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**Ejaz Ahmad Parray**  
Division of Fruit Science,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

**Munib Ur Rehman**  
Division of Fruit Science,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

**GH Rather**  
Division of Fruit Science,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

**SA Bhat**  
Division of Basic Sciences and  
Humanities, Faculty of  
Horticulture, SKUAST, Jammu  
and Kashmir, India

**SA Mir**  
Division of Agri. Statistics,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

**SH Khan**  
Division of Vegetable Science,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

**MA Hajam**  
Division of Fruit Science,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

#### Correspondence

**Ejaz Ahmad Parray**  
Division of Fruit Science,  
Faculty of Horticulture,  
SKUAST, Jammu and Kashmir,  
India

## Understanding the relationship between spatial pattern of fruits and fruit retention in apple (*Malus × domestica* Borkh.) cv. Red Delicious

**Ejaz Ahmad Parray, Munib Ur Rehman, GH Rather, SA Bhat, SA Mir, SH Khan and MA Hajam**

#### Abstract

An investigation was carried out at Commercial orchard, Shalimar (Jammu & Kashmir) during 2016-17 to find out the effect of Spatial Pattern of Flowers on Fruit Retention in Apple (*Malus × domestica* Borkh.) cv. Red Delicious. The fruits were numbered with indelible marker in June, defining the position (king or lateral blossom fruit); number of fruits in the cluster; and fruit from a 2, 3, 4 or 5 year old wood. The floor under the tree was cleaned and fruits were allowed to drop, fruits that dropped before 20<sup>th</sup> September were included under pre-harvest drop (this date was chosen after properly checking the maturity indices). The investigation revealed that fruit retention is significantly influenced by the spatial position of the fruits. Maximum fruit retention (70%) was found in king fruits. Among the different number of fruits in cluster, maximum retention of 100% (all selected fruits retained) was found in fruit clusters containing only 1 fruit and minimum in clusters containing 5 fruits. Among the different ages of wood, maximum fruit retention (80%) was obtained from 5<sup>th</sup> year old wood and minimum in case of youngest wood taken i.e., 2<sup>nd</sup> year old wood.

**Keywords:** Understanding, relationship, between spatial pattern, fruits, fruit retention, apple (*Malus × domestica* Borkh.) cv. red delicious

#### Introduction

Apple (*Malus × domestica* Borkh.) is the most popular and widely grown fruit crop throughout the world. India ranks 4<sup>th</sup> in apple production with the annual production of 24, 97,680 MT on an area of 313,040 ha (Anonymous, 2015) <sup>[1]</sup>. Himachal Pradesh, Jammu and Kashmir and Uttarakhand are the main contributors of apple production in India, while as, Jammu and Kashmir dominates with a production of 19,66,417 MT over an area of 161,773 ha (Anonymous, 2016) <sup>[2]</sup>. However, Apple productivity in the state is very low i.e. 12.16 MT/ha which is far below the level achieved by the horticultural advanced countries like Chile (47.22 MT/ha), Netherland (44.94 MT/ha) and Belgium (46.22 MT/ha) and also the proportion of 'A' grade apple is low.

The cultivation costs of this so-called aristocrat apple fruit, is going up day by day with an increased market competition, making it no longer a profitable enterprise. Several factors contribute to these increased cultivation costs, of which fruit drop before it is harvested is one of the greatest problem growers face. Drop on many cultivars can exceed 20%, but the drop-prone cultivars like McIntosh and Red Delicious, it is not uncommon to have losses exceeding 50% (Greene, 1996) <sup>[8]</sup>.

Pre-harvest apple drop, which occurs before fruit develop optimum red colour, maturity, or size, usually causes a serious economic loss. Conversely, picking fruit before adequate maturity may lead to poor storability, poor quality and lower yields.

Keeping in view the above considerations, the current study was undertaken to understand the effect of spatial pattern of fruits on the fruit retention and the goal of this investigation was to develop recommendations to reduce losses due to pre-harvest drop through other practices that can be implemented in existing orchards and provide a coherent basis for the modification of current cultural practices.

