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Indu Bhushan Bhagat
Assistant Professor –cum- Jr.
Scientist, Department of
Irrigation and Drainage
Engineering, College of
Agricultural Engineering, RAU,
Pusa, Samastipur, Bihar, India

BK Yadav
Scientist (KVK Balumath
Latehar), Birsa Agricultural
University, Ranchi, Jharkhand,
India

Performance evaluation of drip irrigated kinnow orchard in South -Western Punjab – A case study

Indu Bhushan Bhagat and BK Yadav

Abstract

Kinnow is the most important fruit crops in south west Punjab. The studies were based on survey conducted at farmer's field and regional climate data besides analysis of actual installation of drip irrigation system. It was estimated that drip system saves about 35-40 per cent irrigation water, and additional area is being cultivated. The water use efficiency in drip irrigation was 5.41 q/cm compared to 2.83 q/cm in surface irrigation method. Cost benefit ratio was found to be 2.27 in drip irrigation compared to 1.39 in case of surface irrigation. The adoption of drip irrigation system has resulted into higher yield, reduction in labour requirements, reduction in weed and pest incidence, saving in irrigation water and better fruit quality. The high initial cost of the system is one of the constraints, but the techno-economical benefits of the system on kinnow crop fully compensate the initial investments.

Keywords: Evaluation, Drip Irrigated, Kinnow Orchard, Punjab

1. Introduction

The South-West region of Punjab is known for kinnow (*Citrus reticulata* Blanco) cultivation which is the most important fruit crop in citrus family. This region is the largest kinnow growing belt in India with nearly 2.6 lac tons of annual production. Kinnow was introduced in 1956, according to data it has leaped from 500 hectares in 1970 to 25645 hectares in 2005-06. The south western Punjab falls under semi-arid irrigated region predominantly occupied by light texture soil with higher concentration of salts. Due to over exploitation of canal water, the problem of water logging and salinity is coming up and creating a serious threat to citrus cultivation in the entire region. Hence, it is imperative to emphasis on efficient utilization of every drop of water for higher and sustainable production.

Micro irrigation is relatively the latest technology developed all over the world has given a new ray of judicious and efficient use of water which has shown a revolution in horticultural and other crop. This system has been practised in about thirty five countries out of which India ranked seventh in terms of acreage. In the world scenario, almost 54 per cent of the drip irrigation is applied to orchard crops with citrus as a major crop. Sudhakar (1993) [9] reported that about 11 million hectares in the country is suitable for drip irrigation. Till now, only 2.8 lakh hectare area (Table 1) is under drip irrigation which is very less compared to its potential (Kumar 1999) [6].

About 1500 hectares have come under this system in Punjab which is very less compared to many states like Maharashtra, Karnataka, Tamil Nadu, Rajasthan etc. The feedback of this technology from user side is mixed, some farmers are operating this system successfully whereas, others are not able to handle it properly due to certain constraints which has been discussed somewhere in this paper. To exploit the full potential of this system, there is an urgent need for an integrated approach and endeavour on the part of the Government, implementing agencies, researchers, manufacturing agencies, extension agencies and farmers for popularizing the technology for efficient use of water and augmented productivity. Taking into consideration of all these factors, an attempt has been made in the present paper to evaluate the economics of drip irrigation in kinnow orchard for highlighting the potential benefits of the system.

2. Methods and Materials

Field studies were conducted under drip and conventional (border) methods of irrigation for kinnow orchard in South-Western region of Punjab which is well known for kinnow production. Three farmers were selected randomly for collection of data on actual cost of installation of drip system, saving in water, saving in labour, pest management, increase in yield and improvement in quality of the fruit. The whole data was compared to conventional method to determine the water use efficiency and benefit cost ratio.

Correspondence

Indu Bhushan Bhagat
Assistant Professor –cum- Jr.
Scientist, Department of
Irrigation and Drainage
Engineering, College of
Agricultural Engineering, RAU,
Pusa, Samastipur, Bihar, India

The economics of drip irrigation was worked out by taking into account the depreciation and interest of capital (Annexure I, II and III). Cost of cultivation was calculated in term of money invested by the farmer for different inputs including labour and energy. However, the cost of irrigation water and electricity to run the system were not included as water and electricity are free of cost in Punjab for agricultural works. Water used was calculated by addition of total water used in centimetre in different months in case of drip system whereas in conventional method, water used was calculated in terms of centimetre per hectare taking one irrigation depth as 9 cm. Similarly, water use efficiency (q/ha) was calculated by dividing total yield by water used. The main objective of the study was to make a comparative study of drip irrigated orchard with respect to water use, water use efficiency and benefit cost (BC) ratio to determine the actual benefits of the system in respect of saving in water, labour requirement, pest incidence and increase in yield and quality. The study will be beneficial for farmers, entrepreneurs, researchers, extension agencies etc. for convincing them for higher profitability with drip irrigation system in a short span of time.

