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## Studies of three apple pollinizer cultivars on m9 clonal rootstock under high-density plantation in cold dry temperate region of Kinnaur, Himachal Pradesh

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**Abstract**

A field experiment was carried out at the Vegetable Research Station, Kalpa, to study the performance of three pollinizer cultivars grafted on M9 clonal rootstock under high-density plantations in the cold temperate region of Kinnaur, Himachal Pradesh, situated at an altitude of 27,000 meters. The high-density plantation of apples in Kinnaur district is still in the inception stage and it is important to aware the farmers of the area about pollinizer cultivars improve the production of temperate fruits. Sufficient and judicious incorporation of pollinizer cultivars is indeed an important aspect in the enhancement of productivity, keeping in mind that this trial was carried out to benefit the farming community in the coming years. The experiment evaluates three apple cultivars 'Gale Gala/M9', 'Redlum Gala/M9', and 'Auvil Early Fuji/M9', planted in the year 2016 as a feathered plant at a spacing of 2.5X1.0 meters in Randomized Block Design (RBD). Most of the growth and fruiting characteristics were found to be non-significant and significant results were obtained only in the Number of fruits, Fruit Size, Length and fruit weight. However, Maximum, shoot extension growth (13.86 cm), plant height (219.50 cm), Total Number of flowers Number (1211 / tree), Number of fruit set /tree (64.25), Number of fruits/tree (30.17), Yield (3.79 kg/tree) and Productivity (15.14 MT/Ha) were recorded with Redlum Gala on M9, whereas, trunk diameter (30.50 mm), plant spread N-S (120.83 cm), fruit diameter (81.21 mm), percent fruit set (23.06 ) and Fruit Size (Length, 73.77 mm; Breadth 77.68 mm) were observed in Gale Gala on M9. Further, higher Plant Spread E-W (125.00 cm) and fruit weight (218.23 g/fruit) were observed in Auvil Early Fuji. Studies have shown that all three pollinizer cultivars performed similarly with a non-significant difference, yet Redlum Gala/M9 performed better amongst the cultivars studied and it may be recommended to grow under high-density plantations in cold temperate conditions of Kinnaur, Himachal Pradesh.

**Keywords:** high density plantation, redlum gala, productivity, auvil early fuji, M9

**1. Introduction**

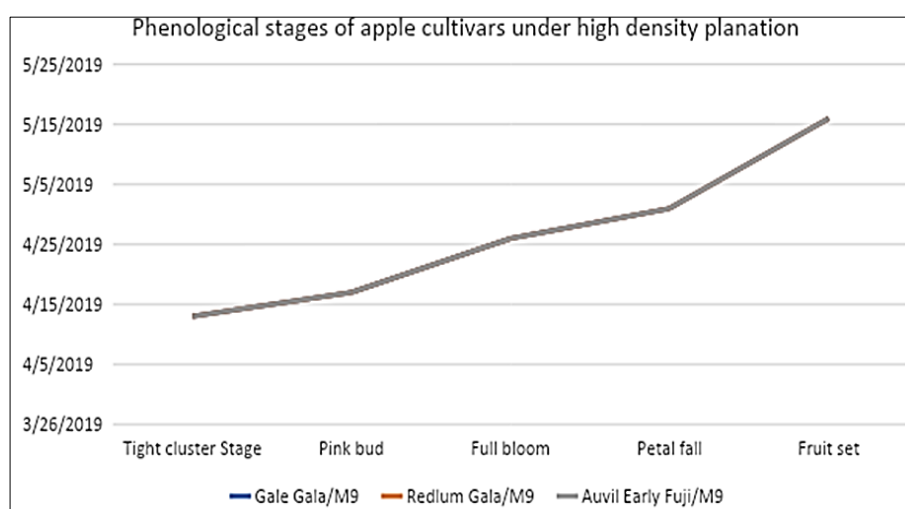
Apple is a major fruit crop of Himachal Pradesh and alone accounts for 49 percent of the total area of fruit crops and 74 percent of total fruit production. The area of apple has increased from 97438 hectares in 2008-09 to 112634 hectares by 2017-18. Fruit crops contribute more than 3313 crores towards GDP. The apple production level has gradually reached 368603 metric tons with a productivity of 3.27 MT in 2018-19 <sup>[1]</sup>. The production of apples has increased gradually, but void of productivity and export quality fruit production, it is still a major concern for the farming community of this state. At present Delicious group of cultivars mainly Red Delicious, Royal Delicious and Starking Delicious constitute nearly 80% of apple trees. In order to improve the production, productivity and quality of fruits to meet the demand and export standards, the horticulture sector needed to introduce new pollinizer cultivars to integrate in the apple cultivation systems. Many commercial varieties of apples require cross-pollination with pollen from compatible pollinizers. For apples, the average pollinizer requirement is twenty-five percent, which means that every second plant in every second row should be a pollinizer, though the standard recommendation is higher (33%). The proportion of pollinizer cultivars in the Kinnaur district is very sparse and mostly negligible, which is the major concern and impediment in apple production in Kinnaur. The farming community of Kinnaur district is currently in the fight to increase their apple productivity in lack of proper pollinizer proportion under changing climatic scenario. The requisite proportion of pollinizer cultivars under the normal and high-density systems of the plantation is a prerequisite under adverse climatic conditions. Farmers are adopting new technologies in apple farming systems like, high-density apple orcharding, which was initially introduced by the state government. One-third of the hill state's population depends on the Rs 4,000-crore apple economy.