#### Material and Methods

An investigation was carried out at Commercial orchard, Shalimar (Jammu & Kashmir) during 2016-17 to find out the effect of Spatial Pattern of Flowers on Fruit Retention in Apple (*Malus × domestica* Borkh.) cv. Red Delicious.

The fruits were numbered with indelible marker in June, defining the position (king or lateral blossom fruit); number of fruits in the cluster; and fruit from a 2, 3, 4 or 5 year old wood. The floor under the tree was cleaned and fruits were allowed to drop, fruits that dropped before 20<sup>th</sup> September

were included under pre-harvest drop (this date was chosen after properly checking the maturity indices). The observations on fruit retention for different fruit positions were calculated by using the following simple percentage formula:

$$\text{Fruit retention (\%)} = \frac{\text{No. of fruits that retained upto maturity}}{\text{No. of fruits of particular position tagged in June}} \times 100$$

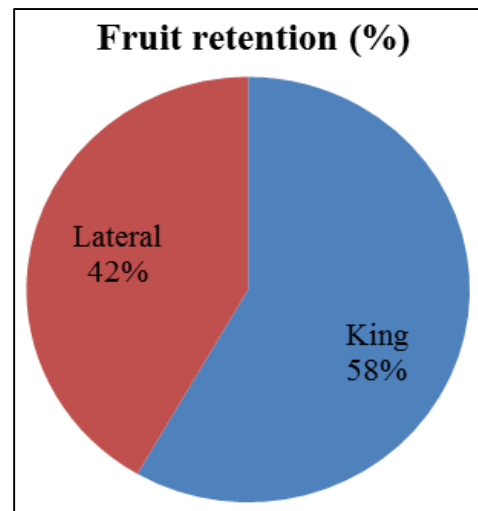
**Results and Discussion**

Present investigation revealed that maximum fruit retention of 70% was obtained from king flowers (P<sub>1</sub>) (Table 1, Figure 1). This could be explained by the fact that for a number of horticultural crops the first pollinated flowers (king flowers in case of apple) are more likely to be retained than later pollinated flowers (Stephenson, 1981) [15] due to higher sink strength of king flowers than the laterals. The apical or king (K) flower in the apple (*Malus x domestica* L. Borkh.) cluster usually develops and blooms first, followed by the lateral (L) flowers, which bloom in sequence (Dennis, 1986) [6]. The K flower has a greater number of cells and better vascular development (Westwood *et al.*, 1967) [16], as well as a greater sink potential, so resources are primarily used by the K fruit, which reduces the set and size of the nearest L fruit (Black *et al.*, 2000; Ferree *et al.*, 2000; Goffinet *et al.*, 1996; Koike and Ono, 1998) [4, 7, 12]. On the other hand other workers have suggested that "dominant" fruit sinks may directly influence other fruit sinks via direct plant hormone inhibition, rather than competition for nutrients per se (Bangerth, 1989) [3]. For instance in apple, lateral fruit have a greater tendency to abscise than king fruit on the same cluster. Lateral fruit set is greater when the king fruit is removed at bloom. Gruber and Bangerth (1990) [9] suggested that a greater production and transport of indole ascetic acid (IAA) from dominant sinks may suppress subsequent IAA transport from weaker sinks. The dominance of the king fruitlet over the lateral fruitlets could be based on greater number of cells and better vascular development as well as greater sink potential of the former (Miranda *et al.*, 2005) [14]. Fruits from king position might dominate fruit from lateral positions by such a mechanism.

