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Investigation on floral phenology, pollen viability and pollen germination in some apple genotypes in climate conditions of Kashmir

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Abstract

This paper presents the floral phenology, Pollen viability and pollen germination in different apple cultivars in Kashmir valley. The experiment was designed to evaluate bloom synchronization and functional pollen ability between different apple cultivars. 1st March was taken as reference date for floral phenology evaluation, the varieties showing full bloom on same date were regarded as synchronous varieties. Four groups of synchronous varieties were observed. The first group included three varieties Starkrimson, Vista Bella, COE- Red Fuji and Mollies Delicious which showed full bloom on 11st April, the varieties Red Fuji, Red Chief, T.E. Worcester, Royal Delicious and Top Red fell under 2nd group, showed full bloom on 12th April, 3rd group included Granny Smith, Spartan and Red Gold which showed full bloom on 14th April and the 4th group consisted of American Apirouge and Golden Delicious, showed full bloom on 17th April. In terms of pollen viability and germination, the highest pollen viability (100%) was observed in Gold Spur, Spartan, Starkrimson, *M. floribunda*, Golden Hornet, Mollies Delicious, Manchurian Scarlet Siberian and Golden Delicious. The highest pollen germination (69.34%) was recorded in Red Gold.

Keywords: Germination, phenology, pollen, synchronization, viability

Introduction

Apple (*Malus domestica* Borkh.) belongs to the Rosaceae (Rose) Family, and the subfamily of Pomoideae. Throughout its history of cultivation, at least 10,000 apple cultivars were developed, many of which are now lost. This was due in part to the older practice of seed propagation. Apple a major temperate fruit of the world has become pride of hill farmers of Northern India for appreciably improving their economy. The major apple growing states in India are Jammu and Kashmir, Himachal Pradesh and Uttarakhand, which cover 95% of total area under apple and 86% of the total apple production. It is successfully grown at an elevation range of 1600-2800 m above MSL and needs chilling requirement of 800-1000 hours at or below 7 °C to overcome the dormancy for flower bud development and flowering. From the past years the percentage of area under apple has increased many fold but its production could not keep a pace with that of its area expansion. Lower apple production is due to many factors the important being lack of bloom synchronization between the varieties, low pollen viability and germination percentage and the important being its self-incompatibility. As the great majority of apple cultivars are self-incompatible (Broothaerts, 2003) [1], they do not fruit by their own pollen due to the antagonism that prevents pollen grains from growing on to stigmas of the same variety. Genetically apples show gametophytic self-incompatibility (Kantoci, 2008) [2] which necessitates the pollen transfer from another pollinizer variety to set fruit in marketable quantities. For cross pollination to be effective it is very important that the cultivars bloom at approximately the same time, produce the sufficient quantity of viable, compatible pollens. The pollen viability and germination are the most important properties in fruit trees. These properties are useful for plant breeders, geneticists, and growers (Sharafi, 2011) [5]. For successful pollination the high quantities and qualities pollen must be transferred to the stigma when it is receptive. However, some times, the pollen is deposited before the receptive period and the pollen should remain viable for a period long enough. The important criteria for a suitable pollinizer is its flowering period, which should coincide with the flowering time of main cultivars.

Besides being regular bearer they should produce sufficient amount of viable and compatible pollen. In order to ensure consistently better yield and quality of delicious apple, there is an urgent need to have a fresh look on new pollinizers, their flowering habits, placement system, etc., and also to make optimum provision of bee hives in the existing orchards to provide supplementary pollination. Therefore, the investigation was undertaken for comparative study of bloom synchronization of various commercial varieties and crab apples that could be used with main variety as a pollinizer so as to enhance the fruit set thereby enhancing production.

Materials and methods

The present investigation was carried out at SKUAST-K Shalimar during 2014 to 2016. The various Vaarieties and crab apples were tested for flowering, flowering duration, bloom synchronization, pollen viability and pollen germination using Randomized Block Design with three replications. Flowering Study Observations were recorded by tagging 100 flowering buds on each of the four branches in four different directions of the tree before the bud had shown any sign of growth reference date (DARD) was fixed arbitrarily as 1st March

Floral studies and synchronization

Flowering duration: The Duration of flowering was worked out as the period (days) between the first bloom and petal fall in each tagged branch of each selected cultivar.

Synchronization of bloom: It was worked out by recording the dates corresponding to the overlapping of the blooming periods of the various apple genotypes under study.

Evaluation of viability and germination

Pollen viability: Fresh pollen grains were dusted on slides and 1-2 drops of 1% acetocarmine was added to pollen. The slide was left for about 10-15 minutes, based on staining, the percentage of viable and dead pollens was examined under microscope. Deeply stained and normal looking pollen grains were considered as viable while as shrivelled and weakly stained were regarded as non viable.

Pollen Germination: Pollen germination studies were conducted in different sucrose concentration viz., 10%, 15%, and 20% at temperature ranging between 25 °C to 30 °C (room temperature). Fresh pollen grains were placed in small drops of 10, 15 and 20 per cent sucrose solution in cavity slides and covered with cover slips. The slides of all the cultivars were placed for germination in petri dishes containing a moist filter paper to ensure uniform and high relative humidity. The pollen germination was observed after 24 hours under a microscope.

