DOI : 10.5958/2349-4433.2024.00109.X

J Krishi Vigyan 2024, 12(3) : 624-630

Prevention of Preharvest Fruit Drop in Apple- A Menace in Temperate Fruit Industry

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ABSTRACT

This study was conducted during the years 2021-22 and 2022-23 on 13 years of Red Delicious, Royal Delicious, and Vance Delicious old apple plants grafted on wild (seedling) rootstock. Plants were treated according to the SKUAST-Kashmir recommended package of practice. Results revealed that maximum preharvest drop in all apple cultivars happened under control. 2,4,5T @ 30 ppm was more effective than NAA @ 10 ppm in reducing preharvest drop percentage irrespective of cultivar. The highest average yield/tree in Red Delicious (157.91kg), Royal Delicious (130.57 kg), and Vance Delicious (161.62kg) was observed in 2,4,5T @ 30ppm treated plants. Preharvest drop in terms of weight was maximum (22.39kg/tree) in Red Delicious, 21.56kg/tree in Royal Delicious, and 18.42 kg/tree in Vance Delicious under control. The highest gross income per ha (Rs 18,32,725) was observed in Vance Delicious treated with 2,4,5T @ 30 ppm followed by Rs 18,01,912/ha under the same treatment in the case of Royal Delicious. Production cost/ha and marketing cost/ha were higher in the case of treated orchards than in control irrespective of apple cultivars. The highest net returns/ha (Rs. 12,20,528) and BC ratio (2.32) were obtained in Royal Delicious sprayed with NAA @ 10 ppm.

Key Words: Apple, Rootstock, Preharvest drop, Cultivar, Gross Income.

INTRODUCTION

Apple (*Malus* x *domestica* Borkh.) is the most popular temperate fruit and ranks third as per global fruit production (FAOSTAT, 2023). Production depends on the high-value fresh market which needs harvesting at optimum time to maintain optimum fruit quality during better storage and shipping (Greene *et al*, 2014). Jammu and Kashmir (UT), Himachal Pradesh, and Uttarakhand are the main apple-producing regions in India and provide the major source of income (Rehman *et al*, 2023). In J&K (UT), Kashmir Valley produces major junk of apples and adds almost 7000 crores to the valley's gross domestic product (Wani *et al*, 2021) and is also an employment generator for over 3.5 million people (Mir and Sampath, 2022). Apple fruit drop that happens during the later stages of fruit development is a challenge to growers across the globe. Dal Cin *et al* (2009) defined June drop as fruitlet drop occurring 5-6 weeks after full bloom and reported it as a major concern in the northern part of the globe, whereas preharvest fruit drop begins approximately 4 weeks before harvest (Arseneault and Cline, 2016) and was the main concern of the current study.

Many apple cultivars grown in Kasmir are susceptible to pre-harvest drop as reported by Raja *et al*, 2017. Ethylene production by ripening fruits stimulates the production of enzymes that cause cell wall disintegration, resulting in the formation of an abscission layer (Yuan and Carbaugh, 2007). After abscission zone formation, the fruit is connected to the tree only by the vascular elements, which easily break causing fruit to drop (Marinho *et al*, 2005). Arseneault and Cline, 2016 reported that preharvest fruit drop before horticultural maturity can occur in several important apple cultivars. The severity of drop is cultivar-specific and henceforth Irish-Brown *et al*, 2011 categorized various apple cultivars as more prone, intermediate, and less prone. Yue *et al*, 2013 reported that the selection of apple cultivars by orchardists is determined by consumer preference

