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Effect of different Doses and Timings of Fertigation on Vegetative Growth of High Density Apple Cultivars Mitch Gala and Red Chief Camspur

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ABSTRACT: The present investigation entitled ''Effect of different doses and timings of fertigation on vegetative growth of high density apple cultivars Mitch Gala and Red Chief Camspur'' was carried out on two apple varieties *viz.*, Mitch Gala and Red Chief Camspur (4 year old) on M9T337 rootstock at a spacing of 1 × 3m (3333 plants ha^{-1}) at the experimental field of Division of Fruit Science, SKUAST-K, Shalimar, Srinagar during the year 2020 and 2021. The said experiment was conducted to determine the optimum dose of fertilizers through fertigation as well as to study the effects of different doses and timings of NPK fertigation on vegetative growth parameters of apple under high density orcharding system. Twenty-six different treatments were given, which comprised of three different fertilizer doses (D_1- 125%, D_2- 100% and D_3- 75% RDF through fertigation) applied at four different time intervals (7, 14, 21 and 28 days interval) replicated in a Randomized Complete Block Design (RCBD) starting from Mid-April to July. The different doses and timings of fertigation had shown significant effect on growth parameters of both the apple cultivars. A comparison of data on overall vegetative growth reveals that fertigation with 125% RDF at 7 days interval increased the plant height, plant girth, TCSA and plant spread which was statistically at par with 100% RDF at 7 days interval. Therefore, applying nutrients to apple plants with 100% RDF through fertigation at 7 days interval may be considered as the best possible levels of fertigation for improving vegetative growth characters of apple under high density orcharding system.

Keywords: Apple, Mitch Gala, Red Chief Camspur, high density, fertigation, vegetative growth.

INTRODUCTION

Apple is the most ubiquitous of temperate fruits belonging to family Rosaceae and sub family Pomoideae, genus *Malus*, with a haploid basic chromosome number of x = 17. It is the most important temperate crop of India with regard to acreage and economic value. Its primary centre of origin is south-western Asia, in the Caucasus region near Gilan in Turkestan and domesticated by Greeks and Romans and few centuries BC in Middle-East and South-eastern Europe as a result of their travel and invasions. Over 7,500 apple cultivars are known (Elzebroek and Wind 2008) and used not only for fresh consumption, but also for consumption as processed materials such as juice, pie or cider. The major acids in apple are maleic and citric acid. Apple is believed to reduce the incidence of dental caries, helps to control obesity and supply extra energy for exercise. Apples are awfully rich in antioxidants, flavonoids and dietary fibres. In India, apple occupies an area of 3, 08,000 hectares with an annual production of 27, 34,000 MT and productivity of 8.88 MT ha^{-1} (Anonymous, 2019-20). The total apple growing area in Jammu and Kashmir is 1, 64,854

hectares with production of 20, 26,472 MT and productivity of 12.29 MT ha^{-1} (Anonymous, 2019-20). The productivity of apple in India is very low as compared to developed countries like China, Italy, Spain, USA etc. The low productivity has been attributed to various reasons *viz*., peculiar location of orchards on slopy lands, shallow, unirrigated and less fertile soils besides inadequate nutrition and improper plant protection measures. In addition, most of the apple orchards are raised as low density orchards which are not precocious but labour intensive, low yielding and produce fruits of low quality. It has necessitated the apple growers to change over to more efficient orcharding systems by the use of critical inputs like water, fertilizers and soil health which will definitely affect the quality and production of fruits. Various studies have shown that increasing the production of high quality fruits per unit area is the best mean to increase the efficacy of the orchard. Increased yield have been recorded when water and fertilizers were applied through a drip irrigation system.

Fertigation *i.e*., application of fertilizer with the irrigation water seems to be a promising and viable option to ensure the delivery of these two basic components efficiently and economically, directly to the root zone of the fruit trees as and when required. This practice is already in vogue in scientifically advanced countries and has yielded manifold benefits to a fruit grower by way of high production per unit area, high quality fruit and better returns from the market. Fertigation has been flourishing in apple orchards, where application of nutrient is accompanied with plant demand, as influenced by age of the plant, growth cycle and weather conditions. Positive effects have been reported on tree vegetative status of apple; for example, application of 125% and 100% RDF as water soluble fertilizers through fertigation resulted in highest vegetative growth characters (Singh *et al.*, 2007; Mason *et al.*, 2018; Thakur *et al.*, 2020; Kumar and Haroon 2021). Although sufficient scientific information is available in the country as well as abroad on the fertigation in different fruit crops. However, no information is generated on the temperate fruit crops especially in the slopy shallow and infertile areas of Jammu and Kashmir. Keeping all these aspects in mind, the present investigation was undertaken in 2020 and 2021 with the objectives to study the influence of fertigation on vegetative growth characters of apple cvs. Mitch Gala and Red Chief Camspur under high density orcharding system in Kashmir valley.

