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Flowering and Cross-compatibility in Apple Cultivars Growing in the Kullu Valley of India

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Abstract

The time and duration, overlap in bloom period and cross-compatibility of different cultivars in the Kullu valley of India were studied. Flowering was 3 to 4 days earlier in 1998 than 1997. The flowering period of different apple cultivars extended between second week of March to the end April/first week of May both years. Flowering duration ranged from 10 to 15 days in 1997, and 9 to 17 days in 1998. The full bloom period of most cultivars synchronized with the pollinizing cultivars viz. Jonathan, Black Ben Davis, Red Gold and commercial. The pollinizers 'Jonathan', 'Black Ben Davis', 'Red Gold' and 'Commercial' are compatible with most of the commercial cultivars as revealed from completion of *in vitro* pollen tube growth 72 to 120 h after pollination. The pollinizer *Malus robusta* and 'Golden Delicious' did not synchronize in bloom with main cultivars. *M. robusta* flowered two weeks and 'Golden Delicious' one week earlier than most cultivars.

Introduction

Most of the apple cultivars are self-incompatible (9,8,4) and require another pollinizing cultivar for cross pollination with compatible pollen grains mediated by bees, to set sufficient crop. The time and duration of flowering in apple is of paramount importance as the synchronization of bloom and cross-compatibility between the main cultivar(s) and pollinizer(s) is a pre-requisite for obtaining optimum fruit set (7).

Poor fruit set can be a colossal economic loss. For these reasons, there is an urgent need to study floral behaviour and identify a suitable set of pollinizing cultivars, overlapped sufficiently in bloom and to ensure effective cross pollination.

Materials and Methods

Different apple cultivars/species were examined during 1997 and 1998 in major apple growing areas in the Kullu valley of Himachal Pradesh in India. A survey of apple orchards was conducted in four locations. In each location four orchards were selected randomly. The sixteen orchards included in the study were located at Bajaura (1097 m amsl), Raison (1463 m amsl), Jari (1524 m amsl) and Naggar (1760 m amsl) (Fig. 1).

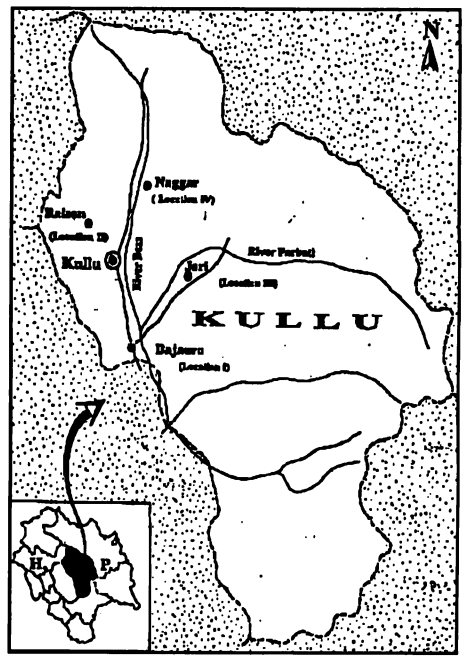

Figure 1. Orchard locations studied in the Kullu Valley.

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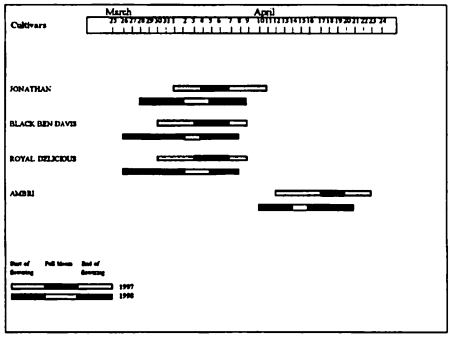

Figure 2. Variation in time and duration of flowering in different cultivars of apple in Hira orchard under Bajaura conditions during 1997 and 1998.