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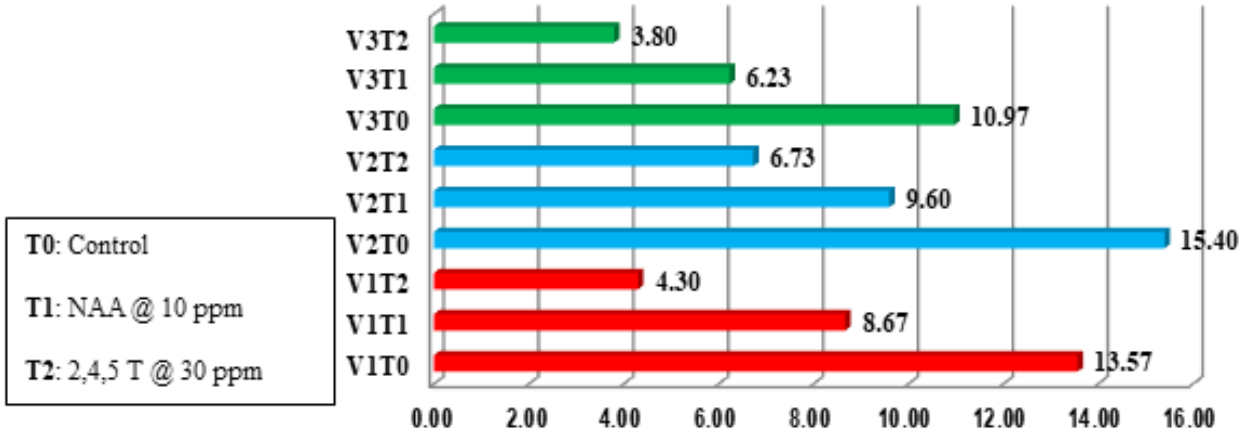


Fig 1: Preharvest drop (%) as influenced by various treatments across studied apple cultivars

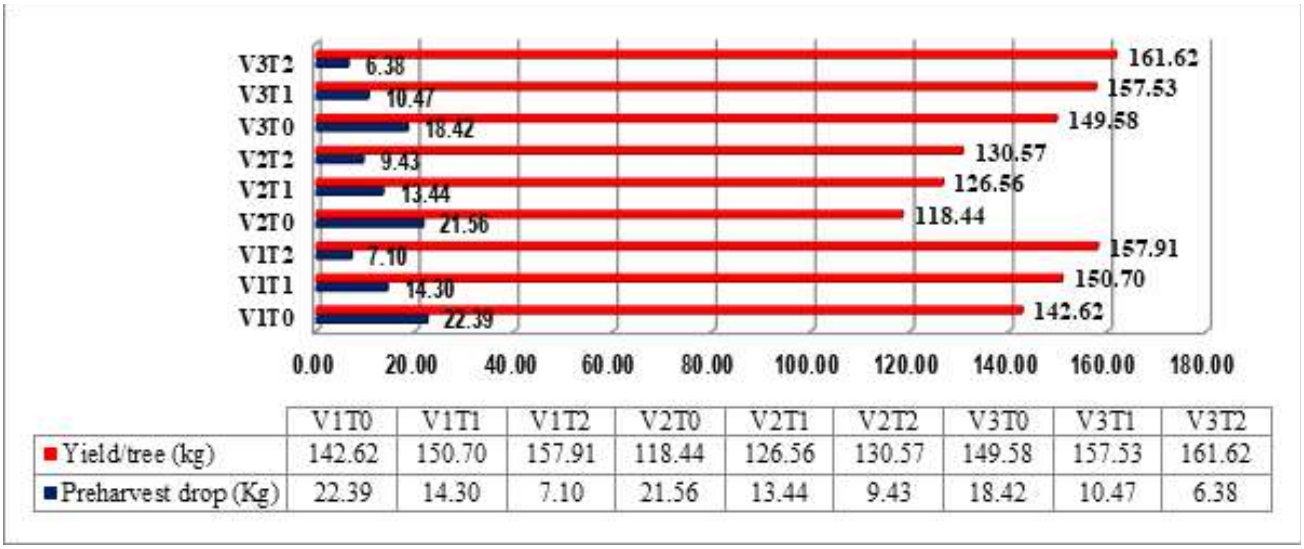
for specific fruit characteristics rather than for ease of production as a result challenges like preharvest fruit drop are inevitable. Plant growth regulators influence the metabolic system in plants and regulate ripening and preharvest drop as reported by Raja *et al*, 2017. Plant bioregulators, such as amino ethoxyvinyl glycine, NAA, and 2,4,5 T, which hamper or reduce ethylene biosynthesis within the plant system, are effective in reducing preharvest fruit drop in apples and other temperate fruits (Yuan and Li, 2008). Such types of plant growth regulators can widen the picking window thereby resulting in fetching better prices by avoiding market glut thereby regulating the market (Unrath *et al*, 2009).

