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Effect of drip water application at sub-surface on grapevine performance– a case study

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Abstract

To minimize the expenditures on irrigation water, efficiency of application of drip water at sub-surface (sub-surface method) was evaluated for one year on a 6.475 ha drip irrigated commercial vineyard at Ghuli Garden at Shohale, in Solapur district of Maharashtra. The vines suffered from moisture stress during the preceding year of the experimentation. There were 21 rainy days; rainfall ranged from 3 to 19 mm per day and the total rainfall was only 183 mm during the entire cropping season under study and received 431.81 mm irrigation. The vineyard had shallow soil with high infiltration rate. The irrigation water from drippers was applied below soil surface at 4 inches depth. In the present study, 3-year-old Y trellis trained and drip irrigated Thompson Seedless vines were used to compare the efficiency of the two methods of irrigation during the year 2003-04. The sub-surface method of irrigation produced higher yield than the surface drip irrigation. The water use efficiency of sub-surface method was 28.91 kg grapes/mm irrigation compared to only 18.88 kg grapes/mm irrigation with surface drip irrigation. The results of this study demonstrated the superiority of sub-surface application of drip irrigation water over surface drip method for grapevines in terms of better yield and less expenditure on irrigation.

Key words: Grape, sub-surface irrigation, moisture stress, yield, water use efficiency

Introduction

Water is the main limiting factor for quality and yield of grapes in arid zones (Fanizza and Riccardi, 1990) and all major grape growing regions of India suffer from water scarcity at one or the other time. At present, no grape variety being grown in India is drought tolerant. Transportation of irrigation water in tankers from distant places during the summers is a common feature in low rainfall areas of Sangli and Solapur regions of Maharashtra, which are the major grape growing areas of the country for raisin production. Presently, the growers in some areas are forced to transport the water in tankers from as long as 40-50 kilometers to keep the vines alive. This increases cost of grape cultivation in these areas.

Considerable soil moisture through evaporation is lost even in surface drip irrigated crops as is evident from the studies of Bonachela *et al.* (2001) and Castel (1994). For maximizing irrigation efficiency the water should be directly applied in the root zone and evaporation losses should be minimized. For this purpose, sub-surface irrigation is an attractive alternative as the availability of organic materials for mulching also becomes scare during the drought years. Sub-surface drip irrigation (SDI) systems offer advantages over other types of irrigation systems for specialty crop production, including water savings and a drier canopy (Steele *et al.*, 1996) and better weed control (Grattan *et al.*, 1988).

Documented information on sub-surface irrigation in grapes and its feasibility under Indian conditions is lacking. In light of the above, the present experiment was carried out to evaluate the performance of sub-surface method of irrigation under different irrigation regimes to reduce the irrigation requirements of the vineyards.

Materials and methods

The experiment was conducted under double pruning and single cropping season for one year on 6.475 ha acre vineyard of Thompson Seedless vines (*Vitis vinifera* L.) raised on Dogridge (*Vitis champini*) rootstocks on a shallow soil on growers field at Ghuli Garden at Shohale, Mohal Solapur. The irrigation water from water drippers was applied below soil surface at 10 cm depth with the help of micro-tube attached to emitters through a 10.2cm long piece of 16 mm drip lateral to avoid the blocking of micro tube. Before the start of the experiment, the vines were raised under uniform management conditions till the framework was developed on Y trellis. Each experimental plot consisted of one-acre area. The total rainfall was 195 mm in the entire cropping season. During the fruiting season the rainfall was only 25 mm. The treatments were imposed after foundation pruning in April 2003 and crop was harvested in April 2004. The vines were pruned in the month of October for fruit pruning. The experimental yield was calculated by multiplying average bunch weight and bunch number per vine. Only a maximum of 40 bunches per vine were retained after 10 days of emergence of bunches. Except method of irrigation all other cultural practices were common. The data was subjected to students' 't' test for comparing treatments.

Results and discussion

The data with respect to yield and yield attributes are given in Table 1 and 2. The yield obtained with the applied quantity of irrigation water was 12.49 t ha^{-1} in case of sub-surface method whereas in case of surface drip it was only 8.16 t ha^{-1}. The higher yield could be attributed to higher bunch weight and lesser drying of bunches under sub-surface irrigation. The moisture stress at pre-bloom stage resulted in bunch drying. This effect was more

severe in case of surface method of irrigation as is evident from bunch number at harvest under the two methods of irrigation although initially equal number of bunches were maintained.

Table 1. Effect of sub-surface irrigation on the performance of Thompson Seedless vines grafted on Dogridge rootstock during 2003-2004

Plot number	Yield (t ha^{-1})		Water use efficiency (kg yield mm^{-1} irrigation)	
	Surface	Sub-surface	Surface	Sub-surface
1	7.29	12.61	16.89	29.20
2	7.74	13.01	17.92	30.12
3	8.65	12.56	20.04	29.09
4	8.78	11.87	20.33	27.48
5	8.95	11.62	20.73	26.91
6	7.37	13.13	17.06	30.40
7	8.06	13.03	18.67	30.18
8	8.41	12.12	19.47	28.06
Mean	8.16	12.49	18.89	28.93
't' value	-14.31		-14.29	

