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Evaluation of drip irrigation to *kinnow* in south–west Punjab

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Abstract

Kinnow is a major fruit crop in southwest Punjab, mainly canal irrigated, as the ground water is brackish. The inadequacy of the canal water warrants the use of the improved methods of irrigation including the drip system. Field experiments to evaluate drip and basin system versus basin were laid out in quadruplicate with a unit of five trees per replication and three levels of irrigation 35, 55, 75 per cent of pan evaporation. Drip system saved similar amount of water under all levels of irrigation allowing 142% net additional area irrigable on replacing basin irrigation.

Drip irrigation increased the water content in the wetted zone, which increased the rooting density. Use of sodic water for over 2.5 years increased the soil pH and the electrical conductivity. The method could not become popular for lack of field verification of experimental results. Field verification of productive orchards drip irrigated from the beginning supported the experimental data. Thus the amount of water to be applied to *kinnow* through drip irrigation has been recommended. The recommendation is likely to increase the orchard area under drip system in the region.

Key words: *Drip irrigation, pipe irrigation, root density, soil moisture profile, soil salinity*

Introduction

Flooding is a common practice for irrigating field crop and orchards in the state. Flooding not only leads to the wastage of the precious irrigation water through conveyance and distribution, but also attracts fungal diseases in fruit plants. In southwest Punjab, surface water resources are inadequate and the ground water is brackish. There has been long felt need to change the prevalent method of flooding basins around fruit plants to cover larger areas with the available water. The drip irrigation system has a great potential to use water judiciously and efficiently along with improvement in the crop yields and its quality (Goldberg and Schumeli, 1969, Nakayama and Buchs, 1986, Sivanappan 1992, Annant Kumar and Bojappa, 1994). Though efforts on introduction of technology in the state was initiated in the early eighties, the benefits of the technology in terms of water and fertilizer saving could not be fully exploited because of a lack of technical know-how/ advisory system and uncertainties associated with canal water / power supply in the region (Singh, 2003). A study was therefore conducted to compare drip/pipe and basin method of irrigation in water saving, scheduling irrigation to *kinnow* and its effects on soil parameters.

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Materials and methods

The drip, pipe and basin irrigation systems were laid out in 1983 in quadruplicate, with a unit of five *kinnow* plants per replication with three levels of irrigation viz. 35, 55, 75 per cent of pan evaporation and two levels of water quality viz. canal water and RSC 6 me/l and EC 1.5 dS m^{-1}, representative of the region, arranged in a randomized block design. The canal water was applied periodically stored in a tank and pumped as per requirements of different treatments. The test water was artificially prepared every day during summer. The soil was non-saline, non-sodic, sandy loam, low in organic carbon and phosphorus and high in potash. The water requirement was worked out in liter per day (lpd) following (Doorenbos and Pruit, 1975).

Water required (lpd) = Pan coefficient X crop coefficient X Evaporation (mm/day) X Spread of the tree $m^2 \div$ application efficiency (%)

The evaluation of the method was done during 1993-94. The growth and yield parameters in the experiment have already been detailed and discussed by Dhindwal *et al* 1999. The soil moisture content was determined thermo gravimetrically with depth in 15 cm to 30 cm increments upto 180 cm depth in the center and periphery of both the basin and the drip irrigated volume. Likewise the rooting density was measured by sampling in the center (Drip 1), periphery (Drip 2) and between the drippers (Drip 3). In case of basin irrigation the measurements were made along the stem (Basin 1), mid of the basin (Basin 2) and the periphery of the basin (Basin 3). The variation of drip discharge was measured for known periods on farmers' fields. The pH and EC were measured in the center and periphery of the drip irrigated volume at different depths.