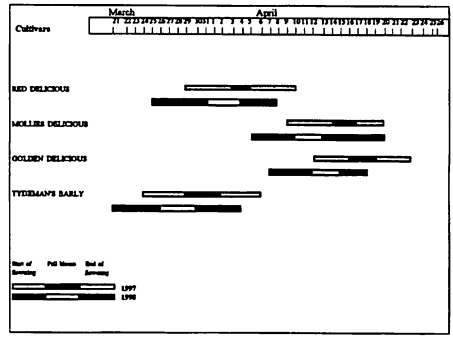

Figure 3. Variation in time and duration of flowering in different cultivars of apple (orchard of Dept. of Horticulture) under Bajaura conditions during 1997 and 1998.

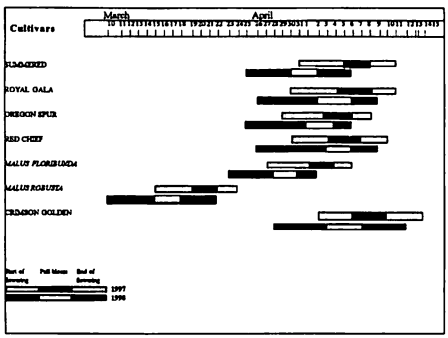

Figure 4. Variation in time and duration of flowering in different cultivars of apple (orchard of Indo-Italian Fruit Development Project) under Bajaura conditions during 1997 and 1998.

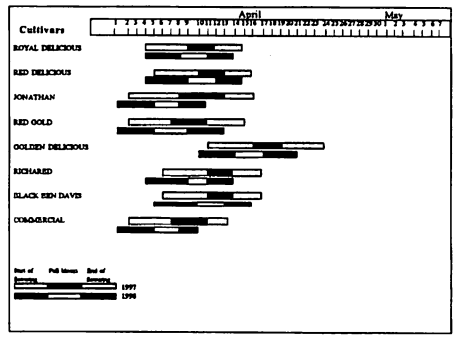

Figure 5. Variation in time and duration of flowering in different cultivars of apple (Khullar orchard) under Raison conditions during 1997 and 1998.

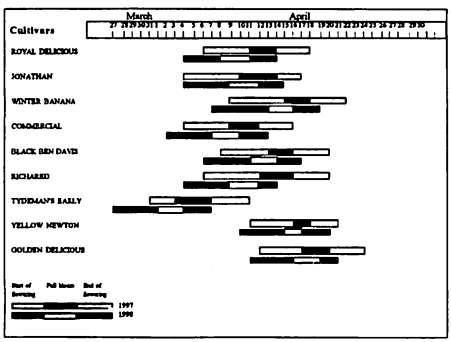

Figure 6. Variation in time and duration of flowering in different cultivars of apple (Sharma orchard) under Raison conditions during 1997 and 1998.

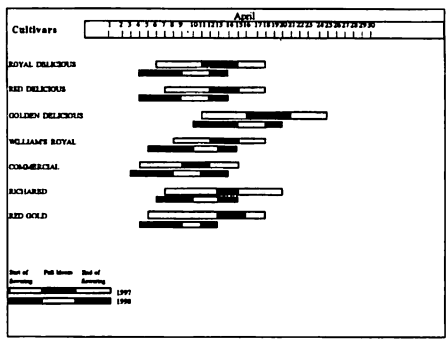

Figure 7. Variation in time and duration of flowering in different cultivars of apple (Rakesh orchard) under Raison conditions during 1997 and 1998.

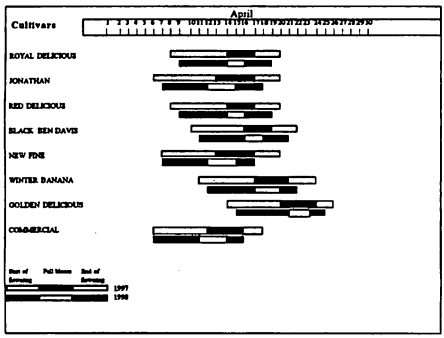

Figure 8. Variation in time and duration of flowering in different cultivars of apple (Mann orchard at Jari) under Parvati Valley conditions during 1997 and 1998.

