Evaluation of different apple planting systems in high, mid, and low altitudes of Kashmir Valley

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ABSTRACT

Keeping the varied profitability of different apple orchards situated in different horticultural zones of Kashmir in consideration, a study entitled "Evaluation of different apple planting systems in high, mid, and low altitudes of Kashmir Valley" was carried out by Krishi Vigyan Kendra, Kulgam, SKUAST-Kashmir. Yield/tree and different marketable grades of apple per tree as affected by cultivar, planting density, and area of plantation were observed during the study. The study revealed marked differences in mean yield/tree in different zones and varied between 22.62 to 24.09kg/tree (Redlum Gala), 24.46-26.35kg/tree (Red Velox) and 21.59-24.61kg/tree (Super Chief) irrespective of planting density. Mean yield/tree between various planting density systems varied significantly irrespective of cultivar and varied between 16.10kg/tree in D1 (3333 plants/Ha) to 31.62kg/tree in D3 (444 plants/Ha). The lowest mean yield/tree was recorded in the Super Chief cultivar in Qaimoh (Low zone) planted in D1 System while as highest mean yield/tree was recorded in the Red Velox cultivar in Kadder (Mid zone) planted in the D3 system. Similarly huge variation in the type of grade/tree in different studied cultivars planted in various zones under different planting systems was observed during the current investigation. Mean fancy grade/tree was observed to be highest (3.38/kg/tree) in D2 (1333 plants/ha) and lowest (2.19kg/tree) in case of the D1 planting system. The lowest mean fancy grade (1.60kg/tree) was observed in Redlum Gala of Qaimoh zone planted in the D2 planting system whereas the highest quantity of fancy grade apple (5.17kg/tree) was recorded in Red Velox of Kadder (mid zone) planted in D2 system (1333 plants/Ha). The quantity of A- grade apples and other types also varied among various zones, planting systems, and various studied cultivars. The mean A-grade per tree ranged between 8.22 kg/tree for Redlum Gala in Qaimoh (Z3) planted in the D1 system to 22.01kg/tree in the case of Super Chief in the Kadder zone planted in the D3 system. Similarly, the yield of B-grade apples varied from 1.39kg/tree in Super Chief in the Qaimoh zone planted in the D1 system to 7.56kg/tree in the Red Velox cultivar of the Qaimoh zone planted in the D3 system. However, the least C-grade per tree (0.78 kg) was obtained in the Redlum Gala cultivar in the Manzgam zone planted in D1 system.

Keywords- Apple, planting density, zones, cultivar, yield, Grade

Introduction

Apple (*Malus* x *domestica* Borkh.) belongs to the Rosaeceae family and has been classified into the subfamily Pomoideae and genus *Malus*. *Malus* species are widely distributed throughout North America, Europe, Asia Minor, and Asia [4]. In India, apple is mainly grown in J&K, Himachal Pradesh and Uttarakhand and provides the main source of income in this region of the country. In J&K (UT), Kashmir Valley produces major junk of apples and adds almost 7000 crores to valley's gross domestic product [18] and is also an employment generator for over 3.5 million people [7]. In recent years, new systems of apple plantation have been tried with little success however still traditional system predominates [12]. These systems have been mainly introduced to fill gaps in productivity and quality as compared to advanced apple-growing regions of the world. In traditional system of the plantation, only 270plants/ha are accommodated however, with the popularization of growth-controlling rootstocks planting density has increased reaching 444 plants/ha using semi-vigorous rootstocks like MM.111, 1333 plants/ha using semi-dwarfing rootstocks like MM.106 and 3333 plants/ha using dwarfing rootstocks like M.9. Area covered under these planting systems is hardly less than 2% of total apple growing area. Huge numbers of recent apple introductions like Gala Strains, Fuji Strains, Red Delicious Strains, Granny Smith, etc. are main cultivars under these systems [10]. A good combination of planting schemes and rootstock can result in a high yield and high-quality apple fruits suitable for the consumer [17]. In recent years, these systems are challenged by a number of edaphic, climatic, pathological and entomological and management factors [1]. In this context, yield and quality parameter of different apple planting systems was evaluated in the high, mid and low lying belt of district Kulgam, an important apple growing belt of South Kashmir. This paper is expected to prevent the unplanned conversion of agricultural land to apple in the future.