Results and discussion

Water applied/saved

The data pertaining to the water saved by drip, and pipe irrigation systems as compared to that under flood irrigation are shown in table 1. It is evident that irrigation water requirement, during the ninth year, for April 15-30 increased from 30 lpd at 35% Pan-E to 64 lpd at 75% Pan-E. Further, it also increased the water saving from 138 thousand liters to 295 thousand liters per hectare if irrigated by pipe/drip system. The water applied and the water saved during the 10th and 11th year corresponded the open pan evaporation fluctuations with the season. Over the three years, the water applied was 16.6, 24.1 and 35.1 thousand liters per plant under 35, 55 and 75 per cent pan evaporation, respectively. As compared to 18395 liters under 100% Pan-E flooding, the drip/pipe system saved 6395.10060,13705 thousands liters ha^{-1}

The results show that drip irrigation saves, nearly 60% water allowing irrigation of 142% additional area. But the drip system may not perform equally well under field conditions. To check this a survey was conducted in the orchards with working drip systems wherein the measured discharge of the drippers (Table 2) was usually found to be lower than that prescribed by the manufacturing company. This was due to inadequate pressure, choked filters and/or choked drippers. It emphasizes the need for proper maintenance of the drip system for which the requisite instructions have been approved for inclusion in the package of practices for fruit crops of Punjab.

Soil moisture distribution

The soil moisture in the profile under basin and drip irrigation is shown in fig. 1. The data revealed that the moisture content at the periphery of the basin could be 1.4% higher in 0-90 cm and 5.3% higher in 90-180 cm depth. In case of drip system, the water content in the center of the bulb is higher than at the periphery and further higher than at the periphery of the basin upto 120 cm depth. This variation in moisture content is due to tendency of water to move downwards more than the laterally. Blaine *et al* (2003) reported similar observations.

Root distribution

The data in figures 2 and 3 revealed that more of roots concentrate in the center of the area wetted by the

Table 1. Mean open pan evaporation, water applied per tree per day and water saved per hectare with pipe and drip system at different irrigation levels

Age (Yrs)	Period	Pan-E, mm/day	Water (000 L) Flooding at 100% Pan-E	Water applied, litre/day/plant Drip/pipe irrigation			Water saved (000L) Drip/pipe irrigation		
				35	55	75	35	55	75
9									
	Apr 15-30	10.5	420	30	47	64	138	218	295
10									
	Dec 1-15	2.2	123	6	10	13	43	65	88
	May 16-31	1.6	673	45	71	96	225	350	478
11									
	Dec 1-15	2.1	22	12	19	25	75	118	160
	May 1-15	8.7	653	46	72	98	215	338	463
	Sep 15-30	3.5	263	18	29	49	88	138	188
	Jan1, 93- Sep30, 95	4464	18395	41.5	60.3	87.8	6395	10061	13705

Table 2. Comparison of specified and measured discharge of the emitters on farmers' fields

Farmer	Discharge, litre/hour	
	Specified	Measured
S. Ranbir Singh	8.0	4.7
S. Sukhpal Singh	14.0	6.0
Sh. Ramesh Setia	8.0	5.3
Sh. Pradeep Dawra	8.0	4.1

drips especially 0-60 cm depth. Further root concentration along the periphery and between the drips decreases successfully. More rooting is encouraged under irrigation at 75% of pan evaporation than with 35% of pan evaporation. Under basin system, the rooting density decreases away from the plant, though with 35% of evaporation, this is more in the middle of the basin. As more of roots concentrate in the drip irrigated volume, which remains continually wet, they are able to meet the water requirements of the plants

Soil salinity

A comparison of the pH and the electrical conductivity of the soil under drip irrigation with fresh and saline water is given in figures 4 and 5 for pH & 6 and 7 for electrical conductivity (EC). The use of saline water raised both the pH and the EC of the soil. The pH was raised to the marginal value of 9.3, but the EC value was still normal. Similar observations were also reported by Blaine *et al* (2003), Charles *et al* (2003) and Choi and Suarez (2004).