MATERIAL AND METHODS

The experiment was conducted during 2021-22 and 2022-23 on thirteen years Red Delicious (V1), Royal Delicious (V2), and Vance Delicious (V3) old apple plants grafted on wild (seedling) rootstock of uniform size and vigor. A standard package of practices as per SKUAST-K was given to experimental trees. Jammu and Kashmir (UT) are situated in the extreme North of the Indian subcontinent at 32°.17 to 37 °.05 N latitude and from 72°.40 to 80 °.30 E longitude. The maximum and minimum temperatures of the valley range between 23^{0}C and 29.9 ^{0}C and -5.8 ^{0}C to 12 ^{0}C, respectively, with 43.90 percent relative humidity and annual precipitation of 650-800 mm mostly received during winter months (December to April). The experiment was set up in a randomized block design, with three replications and five trees per replicate of each cultivar. Treatments were performed 2-3 weeks before the predicted harvest dates of the various apple cultivars. Treatments were labelled as T0: untreated control; T1: NAA @ 10 ppm and T2: 2,4,5T @ 30 ppm. Fruit drop was evaluated 4 times, at 5-day interval to determine the average fruit in each treatment expressed in kilograms/tree. Total fruit drop which includes May, June, and Preharvest drop was expressed as a percentage of total fruit yield as per Yildiz *et al* (2012). Total costs comprising both production (variable) and marketing costs along with gross returns were calculated by formulating specific questionnaires. This information was interpolated to gross return/tree, gross return per ha, and depicted in the form of a graph. The average market price of produce during the study years was used for calculating the gross return, net return, and BC ratio of each treatment and later on expressed in the form of a graph for easy interpretation.

RESULTS AND DISCUSSION

From Figure 1, it can be interpreted that maximum preharvest drop in all apple cultivars when no treatment was done i.e. T0. The drop percentage decreased significantly irrespective of apple cultivars in T1 and T2. 2,4,5T @ 30 ppm was more effective in reducing preharvest drop percentage irrespective of cultivar. Just 3.80% preharvest drop was observed in Vance Delicious when 2,4,5T @ 30 ppm was sprayed as compared to 10.97% in the case of control. Similarly in Red



	V1T0	V1T1	V1T2	V2T0	V2T1	V2T2	V3T0	V3T1	V3T2
Yield/tree (kg)	142.62	150.70	157.91	118.44	126.56	130.57	149.58	157.53	161.62
Preharvest drop (Kg)	22.39	14.30	7.10	21.56	13.44	9.43	18.42	10.47	6.38

Fig 2: Average preharvest drop (Kg/tree) and yield/tree (kg) as influenced by various treatments

