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Pollination Studies in Relation to Fruit Drop in Persimmon (*Diospyros kakiv* L.) cv. Hachiya

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A B S T R A C T

The present investigations entitled **"**Pollination studies in relation to fruit drop in persimmon (*Diospyros kaki* L.) cv. Hachiya was carried out at Horticulture Research and Training Station Kandaghat. Effect of different modes of pollination (no pollination, open pollination and hand pollination) using *Diospyros virginiana* and Kandaghat Pink (local selection) as a source of pollen on fruit development and fruit drop was evaluated. The growth pattern followed a sigmoid growth curve irrespective of different modes of pollination. Fruit drop was minimum when *Diospyros virginiana* was used as a source of pollen. However, maximum fruit drop was observed when the flowers were simply bagged. Fruit size, weight and number of seeds were different in fruits from different mode of pollination while other fruit character namely, total soluble solids (TSS), titratable acidity and sugars were not influenced by pollination.

Introduction

The Persimmon (*Diospyros kaki* L.) belongs to the family Ebenaceae. It is native to China, where it has been cultivated for centuries with a secondary centre of origin in Japan (Zeven and Zhukovsky, 1975). Persimmon also called as national fruit of Japan because of its popularity and extensive cultivation in that country. It is a deciduous tree adapted to warm temperate and subtropical climates. American persimmon (*Diospyros virginiana* L.) is native of the United States. This species produces fragrant flowers which are dioecious, fruit is small, rather seedy and very astringent until fully soft and ripe. It is not grown commercially to the same extent as Oriental persimmon and is occasionally used as rootstock for the Oriental persimmon. In India, persimmon was introduced in 1921 by Captain A.N. Lee in Kullu Valley and is grown on a semi commercial scale in Jammu and Kashmir, Himachal Pradesh and Uttrakhand and as scattered plantation in some parts of North East and Nilgiri Hills in South India. Persimmon is classified into different types like Pollination Constant Non Astringent (PCNA), Pollination Variant Non Astringent (PVNA), Pollination Variant Astringent (PVA) and Pollination Constant Astringent (PCA) types (Sugiura, 1984). Hachiya is the most commercial variety

grown in H.P. It has a tendency to set fruit parthenocarpically. However, it experiences heavy fruit drop after 25-30 days of fruit setting, which is a major limiting factor in its production. Fruit drop may be related to number of causes including lack of pollination, insufficient sunlight, excessive shoot growth or application of nitrogen fertilizer, etc. (Bargioni *et al.*, 1980).

However, in practice pollination is desirable to reduce natural fruit drop and improve fruit quality like size, even shape and uniform skin colouration, especially of non- astringent cultivars. Keeping in view the existence of excessive fruit drop in persimmon pollination studies were carried out with the objective to reduce the extent of fruit drop through pollination and recommend a suitable pollinizer for the cultivar Hachiya.

Materials and Methods

Experiment was conducted during 2013-2014 at an elevation of 1325 m amsl at 30-50° N latitude, 77.8° E longitude in the experimental orchard of Horticultural Research and Training Station, Kandaghat, of Dr YS Parmar University of Horticulture and Forestry, Solan Himachal Pradesh. Data on different parameters namely, fruit drop, fruit growth and various physical and biochemical parameters of the fruits were recorded. For the purpose of fruit drop studies, number of fruit retained on the branches was deducted from the number of fruits set initially and the values were recorded as per cent fruit drop at fortnightly intervals. To study the growth pattern of persimmon fruit size was measured at 15 days interval starting from two weeks after pollination until harvest. Chemical parameters were studied according to the standard procedure of Ranganna (1986). Analysis of variance of replicated field and biochemical analyses data were performed using Randomized Block Design (RBD).