Results and discussion

The flowering (first bloom) in different apple genotypes commenced on 8th April (Gold Spur, T.E. Worcester, Vista Bella, Royal Delicious, Spartan, Mollies Delicious) and extended up to 14th April (American Apirouge). The full bloom commenced on 10th April (Gold Spur) and extended up to 17th April (Golden Delicious and American Apirouge). However the end of flowering commenced from 22nd April (Red Fuji) and extended upto 2nd May (American Apirouge). Significant differences were found between the genotypes during first bloom, full bloom and petal fall stages. The cultivars Spartan and Golden Delicious remained in

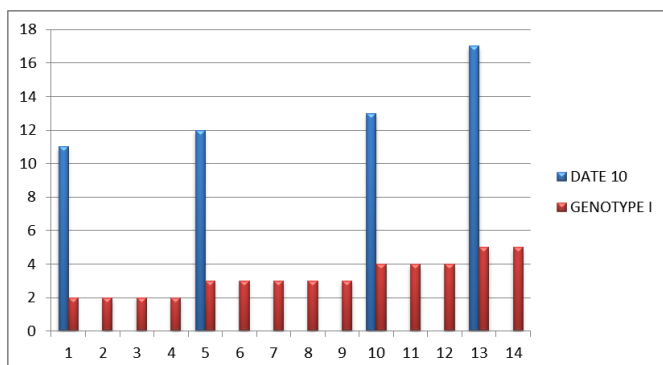
flowering for 18 days however the cultivars Red Fuji and Red Gold showed lowest flower duration of 13 days (Table.1). A good synchronization of blooming (full bloom) was observed in various apple genotypes. Four groups of synchronous genotypes were observed. The first group included three varieties Starkrimson, Vista Bella, COE- Red Fuji and Mollies Delicious which showed full bloom on 11st April, the varieties Red Fuji, Red Chief, T.E. Worcester, Royal Delicious and Top Red fell under 2nd group, showed full bloom on 12th April, 3rd group included Granny Smith, Spartan and Red Gold which showed full bloom on 14rd April and the 4th group consisted of American Apirouge and Golden Delicious, showed full bloom on 17th April. All the genotypes differed significantly, showing almost the perfect coincidence in the date of full bloom. (Fig. 1). This behaviour highlights the high variability of apple genotypes regarding flowering under temperate conditions. The comparison between pollen viability of different apple genotypes showed that the highest viability percentage is for Mollies Delicious, Cooper IV, Oregon Spur, Scarlet Siberian and Gold Spur with 100% and the least percentage was for Vista Bella (64.50%). Significant differences were found with almost all the genotypes however Red Gold, COE-Red Fuji, Top Red, Granny Smith were statistically at par. Pollen germination percentage has shown that Red Gold cultivar with 69.34% and Oregon Spur with 44.24% have the highest and the lowest pollen germination, respectively. Significant differences were observed between all the genotypes under study. (Table 2). Pollen viability and germination are the most important characteristics related to pollen quality, and successful fertilization needs high germination rates. (Sharafi, 2011) ^[5]. In this research, the means of pollen apple cultivars germination in sucrose was between 69.34% and 44.24% which shows high viability of pollens, and no cultivar has been identified to have male sterility with zero pollen germination (Saghali *et al.*, 2013) ^[4]. The value of germination percentage with the medium culture containing sucrose 15% has been suggested to determine pollen germination and tube growth in various apple cultivars. (Fariba *et al.*, 2015) ^[3].

Table 1: Blooming time of different apple varieties grown in Kashmir valley (taking 1st Mar as reference date)

Name of Variety	First Bloom	Full bloom	Petal fall stage	Flowering duration
Gold Spur	39	41	55	16.00
T.E. Worcester	39	43	54	15.00
Starkrimson	40	42	55	15.00
Vista Bella	39	42	54	15.00
Red Chief	40	43	56	16.00
American Apirouge	45	48	63	18.00
Red Gold	42	44	55	13.00
Red Fuji	40	43	53	13.00
Royal Delicious	39	43	54	15.00
Golden Delicious	44	48	61	17.00
COE- Red Fuji	40	42	54	14.00
Top Red	40	43	55	15.00
Granny Smith	40	44	56	16.00
Spartan	39	44	57	18.00
Mollies Delicious	39	42	54	15.00
Red Delicious Control	41	45	57	16.00
Se(d)	0.13	0.12	0.21	1.260
Se m	0.14	0.145	0.24	0.62
Cd \geq 0.05	0.28	0.54	0.48	0.44

Table 2: Flowering duration, Pollen viability and pollen germination in different apple cultivars

S.no	Name of Variety	Pollen viability (%)	Pollen germination (%)
1.	Gold Spur	100	62.23
2.	T.E.Worcestor	94.17	60.81
3.	Starkrimson	100.00	52.39
4.	Vista Bella	64.50	61.25
5.	Maharji	95	65.83
6.	Red Chief	97.18	53.71
7.	American Apirouge	76.63	58.1
8.	Spartan	100	59.11
9.	Red Gold	97.97	69.34
10.	Golden Hornet	100	56.53
11.	COE-Red Fuji	97.53	61.85
12.	Royal Delicious	85.00	55.85
13.	Golden Delicious	100	67.92
14.	Top Red	97.57	51.60
15.	Cooper IV	100	46.48
16.	Oregon Spur	100	44.24
17.	Granny Smith	97.94	64.54
18.	Red Fuji	98.00	45.71
19.	Mollies Delicious	100	59.35
20.	<i>Malus floribunda</i>	100	63.40
21.	Manchurian	100	58.95
22.	Scarlet Siberian	100	65.21
23.	Red Delicious	77.76	55.32
	cd \geq 0.05	0.45	0.15
	Se d	0.10	0.07
	Se m	0.07	0.05

**Fig 1:** Four groups formed as per the coincidence of bloom period (first group with four genotypes falling in same group with bloom date of 11 april)

Conclusion

The present study indicated the bloom synchronization and floral phenology of apple various apple genotypes. It is suggested from this study that all the genotypes possess promise in terms of pollen viability and pollen germination since they reflected the higher percentage of viability and germination. It is hoped this study is used in inbreeding program and investigation of pollen apple viability cultivars that storage for a longtime, until pollination.

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