



Productivity of Different Irrigation Regimes on Leaf Characteristics and NPK Levels in Sweet Cherry under High Density Orcharding System in Kashmir, India

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Abstract: The present study was carried out on drip irrigation scheduling in sweet cherry cv. Regina in Kashmir valley where this fruit crop is exclusively being grown under the rain fed conditions. The treatment combinations I_3T_3 (100 percent ETc level of irrigation applied at fruit growth stage) and I_3T_4 (100 percent ETc level of irrigation applied at fruit bud differentiation stage) significantly improved growth, yield, quality, leaf characteristics and nutrient levels in sweet cherry. Crop evapotranspiration (ETc) was minimum during winter (December-February) and maximum in summer months (June-August). The average crop water requirement in sweet cherry varied from 13.48 to 22.21 litres/tree/day. Leaf area as well as leaf chlorophyll were significantly higher in plants receiving highest irrigation level as compared to control trees. The maximum leaf N content (2.107%), P content (0.193%) and K content (1.538%) were recorded when 100 per cent ETc (I_3) level of irrigation was used, which was significantly at par with leaf N and P content of sweet cherry at 75 per cent ETc (I_2) level of irrigation. On applying the higher irrigation levels (75 and 100 %), the nutrient contents in the sweet cherry leaves were significantly higher in comparison to the lower water levels (50 and 0%). The results can be utilized to manage the water requirement of sweet cherry especially during the periods of water scarcity as it defines the appropriate amounts of water requirement at different growth stages of sweet cherry thereby help in conserving the water resources to a larger extent for their use in future.

Keywords: Crop water requirement, Evapotranspiration, Irrigation, Sweet cherry

Erratic water distribution throughout the year reduces the yield and quality of fruit crops as water isn't available during their critical stages of growth and development and becomes imperative to analyse the crop water requirement of each and every crop so that irrigation can be tailored during the most important stages of crop growth. The system of irrigation used in the orchards also plays a phenomenal role in the conservation of water and increase in yield (Kumar et al 2017). The use of micro irrigation system i.e., drip irrigation uses water very efficiently with a minimum or zero wastage, use of micro irrigation in the orchards can help the farmers to mitigate the effects of drought (Sharma and Yadav 2021). Drip irrigation ensures water use efficiency as much as 90-95% (Khadeeja and Ratansharan 2017). Sweet cherry is one of the most important fruits grown throughout the temperate region of Asia, Europe, Northern Africa, Australia and most of North America. The commercially important edible cherries are mainly obtained from *Prunus avium* (sweet cherry) and *Prunus cerasus* (sour or tart cherry). Sweet cherry (*Prunus avium* L.) belongs to the family Rosaceae and sub-family Prunoideae. Attractive colour, sweetness, sourness, firmness, wealth of antioxidants and nutrients are the main characteristics for cherry quality (Gabriele et al 2013). However, a very high percentage of perennial fruit orchards including the sweet cherry in India and particularly in Jammu

and Kashmir are bereft of any irrigation facilities and rainfall is the only source of moisture. Consequently water is not available to the plants during their critical stages of growth, leading to poor yield and poor fruit quality. Moreover, orchards are mostly raised on foothills or *Karewas* where there are negligible irrigation facilities. The tree after harvest should be also irrigated as the stress is one of the reasons for gummosis of tree trunk. Furthermore, the traditional irrigation system of flooding practiced by a majority of orchardists results in wastage of water besides ill effect on tree growth and fruit quality. Thus, there was a need to assess the critical stages of irrigation for qualitative and quantitative attributes of cherry. Therefore, fundamental research on the water needs of the sweet cherry was undertaken so that the growers could manage their orchards properly, particularly in drought periods.

