

Evaluation of Tall Spindle planting System of apple cultivars at low, mid, and high altitudes of Kulgam district of J&K (UT)

Abstract

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. 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. Results revealed average yield/ha, quality, and overall profitability varied in tall spindle systems depending on cultivar and altitude. 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) 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 as compared to other zones. However, Jeromine cultivar 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.

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 33⁰.598' North Latitude and 74⁰.734' East Longitude. Reasi, Ramban and Rajouri districts fall on its South and Southwest,

Comment [H1]: Capital Letter

Comment [H2]: No need

Comment [H3]: Italic

Comment [H4]: Capital letter and numbering

Comment [H5]: No paragraph

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 (Mirand 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.

Material 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., H₁ (Manzgam), H₂ (Kulgam), and H₃ (Qaimoh) representing respectively high, mid and low altitude zone of district Kulgam. Experimental orchards were 5 years old orchard containing V₁ (Red Chief), V₂ (Redlum Gala), V₃ (Red Velox), V₄ (Jeromine), and V₅ (Golden Delicious Reinders) apple

Comment [H6]: No paragraph

Comment [H7]: Capital letter and numbering

Comment [H8]: No paragraph

Comment [H9]: orchard

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.

Results and Discussion

As presented in Figure 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 H₃ (Qaimoh zone) under TSS. However, higher average yield/ha in case of Jeromine (48328.5kg) and Golden Delicious Reinders (60882.8kg) was obtained in H₂ (Kulgam zone) as compared to H₁ (Manzgam zone) while as in Manzgam zone, Red Chief, Redlum Gala and Red Velox performed better as compared to H₂ (Kulgam zone) in terms of average yield/ha as shown in Figure 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).

Comment [H10]: Capital letter

Comment [H11]: No paragraph

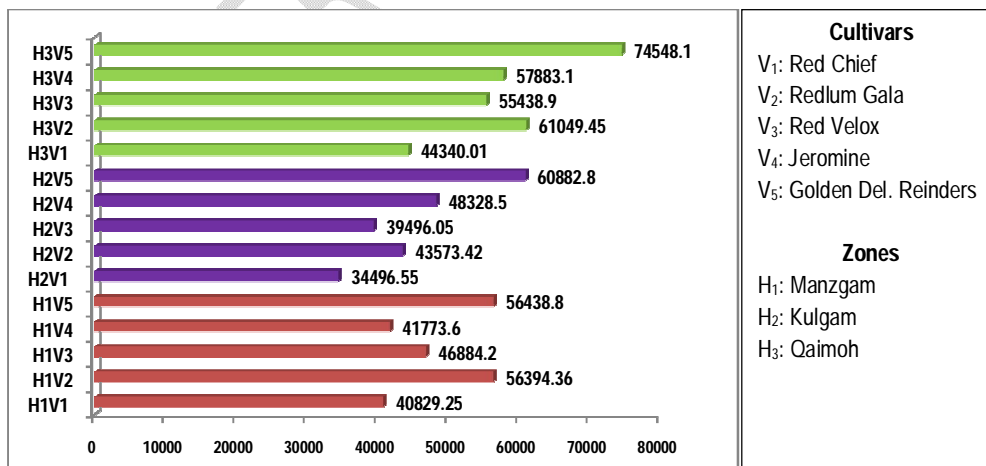
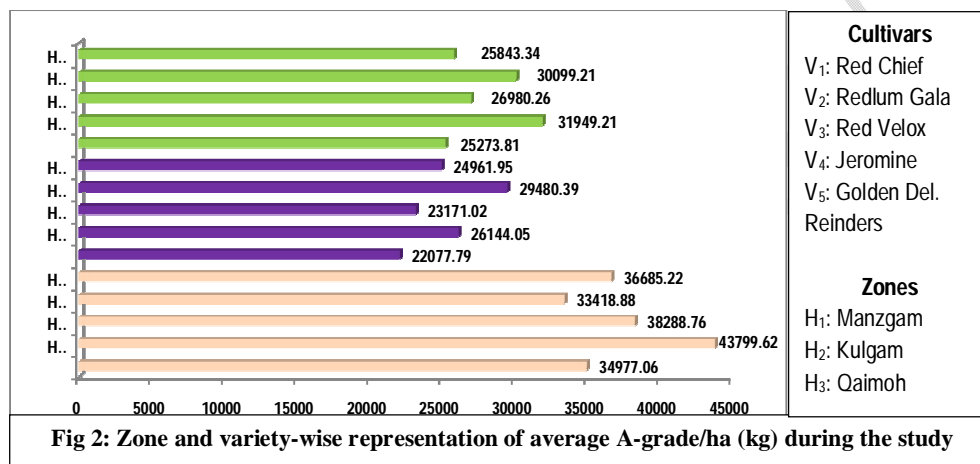


Fig 1: Zone and variety-wise representation of average yield/ha (kg) during the study

From Figure 2, average A-grade apple were obtained highest in H₁ (Manzgam) zone in all studied apple cultivars in contrast to average yield/ha that was least in case of same zone as shown by figure 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 H₃ (Qaimoh) zone as compared to H₂ (Kulgam) zone as shown in figure 2.