MATERIAL METHODS

The experiment was conducted in the Experiment Farm of Division of Fruit Science at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar during the years 2020 and 2021 to ascertain the response of different doses and timings of fertigation on Apple Cv. Mitch Gala and Red Chief Camspur. The details of the experimental treatments are illustrated in Table 1. The experiment consisted of 26 treatment combinations containing three levels (125, 100 and 75% recommended dose of fertilizers through fertigation) applied at four different time intervals (7, 14, 21 and 28 days interval) replicated in a Randomized Complete Block Design (RCBD). The SKUAST-K campus is located within Srinagar district at an elevation of 1605 m above mean sea level and latitude and longitude of 34^{o} 05' N and 74^{o} 50' E. The climate of the experimental site was temperate with average maximum and minimum temperatures of 24.5 ^{o}C and 16.7^{o}C respectively. The average annual rainfall is around 720mm. The nutrients N, P and K were applied through fertilizers such as Urea, TSP and K_2SO_4 and applied through fertigation application after working out the appropriate dosage. Under conventional soil fertilization, full doses of DAP was applied fortnight before flowering and urea and MOP was applied in two split doses, half of the amount was applied fortnight before flowering and remaining half dose was applied three weeks after fruit set. Fertigation was done through venturi starting from mid-April of each experimental year and continued till July. In fertigation, the total quantities of water soluble NPK fertilizer were divided into different split doses as shown in Table 1 depending upon the fertigation treatments and were applied through drip irrigation. The study focused on vegetative growth parameters *viz.*, plant height, plant girth, TCSA and plant spread. The statistical analysis of the data was carried out as per the method described by Gomez and Gomez (1984). The test of significance was made with 5 per cent of significance.

Table 1: Treatment details.

Treatments	Dosage (2020)	Dosage (2021)
Control	Full P and half dose of N &K applied one fortnight before bloom and rest 3 weeks after fruit-set	Full P and half dose of N &K applied one fortnight before bloom and rest 3 weeks after fruit-set
D_1t_1	V_1: 14 split doses (27N, 15P, 32K-g/tree) V_2: 16 split doses (24N,13P,28K- g/tree)	V_1: 14 split doses (33N, 18P, 40K-g/tree) V_2: 16 split doses (29N, 16P, 35K-g/tree)
D_1t_2	V_1: 07 split doses (54N, 29P, 64K-g/tree) V_2: 08 split doses (47N, 25P, 56K-g/tree)	V_1: 07 split doses (65N, 36P, 80K-g/tree) V_2: 08 split doses (57N, 32P, 70K-g/tree)
D_1t_3	V_1: 05 split doses (75N, 40P, 90K-g/tree) V_2: 06 split doses (63N, 34P, 75K-g/tree)	V_1: 05 split doses (91N, 51P, 112K-g/tree) V_2: 06 split doses (76N, 42P, 94K-g/tree)
D_1t_4	V_1: 04 split doses (94N, 51P, 113K-g/tree) V_2: 05 split doses (75N, 40P, 90K-g/tree)	V_1: 04 split doses (114N, 63P, 141K-g/tree) V_2: 05 split doses (91N, 51P, 112K-g/tree)
D_2t_1	V_1: 14 split doses (22N, 12P, 26K-g/tree) V_2: 16 split doses (19N, 11P, 23K-g/tree)	V_1: 14 split doses (26N, 14P, 32K-g/tree) V_2: 16 split doses (23N, 13P, 28K-g/tree)
D_2t_2	V_1: 07 split doses (43N, 23P, 51K-g/tree) V_2: 08 split doses (38N, 20P, 45K-g/tree)	V_1: 07 split doses (52N, 29P, 64K-g/tree) V_2: 08 split doses (46N, 25P, 56K-g/tree)
D_2t_3	V_1: 05 split doses (60N, 33P, 72K-g/tree) V_2: 06 split doses (50N, 27P, 60K-g/tree)	V_1: 05 split doses (73N, 40P, 90K-g/tree) V_2: 06 split doses (61N, 34K, 75K-g/tree)
D_2t_4	V_1: 04 split doses (75N, 41P, 90K-g/tree) V_2: 05 split doses (60N, 33P, 72K-g/tree)	V_1: 04 split doses (92N, 51P, 113K-g/tree) V_2: 05 split doses (73N, 40P, 90K-g/tree)
D_3t_1	V_1: 14 split doses (16N, 9P, 19K-g/tree) V_2: 16 split doses (14N, 8P, 17K-g/tree)	V_1: 14 split doses (16N, 11P, 19K-g/tree) V_2: 16 split doses (14N, 8P, 17K-g/tree)
D_3t_2	V_1: 07 split doses (32N, 17P, 39K-g/tree) V_2: 08 split doses (28N, 15P, 34K-g/tree)	V_1: 07 split doses (32N, 17P, 39K-g/tree) V_2: 08 split doses (28N, 15P, 34K-g/tree)
D_3t_3	V_1: 05 split doses (45N, 24P, 54K-g/tree) V_2: 06 split doses (38N, 20P, 45K-g/tree)	V_1: 05 split doses (45N, 24P, 54K-g/tree) V_2: 06 split doses (38N, 20P, 45K-g/tree)
D_3t_4	V_1: 04 split doses (57N, 31P, 68K-g/tree) V_2: 05 split doses (45N, 24P, 54K-g/tree)	V_1: 04 split doses (57N, 30P, 68K-g/tree) V_2: 05 split doses (45N, 24P, 54K-g/tree)