Results and Discussion

Fruit drop

The data on the fruit drop showed that different modes of pollination exerted significant influence on the fruit drop percentage (Table 1). The highest fruit drop (46.36 %) was recorded in T_1 (no pollination). The lowest fruit drop percentage (18.22 %) was noted in T_3 (Hachiya cross with *Diospyros virginiana*). The data further indicated that time interval had significant effect on fruit drop percentage. The maximum fruit drop (3.80 %) after 15 days of fruit set was observed in T_1 (no pollination) followed by T_2 (open pollination) 1.40 per cent, whereas; minimum in T_3 (cross with *Diospyros virginiana*) 0.60 per cent. The treatment T_1 (no pollination) observed maximum fruit drop (16.60 %) while, T_3 (cross with *Diospyros virginiana*) observed minimum fruit drop (8.58 %) 30 days after fruit set. After 45 days of fruit set, minimum fruit drop was observed in T_3 (6.10 %) followed by T_4 (7.12 %), T_2 (13.76 %) and T_1 (15.33 %). No fruit drop was recorded in T_3 and T_4 while, 3.10 and 2.00 per cent fruit drop was recorded in treatment T_1 and T_2 respectively 60 days after fruit set. After 75 days of fruit set minimum fruit drop of 2.94 per cent was observed in treatment T_3 (cross with *Diospyros virginiana*) whereas, maximum in T_1 (no pollination). In T_1 1.40 per cent fruit drop was recorded whereas, in other treatments no fruit drop was observed 90 days after fruit set. All the treatments showed no fruit drop after 90 days of fruit set.

In the present study, significantly lesser fruit drop occurred in flowers which were hand pollinated with *Diospyros virginiana* or pollinated by Kandaghat pink. The present findings are in conformity with those of Piazza and Intoppa (1996) who observed that

cultivars of persimmon are known to have problems with low fruit set and fruit fall when produced parthenocarpically and concluded that it is necessary to plant pollinizers to increase fruit set and reduce fruit drop. Seeded persimmon fruit have several advantages over non pollinated fruit because they are generally larger, compete better for assimilates, and are less prone to abscise than non-pollinated fruit (Hasegawa and Nakajima, 1990; Kitagawa and Glucina, 1994; Yamada *et al.*, 1987).

From various pollination studies George *et al.*, (1995) concluded that fruit drop from hand pollinated fruits was significantly lower. Messaoudi *et al.*, (2009) also observed lesser fruit drop in case of pollinated tress as compare to non-pollinated trees. The maximum fruit drop was observed between 30 days to 45 days after fruit set (10th June to 25th June). The results are in line with Srivastava and Das (2005). They reported that maximum fruit drop was recorded between 2nd week of June to last week of July.

Fruit growth

To study the fruit growth pattern, fruit size (L x B) was recorded at 15 days interval starting from two weeks after pollination and the data is presented in Table-2. Initially there was a rapid increase in fruit size for the first 45 days after fruit set and thereafter a slow increase in growth was recorded up to 105 days after fruit set. Following this time period there was again a rapid increase in fruit growth till harvest of fruit i.e. 135 days after fruit set. A similar growth pattern was observed in fruits developed by different modes of pollination.

The persimmon fruit exhibits a double sigmoidal growth curve which is divided into three stages; two active stages of growth, stage I and stage III separated by a less active stage II (Kitagawa and Glucina, 1984; Nakano *et al.*, 1997). Temperatures of 30º C or greater have been found to extend stage II of fruit development delaying fruit maturation (Sugiura *et al.*, 1991; Mowat *et al.*, 1995). Nakano *et al.*, (1997) reported that the growth stage I was thought to be associated with cell division/differentiation and growth stage III with cell expansion/maturation.

Candir *et al.*, (2009) also observed similar trend in fruit growth. They reported that fruit growth follows a typical double sigmoid curve, consisting of two rapid growth stages, stage I and stage III, separated by a period of slow growth (stage II). Kim *et al.*, (1997) also indicated a double sigmoid growth curve, and reported that seasonal growth pattern of fruits were not affected by the pollen sources.

Fruit weight, size and number of seeds

Data pertaining to the effect of different modes of pollination on fruit size, weight and number of seeds is presented in Table-3.