Material and Methods

This study was carried out by Krishi Vigyan Kendra, Kulgam during the year 2021-22 and 2022-23 on seeing the unplanned and unscientific conversion of agricultural land or traditionally apple-growing land in recent apple growing systems in the last decade (Mubarak *et al*., 2023). Out of ten horticultural zones of district Kulgam, three zones i.e. Manzgam (33.61^0N and 74.875^0E), Kadder (33.71^0N and 74.999^0E) and Qaimoh (33.72^0N and 75.095^0E) representing high, mid and low altitude respectively were selected for the study with a mean altitude of 5705ft above mean sea level. The sample consists of five orchards covering not less than 0.25 Ha were selected from each zone for data collection. Performance of three main cultivars i.e. V1 (Redlum Gala), V2 (Red Velox) and V3 (Super Chief) grafted on MM.111, MM.106 and M.9 rootstock in three planting densities i.e. D1 (444 plants/Ha), D2 (1333 plants/Ha) and D3 (3333 plants/Ha) was studied. Standardized cultural operations were applied in all the trees under study. The trees were trained on a modified central leader

training system. The experiment was laid out in a factorial randomized block design**.** Two-year data in terms of yield and apple grade was collected in the selected orchards. Yield/tree represents the mean yield of two years while as grades were assigned as per as standard procedure keeping color, size, defect, blemish, disease symptom, physiological disorder and pest scar in consideration. The data were analysed statistically as per the procedure given by Sheoran *et al*. [14] and are being presented in the table for interpretation of the results.

Results and Discussion

As evident from Table 1, irrespective of area and planting density, average yield/tree was significantly higher (25.31kg) in the Red Velox apple cultivar as compared to Redlum Gala (23.15kg) and Super Chief (22.89kg). Significantly higher quantities of fancy grade apples were obtained in Red Velox (3.45kg) as compared to super chief (3.20kg) and Gala Redlum (2.23kg). However irrespective of variety and area of cultivation, higher yields per tree were obtained in low planting density (D3) i.e. 31.62kg/tree as compared to other planting densities. Kadder Zone (Z2) outperformed other zones in terms of average yield/tree (25.02). The average yield per tree was higher in Red Velox plants in the Kadder zone (26.35kg) irrespective of planting densities although these values were significantly at par with Red Velox plants in Qaimoh (25.13) and Manzgam (24.46) zones. Similarly, significantly higher Fancy grade apple were harvested from Red Velox plants in the Kadder zone (4.07kg) as compared to other cultivars irrespective of planting density. Average yield/tree of low-density Red Velox (32.32kg) was significantly at par with low-density Super Chief (32.38) irrespective of the horticulture zone. Significantly more quantity of Fancy grade Super Chief apples (4.07kg) was obtained in low-density planting system as compared to other combinations irrespective of area of cultivation although this value was at par with medium (3.96kg) and low density (3.71kg)

Red Velox cultivar. As far as the interaction of various factors is concerned, highest average yield per tree was obtained in the low- density Red Velox of Qaimoh zone (34.27kg) although this value was significantly at par with the yields obtained in low-density Redlum Gala of Qaimoh zone (31.87kg), low-density Red Velox of Kadder Zone (32.34kg), low-density Super Chief of Manzgam (32.40kg) and low- density Super Chief of Kadder Zone (33.87kg). Similarly data shown in table 1 reveals that significantly more quantity of Fancy grade was obtained in medium density Red Velox of Kadder zone (5.17kg) as compared to other combinations although significantly at par fancy grade apples were obtained in medium density Red Velox of Manzgam zone (4.92). Variation of yield/tree in different planting density systems in apple has been earlier reported by Dhiman *et al*. [2], Shrivastava *et al*. [16], Mir *et al*. [8], Widmer and Krebs [19]. Decrease in yield/tree (kg) with higher plant densities under the study are in concordance with Shrivastava *et al*. [16], Rana *et al*. [11] and Dhiman *et al*. [2]. Similarly, yield difference of apple cultivars within and across different planting density systems has been reported by Widmer and Krebs [19], Shrivastava *et al*. [16], Rana *et al*. [11]. Differences in yield may be attributed to difference in fruit weight, fruit set percentage and other yield-controlling factors. The zonal difference in yield of various studied apple cultivars under different planting systems 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. Shah *et al*. [13] also pointed out the difference of apple productivity and quality among various districts and different areas of the same district in J&K (UT) and listed the various contributing factors for this variation. Uselis *et al*. [17] and Kumar *et al*. [5] reported a significant difference in terms of yield and marketable fruit traits in different apple cultivars grown on various rootstocks at varied planting distances at various locations.