D_1 - 125% RDF through fertigation; D_2 - 100% RDF through fertigation; D_3 - 75% RDF through fertigation; t_1 -7 days interval; t_2 -14 days interval; t_3 -21 days interval and t_4 -28 days interval; V_1- Mitch Gala; V_2- Red Chief Camspur

RESULTS AND DISCUSSION

The data presented in Tables 2-5 revealed that the increase in vegetative tree growth parameters like plant height (m), plant girth (cm), trunk cross sectional area (cm^2) and plant spread (m) were significantly influenced by the application of various doses and timings of nitrogen, phosphorous and potassium fertigation. Among all treatments, maximum plant height (cm), plant girth (cm), trunk cross sectional area (cm^2) and plant spread (m) were observed with 125% RDF through fertigation at 7 days interval in both the varieties *viz.,* Mitch Gala (3.13m, 15.93 cm, 20.25 cm^2 and 0.99m) and Red Chief Camspur (2.45m, 14.93 cm, 17.79 cm^2 and 0.92 m) which was statistically at par with plant height, plant girth and TCSA at 100% RDF through fertigation at 7 days interval (3.02 m, 15.87 cm and 20.10 cm^2; 2.40 m, 14.86 cm and 17.61 cm^2) and 125% RDF through fertigation at 14 days interval (3.06 m, 15.77 cm and 19.83 cm^2; 2.40 m, 14.77 cm and 17.40 cm^2) while as minimum was recorded in control in both the varieties (2.39 m, 14.67 cm, 14.67 cm^2 and 0.76 m; 1.87 m, 12.83 cm, 12.83 cm^2 and 0.73 m) respectively. Interactive effect of V × Days × D had shown non-significant effect on plant height, plant girth, trunk cross sectional area and plant spread during both years of study.

The increase in vegetative growth parameters (Fig. 1) were probably due to more absorption of nitrogen, phosphorus and potassium by plant, which is directly involved in carbohydrate synthesis in the leaves leading to formation of many bio compounds *viz.,* amino acids, proteins, chlorophyll and other amides. This increases the photosynthetic activity of the plants leading to building up of new tissues, hence enhanced the overall plant growth. There was a continuous supply of nutrients in fertigation treatments as fertilizers were applied in 14-16 split doses during the entire growth period of the plant which might have helped in meeting the requirement of nutrients during critical period of crop growth. The higher vegetative growth parameters recorded under 125% and 100% RDF through fertigation at 7 days interval may be due to the increased nutrient use efficiency by minimizing the leaching losses coupled with split application of NPK fertilizers through drip over one time application of fertilizers as soil application. The influence of drip fertigation on plant growth of apple and found that trees subjected to F_1 fertigation level [100 % of AD (NPK)] registered significantly higher tree height (26.60 and 28.10 cm) and tree spread (18.14 and 19.65 cm) than F_2 fertigation level [75 % of AD (NPK)] respectively. Similar results have been obtained by Kumar and Haroon (2021) who found that fertigation with 125% RDF resulted in highest plant height (271.0 cm), tree spread (179.00 cm) and plant girth (30.02 mm) while evaluating water requirement and fertigation in high density planting of apples. The present investigation lead credence to the earlier observations made by Haneef *et al.* (2014) in pomegranate, Goud *et al*. (2017) in Nagpur Mandarin, Verma *et al.* (2017) in peach, Thakur *et al*. (2020) in apple, Chennakesavulu *et al.* (2021) custard apple, who observed that fertigation leads to increase in vegetative growth parameters.