From the figure 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 variability etc as reported by Rehman *et al* (2023); Rehman *et al* (2024); Priyanka *et al* (2021); Verma and Thakur (2019); Sharma and Chauhan (2008).

Comment [H12]: No paragraph

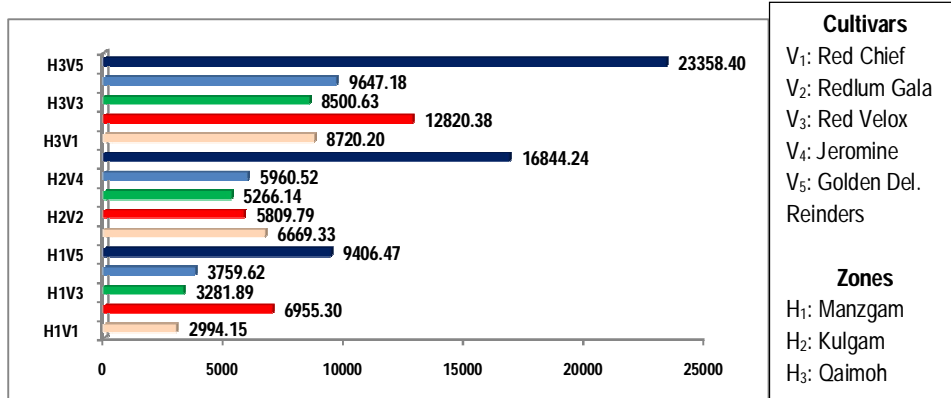


Fig 3: Zone and variety-wise representation of average B-grade/ha (kg) during the study

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).

Comment [H13]: No paragraph

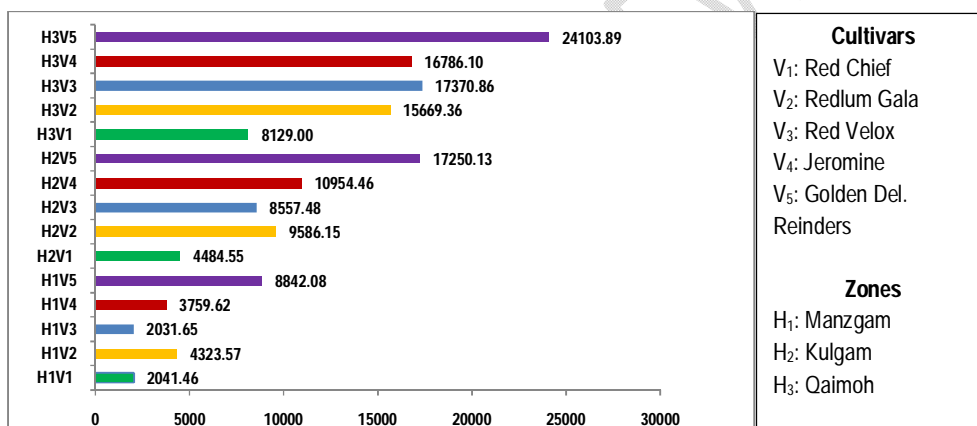
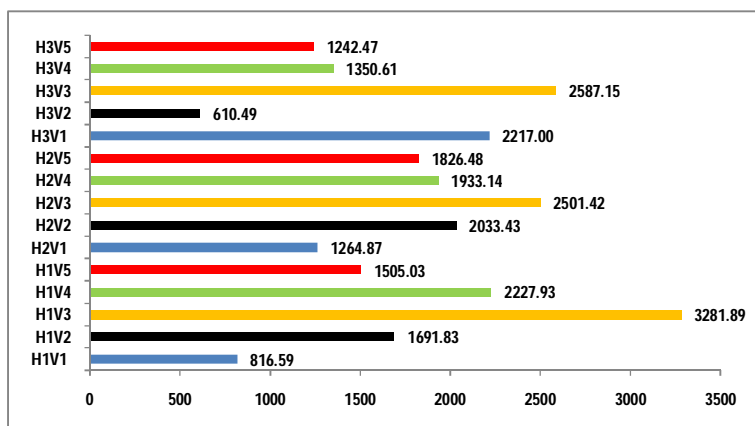


Fig 4: Zone and variety-wise representation of average C-grade/ha (kg) during the study

Average fancy-grade/ha (kg) showed mixed results among various zones as shown in Figure 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

Comment [H14]: No paragraph



Jeromine(3281.89kg/ha) and Red Velox (2227.93kg/ha) as shown in Figure 5.