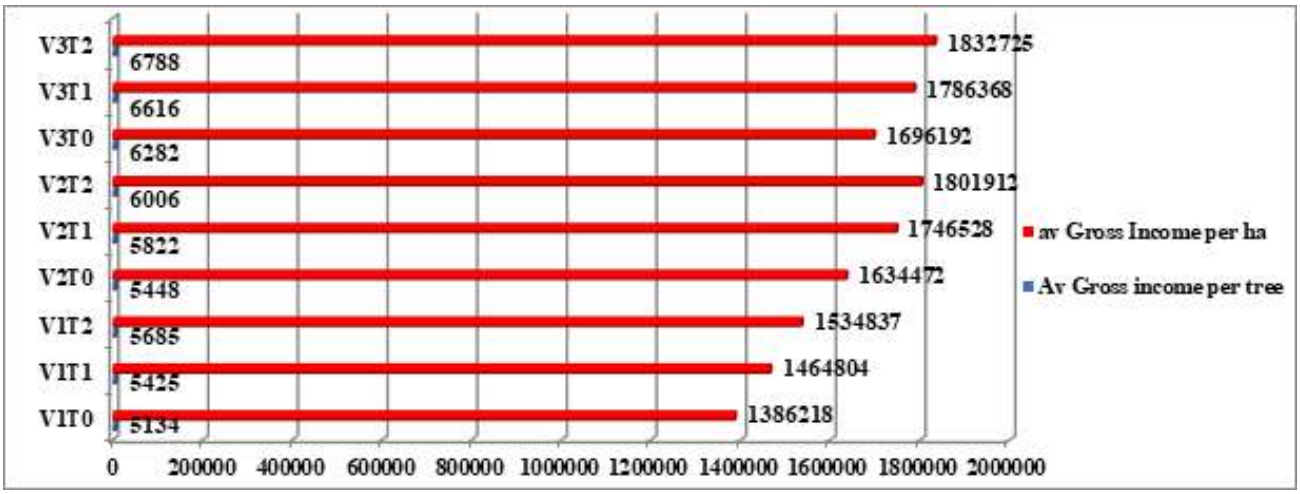


Fig 3: Gross return/tree (Rs) and gross return/ha (Rs) as influenced by various treatments

Delicious and Royal Delicious, results were promising in treated plants in terms of preharvest drop percentage prevention but 2,4,5T performed better (Fig. 1). Exogenous application of auxins a few weeks before the expected harvest date has been reported to reduce the preharvest drop in a number of temperate fruits including apple (Basak and Buczek, 2010; Sazo and Robinson, 2013 and Chishti *et al*, 2022).

Figure 2 shows that better results in terms of average yield per tree (kg) were observed in treated plants as compared to control. The highest average yield/tree in Red Delicious (157.91 kg), Royal Delicious (130.57 kg), and Vance Delicious (161.62 kg) was observed in 2,4,5T @ 30 ppm treated plants. NAA @ 10 ppm also resulted in better yield/tree as compared to control but results were significantly higher in 2,4,5T treated plants irrespective of cultivars. Preharvest drop in terms of weight was maximum (22.39 kg/tree) in Red Delicious, 21.56 kg/tree in Royal Delicious, and 18.42 kg/tree in Vance Delicious under control treatment when no spray was done. The least preharvest drop irrespective of cultivar was observed in plants sprayed with 2,4,5T @ 30 ppm (Fig. 2). Higher yields/tree obtained in the case of 2,4,5T and NAA sprayed plants are obviously because of the reduction of preharvest fruit drop as compared to control (T0) as reported earlier (Rehman *et al*, 2018; Moneruzzaman *et al*, 2011; Iqbal *et al*, 2009; Ghosh *et al*, 2012; Raja *et al*, 2017 and Arseneault and Cline, 2017).