Among different number of fruits in cluster (selected in June) maximum fruit retention of 100% (all retained) was obtained in case of 1 fruit in a cluster (A) (Table 2, Figure 2). These results imply greater competition for resources between developing fruit as the number of fruits within cluster increases, right from the first stages of development, as commonly known and widely reported in previous research (Dennis, 1986; Knight, 1980; Miranda and Royo, 2004; Stover, 2000) [6, 11, 13]. Similar results were obtained by Miranda *et al.*, 2005 [14] who worked on the intensity of flower removal (FRI) in Golden Delicious' and 'Royal Gala'. Among different ages of bearing wood selected, maximum fruit retention of 80% was obtained from 5<sup>th</sup> year old wood (Table 3, Figure 3). Fruit from five-year old wood may be able to compete more successfully for nutrients than fruits from the other wood types because of their developmental advantage resulting in greater fruit retention. Denne (1963) [5] found that early flowering clusters retain better than late flowering clusters, although early clusters also had a greater flower bud quality and leaf area at bloom. For crops, such as tomato, where fruit abscission does not usually take place, early flowering fruit compete more successfully for assimilate than late flowering fruit (Ho, 1988) [10].

**Table 1:** Influence of fruit position (King and lateral) on the fruit retention (%) of fruits in apple cv. Red Delicious

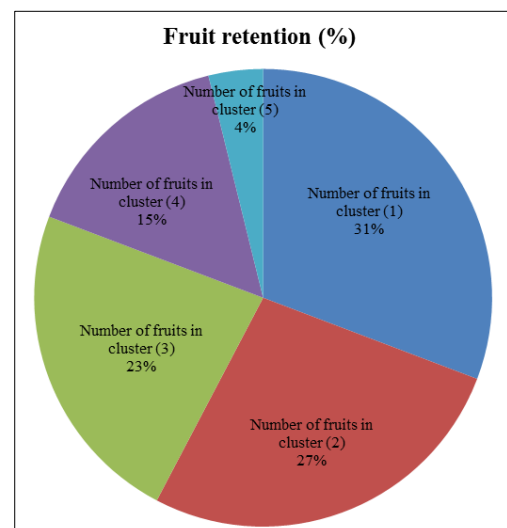
Position	Fruit retention (%)
King	70
Lateral	50



**Fig 1:** Contribution of fruit positions (King and lateral) to the total fruit retention

**Table 2:** Influence of fruit position (Different number of fruits in the cluster) on the fruit retention (%) of fruits in apple cv. Red Delicious

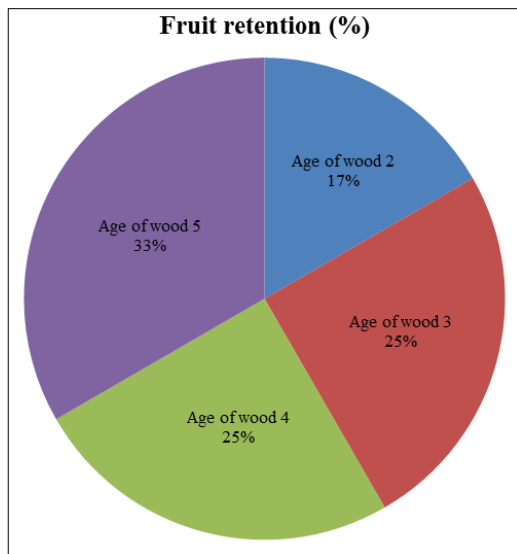
Position	Fruit retention (%)
Number of fruits in cluster (1)	100
Number of fruits in cluster (2)	87.5
Number of fruits in cluster (3)	75
Number of fruits in cluster (4)	50
Number of fruits in cluster (5)	12.5



**Fig 2:** Contribution of fruit positions (Different number of fruits in the cluster) to the total fruit retention

**Table 3:** Influence of fruit position (Different age of bearing wood) on the fruit retention (%) of fruits in apple cv. Red Delicious

Position	Fruit retention (%)
Age of wood (2 year)	40
Age of wood (3 year)	60
Age of wood (4 year)	60
Age of wood (5 year)	80

**Fig 3:** Contribution of fruit positions (Different age of bearing wood) to the total fruit retention

### Conclusion

Spatial pattern of fruits have a pronounced effect on the retention of fruits. From the current investigation it is clear that fruits on a 5 year old wood with one fruit in the cluster, that also a king fruit can be retained well with minimal chances of drop. Therefore, care is to be taken at the time of thinning and pruning to ensure that such principles are followed properly.

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