Cultivars
V1: Red Chief
V2: Redlum Gala
V3: Red Velox
V4: Jeromine
V5: Golden Del. Reinders

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

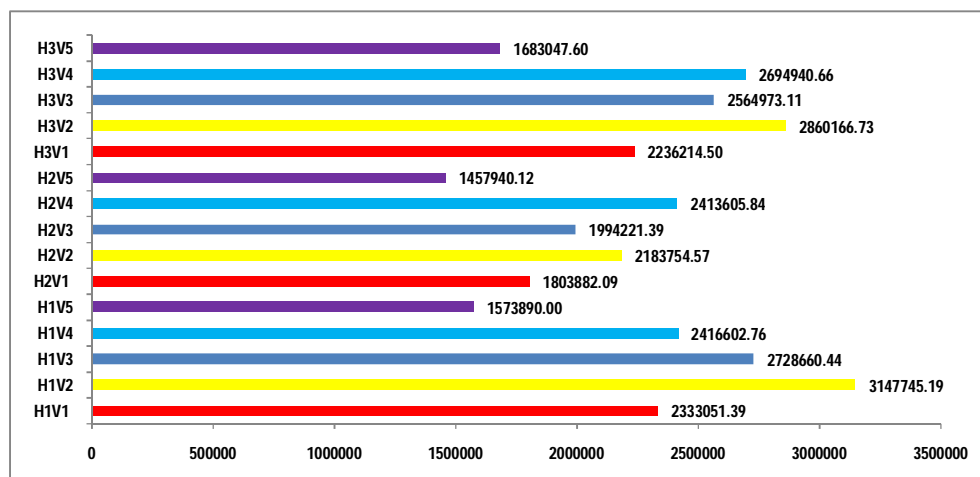


Fig 6: Zone and variety-wise representation of gross returns/ha (Rs.) during the study

Figure 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 figure 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.

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

Comment [H15]: No paragraph

Comment [H16]: Capital letter and numbering

Comment [H17]: No paragraph

as the economic viability is concerned. Such studies need to be carried out across the valley to guide the growers before laying tall spindle apple planting systems.

References

Comment [H18]: Capital letter and numbering

- Ahmad M and Bhat I A (2015). Monitoring of NHM state programme implementation plant 2015-16: Jammu and Kashmir (A case study of Kulgam district). A report submitted to Ministry of Health and Family Welfare, Government of India, New Delhi-1100018.
- Farooq M, Singh S K, Kanga S, Meraj G, Mushtaq F, Durin B, Pham Q B and Hunt J (2024). Assessing Future Agricultural Vulnerability in Kashmir Valley: Mid and Late-Century Projections Using SSP Scenarios. *Sustainability*. **16**: 7691.
- Hassan B, Bhattacharjee M and Wani S A (2020). Economic analysis of high-density apple plantation scheme in Jammu and Kashmir. *Asian Journal of Agriculture and Rural Development*. **10** (1): 379-391.
- Kafle R, Pandit S, Aryal R, Pokhrel A, Bist P and Timilsina R H (2021). Comparing high-density plantation (HDP) system and the conventional plantation system of apple cultivation in Mustang and Manang districts of Nepal. *Cogent Food and Agriculture*. **7**: 1896118.
- Khan B A (2018). Demography of Jammu and Kashmir in Historical Perspective. *Asian Review of Social Sciences*. **7** (3): 143-153.
- Kumar A, Pandey V, Sharma K, Pal A, Pal D, Kumar A (2023). A comparison of apple varieties based on yield and production efficiency under North-western plain zones of Uttar Pradesh. *Environ Cons J*. ISSN 0972-3099 (Print) 2278-5124 (Online).
- Kumar V and Jain S K (2010). Trends in seasonal and annual rainfall and rainy days in Kashmir Valley in the last century. *Quaternary International*. **212**(1): 64-69.
- Kumawat K L and Mir J I (2020). Tall Spindle – Apple orchard planting system for the future. *Indian Horticulture*. 31-36.
- Majid I, Khalil A and Nazir N (2018). Economic Analysis of High-Density Orchards. *International Journal of Advance Research in Science and Engineering*. **7** (4): 821-829.
- Malla R A, Ganaie I H and Farooq U (2020). An Analysis of Conversion of Paddy Land into Apple Orchards of District Kulgam. *Journal of Critical Reviews*. **7**(19):
- Mir A A and Sampath R (2022). Growth and performance of Apple production in Kulgam district of Jammu and Kashmir. *Journal of Xi'an Shiyou University, Natural Science*. **18** (4): 368 -376.