In the past, very low market value, demand and scarcity of available land were the main reasons why farmers ignored the planting of pollinizers. In Kinnaur, the farmers are now more inclined to increase the pollinizer proportion in their orchards by planting more pollinizer trees or by top grafting on to the main varieties. Yet, the lack of sufficient pollinizer varieties in farmers' orchards is a key factor in inadequate pollination today. It's utterly important to identify a pollinator variety that blooms profusely and has a flowering period that overlaps with commercial varieties, to ensure sufficient pollination. Findings in this area showed that more than fifty percent of farmers in all study areas have less than twenty percent pollinators (the majority between 7 and 12%) in their orchards. Only two percent of farmers in Shimla Hills and two percent in Kullu Valley of Himachal Pradesh meet the standard pollinator requirement. Their gardens have more than thirty percent pollinators. Some 26 percent of farmers in Himachal have 21 to 25 percent pollinators and the rest have less than twenty percent. These studies also state that, partly due to market demand and partly due to a lack of knowledge about the importance of pollinators and pollination systems, farmers overlooked planting the appropriate proportion of pollen apple varieties. With increasing pressure on land and a decrease in the average size of land holdings, shifting is needed for higher density planting with sufficient pollinizer proportions, makes trees more precarious, heavier yielding and better quality fruit yielding. Furthermore, since high-density orchards can be developed on any fertile land, the technology is helpful in utilizing the land, providing ease in orchard intercultural operations, plant protection, harvesting and utmost, obtaining export quality produce. Hence, this study of three apple pollinizing varieties; Gale Gala, Redlum Gala and Auvil Early Fuji are carried out at this research station to screen out the superior commercial cultivar for future recommendation to the farming community to uplift the farmer's socio economic status.

## 2. Materials and Methods

The study was conducted in the Vegetable Research Station, Kalpa farm, Dr YS Parmar University of Horticulture &