Table 2: Effect of various doses and timings of fertigation on plant height (m) of apple cvs. Mitch Gala and Red Chief Camspur.

Varieties (V)	Doses (D)	Plant height (m)					
		Pooled (2020 and 2021)					
		Days					Control
		7	14	21	28	Sub-Mean	
V_1	D_1	3.13	3.06	3.00	2.93	3.03	2.39
	D_2	3.02	2.96	2.80	2.74	2.88	
	D_3	2.51	2.48	2.44	2.40	2.45	
	Sub-Mean	**2.86**	**2.85**	**2.74**	**2.69**	**2.78**	
V_2	D_1	2.45	2.40	2.37	2.34	2.39	1.91
	D_2	2.40	2.13	2.09	2.05	2.17	
	D_3	2.04	1.96	1.92	1.87	1.95	
	Sub-Mean	**2.29**	**2.16**	**2.13**	**2.08**	**2.17**	
	D_1	2.79	2.73	2.68	2.63	2.71	
	D_2	2.68	2.58	2.44	2.39	2.52	
	D_3	2.28	2.22	2.18	2.13	2.20	
Overall days		**2.58**	**2.51**	**2.44**	**2.39**	**2.48**	
CD (P≤0.05)		V × Days				NS	
V	0.150	V × D				NS	
Days	0.130	Days × D				NS	
D	0.213	V × Days × D				NS	

Table 3: Effect of various doses and timings of fertigation on plant girth (cm) of apple cvs. Mitch Gala and Red Chief Camspur.

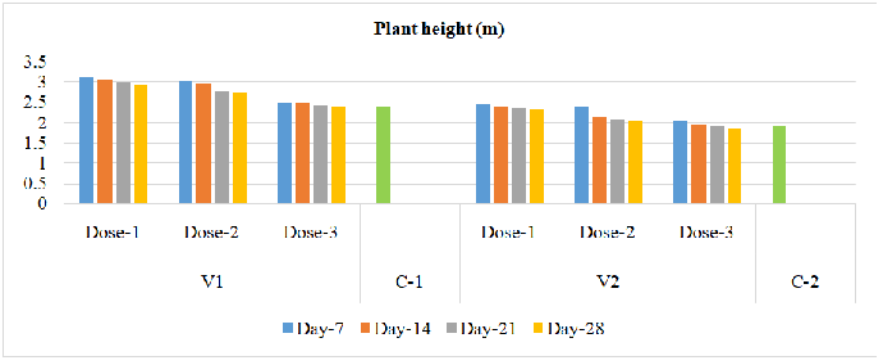
Varieties (V)	Doses (D)	Plant girth (cm)					
		Pooled (2020 and 2021)					
		Days					Control
		7	14	21	28	Sub-Mean	
V_1	D1	15.93	15.77	15.54	15.42	15.67	14.67
	D_2	15.87	15.39	15.24	15.07	15.39	
	D_3	15.20	14.98	14.88	14.76	15.00	
	Sub-Mean	**15.67**	**15.38**	**15.22**	**15.08**	**15.34**	
V_2	D_1	14.93	14.77	14.63	14.37	14.67	12.83
	D_2	14.86	14.02	13.80	13.52	14.05	
	D_3	13.62	13.36	13.17	12.85	13.25	
	Sub-Mean	**14.47**	**14.05**	**13.87**	**13.58**	**13.99**	
	D_1	15.43	15.27	15.09	14.89	15.17	
	D_2	15.37	14.71	14.52	14.30	14.72	
	D_3	14.41	14.17	14.02	13.81	14.10	
Overall days		**15.07**	**14.72**	**14.54**	**14.33**	**14.66**	
CD (P≤0.05)		V × Days				NS	
V	0.478	V × D				NS	
Days	0.414	Days × D				NS	
D	0.676	V × Days × D				NS	

Table 4: Effect of various doses and timings of fertigation on TCSA (cm^2) of apple cvs. Mitch Gala and Red Chief Camspur.