It is evident from the data presented in Table 3 that the fruit weight was significantly increased by different treatments. The values of fruit weight varied from 208.78 to 265.22 g, and the maximum fruit weight (265.22 g) was recorded with T3 (cross with *Diospyros virginiana*) which was statistically at par with T4 (cross with Kandaghat Pink), whereas minimum fruit weight (208.78 g) was observed in T1 (No pollination). Similarly maximum fruit size was observed under the same treatment i.e. T3 (83.23 x 75.27 mm) and minimum was in T1. Number of seeds follow the same trend i.e. maximum (3.4) in T3 whereas, no seed was observed in T1.

The findings are in accordance with those of George *et al.*, (1993). They concluded that

fruit weight of open pollinated or non-pollinated fruits was 5-20 per cent lower than that of hand pollinated fruits.

Fruit length and diameter was higher in fruits which were hand pollinated and open pollinated, minimum with no pollination (Woodburn and Andersen, 1996). Further according to Matos (1997) fruit weight was maximum with the highest number of seeds in pollinated fruits than in parthenocarpic fruit without seeds. Messaoudi *et al.*, (2009) observed that highest fruit diameter and weight in pollinated trees while, lowest in non-pollinated trees.

Physico-chemical characters

The results pertaining to the physico-chemical characters of Hachiya cultivar as influenced by different modes of pollination is presented in Table-4. Different modes of pollination exerted significant influence on the total soluble solid content of the fruit. The values of fruit TSS content varied from 13.15 to 15.12º Brix, being maximum (15.12 º Brix) in fruits obtained as a result of artificial pollination with *Diospyros virginiana* and minimum (13.15 º Brix) was recorded in open pollination. Acidity in fruit is an important factor in determining maturity. In the present study it is apparent from the data that different mode of pollination had significant influence on titratable acidity of the fruits. Titratable acidity in different treatment ranged from 0.33 to 0.46 per cent. Significantly, higher titratable acidity was recorded in fruit developed as a result of open pollination and lowest in fruit that developed parthenocarpically. Sugar content varied significantly in different treatment. Reducing sugar was maximum (4.76 %) in the fruits produced by crossing with *Diospyros virginiana* and the minimum (3.30 %) was recorded in cross with Kandaghat Pink.

Table.1 Per cent fruit drop under various modes of pollination in cv. Hachiya

Treatment \ Days		15 days	30 days	45 days	60 days	75 days	90 days	Total
T1	No Pollination	3.80 (2.17)*	16.60 (4.19)	15.30 (4.04)	3.10 (2.00)	6.13 (2.47)	1.40 (1.83)	46.36
T2	Open pollination	1.40 (1.51)	12.3 (3.64)	13.76 (3.83)	2.00 (1.72)	4.99 (2.23)	0.00 (0.00)	34.45
T3	Cross with *Diospyros virginiana*	0.60 (1.23)	8.58 (3.06)	6.10 (2.64)	0.00 (0.00)	2.94 (1.71)	0.00 (0.00)	18.22
T4	Cross with Kandaghat Pink	1.10 (1.43)	10.88 (3.44)	7.12 (2.84)	0.00 (0.00)	3.41 (1.84)	0.00 (0.00)	22.24
Total		6.90	48.36	42.31	5.10	17.47	1.40	
C.D. (0.05)		0.52	0.45	0.34	0.24	0.22	0.12	

*Figures in parenthesis are square root transformed values

Table.2 Growth pattern of persimmon fruit

Days from fruit set to harvest	Fruit length (mm)	Fruit diameter (mm)
Fruit set	16.17	14.39
15 days	29.68	25.21
30 days	43.81	40.06
45 days	51.11	48.75
60 days	53.16	50.04
75 days	57.44	52.33
90 days	60.59	55.49
105 days	68.35	60.26
120 days	77.23	69.87
135 days	82.13	73.3

Table.3 Effect of different modes of pollination on fruit size, weight, and number of seeds

Mode of Pollination		Fruit size (mm)		Weight(g)	Number of seeds
		Length	Width		
T_1	No pollination	79.70	66.99	208.78	0
T_2	Open Pollination	78.40	68.48	239.64	1.60
T_3	Cross with *Diospyros virginiana*	83.23	75.27	265.22	3.40
T_4	Cross with Kandaghat Pink	82.13	73.70	262.50	2.20
C.D. $_{(0.05)}$		3.71	2.33	5.54	1.38

