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Evaluation of Tall Spindle Planting System of Apple Cultivars at Low, Mid, and High Altitudes of Kulgam District of J&K (UT), India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study to evaluate the apple tall spindle system located in low, mid, and high altitudes of district Kulgam was undertaken during 2022-23 and 2023-24 covering production, quality, and profitability parameters. The highest average yield/ha (kg) in all apple cultivars was observed in the Qaimoh zone. Average A-grade apple/ha were obtained highest in the Manzgam zone in all studied apple cultivars although the same zone resulted in the lowest average yield/ha (kg). The lowest average B-grade apples/ha in case of Red Chief (2994.15kg), Jeromine (3281.89kg), Red Velox (3759.62kg)

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and Golden Delicious Reinders (9406.47kg) was obtained under high altitude Manzgam zone while as Redlum Gala performed better in terms of least B-grade apple production as compared to other studied cultivars across zones. Similarly, the maximum C-grade apple (kg/ha) resulted in tall spindle system of low altitude Qaimoh zone followed by Kulgam zone and the least quantity in the Manzgam zone. Red Chief laid in TSS located at low altitude zone resulted in maximum fancy-grade apple (2217kg/ha) whereas, highest fancy-grade apple in Redlum Gala (2033.43kg/ha) and Golden Delicious Reinders(1826.48kg/ha) was obtained in Kulgam zone. Manzgam zone outperformed other zones in terms of average fancy-grade/ha in case of Jeromine (3281.89kg/ha) and Red Velox (2227.93kg/ha). The highest gross return/ha was obtained in Manzgam zone (Rs. 2333051.39) followed by Qaimoh zone (Rs. 2236214.50) and the least in case of Kulgam zone (Rs. 1803882.09). Redlum Gala followed a similar trend with the highest in the Manzgam zone (Rs. 3147745.19/ha) and the minimum in the Kulgam zone (Rs. 2183754.57/ha). In case of Red Velox and Golden Delicious Reinders, low altitude of Kulgam proved to be better sites as far as average gross income/ha is concerned. Jeromine cultivated in Manzgam zone outperformed the same cultivar grown in other zones on an average gross returns/ha basis.

Keywords: Tall spindle system; production; quality; profitability; altitude.

1. INTRODUCTION

Kulgam is one of the eight new districts created during 2006-07. It has been carved out from district Anantnag, which lies on its Eastern side, and district Shopian on its Northern side (Khan, 2018). Geographically the district lies between 33^0.598' North Latitude and 74^0.734' East Longitude. Reasi, Ramban and Rajouri districts fall on its South and Southwest, though separated by the majestic mountainous range of Peer Panchal (Ahmad and Bhat, 2015). Kulgam district is bestowed with low, mid, and high-altitude areas having their unique microclimate resulting in different flora and fauna domination (Kumar and Jain, 2010). In the last few decades, horticultural crops particularly apple has taken up rice in terms of area and production (Malla et al, 2020). Kulgam once known as rice bowl of J&K (UT) has seen a lot in terms of land conversion and now appears as one of the leading producers of apples in the Valley (Reshi et al, 2010). Being a new district in apple production and still in conversion from agriculture to horticulture, this district has become spotlight in terms of area expansion under HDP apple programme (Mir and Sampath, 2022). Number of high-density apple orchards are coming up in the Kulgam district occupying either rice fields, agricultural land or old traditional orchards either through the developmental department, private players or at personal level (Malla et al, 2020). People of district Kulgam being new apple growers possess limited experience in this regard and follow only a few components of tall spindle system and don't follow full crop husbandry practices essential for obtaining predicted productivity, quality, and orchard profitability (Rehman et al, 2023). In addition, Kulgam possesses uniqueness in terms of diversity in terms of altitude, microclimate, soil, terrain (Farooq et al, 2024).

