious Reinders, Red Delicious Campsur, Red Braeburn, Jonagold A and Jonagold DC Robijin on M9T337 rootstock, were evaluated under Kashmir conditions. Blooming behavior and pollen characteristic measurements were performed on all the cultivars. Flowering characteristics revealed that earliest blooming cultivar was Red Braeburn while as Golden Delicious Reinders was the late blooming cultivar. In case of flowering duration maximum days of 13.03 was recorded in Golden Delicious Reinders while as minimum of 10.33 days in Elrosa. Maximum pollen viability (80.80%) and pollen germination (73.38%) was recorded in cultivar Golden Delicious Reinders while as Jonagold DC Robijin recorded minimum percentage of pollen viability (50.30%) and pollen germination (34.66%).

Keywords: Flowering, high density, cultivars, exotic, pollens

1. Introduction

Apple is the most produced fruits in temperate climate areas and is expanding into subtropical and tropical areas (Brown, 2012) [5]. Present world production of apples is close to 8, 93, 29, 179 metric tons (FAOSTAT, 2016). In India, the area under apple is 314 thousand hectares with a production of 2872 thousand metric tons and productivity of 6.98 M.T/ha (Anonymous, 2016) [1]. Jammu and Kashmir State being endowed with natural advantages of topography and climate with enormous diversity of agro-climatic conditions has immense scope for horticultural development. Horticulture industry in the state made rapid strides during the last few decades. Among the temperate fruits, apple ranks first covering 43.30 per cent area and 80.18 per cent production. Yield of apple has shown an increase from 4.12 to 12.16 MT/ha (1975-2016). The area under apple cultivation in Jammu and Kashmir state is 162.97 thousand ha with the production of 11726.83 thousand MT and productivity 10.60 MT/ha (Anonymous, 2017) [2]. 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) [15, 16]. 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, e.g. pears (Buban & Faust 1982) [6]. Moreover, the study of flowering is also interesting in connection to climate and climate change, for the breeding of new cultivars adapted to different climatic regions, to understand the mechanisms of biennial bearing and for modelling the risk of attack by pests. Despite the importance of flowering for apple production and research, most of the studies in the literature have focused on solving practical problems and on later stages of flower and fruit development (Tromp *et al.* 2005) [15].

Little attention has been paid to the understanding of the different stages of the process, their timing under specific environmental conditions and their relationship to other developmental processes in the tree, such as anthesis, vegetative growth and fruit maturation (Tromp, 2005b) [16]. As apple (*Malus × domestica*) shows gametophytic self and cross-incompatibility, and at least two genetically distinct cultivars are necessary for stable apple production. Therefore, 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 (Chauhan *et al.*, 2008) [7]. The viability, tube growth and morphological homogeneity related to pollen quality are the most important properties in fruit trees. These properties are useful for plant breeders, geneticists, researchers, development departments and growers (Bolat and Pirlak, 1999).

2. Materials and Methods

Eight exotic varieties of apple namely Mitch Gala, Elrosa, Wiltons Star, Golden Delicious Reinders, Red Delicious Camspur, Red Braeburn, Jonagold A and Jonagold DC Robijin grafted on M9-T337 rootstock were introduced by SKUAST-Kashmir from Holland in summer 2016. In order to access the performance of these exotic cultivars, it was proposed to conduct the study on their flowering and Pollen characteristics. The plant material was two year old knip boom trees planted at a spacing of 3x1m. The experiment was laid in Randomized Complete Block Design (RCBD) with four replications and three trees per treatment as plot size. The phenological stages were observed visually when the buds started showing respective stages like date of pink bud (when the flower buds started showing pink colour at the top of its leaf scars and converted into days after reference date), date of first flower opening (when 10 per cent of flowers were open), date of full bloom (when about 80-90% of flowers were open) and date of petal fall (when 80% of flowers exhibited petal fall) was recorded (Figure 1). The duration of flowering was worked out as the period (days) between the initial bloom and petal fall in each tagged tree.

Pollen viability was tested by using triphenyl tetrazolium chloride (TTC) solution prepared by taking 1 g of TTC, 40 ml of 95 per cent ethanol and the total volume was made to 100 ml with distilled water. Then pollens were left for 1 hour for staining and examined under microscope. Deeply stained and normal looking pollen grains were considered as viable while as shriveled and weakly stained were regarded as non-viable. Freshly dehisced pollen grains were used for *in vitro* pollen germination test. Sucrose 15 per cent was prepared with 0.5 per cent agar as solidifying medium and 5 ppm boric acid. Solution was placed in the petri dishes and pollen grains were dusted over it and then covered. Pollen tube growth was observed for each genotype under microscope after 24 hours

of incubation period at 22±2 °C. The pollen grains having pollen tube at least two times longer than pollen size were considered to be.