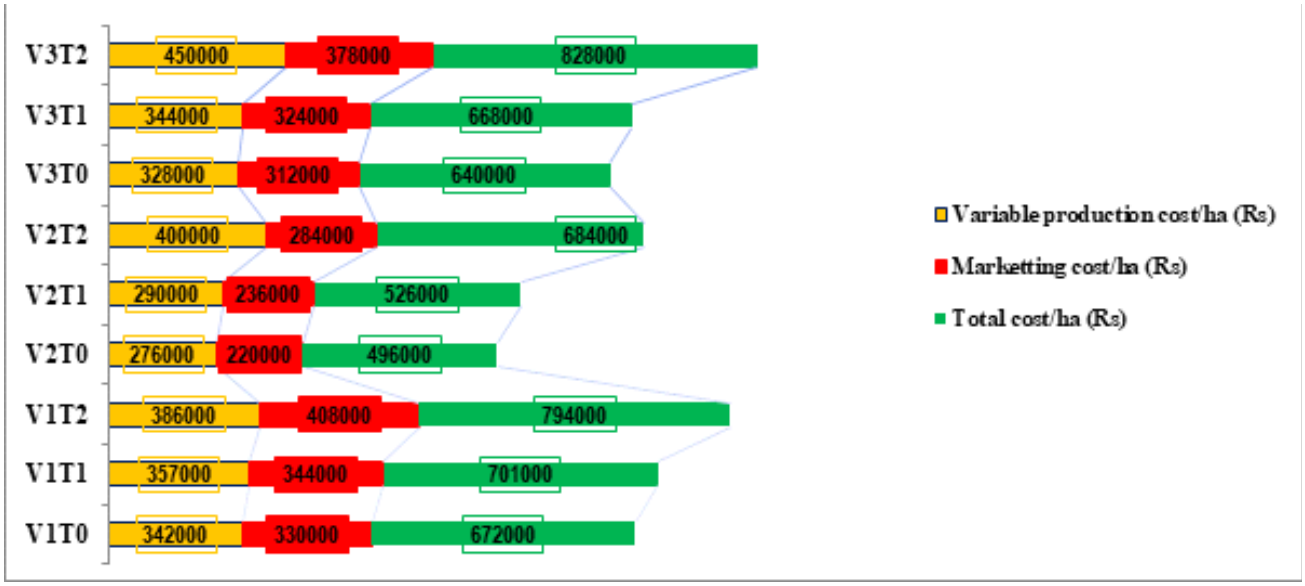


Fig 4: Production cost (Rs/ha) as influenced by various treatments during the study