Varieties (V)	Doses (D)	TCSA(cm^2)					
		Pooled (2020 and 2021)					
		Days					Control
		7	14	21	28	Sub-Mean	
V_1	D_1	20.25	19.83	19.25	18.95	19.57	17.20
	D_2	20.10	18.88	18.34	18.09	18.85	
	D_3	18.40	17.88	17.64	17.36	17.82	
	Sub-Mean	**19.58**	**18.86**	**18.41**	**18.13**	**18.75**	
V_2	D_1	17.79	17.40	17.13	16.48	17.20	13.10
	D_2	17.61	15.67	15.18	14.58	15.76	
	D_3	14.77	14.23	13.81	13.17	14.00	
	Sub-Mean	**16.73**	**15.77**	**15.37**	**14.74**	**15.65**	
	D_1	19.02	18.61	18.19	17.72	18.38	
	D_2	18.86	17.27	16.76	16.33	17.31	
	D_3	16.59	16.05	15.73	15.27	15.91	
Overall days		**18.15**	**17.31**	**16.89**	**16.44**	**17.20**	
CD (P≤0.05)		V × Days				NS	
V	1.705	V × D				NS	
Days	1.477	Days × D				NS	
D	2.412	V × Days × D				NS	

Table 5: Effect of various doses and timings of fertigation on plant spread (m) of apple cvs. Mitch Gala and Red Chief Camspur.

Varieties (V)	Doses (D)	Plant spread (m)					
		Pooled (2020 and 2021)					
		Days					Control
		7	14	21	28	Sub-Mean	
V_1	D_1	0.99	0.94	0.93	0.91	0.94	
	D_2	0.94	0.89	0.87	0.86	0.89	0.76
	D_3	0.83	0.81	0.79	0.77	0.80	
	Sub-Mean	**0.92**	**0.88**	**0.86**	**0.84**	**0.88**	
V_2	D_1	0.92	0.91	0.90	0.88	0.90	
	D_2	0.90	0.87	0.84	0.83	0.86	0.73
	D_3	0.84	0.80	0.79	0.77	0.80	
	Sub-Mean	**0.89**	**0.86**	**0.84**	**0.83**	**0.85**	
	D_1	0.95	0.93	0.91	0.90	0.92	
	D_2	0.92	0.88	0.86	0.84	0.87	
	D_3	0.84	0.80	0.79	0.77	0.80	
Overall days		**0.90**	**0.87**	**0.85**	**0.84**	**0.86**	
CD (P≤0.05)							
V	0.021	V × Days			NS		
Days	0.018	V × D			NS		
D	0.029	Days × D			NS		
		V × Days × D			NS		



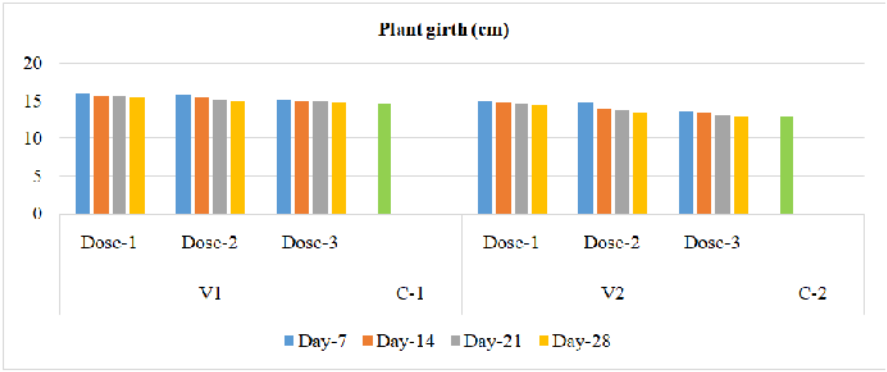


Fig. 1. Effect of various doses and timings of fertigation on plant height (m) and plant girth (cm) of apple cvs. Mitch Gala and Red Chief Camspur.

CONCLUSION

This two years study shows positive effects of different doses and timings of NPK fertigation on enhancing vegetative growth characters of apple cvs. Mitch Gala and Red Chief Camspur. Fertigation with 125% RDF at 7 days interval gave the highest plant height, girth, TCSA and plant spread in both the varieties Mitch Gala and Red Chief Camspur under high density planting conditions which is statistically at par with 100% RDF through fertigation at 7 days interval and 125% RDF at 14 days interval. Thus 100% RDF through fertigation at 7 days interval can be recommended for growing apples under high density conditions of Kashmir. Further research on the use of sensors in fertigation is required in order to fully develop the scientific basis for recommending fertigation to local growers thus adding helping hand to their income.

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Conflict of Interest. None.

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