3. Results and Discussion

3.1 Saving of Irrigation water

Irrigation water was most efficiently used through drip irrigation system. It was observed that approximately 35 per cent irrigation water could be saved through the system. Saved water was used for another crops resulting into more area under cultivation which otherwise was uncultivated. The water used and water use efficiency in drip and conventional methods is given in Table 2. It was observed that 42.10 cm (about 35 percent) water was saved in drip system compared to conventional method resulting into higher water use efficiency 5.41 q/cm) which clearly shows the better utilization of available water. The saving in water with the use of drip irrigation has already been documented in literature (Braven 1976 and Kumar 1999) [6].

3.2 Efficient land use pattern

Efficient use of irrigation water by drip irrigation has resulted into saving of water which can further be utilised for other crops. It was observed that when only 60 acres of land (40 acres of orchard and 20 acres of cotton- wheat) which was under cultivation when irrigated with conventional system. With the use of drip irrigation, increase in area under cultivation could increase up to 115 acres (75 acres of orchard and 40 acres of cotton-wheat crop rotation) with the same amount of irrigation water (Table 4). This shows the indirect benefits of the system by increasing the cultivable land which otherwise either kept fallow or cultivation under rain was fed conditions as subsidiary crop since rainfall is very less in this region (less than 700 mm). Similarly Padma Kumari and Sivanappan (1979) [8] also reported that the area under irrigation increased nearly three times with the use of drip system.

3.3 Prevention of pest and Diseases

In conventional method, the border is filled up with water completely creates a higher relative humidity in surrounding atmosphere, which provides suitable condition for break out of the pest and diseases. There are chances of rapid spread of diseases i.e. gummosis and root rot in citrus through flood irrigation. Such type of transmission through irrigation water is prevented in drip irrigation system. In this study, it was

found that attack of pest and disease was very less in the orchard irrigated with drip system compared to conventional method due to better micro climate. The number of fungicide sprays significantly reduced from 7 to 2 in case of drip irrigated orchard as compared to conventional irrigated (Table 4).

3.4 Saving of labour and energy

With the installation of drip irrigation system, there was considerable saving in labour and energy mainly due to less weed growth, crop can be irrigated through drip system at any time only by a single man, reduction in number of sprays etc. (Table 4). Similarly, Gural *et al.*, (1989) [5] reported that the saving of labour charges was to the extent of 25 percent in drip system compared to conventional method.

Application of fertilizers along with water through drip has resulted into saving of costly fertiliser (Benami *et al.*, 1993). Application of nitrogen in the form of urea and phosphorus in the form of phosphoric acid can be given through fertigation within a short time, prevent the wastage of fertilisers which has resulted into better fertiliser use efficiency and ultimately saving in energy. Similarly, Ber Yosef (1977) [1] found urea to be best source of fertiliser through trickle irrigation. Use of orthophosphoric acid as phosphorus for fertilisation was demonstrated by Oneill *et al.*, (1979) [7].

3.5 Mitigating water stress in adverse condition

Water stress at critical stage can cause flower and fruit drop which result into poor bearing. In case of drip irrigation, crop can easily be irrigated in any type of adverse climate conditions i.e. too hot or cold climate, both during day or night and also at high wind velocity. Water application throughout the year in this study is given in Table 3 and it was found that during peak summer when irrigation water is limited, sufficient amount of water can be provided by drip system which otherwise result into water stress in conventional system. This helps in mitigating water stress in drip irrigation system at any point of time and result into normal bearing (less flower drop in May-June and less fruit drop in November-December). Hence, application of water through drip can be managed according to climatic conditions for better and uniform fruit retention. Similarly Dhillon and Singh (1995) [4] also observed that citrus tree is sensitive to water stress during period of rapid growth, flowering and fruit set. Water stress was detrimental to fruit retention and fruit size.

3.6 Improvement in yield and quality

Crop can regulate accordingly with frequent irrigation through drip system. This results into better yield and quality of the fruit. This system also reduce fruit drop due to constant supply of water by mitigating water stress during adverse climatic conditions. Uniform size of fruit is increased and improved its quality. Uniform size (3 grades) of fruit in drip irrigated orchard fetches higher prices compared to non-uniform size (5-6 grade) in conventional irrigated orchard (Table 4). Fruit yield (kg/ plant) was significantly higher (150 kg/plant) in drip irrigated orchard compared to (115 kg/plant) conventional irrigated orchard. Water use efficiency and B:C ratio of all the case studies is given in table which clearly shows the benefits of drip irrigation system. B: C ratio was found to be 2.20, 2.58 and 2.03 respectively in all the three case studies in drip system compared to 1.44, 1.46 and 1.27 respectively in conventional irrigation system. Similarly, Padma Kumari and Sivanappan (1979) [8] and Gural *et al.*,

(1989) ^[5] worked out economics of drip irrigation by taking into account the depreciation and interest of capital and calculated B: C ratio which was significantly higher in drip irrigation system compared to conventional system. The better auction price was obtained in orchard irrigated through drip (Rs.42000-45000/- per acre) which was just double the price obtained in orchard irrigated through conventional irrigated (Rs. 25000-30000/- per acre) mainly due to more bearing with uniform fruit size. Similarly, Kumar (1999) ^[6] also reported 30.6 percent higher yield in kinnow when irrigated with drip system.