One of the apprehensions in popularizing the drip irrigation system has been that the root system of the trees under the system may be different, which may not be productive and economic. The survey further revealed that the ground cover of *kinnow* trees, drip irrigated from the beginning, at full maturity is only 50% instead of 70%, which was presumed earlier to work out the water requirement (Doorenbos and Pruit, 1975). Similarly, under limited water conditions, farmers were supplying only 40-50 liters water per day per plant without any adverse effect on growth though their yield was effected some what. In support of the rooting density observation in the study, the data in table 3 reveals that the production level of drip irrigated *kinnow* trees has been satisfactory. On the basis of this information, the water requirement (Table 4) for

Table 3. Actual water applied to drip irrigated kinnow and returns per hectare

Farmer	Plant age, yrs	Water applied, litrer/plant/day	Returns per acre, Rupees
S. Ranbir Singh	9	31	-
S. Bhagwant Singh	6	55	-
S. Ranjit Singh	10	45	-
S. Sukhpal Singh	15	56	1,25,000
S. Robinder Singh	16	80-160	2,00,000
Sh. Somnath	3	20	-
Sh. Ramesh Setia	6	32	1,00,000
Sh. Rai Singh	5	57	1,00,000
Sh. Pradeep Dawra	8	82	>2,00,000

Table 4. Amount of water (litre/day/plant) to be applied to *kinnow* through drip irrigation

Month	Age of the plant (Yrs)				
	0-2	3-4	5-6	7-8	9 and above
Jan	3	6	9	12	15
Feb	6	12	18	24	30
Mar	9	18	27	36	45
Apr	13	26	39	52	65
May	16	32	48	64	80
Jun	17	34	51	68	85
Jul	13	26	39	52	65
Aug	12	24	36	48	60
Sep	11	22	33	44	55
Oct	8	16	24	32	40
Nov	5	10	15	20	25
Dec	3	6	9	12	15

Note:

1. Follow the instructions for use of drip irrigation system (Singh, *et al* 2005)
2. Amount of irrigation water may vary by 10-15% depending upon the prevailing weather conditions
3. For lifting water from canal storage tank, a booster pump with solar/electric motor of 2 HP will be sufficient for 4 ha *kinnow* orchard. However, for 6 and 10 ha a booster pump with electric motor of 3 and 5 HP will be required for lifting water.
4. In the beginning, 1-2 drippers per plant/tree. For efficient use of water sub lateral loops of the drippers should be used around each plant/tree.

drip irrigation of *kinnow* in the state has been suggested (Singh *et al* 2005). It is hoped that the adoption of these will help increase the area under this technology in the state. Since the pipe system is equally efficient, those with smaller land holding may take up the system initially.

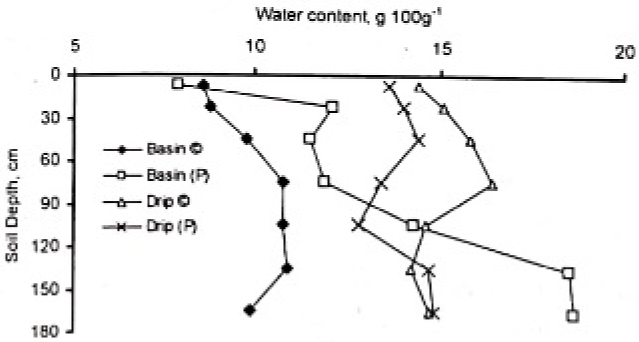

Fig. 1 Soil moisture profile in the centre © and the periphery (P) of basin and drip system at 0.75 Pan-E (May 1993)