Table.4 Effect of different modes of pollination on TSS, titratable acidity and sugars of persimmon cv. Hachiya

Treatments		TSS (^{o}Brix)	Titratable acidity (%)	Reducing sugars (%)	Non-Reducing sugars (%)	Total sugars (%)
T_1	No pollination	14.4	0.33	3.60	2.85	6.60
T_2	Open pollination	13.15	0.46	3.54	4.06	7.81
T_3	Cross with *Diospyros virginiana*	15.12	0.45	4.76	3.16	8.09
T_4	Cross with Kandaghat Pink	14.54	0.38	3.30	2.72	6.15
C.D. $_{(0.05)}$		1.36	0.11	0.17	0.55	0.52

Fig.1 Fruit drop under different treatment

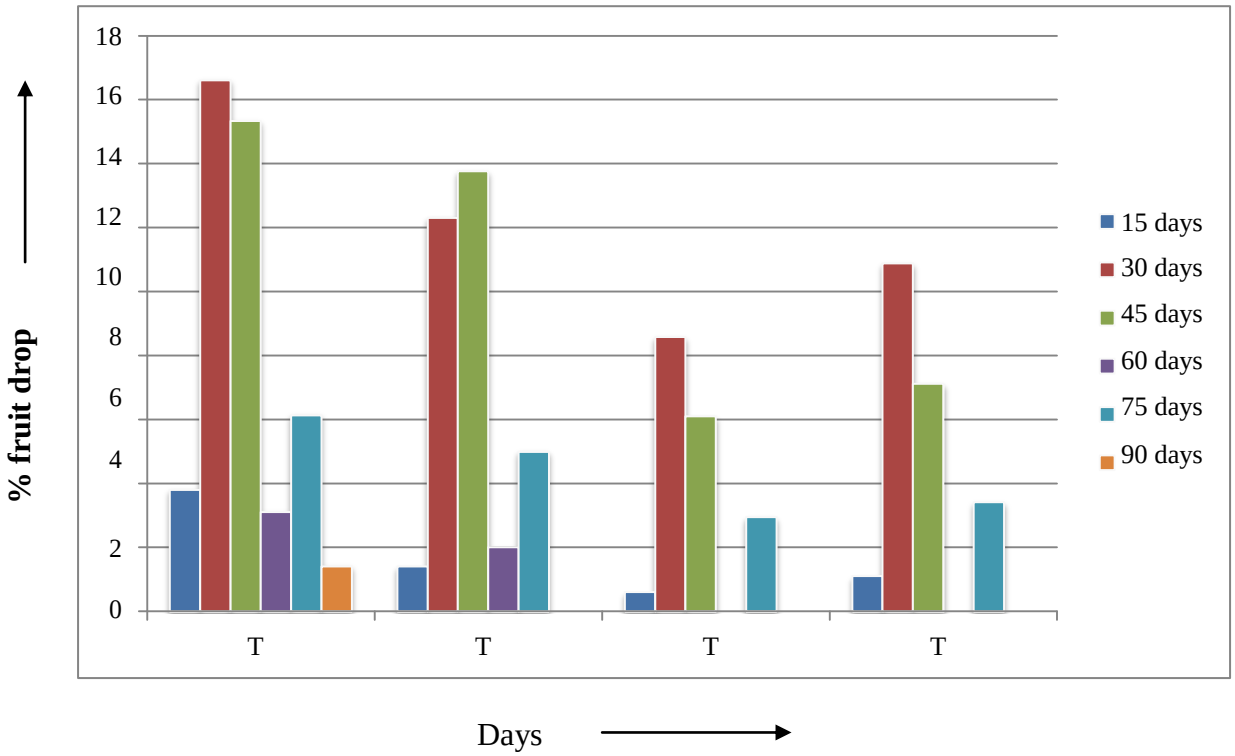
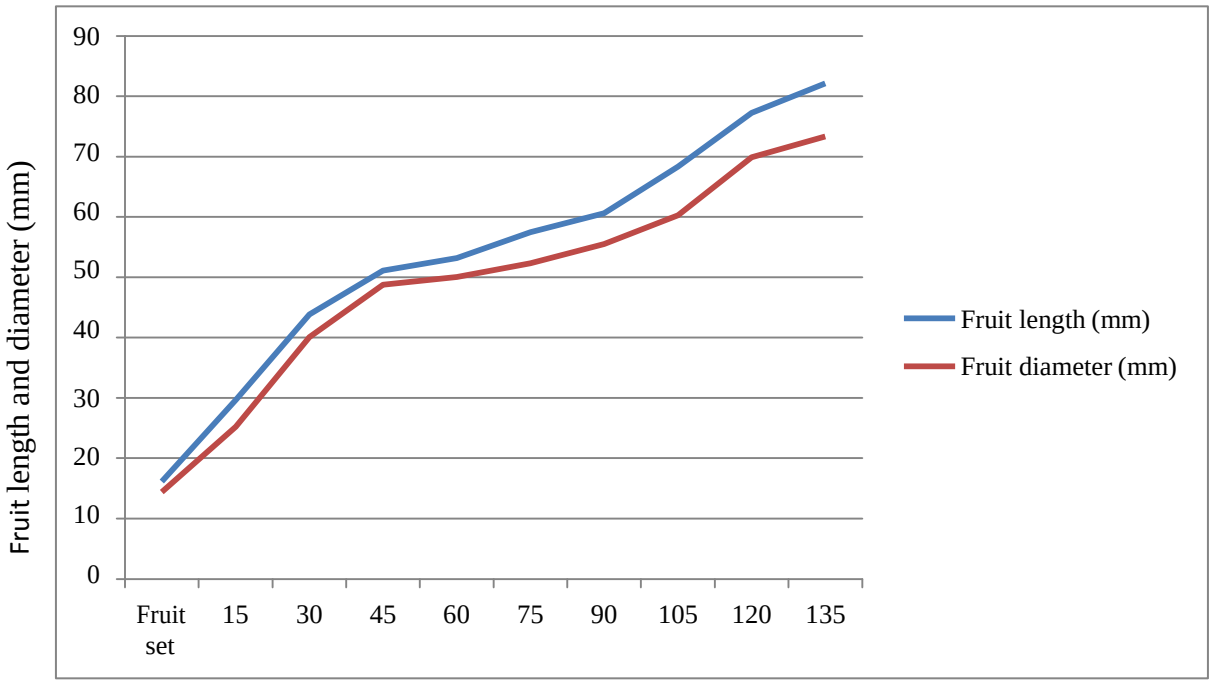