The tall spindle planting system is an amalgamation of several orchard systems that incorporates aspects of the slender spindle system, the vertical axis system, the solaxe system, and the super spindle system (Robinson et al, 2011). Tall spindle apple-planting system utilizes highly feathered nursery trees planted at a density of 2,500-3,300 trees/ha. The trees are pruned minimally after planting but feathers are tied below horizontal soon after planting (Robinson et al, 2014). The tree is grown rapidly to 3.3 m tall with no heading of the leader and little pruning for the first 4-5 years after which tree height is limited each year to 3.3 m by cutting to a side branch. The mature tree is pruned using limb renewal pruning by removing 2-3 of the largest limbs (>2 cm diameter) in the canopy each year by cutting them back to a 2-3 cm long stub (Ozkan et al, 2016). Important components of this highly profitable apple planting system include higher planting density, fully dwarfing rootstocks, feathered planting material, minimal pruning at planting, leader management, support system, branch devigoration, limb renewal, drip irrigation, fertigation, crop load management, and early fruiting (Kumawat and Mir, 2020). Adoption of all these components is significant for harnessing the benefits of this advanced planting system. However, on-ground growers think that planting more plants per unit area will come to their rescue in terms of productivity, quality, and economic returns. In this regard, a study to

evaluate TSS of apple covering different altitudes of this unique district was undertaken covering production, quality, and profitability parameters.

2. MATERIALS AND METHODS

This study was carried out by Krishi Vigyan Kendra, Kulgam with experimental orchards at farmer's field located in three different horticultural zones i.e., H_1 (Manzgam), H_2 (Kulgam), and H_3 (Qaimoh) representing respectively high, mid and low altitude zone of district Kulgam. Experimental plots were 5 years old orchards containing V_1 (Red Chief), V_2 (Redlum Gala), V_3 (Red Velox), V_4 (Jeromine), and V_5 (Golden Delicious Reinders) apple cultivars established in intensive system of planting following uniform crop husbandry practices as recommended by SKUAST-Kashmir and Krishi Vigyan Kendra, Kulgam. It was a two-year study done during 2022-23 and 2023-24 and replicated 3 times in above mentioned horticultural zones. Yield data (kg) was collected by taking mean of five plants of each cultivar from each location. Grades were assigned to harvested fruits by adopting standard grade criteria like size/weight, color, shape, defect, shininess, scar etc. Average yield/tree (kg) and grade data/tree (kg) were converted to hectare basis by simply multiplying it with planting density adopted in TSS i.e., 3333 at 3m x 1m spacing. Gross return/ha was calculated by multiplying the average grade (kg) with the average market rate at the terminal/local market of different apple cultivars.

3. RESULTS AND DISCUSSION

As presented in Fig. 1, the average yield/ha (kg) of different apple cultivars varied among various studied horticultural zones. The highest average yield/ha (kg) in all apple cultivars was observed in H_3 (Qaimoh zone) under TSS. However, higher average yield/ha in case of Jeromine (48328.5kg) and Golden Delicious Reinders (60882.8kg) was obtained in H_2 (Kulgam zone) as compared to H_1 (Manzgam zone) while as in Manzgam zone, Red Chief, Redlum Gala and Red Velox performed better as compared to H_2 (Kulgam zone) in terms of average yield/ha as shown in Fig. 1. Variation in average yield/ha among studied zones may be due to differences in the initial fruit set, fruit drop percentage, fruit size as reported earlier by Univer et al (2010); Priyanka et al (2021); Rehman et al (2024), Sharma et al (2017); Wertheim and Schmidt (2005); Sharma and Karkara (2004); Sumrah et al (2000). The zonal difference in yield of various studied apple cultivars may be attributed to local microclimatic factors, differences in fruit set percentage, amount of losses in terms of fruit drop, varied spectrum of diseases and pests, edaphic factors etc as pointed by Rehman et al (2024); Shah et al (2022); Uselis et al (2020); Kumar et al (2023).