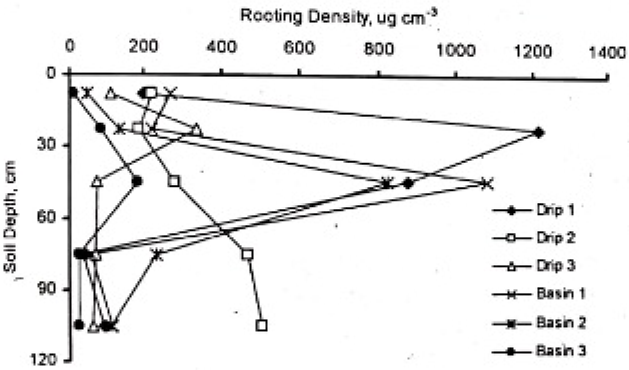

Fig. 2. Rooting density of kinnow at 0.35 Pan-E under drip and basin irrigation

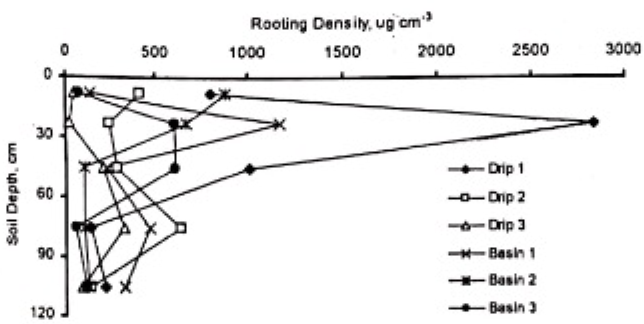

Fig. 3. Rooting density of kinnow at 0.75 Pan-E under drip and basin irrigation

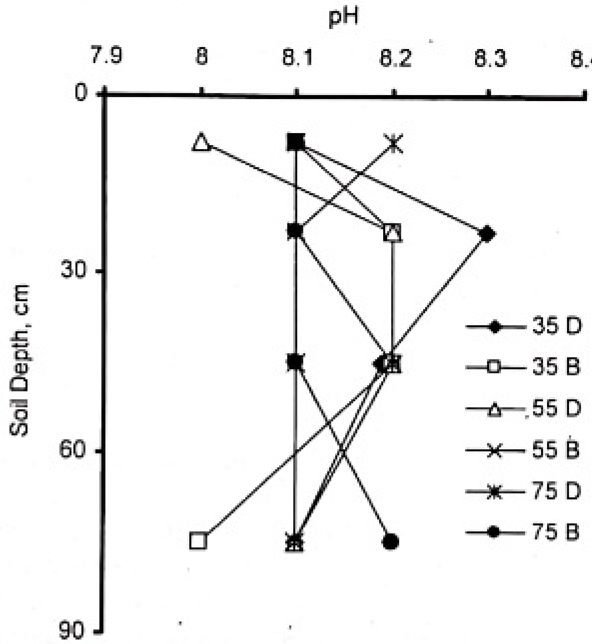

Fig. 4 Soil pH under different levels of irrigation in the centre and periphery of drip irrigated volume

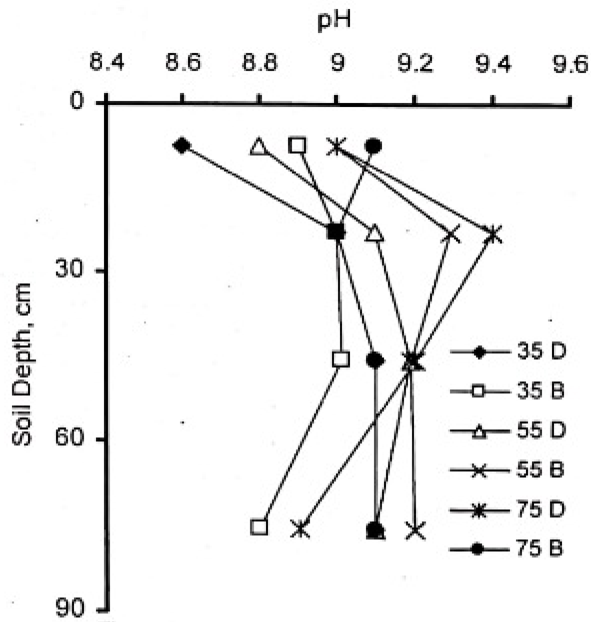

Fig. 5 Soil pH under drip irrigation with saline water, D (s), in the centre and periphery of drip irrigated volume

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