Table 1: Yield/tree (kg) and Fancy grade/tree (kg) as influenced by cultivars, zone of cultivation, and planting Density in apple

Cultivars	Densities / Zones	Yield/tree (kg)				Fancy grade apple/tree (kg)			
		D1	D2	D3	Mean	D1	D2	D3	Mean
V1	Z1	16.93	22.07	28.87	22.62	1.64	3.26	1.71	2.20
	Z2	17.40	25.09	29.77	24.09	1.88	3.25	2.35	2.49
	Z3	15.90	20.50	31.87	22.76	1.87	1.60	2.53	2.00
Sub-Mean		**16.74**	**22.55**	**30.17**	**23.15**	**1.80**	**2.70**	**2.19**	**2.23**
V2	Z1	18.30	24.70	30.37	24.46	2.34	4.92	3.61	3.62
	Z2	19.87	26.83	32.34	26.35	2.91	5.17	4.14	4.07
	Z3	17.73	23.38	34.27	25.13	2.80	1.78	3.39	2.66
Sub-Mean		**18.63**	**24.97**	**32.32**	**25.31**	**2.69**	**3.96**	**3.71**	**3.45**
V3	Z1	12.37	22.60	32.40	22.46	2.07	3.99	4.50	3.52
	Z2	14.47	25.50	33.87	24.61	2.29	3.80	3.69	3.26
	Z3	11.90	22.00	30.87	21.59	1.86	2.61	4.01	2.82
Sub-Mean		**12.91**	**23.37**	**32.38**	**22.89**	**2.07**	**3.47**	**4.07**	**3.20**
Factor Mean	Densities	**16.10**	**23.63**	**31.62**		**2.19**	**3.38**	**3.32**	
	Zones	**23.18**	**25.02**	**23.16**		**3.11**	**3.27**	**2.49**	

CD (p<0.05)	Cultivars (V) = 1.10 Zones (Z) = 1.10 Density (D) = 1.10 Cultivars* Zones (V*Z) = 1.91 Cultivars* Density (V*D) = 1.91 Density*Zones (D*Z) = 1.91 Cultivars* Density * Zones (V*D*Z) = 3.32	Cultivars (V) = 0.21 Zones (Z) = 0.21 Density (D) = 0.21 Cultivars* Zones (V*Z) = 0.37 Cultivars* Density (V*D) = 0.37 Density*Zones (D*Z) = 0.37 Cultivars* Density * Zones (V*D*Z) = 0.64
V1 = Redlum Gala	**Z1=Manzgam**	**D1=3333 plants per Ha**
V2= Red Velox	**Z2=Kadder**	**D2=1333 plants per Ha**
V3=Super Chief	**Z3=Qaimoh**	**D3=444 plants per Ha**

From the data in Table 2, more quantity of A-grade apples/tree was obtained in the Red Velox cultivar (14.05 kg) as compared to other cultivars irrespective of planting density and area of cultivation. Similarly, irrespective of cultivar and horticulture zone, higher A-grade apple was obtained in low-density planting system (19.70 kg) as compared to other planting systems. Higher quantity of A-grade apple resulted from the Kadder zone (14.97kg) irrespective of variety and planting density. As far as interaction of cultivar and the planting density is concerned, significantly higher amount of A-grade apples per tree was obtained in Low-density Super Chief plants (20.83kg). Similarly, interaction values between cultivar and zone from Table 2 reveals that a higher quantity of A-grade apple/tree was obtained in Super Chief of Kadder zone (15.88kg) irrespective of planting density however this value was at par with the A-grade apples/tree of Red Velox of Kadder zone (15.19kg). As far as the interaction of cultivar, zone and the planting density is concerned, higher quantity of A-grade apple/tree was obtained in low density Super Chief of Kadder zone (22.01kg) followed by low density Super Chief of Manzgam zone (21.36kg). Table 2 also shows that the quantity of B-grade apple/trees varied significantly among various studied zones, densities and varieties. Difference in final marketable apple grade among cultivars grown in different planting systems may be attributed to variety, rootstock, canopy size, light interception, disease and pest incidence, and edaphic factors [6, 3, 15].

Table 2: Yield of A grade/tree and B grade/tree (kg) as influenced by cultivars, zone of cultivation, and planting Density in apple.