From Fig. 2, average A-grade apple were obtained highest in H_1 (Manzgam) zone in all studied apple cultivars in contrast to average yield/ha that was least in case of same zone as shown by Fig. 1. Optimum fruit set, less disease and pest incidence, better light interception, favorable microclimate, better fruit leaf ratio at higher altitudes of district Kulgam may have contributed to higher A grade yield/ha as compared to other zones irrespective of cultivars. These results are in concordance with the findings of Rehman et al (2023); Shah et al (2022); Sharma et al (2017). Better results in terms average A-grade/ha were obtained in all apple cultivars in H_3 (Qaimoh) zone as compared to H_2 (Kulgam) zone as shown in Fig. 2.

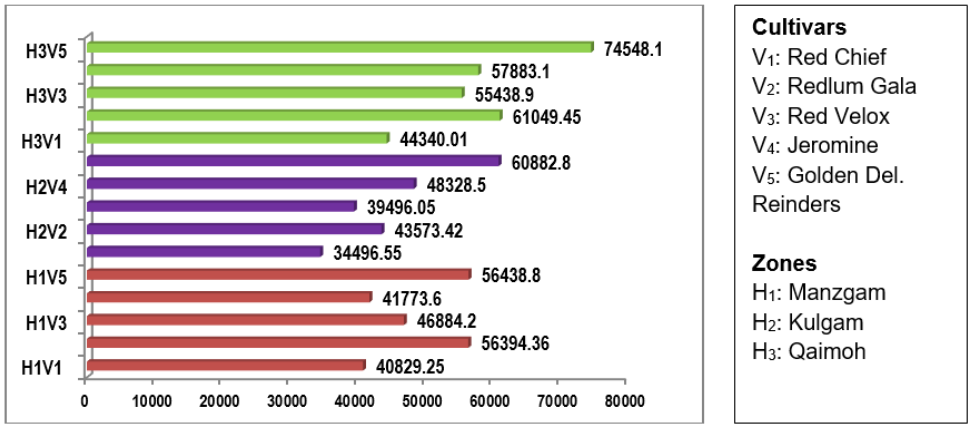

Fig. 1. Zone and variety-wise representation of average yield/ha (kg) during the study

From the Fig. 3, least average B-grade apples/ha in case of Red Chief (2994.15kg), Jeromine (3281.89kg), Red Velox (3759.62kg) and Golden Delicious Reinders (9406.47kg) was obtained under high altitude Manzgam zone (H1) while as Redlum Gala performed better in terms of least B-grade apple production as compared to other studied cultivars across zones. Maximum average B-grade apple resulted in low altitude zone (H3) in all apple cultivars in TSS as compared to mid and high altitude zones. Variations in terms of B-grade apple yields across zones may be attributed to colour development, fruit weight, incidence of diseases and pests, microclimate variabilty etc as reported by Rehman et al (2023); Rehman et al (2024); Priyanka et al (2021); Verma and Thakur (2019); Sharma and Chauhan (2008).

Similarly, from Fig. 4, the maximum C-grade apple (kg/ha) resulted in Tall Spindle System (TSS) of low altitude Qaimoh (H3) zone followed by mid-altitude (Kulgam) zone and least quantity of average C-grade/ha was obtained in TSS of Manzgam zone (H1).

Average fancy-grade/ha (kg) showed mixed results among various zones as shown in Fig. 5. Red Chief laid in TSS located at low altitude (H3) zone resulted in maximum fancy-grade apple (2217kg/ha) whereas, the highest fancy-grade apple in Redlum Gala (2033.43kg/ha) and Golden Delicious Reinders(1826.48kg/ha) was obtained in Kulgam zone. Manzgam zone (H1) outperformed other zones in terms of average fancy-grade/ha in case of Jeromine (3281.89kg/ha) and Red Velox (2227.93kg/ha) as shown in Fig. 5.