Forestry, Nauni, Solan H.P. during the year 2018-19. The orchard was established at an altitude of 2740 meters above sea level, which delineates the true arid cold temperate climate of North-West Himalayas. The climate is cold and temperate. Rainfall is about 800 mm well distributed, mostly in the form of snow during winter with the main rainfall during June July. Dr YSPUHF introduced three exotic pollinizer cultivars of apple *viz.* 'Gale Gala/M9', 'Redlum Gala/M9' and 'Auvil Early Fuji/M9', in the year 2016 from the Italian nursery GRIBA. The selected trees for this study were planted at a spacing of 2.5 m x 1 (4000 trees/ha) in a randomized block design with five replications. Every pollinizer plant was planted in every alternate row in a block to make 25 percent polliniser proportion. The data on growth parameters *viz.*, shoot extension growth, plant girth, height, spread, fruit characteristics like fruit weight, length and breadth and finally the yield were recorded at the harvesting stage of the apple crop. Plant spread was appraised with the help of measuring wooden scale by recording the maximum canopy spread in north-south and east-west directions. The contemplation on the fruit set were recorded at two weeks after petal fall and then were again corroborated at six weeks after full bloom so as to allow advisable time for the abscission of unfertilized fruits. The final fruit set was then computed by applying the formula as propounded by Westwood [7]. The total number of fruit set was enumerated from five randomly selected branches of each experimental tree. Productivity was numerated on kg/plant and per unit areas basis. The fruits harvested from each selected plant were counted at every harvest and finally summed up to work out the average number of fruits per plant. Further for this study, it was recorded the following phenological characteristics: Half inch green tip, Tight cluster Stage, Pink bud, Full bloom, Petal fall and Fruit set recorded visually by observing peculiar stages of each parameter (Fig. 1). Flowering stages including initial and final bloom of each variety was recorded when 10 and 80 percent of the flowers had opened. The period from the date of flowering initiation to the date of petal fall was calculated as duration of flowering. The date for petal fall was recorded when 80% of petals were fallen.



**Fig 1:** Phenological stages of apple pollinizer cultivars under high-density plantation for the 2019 season at the experimental orchards of VRS Kalpa farm

## 3. Results and Discussion

Growth characteristics *viz.* shoot extension growth, trunk girth, plant height and plant spread, showed non-significant differences during the study as depicted in Table 1. The study

revealed (Table 1) that the maximum shoot extension growth (13.86 cm) and plant height (219.50 cm) was recorded in Redlum Gala and maximum trunk diameter (30.50 mm), plant spread (120.83 cm NS) was recorded in cultivar Gale Gala

grafted on clonal rootstock M9, whereas maximum plant spread (125.00 cm) E-W direction was found in Auvil Early Fuji. However, minimum shoot extension growth (12.31 cm) and plant spread (East-West, 77.17 cm) was recorded in Gale Gala, whereas, minimum trunk diameter (28.24 mm) and plant height 195.33 cm) was observed in Auvil Early Fuji. However, minimum plant spread N-S (96.67 cm) was recorded in Redlum Gala. Growth characteristics *viz.* shoot extension growth, trunk girth, plant height, and plant spread, showed non-significant differences during the study, which might be due to the heredity character of the variety, which increases the growth by increasing the uptake of nutrients from root to aerial part of the tree. Similarly, a finding on apricot was reported by Kumar [5].

In this study, (Table 2) most of the flowering and fruiting characteristics amongst the cultivars were found non-significant. The pollinizer cultivar Redlum Gala/M9 had higher total flowers/tree (1211.00), in comparison to the other two cultivars, whereas least (228.75) was recorded in Redlum Gala, which was statistically at par with cultivar Auvil Early Fuji/M9). The number of fruit set per tree was non-significant amongst the cultivars study and a maximum (64.25) was recorded in cultivar Redlum Gala/M9, which was non-significantly higher than the rest of the cultivars under study. The minimum number of fruit set per tree was observed in cultivar Auvil early Fuji/M9. Furthermore, in this study, the percent fruit set was non-significantly variable (9.20 to 23.06 %) among the different pollinizer cultivars, which was higher in Gale Gala (23.06 %), whereas, fruit set was found to be lower in cultivar Auvil Early Fuji (8.34 %) and Redlum Gala (11.08), which were statistically at par with each other. Similarly, a significantly higher number of fruits per tree was found in cultivars Redlum Gala/M9 (30.17) and Gale Gala/M9 (21.67)), which were statistically at par with each other, while these were statistically lower (9.20) in cultivar Auvil Early Fuji/M9. During the study (Table 2), the cultivar Gale Gala/M9 had a significantly higher length (73.77 mm) and breadth (77.68 mm) of fruits, which were significantly