3.7 Limitations of drip irrigation system

The area under drip irrigation in South-West Punjab is increasing day by day particularly in orchards. The feedback of this technique from farmers is mixed; some farmers are operating this system quite successfully whereas others are not able to handle this system properly and therefore discarded it. In spite of this, the technology is being able to gain certain amount of acceptability over past few years; there are still a lot of apprehensive in the minds of farmers about it. The major constraints experienced by the farmers and their suggestions are summarised below:

Parameters	Farmer=s experience/constraints	Suggestions
Cost	Initial cost is very high. Small & marginal farmers can not afford it.	Initial cost to be lowered and loan at concessional rate.
Subsidy	Subsidy offered by govt. is different to obtain due to procedural difficulties.	The procedure may be simplified to enable processing of subsidy case within one month.
Clogging	System gets clogged	Provision of efficient filter in the system.
Intercultivation	Difficulties are faced in interculture operations	-
Skilled labour	Non availability of skilled labour	Rural unemployment youth may be provided training in operation and maintenance of the system.
After sale service	Unsatisfactory	Companies should supply manuals indicating common faults and their rectification.
Training	Farmers need training in operation & maintenance by the manufacturers	Companies and extension agencies should impart training for efficient functioning of the system.

Table 1: Area covered under micro irrigation (drip and sprinkler) in India

States	Area (000, ha)		States	Area (000,ha)	
	Drip	Sprinkler		Drip	Sprinkler
Andhra Pradesh	31.60	17.09	Orissa	2.80	0.40
Assam	0.20	90.00	Punjab	1.50	0.20
Gujrat	8.00	27.74	Rajasthan	30.30	47.85
Haryana	1.90	83.60	TamilNadu	34.00	32.13
Karnataka	40.00	41.90	Uttar Pradesh	2.00	7.36
Kerala	6.00	5.80	West Bengal	0.20	120.04
Madhya Pradesh	3.00	149.98	Others	2.00	0.76
Maharashtra	123.00	33.12	Total	286.50	657.97

Table 2: Effect of different irrigation methods on water used, water use efficiency WUE) and B:C ratio in different case studies

Cases	Water used (cm)		WUE (q/cm)		B:C ratio	
	Drip	Surface	Drip	Surface	Drip	Surface
Case 1	82.60	126.00	5.32	2.78	2.20	1.44
Case 2	84.00	124.00	5.71	3.06	2.58	1.46
Case 3	77.02	120.00	5.19	2.66	2.03	1.27
Average	81.21	123.33	5.41	2.83	2.27	1.39

Table 3: Monthly water used and maximum minimum temperature during the year

Month	Water use (cm)		Temperature (BC)	
	Drip	Surface	Maximum	Minimum
January	7.00	9.00	20.10	1.90
February	6.60	9.00	23.30	4.80
March	7.40	9.00	27.40	11.10
April	7.00	9.00	33.20	16.30
May	10.50	18.00	37.60	20.40
June	10.20	18.00	37.50	23.80
July	5.60	9.00	37.20	25.40
August	3.30	9.00	33.50	24.10
September	5.20	9.00	35.30	23.00
October	6.60	9.00	28.00	16.20
November	6.60	9.00	25.20	10.30
December	6.60	9.00	16.20	6.60
Total / Average	82.60	126.00	29.60	15.30

Table 4: Comparative study on different parameters as affected by Drip irrigation system

S. No.	Parameters	Before drip (Conventional)	After drip
1.	land use pattern	Cultivated only 40 acres of citrus orchard (old) 20 acres of cotton- wheat Total 60 acres under cultivation*	40 acres of citrus orchard (old) 35 acres of new orchard 40 acres of cotton-wheat Total 115 acres under cultivation*
2.	Pesticides used	7-9 spray per year in orchard	2-3 sprays per year in orchard
3.	Fertilizer economy	broadcasting (Rs. 2000)	Fertigation (Rs. 1500) (25 % saving in terms of money)
4.	Energy saving a) Manual b)Tractor operated c)electricity	3 manual hoeing under plant canopy @ Rs. 4/plant(110 plant/acre) a)10 hoeing in between plants b)Tractor operated pump for spray Nil	One hoeing under plant canopy @ Rs. 4/plant(110 plant/acre) 3 hoeing by tractor electricity operated drip system (Electricity free)
5.	Yield and Quality	1) 800-1000 fruits/plant 2) non uniform size (5-6 grades) 3) more dropping of fruit 4) 110-115 kg fruit/plant 5) Rs. 25000-30000/acre (auction price)**	1) 800-100 fruits/plant 2) uniform size(3 grades) 3) dropping is less 4) 150-160 kg fruit/plant Rs. 42000-45000/acre (auction price)**