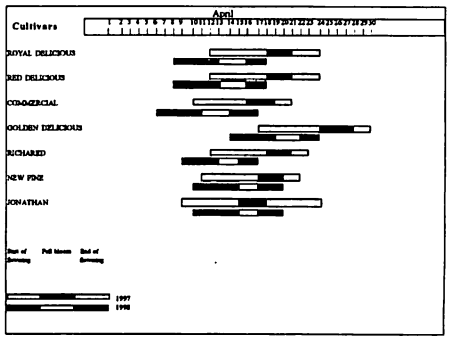

Figure 9. Variation in time and duration of flowering in different cultivars of apple (Mohar orchard) under Naggar conditions during 1997 and 1998.

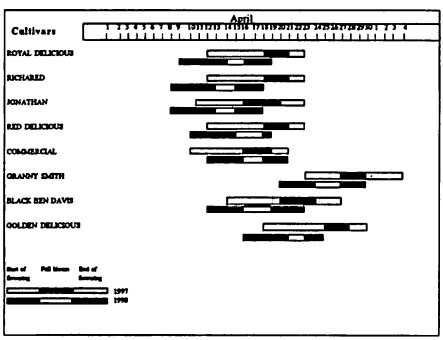

Figure 10. Variation in time and duration of flowering in different cultivars of apple (Govind orchard) under Naggar conditions during 1997 and 1998.

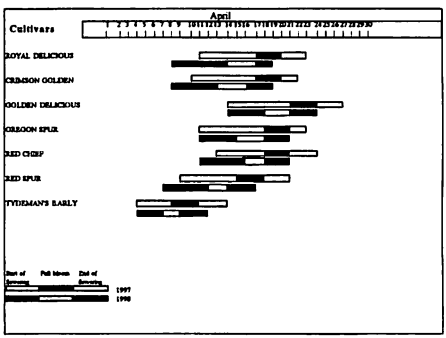

Figure 11. Variation in time and duration of flowering in different cultivars of apple (Aroma orchard) under Naggar conditions during 1997 and 1998.

Time and duration of flowering

Data on time and duration of flowering were recorded for each cultivar in every orchard under study, from the opening of first flower to the last flower. Five representative branches around the periphery of the tree were selected in each cultivar. The date on which more than 50 per cent of the flowers were opened was considered the date of full bloom (5). Data were collected in 1997 and 1998 to determine the yearly variation and influence of weather conditions on time and duration of flowering.

In vivo pollen tube growth

In vivo pollen tube growth was studied to determine cross-compatibility or incompatibility reactions between the cultivars having synchronous flowering, following the modified procedure (14).

In different cultivars under study, the flowers at balloon stage were radically emasculated and pollinated with freshly collected pollen grains. Reciprocal crosses were also made. Sampling of the crossed pistils (5-10 flowers/cross) was made after every 24 hours up to 120 hours to carry out laboratory/microscopic studies. Pistils were fixed in Randolphís fixative for 24 hours followed by washing and preservation in 70 per cent alcohol. Pistils were reduced to styles, then softened by keeping overnight in 5N NaOH, squashed and mounted in 1 per cent water soluble aniline blue. The germinating pollen grains and growing pollen tubes into the styles were

identified by their brilliant yellow fluorescence under Olympus BX-40-FLA (with reflected light fluorescence attachment) microscope.

Results and Discussion

The start of flowering was 3 to 4 days earlier in 1998 as compared to 1997 for different cultivars of apple in all the orchards in the Kullu valley. A similar trend was observed for the end of flowering. The earliest to flower was *Malus robusta* (15th March, 1997; 10th March, 1998), while 'Ambri' flowered last (12th April, 1997; 10th April, 1998). The duration of flowering ranged from 10 (*Malus floribunda*) to 15 days ('Jonathan' and 'Golden Delicious') in 1997, whereas, in 1998, it varied from 9 ('Richared' and 'Tydeman's Early') to 17 days ('Royal Delicious'). In general, the order of blossoming of different cultivars in the orchards in four locations remained consistent, irrespective of whether the blossoming period was early or late. In most other studies, flowering varied from 6 to 26 days in different cultivars under different climatic conditions (1, 10, 13, 3, 2, 11).