MATERIAL AND METHODS

The research was carried out at SKUAST-K, Shalimar during 2016-17 and 2017-18. The effect of four different irrigation regimes through drip irrigation system at four growth stages was tested on 4 year old sweet cherry trees cv. Regina on Gisela 5 rootstock planted at a distance of 4 x 2 m² spacing with uniform size, vigour and health (Table 1). Irrigation scheduling of sweet cherry trees planted under the

high density orcharding system was carried out in Kashmir to meet growing water issues by evaluating the water requirement of sweet cherry on daily basis. Sweet cherry growing season was split into four phenological stages viz., fruit set stage (T_1), pit hardening stage (T_2), fruit growth stage (T_3) and fruit bud differentiation stage (T_4). The effect of different irrigation levels at various phenological stages on vegetative, yield, quality and nutritive parameters were determined. Four irrigation regimes viz., 0% ETc (I_0), 50% ETc (I_1), 75% ETc (I_2) and 100% ETc (I_3) were applied based on different percentages of Class A pan evaporation at four phenological stages viz., T_1 , T_2 , T_3 and T_4 . The difference between water levels was 25%. The impact of different water levels applied at different growth stages on leaf parameters like the leaf area, leaf chlorophyll content and leaf nutrient levels was evaluated using the drip system of irrigation.



Sweet cherry at peak bloom stage



Sweet cherry plants at pre harvest stage

Observations

Leaf area: Leaf area was measured with the help of Systronics leaf area meter-211.

Leaf chlorophyll: Chlorophyll content in leaf samples was

estimated by DMSO method given by Arnon (1949).

Leaf nutrient analysis: Leaf sampling was done in mid-July. The samples were prepared for analysis by proper washing and drying. Dried leaves were then used for chemical analysis.

Leaf N: Nitrogen was estimated by Kjeldahl method (Kjeldahl1883).

Leaf P and K: Phosphorus (P) content was determined by using ammonium-molybdate: ammonium metavanadate (Jackson 1973).

RESULTS AND DISCUSSION

Leaf area: Maximum leaf area (44.85cm^2) was exhibited by trees receiving (I_3)100 per cent ETc level of irrigation. The highest leaf area of sweet cherry (44.65cm^2) was observed at fruit bud differentiation stage (T_4 phenological stage). I_3T_4 (44.99cm^2) treatment combination was best combination for leaf area in sweet cherry (Table 1). Leaf area increased with increased levels of irrigation during both the years of investigation. Increased leaf area under optimum irrigation regimes is due to the increased turgidity, efficient photosynthesis and production of more assimilates(Tamboli et al 2024). Increased leaf area at higher levels of irrigation might be due to better root establishment. The maximum development of leaf apparatus i.e., to reach a maximal leaf area on which the biological and the economic yields largely depend is ensured by optimal irrigation level at a particular stage. The results are in uniformity with other studies (Mishra et al 2019, Kumar and Dhillon 2023).

Leaf chlorophyll: There was significant increase in leaf chlorophyll content of sweet cherry with increased levels of irrigation. The maximum of $2.308\text{mg}/100\text{g}$ was recorded with 100 per cent ETc (I_3) level of irrigation and the lowest of $1.980\text{mg}/100\text{g}$ was obtained with 0 per cent ETc (I_0) level of irrigation. Leaf chlorophyll of sweet cherry significantly increased with different levels of irrigation. The decrease in chlorophyll content at lower irrigation regimes might be due to disorganization of chloroplasts.

Leaf nutrient content: Leaf NPK levels indicated significant variation with application of different irrigation levels at various phenological stages of growth in sweet cherry. The maximum leaf N content (2.107%), P content (0.193%) and K content (1.538%) were at 100 per cent ETc (I_3) level of irrigation. The highest leaf N content (1.901%), P content (0.208%) and K content (1.550%) were at T_4 phenological stage. The interaction effect of irrigation and phenological stages also showed a significant influence on leaf N and K content of sweet cherry. The maximum leaf N and K content of 2.212 and 1.585% were obtained in I_3T_3 and I_3T_4 combination, respectively (Table 2). The results were in

Table 1. Effect of different irrigation levels at various phenological stages on leaf area (cm²) and leaf chlorophyll (mg/100g) of sweet cherry (Pooled data for 2 years)