- Nabi T, Imtiyaz M and Parvaiz O (2022). Cost Benefit Analysis of Ultra High-Density Apple Plantation: A Comparative Study of Baramulla and Budgam Districts of Jammu and Kashmir. *Journal of Positive School Psychology*. **6**(9): 2813-2828.
- Ozkan Y, Yildiz K, Kucuker E, Cekic C, Ozgen M and Akca Y (2016). Performance of 'Fuji' apple on M.9 rootstock in different tree training systems for the first five years. *Journal of Agricultural Science and Technology*. **18**: 1647-1653.
- Priyanka, Bhardwaj and Thakur D (2021). Altitudinal-wise variations in phenological stages of apple crop in North-Western Himalayan regions of Himachal Pradesh. *International Journal of Current Microbiology and Applied Sciences*. **10**(01): 686-692.
- Rafiya M (2019). High-density apple orchard management, Kashmir images. 25 Mar.
- Rehman H U, Ganai M A and Khanday A S (2024). Prevention of Preharvest Fruit Drop in Apple- A Menace in Temperate Fruit Industry. *Journal of Krishi Vigyan*. **12**(3): 624-630.
- Rehman H U, Mubarak T, Khanday A S, Shergojry S A, Ganai M A and Dar E A (2023). Evaluation of different apple planting systems in high, mid, and low altitudes of Kashmir Valley. *Theoretical Biology Forum*. **12**(2): 350-354.
- Reshi M I, Malik M A and Vijay K (2010). Assessment of problems and prospects of apple production and marketing in Kashmir Valley, India. *Journal of Environmental Research and Development*. **4**(4): 1077-1082.
- Robinson T L, Hoying S A and Reginato G (2011). The Tall Spindle planting system: principles and performance. *Acta Horticulturae*. **903**(903): 571-579
- Robinson, T L, Hoying S A, Miranda Sazo M, Dominguez L I and Fachinello J C (2014). Yield, fruit quality and mechanization of the tall spindle apple production system. *Acta Horticulturae*. **1058**: 95-103.
- Shah ZA, Dar MA, Dar EA, Obianefo CA, Bhat AH, Ali MT, ElSharnouby M, Shukry M, Hosny Kesba, Sayed S (2022) Sustainable Fruit Growing: An Analysis of Differences in Apple Productivity in the Indian State of Jammu and Kashmir. *Sustainability*. **14** (21): 14544.
- Sharma D P and Chauhan J S (2008). Performance of Apple Cultivars under Cold Desert Conditions of North-Western Himalayas. Proc. XXVII IHC - Enhancing Economy and Environmental Sustainability of Fruit Production in a Global Economy. *Acta Horticulturae*. **772**: 199-201.
- Sharma D P, Sharma H R and Sharma N (2017). Evaluation of apple cultivars under sub-temperate mid hill conditions of Himachal Pradesh. *Indian Journal of Horticulture*. **74**(2): 162-167.

- Sharma R P and Karkara B K (2004). Performance of some cultivars of Delicious apple in low altitude warmer valley of Shimla. *Acta Horticulturae*. **662**: 175-77.
- Sumrah M A, Nasir M A, Nasir M M, AllahBaksh and Nawaz M Z (2000). The performance of some apple cultivars under sub-mountain climatic conditions. *Sarhad Journal of Agriculture*. **16**:393-95.
- Univer T, Kviklys D, Lepsis J and Univer N (2010). Early performance of 'Auksis' apple trees on dwarfing rootstocks in the Baltic region. *Agronomy Research*. **8** (3): 743-748.
- Uselis N, Viskelis J, Lanauskas J, Liaudanskas M, Janulis V, Kviklys D (2020). Planting distance affects apple tree growth, fruit yield and quality. *Zemdirb Agriculture*. **107**: 367-72.
- Verma P and Thakur B S (2019). Comparative Studies on Growth, Flowering, Fruit Set and Yield of some Apple (*Malus × domestica* Borkh.) Cultivars under Mid Hill Conditions of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. **8**(2): 2710-2716.
- Wani M H, Bhat A and Baba S H (2021). Economic evaluation of high-density apple (Ex-Ante) in Kashmir, *International Journal of Fruit Science* **21**(1): 706-711.
- Wertheim SJ and Schmidt H (2005). Flowering, pollination and fruit set. In: Tromp J, Webster AD, Wertheim SJ. (Ed.). *Fundamentals of temperate zone tree fruit production*. Leiden: Backhuys Publishers. Pp. 216-239.
- Yuri J A, Moggia C, Torres C A, Sepulveda A, Lepe V and Vasquez J L (2011). Performance of apple (*Malus x domestica* Borkh.) cultivars grown in different Chilean regions on a Six-year trial, Part I: vegetative growth, yield, and phenology. *Hortscience*. **46**(3):365-370.