Cultivars	Density \ Zones	A grade apple/tree (kg)				B grade apple/tree (kg)			
		D1	D2	D3	**Mean**	D1	D2	D3	**Mean**
V1	Z1	10.96	13.17	18.95	14.36	3.55	4.46	4.09	4.04
	Z2	9.03	14.49	18.00	13.84	3.50	3.06	3.63	3.40
	Z3	8.22	11.25	20.69	13.39	3.54	4.55	5.11	4.40
Sub-Mean		9.40	12.97	19.21	**13.86**	3.53	4.02	4.28	**3.94**
V2	Z1	10.75	14.30	19.09	14.71	2.25	4.46	3.98	3.56
	Z2	9.67	15.23	20.69	15.19	3.85	4.38	4.77	4.33
	Z3	8.64	10.64	17.42	12.24	2.68	6.06	7.56	5.44
Sub-Mean		9.69	13.39	19.06	**14.05**	2.93	4.97	5.44	**4.44**
V3	Z1	6.87	13.14	21.36	13.79	2.26	3.59	3.95	3.27
	Z2	7.79	17.83	22.01	15.88	3.35	2.58	5.10	3.68
	Z3	6.78	11.18	19.13	12.36	1.39	5.01	3.41	3.27
Sub-Mean		7.15	14.05	20.83	**14.01**	2.33	3.73	4.15	**3.40**
Factor Mean	Densities	**8.74**	**13.47**	**19.70**		**2.93**	**4.24**	**4.62**	
	Zones	**14.29**	**14.97**	**12.66**		**3.62**	**3.80**	**4.37**	
CD (p<0.05)		Cultivars (V) = 0.44 Zones (Z) = 0.44 Density (D) = 0.44 Cultivars* Zones (V*Z) = 0.77 Cultivars* Density (V*D) = 0.77 Density*Zones (D*Z) = 0.77 Cultivars* Density * Zones (V*D*Z) = 1.33				Cultivars (V) = 0.54 Zones (Z) = 0.54 Density (D) = 0.54 Cultivars* Zones (V*Z) = 0.95 Cultivars* Density (V*D) = 0.95 Density*Zones (D*Z) = 0.95 Cultivars* Density * Zones (V*D*Z) = 1.64			
V1 = Redlum Gala	**Z1=Manzgam**				**D1=3333 plants per Ha**				
V2= Red Velox	**Z2=Kadder**				**D2=1333 plants per Ha**				
V3=Super Chief	**Z3=Qaimoh**				**D3=444 plants per Ha**				

Data in the table 3 reveals that the least quantity of C-grade apples/tree was obtained in Super Chief cultivar (2.27kg/tree) irrespective of planting density and zone of cultivation. Similarly, data in Table 3 shows that irrespective of cultivar and planting density, lowest quantity of C-grade apples was observed in the Manzgam zone (2.16kg/tree) while as high density system resulted in the lowest quantity of C-grade apples/tree (2.23kg/tree). Super chief cultivar yielded lowest C-grade apple in Kadder zone (1.80kg/tree), while as highest quantity of C-grade apple resulted in Red Velox cultivar of grown in Qaimoh zone (4.79kg/tree).

Table 3: Yield of C-grade/tree as influenced by cultivars, zone of cultivation, and planting Density in apple.

Cultivars	Density / Zones	C-grade apple/tree (kg)			
		D1	D2	D3	**Mean**
V1	Z1	0.78	1.18	4.12	2.03
	Z2	2.99	4.29	5.79	4.36
	Z3	2.27	3.10	3.54	2.97
Sub-Mean		**2.01**	**2.86**	**4.48**	**3.12**
V2	Z1	2.96	1.02	3.69	2.56
	Z2	3.44	2.05	2.74	2.75
	Z3	3.58	4.89	5.89	4.79
Sub-Mean		**3.33**	**2.65**	**4.11**	**3.36**
V3	Z1	1.17	1.88	2.59	1.88
	Z2	1.04	1.29	3.07	1.80
	Z3	1.87	3.20	4.32	3.13
Sub-Mean		**1.36**	**2.12**	**3.33**	**2.27**
Factor Mean	Densities	**2.23**	**2.54**	**3.97**	
	Zones	**2.16**	**2.97**	**3.63**	
CD (p<0.05)		Cultivars (V) = 0.63 Zones (Z) = 0.63 Density (D) = 0.63 Cultivars* Zones (V*Z) = 1.10 Cultivars* Density (V*D) = 1.10 Density*Zones (D*Z) = 1.10 Cultivars* Density * Zones (V*D*Z) = 1.91			
V1 = Redlum Gala		**Z1=Manzgam**	**D1=3333 plants per Ha**		
V2= Red Velox		**Z2=Kadder**	**D2=1333 plants per Ha**		
V3=Super Chief		**Z3=Qaimoh**	**D3=444 plants per Ha**		

Similarly, irrespective of the zone of cultivation, least quantity of C-grade apple/tree resulted in high-density Super Chief cultivar (1.36kg/tree), while as highest c-grade apple was obtained in low density Redlum Gala cultivar (4.48kg/tree). As far as interaction is concerned, high-density Redlum Gala in Manzgam horticultural zone produced least quantity of C-grade apple/tree (0.78kg) whereas, highest quantity of C-grade apple resulted from low density Red Velox of Qaimoh Zone followed by low-density Redlum Gala of Kadder Zone.