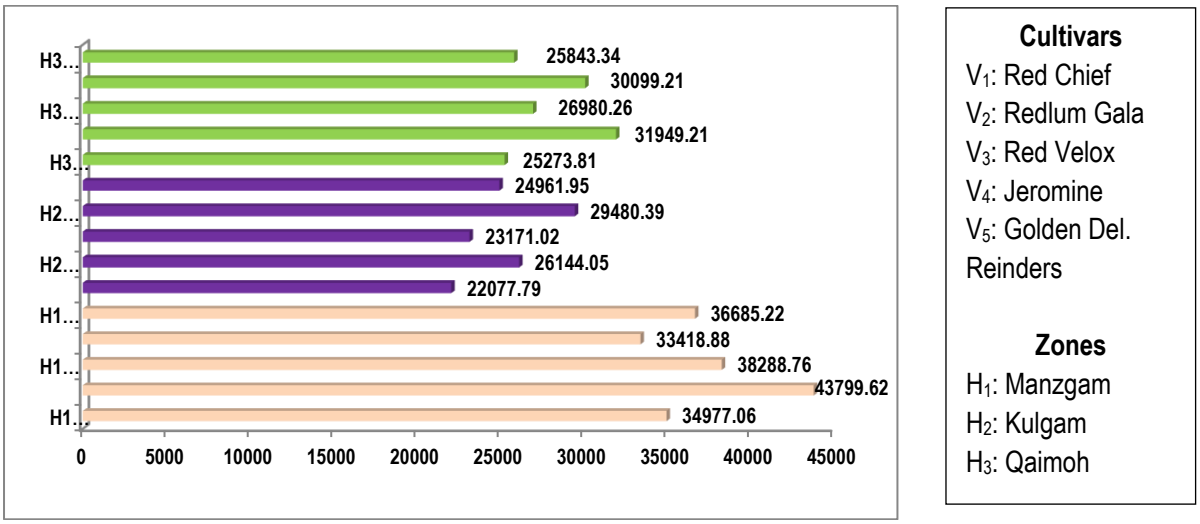

Fig. 2. Zone and variety-wise representation of average A-grade/ha (kg) during the study

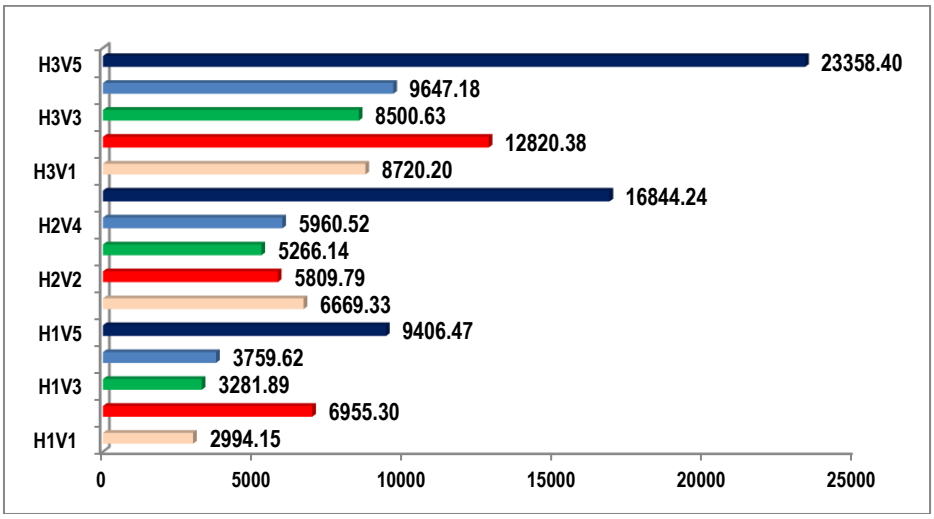

Fig. 3. Zone and variety-wise representation of average B-grade/ha (kg) during the study