Year	Leaf area (cm ²)					Leaf chlorophyll (mg/100g)				
	T ₁	T ₂	T ₃	T ₄	Mean	T ₁	T ₂	T ₃	T ₄	Mean
Phenological stages										
Irrigation levels										
I ₀	44.35a	44.28a	44.34a	44.43a	44.35b	1.751	1.826	2.105	2.239	1.980d
I ₁	44.47a	44.55a	44.52a	44.68a	44.53a	2.143	2.207	2.225	2.296	2.218c
I ₂	44.51a	44.50a	44.51a	44.65a	44.59a	2.160	2.238	2.284	2.369	2.262b
I ₃	44.66a	44.74a	44.88a	44.99a	44.82a	2.173	2.288	2.302	2.470	2.308a
Mean	44.50a	44.52a	44.63a	44.65a		2.057	2.140	2.229	2.343	
CD (p=0.05)	Irrigation (I) = 0.355					Irrigation (I) = 0.042				
	Stages (T) = 0.355					Stages (T) = NS				
	I x T = 0.710					I x T = NS				

T₁= Fruit set stage (15April-5May); T₂ = Pit hardening stage (6 May-25May);
T₃ = Fruit growth stage (26 May-8 June); T₄ = Fruit bud differentiation stage (1 July- 31 August)
I₀ = 0 % ETc; I₁ = 50 % ETc; I₂ = 75 % ETc; I₃ = 100 % ETc

Table 2. Effect of different irrigation levels at various phenological stages on leaf N, P and K of sweet cherry (Pooled mean for two years)

Nutrients	N (%)					P (%)					K (%)				
	T ₁	T ₂	T ₃	T ₄	Mean	T ₁	T ₂	T ₃	T ₄	Mean	T ₁	T ₂	T ₃	T ₄	Mean
Phenological stages															
Irrigation levels															
I ₀	1.132	1.112	1.239	1.159	1.160c	0.173	0.152	0.180	0.193	0.174c	1.455	1.477	1.503	1.537	1.493d
I ₁	1.930	1.623	1.975	2.125a	1.913b	0.173	0.160	0.187	0.197	0.179b	1.456	1.505	1.546	1.551	1.513c
I ₂	1.948	1.778	2.160a	2.148a	2.009a	0.180	0.168	0.197	0.211	0.189a	1.473	1.497	1.522	1.558	1.514b
I ₃	2.112a	1.930	2.212a	2.175a	2.107a	0.180	0.173	0.187	0.232	0.193a	1.495	1.523	1.550	1.585a	1.538a
Mean	1.780a	1.611c	1.896a	1.901a		0.176c	0.163d	0.188b	0.208a		1.469c	1.490d	1.530b	1.550a	
CD (p=0.05)	Irrigation (I) = 0.129					Irrigation (I) = 0.005					Irrigation (I) = 0.007				
	Stages (T) = 0.129					Stages (T) = 0.005					Stages (T) = 0.007				
	I x T = 0.258					I x T = NS					I x T = 0.014				

See Table 1 for details

uniformity with earlier study (Zaliha et al 2014). Water is essential for nutrient uptake by root interception, mass flow and diffusion also the increased availability of nutrients under high moisture conditions might have accounted for their higher uptake (Ray et al 2016). Roots intercept more nutrients when they grow in a moisture rich soil rather than in a drier soil because root growth is more extensive might be the reason for higher nutrient uptake at higher irrigation levels (Sharma and Singh 2022). The root growth, nutrient transport to rhizosphere and solubility of nutrients in soils are inversely related to water deficiency in the soils, nutrient uptake and transport in the plants are negatively affected under water scarcity.

CONCLUSION

Management of irrigation for HDP is the most influential factor for yield and quality. To obtain higher yield and better quality fruits in sweet cherry, water management conditions

must be improved by applying irrigation at critical phenological stages. It was observed that the higher levels of irrigation showed superiority in most of the characters including the leaf area, leaf chlorophyll and NPK Levels in sweet cherry. The fruit growth and fruit bud differentiation stages were found to be the most critical stages of irrigation in sweet cherry wherein the water stress can adversely affect the growth and development and also the irrigation at fruit bud differentiation stage may prove beneficial in increasing the subsequent year flowering and fruit set.

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AUTHOR'S CONTRIBUTION

Conceptualization of research - Rehana Javid, W.M. Wani; Designing of the experiments - G.H. Rather, Rehana

Javid; Contribution of experimental materials -W.M. Wani; Execution of field/lab experiments and data collection - Rehana Javid; Analysis of data and interpretation -R. Javid, G.H. Rather, Kounsar Javid; Preparation of the manuscript - Rehana Javid, Kounsar Javid.

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