References

1. Bhat TA, Choure T (2014). Status and strength of apple industry in Jammu and Kashmir. *Inter J Res* 1(4): 277-83.

2. Dhiman N, Chandel JS, Verma P (2018). Effect of planting density on growth, yield and fruit quality of apple cv. Jeromine. *J Hill Agri* 9(3): 289-91.

3. Ganiyeva FA(2023). Apple tree productivity depending on planting density and rootstock variety combinations. *E3S Web of Conferences* 389. 10.1051/e3sconf/202338903014.

4. Hokanson S, Lamboy W, Szewc-McFadden A, McFerson J(2001). Microsatellite (SSR) variation in a collection of *Malus* (apple) species and hybrids. *Euphytica* 118 : 281–94.

5. 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)

6. Lauzike K, Uselis N, Samuoliene G(2021). The Influence of Rootstock and High-Density planting on Apple cv. Aukis Fruit quality. *Plants (Basel)* 10(6):1253 https://doi.org/10.3390/plants10061253.

7. Mir AA, Sampath R (2022). Growth and performance of Apple production in Kulgam district of Jammu and Kashmir. *J Xi'an Shiyou Uni, Nat Sci* 18 (4): 368 -76.

8. Mir JI, Ahmed N, Singh DB, Sharma OC, Sharma A, Shafi W, Zaffer S, Hamid, A. (2016). Effect of planting densities on productivity of different cultivars in apple (*Malus × domestica*) *Ind J Agricul Sci* 86 (8): 1059–62.

9. Mubarak, T., Khanday, A. S., Shergojry, S.A. and Rehman, H.U. 2023. Impact of Integrated Farming System (IFS) on crop production and farm income under Temperate Hill Ecology. *SKUAST Journal of Research* 25(1): 141-45.

10. Mushtaq R, Pandit A, Mir MA, Malik AR, Wani AW, Sharma MK, Nowsheen N (2023). Physico-chemical and sensory evaluation of fruit quality of introduced exotic apple varieties under high density plantation in Kashmir Valley. *SKUAST J Res* 25(2): 207-13.

11. Rana HS, Awasthi RP, Sharma RM, Jha A (1998). Effect of training system on canopy physiology, fruit yield and quality of peach. *J Hill Res* 11: 38-42.

12. Rehman HU, Mubarak T (2023). Evaluation of performance of rejuvenated apple orchard in North Western Himalayas. *J Emer Tech Innov Res* 10(6): 770-76.

13. Shah ZA, Dar MA, Dar EA, Obianefo CA, Bhat AH, Ali MT, El-Sharnouby 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. https://doi.org/10.3390/su142114544.

14. Sheoran OP, Tonk DS, Kaushik LS, Hasija RC, Pannu, RS(1998) Statistical Software Package for Agricultural Research Workers. Department of Mathematics Statistics, CCS HAU, Hisar, 139-43.

15. Srivastava KK, Kumar D, Singh SR, Sharma OC (2019). Effect of cultivars on tree growth, yield and quality attributes of apple on espalier architecture under high density planting system. *J Horti Sci* 14(1): 20-25.

16. Srivastava KK, Singh DB, Kumar D, Singh SR, Sharma OC, Lal S (2017). Effect of planting densities and varieties on yield and yield associated characters of apple (*Malus× domestica*) on semi-dwarfing rootstock. *Ind J Agri Sci* 87 (5): 593-96.

17. Uselis N, Viskelis J, Lanauskas J, Liaudanskas M, Janulis V, Kviklys D (2020). Planting distance affects apple tree growth, fruit yield and quality. *Zemdirb Agri* 107: 367–72.

18. Wani SA, Kumar S, Naqash F, Shaheen FA, Wani FJ, Rehman HU (2021). Potential of apple cultivation in doubling farmer's income. *Ind J Agri Econ* 76(2): 278-91.

19. Widmer A, Krebs C (2001). Influence of planting density and tree form on field and fruit quality of 'Golden Delicious' and 'Royal Gala' apples. *Acta Hort* 557: 235-41.