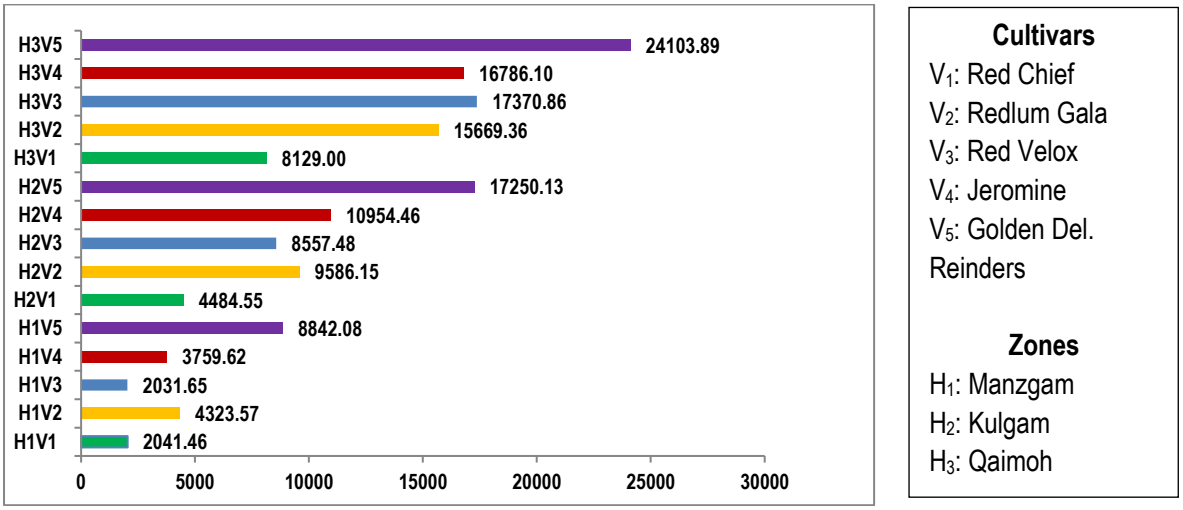

Fig. 4. Zone and variety-wise representation of average C-grade/ha (kg) during the study

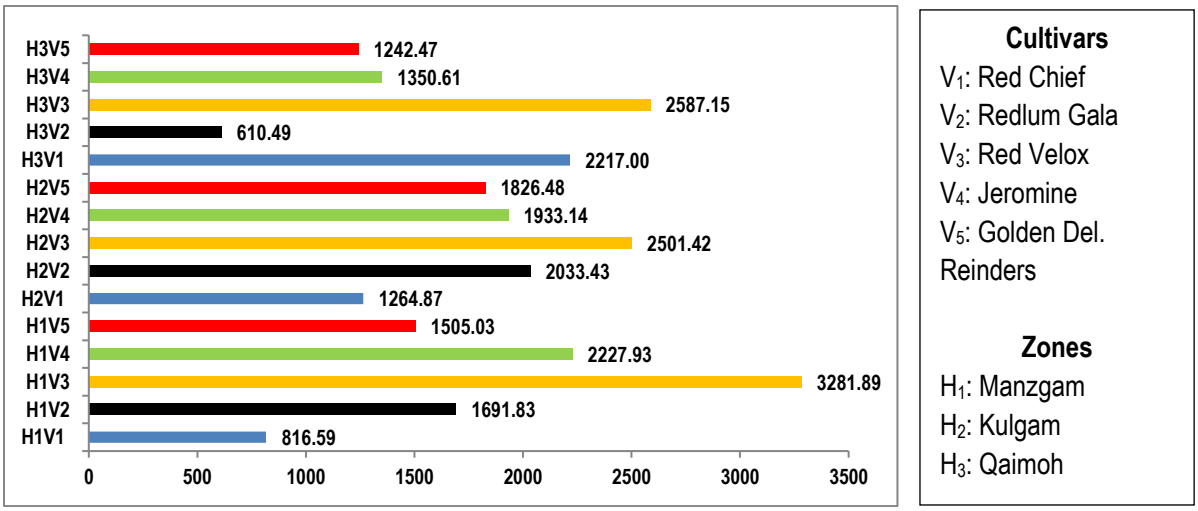

Fig. 5. Zone and variety-wise representation of average Fancy-grade/ha (kg) during the study