more than the rest of the cultivars under study. Whereas, significantly lower fruit length (62.43 mm) and breadth (70.08 mm) were seen in Auvil Early Fuji. The variations in flowering/fruit set might be due to varietal characters [3]. The significantly higher fruit weight was observed in the cultivars of Auvil Early Fuji/M9 (218.23 g/fruit). However, the fruit weight was significantly lesser (121.93 g/fruit) in cultivar Gale Gala/M9 and Redlum Gala (140.08 g/fruit), which were statistically at par with each other. The better performance of Auvil early Fuji/M9 might be due to the inherent vigor and bearing habit of the apricot variety. Kumar [5] reported similar findings. As evident from Table 2, the fruit yield differs in a non-significant way among different cultivars. The fruit yield per tree was non-significantly higher in the cultivars Redlum Gala/M9 (3.79 Kg/tree), whereas yield per tree was found to be lower (1.59 kg/tree) side in cultivar Auvil Early Fuji, The higher yield in spur type cultivars in comparison to standard cultivars is primarily because of their genetic makeup towards more spur formation and precocity. Denby [2] has reported yield variations among various apple cultivars. The productivity of fruits per hectare was more in cultivars Redlum Gala (15.14 MT/Ha), which was statistically higher than the rest of the cultivars in the study, while minimum productivity (6.35 MT/Ha.) was recorded in cultivar Auvil Early Fuji and Gale Gala (9.71 MT/Ha), which were statistically at par with each other. Maximum productivity efficiency in cultivar Redlum Gala/M9 might be due to the positive relationship between growth, flowering, and yield. A similar, positive relationship was also reported by Kumar [6]. Further, during the study Phenological characteristics *i.e.* Half inch green tip, Tight cluster Stage, Pink bud, Full bloom, Petal fall, and Fruit set enumerated in Fig. 1 were observed invariably different amongst the cultivars, which might be due to the occurrence of similar temperatures during an early stage of vegetative development. Flowering date and period of blooming vary according to cultivar aptitude as well as ecological and cultural conditions [4].

**Table 1:** Growth characteristics of various improved apple pollinizer cultivars planted at Vegetable Research Station, Kalpa

Name of cultivar	Rootstock	Shoot Extension Growth (cm)	Trunk Dia.(mm)	Plant Height (cm)	Plant Spread E-W (cm)	Plant spread N-S (cm)
Gale Gala	M9	12.31	30.50	199.67	77.17	120.83
Redlum Gala	M9	13.86	30.20	219.50	100.00	96.67
Auvil Early Fuji	M9	13.57	28.24	195.33	125.00	97.92
CD <sub>0.05</sub>		NS	NS	NS	NS	NS

**Table 2:** Fruiting characteristics of various improved apple pollinizer cultivars planted at Vegetable Research Station, Kalpa

Name of cultivar	Clonal Rootstock	Total number of flowers/tree	Number of fruit set /tree	% fruit set	Number of fruits/tree	Fruit Size (mm)		fruit weight (g/fruit)	Yield (kg/tree)	Productivity (MT/Ha)
						Length	Breadth			
Gale Gala	M9	228.75	41.25	23.06	21.67	73.77	77.68	121.93	2.43	9.71
Redlum Gala	M9	1211.00	64.25	11.08	30.17	66.87	73.38	140.08	3.79	15.14
Auvil Early Fuji	M9	385.25	38.63	8.34	9.20	62.43	70.08	218.23	1.59	6.35
CD <sub>0.05</sub>		NS	NS	NS	16.34	7.20	NS	21.86	NS	NS

## 5. Conclusion

Studies have shown that all three-pollinating cultivars have performed similarly with non-significant differences in growth and fruiting characteristics, yet cultivar like Redlum Gala plants on M9 is superior in terms of shoot extension growth, plant height, total number of flowers/tree, number of fruit set/tree, number of fruits/tree yield efficiency and productivity. Thus, it may be recommended to grow under high-density plantations in cold temperate conditions of Kinnaur, Himachal Pradesh.

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