A somewhat shorter bloom duration in some cultivars may have been due to quick warming of the season. The length of blossoming period varied according to the cultivar (6). A single tree could show variation in duration of flowering period (6 to 15 days) over a period of years (10). A similar trend of flowering was observed in present study (13). Most cultivars of different locations attained full bloom within 4 to 9 days after the start of flowering. The time to full bloom depended upon the temperature regimes and varied from 4 to 13 days (11).

Based on the synchronization of flowering, the cultivars 'Jonathan', 'Black Ben Davis', 'Red Gold' and 'Commercial'(Fig. 2-11) overlap bloom with main cultivars (Royal Delicious, Red Delicious, Richared etc.) of the Kullu valley. the pollinizing cultivar, *Malus robusta* did not synchronize with any cultivars, whereas, 'Golden Delicious' had some overlap with 'Mollie's Delicious', 'Yellow Newton' and 'Granny Smith'. *M.robusta'* flowered two weeks before and 'Golden Delicious' flowered one week later than most cultivars. In all the cross-combinations attempted, pollen tube growth was completed 72 to 120 h after pollination. The pollen tube traveled down the stylar tissue without terminal swelling of the callose plugs. Such characters are indicative of cross-compatibility (12, 15). Results indicate that 'Jonathan', 'Black Ben Davis', 'Red Gold', and 'Commercial' had very good overlap in full bloom period as well as cross-compatibility with main cultivars whereas, 'Golden Delicious' is suitable only in orchards with late flowering cultivars and not for 'Royal Delicious', 'Red Delicious' and 'Richared' as it does not fulfill the pre-requisite of synchronization of flowering (7).

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Phenotypic Differences of Nut and Yield Characteristics In 'Siirt' Pistachios (*Pistacia vera* L.) Grown In Siirt Province

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Abstract

With good fruit characteristics, 'Siirt' is an important pistachio cultivar of Turkey. The harvest season of this cultivar usually is from early September to late September. The study was conducted in central Siirt province, origin of the cultivar 'Siirt', (the Southeastern Anatolia Region) during 1998 and 2000. This study determines the phenotypic differences related to nut and yield characteristics within the cultivar 'Siirt'. The data from nineteen selections grafted onto *P. khinjuk* and eleven selections grafted onto *P. terebinthus* were evaluated. The tree characteristics were determined for three years and nut characteristics were recorded for two years. The selections on *P. khinjuk* showed a range of 0.52-6.80 kg for yield per tree, 11.9-67.1 g/cm^2 for yield efficiency, 103-118 g for dehulled nut weight, 50.7-59.4 g for kernel weight and 66-93% for split nuts. In addition, selections on *P. terebinthus* had a range of 0.70-2.84 kg for yield per tree, 7.5-29.1 g/cm^2 for yield efficiency, 98-130 g for dehulled nut weight, 53.4-60.6 g for kernel weight and 71-91% for split nuts.

Introduction

As a species increasingly gaining popularity in the world, pistachio trees have been grown since ancient times in Anatolia, one of its origins (1, 2, 3). Turkey has intensive native populations belonging to the pistachio species. Although pistachio growing is distributed among various regions, Southeastern Anatolia including Gaziantep, Kahraman Maras, Urfa, Diyarbakır, Mardin, Siirt, Batman, Sırnak and Adı yaman provinces, is one of the most important production regions of Turkey and the world. This region has a quite suitable climate for pistachios and includes 94% of Turkey's pictacio production (4). It is supposed to be the motherland of the pistachio cultivars known today (1, 3). The summers in this region are hot enough to ripen the fruits and the winters are cold enough to meet a good chilling requirement (1). On the other hand, the edible species *Pistachia vera L.* is commercially grown mostly under unirrigated conditions on stony, rock, calcereous and poor arid soils of this region with 300-500 mm annual rainfall (3, 5).

In Turkey, one of the major pistachio producing countries, traditional techniques

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