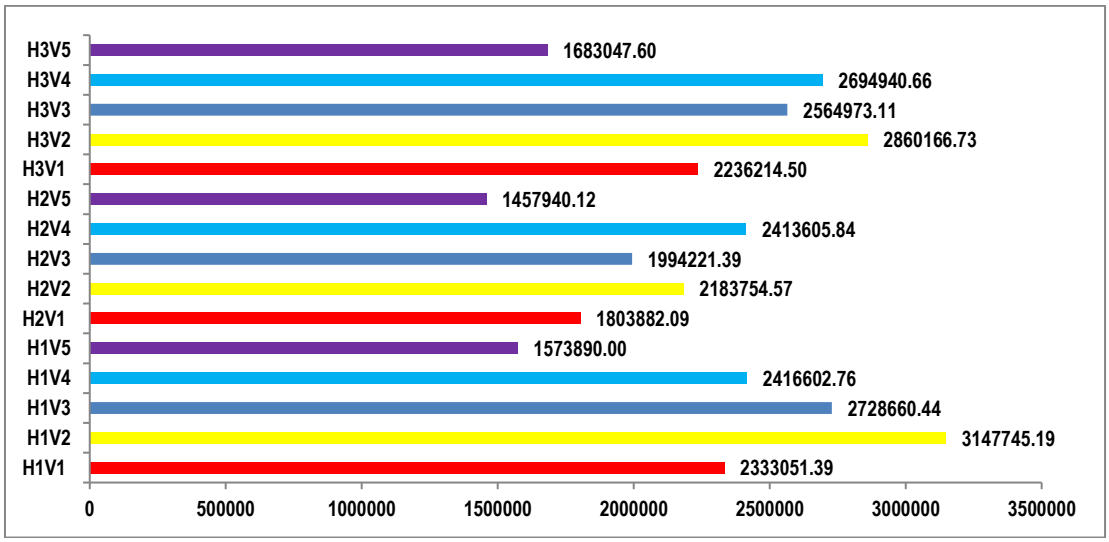

Fig. 6. Zone and variety-wise representation of gross returns/ha (Rs.) during the study

Fig. 6 represents the average gross returns/ha (Rs.) from the various TSS apple cultivars in various studied horticultural zones. In case of Red Chief cultivar, highest gross return/ha was obtained in Manzgam zone (Rs. 2333051.39) followed by Qaimoh zone (Rs. 2236214.50) and the least in case of Kulgam zone (Rs. 1803882.09). Redlum Gala followed similar trend with the highest in Manzgam zone (Rs. 3147745.19/ha) and minimum in Kulgam zone (Rs. 2183754.57/ha). In case of Red Velox and Golden Delicious Reinders, low altitude of Kulgam proved better sites as far as average gross income/ha is concerned as compared to other zones as evident from Fig. 6. Comparatively Jeromine cultivar cultivated in Manzgam zone (H1) outperformed the same cultivar grown in other zones on average gross returns/ha basis. Higher average yields of better marketable grade apples along with lesser yields of inferior grade apples in high altitudes of Kulgam district i.e. Manzgam resulted in better gross returns as reported in the current study. Results obtained in current study are in agreement with earlier findings reported by Wani et al, 2021; Rehman et al, 2023; Rehman et al, 2024; Yuri et al, 2011; Nabi et al, 2022; Kafle et al, 2021, Majid et al, 2018; Rafiya, 2019; Hassan et al, 2020.

4. CONCLUSION

Tall spindle system is highly profitable for apple planting and is an amalgamation of several orchard systems that incorporate aspects of the slender spindle system, the vertical axis system, the solaxe system, and the super spindle system. The study revealed average yield/ha, quality, and overall profitability of apple varied in tall spindle systems depending on cultivar and altitude. The choice of apple cultivar as per altitude becomes indispensable as far as the economic viability is concerned. Such studies must be conducted across the valley to guide the growers before laying tall spindle apple planting systems. This study provides valuable insights for apple growers in the Kulgam district. Further research could investigate factors beyond altitude, such as soil type, irrigation practices, and pest and disease management, to further optimize apple production in the region.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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