Annexure-I**Economics of Kinnow Orchard under Drip Irrigation System**

- Name of Farmer : Sh. Rai Singh Bhadu
- Address : Viryam Khera, Abohar (Pb.)
- Area : 30.0 ha.
- Source of water : Canal (Pucca tank- 160 x 160 x 14 ft.)

S. No.	Particulars	Drip System (Rs.)	Surface (Rs.)
1.	a. Life (Years)	10	-
	b. Fixed Cost Per Hectare	Rs.11600.00	-
	c. Depreciation @ 10% P.A.	Rs.1160.00	-
	d. Interest @ 12% P.A.	Rs.1392.00	-
	e. Repairs & Maintenance @ 5% P.A.	Rs.580.00	-
	f. Total (b+c+d)	Rs.14732.00	-
2.	Cost of cultivation (Rs./ha.)	18050.00	30750.00
3.	Seasonal Total Cost (1e+2)Rs./ha.	32782.00	30750.00
4.	Water used in (cm)	82.60	126.00
5.	Yield of produce (t/ha.)	440.00	350.00
6.	Income From Produce (5x6) I Rs.	105000.00	75000.00
7.	Net Seasonal Income (6-3)in Rs.	72218.00	44250.00
8.	Benefit Cost Ratio (6/3)	2.20	1.44
9.	WUE (q/cm)	5.32	2.78

Annexure-II**Economics of Kinnow Orchard under Drip Irrigation System**

- Name of Farmer : Sh. Sahib Ram Siag
- Address : Dinga Wali, Abohar (Pb.)
- Area : 6.0 ha.
- Source of water : Canal (Semi Pucca tank-70 x 70 x 14 ft)

S. No.	Particulars	Drip System	Surface
1.	Fixed Cost Per Hectare	Rs.13500.00	-
	a. Life (Years)	10	-
	b. Depreciation @ 10% P.A.	Rs.1350.00	-
	c. Interest @ 12% P.A.	Rs.1620.00	-
	d. Repaires & Maintenance @ 5% P.A.	Rs.675.00	-
	e. Total (b+c+d)	17145.00	-
2.	Cost of cultivation (Rs./ha.)	20550.00	28500.00
3.	Seasonal Total Cost (1e+2)Rs./ha.	37695.00	28500.00
4.	Water used in (cm)	84.00	124.00
5.	Yield of produce (t/ha.)	480.00	380.00
6.	Income From Produce (5x6) I Rs.	135000.00	70000.00
7.	Net Seasonal Income (6-3)in Rs.	97305.00	41500.00
8.	Benefit Cost Ratio (6/3)	2.58	1.46
9.	WUE (q/cm)	5.71	3.06

Annexure-III**Economics of Kinnow Orchard under Drip Irrigation System**

- Name of Farmer : Sh. Surjit Kumar
- Address : Sher Garh, Abohar (Pb.)
- Area : 8.0 ha.
- Source of water : Canal (Pucca tank- 100 x 100 x 10 ft.)

S. No.	Particulars	Drip System Rs.	Surface Rs.
	Fixed Cost Per Hectare	12500.00	-
1.	a. Life (Years)	10	-
	b. Depreciation @ 10% P.A.	1250.00	-
	c. Interest @ 12% P.A.	1500.00	-
	d. Repaires & Maintenance @ 5% P.A.	625.00	-
	e. Total (b+c+d)	15875.00	-
2.	Cost of cultivation (Rs. /ha.)	14650.00	26400.00
3.	Seasonal Total Cost (1e+2) Rs./ha.	30525.00	26400.00
4.	Water used in (cm)	77.02	120.00
5.	Yield of produce (t/ha.)	400.00	320.00
6.	Income From Produce (5x6) I Rs.	92,500.00	60,000.00
7.	Net Seasonal Income (6-3)in Rs.	61975.00	33,600.00
8.	Benefit Cost Ratio (6/3)	2.03	1.27
9.	WUE (q/cm)	5.19	2.66

4. Conclusion

From overall study of drip irrigation system on various factors, it can be concluded that however, the high cost of this system, it is economically viable after few years as it increases the yield and improve quality of fruit which fetches considerably higher prices besides reduces the cost of cultivation by reduction in labour charges, energy and saving in water which helps in further increasing area under cultivation ultimately increasing the profitability.

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