Table 2. Effect of method of irrigation on bunch weight, T.S.S. and bunch number

Plot number	Bunch weight(g)		TSS (^{o}B)		Bunch number at harvest	
	Surface	Sub-surface	Surface	Sub-surface	Surface	Sub-surface
1	127	176	18.9	18.7	32	40
2	131	191	19.6	19.1	33	38
3	138	216	19.2	20.2	31	37
4	153	190	20.0	19.0	32	40
5	142	166	19.3	19.0	35	39
6	124	192	19.1	20.2	30	38
7	140	186	20.0	19.2	32	39
8	127	182	18.8	18.8	37	37
Mean	135	187	19.4	19.3	32.75	38.50
't' value	-8.41		NS		-6.3	

The lower bunch weight in case of surface method has been attributed partly to more incidence of bunch drying due to moisture stress at pre-bloom stage. There were no significant differences in TSS content. The higher water use efficiency was calculated by dividing the yield (kg/ha) by total quantity of irrigation (mm/ha) applied. The water use efficiency was also significantly higher in case of sub-surface drip irrigation method. The superiority of sub-surface irrigation over conventional surface drip is attributed partly to reduction in soil evaporation as a result of application of water at depth directly in the root zone and partly to better moisture distribution in root zone. Moisture distribution under sub-surface drip irrigation is better adjusted to the root pattern in order to counteract osmotic effects of the soil salinity in comparison to conventional drip irrigation (Oron *et al.,* 2002). Evaporation from the emitter zones in drip irrigated olive orchards ranged from 4 to 12% for a mature (36% ground cover) and from 18 to 43% of ET for a young orchard (5% ground cover), depending on the fraction of soil surface wetted by the emitters (Bonachela *et al.,* 2001). Soil evaporation in clementine tree orchards (cv. Clementina de Nules) subjected to differential drip-irrigation ranged from about 50% of evapo-transpiration in months with frequent rainfall to 8-30% in rainless months (Castel, 1994). Sub-surface micro-irrigation technique using clay pipes was particularly effective in improving yields, crop quality and water use efficiency for a range of crops grown under different climatic conditions (Batchelor *et al.,* 1997). The superiority of sub-surface method of irrigation using different technologies in different crops has also been demonstrated by several workers (Litvinov and Shevchenko, 1978; Lyannoi *et al.*, 1982; Matouk *et al.*, 2000; Novotny *et al.*, 1982; Wunderer and Schmuckenschlager, 1990; Sriniwas, 1996 and Oron *et al.,* 2002). Good results were also obtained with sub-surface irrigation when irrigation was carried out using poor quality irrigation water (Batchelor *et al.*, 1997).

The results of the present investigation showed that sub-surface irrigation is superior to surface method both in terms of higher yield, water use efficiency and bunch weight. The method does not require any major changes in the already laid down surface drip system. Further, the weed incidence is reduced. Also the application of chemicals is not required to prevent the entry of roots into the emitter/drippers. Considering the fruit yield, bunch weight and water use efficiency, sub-surface method of irrigation is recommended for better economic returns.

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References

Batchelor, C., C. Lovell and M. Murata, 1997. Simple micro-irrigation techniques for improving irrigation efficiency on vegetable gardens. *Agricultural Water Management,* 32(1): 37-48

Bonachela, S., F. Orgaz, F.J. Villalobos and E. Fereres, 2001. Soil evaporation from drip-irrigated olive orchards. *Irrigation Science,* 20(2): 65-71

Castel, J.R. 1994. Response of young clementine citrus trees to drip irrigation. I. Irrigation amount and number of drippers. *Journal of Horticultural Science* 69(3): 481-9.

Fanizza, A. and I. Riccardi, 1990. Influence of drought stress on shoot, leaf growth, leaf water potential, stomatal resistance in vine grape genotypes. *Vitis* (special issue): 371-381.

Grattan, S.R., L.J. Schwankl and W.T. Lanini, 1988. Weed control by sub-surface drip irrigation. *California Agriculture,* 42(3): 22-4.

Litvinov, P.I. and Shevchenko, 1978. The advantages of sub-surface and drip irrigation. Soil moisture and the productivity of grapevines irrigated by various means. *Vestnik Sel'skokhozyaistvennoi Nauki Moskva,* 1: 75-82

Lyannoi, A.D., Polyakov-VI and Shevchenko-IV, 1982. Effectiveness of different irrigation methods in vineyards. *Sadovodstvo Vinogradarstvo I Vinodelie Moldavii,* No.5: 43-5.

Matouk, A.M., A.M. El Gindy, M.A. El Adl and M.Y. Bondok, 2000. Grape yield response to sub-surface drip irrigation in old valley. *Egyptian Journal of Agricultural Research,* 78(3): 1411-33

Novotny, M. and A. Klopcek, 1982. A new system of sub-surface irrigation for fruit trees. *Archiv fur Gartenbau,* 30(3): 147-53.

Oron, G., Y. DeMalach, L. Gillerman, I. David and S. Lurie, 2002. Effect of water salinity and irrigation technology on yield and quality of pears. *Biosystems Engineering,* 81(2): 237-47

Steele, D.D., R.G. Greenland and B.L. Gregor, 1996. Sub-surface drip irrigation systems for specialty crop production in North Dakota. *Applied Engineering in Agriculture,* 12(6): 671-679.

Srinivas, K. 1996. Plant water relations, yield, and water use of papaya (*Carica papaya* L.) at different evaporation-replenishment rates under drip irrigation. *Tropical Agriculture,* 73(4): 264-9.

Wunderer, W. and J. Schmuckenschlager, 1990. Results of subsoil and trickle irrigation of vines over several years. *Mitteilungen Klosterneuburg Rebe und Wein Obstbau und Fruchteverwertung,* 40(3): 105-8.