3. Statistical analysis

The observations recorded during the course of investigation were subjected to statistical analysis as per the method of 'Analysis of Variance' (Fisher, 1950). The significance and non-significance of treatment effects were judged with the help of software OP stat. The significant difference on the means was tested against the critical difference at 5% level.

3. Results and Discussion

Considerable variations were exhibited by the different cultivars in attaining the different flowering stages from pink bud to petal fall stage (Table 1). Pink bud stage was first noticed at 32.49 days after reference date (DARD) in the cultivar 'Red Braeburn' and last in the cultivar 'Golden Delicious Reinders' (37.74 DARD). Likewise, date of initial bloom was attained first (37.49 DARD) by 'Red Braeburn' while as 'Golden Delicious Reinders' reached this stage very late (42.80 DARD). Date of full bloom stage, was observed earliest in Red Braeburn (45.16 DARD) and late in Golden Delicious Reinders (52.16 DARD). Our results are in conformity with the findings of Pandit *et al.* (2017) [10] who reported that cultivar Braeburn took 36.74 DARD to reach initial bloom and 50.59 DARD to reach full bloom. The differences in the phenological stages may be due to their genetic differences or the differential chilling requirements of these cultivars may be the reason for such variations. Furthermore these cultivars may be different in their photo sensitivity and response to temperature resulting in such variations. These results are in corroboration with the results of Gasser (1994) [8] who has reported that beginning of blooming depends highly on the site of cultivation. In the present study, the petal fall (50.16 DARD) was recorded earliest in the cultivar 'Red Braeburn' and at last (55.83 DARD) in 'Golden Delicious Reinders'. These differential results may be due to the different requirements of temperature and ecological conditions of the cultivars, as the average temperature during bloom period may affect the flowering duration.

Significant differences were observed among the various cultivars of apple with respect to flowering duration (Figure 2). The duration of flowering ranged from 10.33 days in Elrosa to 13.03 days in Golden Delicious Reinders. The results are in accordance with the findings of Blazek *et al.* (1983) [3] who reported 17 days of flowering duration in apples. Kumar (1996) [9] studied duration of 10-17 days in different apple cultivars and suggested long duration to be more useful as pollinizers. According to Sharma *et al.* (2005) [14] and Sharma *et al.* (2006) [15], flowering duration in apple ranged from 10-17 days in Himachal Pradesh.

Table 1: Flowering characteristics of exotic apple cultivars

Cultivar	Days taken to pink bud (DARD)	Days taken to initial bloom (DARD)	Days taken to full bloom (80%)(DARD)	Days taken to petal fall (DARD)
Mitch Gala	34.16	39.58	46.16	51.49
Elrosa	36.83	42.49	47.83	51.49
Wiltons Star	34.49	40.49	47.49	52.16
Golden Delicious Reinders	37.74	42.80	52.16	55.83
Red Delicious Camspur	36.83	41.49	48.83	53.24
Red Braeburn	32.49	37.49	45.16	50.16
Jonagold A	36.49	42.49	48.24	53.16

Jonagold DC Robijin	36.83	42.74	48.16	53.08
C.D ($p \leq 0.05$)	0.63	0.86	0.80	0.57

(DARD- Days after reference date), (Reference Date; 1st March)