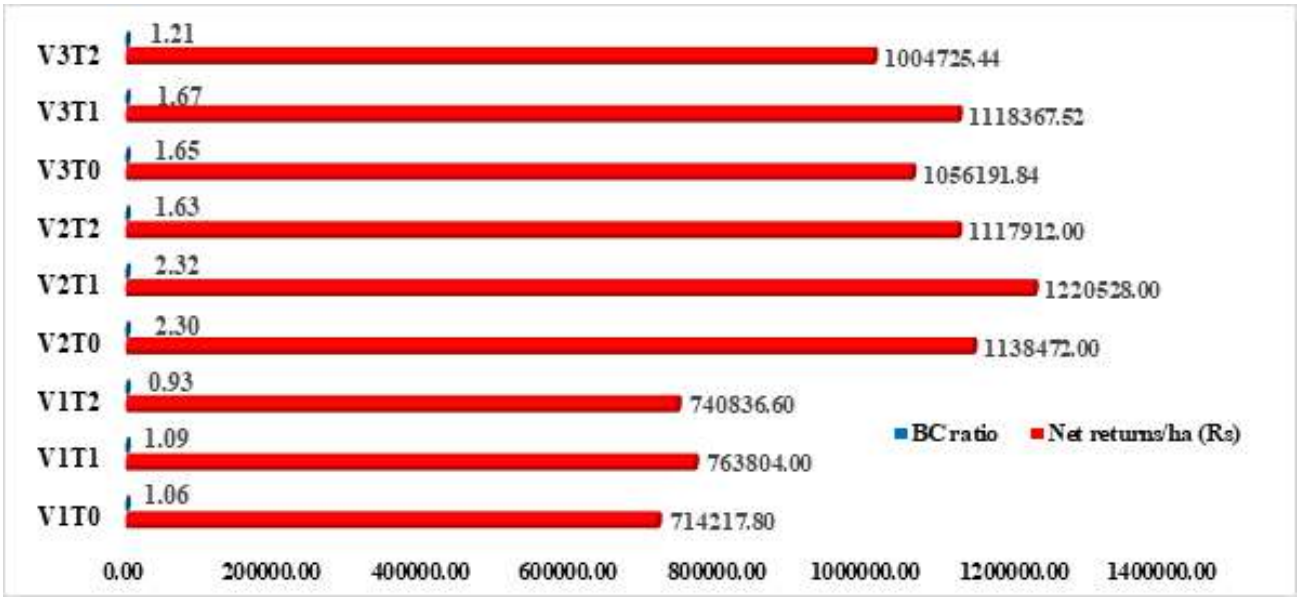


Fig 5: Graphical representation of net return/ha (Rs) and BC ratio of various treatment combinations

collecting specific information. Afterward, gross income per tree was interpolated to gross income per ha (Rs) and represented in the form of Figure 3. As evident from Figure 3, the highest gross income (Rs 18,32,725/ha) was observed in Vance Delicious treated with 2,4,5T @ 30 ppm followed by Rs 18,01,912/ha under the same treatment in the case of Royal Delicious. A spray of both NAA @ 10ppm and 2,4,5T @ 30ppm improved both gross income per tree and per ha basis as compared to control but gross returns obtained in 2,4,5T @ 30 ppm treated were comparatively better. Higher yields obtained in the case of treated plants contributed to more gross returns/tree in the current study. The above results were in conformity with the findings of Byers *et al*, 2005; Yuan and Carbaugh, 2007; Dal Cin *et al*, 2008 and Aglar *et al*, 2016.

From Figure 4, it can be seen that total costs/ha varied among various treatments across studied apple cultivars and was found maximum (Rs. 828000/ha) in 2,4,5T treated orchards of Vance Delicious followed by Rs. 794000 in the case of 2,4,5T@ 30 ppm treated orchards of Red Delicious. Minimum total cost/ha was observed in control orchards of Royal Delicious (Rs. 496000).

Figure 4 also depicts that production cost/ha and marketing cost/ha were higher in the case of treated orchards as compared to control irrespective of apple cultivars. Higher costs/ha obtained in NAA and 2,4,5T treated plants as compared to control are because of higher marketing costs because of higher yields. The production cost of 2,4,5T treated plants was higher as compared to NAA treatment due to the high market price of 2,4,5T.

Net returns/ha and BC ratio of various treatments of various apple cultivars are represented in the form of Figure 5. From Figure 5, it can be deduced that the highest Net returns/ha (Rs. 12,20,528) and BC ratio (2.32) were obtained in Royal Delicious sprayed with NAA @ 10ppm. 2,4,5T sprayed orchards resulted in minimum net returns/ha and least BC ratio during the study across the studied apple cultivars when compared with NAA @ 10ppm as depicted in figure 5. A better BC ratio and more net returns/ha obtained in T1 as compared to T2 may be attributed to higher total costs/tree in T2. While as, a better BC ratio of T0 as compared to T2 is mainly due to less marketing cost although yields are comparatively less in T0 as compared to other treatments and these results are in concordance with the results reported by Naqash *et al*, 2019; Rather *et al*, 2013; Hassan *et al*, 2020 and Shaheen *et al*, 2019.

CONCLUSION

Preharvest fruit drops result in direct economic loss as it happens just a few weeks before harvest and henceforth was the focus point of the current study. From the results of this study, it can be concluded spraying of growth regulators like NAA and 2,4, 5 T decreased drop percentage at varying degrees irrespective of cultivar thereby resulting in higher yields per tree as compared to control. Spraying of both growth regulators improved gross returns/ha as compared to control, however, NAA results in higher net returns and BC ratio as compared to control and 2,4,5 T application. The availability of such molecules in various markets across the valley has remained an issue and the decrease in the post-harvest life of harvested apples is the main concern that needs further study in this regard.

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Received on 5/6/2024 Accepted on 7/8/2024