Fig.2 Growth pattern of persimmon fruit



Non reducing sugar was highest in (4.06 %) under open pollination and lowest (2.72 %) in case of cross with Kandaghat Pink. Total sugar ranged from 8.09-6.15 per cent in different treatments being highest in fruit developed by cross with *Diospyros virginiana* and lowest in cross with Kandaghat pink. Present study revealed that fruits obtained through different modes of pollination have no significant change in their quality with respect to TSS, acidity and sugar content.

The results of the present findings are in line with the finding of Hasegawa *et al.,* (2003). They reported that pollination treatments had no significant effect on TSS value compared to non-pollination treatment. Similar observations have been made by Krisanapook *et al.,* (2004) and Sillapapetch *et al.,* (2005). They reported that fruit TSS was not influenced by different modes of pollination only number of seed per fruit was affected by pollination treatment. Messaoudi *et al.,* (2009) reported that pollination treatment did not affect titratable acidity or total soluble solid content of fruit and influenced only fruit size and weight when pollinated.

It is concluded from the present work that fruit drop was maximum where no pollination was done. Artificial hand pollination with the pollen of *Diospyros virginiana* resulted in reduced fruit drop and no fruit drop occured after 90 days of fruit set. Fruit size and weight increased with the increase in seed number and maximum fruit size was observed when artificial pollination was done with the pollen of *Diospyros virginiana* and Kandaghat Pink. Therefore both the genotype can be effectively used as pollinizer for the cultivar Hachiya.

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