Fig 1: Flowering stages of apple

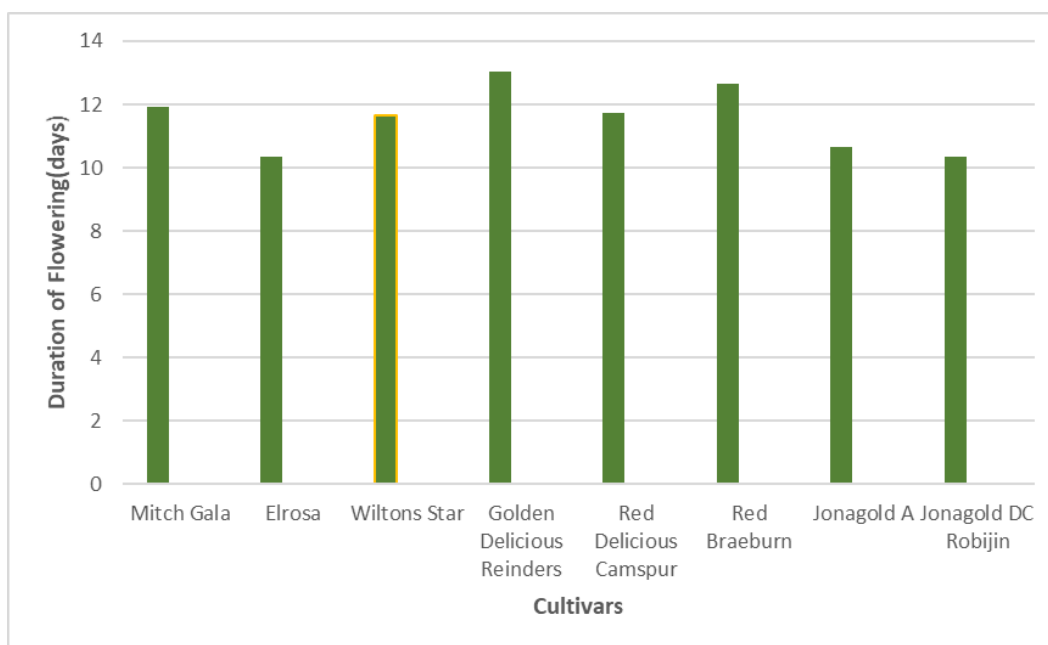


Fig 2: Flowering duration of different exotic apple cultivars

Pollen viability and germination varied significantly among the various cultivars under study (Figure 3). Among the eight varieties evaluated, highest pollen viability (80.80%) and pollen germination (70.85%) was recorded in cultivar Golden Delicious Reinders whereas the lowest percentage of pollen viability (50.30%) and pollen germination (34.66%) was recorded in Jonagold DC Robijin. Pollen viability and germination are the most important characteristics related to pollen quality and successful fertilization needs high germination rates. (Sharafi, 2011) [13]. The lower pollen viability and germination of triploid apple cultivars has been

attributed to the fact that mature anthers of triploids mostly contain 90% of degenerated pollen probably due to the asymmetry in the reduction division of meiosis (Schmidt 1964) [12]. Our results are in conformity with the findings of Petrisor *et al.* (2012) [11] who reported that cultivar that shows the lowest values on pollen viability and germination percentage was ‘Jonagold’ which is a triploid cultivar. Our results are also in agreement with Pandit *et al.* (2017) [10] who reported that highest pollen viability and pollen germination percentage was recorded in Golden Delicious.

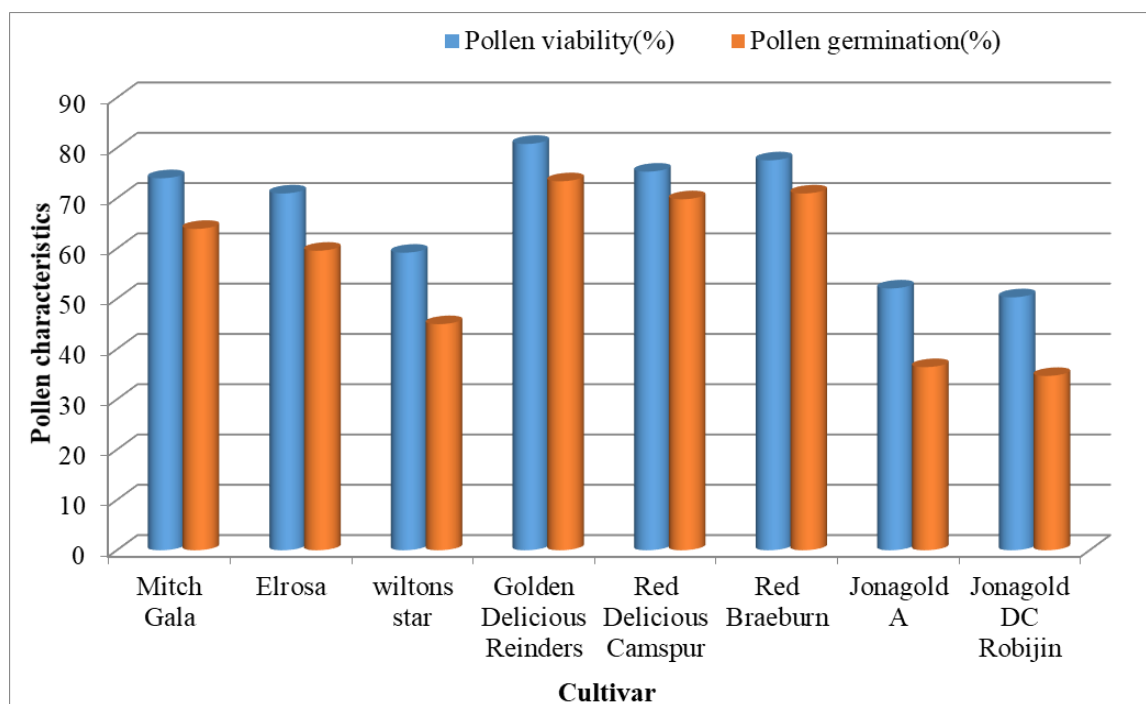


Fig 3: Pollen characteristics of exotic apple cultivars

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